Appendix 33

Meadowbank and Whale Tail 2022 Core Receiving Environment Monitoring Program Report

2022 Core Receiving Environment Monitoring Program

Meadowbank Complex

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EXECUTIVE SUMMARY

The Core Receiving Environment Monitoring Program (CREMP) for the Meadowbank Complex focuses on identifying changes in water quality, sediment chemistry, and aquatic communities—both primary producers (phytoplankton) and secondary producers (benthic invertebrate community)—that may be associated with mining activities. Changes are identified using a temporal/spatial trend assessment that detects changes or differences in key measures over time and/or among locations. The trend assessment includes the use of early warning *triggers* and action *thresholds* to support management decisions within the Aquatic Effects Management Program (AEMP). The AEMP is the overarching 'umbrella' program that integrates results of individual, but related, monitoring programs for the purpose of implementing management actions before unacceptable adverse impacts occur to aquatic life.

Meadowbank

The 2022 CREMP results for the Meadowbank study area are presented below and summarized in **Table ES-1**.

Water Quality (Limnology & Water Chemistry)

Water quality monitoring for limnology and chemistry was completed in March, May, July, August, and September 2022 according to the CREMP study design. Limnology profiles were taken at the Near-Field (NF) areas—Third Portage Lake (TPN, TPE), Second Portage Lake (SP), and Wally Lake (WAL)—in the winter months when ice conditions were safe (January, February, April, November, and December), to verify the absence of anomalous changes in water quality (e.g., conductivity) attributable to site-related activities.

The NF areas close to the mine have higher concentrations of dissolved solids and constituent major ions such as calcium and magnesium compared to baseline/reference conditions. This observation is consistent with previous findings. While these changes to water quality are mine-related, the observed concentrations are still relatively low and there is no evidence to suggest concentrations are increasing year-over-year or that the observed concentrations would result in adverse ecological effects. Consistent with previous reporting cycles, there were no trigger exceedances in 2022 for any water quality parameters with CCME water quality guidelines (WQG), including metals. In the context of the assessment framework outlined in the Final Environmental Impact Statement (FEIS), the magnitude of potential effect on water quality in each of the near-field lakes in 2022 was considered *low* (i.e., less than 1X the CCME WQGs) and consistent with the original predictions. **Routine water quality monitoring is recommended for 2023.**

Long-term Trend Analysis – In addition to the routine water quality assessment summarized above, a more detailed assessment of temporal changes for a subset of parameters in NF areas was completed for the first time in 2021 using the long-term Meadowbank water quality dataset. The analysis used a mixed-effects model approach focusing on physical/ionic parameters that have consistently increased over time relative to control and exceeded triggers and/or FEIS predictions. These parameters included conductivity, water hardness, calcium, magnesium, total alkalinity, and total dissolved solids (TDS). The routine Before-After-Control-Impact (BACI) analysis is designed to test for changes in parameters for a particular year relative to baseline/reference conditions, however, it is not designed to test for longer-term trends in key parameters over time. The mixed-effects trend analysis was developed in 2021 to provide a statistically supported understanding of long-term trends in key water chemistry parameters.

The 2021 trend analysis results showed that there is strong evidence that differences in physical/ionic parameters relative to INUG have been stable since 2014 at TPN, TPE and SP, though there was more variability in year-to-year differences at SP between 2014 and 2021. Since this analysis focused on long-term trends, it is not intended to be repeated annually. Rather, the BACI will continue to be used routinely to test for changes in a particular year relative to baseline/reference conditions.

Phytoplankton Community

Phytoplankton community sampling was completed at the same time as the water chemistry sampling program in 2022, though May samples were archived as per the 2022 *CREMP Plan Update*. The phytoplankton community showed no significant changes relative to baseline for biomass or richness in 2022, though the effect sizes for total biomass at TPN, SP, and WAL were above the 20% trigger. The apparent increase in biomass is not associated with higher nutrient concentrations, which implies the increase observed in 2022 may be natural variability. Ultimately, the long-term phytoplankton monitoring data demonstrates that mining operations have not contributed to pervasive changes in primary productivity among the NF areas. **The trends in phytoplankton biomass and richness will be reviewed again in 2023.**

Sediment Chemistry

Sediment grab sampling was conducted at the NF and reference areas to support the benthic invertebrate community monitoring component of the CREMP. Sediment was analyzed for grain size and total organic carbon. The remaining sediment was archived for chemistry. The samples collected from INUG and PDL had high moisture content, resulting in not enough sediment remaining for determining grain size after sediment chemistry analysis. While historically there have been no changes in grain size in these areas, additional sediment will be collected for each sample in 2023 to mitigate this from happening in the future. **The next sediment coring program will be conducted in August 2023 to review**

trends in chemistry. In addition, grab samples will be collected to support the benthic invertebrate community sampling program.

Benthos Community

There were no statistically significant changes to the benthic invertebrate community at Meadowbank relative to baseline/reference conditions identified by the 2022 BACI assessment, except for an increase in taxa richness at SP during the 2019-2022 time period. The number of taxa at SP were within the range of reference area INUG in 2022. **The trends in benthos abundance and richness will be reviewed again in 2023.**

Whale Tail

The 2022 CREMP results for the Whale Tail study area are presented below and summarized in **Table ES-2**.

Overview of the 2022 Whale Tail CREMP

Data analysis for Whale Tail study areas follows the same methods and framework as Meadowbank. 2022 was the fourth full year where most Whale Tail study area lakes were classified as *impact*. Whale Tail South (WTS) and Mammoth Lake (MAM) switched from *control* to *impact* in 2018 coinciding with construction of the Whale Tail Dike. The status of Lake A20, Lake A76, and Lake DS1 switched to *impact* in January 2019. Nemo Lake (NEM) transitioned after July 2019.

Water Quality (Limnology & Water Chemistry)

Surface water monitoring for limnology and water chemistry were completed in March, May, July, August, and September according to the CREMP study design for the Whale Tail study area. Supplemental limnology profiles were taken at Whale Tail South (WTS), Mammoth Lake (MAM), Nemo Lake (NEM), and Lake A20 in select winter months to verify that water quality is broadly within the range of expected values, particularly for conductivity and dissolved oxygen.

Changes in water quality in lakes downstream from the mine were predicted to occur during construction and operations. Water quality within the Whale Tail study area lakes exhibited fairly stable conditions during the baseline period. Consequently, when interpreting time series plots to examine spatial-temporal trends in water quality, the *signal* of development-related inputs was expected to be easily observed relative to the low *noise* levels of the baseline period. The following parameters have increased relative to baseline/reference conditions:

- *Ionic Compounds* – total dissolved solids and constituent ions such as calcium, magnesium, potassium, and sodium were elevated in the NF lakes and downstream of MAM to Lake A76.

- *Nutrients* – total Kjeldahl nitrogen, total phosphorus, total organic carbon, and dissolved organic carbon were elevated at NF areas WTS, MAM, and A20. The elevated parameters are likely the result of inputs from flooded terrestrial habitats following impoundment, dewatering inputs from WTN, and the joining of WTS to A20.
- *Metals/metalloids* – total and dissolved lithium was elevated at MAM and total titanium was elevated at WTS. These parameters do not have an effects-based guideline for protection of freshwater aquatic life.

Of the parameters with trigger exceedances, FEIS predictions were exceeded for total phosphorus at WTS and total alkalinity, TDS, total lithium, and several ionic compounds at WTS and MAM in one or more sampling events. Importantly, the absolute concentrations of these parameters remain *low*. Total phosphorus and arsenic at WTS and MAM are within the normal operating ranges and Level 0 water management strategy is in effect in 2023 as per the Adaptive Management Plan. **Routine water quality monitoring will continue in 2023 to track emerging spatial and temporal trends.**

Phytoplankton Community

Phytoplankton community sampling was completed at the same time as the water chemistry sampling program in 2022. Phytoplankton communities vary naturally throughout the year in total biomass (and density) and community composition (taxa richness). The primary stressors for the phytoplankton community include nutrients and metals in surface contact water discharged to MAM and WTS. Nutrient loading can manifest as an increase in total biomass or a change in community structure, while increasing metals concentrations would be expected to cause lower biomass and taxa diversity.

Increased total biomass was reported at WTS (77%), MAM (32%), A20 (128%), A76 (73%), and NEM (43%) relative to control/baseline conditions. None of the changes in total biomass were statistically significant ($p > 0.1$). No significant changes in the taxonomic richness of the phytoplankton community were observed in 2022. **Phytoplankton community monitoring is scheduled for 2023 according to the CREMP Plan.**

Sediment Chemistry

Concentrations of metals were similar to results from the baseline period and early operations. The sediment samples collected at Lake A76 in August 2022 had high water content and therefore grain size analysis could not be completed. A larger sediment sample will be collected in 2023 to mitigate this from happening again. **The next sediment coring program will be conducted in August 2023 to review trends in chemistry. In addition, grab samples will be collected to support the benthic invertebrate community sampling program.**

Benthos Community

Benthic invertebrate (benthos) community structure (taxa richness) and function (abundance) in the Whale Tail study area lakes is typical of northern headwaters lakes in the region (i.e., relatively low abundance and few taxa). Although total abundance tends to be low, within-area variability can be substantial. Taxa richness, unlike abundance, is considerably less variable, both temporally (i.e., inter-annually) and spatially (i.e., among the different lakes). There was an apparent increase in taxa richness and total biomass at MAM and NEM, but not at other NF and MF area lakes in 2022, suggesting the increases may be due to natural variability rather than mining influence. All other study areas were comparable with baseline/reference conditions. **Benthos community monitoring will be conducted in 2023 according to the CREMP Plan.**

Baker Lake

CREMP monitoring at Baker Lake started in 2008. Important mine-related activities in Baker Lake include barge/shipping traffic and general land-based activities associated with the tank farm area. The number of barge shipments in 2022 were slightly less than 2021 which reported the highest shipments since monitoring began in 2008. In 2022, there was turbid water runoff flowing from the Marshalling Facilities that reached the shore of Baker Lake. Silt fences and wood-chip booms were utilized to intercept flows. There were no elevated TSS concentrations observed in the Baker Lake sampling areas in subsequent sampling events.

Water Quality

Water quality sampling was conducted at two NF areas (BBD, BPJ) and one FF area (BAP) in Baker Lake in July, August, and September 2022. The mean concentrations for total and dissolved organic carbon water exceeded their respective triggers in 2022 at all three areas. The BACI showed no statistically significant increase above baseline/reference for BBD or BPJ. There was no evidence of any barge-related impacts to water quality at *impact* areas in Baker Lake.

Concentrations measured in water at Baker Lake in 2022 were comparable to results reported in previous annual monitoring reports. **Monitoring in 2023 will follow the scope and schedule of the CREMP Plan.**

Phytoplankton Community

There was an apparent increase in total biomass at impact areas BPJ and BBD, however this may be attributed to the decrease observed at reference area BAP. Overall, the phytoplankton community in Baker Lake was similar to previous years and has not exhibited any changes attributable to Agnico Eagle’s activities in Baker Lake. **Monitoring in 2023 will follow the scope and schedule of the CREMP Plan.**

Sediment Chemistry and Benthic Community

Sediment chemistry and benthos sampling at Baker Lake was not completed in 2022 as per the revised *CREMP Plan Update* (Azimuth, 2022b). Sediment and benthos sampling will now occur on a three-year cycle beginning in August 2023 which coincides with the CREMP sediment coring program and EEM cycle. Changes in sediment chemistry data and the benthic community will be evaluated in 2023. **Sediment chemistry and benthos community monitoring in 2023 will follow the CREMP Plan.**

Table ES-1. Summary of key findings from the 2022 Meadowbank CREMP.

Notes:
1. Temporal and spatial trends are outlined for monitoring components and variables that exceeded trigger or effects-based thresholds (i.e., apparent change from baseline).
2. Spatial scale ratings are: localized = small area within the lake/area; widespread = basin to whole lake.
3. Causality ratings are: low = no evidence of a mine-related source; moderate = some likelihood of a mine-related source; high = the source of the change is likely mine-related.

Monitoring Component (and report section)	**Variable**	**Summary**	**Temporal and Spatial Trend Assessment**[1, 2, 3]	**Annual CREMP Results Compared to FEIS Predictions** (Cumberland, 2005)
Limnology Section 4.2	Temperature and Dissolved Oxygen	The limnology profiles collected in 2022 indicated dissolved oxygen and temperature readings are consistent with range of conditions typical of previous monitoring cycles.	There is no evidence to suggest seasonal fluctuation in dissolved oxygen and temperature among the NF study area lakes is attributed to mining site-related activities.	No predictions in the FEIS.
	Conductivity	The observations of minor stratification in early year monitoring events followed the pattern from previous years of being well mixed and unstratified by July.	The spatial and temporal trends appear to be consistent with previous years.	No predictions in the FEIS.
Water Chemistry Section 4.3	Conventional Parameters and Major Ions	Conductivity, hardness, TDS, alkalinity, and major cations exceeded their trigger values at one or more NF areas in 2022. These results are consistent with recent years. The trigger value for these parameters is set at the 95th percentile of concentrations measured during the baseline period. There are no effects-based thresholds for most of these parameters.	**Spatial scale – widespread**; concentrations have increased lake-wide in Third Portage from TPE to TPN and between lakes (SP and WAL). **Temporal trend – stable**; concentrations are elevated relative to the baseline period according to the BACI analysis, no evidence of-year-over-year increases (i.e., concentrations in 2022 are similar to 2021, 2020, 2019, etc.) **Causality – high**; the spatial pattern and temporal trend of increasing concentrations in the *after* period is plausibly attributed to activities at the mine, though concentrations are consistently below effects-based thresholds for the few parameters with thresholds (**Figure 4-7**, **Figure 4-8**).	Water quality constituents without effects-based CCME thresholds were not incorporated in the magnitude ratings for assigning effects in the FEIS; however, following the intent of the FEIS magnitude ratings, constituents exceeding baseline but below concentrations associated with adverse effects were considered consistent with a *low* magnitude rating.
	Nutrients	A minor trigger exceedance of reactive silica at WAL, similar to 2021 and 2020, otherwise most concentrations of nutrients are similar to baseline.	**Spatial scale – localized**; reactive silica is only elevated at WAL. **Temporal trend – none**. **Causality – low**; no evidence of mine-related source.	*Low* (i.e., < CCME water quality guidelines).
	Metals	The yearly mean for total and dissolved silicon exceeded the trigger value at SP, similar to 2021 and 2020. There are no *before* data to use in the BACI statistical analysis of changes over time for silicon, but concentrations appear stable throughout the monitoring period. All other metals concentrations (total and dissolved) were consistently low or below their respective MDLs at the NF, MF, and FF locations in 2022.	**Spatial scale – localized, silicon (Si)**; Si is elevated at SP only. **Temporal trend – stable (Si)**; 2022 Si concentrations appear to be unchanged over all sample years in SP since 2011. **Causality – low (Si)**; the long-term stability and the monthly stability in 2022 of Si concentrations in SP suggest conditions are not mine related.	Recent temporal water quality analysis for areas in Third Portage Lake (TPE and TPN), Second Portage Lake, and Wally Lake indicates the results conform with the *low* effect rating predicted in the FEIS. This conclusion is corroborated by the phytoplankton and benthos community results, which show relatively diverse, abundant, and stable communities at the NF areas relative to baseline / reference conditions.
Phytoplankton Section 4.4	Chlorophyll-a	There is no trigger for chlorophyll-a for the CREMP. For reference area PDL and NF areas, chlorophyll-a concentrations peaked in May.	Concentrations in the reference area samples typically range between 0.2 and 0.9 µg/L in summer months, reflecting the oligotrophic, nutrient poor condition of these lakes; a trend that has not changed over time.	No predictions in the FEIS.

Monitoring Component (and report section)	Variable	Summary	Temporal and Spatial Trend Assessment[1, 2, 3]	Annual CREMP Results Compared to FEIS Predictions (Cumberland, 2005)
Phytoplankton (cont'd) Section 4.4	Total Biomass	Increases in phytoplankton biomass were detected at NF areas in 2022 relative to baseline/reference conditions but were not confirmed by the time-series plots. The magnitude of the BACI analysis increase ranged up to 49% at TPN (**Table 4-7**). Nutrient concentrations (i.e., nitrogen and total phosphorus) were similar to baseline (**Section 4.3**).	**Spatial scale – localized**; phytoplankton biomass increased in the BACI analysis at NF areas relative to baseline/reference conditions in 2022, though the increases were not significant. **Temporal trend – stable**; historical biomass levels for the NF areas do not show obvious visual signs of temporal increases for individual NF study areas (**Figure 4-14**). **Causality – low**; SP was the only NF area that received effluent discharge in 2022. The magnitude of the change in biomass at the NF areas TPN, SP, and WAL suggests the observed pattern of increase in phytoplankton biomass is likely annual variability in the community rather than mine-related.	The absolute biomass values at the NF are comparable to their historical values. Taking into consideration all the lines of evidence (BACI and absolute values plotted over time), there is no evidence to suggest mining operations are increasing primary productivity in the NF areas.
	Taxa Richness	Based on the BACI analysis, the estimated changes in NF areas relative to baseline/reference were small (< 20% effect size) and changes were not statistically significant (**Table 4-7**).	**Spatial scale – localized**; slight increase in taxa richness relative to reference/baseline conditions at TPN, SP, and WAL. Slight decrease at TPE compared to reference/baseline. **Temporal trend – stable**; richness has remained stable during the *after* period (**Figure 4-17**). **Causality – low**; there is no indication that mine activities are influencing taxa richness.	Taxa richness for the phytoplankton communities has been stable throughout the 'after' period (i.e., no apparent loss of community diversity).
Sediment Chemistry Section 4.5	Metals	Grab samples were collected alongside benthic invertebrate samples. Grab sample results were analyzed for grain size, moisture, and TOC. Remaining sediment was archived for chemistry analysis. Grab sample results are used to support benthic invertebrate interpretation. No core samples were collected in 2022 and the next coring program is planned for 2023.	Grab samples were not analyzed for chemistry in 2022. Trends will be reviewed in 2023 with the sediment coring program.	The FEIS noted that release of effluent (i.e., settling of TSS and altered sediment chemistry) *may impact benthos.*
	Hydrocarbons	Sediment hydrocarbon concentrations in grab samples were below detection for all sampling areas in 2022 except for naphthalene at INUG and mineral oil and grease at TPN and WAL.	Hydrocarbons are not contaminants of potential concern for the CREMP based on recent and historical results. There have been no instances of measured concentrations attributable to site-related activities during the monitoring period.	No predictions in the FEIS.
Benthos Section 4.6	Total Abundance	Benthic invertebrate communities at the NF areas were monitored in 2022. Decreased abundance at TPE and increased abundance at WAL relative to reference/baseline conditions in 2022. No statistically significant differences were reported in the BACI. Abundance at WAL and TPE shows year-over-year variability consistent with baseline sampling results.	**Spatial scale – localized**; lower abundance (based on the BACI analysis) observed at WAL and increased abundance at TPE. Both changes exceed 20% effect size. **Temporal trend – stable**; abundance (absolute values) at TPE was lower in 2022 compared to the last seven years but was consistent with the range observed in baseline (**Figure 4-19**). **Causality – low**; the 'apparent' reduction in abundance at TPE in the BACI analysis is partly an artefact of high variability between sample replicates in 2022. TPE has remained relatively stable during the operation phase.	The identification of potential mine-related impacts generally involves visually examining the data for spatial/temporal patterns that matched mine-related events. An apparent reduction in total abundance was identified in the BACI analyses at TPE in 2022 but the results were considered a BACI *artefact* as abundance has been consistently trending within the baseline range (**Figure 4-19**).
	Total Richness	Apparent increases at TPN, and SP in all time periods for the BACI > 20% effect size. The only change that is statistically significant is in the 2019-22 time period at SP. Taxa richness in 2022 at the NF areas are still within the range of baseline.	Richness continues to track higher for most areas. The benthic communities are dominated by chironomids, and the relative proportion of major taxa remains stable at all areas.	No predictions in the FEIS.

Table ES-2. Summary of key findings from the 2022 Whale Tail CREMP.

Notes:
1. Temporal and spatial trends are outlined for monitoring components and variables that exceeded trigger or effects-based thresholds (i.e., apparent change from baseline).
2. Spatial scale ratings are: localized = small area within the lake/area; widespread = basin to whole lake.
3. Causality ratings are: low = no evidence of a mine-related source; moderate = some likelihood of a mine-related source; high = the source of the change is likely mine-related.

Monitoring Component (and report Section)	**Variable**	**Summary**	**Temporal and Spatial Trend Assessment**[1, 2, 3]	**Monitoring Results Compared to FEIS Predictions (Golder, 2019) and AMP Thresholds**
Limnology Section 5.2	Temperature and Dissolved Oxygen	The limnology profiles collected in 2022 show dissolved oxygen and temperature readings are consistent with range of conditions observed in previous monitoring cycles (2015 –2021).	Spatial and temporal trends were stable in 2022.	No predictions in the FEIS.
	Field Measured Conductivity	WTS, MAM, A20, A76, and NEM all demonstrated conductivity profiles elevated above baseline conditions. The 2022 conductivity profiles for WTS were comparable to 2021 with highest conductivities during discharge periods (i.e., March and May). The conductivity in MAM indicated a spatial trend with higher conductivity readings in the east basin compared to the west basin. Conductivity readings in MAM dropped from a range of 175-360 µS/cm in 2021 to 100-225 µS/cm in 2022. Conductivity in Lake A20 was higher than in 2021 while conductivity readings at NEM and A76 were comparable to 2021.	**Spatial scale – localized**; no spatial trends within WTS but observed an increase in conductivity at A20. Slight spatial trend observed within MAM (east basin elevated compared to west basin), which appeared to become more well mixed by July. The spatial trend extended to Lake A76, though not to further downstream area DS1. NEM is within a separate watershed and there is no spatial trend to review. **Temporal trend – stable (WTS); decreasing (MAM); increasing (A20);** similar to 2021, conductivity in WTS appeared to trend upwards during the ice-covered months and decline during the summer. Apparent increase in conductivity observed in MAM since late 2018 has reversed in 2022 with conductivities decreasing. Apparent increase in conductivity in 2022 at A20 with conductivities higher than baseline throughout the year and is expected to track more closely with WTS now that the lakes are joined. NEM also increased in later 2019 and has remained higher than baseline but was stable in 2020, 2021, and 2022. **Causality – high (WTS, MAM, A20);** Spatial and temporal trends at WTS and MAM suggest mine activities are influencing conductivity. In 2022 changes in effluent management are likely responsible for decreasing conductivity trends at MAM. Conductivities at A20 increased markedly following inundation and joining to WTS, this correspondence with mining activity and conductivity response indicates a high level of causality (**Figure 5-7**). While laboratory conductivity measurements at WTS, MAM, and A20 exceeded the trigger in 2022, there is no effects-based threshold for this parameter (**Figure 5-9**).	No predictions in the FEIS.

Monitoring Component (and report Section)	**Variable**	**Summary**	**Temporal and Spatial Trend Assessment**[1, 2, 3]	**Monitoring Results Compared to FEIS Predictions (Golder, 2019) and AMP Thresholds**
Water Chemistry Section 5.3	Major Ions and Conventional Parameters	Statistically significant increases above trigger values were observed at all NF areas for TDS, the cations Ca, Mg, K, Na as well as the HCO_3 anion (alkalinity). The effects-based triggers for the remaining anions (Cl, SO_4) were not exceeded, though concentrations track with increases in the other major ions. Statistically significant increases extended to MF areas A20 and A76 for all these parameters.	**Spatial scale – widespread**; the 2022 results indicated changes to WTS and MAM and to a lesser extent A20 and A76 as well as NEM which is located in a separate watershed. **Temporal trend – stable (WTS, NEM, A76); decreasing (MAM); increasing (A20)**; Conditions at WTS were stable or declining for Ca and Cl ions, while increasing for the other major ions. Conditions at NEM have remained stable since 2019. Conditions at A76 have generally remained stable in 2022 compared to 2021. MAM demonstrated decreasing trends for all major ions. All seven major ions were increasing at A20. **Causality – high**; these parameters have increased in the Meadowbank study area lakes and it seems likely that the apparent increase observed in the Whale Tail study area lakes in 2022 follows a similar trend and with more samples in the *after* period, it is easier to assign causality.	Water quality constituents without effects-based CCME thresholds were not incorporated in the magnitude ratings for assigning effects in the FEIS; however, following the intent of the FEIS magnitude ratings, constituents exceeding baseline but below concentrations associated with adverse effects were considered consistent with a *low* magnitude rating. FEIS predictions are for Mammoth Lake and Whale Tail South. Monthly mean concentrations for several parameters exceeded FEIS predictions but all conform with the *low* effect rating predicted in the FEIS.
	Nutrients	Statistically significant increases above trigger values were observed at WTS, MAM, and A20 for TKN and total phosphorus.	**Spatial scale – widespread**; the 2022 results indicated changes at NF and MF locations. **Temporal trend – variable**; Comparing 2021 to 2022, TKN was stable at WTS, dropping at MAM, and increasing at the MF lakes (A20 and A76). Total phosphorus was stable at the NF and MF lakes. **Causality – moderate**; the changes in TKN concentrations were restricted to NF and MF areas of the Whale Tail study area lakes, which suggests the apparent changes may be due to mine activities in 2022.	The yearly mean for total phosphorus at WTS and MAM fell below the FEIS predictions. The AMP Level 0 is in effect for both WTS and MAM. **Total phosphorus exceeded the effects-based trigger value consistent with a *moderate* degree of change rating (Sections 2.2.3 and 5.3.5). Based on the total phosphorus results, the full suite of CREMP water sampling is scheduled for 2023.**
	TOC and DOC	The yearly mean for TOC and DOC exceeded the trigger in WTS, MAM, A20, and DS1 in 2022. The BACI analysis indicated that the increases were significant at each of the lakes except for at DS1.	**Spatial scale – widespread**; TOC and DOC were over the trigger at NF (WTS and MAM), MF (A20), and FF (DS1) areas. **Temporal trend – increasing**; there were apparent increases in TOC and DOC at WTS, MAM, A20, and DS1 in 2022. **Causality – moderate**; while mining activity and flooded terrestrial areas may be responsible in part for changes in TOC and DOC at the NF and MF lakes, reference locations (INUG and PDL) also indicate an increasing trend in 2022. This trend is also visible in the Meadowbank and Baker Lake study areas. Natural regional factors may be at play in addition to the spatially isolated effects of mining at WTS, MAM, and A20.	No predictions in the FEIS. The observed trends may be in part due to natural variability. These parameters will be monitored in 2023.
	Metals	Statistically significant increases of total and dissolved lithium were observed at NF area MAM as well as total titanium at WTS. These were the only metals where mean annual concentrations exceeded triggers. Mean annual silicon concentrations have exceeded the trigger in the past, though this parameter demonstrated a downward trend in 2022 at all NF and MF areas. Arsenic has not exceeded its trigger value since sampling began, however it has trended upwards in recent years. This parameter is monitored in the receiving environment on a monthly basis under the AMP (**Section 5.3.4**) and also in effluent via the MDMER and Water Licence limits (**Section 5.1**).	**Spatial scale – localized**; mean lithium concentrations exceeded the trigger value at MAM and titanium in WTS, but elevated concentrations did not extend to Lakes A20 or A76. **Temporal trend – decreasing or stable**; lithium concentrations appear to have declined in 2022 relative to 2021. Titanium concentrations have not demonstrated discernible trends. **Causality (Figure 5-12):** **Lithium – high**; the exceedances of lithium have historically occurred at both NF locations (MAM and WTS). There is a marked increase in this parameter following the start of mining activity in 2018. The declining trend in 2022 matches the declining trend in other parameters (e.g., major ions) and is likely due to changes in effluent management.	*Low* (i.e., < CCME water quality guidelines). For total arsenic, the AMP Level 0 is in effect for WTS and MAM.

Monitoring Component (and report Section)	Variable	Summary	Temporal and Spatial Trend Assessment[1, 2, 3]	Monitoring Results Compared to FEIS Predictions (Golder, 2019) and AMP Thresholds
Water Chemistry (cont'd) Section 5.3	Metals		**Titanium – low**; trigger exceedances for titanium are sporadic, occurring in NF as well as FF and reference lakes since sampling began. The greatest exceedances of the trigger occurred at WTS in 2018 and 2019, though no trend has immerged and the magnitude of the 2022 exceedances are comparable to exceedances at reference (INUG) in 2021.	
Phytoplankton Section 5.4	Chlorophyll-a	There is no trigger for chlorophyll-a for the CREMP. Chlorophyll-a concentrations varied in 2022 with larger seasonal fluctuations at the NF and MF lakes. Mean annual concentrations at the NF and MF lakes were higher relative to reference.	**Spatial scale – localized**; chlorophyll-a appeared to increase in WTS and MAM in 2022. Increases at the MF lakes were less apparent. There was no formal BACI analysis on this parameter. **Temporal trend – variable (WTS, MAM, A20, A76)**; a notable increase from July to September in WTS, while peak concentrations occurred in May and trended downward through September at MAM, A20, and A76. **Causality – moderate (WTS, MAM)**; unlike 2021, an obvious spatial trend did not extend into the MF lakes. Correspondence between elevated nutrients and chlorophyll-a at the NF lakes support causality, though large seasonal fluctuations make interpreting temporal trends challenging.	No predictions in the FEIS. Chlorophyll-a appears to have increased in NF areas WTS and MAM in 2022. An increase in productivity is normally indicative of an increase in nutrient concentrations. Nutrients are discussed above and increases may have been partly driven by natural variability in 2022. Nutrients and primary productivity in the water column will be monitored in 2023.
	Total Biomass	WTS, MAM, A20, A76, and NEM results showed an increase in biomass compared to baseline conditions. The BACI analysis showed non-significant increases though effect sizes for these lakes ranged from 43% to 128%.	**Spatial scale – localized**; an increase in phytoplankton biomass was observed at WTS, MAM, A76, A20 and NEM. **Temporal trend – variable**; statistical analysis indicated an increase in biomass at WTS, MAM, A76, A20 and NEM over baseline/control; however, these results were not statistically significant. **Causality – moderate**; the potential increases in biomass were only observed at NF and MF area lakes where mining activities would likely be an influence. An increase in nutrients as shown by the water chemistry data may have influenced phytoplankton growth. The trends observed were similar in terms of seasonal variability but the magnitude of change appeared to be greater at the NF and MF area lakes compared to the reference areas PDL and INUG a further indication of mining influence.	No predictions in the FEIS. The increase in total biomass at NF and MF area lakes but not FF and corresponding increases in nutrient concentrations in water suggest the changes may be attributed to mining activities. Biomass and nutrient patterns will be re-examined in 2023.
	Taxa Richness	Slight decreases in taxa richness were observed at WTS and MAM, though the changes were not statistically significant and the reductions at both areas were below the 20% trigger (**Table 5-11**).	**Spatial scale – localized**; Though slight decreases were observed at WTS and MAM relative to baseline/reference, the changes were small and not statistically significant. **Temporal trend – variable**; richness has been variable during the *after* period (**Figure 5-18**). The apparent decreased in richness relative to baseline/reference conditions may be attributed to natural variability due to similar observed trends at reference areas INUG and PDL. **Causality – low**; the decrease in richness relative to baseline suggests there may be influences from mine activities. However, there is uncertainty due to the small effect size (<20%) and lack of significance.	No predictions in the FEIS. Taxa richness for the phytoplankton communities has been variable throughout the *after* period, however it appears there may be a slight loss in community diversity compared to the baseline period.

Monitoring Component (and report Section)	**Variable**	**Summary**	**Temporal and Spatial Trend Assessment**[1, 2, 3]	**Monitoring Results Compared to FEIS Predictions (Golder, 2019) and AMP Thresholds**
Sediment Chemistry Section 5.5	Metals	Grab sample chemistry (for areas that were analyzed) was similar to other years for most analytes. No core samples were collected in 2022 and the next coring program is planned for 2023. Coring results will allow for formal statistical analysis which will provide greater clarity on temporal and spatial patterns (if any).	**Spatial scale – localized**; concentrations of As, Cu, Cd, and Zn exceeded triggers in 2022 but still generally remained within background conditions. Cr concentrations may have demonstrated an increase above background at WTS, MAM, and NEM in 2022. **Temporal trend – stable**; Results are highly variable within years due to spatial heterogeneity, and do not appear to show temporal trends since the baseline sampling period for any metals. Cr results (**Figure 5-23**) will be evaluated against coring results in 2023. **Causality – low**; there is currently insufficient data to link the observed patterns of sediment Cr at WTS, MAM, and NEM to mining activity. However, increases in Cr were identified previously at the Meadowbank study lakes. Other metals (e.g., As) have demonstrated increasing trends in water chemistry at NF and MF lakes. These metals and Cr will continue to be monitored on an annual basis.	No predictions in the FEIS for grab sample chemistry.
	Hydrocarbons	Sediment hydrocarbon concentrations were below detection for most samples. Analytes that had detectable concentrations did not exceed ISQG or PEL screening values.	Hydrocarbons are not contaminants of potential concern for the CREMP based on recent and historical results. There have been no instances of measured concentrations attributable to site-related activities during the monitoring period.	No predictions in the FEIS for grab sample chemistry.
Benthos Section 5.6	Total Abundance	Benthic abundance was highly variable between replicates and was variable between areas. Abundances at WTS, MAM, A20, A76, and NEM in 2022 were all above baseline and also higher than 2021 levels. The BACI results for WTS, MAM, A76, and NEM showed high effect sizes (>200%), though these were not significant at WTS and A76.	**Spatial scale – localized**; in 2022 higher abundance observed at NF and MF locations. **Temporal trend – increasing**; abundance at the NF and MF lakes increased markedly in 2022, though this increase was only significant relative to baseline conditions at MAM and NEM (**Figure 5-28**). **Causality – moderate**; increases were observed across the NF and MF study lakes in 2022, however this does not necessarily indicate a response to mining. Increases in mine derived nutrients could have a cascading effect on phytoplankton and in turn benthic communities, however natural limnological factors or population cycles can also influence results. Abundance will be monitored in 2023 for sustained increases at the NF and MF lakes.	No predictions in the FEIS.
	Total Richness	The BACI analysis indicated a statistically significant increase in taxa richness at MAM and NEM in 2022 compared to baseline conditions.	**Spatial scale – localized**; significant increases in taxa richness only observed at MAM and NEM. **Temporal trend – variable;** taxa richness has been highly variable since the baseline period, though there appears to be an upward trend at MAM. **Causality – low;** the benthic communities are dominated by chironomids, and the relative proportion of major taxa remains stable at all areas. There is also little correspondence across the NF study lakes (no significant increasing trends at WTS).	No predictions in the FEIS.

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ACKNOWLEDGEMENTS

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ACRONYMS

AEMP	Aquatic effects monitoring program
AMP	Adaptive management plan
AIC	Akaike information criterion
ANOVA	Analysis of variance
AWAR	All weather access road
BACI	Before/after control/impact
BACIP	Before/after control/impact paired
BAER	Baseline aquatic ecosystem report (for Meadowbank)
BAP	Baker Lake – Akilahaarjuk Point
BBD	Baker Lake – barge dock
BES	Baker Lake – east shore
BPJ	Baker Lake – proposed jetty
CCME	Canadian Council of Ministers of the Environment
COC	Chain of custody
COPC	Contaminant of potential concern
CREMP	Core receiving environment monitoring program
CRM	Certified reference material
DFO	Fisheries and Oceans Canada
DI	Deionized blank
DOC	Dissolved organic carbon
DQO	Data quality objective
EAS	Effects assessment strategy
EB	Equipment blank
EEM	Environmental effects monitoring
EIA	Environmental impact assessment
FEIS	Final environmental impact statement
FF	Far-field
FWAL	Freshwater aquatic life guidelines (e.g., CCME)
GPS	Global positioning system
HCF	Habitat compensation feature
HCMP	Habitat compensation monitoring program
HEPH	Heavy extractable petroleum hydrocarbons
ICP-MS	Inductively coupled plasma mass spectrometry

INUG	Inuggugayualik Lake
ISQG	Interim sediment quality guidelines
LCS	Laboratory control sample
LEPH	Light extractable petroleum hydrocarbons
MAM	Mammoth Lake
MDL	Method detection limit
MDMER	Metal and Diamond Mining Effluent Regulations
MF	Mid-field area
NEM	Nemo Lake
NF	Near-field
NWB	Nunavut Water Board
PAG	Potentially acid generating
PAHs	Polycyclic aromatic hydrocarbons
PDL	Pipedream Lake
PEL	Probable effect level
QA/QC	Quality assurance / quality control
REF	Reference
RPD	Relative percent difference
SEP	Sequential extraction procedure
SOP	Standard operating procedure
SP	Second Portage Lake
SQG	Sediment quality guidelines
SSD	Species sensitive distribution
SSWQO	Site specific water quality objective
TDS	Total dissolved solids
TE, TEFF	Tehek Lake sampling areas
TIA	Tailings impoundment area
TKN	Total Kjeldahl nitrogen
TOC	Total organic carbon
TP	Total phosphorus
TPE, TPN, TPS	Third Portage Lake sampling areas
TSF	Tailings Storage Facility (North and South Cells)
TSS	Total suspended solids
UTM	Universal Transverse Mercator
WAL	Wally Lake

WOE	Weight of evidence
WQG	Water quality guideline
WRSF	Waste rock storage facility
WTN, WTS	Whale Tail Lake – North and South basins

REPORT ORGANIZATION

The 2022 Core Receiving Environment Monitoring Program (CREMP) report is organized into a main document and six appendices (A through F). An overview of the various sections of the report is provided to help guide the reader as they navigate the document.

Executive Summary provides a high-level summary of the monitoring results by study area (Meadowbank, Whale Tail, and Baker Lake).

Section 1 introduces the CREMP with overview of the environmental setting for the project. The pace and scope of mining development is also outlined to catalogue how the CREMP has been implemented to monitor changes in the aquatic receiving environment.

Section 2 outlines elements of the CREMP study design including sampling areas, a description of the routine monitoring components, details regarding any targeted studies conducted for a given cycle, and the statistical framework used to assess spatial and temporal changes in chemistry (water and sediment) and biological communities (phytoplankton and benthic invertebrates).

Section 3 summarizes results of the detailed quality assurance and quality control assessment (QA/QC) presented in **Appendix A**.

Section 4 (Meadowbank), **Section 5** (Whale Tail), and **Section 6** (Baker Lake) are stand-alone chapters detailing the results of the spatial and temporal trends in water quality, sediment chemistry, and biological community health (phytoplankton and benthos) specific to each study area. Figures and Tables are included at the end of each section.

Section 7 provides recommendations for the scope of the 2023 CREMP for Meadowbank, Whale Tail, and Baker Lake study areas.

1 INTRODUCTION

This CREMP report documents the methods and results of aquatic receiving environment monitoring activities completed at Meadowbank, Whale Tail, and Baker Lake study areas in 2022. As in previous years, this report integrates historical data to identify changes in limnology or water chemistry parameters, sediment chemistry, phytoplankton biomass and benthic community structure associated with mine-related activities at Meadowbank Mine (since 2006), Whale Tail (since 2018), or in Baker Lake (since 2008).

1.1 Development of the Aquatic Monitoring Program

Agnico Eagle Mines Ltd.'s (Agnico Eagle) Meadowbank Complex is situated approximately 75 km north of the hamlet of Baker Lake, Nunavut. The aquatic monitoring program has evolved since its inception in 2005; terms and acronyms used to describe the aquatic monitoring programs for the Meadowbank Complex are described below:

AEMP

The AEMP acronym was first used in the 2005 report *(Aquatic Effects Management Program*[1]; Azimuth, 2005a). The AEMP was developed to address issues identified during the Environmental Impact Assessment (EIA) process that could potentially impact the aquatic receiving environments surrounding the development. The scope of the original AEMP described the rationale, framework, strategy, methods, and scope of receiving environment monitoring for the Meadowbank mine. Receiving environment monitoring conducted in 2006 and 2007 use the term *AEMP* in the annual report titles[2].

Agnico Eagle has several monitoring programs (e.g., effluent monitoring, ground water monitoring, air quality monitoring) relevant to tracking potential changes to the aquatic receiving environment surrounding the Meadowbank mine. A restructuring of the AEMP was completed in 2012 (Azimuth, 2012c) to broaden the scope of the AEMP to serve as the overarching 'umbrella' strategy that provides an opportunity to integrate results of individual, but related, monitoring programs (e.g., construction, groundwater, water quality and flow, air quality) in accordance with the original Nunavut Water Board (NWB) Type A Water Licence requirements. On an annual basis, the restructured AEMP brings in the results of the individual monitoring programs, assesses them using a site-specific conceptual model

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[1] The 2005 AEMP refers to the original AEMP document that served as the blueprint for the CREMP until the CREMP Design Document 2012 (Azimuth, 2012d) was completed.

[2] The Nunavut Water Board Type A License, issued in 2008 and renewed in 2015, defines the "AEMP" as the *Aquatic Effects Monitoring Program*; annual receiving environment monitoring reports since 2008 reflect this subtle change.

framework and recommends specific management actions to address potential issues. Previously, the term *AEMP* was essentially synonymous with receiving environment monitoring. Given the AEMP's broadened scope, more specific terminology (i.e., CREMP; see below for more details) was developed when referring to aquatic receiving environment monitoring for the Meadowbank mine. The AEMP Plan was updated in 2022 (Version 5). The report is included in Agnico Eagle's Annual Report for review by the NWB.

CREMP

CREMP is the acronym for Core Receiving Environment Monitoring Program. This term, which is synonymous with *core monitoring program* was first used for the 2009 annual report. It encompasses the core receiving environment monitoring program dating back to 2006. The study design for the CREMP was reviewed and formalized in 2012 (*Core Receiving Environment Monitoring Program (CREMP): Design Document 2012*; Azimuth, 2012d), but has its origins in the AEMP (Azimuth, 2005a). The 2012 design document reviewed all historic monitoring CREMP data, presented the trigger/threshold derivation process (see **Section 1.5** for description of triggers/thresholds), determined trigger/threshold values for individual parameters, and established the experimental design to optimize the program. The resulting triggers/thresholds and experimental design changes have been integrated into the CREMP since 2012.

The *CREMP Plan*, which is the "how-to" manual for conducting aquatic receiving environment monitoring at the Meadowbank Complex, is updated from time to time to adapt the program to reflect the state of development of the site. The 2022 update (*CREMP: 2022 Plan Update*; Azimuth, 2022b) involved integrating the 2015 version of the *CREMP Plan* (Azimuth, 2015b) with an addendum that focused on the Whale Tail Expansion Project. The only notable technical change in the 2022 version of the *CREMP Plan* is in the frequency of benthic invertebrate and sediment chemistry monitoring in Baker Lake, which will now move to a three-year cycle rather than annually, coinciding with the sediment coring program starting in August 2023. This change is supported by the long-term data that clearly shows the benthic invertebrate communities are stable and healthy relative to baseline and reference conditions in each lake.

1.2 Environmental Setting

1.2.1 Meadowbank and Whale Tail Study Areas

The Meadowbank and Whale Tail mines (collectively termed the Meadowbank Complex) are situated in the barren-ground central Arctic region of Nunavut within an area of continuous permafrost known as the Wager Bay Plateau (Campbell et al., 2012). These are headwater, ultra-oligotrophic/oligotrophic (nutrient poor and unproductive) lakes, situated on the watershed boundary that separates two main drainages – the Arctic and Hudson Bay drainages. Only a few hundred meters to the north of Second and Third Portage lakes is the divide between water that flows north to the Arctic Ocean (via the Meadowbank and Back River system) or to Chesterfield Inlet and Hudson Bay (via the Quoich River system). Lakes near the Meadowbank mine (i.e., Third Portage, Second Portage, and Tehek) flow into the Quoich River system, while CREMP reference lakes (Tasirjuaraajuk Lake; aka Pipedream Lake [PDL] and Inuggugayualik [INUG]) and lakes in the vicinity of Whale Tail flow north via the Meadowbank and Back River system (**Figure 1-1**).

The local landscape around Meadowbank and Whale Tail consists of rolling hills and relief with low-growing vegetative cover and poor soil development. Numerous lakes are interspersed among boulder fields, eskers and bedrock outcrops, with indistinct and complex drainages. As is common of headwater lakes, all the project lakes have small drainage areas relative to the surface area of the lakes themselves. Local inflow from surrounding terrain is the predominant influence on water movement within the system. Small channels connect the project area lakes, although there is little flow between lakes except during freshet and possibly none during winter months. Movement by fish between lakes is also rare, as populations remain quite isolated from one another. The ice-free season on these lakes is short, with ice break-up in late-June to mid-July and ice-up beginning in late September or early October. Maximum ice thickness is often 2 m thick or more by March or April.

The Meadowbank and Whale Tail area lakes support healthy communities of plankton, benthos and fish that are typical of oligotrophic Arctic lakes (Azimuth, 2005b). Biological productivity of the lakes is limited by nutrient availability, cold water, and a short growing season.

1.2.2 Baker Lake

Baker Lake receives drainage from three major river systems that drain much of the central Arctic: the Thelon River, the Kazan River, and the Dubawnt River (Hutchinson et al., 2018). Baker Lake is the fifth largest lake in Nunavut with a surface area of approximately 1,900 km^2 and 90 km from the mouth of the Thelon River to the narrows at the eastern end of the lake (Nunami, 2007). Water quality in Baker Lake is indicative of a nutrient poor, low alkalinity, soft water Arctic Lake (Hutchinson et al., 2018). Analysis of surface water for metals analysis indicate dilute concentrations throughout Baker Lake with no reported exceedances of human health or freshwater quality guidelines. Water quality in Baker Lake is strongly influenced by freshwater inputs during freshet; results from the lake-wide survey completed by Hutchinson et al. (2018) show only weak spatial and seasonal patterns in water quality except for conductivity.

Specific conductivity measurements collected throughout the monitoring period occasionally detect the influence of the deep marine-water influence in Baker Lake. A report by Johnson (1965) suggested three scenarios to explain saline conditions in Baker Lake: 1) ancient seawater trapped during isostatic rebound following glacial retreat, 2) seawater seeping into Baker Lake near the outlet, and 3) seawater entering Baker Lake driven by tides and storm events. Data generated from a more recent 3-year limnological study in Baker Lake between 2015 and 2017 suggest scenario 3 is the most likely explanation for saline water in Baker Lake. The channel or sill separating Baker Lake from marine influence is shallow and strong tidal currents and higher tidal amplitude at Chesterfield Inlet compared to other regions in Hudson Bay could contribute salt water to Baker Lake (Hutchinson et al., 2018). Conductivity readings over 1,000 µS/cm were recorded at depths between 10 and 20 m at locations further away from the influence of freshwater from the Thelon River (Hutchinson et al., 2018). Spring freshet is postulated as a key factor that prevents saline water from accumulating in Baker Lake year-over-year.

1.3 Mine Development and Operation

An overview of the mine development for the Meadowbank Complex is provided below. A list of within-year site activities and a summary of previous CREMP results dating back to 2008 are provided in **Table 1-1**.

1.3.1 Meadowbank

The construction phase of the Meadowbank mine officially started in June 2008, upon receipt of the NWB A Water Licence (2AM-MEA0815; renewed to 2AM-MEA1525 in 2015, amended to 2AM-MEA1526 in 2018 and to 2AM-MEA1530 in 2020) for the project. The Fisheries and Oceans Canada (DFO) Fisheries Act Authorization (NU-03-0191) for the project was issued on July 30, 2008, thus allowing the start of in-water construction activities. Dike construction at Second Portage (East Dike) and Third Portage Lake (Bay-Goose Dike) between 2008 and 2010 allowed development of the open pit deposits. The mine officially opened on February 27, 2010, marking the start of the operations period. Five deposits were mined in the 10 years of operations: North Portage, South Portage, Bay-Goose, Vault Phaser, and BB Phaser. Mining operation ceased in 2019 at Meadowbank Site but the mill is still in operation and processes the ore from Whale Tail mine. In addition to mill operations, key ongoing activities involve reclaim water use and tailings discharge, as well as management of East Dike seepage.

1.3.2 Whale Tail

The Whale Tail mine is situated within the Amaruq property, a 408 km^2 exploration area on Inuit and federal crown land. The Whale Tail mine is located approximately 50 km northwest of the Meadowbank mine and is connected by a 64 km all-weather access road that was completed in 2018. The Whale Tail mine is permitted under a separate NWB license, 2AM-WTP1830, with ore being trucked to Meadowbank to take advantage of the existing infrastructure (e.g., mill, tailings storage, air strip). The Whale Tail mine is made up of three locations of active ore extraction. These include the Whale Tail Pit, IVR Pit, and the underground mine. Commercial production officially began at the underground mine in 2022. Major in-water construction activities at Whale Tail from 2018 to 2021 included:

- Dike construction in Whale Tail Lake
- Mammoth Dike Construction
- Fishout of the isolated north basin of Whale Tail Lake
- Road construction around MAM
- Dewatering and surface water management at Whale Tail Lake (South Basin; WTS) and MAM
- Construction and completion of the diversion channel between WTS and MAM
- Dewatering and fishout of lakes in the footprint of the IVR Pit and IVR WRSF and the future attenuation pond
- Completion of the IVR diversion channel.

1.3.3 Baker Lake

The hamlet of Qamani'tuaq (aka Baker Lake) located on the northwest shore of Baker Lake is the point of entry for fuel, equipment and goods arriving by barge. Open-water access to the hamlet from Chesterfield Inlet on Hudson Bay is limited to approximately 2.5 months from the end of July through to mid-October, depending on annual ice conditions. Goods and fuel typically travel from Quebec, around Labrador, and through Hudson Straight. Cargo and fuel tanker vessels moor in Chesterfield Inlet and shallow draft ships or barges pulled by tugs are used to navigate the channel that connects Baker Lake with Chesterfield Inlet (Agnico Eagle, 2018). Dry goods are transferred at a floating dock facility to the east of the hamlet (CREMP area BPJ is the closest sampling area). Fuel is transferred from the barges to an 80-million-liter capacity tank farm located upgradient from the floating dock. Equipment, goods, and fuel are trucked year-round from the hamlet to Meadowbank via 110 km all-weather access road (AWAR) completed by Agnico Eagle in 2008.

Monitoring at Baker Lake began in 2008, coinciding with the first barge season. The number of barge trips for fuel and goods dating back to 2008 are shown in **Figure 6-2**.

1.4 CREMP Objectives

The CREMP focuses on identifying changes in limnological parameters, water and sediment chemistry, and in primary (phytoplankton) and secondary (benthic invertebrate community) aquatic producers that may be associated with mine development activities. This is accomplished through the application of a temporal/spatial trend assessment that includes application of quantitative decision criteria (i.e., early warning *triggers* and action *thresholds*) to facilitate immediate and objective decision-making regarding appropriate management actions. This information is integrated annually into the Aquatic Ecosystem Monitoring Program (AEMP) for holistic environmental management and decision making.

The 2005 AEMP framework (Azimuth, 2005a) presented a receiving environment monitoring strategy consisting of two components:

Core Receiving Environment Monitoring Program – was designed based on our understanding of mine construction, operation and infrastructure (e.g., dikes, effluents, stream crossings, roads, etc.) and has been developed to detect mine-related effects at temporal and spatial scales that are ecologically relevant. The program was expanded to include Baker Lake in 2008 and Whale Tail in 2018. The program was updated based on the recommendations of the *CREMP: Design Document 2012* (Azimuth, 2012d) and more recently, described in detail in the *CREMP Plan* (Azimuth, 2015b) and *Whale Tail Pit Addendum* (Azimuth, 2018b), and the *CREMP Plan Update* (Azimuth, 2022b). The study design is based on a before-after-control-impact (BACI) approach, but has also incorporated the concept of gradients in exposure (e.g., by incorporating near-field, mid-field, and far-field areas in addition to reference areas).

Targeted Studies – are designed to address specific questions related to mine development during construction or operation and typically have narrower temporal or spatial bounds. These results are integrated with and complementary to the routine CREMP. Examples include dike construction monitoring (e.g., Azimuth, 2009a) and the total suspended solids (TSS) effects assessment studies (EAS) (e.g., Azimuth, 2009b). Recently, targeted studies have been carried out to determine the toxicity and bioavailability of metals in sediments at TPE (Azimuth, 2016; Azimuth, 2020a).

1.5 CREMP Strategy

CREMP reporting for the Meadowbank and Baker Lake study areas changed substantially starting in 2011 with a stronger focus on assessing potential temporal and spatial trends in the data related to mining activity. Greater emphasis is now placed on identifying changes to support the AEMP (**Section 1.1**) and ultimately the environmental management process, rather than on providing a detailed description of the annual results in isolation. To that end, this CREMP report applies numerical decision criteria (i.e., triggers and thresholds) to assess the magnitude of change in CREMP monitoring variables (e.g., water quality, sediment chemistry, lower trophic level communities [i.e., phytoplankton and benthos]). The same approach has been applied at the Whale Tail study area for 2020; in 2019 this study area transitioned from the baseline 'before' period to the 'after' period.

The 2012 AEMP (Azimuth, 2012c) with minor updates in 2022 (Azimuth, 2022b) described a two-tiered approach (**Figure 2-2**) for evaluating changes in the monitoring components (e.g., water quality, benthos community) based on 'trigger' and 'threshold' level changes:

- **Trigger values** are typically lower or more conservative than threshold values. They serve as early warning criteria that might lead to action. Exceedance of a trigger value does not necessarily imply that an adverse effect may be expected. The triggers may be based on absolute numbers (e.g., an increase half-way from baseline to an identified effect threshold) or statistical criteria (e.g., statistically significant trend that predicts exceedances of a threshold within 3 years).

- **Effects-based thresholds** are legal requirements, regulatory guidelines (e.g., CCME), or other discrete benchmarks, below which unacceptable adverse effects are not expected and above which adverse effects may occur. If effects-based thresholds do not exist or are not warranted for a variable, then early warning triggers will be developed without thresholds. In such cases, if triggers are exceeded then the implications of such exceedances can only be understood through the integration of results from other AEMP monitoring programs, or, if important information gaps still exist, through focused studies (e.g., risk assessment).

Comparison of the data to trigger values is the initial analytical focus. If trigger values are exceeded, the data are then compared to the applicable effects-based thresholds (if available[3]). Details regarding the derivation of trigger and threshold values for the CREMP are presented in the *CREMP: Design Document 2012* (Azimuth, 2012d).

In addition to triggers and effects-based thresholds, the results are also compared to water quality predictions developed as part of the Federal Environmental Impact Statement (FEIS) process (see **Section 2.3.1** for more details). The FEIS predictions provide context for whether any observed changes in water quality are consistent with expectations for the approved projects at two levels:

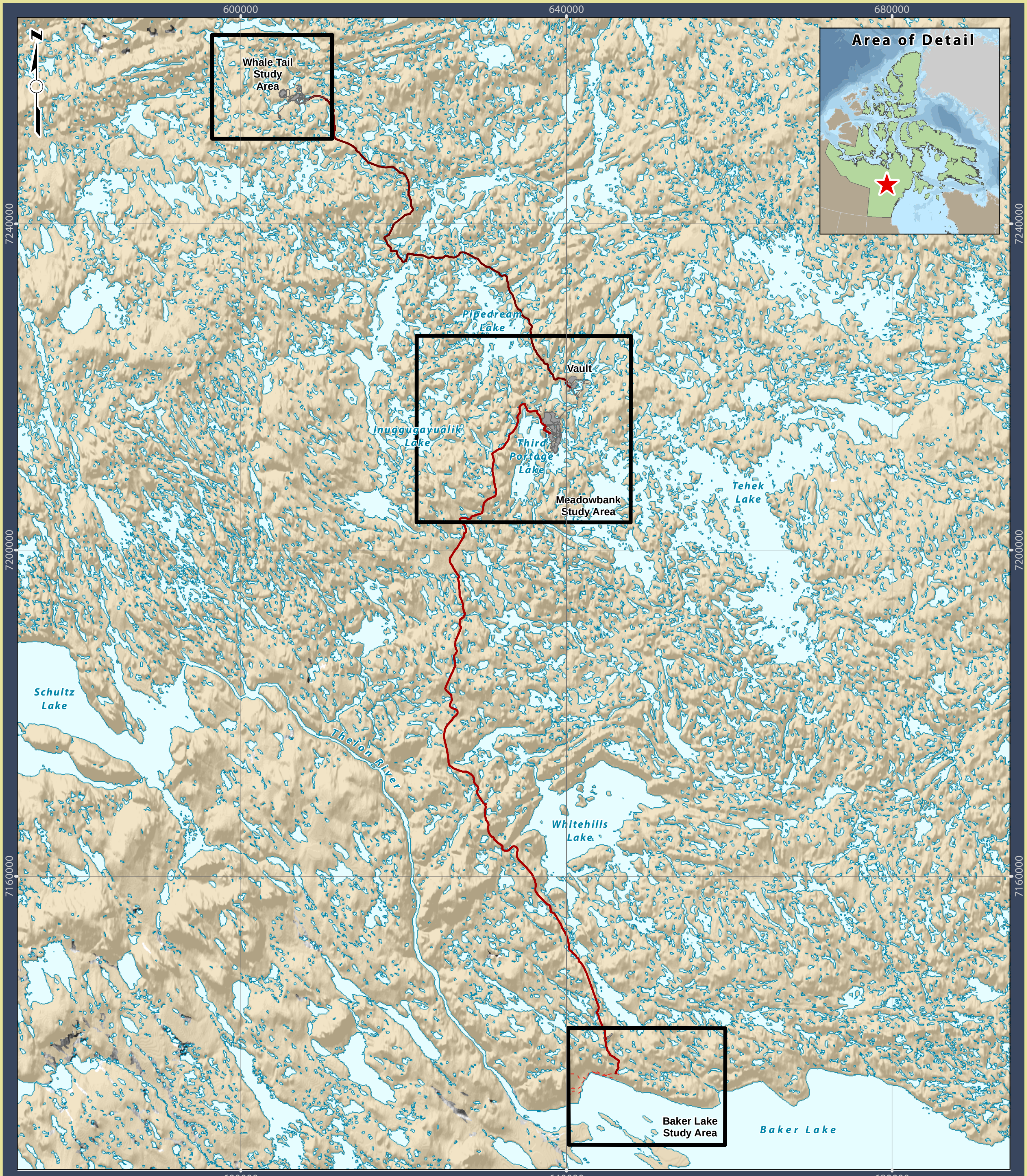
1. Numerical predictions – the actual concentrations predicted to occur for a suite of parameters. Given the uncertainties associated with water quality model development, these predictions are provided as a guide only.
2. Narrative predictions – these were categorical predictions used to classify the expected magnitude of change, typically relative to baseline conditions and water quality guidelines (see **Section 2.3.1**).

The application of trigger and effects-based threshold values complements the spatial-temporal trends assessment initiated in the 2011 CREMP (Azimuth, 2012a), which used trend plots (each showing monitoring results since 2006) to identify patterns of change consistent with one or more of the mining activities described in **Section 1.3**.

The general rationale for conducting the trend assessment followed these principles:

[3] For water and sediment quality, effects-based thresholds were generally set to existing environmental quality guidelines. Thresholds were not derived in cases where guidelines were unavailable or when baseline concentrations naturally exceeded existing guidelines (e.g., some metals in sediment).

- **Establish Expected Conditions** – Control data, i.e., combination of baseline [i.e., pre-mining] data from impact areas and data from remote reference or control areas) were examined to set expectations for a parameter (e.g., water or sediment metal concentration) in the absence of mining activity (see **Table 2-3**). Baseline data were used to infer relative spatial differences (e.g., between a NF and Ref area) and reference data were used to infer regional temporal changes (e.g., the regional decrease in benthic community abundance between 2009 and 2010).
- **Compare Patterns of Change** – With expected conditions in mind, impact data (i.e., data collected at NF and MF areas after the onset of mining-related activity in proximity to an area; see **Table 1-1**) were assessed visually for spatial-temporal patterns (e.g., short-term [in any year] spikes [rapid rises that return to baseline] or longer-term trends [gradual or rapid increases that persist]) matching mining activity (e.g., rise in TSS concentrations at SP in August 2008). Where observed, the spatial and temporal extent and magnitude of the changes were characterized (i.e., do they extend to MF or FF areas, and if so, at what magnitude/duration?).
- **Provide Context for Magnitude of Change** – As discussed above, site-specific triggers and effects-based thresholds and FEIS predictions were used to provide some context for observed changes to CREMP monitoring parameters. In addition, where applicable and available, results of target studies (e.g., TSS EAS studies) were used to help interpret changes in biological parameters and endpoints.
- **Identify Parameters for Management** – Identify parameters requiring management action on one of two levels: continued trend monitoring (i.e., to follow low magnitude or weak trends), or active follow-up with more detailed quantitative assessment (i.e., a targeted study to address a potential concern). This process will emphasize issues or concerns present in this year's CREMP results.



Legend

- Figure Extents
- Mine Sites
- All-Weather Access Road
- Whale Tail Haul Road
- River
- Lake

0 5 10 15 20

Kilometres

Projection: UTM Zone 14 NAD83

Data Sources:
Natural Resources Canada, GeoBase®
National Topographic Database
Agnico-Eagle Mines Limited.
Azimuth Consulting Group Inc.

Figure 1-1. Meadowbank – Complex Study Area Overview

Meadowbank Gold Project

Prepared for: AGNICO EAGLE

By: CASLYS CONSULTING

March 2023

Table 1-1. Chronology of major mine development and operational activities, along with corresponding receiving environment findings (2008–2022).

Note: The summary provided here pertains to Meadowbank (since 2008) and Whale Tail (since 2018) study areas.

Year	Major Mine-Related Activities	Receiving Environment Overview
2008	• Major in-water construction activities included the East Dike (located in Second Portage Lake) and the Western Channel Dike (located between Third Portage Lake and Second Portage Lake); the closest CREMP sampling area to these activities was the Second Portage Lake area (SP). • Other site-related activities included rock crushing, road building, pit blasting, ground preparation, and infrastructure construction. • Barge traffic increases in Baker Lake to support construction.	• As described in detail elsewhere (Azimuth, 2009a; 2009b), East Dike construction led to a sedimentation event that extended through Second Portage Lake (SP) to Tehek Lake (TE). The potential impact of construction-related sediment releases to the aquatic environment was the focus of the four-year EAS study (Azimuth, 2009b, 2010d, 2011a, 2012c).
2009	• Dewatering discharges (i.e., impounded Second Portage Lake water with TSS) were directed primarily into the north basin of Third Portage Lake (TPN), but also into Second Portage Lake (March to July and Oct to Dec, 2009). • Bay-Goose Dike construction started in late July 2009. • Most of the site preparation and road infrastructure was completed in 2009. • North Portage Pit was the primary focus of blasting and mine operations. • Barge traffic increases in Baker Lake.	• Despite several precautions, storm winds broke the Bay-Goose Dike turbidity barrier containment system, leading to another sedimentation event in late August. • Elevated TSS (and other parameters) was primarily restricted to east basin of Third Portage Lake (TPE) and to a minor extent into SP and TE. The implications of the release were assessed in the EAS study (see above).
2010	• Bay-Goose Dike construction completed using additional mitigation measures. • Mine officially opened on 27 Feb 2010, marking the start of the operations period. • Pit development focused on North Portage and South Portage pits • Waste rock to rock storage facility (RSF). Tailings to impoundment area (TIA). Contact water from operations not discharged to receiving environment. • Dewatering of SP impoundment to TPN continued, with discharge now subject to MMER • Barge traffic increases in Baker Lake.	• Bay-Goose Dike construction leads to less-pronounced sedimentation event in TPE and extends through SP to TE; EAS studies continue. • TPN (dewatering) TSS concentrations generally consistent with baseline conditions.
2011	• Mining operations focus on North Portage and South Portage pits. • Waste rock to rock storage facility (RSF). Tailings to impoundment area (TIA). • Construction activities limited to mine footprint. • Dewatering of SP and TPE to TPN continued, with treatment added to reduce fine sediment and turbidity. • Barge traffic stabilizes in Baker Lake.	• TPN focus of routine EEM study - no mine-related effects detected (Azimuth, 2012e). • TPN TSS concentrations consistent with baseline. • The TSS EAS targeting dike construction sedimentation events completed.
2012	• SP and TPE dewatering discharges to TPN finished by spring. Diffuser installed and effluent (mix of residual Bay-Goose water, contact water, East Dike seepage and run-off) discharge to TPN commences; treatment (for fine sediment, turbidity) continues. • North cell non-contact water diversion ditches completed in August (intercepting run-off prior to the tailings and waste rock areas and diverting to NP2 and Dogleg ponds). • Vault access road constructed and site preparation activities for the Vault Pit and Vault Dike commence. • Barge traffic remains stable in Baker Lake; 200-L diesel spill occurs, but cleaned up successfully.	• TPN TSS concentrations generally consistent with baseline. • Minor mine-related trends identified for several water chemistry parameters at near-field areas: conductivity, sulphate and total dissolved solids. • Spill-related monitoring shows no traces of hydrocarbons in Baker Lake.
2013	• Effluent discharge to TPN continued. • Fishout activity in Vault lake was completed. • Vault lake was dewatered into Wally Lake (ongoing) and did not require TSS treatment. • Minor construction modifications to north cell diversion ditches completed. • Completion of the Airstrip extension (18m) into Third Portage Lake in March. • Seepage from Rock Storage Facility (ST-16) through the road into NP2 identified (additional monitoring in NP2 to evaluate near-shore water quality).	• TPN TSS concentrations consistent with baseline. • Minor mine-related trends identified for several water chemistry parameters at near-field areas: alkalinity, conductivity, calcium and total dissolved solids. • TPE sediment chromium concentrations were elevated above trigger value; better spatial coverage needed to reduce uncertainty in 2014.

Year	Major Mine-Related Activities	Receiving Environment Overview
2014	• Effluent discharge to TPN from the Portage Attenuation Pond occurred only from June 10 to July 5. Discharge to TPN is now complete. The former Portage Attenuation Pond has now become the South Cell for tailings deposition. • EEM Cycle 2 Study Design was conducted at the end of August through the beginning of September (no TPN discharge at this time). • Vault Dewatering into Wally Lake from June 20 to 29 (now complete); discharge from Vault Attenuation Pond into Wally Lake from July 24 to August 14. No TSS treatment for Vault Discharge. • New discharge into Second Portage Lake during all of 2014 (except from May 3 to July 28): two seepage collection points (North and South) are situated on west side of the East Dike to collect seepage through dike from SP. Water is pumped from both collection points, which are connected together before discharging back into Second Portage Lake through a diffuser. No TSS treatment for East Dike Discharge. • No seepage water from Rock Storage Facility (ST-16) reaching the NP2 Lake in 2014. • Commercial mining in Vault Pit started at the beginning of 2014. No major construction or modifications in 2014.	• Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg/K/Na and total dissolved solids. • Temporal trend in TPE sediment chromium confirmed in coring study; targeted study recommended for 2015.
2015	• No discharge to TPN in 2015. • Vault discharge to Wally from July 7 to September 10. No TSS treatment needed. • East dike (North-South) discharge to SP all year except from June 16 to August 10. Discharge was stopped for increasing TSS levels as no treatment is available for this location. The discharge from East Dike that was not directed to 2PL was discharged in the Portage Pit and then pumped to the South Cell TSF (Tailings Storage Facility). • No seepage water from Rock Storage Facility to NP-2. Monitoring ongoing. • HCMP work completed for TP, SP and Dogleg lakes and at water crossing R02 along the AWAR. • One incident of elevated TSS from Vault road culverts to NP-1, early June, during freshet. Barriers installed. No impacts observed to Dogleg Lake.	• Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg/K/Na and total dissolved solids. Parameters with effects-based thresholds (e.g., CCME water quality criteria) were below their respective trigger values in 2016. • Targeted sediment bioavailability and toxicity testing was completed at TPE. Toxicity test results on *Chironomus dilutus* and *Hyalella azteca*, combined with sequential extraction tests on the sediment, indicated current chromium concentrations at TPE are unlike to adversely affect the benthic invertebrate community. Continued monitoring was recommended for 2016, but addition target studies were not recommended for 2016. • Phytoplankton and benthic invertebrate community results for the impact areas were within the range of reference/baseline conditions.
2016	• Vault discharge to Wally from June to September. No TSS treatment needed. • East dike (North-South) discharge to SP all year. • No seepage water from Rock Storage Facility to NP-2. Monitoring ongoing. • Phaser lake dewatering - August 26 to September 10 and September 15 to October 4. • Phaser Lake fishout from August 13 to 31 and September 10 to 25. • No Goose Pit reflooding activities. • Pit E and pushback assessment. • Mining focused on Vault Pit and Pit A. • Amaruq exploration road construction (km 25 at end of 2016).	• Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg/K/Na and total dissolved solids. • Similar trend of elevated chromium in sediment grab samples from TPE, but the concentrations appear stable relative to those measured in 2015. • Phytoplankton and benthic invertebrate community results for the impact areas were within the range of reference/baseline conditions.
2017	• Vault discharge to Wally from June to October. No TSS treatment needed. • East dike (North-South) discharge to SP all year except from May 12 to September 5. Discharge was also stopped from September 23 to October 29. Discharge was stopped for increasing TSS levels as no treatment is available for this location. The discharge from East Dike that was not directed to SP was discharged in the Portage Pit and then pumped to the South Cell TSF (Tailings Storage Facility). • No seepage water from Rock Storage Facility to NP-2. Monitoring ongoing. • No Goose Pit reflooding activities. • Mining focused on Vault Pit and Pit A, Pit E, and Phaser Pit. • Amaruq exploration road completed. • Phaser Pit started in November. • HCMP work completed for TP, SP and Dogleg lakes and at water crossing R02 along the AWAR. • One incident of elevated TSS from Vault road to NP-1, early June, during freshet. Barriers installed. No impacts observed to Dogleg Lake.	• Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg/K/Na and total dissolved solids. Parameters with effects-based thresholds (e.g., CCME water quality criteria) were below their respective trigger values in 2017. • Phytoplankton and benthic invertebrate community results for the impact areas were within the range of reference/baseline conditions. • Core chemistry was analyzed for all study areas in 2017. Chromium in TPE and Arsenic in WAL were flagged for follow-up assessment in 2018 based on BACI results.

Year	Major Mine-Related Activities	Receiving Environment Overview
2018	*Meadowbank* • East dike (North-South) discharge to SP all year except from June 4 to August 21. Discharge was stopped for increasing TSS levels as no treatment is available for this location. The discharge from East Dike that was not directed to SP was discharged in the Portage Pit and then pumped to the South Cell TSF (Tailings Storage Facility). • No seepage water from Rock Storage Facility to NP-2; monitoring ongoing. • No Goose Pit reflooding activities. • Mining focused on Vault Pit and Pit A, Pit E and Phaser Pit. • No discharge to Wally in 2018.	• Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg/K/Na and total dissolved solids. Parameters with effects-based thresholds (e.g., CCME water quality criteria) were below their respective trigger values in 2018. • Phytoplankton and benthic invertebrate community results for the impact areas were within the range of reference/baseline conditions. • Core chemistry was collected for TPE and WAL to follow-up on 2017 results. The 2018 results showed an overall improvement though concentrations for Chromium in TPE and Arsenic in WAL remain slightly above background concentrations.
	Whale Tail • Whale Tail Dike Construction began on July 27. • Whale Tail Pit commencement of Quarry 2 began in September. • Freshwater intake from Nemo Lake started on October 28. • Whale Tail North fishout August 13 - September 28. • Newterra Wastewater treatment system at AMQ operational in March. • Crusher activities started on the waste rock storage facility (WRSF) on October 21. • Quarry 2 overburden stripping. • Snow removal in preparation of dike construction near Mammoth Lake (WRSF dike and Mammoth Dike).	• 2018 was a transition year for the Whale Tail Mine study area. Only WTS was considered *impact* from August onwards and impacts to water quality, sediments, and biota were not found for 2018.
2019	*Meadowbank* • East dike (North-South) discharge to SP was stopped on March 30. Restarted on November 13. • No seepage water from Rock Storage Facility to NP-2; monitoring ongoing. • Goose Pit water transfer from South Cell to Goose started on June 11. • In-pit disposal started at Bay-Goose in July. • End of mine production at Phaser Pit, BB Phaser Pit, Vault (Q1), and Pit E (Q4). • No discharge to Wally in 2019. • Addition of tank infrastructure at Baker Lake (1 tank, containment for 2).	• Study focused on monitoring changes in the near field study areas in TPE, SP and WAL. • Targeted bioavailability studies conducted at TPE. • Limnology results were consistent with previous years. • Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg/K/Na, total silicon and total dissolved solids. • Phytoplankton community results for the impact areas showed an increase in biomass and taxa richness in 2019 compared to 2018. • Benthic invertebrate community results for the impact areas were within the range of reference/baseline conditions. • Core chemistry was collected for TPE to follow-up on 2018 results. Results were comparable to 2018 with concentrations of chromium in TPE still slightly above background concentrations. In 2019, concentrations of zinc in one core sample exceeded the trigger and threshold values.
	Whale Tail • Mining from the Whale Tail Pit (WTP) began in 2019. • Dewatering/Diversion pumping into Whale Tail Lake South Basin (WTS) started April 1 and is ongoing. • Dewatering of Whale Tail Lake North Basin (WTN) to WTS occurred from April 1 to April 9, May 3 to May 17 and again from May 24 to May 29. • Dewatering/Diversion pumping into Mammoth Lake (MAM) started June 22 and ended November 18. • Higher than expected precipitation in June and July required additional water management. • NE Dike impoundment pumped to AP5 and through to Nemo watershed June 21 to September 27. • Dewatering of WTN to MAM occurred from June 22 to June 30 and August 1 to October 26. • Water transfer from Quarry 1 pond to MAM August 26 to October 23. • Water seep from WTS through dike pumped back into WTS from October 4 to November 2, and November 7 to 16. • Dewatering of WTN to WTS through WTP November 7 is ongoing. • Whale Tail Dike Grouting project started on November 14 is ongoing. • Pumping from WTS to MAM occurred October 24 to December 9. • Lake A45 dewatering to the tundra near MAM shoreline occurred from November 25 to November 27.	• 2019 was a transition year for the Whale Tail study area when most lakes switched designation from *control* to *impact*. • Minor mine-related trends identified for 16 water chemistry parameters at WTS. • Phytoplankton community results for WTS and MAM showed an increase in biomass in 2019 compared to 2018. • Benthic invertebrate community results for the impact areas were within the range of baseline conditions. • Sediment chemistry results for 2019 were generally consistent with previous years and showed no indications of construction-related changes.

Year	Major Mine-Related Activities	Receiving Environment Overview
	• Construction in the South Whale Tail Channel (SWTC) between A20 and MAM began around December 1.	
2020	*Meadowbank* • East Dike seepage discharge to SP was stopped on June 5 and restarted on October 23. • No seepage water from Portage RSF to NP2; monitoring ongoing. • Tailings Discharge to Goose Pit up to July 2020 and the in-pit deposition started at Pit E started in August. • Reclaim Water Set up in Pit A completed in October. • No discharge to Wally in 2020.	• Study focused on monitoring changes in the near field study areas in TPN, TPE, SP and WAL. • Limnology results were consistent with previous years. • Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg, TDS, and alkalinity. Other minor trends were identified for reactive silica, total & dissolved silicon, and dissolved zinc which were not mine-related. • Phytoplankton community results for the impact areas showed a slight decrease in biomass and an increase in taxa richness in 2020 compared to 2019. • The sediment coring program focused on NF and reference areas only. The mean sediment concentrations exceeded the trigger for arsenic at WAL, for chromium at TPE, and for zinc at SP and TPE. Concentrations were similar or less than those in 2019. • Benthic invertebrate community data for impact areas were within the range of reference/baseline conditions.
	Whale Tail • South Whale Tail Channel (SWTC) Construction between Lake A20 and Mammoth Lake is completed. • Whale Tail Dike Remedial Grouting Project January 11 to March 25. • WRSF Dike Mitigation Work from April 8 to April 28. • NE Dike Dismantling occurred in September. • IVR Diversion Construction. • Temporary Diffuser installation in WTS occurred in October. • Fishout occurred from August 1 to September 8. • Dewatering of fishout lakes and installation of dewatering line from July to September. • Construction of IVR Ring Road and IVR Waste Dump in September. • Mining from IVR Pit began September 20. • IVR Attenuation Pond jetty occurred in October. • Dewatering completed and WTN became attenuation pond on May 20. • Water transfer from WTN to WTS from January 1 to January 26, February 11 to February 23, February 29 to March 8, March 15 to March 22, March 30 to April 3, April 15 to April 20, April 25 to April 30, and May 7 to May 15. • Water transfer from Quarry 1 to MAM from April 13 to April 15 and April 25 to April 29. • Water transfer from attenuation pond to MAM from May 20 to May 28, June 14 to July 5, July 7 to July 22, July 25 to August 5, August 7 to September 20, September 15 to October 7. • Water transfer from attenuation pond to WTS from May 28 to June 16 and October 12 to November 1, November 6 to December 2, December 5 to December 14, December 27 to December 31.	• All Whale Tail study area lakes designated as *impact* in 2020. • Minor mine-related trends identified for about 18 water chemistry parameters at WTS and MAM, about 10 parameters at NEM, and 2-7 parameters at the MF/FF areas. • Phytoplankton community results for WTS and MAM showed a decrease in biomass and total species in 2020 compared to 2019. • Sediment chemistry results showed exceedances of As, Cr and Cu in 2020; however, it is uncertain whether these changes are related to mining activities. • Benthic invertebrate community results for the impact areas were within the range of baseline conditions.

Year	Major Mine-Related Activities	Receiving Environment Overview
2021	*Meadowbank* • East Dike seepage discharge to SPL (MMER-3) stopped on May 6 and restarted on December 9. • No seepage water from Portage RSF to NP2; monitoring ongoing. • Tailings discharge to Pit E all year long, with a hiatus in July and August when tailings were discharged in the North Cell. • Reclaim Water from Pit A all year. • Reclaim Water from Pit E ongoing November to December. • Aerial application of dust suppression on the Tailings Storage Facility in August. • No discharge to Wally Lake or Third Portage Lake in 2021.	• Overall, results from NF areas were consistent with the previous 5 years demonstrating stabilization since mine activities ceased. • Minor water chemistry trigger exceedances identified for physical/ionic parameters (conductivity, hardness, TDS, alkalinity Ca/Mg/K) at NF areas TPN, TPE, SP, and WAL. Minor trigger exceedances for Si and reactive silica at SP and WAL respectively. • Long-term trend analysis on physical/ionic parameters supported the hypothesis that concentrations had increased during mine activity (2009-2013) and have now stabilized since 2014. • Phytoplankton community results for the impact areas showed a slight increase in biomass and taxa richness in 2021 compared to 2020. • Only sediment grabs were collected in 2021. A laboratory error resulted in a subset of the grab samples that were collected in 2021 to be discarded prior to analysis. Sediment chemistry results for samples that were analyzed showed no mining related temporal and spatial patterns. Sediment concentrations for a few replicates at TPE and SP exceeded the trigger for Cr (TPE only) and Zn. Concentrations were similar to 2020. • Benthic invertebrate community data for impact areas were within the range of reference/baseline conditions.
	Whale Tail • First year of operation - IVR diversion ditch. • Construction of IVR Dike D1. • Commissioning of IVR attenuation pond. • Excavation IVR West Pit began October 22. • Start of IVR WRSF. • Discharge to WTS through MDMER-5 between March 1 and June 8. • Discharge to WTS through MDMER-11 between January 1 to February 13, June 6 to June 17 and October 2 to November 23. • Discharge to Mammoth through MDMER-7 between June 9 and September 28. • Discharge to Mammoth through MDMER-8 between June 18 and August 26.	• Greatest magnitude of exceedances at NF area MAM where physical/ionic parameters (conductivity, hardness, TDS, alkalinity Ca/Mg/K), anions/nutrients (TKN, reactive silica), metals (Li and Si), and TOC/DOC exceeded triggers. • Increasing mine influence on MF areas A76 (down gradient of MAM) and A20 (inundated in summer 2019 and now connected to NF area WTS) where physical/ionic and TOC/DOC trigger exceedances occur, in addition to a threshold exceedance for P. • Phytoplankton community results for MAM, A76, and A20 showed an increase in biomass in 2021 compared to 2020. Taxa richness was similar to 2020. • A laboratory oversight upon sample receipt resulted in a subset of the grab samples that were collected in 2021 to be discarded prior to analysis. Sediment chemistry results for samples that were analyzed showed trigger exceedances in individual replicates for As, Cr, Cu, and Zn in 2021. Formal statistical assessment is planned for the next coring event in 2023. • Benthic invertebrate community results for the impact areas were within the range of baseline conditions.
2022	*Meadowbank* • Construction of additional 3.3ML fuel tank, completed in January 2023. • All Weather Access Road bridge repair/ maintenance ongoing (at KM 62 and 69). • East Dike seepage discharge to SPL (MMER-3) from January 1 to January 25, from April 7 to April 30, and from November 20 until the end of the year. • Reclaim Water from Pit A from January 1 to mid-April. • Reclaim Water from Pit E from mid-April until the end of 2022. • Aerial application of dust suppression on the Tailings Storage Facility in August. • Tailings discharge to Pit E all year long. • No discharge to Wally or Third Portage Lake in 2022.	• Overall, results from NF areas were consistent with the previous six years demonstrating stabilization since mine activities ceased. • Minor water chemistry trigger exceedances were identified for physical/ionic parameters (conductivity, alkalinity, hardness, TDS, Ca/Mg/K) at one or more NF areas TPN, TPE, SP, and WAL. Minor trigger exceedances identified for reactive silica at WAL and total and dissolved silicon at SP. • Phytoplankton community results for the impact areas in 2022 showed that total biomass was higher than reference/baseline conditions, though results were not statistically significant. Only slight changes reported for taxa richness compared to baseline/reference. • Sediment grabs were collected in 2022 and analyzed for grain size, and TOC. Remaining sediment was archived for chemistry analysis. The next sediment coring program to review trends in chemistry is planned for August 2023. • Benthic invertebrate community data for impact areas were within the range of reference/baseline conditions except for taxa richness at SP in the 2019-2022 time period which showed an apparent increase relative to reference/baseline conditions.
	Whale Tail • Commercial production from the underground mine began in 2022. • Landfarm construction completed on September 30. • Discharge to WTS through MDMER-11: sporadic in January, February and April, from May 22 to June 16, and from October 3 to October 29. • Discharge to Mammoth Lake through MDMER-8 between June 16 and September 20.	• Greatest magnitude of exceedances at MF area A20 where physical/ionic parameters (conductivity, hardness, TDS, alkalinity, Ca/Mg/K/Na), anions/nutrients (TKN, total phosphorus), and TOC/DOC exceeded triggers. Only metals that exceeded the trigger in 2022 were lithium at NF area MAM and titanium at WTS. Total phosphorus, a parameter with an effects-based threshold exceeded the trigger at WTS, MAM, and A20. • Increasing mine influence on MF areas A76 (downgradient of MAM) and A20 (inundated in summer 2019 and now connected to NF area WTS).

Year	Major Mine-Related Activities	Receiving Environment Overview
	• Construction of a thermal berm at the West abutment of Whale Tail Dike (upstream) from September 24 to September 30.	• Phytoplankton community results for WTS, MAM, A20, and A76 showed an increase in biomass in 2022 compared to reference/baseline, but results were not significant. Taxa richness was similar to 2021. • Sediment chemistry results for samples that were analyzed showed trigger exceedances in individual replicates for As, Cu, Cd, and Zn in 2022. Formal statistical assessment is planned for the next coring event in 2023. • Benthic invertebrate abundance and taxa richness increased at MAM and NEM compared to baseline/reference. Taxa richness also increased compared to baseline/reference at A20, however only in some of the time periods assessed.

2 CREMP STUDY DESIGN

2.1 Overview

To streamline the annual report and reduce redundancy, aspects of the CREMP study design presented in the *CREMP Plan* are not repeated herein. Readers looking for detailed information on the aspects of the study design such as sampling methods, QA/QC protocols and procedures, and data evaluation criteria are referred to Azimuth (2022b). A summary of the CREMP study design is included to guide the reader.

2.2 Routine CREMP Sampling

2.2.1 Sampling Areas

The CREMP is designed to detect spatial and temporal changes in water quality, sediment chemistry, or biological communities (phytoplankton and benthos) at the scale of the lake or basin, in the case of large lakes such as Third Portage Lake. A common element for the Meadowbank and Whale Tail study designs is the use of near-field (NF), mid-field (MF), and far-field (FF) areas to provide spatial context when interpreting potential changes year-over-year. Near-field areas provide the first line of early-warning for introductions of stressors into the receiving environment. These areas are situated closest to the development near dikes, dewatering discharge points, and proposed effluent sources. MF and FF areas are located farther downstream from the NF monitoring areas and provide insights into the spatial extent of any observed changes in chemistry or biological communities closer to the source. Brief descriptions of the Meadowbank, Whale Tail, and Baker Lake study areas are provided below.

Meadowbank

There are nine sampling areas included in the Meadowbank CREMP. Third Portage Lake East Basin and North Basin (TPE and TPN), Second Portage Lake (SP), and Wally Lake (WAL) are the NF areas monitored annually for changes related to operations at the Meadowbank mine and mill. Starting in 2023, MF areas Tehek Lake (TE), the South Basin of Third Portage Lake (TPS), and FF area Tehek Lake far-field (TEFF) are monitored only if *moderate changes*[4] are detected upstream at the NF locations consistent with the strategy outline in **Section 2.2.3** (Azimuth, 2022b). Two reference areas are shared for the Meadowbank and Whale Tail programs: Inuggugayualik Lake (INUG) and Tasirjuaraajuk Lake (aka Pipedream Lake [PDL]). INUG has been the core reference area since formal monitoring began in 2006. PDL was added to

[4] *Moderate changes* in water quality are defined as statistically significant increases exceeding the early warning trigger for parameters with effects-based thresholds (i.e., CCME FWAL).

the Meadowbank CREMP in 2009; while the absence of data at this area from 2006 to 2008 make its utility limited in the BACI statistical analyses, it provides insights into the strength of regional patterns (i.e., how well it matches INUG).

The 2022 sampling areas for the Meadowbank CREMP are shown in **Figure 4-1** (water and phytoplankton) and **Figure 4-2** (sediment and benthos).

Whale Tail

There are six lakes currently included in the Whale Tail CREMP study design. Whale Tail Lake South Basin (WTS) and Mammoth Lake (MAM) are NF areas designed to detect changes related to dike construction in Whale Tail Lake and Mammoth Lake and discharge of treated water during operations. Nemo Lake (NEM) is also considered a NF area because of its proximity to the site, even though it is situated in a different watershed. MF areas are Lake A20 (upstream from WTS, but joined to WTS after flooding) and Lake A76 located downstream from MAM. Lake A76 is situated at the junction of the two flow paths leading to Lake DS1. Given its morphology and location, it represents an ideal MF exposure area for both flow paths. Lake DS1 is the FF location to provide additional context for characterizing spatial extent of effects.

The 2022 sampling areas for the Whale Tail CREMP are shown in **Figure 5-1** (water and phytoplankton) and **Figure 5-2** (sediment and benthos).

Baker Lake

There are two NF areas for the Baker Lake CREMP, one targeting the hamlet's barge landing area (Baker Barge Dock [BBD]) and the other Agnico's fuel storage facility (Baker Proposed Jetty[5] [BPJ]). The primary reference area for Baker Lake is located approximately 10 kilometers east of the hamlet along the north shore of the lake (Baker Akilahaarjuk Point [BAP]). A second reference area on the East Shore of Baker Lake (BES) between BAP and BPJ was added in 2011 to provide additional context for interpretation of sediment chemistry and benthic invertebrate data.

The 2022 sampling areas for the Baker Lake CREMP are shown in **Figure 6-1.**

2.2.2 Monitoring Components

Water quality, sediment quality, phytoplankton community, and benthic invertebrate community were monitored in the core 2022 program. Sampling was undertaken according to SOPs provided in the *CREMP Plan* (Azimuth, 2022b). Locations for water, limnology, and phytoplankton were selected randomly for the Meadowbank and Baker lakes areas from within their respective lake basins. The

[5] Note that while a jetty was initially considered, the idea was abandoned in favour of continued use of the existing barge landing.

Whale Tail study area lakes are smaller and more variable in depth compared to the Meadowbank project lakes. Fixed water quality monitoring locations are used for the Whale Tail study area lakes to avoid selecting locations in less than 5 m of water. Two fixed locations were randomly selected for water quality and phytoplankton community monitoring in each full event. Water sampling was completed in March, May, July, August, and September as per the study design. A single limnology profile is taken at the NF areas during the remaining winter months, when travel on ice is safe, to verify water quality is within the range of expected conditions. In 2022, limnology only monitoring occurred in January, February, April, November, and December[6].

Sediment for chemistry and benthic invertebrate community analyses were collected from the established areas (i.e., depositional zones between 6.5 m and 9 m) in each basin/lake.

Table 2-1 lists the monitoring components sampled at the various study areas in 2022. Global Positioning System (GPS) Universal Transverse Mercator (UTM) coordinates (in NAD 83) are shown in **Table 2-2** for all CREMP study areas.

Samples from the 2022 CREMP were sent to the laboratories listed below for analysis:

- Water and bulk sediment chemistry – ALS Laboratories (Burnaby, BC)
- Phytoplankton taxonomy – Plankton R Us Inc. (Winnipeg, MB)
- Benthic invertebrate taxonomy – ZEAS Inc. (Nobleton, ON)

2.2.3 Sampling Effort

A results-driven sampling strategy for the Meadowbank study lakes was developed as part of the *CREMP Plan* (Azimuth, 2015b) which was then updated in 2022 (Azimuth, 2022b). The strategy was developed to increase the efficiency of the CREMP by focusing resources on monitoring in the areas most likely to be affected by mining-related activities. The decision framework outlines when the frequency of monitoring at MF and FF areas can safely be reduced. The annual decision framework presented in the 2022 *CREMP Plan Update* applies to MF and FF areas at Meadowbank (Azimuth, 2022b; **Figure 2-1** [below]). More specifically, the framework applies to MF area TE (which is paired with upstream NF areas TPE, SP, and WAL), MF area TPS (which is paired with NF area TPN), and to FF area TEFF (which is paired with upstream MF area TE). The same strategy may eventually be implemented at Whale Tail as more years of ‘after’ data become available. For the time being, monitoring at Whale Tail MF and FF areas will continue at the same frequency as the NF areas (i.e., there were five water chemistry/phytoplankton sampling events in 2022).

[6] Limnology only profiles are collected at a subset of the areas.

As per the normal Meadowbank CREMP data analysis process, NF results are evaluated on an annual basis (i.e., with CREMP reporting due at the end of March following each monitoring year), with the NF results (i.e., for *Year*) dictating the monitoring requirements for the MF area in the subsequent year (i.e., *Year +1*). The Year +1 NF and MF results are used as the basis to determine the MF and FF monitoring requirements for Year +2, and so on. While the full CREMP program will be conducted at each NF area each year, the specific monitoring requirements for the MF and FF areas vary based on the NF and MF results, respectively. Below are the various outcomes of the CREMP data analysis and associated program requirements for MF and FF areas in the following year (see Azimuth, 2022b for more details):

- No changes identified – no statistical changes above any trigger values. No further sampling required.
- Minor changes identified – statistically significant changes exceeding the early warning trigger values for parameters without effects-based threshold values (i.e., trigger values are based on the 95th percentile of the baseline distribution). No further sampling required at MF and FF areas unless moderate changes (see below) are identified in NF areas.
- Moderate changes identified – statistically significant changes exceeding the early warning trigger values for parameters with effects-based thresholds (e.g., CCME water quality guidelines for water chemistry parameters). Full CREMP water sampling (all events) is required to determine if changes extend to MF area (or to FF if such changes are seen at an MF area).
- Major changes identified – statistically significant changes exceeding the effects-based threshold values. Full CREMP program including sediment and biological components is required to determine if changes extend to MF area (or to FF if such changes are seen at an MF area).

Minor changes to water quality parameters without toxicologically-derived effects-based thresholds were identified in the 2021 CREMP (Azimuth, 2022a). Following the strategy outlined above, these results warranted a pared-down monitoring program at MF (TPS and TE) and FF (TEFF) areas in 2022. Water sampling through-ice was completed (at NF, MF and FF areas) in March 2022, but further water sampling at MF or FF areas during the open-water season was not completed.

Table 2-1. CREMP sampling summary, 2022.

Sampling Month	Sampling Crew	Conditions	Components	Meadowbank Areas									Baker Lake Areas				Whale Tail Areas					
				INUG	PDL	TPN	SP	TPE	WAL	TPS	TE	TEFF	BAP	BES	BBD	BPJ	WTS	MAM	NEM	A20	A76	DS1
				REF	REF	NF	NF	NF	NF	MF	MF	FF	REF	REF	NF	NF	NF	NF	NF	MF	MF	FF
January	Agnico	Ice	L			✓	✓	✓	✓								✓	✓	✓	✓		
February	Agnico	Ice	L			✓	✓	✓	✓								✓	✓	✓	✓		
March	Agnico	Ice	L,W,P	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓
April	Agnico	Ice	L			✓	✓	✓	✓								✓	✓	✓	✓		
May	Agnico	Ice	L,W,P	✓	✓	✓	✓	✓	✓								✓	✓	✓	✓	✓	✓
June	***Ice not safe***																					
July	Agnico	Open-water	L,W,P	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	✓	✓	✓	✓
August	Azimuth	Open-water	L,W,P	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	✓	✓	✓	✓
			B,S	✓	✓	✓	✓	✓	✓								✓	✓	✓	✓	✓	✓
September	Agnico	Open-water	L,W,P	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	✓	✓	✓	✓
October	***Ice not safe***																					
November	Agnico	Ice	L			✓	✓	✓	✓								✓	✓	✓	✓		
December	Agnico	Ice	L			✓	✓	✓	✓								✓	✓	✓	✓		

Notes:
Components: L=Limnology; W=Water chemistry; P=Phytoplankton; B=Benthic invertebrates; S=Sediment grab chemistry.
✓ = monitoring components were collected.
Area designations: C=Control; I=Impact; REF=reference (in grey shading); NF=near-field (in blue shading); MF=mid-field (in pink shading); FF=far-field (in teal shading)
Area IDs: Meadowbank and Whale Tail Reference areas: INUG = Inuggugayualik Lake; PDL = Pipedream Lake. Meadowbank areas: TPN, TPE, TPS = Third Portage Lake – North, East, South basins; SP = Second Portage Lake; WAL = Wally Lake; TE, TEFF = Tehek Lake (Mid-field and Far-field). Baker Lake areas: BAP, BES, BBD, BPJ=Baker Lake – Akilahaarjuk Point, East Shore, Barge Dock, Proposed Jetty. Whale Tail areas: WTS = Whale Tail Lake South Basin; MAM = Mammoth Lake; NEM = Nemo Lake; A20 = Lake A20; A76 = Lake A76; DS1 = Lake DS1.

Table 2-2. CREMP sampling coordinates for Meadowbank, Whale Tail, and Baker Lake study areas, 2022.

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
Meadowbank													
TPE	NF	TPE-limno	January	7.0	14W	638175	7211299	TPE-1	B & C	7.8	14W	639064	7211506
		TPE-limno	February	11.5	14W	638060	7211318	TPE-2	B & C	8.9	14W	639101	7211535
		TPE-limno	April	5.6	14W	639210	7211124	TPE-3	B & C	8.5	14W	639127	7211560
		TPE-limno	November	11.1	14W	638273	7211785	TPE-4	B & C	8.4	14W	639135	7211761
		TPE-limno	December	9.5	14W	637773	7211700	TPE-5	B & C	6.8	14W	639149	7211701
		TPE-150	March	5.2	14W	639599	7210648	TPE-COMP	C				
		TPE-151	March	12.1	14W	637861	7210160						
		TPE-152	May	14.7	14W	639346	7212579						
		TPE-153	May	9.5	14W	637773	7211700						
		TPE-154	July	5.0	14W	639317	7211154						
		TPE-155	July	8.4	14W	638493	7211609						
		TPE-156	August	17.4	14W	637858	7211408						
		TPE-157	August	16.2	14W	639473	7211752						
		TPE-158	September	6.3	14W	639086	7212428						
		TPE-159	September	5.3	14W	639728	7210566						
TPN	NF	TPN-limno	January	8.9	14W	636212	7213476	TPN-1	B & C	8.5	14W	636335	7215520
		TPN-limno	February	10.4	14W	636309	7214389	TPN-2	B & C	7.9	14W	636362	7215535
		TPN-limno	April	12.0	14W	635934	7213876	TPN-3	B & C	8.5	14W	636395	7215546
		TPN-limno	November	>20	14W	636501	7213401	TPN-4	B & C	8.4	14W	636412	7215527
		TPN-limno	December	9.1	14W	636212	7213476	TPN-5	B & C	7.7	14W	636464	7215476
		TPN-150	March	11.3	14W	634265	7215091	TPN-COMP	C				
		TPN-151	March	9.3	14W	635693	7212863						
		TPN-152	May	14.5	14W	634710	7216091						
		TPN-153	May	>20	14W	636432	7212984						
		TPN-154	July	10.3	14W	634232	7215068						
		TPN-155	July	8.9	14W	635393	7212840						

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
TPN	NF	TPN-156	August	18.3	14W	635720	7213544						
		TPN-157	August	7.0	14W	634360	7214728						
		TPN-158	September	>20	14W	635435	7213507						
		TPN-159	September	15.5	14W	636647	7214381						
TPS	MF	TPS-67	March	>20	14W	633534	7207729						
		TPS-68	March	9.4	14W	635337	7208532						
SP	NF	SP-limno	January	11.9	14W	640387	7213530	SP-1	B & C	9	14W	640006	7214081
		SP-limno	February	8.9	14W	639728	7214012	SP-2	B & C	6.9	14W	640030	7214130
		SP-limno	April	10.8	14W	640104	7212802	SP-3	B & C	8.3	14W	640050	7214150
		SP-limno	November	6.2	14W	639469	7213816	SP-4	B & C	8.3	14W	640072	7214179
		SP-limno	December	8.5	14W	639831	7213176	SP-5	B & C	8.3	14W	640078	7214202
		SP-150	March	10.7	14W	640199	7212663	SP-COMP	C				
		SP-151	March	5.1	14W	639909	7213787						
		SP-152	May	9.2	14W	640513	7213767						
		SP-153	May	5.8	14W	639441	7213977						
		SP-154	July	15.4	14W	640274	7213659						
		SP-155	July	12.4	14W	639711	7214076						
		SP-156	August	>20	14W	640746	7213485						
		SP-157	August	>20	14W	639877	7213962						
		SP-158	September	7.1	14W	639779	7213922						
		SP-159	September	11.7	14W	640197	7212666						
TE	MF	TE-102	March	9.2	15W	360065	7212195						
		TE-103	March	6.0	15W	361085	7213162						
TEFF	FF	TEFF-54	March	6.8	15W	362805	7209899						
		TEFF-55	March	5.3	15W	364427	7209626						
WAL	NF	WAL-limno	January	6.9	15W	361000	7220338	WAL-1	B & C	8.6	15W	360959	7220390
		WAL-limno	February	6.9	15W	360931	7221897	WAL-2	B & C	8.0	15W	360930	7220426
		WAL-limno	April	7.6	15W	361814	7222869	WAL-3	B & C	8.6	15W	360918	7220464
		WAL-limno	November	5.6	15W	360906	7220846	WAL-4	B & C	9.2	15W	360924	7220491

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
WAL	NF	WAL-limno	December	6.5	15W	361859	7221866	WAL-5	B & C	8.7	15W	360902	7220519
		WAL-119	March	6.7	15W	360817	7220858	WAL-COMP	C				
		WAL-120	March	5.6	15W	361959	7222849						
		WAL-121	May	5.0	15W	360772	7221563						
		WAL-122	May	7.0	15W	361477	7222326						
		WAL-123	July	5.7	15W	361224	7221652						
		WAL-124	July	6.1	15W	360395	7222416						
		WAL-125	August	5.7	15W	360430	7221328						
		WAL-126	August	5.7	15W	362009	7221946						
		WAL-127	September	9.8	15W	360872	7220593						
		WAL-128	September	9.6	15W	361804	7222670						
INUG	Ref	INUG-138	March	7.8	14W	622709	7215333	INUG-1	B & C	8.4	14W	622834	7216813
		INUG-139	March	7.7	14W	622975	7216889	INUG-2	B & C	7.8	14W	622775	7216784
		INUG-140	May	7.1	14W	621941	7216052	INUG-3	B & C	8.3	14W	622740	7216785
		INUG-141	May	7.6	14W	622139	7214347	INUG-4	B & C	8.4	14W	622720	7216787
		INUG-142	July	6.2	14W	622817	7216849	INUG-5	B & C	9	14W	622757	7216749
		INUG-143	July	6.3	14W	621873	7216651	INUG-COMP	C				
		INUG-144	August	8.5	14W	622832	7215662						
		INUG-145	August	5.8	14W	621843	7214900						
		INUG-146	September	7.2	14W	622814	7215282						
		INUG-147	September	6.8	14W	621917	7216059						
PDL	Ref	PDL-103	March	>20	14W	632420	7225007	PDL-1	B & C	7.3	14W	630568	7223002
		PDL-104	March	14.7	14W	630372	7225508	PDL-2	B & C	7	14W	630543	7222980
		PDL-105	May	10.2	14W	632184	7224365	PDL-3	B & C	7.5	14W	630578	7223022
		PDL-106	May	10.5	14W	630057	7222846	PDL-4	B & C	7	14W	630594	7223047
		PDL-107	July	6.3	14W	630317	7224689	PDL-5	B & C	6.8	14W	630605	7223066
		PDL-108	July	>20	14W	631485	7224202	PDL-COMP	C				
		PDL-109	August	5.7	14W	630588	7223958						

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
PDL	Ref	PDL-110	August	11.0	14W	631395	7223904						
		PDL-111	September	13.8	14W	629936	7222801						
		PDL-112	September	11.1	14W	632184	7224365						
Baker Lake													
BBD	NF	BBD-79	July	12.1	14W	644517	7135146						
		BBD-80	July	17.6	14W	643900	7135191						
		BBD-81	August	9.5	14W	644676	7135247						
		BBD-82	August	9.4	14W	644949	7135311						
		BBD-83	September	13.1	14W	643886	7135207						
		BBD-84	September	5.7	14W	644880	7135234						
BPJ	NF	BPJ-79	July	>20	15W	356702	7134169						
		BPJ-80	July	10.4	15W	357332	7134014						
		BPJ-81	August	6.9	15W	357409	7134026						
		BPJ-82	August	>20	15W	356716	7133413						
		BPJ-83	September	10.9	15W	356598	7134408						
		BPJ-84	September	10.9	15W	357329	7134017						
BAP	Ref	BAP-79	July	>20	15W	363607	7131058						
		BAP-80	July	>20	15W	364234	7130683						
		BAP-81	August	10.7	15W	362923	7131474						
		BAP-82	August	14.6	15W	363507	7131191						
		BAP-83	September	16.6	15W	363440	7131195						
		BAP-84	September	8.9	15W	364128	7131087						
Whale Tail													
WTS	NF	WTS-limno	January	7.9	14W	607373	7254408	WTS-1	B & C	9.3	14W	607140	7253547
		WTS-limno	February	8.9	14W	607596	7254078	WTS-2	B & C	8.4	14W	607178	7253515
		WTS-limno	April	11.9	14W	607429	7253943	WTS-3	B & C	9.5	14W	607115	7253593
		WTS-limno	November	10.3	14W	607448	7253810	WTS-4	B & C	8.3	14W	607094	7253671
		WTS-limno	December	14.4	14W	607415	7254394	WTS-5	B & C	9.4	14W	607155	7253658

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
WTS	NF	WTS-67	March	8.5	14W	607612	7253907	WTS-COMP	C				
		WTS-68	March	10.7	14W	607159	7253588						
		WTS-69	May	14.2	14W	607385	7254484						
		WTS-70	May	10.0	14W	607163	7253609						
		WTS-71	July	8.8	14W	607638	7254078						
		WTS-72	July	10.4	14W	607120	7253603						
		WTS-73	August	9.1	14W	607156	7253538						
		WTS-74	August	11.5	14W	607362	7254445						
		WTS-75	September	15.5	14W	607390	7254488						
		WTS-76	September	10.7	14W	607163	7253609						
MAM	NF	MAM-limno	January	8.0	14W	604902	7254822	MAM-1	B & C	8.4	14W	605062	7254888
		MAM-limno	February	5.2	14W	605160	7254898	MAM-2	B & C	7.7	14W	605044	7254883
		MAM-limno	April	5.8	14W	605131	7254831	MAM-3	B & C	7.9	14W	605018	7254885
		MAM-limno	November	9.5	14W	604435	7254499	MAM-4	B & C	8.2	14W	604988	7254874
		MAM-limno	December	8.1	14W	604986	7254854	MAM-5	B & C	9.2	14W	605023	7254855
		MAM-67	March	9.7	14W	605359	7255129	MAM-COMP	C				
		MAM-68	March	15.8	14W	604059	7254491						
		MAM-69	May	7.8	14W	604455	7254539						
		MAM-70	May	9.5	14W	605354	7255109						
		MAM-71	July	8.1	14W	604068	7254478						
		MAM-72	July	12.9	14W	605393	7255097						
		MAM-73	August	7.8	14W	604211	7253845						
		MAM-74	August	6.0	14W	605345	7254988						
		MAM-75	September	8.1	14W	604357	7254348						
		MAM-76	September	8.0	14W	604972	7254844						
NEM	NF	NEM-limno	January	9.9	14W	606474	7257094	NEM-1	B & C	8.9	14W	606543	7257384
		NEM-limno	February	10.8	14W	606563	7257501	NEM-2	B & C	8.5	14W	606550	7257365
		NEM-limno	April	12.8	14W	606411	7257433	NEM-3	B & C	8.6	14W	606524	7257306

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
NEM	NF	NEM-limno	November	9.9	14W	606524	7257367	NEM-4	B & C	6.7	14W	606558	7257328
		NEM-limno	December	12.1	14W	606407	7257509	NEM-5	B & C	7	14W	606563	7257345
		NEM-67	March	18.7	14W	606671	7257916	NEM-COMP	C				
		NEM-68	March	13.1	14W	606184	7257633						
		NEM-69	May	8.4	14W	606131	7257409						
		NEM-70	May	12.4	14W	606992	7257819						
		NEM-71	July	13.9	14W	606979	7257832						
		NEM-72	July	14.6	14W	606152	7257527						
		NEM-73	August	8.4	14W	606094	7257633						
		NEM-74	August	8.7	14W	607113	7257842						
		NEM-75	September	7.8	14W	606411	7257025						
		NEM-76	September	6.2	14W	606389	7257854						
A20	MF	A20-limno	January	9.6	14W	604578	7252577	A20-1	B & C	7.6	14W	604607	7252539
		A20-limno	February	8.9	14W	604590	7252559	A20-2	B & C	8	14W	604650	7252543
		A20-limno	April	5.8	14W	604728	7252531	A20-3	B & C	8.3	14W	604625	7252500
		A20-limno	November	5.0	14W	604748	7252558	A20-4	B & C	8.2	14W	604669	7252524
		A20-limno	December	6.2	14W	605160	7252761	A20-5	B & C	8.2	14W	604608	7252558
		A20-61	March	>20	14W	604387	7252618	A20-COMP	C				
		A20-62	March	5.9	14W	605157	7252791						
		A20-63	May	6.5	14W	604605	7252513						
		A20-64	May	5.6	14W	605204	7252788						
		A20-65	July	6.2	14W	604687	7252485						
		A20-66	July	5.6	14W	605251	7252790						
		A20-67	August	6.0	14W	604688	7252452						
		A20-68	August	6.0	14W	605234	7252752						
		A20-69	September	5.4	14W	604706	7252475						
		A20-70	September	5.7	14W	605219	7252782						
A76	MF	A76-59	March	14.6	14W	602505	7257147						

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
A76	MF	A76-60	March	11.8	14W	601716	7256886						
		A76-61	May	5.0	14W	601832	7256959	A76-1	B & C	8.9	14W	602277	7256913
		A76-62	May	14.6	14W	602554	7257152	A76-2	B & C	7.7	14W	602228	7256929
		A76-63	July	5.6	14W	602129	7256983	A76-3	B & C	8	14W	602278	7256944
		A76-64	July	12.6	14W	601732	7256880	A76-4	B & C	7.9	14W	602291	7256978
		A76-65	August	13.0	14W	601768	7256853	A76-5	B & C	8	14W	602209	7256941
		A76-66	August	14.6	14W	602556	7257131	A76-COMP	C				
		A76-67	September	8.8	14W	602391	7257048						
		A76-68	September	7.9	14W	601744	7256971						
DS1	FF	DS1-57	March	12.8	14W	597514	7261555	DS1-1	B & C	8	14W	598030	7262012
		DS1-58	March	9.3	14W	598022	7258275	DS1-2	B & C	7.1	14W	598092	7262011
		DS1-59	May	>20	14W	597582	7260651	DS1-3	B & C	8	14W	598070	7262059
		DS1-60	May	8.4	14W	598029	7258283	DS1-4	B & C	7.9	14W	598107	7262012
		DS1-61	July	13.1	14W	597514	7261544	DS1-5	B & C	8.8	14W	598121	7261968
		DS1-62	July	6.0	14W	598020	7258260	DS1-COMP	C				
		DS1-63	August	9.7	14W	597851	7258433						
		DS1-64	August	6.3	14W	597796	7260913						
		DS1-65	September	5.7	14W	598029	7258283						
		DS1-66	September	7.5	14W	597514	7261555						

Notes:

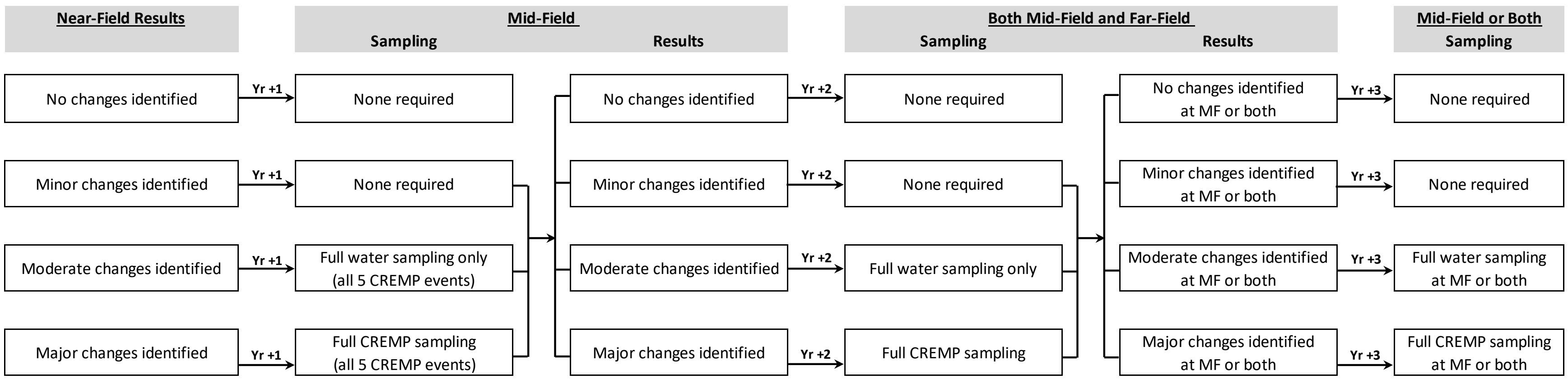
1. Area IDs are as follows: TPE, TPN, TPS=Third Portage Lake - East, North, South basins; SP=Second Portage Lake; TE, TEFF=Tehek Lake - Farfield; INUG=Inuggugayualik Lake; WAL=Wally Lake; PDL=Pipedream Lake; BBD, BPJ, BES, BAP=Baker Lake - Barge Dock, Proposed Jetty, East Shore, Akilahaarjuk Point. WTS = Whale Tail Lake – South Basin; MAM = Mammoth Lake; NEM = Nemo Lake.
2. Area types: NF=near-field; MF=mid-field; FF=far-field; Ref=reference.
3. Sample types: B=Benthos; C=chemistry; Comp = composite sample of all 5 replicate samples from each area (no coordinates).
4. Comp = composite sample of all 5 replicate samples from each area (no coordinates).

Note that water sampling at BES and sediment/benthic invertebrate sampling at TPS, TE, or TEFF was not completed as per the study design (Azimuth, 2015b).

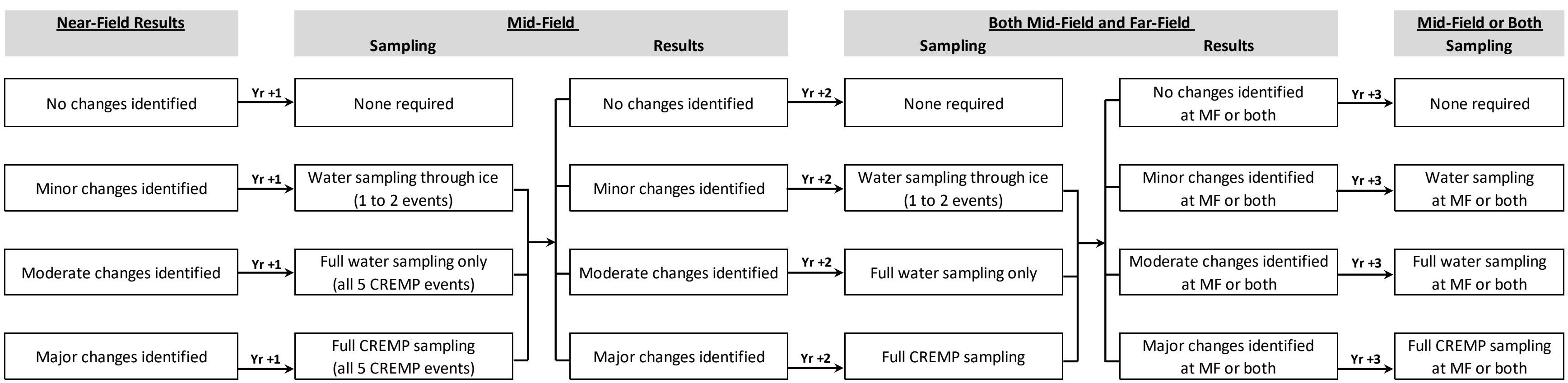
N/R = depth not recorded (no limnology data for this sample).

Figure 2-1. Annual results-based sampling strategy rules for mid-field and far-field sampling areas.

Meadowbank Study Area Lakes



Whale Tail Study Area Lakes



2.3 Data Evaluation Criteria

The specific methods used to apply triggers/thresholds in the evaluation of CREMP monitoring parameters varied by study component; details are presented in the following sections. The evaluation process focused on comparisons to early warning triggers; only when triggers were exceeded were monitoring results compared to effects-based thresholds. Consequently, methods for applying numerical decision criteria focus on triggers only, but apply equally to threshold values.

2.3.1 Water Chemistry

An iterative process was utilized to identify water chemistry parameters of primary concern at the Meadowbank, Whale Tail, and Baker Lake project areas. For each water chemistry parameter analyzed, the yearly mean concentration for each lake or basin was compared to its respective trigger value. Parameters where the yearly mean was equal to or exceeded the trigger value were formally tested using the Before-After-Control-Impact (BACI) statistical model. In addition to BACI analysis, a trigger screening assessment was conducted to evaluate the extent of changes in water quality as a guide for decision making (See **Section 2.2.3**). Finally, a conservative three-step assessment process was used to identify parameters to include in the formal trend assessment to streamline the interpretation process. In this assessment, water chemistry trends were examined broadly for all parameters meeting detection limits (>10% of samples > method detection limit [MDL]), control-impact, and mine related criteria outlined below.

Trigger Evaluation

Water quality data collected in 2022 were evaluated against triggers and effects-based thresholds consistent with the two-tiered approach outlined in **Section 1.5**. Formal comparison of the water quality data for decision-making purposes was done by comparing the yearly mean[7] parameter concentrations to the trigger values developed separately for the Meadowbank area lakes, Wally Lake[8], Baker Lake areas, and the Whale Tail area lakes[9]. The derivation methods and a full list of triggers and effects-based thresholds for each study area are provided in the *CREMP Plan*[10] (Azimuth, 2022).

Parameters where the yearly mean was equal to, or exceeded the trigger value were formally tested using a one-tailed test of the null hypothesis[11] (significance level of p=0.05) using the Before-After-

[7] Yearly means were calculated by first calculating the monthly mean for each parameter per area, then calculating the yearly mean on an area-specific basis. Values that were less than the MDL were conservatively set to the MDL.

[8] Separate water quality triggers were developed for Wally Lake from the other Meadowbank areas when mining activities transitioned from the North and South Portage Pits (discharge to TPN) to the Vault Lake area (discharge to WAL) in 2013.

[9] Water quality triggers specific to the Whale Tail study area lakes were developed in 2019 (Azimuth, 2020a).

[10] The CREMP plan was revised in April 2022 and was formally implemented in August 2022.

[11] The null hypothesis is that “test” area concentrations either did not change or decreased. The alternative hypothesis is that they increased.

Control-Impact (BACI) statistical model. The BACI model is *paired* (i.e., BACIP) when multiple *before* and *after* events are available. Across each of the study areas, the following BACI components were included in the analysis:

- **Meadowbank Study Area Lakes and Wally Lake**: In the BACI model, INUG was used as the reference (*control*) area[12], with the other areas tested as exposure (*impact*) areas. True *pre-impact* data, when both INUG and the test area had *control* ("C") status, were used for the *before* data (see **Table 2-3**). Only events when both INUG and the test area were sampled in 2022 were used as the *after* data.
- **Whale Tail**: BACI analysis followed the approaches outlined for Meadowbank including INUG as the reference (*control*) area.
- **Baker Lake**: Baker Lake areas were designated as *control* (BAP) or *impact* (BPJ and BBD) when sampling started in 2008 (i.e., there was no detailed baseline sampling conducted for Baker Lake; see **Table 2-3**), so there are no true *pre-impact* or *before* data. While a spatial *CI* design could be used to test for differences between reference *control* and exposure *impact* areas, the design does not allow for distinguishing natural differences between areas from development-related changes. Given that no development-related changes had been identified to date, all years of data up to and including 2019 were considered in the *before* period, while the 2020 results were considered *after* period data (i.e., allowing the more robust BACI analysis). The BACI analyses specifically looked at changes in 2022 at the two *impact* areas relative to previous years.

In addition to BACI analysis, a trigger screening assessment was conducted to evaluate the extent of changes in water quality as a guide for decision making. This approach falls into the framework outlined in **Section 2.2.3** and involved evaluating the extent and magnitude of trigger exceedances to direct the level of sampling intensity in proceeding years.

Parameter Assessment

Given the number of parameters routinely below laboratory MDLs (i.e., thus providing little insight for assessing mine-related changes to water quality), a conservative three-step assessment process was used to identify parameters to include in the formal trend assessment to streamline the interpretation process (the results are summarized in **Table 4-2**):

- **Overall Detection Frequency** – Only those water quality parameters that exceeded MDLs in at least 10% of the samples are included for this discussion. Because the project lakes are ultra-

[12] PDL and TEFF are excluded as control areas in the BACI analysis because neither area was sampled in the before period between 2006 and 2008 (i.e., limiting their utility as reference areas in the BACI model, but both providing valuable context for interpreting the strength and consistency of regional trends seen at INUG).

oligotrophic, it is normal for many parameters to be below MDLs. The temporal (and spatial) trend assessment includes data from all study years. In 2022, just over half (54%) the parameters exceeded MDLs at least 10% of the time. These parameters are included in this discussion. Overall, there were no changes in detection frequency between 2021 and 2022.

- **Control-Impact Detection Frequency Comparison** – To avoid screening out infrequently detected parameters that were detected more often in association with mining activities, the proportion of samples exceeding MDLs between *control* and *impact* samples was compared. The intent was to identify parameters with <10% detection frequency (i.e., those screened out above) for which the proportion of detected values increased by 0.1 or more. Based on this second screening, no parameters were added back into the trend assessment.
- **Apparent Detection Pattern Matching Mining Activity** – As a further step to avoid screening out potentially important parameters at Meadowbank and Whale Tail study area lakes, trend plots for infrequently detected parameters were used to visually identify parameters with measured values associated with periods/locations of known mining activities (see **Table 1-1**). Where such patterns were observed or where parameters were measured at greater than five times the MDL at near-field sampling areas in at least one event, these parameters were added back into the trend assessment process.

FEIS Model Comparisons

In addition to the trigger/threshold BACI evaluation, the 2022 CREMP water quality data at Meadowbank and Whale Tail study area lakes were compared to water quality predictions developed as part of the FEIS process introduced in **Section 1.5**.

- **Meadowbank Study Area Lakes and Wally Lake** – Annual Meadowbank CREMP water quality data were also compared to the maximum whole-lake average water quality modelling predictions for Third Portage, Second Portage, and Wally Lakes made during the environmental assessment process (Cumberland, 2005).
- **Whale Tail** – Monthly Whale Tail CREMP water quality data for Whale Tail Lake (South Basin) and Mammoth Lake were compared to their respective water quality monthly modeled predictions presented in the revised FEIS for the Expansion Project (see Golder, 2019).

While direct comparisons were made, the difference in spatial focus (i.e., the CREMP at the basin scale and the water quality model at the whole-lake scale) warrants caution interpreting any differences. To that end, the assessment criteria outlined in the Final Environmental Impact Statement (FEIS; Cumberland, 2005) for defining the predicted magnitude of impacts to water quality will be used to provide the appropriate context for interpreting the screening results as follows:

- **Negligible**: water quality concentrations are similar to baseline

- **Low**: concentrations are < 1x the CCME Water quality guideline (WQG)
- **Medium**: concentrations are between 1 and 10-times the CCME guidelines
- **High**: concentrations are less than MDMER but greater than 10-times the CCME guidelines
- **Very High**: concentrations exceed MDMER standards.

Adaptive Management Strategy

Agnico Eagle developed an adaptive management strategy in 2021 to guide water management decisions at MAM and WTS[13] for two key contaminants of potential concern (COPCs): arsenic and phosphorus (Agnico Eagle, 2021). The strategy uses 'Levels' linked to specific criteria for total phosphorus and arsenic, and each Level has prescribed management actions. The Levels range from 0 (normal operating conditions) to 4 (emergency situation). The 'Level' for each lake is based on the concentration of total phosphorus and arsenic relative to predictions in the FEIS (Golder, 2019) and relative to the CCME water quality guidelines (WQG) of 0.01 mg/L for total phosphorus and the site-specific water quality objective (SSWQO) of 0.025 mg/L for arsenic. The adaptive management thresholds and corresponding adaptive management levels and strategies are summarized in **Table 2-4**. A detailed description of the adaptive management thresholds and management strategies is provided in Table 3 of the Adaptive Management Plan (AMP; Agnico Eagle, 2021).

Water quality data collected as part of the annual CREMP are used in the assessment. Results of the water quality comparison to AMP thresholds are provided in **Section 5.3.4**.

2.3.2 Sediment Chemistry

Sediment grab samples are at Meadowbank and Whale Tail lakes are collected annually with the benthic invertebrate samples. Starting in 2022, sediment grab samples are collected at Baker Lake on a three-year cycle coinciding with the sediment coring program (Azimuth, 2022b). In addition to characterizing physical conditions (e.g., grain size and organic carbon content), samples provide information on temporal changes in concentrations of metals and organics in sediment. Sediment chemistry core sampling for the CREMP is completed every three years at the same time as Environmental Effects Monitoring (EEM) sampling. The intent of the coring program is to monitor long-term trends in metals concentrations in the top layer of sediment (1.5 cm [approximately]). In sediment coring years, metals analyses from the core samples replaces metals analyses from the grab samples. The next full coring program is scheduled for 2023 (coinciding with the EEM program).

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[13] Mitigation measures include but are not limited to targeted studies, implementing activities to prevent, stabilize or reverse a change in environmental conditions or to protect the receiving environment.

Trends in sediment chemistry are evaluated by comparing the yearly mean parameter concentrations in the core samples to the trigger[14] values applicable to the Meadowbank study area lakes, Wally Lake, and the Whale Tail study area lakes (see discussion below). Those parameters where the yearly mean was equal to or exceeded triggers were formally tested using a before-after (BA) statistical model[15]. Sediment chemistry can be quite variable over a small spatial scale within a given basin, but natural seasonal variability in sediment chemistry is assumed to be low given the low rates of natural sediment deposition in Arctic lakes (Azimuth, 2012d). The BA statistical model assumes that, in absence of mining-related inputs, annual variability in sediment chemistry is negligible.

The naturally high sediment concentrations in the Whale Tail lakes necessitated triggers that were lake specific, similar to the approach that was used to develop triggers for Wally Lake. The derivation of these triggers was completed in 2019 and included in the analysis of grab sediment chemistry. The statistical analysis of sediment in the Whale Tail study area will be implemented for the next sediment coring program scheduled for August 2023 (3-year cycle). Evaluation of the data will follow the same approach used for Meadowbank by comparing the yearly mean concentrations to new trigger values and BA statistical analysis of temporal changes for parameters that exceeded their respective triggers. Triggers were developed using the baseline sediment core chemistry data collected in 2017 and the statistical approach described in Azimuth (2012d). CCME sediment quality guidelines were set as the thresholds when applicable (i.e., for those parameters with CCME sediment quality guidelines). Triggers were set to the maximum of one of three methods for the Whale Tail lakes:

- Method A: the value halfway between the baseline median and the effects-based threshold (CCME ISQG),
- Method B: the 90th percentile of the baseline data, or
- Method C: the value corresponding to a 20% increase above the median value.

2.3.3 Phytoplankton and Benthos Community Variables

Trigger and threshold value development for phytoplankton and benthos communities was presented in detail in the original *CREMP Design Document* (Azimuth, 2012d). Unlike water or sediment, where environmental quality guidelines can be used to develop triggers or thresholds, there are no universal benchmarks for biological variables such as abundance, biomass or diversity. Rather, the magnitude of change or difference relative to expected conditions must be used to establish *critical effect sizes* (CES) for biological variables. Effect sizes of 20% and 50% were established as the *trigge*r and *threshold* for

[14] The trigger values for the Meadowbank project lakes were updated in the 2017 CREMP report (Azimuth, 2018c).

[15] One-tailed test of the null hypothesis that concentrations are not different (or lower) in the after period relative to the before period (significance level of p=0.05); the alternate hypothesis is that concentrations have increased in relation to mining.

assessing changes in biological variables. Importantly, the terms *threshold* and *trigger* for biological variables are not used as strictly as for water and sediment chemistry parameters for two reasons:

1. Statistical Power – For most biological variables, natural variability can make it difficult to statistically detect effect sizes as low as 20%. It is more realistic to detect larger effect sizes such as 50%.
2. Causality – Regardless of effect size, even if statistically-significant changes are documented the cause of the change needs to be understood in order to effectively manage the situation. For the Meadowbank biological data, effect sizes exceeding 50% have been observed due to natural variability in the baseline data.

Phytoplankton Taxonomy

Total phytoplankton biomass and taxa richness were selected as the metrics to assess changes in the phytoplankton community using the BACI framework[16]. Phytoplankton triggers and thresholds are set to relative changes of 20% and 50%, respectively. The evaluation procedure was analogous to that used for water chemistry, except that area means for 2022 were not directly comparable to triggers (i.e., since the triggers/thresholds are based on the relative change over time in a parameter rather than on a finite value), so the process started with the BACI testing. Two-tailed tests of the null hypothesis (i.e., that test areas experienced no relative change up or down) were conducted with a significance level of p=0.1.

Benthos Taxonomy

For benthos, trigger and threshold values are set to relative changes (increases or decreases of 20% and 50%) in total biomass and species richness at test areas using the BACI framework. The CREMP uses percent change rather than standard deviations which are used in EEM, to maintain a transparent (fixed) effect size that is more likely to be ecologically relevant. Statistical power increases with consideration of more *after* period years; consequently, BACI analyses for the Meadowbank lakes were conducted on four *after* data period lengths: one year (2022 only), two years (2021–2022), three years (2020–2022), and four years (2019–2022) and for the Whale Tail lakes for either one year (2022 only) or for WTS and MAM both one year and two years (2021–2022). One-tailed tests of the null hypothesis were conducted with a significance level of p=0.1. Failure to reject the null hypothesis implies the endpoint (i.e., total abundance or species richness) either did not change or increased. The alternative hypothesis is that the endpoint decreased. Despite this BACI being conducted as a one-tailed test, the p value was left at 0.1 to help improve statistical power for the benthic invertebrate endpoints.

[16] BACI framework involves paired monthly sampling events at *control* [INUG or BAP] and *impact* [i.e., NF or MF areas] areas over two periods [*before* and *after*], with *months* as the unit for temporal replication.

In accordance with the *CREMP 2022 Plan Update*, no benthos were collected from Baker Lake in 2022 (Azimuth, 2022b). No baseline benthic community data are available for Baker Lake, so there is no true *pre-impact* or *before* data. While a spatial *CI* design could be used to test for differences between reference *control* and exposure *impact* areas, the design does not allow for distinguishing natural differences between areas from development-related changes. Rather, since no development-related changes had been identified to date, BACI analyses for Baker Lake benthos are conducted using a series of four temporal scenarios using all years of data (i.e., 2021 compared to 2008–2020; 2020/2021 compared to 2008–2019 and so on). These series of comparisons are a more robust method for identifying temporal changes due to mining-related activities in Baker Lake without needing to assume that sampling areas should have identical communities (i.e., like the *CI* design).

Figure 2-2. Management response plan for the Meadowbank Mine Aquatic Environment Monitoring Program (AEMP).

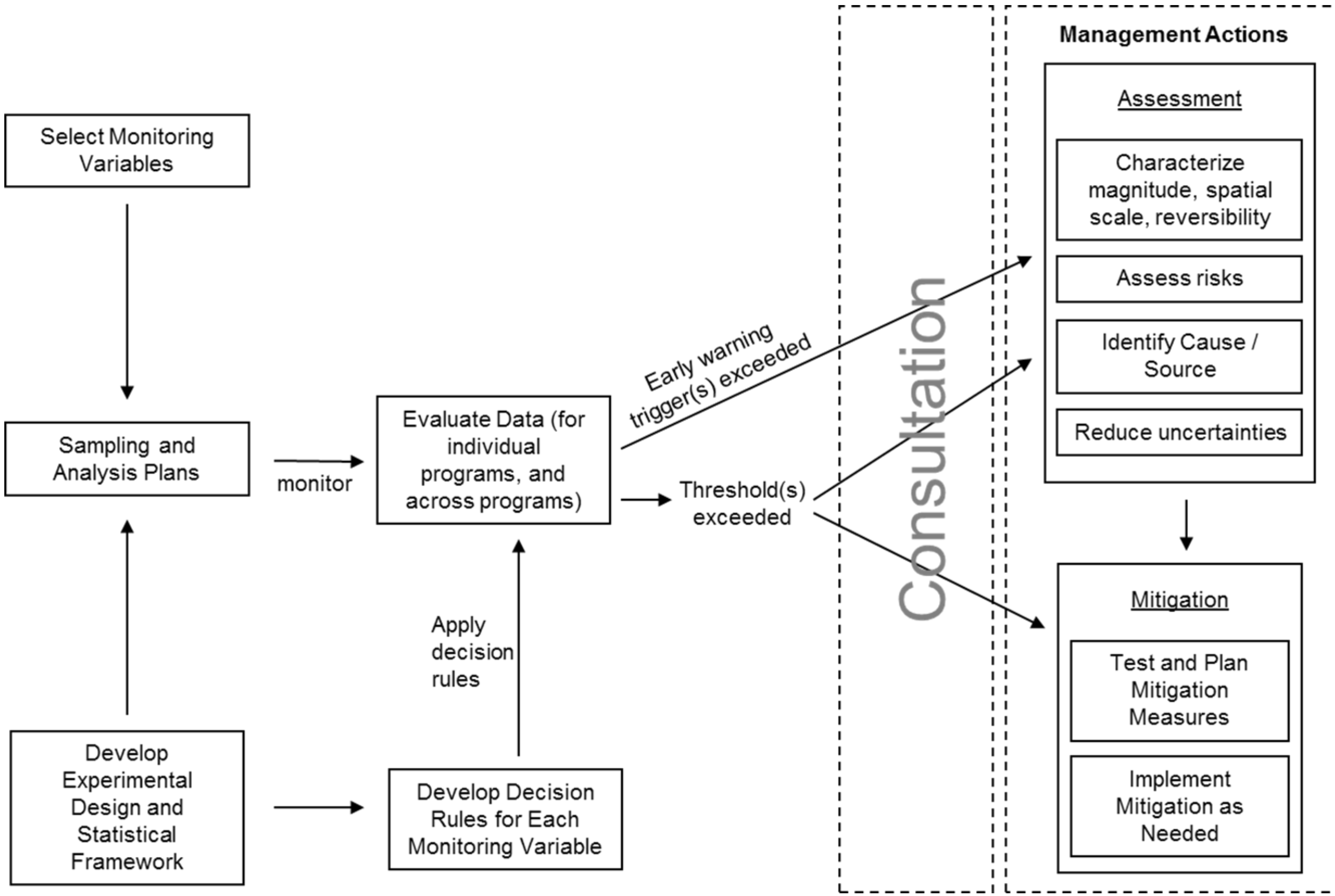

Table 2-3. Status of all CREMP sampling areas since the beginning of monitoring.

	Meadowbank Areas									Baker Lake Areas				Whale Tail Areas					
Designation	**REF**	**REF**	**NF**	**NF**	**NF**	**NF**	**MF**	**MF**	**FF**	**REF**	**REF**	**NF**	**NF**	**NF**	**NF**	**NF**	**MF**	**MF**	**FF**
Area	**INUG**	**PDL**	**TPN**	**SP**	**TPE**	**WAL**	**TPS**	**TE**	**TEFF**	**BAP**	**BES**	**BBD**	**BPJ**	**WTS**	**MAM**	**NEM**	**A20**	**A76**	**DS1**
2006	C		C	C	C	C	C	C											
2007	C		C	C	C	C	C	C											
2008	C		C	I (Aug)	C	C	C	I (Aug)		C		I	I						
2009	C	C	I (Mar)	I	I (Aug)	C	C	I	C	C		I	I						
2010	C	C	I	I	I	C	C	I	C	C		I	I						
2011	C	C	I	I	I	C	C	I	C	C	C	I	I						
2012	C	C	I	I	I	C	C	I	C	C	C	I	I						
2013	C	C	I	I	I	I (Jul)	C	I	C	C	C	I	I						
2014	C	C	I	I	I	I	C	I	C	C	C	I	I	C	C	C			
2015	C	C	I	I	I	I	C	I	C	C	C	I	I	C	C	C			
2016	C	C	I	I	I	I	C	I	C	C	C	I	I	C	C	C	C	C	C
2017	C	C	I	I	I	I	C	I	C	C	C	I	I	C	C	C	C	C	C
2018	C	C	I	I	I	I	C	I	C	C	C	I	I	I (Aug)	I (Nov)	C	C	C	C
2019	C	C	I	I	I	I	C	I	C	C	C	I	I	I	I	I (Aug)	I	I	I
2020	C	C	I	I	I	I	C	I	C	C	C	I	I	I	I	I	I	I	I
2021	C	C	I	I	I	I	C	I	C	C	C	I	I	I	I	I	I	I	I
2022	C	C	I	I	I	I	C	I	C	C	C	I	I	I	I	I	I	I	I

Notes:

Area designations:

C=Control; I=Impact; REF=reference (in grey shading); NF=near-field (in blue shading); MF=mid-field (in pink shading); FF=far-field (in teal shading).

Blank cells indicate the area was not part of the monitoring program that year.

Area IDs:

Meadowbank and Whale Tail Reference areas: INUG = Inuggugayualik Lake; PDL = Pipedream Lake.

Meadowbank: TPN, TPE, TPS = Third Portage Lake – North, East, South basins; SP = Second Portage Lake; WAL = Wally Lake; TE, TEFF = Tehek Lake (Mid-and Far-field).

Baker Lake areas: BAP, BES, BBD, BPJ=Baker Lake – Akilahaarjuk Point, East Shore, Barge Dock, Proposed Jetty.

Whale Tail areas: WTS = Whale Tail Lake South Basin; MAM = Mammoth Lake; NEM = Nemo Lake; A20 = Lake A20; A76 = Lake A76; DS1 = Lake DS1.

Table 2-4. Adaptive Management Strategy for contaminants of potential concern (COPCs) in water from Whale Tail Lake (South Basin) and Mammoth Lake.

Adaptive Management Level*	Threshold (Total Phosphorus and Arsenic)	Management Strategy[1]
Level 0 (Normal operating condition)	Within 20% of FEIS predicted concentrations.	No changes – continue with CREMP monitoring plan.
Level 1 (Area of concern)	Concentrations equal to or greater than 20% FEIS predicted concentrations AND less than 80% of the WQG or SSWQO.	Continue with Level 0 management strategy. Analyze site wide water quantity and quality data to identify and assess cause(s) of the difference(s) and reported to the NWB. Report results of data review in annual reporting to the NWB including implications on the Water Management Plan and evaluation of potential mitigation strategies (e.g., enhance water treatment plant efficiency and reduce maximum effluent discharge concentration by 10%).
Level 2 (Area of concern)	Concentrations equal to or greater than 20% FEIS predicted concentrations AND between 80% and 100% of the WQG or SSWQO.	Continue with Level 1 management strategy. Report results of data review to the NWB in the Annual Report, including implications on the Water Management Plan and the evaluation of potential mitigation strategies (e.g., enhance water treatment plant efficiency and reduce maximum effluent discharge concentration by 20%). Move discharge location to MAM or WTS. Assess potential discharge in lakes D1 or D5 in case level 3 is reached, with approval from the NWB as per NIRB Project Certificate Conditions.
Level 3 (High risk situation)	Concentrations equal to or greater than 20% FEIS predicted concentrations AND between 100% and 120% of the WQG or SSWQO.	Continue Level 2 management strategy. Report results of data review in the Annual Report to the NWB including implications on the Water management plan and the evaluation of potential mitigation strategies (e.g., review overall water management strategy to stay within assimilative capacity of the receivers). Continue monitoring in the original receiving area to evaluate if they recover and define threshold to restart using them.
Level 4 (Emergency situation)	Concentrations equal to or greater than 20% FEIS predicted concentrations AND greater than 120% of the WQG or SSWQO.	Continue Level 3 management strategy. Report results of detailed data review in the Annual Report to the NWB, including implications on the Water management plan and the evaluation of potential mitigation strategies (e.g., move discharge location to an approved location). Continue monitoring in the original receiving area to evaluate if they recover and define thresholds to restart using them. Evaluate potential new discharge location to resume operation.

Notes:

* Agnico Eagle will consult with the NWB on the required approval process, execution, and implementation prior to initiating the adaptive management strategy items for Adaptive Management Levels 3 and 4.

[1] See Table 3 in the Adaptive Management Plan for more details on management strategies for each Adaptive Management Level (Agnico Eagle, 2021).

Acronyms

FEIS = Final environmental impact statement.

SSWQO = Site-specific water quality objective.

WQG = Water quality guideline.

3 QUALITY ASSURANCE / QUALITY CONTROL

3.1 Overview of CREMP QA/QC

The objective of quality assurance/quality control (QA/QC) is to assure that the chemical and biological data collected are representative of the material or populations being sampled, are of known quality, have sufficient laboratory precision to be highly repeatable, are properly documented, and are scientifically defensible. Data quality was assured throughout the sample collection and analysis using specified standardized operating procedures, by using laboratories that have been certified for all applicable methods, and by staffing the program with experienced technicians.

The framework of the QA/QC program is outlined in *CREMP Plan* (Azimuth, 2022b), which includes a description of the established SOPs. The plan update document is the foundation for assessing data quality for each routine component of the CREMP (e.g., water, sediment) and was adopted for the Whale Tail mine baseline sampling program (Azimuth, 2018b). Detailed analysis of the data quality for each component of the CREMP is provided in **Appendix A**. A summary of the key messages from the 2022 QA/QC program is provided in the subsections below.

3.2 Sample Shipping and Handling

Sample shipping and handling concerns documented in earlier CREMP reports have largely been rectified in recent years. ALS's QA/QC summary results from each laboratory report are integrated into **Appendix A**.

The sample shipping and handling QA/QC for 2022 was comparable to 2021. There were a few discrepancies between samples submitted and the COCs, but most were rectified without impacting the analytical results. The logistics, distances, and general challenges of collecting and shipping samples from a remote mine in Nunavut meant that hold times were exceeded for several parameters/analytes, but the impact on results is considered negligible.

3.3 Water Chemistry

Briefly, the standard QA procedures for the water chemistry program include thoroughly flushing the flexible tubing and pump to prevent cross-contamination between areas. Field QC procedures include collection and/or analysis of field duplicates and blanks (travel, equipment, and deionized water blanks). The laboratory QC program includes duplicate analysis, blanks, and analysis of spike samples and reference material to verify the accuracy and precision of the analytical method.

The objectives and methods for surface water QA/QC are outlined in detail in **Appendix A**. The field and laboratory QA/QC results for water chemistry for 2022 were very good and were comparable to the results from the previous year:

1. Sample integrity was good in 2022. There was a similar number of lost samples from breakage or mislabeling as the previous year, which represents a small proportion of total samples submitted in 2022. Sample temperatures received at the laboratory were variable depending on season and reflect the challenges with shipping from a remote mine site. Holding times were routinely exceeded for alkalinity, turbidity, laboratory pH, nitrate, nitrite, total dissolved solids (TDS), TSS, and dissolved orthophosphate (as P). Very occasionally hold times were exceeded for cyanides (free and total), total Kjeldahl nitrogen (TKN), ammonia, total mercury, and chlorophyll-a. These hold-time exceedances are not considered likely to impact data analysis and interpretation.
2. Travel, deionized (DI) water, and equipment (EB) blank results for 2022 were similar to 2021 and indicated reliable sample handling and that systematic cross-contamination related to sampling equipment is unlikely. The DI blanks and travel blanks did not warrant flagging any parameters as unreliable in the 2022 analyses.
3. The implication of possible cross-contamination (i.e., where analytes were detected in the EBs) on interpretation of the 2022 water quality data was evaluated by comparing the sample concentrations with the EB results from the same event. Sample results were given a cautionary flag (shown in tables using underlining; e.g., <u>0.001</u>) when the measured concentration was less than 5-times the concentration detected in the EB. Several analytes were occasionally given cautionary flags, including aluminum, copper, and manganese. None of the results with cautionary flags exceeded the trigger. Sample results, including results with cautionary flags, are reported in **Appendix B1** (Meadowbank), **Appendix B2** (Whale Tail), and **Appendix B3** (Baker Lake).
4. It should be noted that isolated instances of trigger exceedances for individual water chemistry parameters do not necessarily indicate a trend or even real conditions. The QA/QC program provides an added layer of context to data interpretation by highlighting those variables for which the results appear to be influenced by laboratory anomalies or cross-contamination rather than by mining activities. Overall, potential cross-contamination is considered unlikely to bias interpretation of the 2022 water quality analysis.
5. There were a few cases where planned method detection limits (MDL) were not met by the laboratory. The MDL for chromium was adjusted by the laboratory from 0.0001 to 0.0005 mg/L in May 2021 and for beryllium in 2018 from 0.00002 to 0.00001 mg/L due to method re-validation (Pers. Comm. Brent Mack, ALS November 28, 2022). For both parameters, the revised MDLs still meet the lowest available Canadian quality guidelines (0.1 µg/L for beryllium, 0.5 µg/L for

chromium; Pers. Comm. Brent Mack, ALS November 28, 2022). Beryllium has consistently remained below MDL since baseline and is not a parameter of concern for the Site. Furthermore, the revised MDL is below the trigger and threshold values for the Meadowbank, Whale Tail, and Baker Lake study areas. As such, the revised MDL is sufficient to detect changes in concentrations of beryllium at the Site. There is no lower MDL analysis available for beryllium. For chromium, concentrations above MDL have been detected during operations and the revised MDL is higher than those detected concentrations. Therefore, in 2023, low-level chromium (MDL = 0.1 µg/L) will be analyzed in order to ensure any potential changes in chromium concentrations due to mining activities are detected. The 2022 results for chromium and beryllium were less than the revised MDLs.

6. The 2022 field duplicate results were very good, with only 1.3% of the calculated RPDs not meeting DQOs. There was one field duplicate collected in September with metals concentrations much higher than concentrations in the sample (NEM-75) and compared to the paired sample collected in Nemo Lake (NEM-76). The results for this field duplicate sample were likely due to cross-contamination. The other samples collected during the same sampling event do not appear to be affected.
7. Laboratory QC results for water chemistry were also very good in 2022, with very few laboratory data quality qualifiers and none that were deemed likely to impact data interpretation.
8. Two QC screening steps comparing total to dissolved fractions and examining disparities between paired sample results were also utilized. The first analysis compared the total and dissolved concentrations for a given parameter in each sample. Samples for which dissolved concentrations were greater than total concentrations and which had a relative percent difference (RPD) of more than 30% were flagged for review. The second analysis compared parameter concentrations of samples collected within a given area in each sampling event; parameters within a given area and sampling event that had concentrations that differed by more than a factor of 5 (or a factor of 10, if at least one of the samples was within a factor of 10 from the MDL) were flagged for review. All samples that were flagged for further validation are summarized by sampling event in **Appendix A**. Based on these screening steps, a few of the 2022 water quality results were removed from the analysis due to data quality issues (i.e., *unreliable* flags). For transparency, the results are shown in the water quality tables provided in **Appendix B**.

Unless discussed as unreliable above, the water quality QA/QC assessment verified that data are reliable for analysis and interpretation of spatial and temporal trends.

3.4 Sediment Chemistry

The sediment chemistry QA/QC assessment is comprised of field and laboratory duplicates, filter swipes for cross-contamination, and the QC report from ALS for sediment grab samples submitted in 2022. Key results of the sediment chemistry QA/QC, presented in **Appendix A**, are as follows:

- Sediment samples collected at INUG, PDL, and Lake A76 had high moisture content therefore grain size analysis could not be completed following chemistry analysis. More sediment will be submitted in 2023 to avoid this from happening in the future.
- For the sediment QA/QC samples, there were no sample integrity concerns.
- Several analytes were detected in the sediment grab equipment filter swipes. However, none were estimated to affect sediment chemistry results by more than 0.02%, suggesting negligible cross contamination.
- There were nine grab sample field duplicates collected in 2022. Out of the RPDs calculated, 99% met the DQOs for sediment grabs. The only RPDs that failed to meet DQOs were for particle size (clay < 0.004mm) at WAL and methylmercury at MAM. For the composite sample duplicates, all RPDs met the DQOs for hydrocarbon/PAHs in sediment. Overall, field duplicate results indicate good field collection methods and a high degree of replicability in sampling.
- The laboratory QC results show a high degree of precision for the laboratory analysis and laboratory processing and analytical methods were consistent between sub-samples. The only qualifiers assigned to the sediment grab chemistry results were for polycyclic aromatic hydrocarbon (PAH) detection limits in composite samples due to high moisture content, however these results are unlikely to impact data interpretation.

3.5 Phytoplankton Taxonomy

Field duplicates are collected for phytoplankton during each sampling event in coordination with water sample duplicates and are taken in order to assess sampling variability and sample homogeneity. An RPD of 50% for total density and total biomass concentrations is considered acceptable. As a measure of laboratory QA/QC on the enumeration method, replicate counts are performed on 10% of the samples. Replicate samples are chosen at random and processed at different times from the original analysis to reduce biases.

Detailed analysis of the phytoplankton data quality is included in **Appendix A**. Phytoplankton QA/QC for both field and laboratory components in 2022 was good, indicating reproducible results across both sampling and taxonomic analysis process. Phytoplankton taxonomy results for 2022 met project DQOs and are considered reliable for data analysis and interpretation of spatial and temporal trends.

3.6 Benthos Taxonomy

Quality assurance measures in the field involved adherence to the standardized method for collecting, sieving, and preserving samples for taxonomic identification (see Appendix B in Azimuth, 2015b). While field duplicates are not collected, inferences regarding within-area variability are gained by directly looking at results across replicate samples (see **Section 4.6** and **Section 5.6**). The laboratory (ZEAS) QA/QC procedures include re-sorting and re-counting 10% of the samples targeting a DQO of > 90% recovery. Details of the benthos taxonomy data quality assessment is included in **Appendix A**. Percent recovery was above 95% in all re-sorted samples, with an average percent recovery of 95.7%.

The 2022 benthos taxonomy metrics met DQOs and are considered reliable for data analysis and interpretation of spatial and temporal trends.

4 MEADOWBANK

4.1 Overview of the Meadowbank CREMP

This section summarizes the 2022 CREMP results for monitoring water quality, sediment chemistry, phytoplankton community, and benthic invertebrate communities at the Meadowbank study area. Relevant figures and tables are included at the end of the section.

The CREMP monitoring plan for routine CREMP sampling years is outlined in **Section 2.2**. The 2022 CREMP focused on monitoring changes in the NF study areas in Third Portage Lake (East Basin [TPE] and North Basin [TPN]), Second Portage Lake (SP) and Wally Lake (WAL). Reference area sampling at INUG and PDL was completed concurrently with sampling at the NF areas. Based on the results of the 2021 CREMP[17] (Azimuth, 2022a), limnology and water quality at MF (TE, TPS) and FF (TEFF) stations was monitored once during the early season sampling event in March. CREMP sampling locations for water and sediment/benthos are shown in **Figure 4-1** and **Figure 4-2**, respectively.

4.2 Limnology

Limnology data, when compared to previous monitoring data, provide an initial assessment of whether conditions are changing within a sampling area and may require additional investigation. At least one depth profile was conducted monthly for temperature, dissolved oxygen, and conductivity from NF areas except when ice conditions were unsafe (June and October). Two profiles were completed along with water sampling for chemistry and phytoplankton taxonomy in March, May, July, August, and September. Limnology profiles, without paired water chemistry or phytoplankton sampling, were also collected in January, February, April, November, and December. Qualitative evaluation of the limnology data was completed using plots of the deepest sample within each lake for a given event. Samples used for plotting and interpreting the 2022 limnology data are specified in **Table 4-1**.

[17] There were no trigger exceedances for parameters with effects-based thresholds at the NF areas in 2021 (Azimuth, 2022a). Consistent with the adaptive monitoring strategy implemented in 2015 (summarized in Azimuth, 2022b), sediment chemistry or benthic invertebrate community sampling was not required at MF and FF areas in 2022.

Table 4-1. Samples included in the limnology profiles in 2022.

Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
INUG			INUG-138		INUG-140	Ice not safe for travel	INUG-142	INUG-144	INUG-146	Ice not safe for travel		
PDL			PDL-103		PDL-105		PDL-108	PDL-110	PDL-111			
TPN	☑	☑	TPN-150	☑	TPN-153		TPN-154	TPN-156	TPN-158		☑	☑
TPE	☑	☑	TPE-151	☑	TPE-152		TPE-155	TPE-156	TPE-158		☑	☑
SP	☑	☑	SP-150	☑	SP-152		SP-154	SP-156	SP-159		☑	☑
WAL	☑	☑	WAL-119	☑	WAL-122		WAL-124	WAL-125	WAL-128		☑	☑
TPS			TPS-67									
TE			TE-102									
TEFF			TEFF-54									

Notes:
Empty cells indicate no limnology profiles were collected, consistent with the study design.
☑ = One profile is collected from the near-field areas (and occasionally one mid-field area) in months where water sampling is not completed.
The sample IDs shown represent the deeper of the two locations sampled each month.

4.2.1 General Observations

The ice-free season on the Meadowbank study area lakes is very short. Ice break-up usually occurs during mid- to late-June, and ice begins to form again beginning in late September or early October, with complete ice cover by late October. Maximum ice thickness is about 2 m and occurs in March/April, increasing the concentration of some ions, such as chloride, in the water near the ice-water interface. This occurs due to cryo-concentration, where ice formation excludes certain ions and increases their concentration in the water column (Wetzel, 1983). Because the lakes are ice-covered for most of the year, gas exchange with the atmosphere is limited, although oxygen concentrations usually remain high under the ice because of the low rates of biological activity and organic decomposition (processes that consume oxygen from the water). Historically, there is typically a slight negative thermal stratification in the winter with water temperatures of 0°C near the ice-water interface and increasing to between 3°C and 5 °C at depth.

The maximum temperature measured during the open-water sampling events in 2022 was 13.79 °C at SP and WAL in mid-August. During open-water events, maximum water temperatures may reach 15°C in the summer with little evidence of thermal stratification, except for brief periods (days) when there is typically only a 4°C to 5°C temperature difference. High winds maintain uniform temperature and high oxygen profiles in the water column due to vertical mixing.

4.2.2 Temporal and Spatial Trends

Temperature and Dissolved Oxygen

Water temperatures and oxygen concentrations in the Meadowbank study area lakes in 2022 followed similar patterns of seasonal change compared to previous monitoring cycles. Surface water (3 m) temperatures in 2022 were similar to previous years (**Figure 4-3**), showing substantial differences between winter and summer events.

Winter temperature profiles for the through-ice sampling events show a slight negative thermal stratification with water temperatures near 0°C at the ice-water interface, typically increasing to between 2°C and 3.5°C at depth (**Figure 4-4**). Oxygen concentrations in winter generally decrease slightly with increasing depth, with occasional values measured above theoretical limits of air saturation[18] (14.6 mg/L at 0°C) (**Figure 4-5**). Oxygen concentrations in all basins are greater than 5 mg/L, and usually greater than 10 mg/L at even the lowest depths, despite nearly nine months of ice cover.

The study area lakes typically turn over by mid-July, leading to a well-mixed water column with uniform temperature and high oxygen concentrations. Water temperatures warm rapidly to reach maximum temperatures of around 15°C by late July and into August. Deeper lakes and basins, such as TPN and INUG, are typically 2°C to 3°C colder than the shallower locations, Wally Lake (WAL) and Second Portage Lake (SP). Temperatures in the 2022 depth profiles were typical of historical temperature patterns (**Figure 4-4**). Aside from slight stratification at INUG and TPN in July, there was no evidence of vertical stratification from July through September in any lakes. In November, the study lakes froze and became stratified, with surface waters near 0°C and bottom waters ranging up to 2.7°C at TPE. With vertical mixing, oxygen concentrations were high, and the water was fully saturated in November and December (**Figure 4-5**).

Temperature and oxygen concentrations in 2022 were consistent with previous years, and the seasonal patterns were typical of this Arctic area. There were no differences in these patterns between the control lakes (INUG and PDL) and the NF and MF monitoring areas.

Conductivity

Field conductivity[19] is an indicator of stratification in the water column and is an effective way of assessing changes in water quality that may be related to mining activities such as discharge of treated water and seeps. From a monitoring perspective, uniform conductivity provides confidence that the

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[18] Photosynthesis occurring under ice can lead to DO results exceeding theoretical air saturation limits. This is due to photosynthesis producing pure oxygen, as opposed to the approximate oxygen content of 21% in air.

[19] Throughout this report, any discussion of *conductivity* refers to specific conductance, which is conductivity normalized to 25°C.

water column is well-mixed and that a water sample collected at a discrete depth is representative of conditions from the surface to near the bottom of the lake. In contrast, variable conductivity in areas close to mining activity may indicate the presence of water with different chemical properties. Surface water sampling is done at 3 m below the surface, but conductivity profiles can help identify if additional samples should be collected at other depth intervals. Conductivity of oligotrophic systems with low concentrations of dissolved solids is typically less than 50 µS/cm and uniform from top to bottom in any given month, with minor seasonal fluctuations. While the overall range in conductivity is similar between ice-on (10–50 µS/cm) and ice-off (10–40 µS/cm) months, the conductivities in ice-off months are generally lower, which is consistent with cryo-concentration during progressive ice formation in winter.

Field-measured conductivity was unstratified for most of the 2022 limnology profiles. Minor fluctuations in conductivity were evident during some of the winter sampling events due to cryo-concentration (see **Figure 4-6**).

Conductivity values at SP in 2022 were generally within the range of historical values dating back to 2009. Field collected conductivity at SP was typically between 20 µS/cm and 30 µS/cm prior to 2014. More recent results from 2014–2022 have trended towards 30 µS/cm to 40 µS/cm. The change in laboratory reported conductivity at SP was previously identified in the water chemistry BACI analysis but has not been linked to any adverse effects to the biological community (see **Section 4.3** and **Figure 4-7** for more details).

Conductivity at WAL exhibited a similar pattern as previous years. WAL had higher conductivity observed from January through March (~ 50 µS/cm) and April through May (~ 60 µS/cm), which then stabilized for the rest of the year (July through December) between 30 and 40 µS/cm. Baseline results for WAL during the open-water period were between 30 and 40 µS/cm. As with SP, laboratory reported conductivity at WAL has been identified in the BACI analysis, but has not been linked to any adverse effects to the biological community (see **Section 4.3** and **Figure 4-7** for more details).

4.3 Water Chemistry

Tabulated water quality data for 2022 are presented in **Appendix B1**. Water chemistry samples were collected simultaneously with limnology samples in March, May, July, August, and September (see **Section 4.2** for limnology results).

4.3.1 General Observations

The general conditions affecting water quality in this region were described in **Section 4.2**. Key points are:

- The Meadowbank study lakes are generally nutrient-poor and well-mixed (uniform temperature and oxygen profiles), with no winter anoxia beneath ice cover.
- The Meadowbank study lakes are headwater lakes with no significant natural sources of nutrients or sediment except from local runoff that contributes little nutrient enrichment, but sustains the aquatic ecosystems. Many chemicals in the water have typically been below laboratory detection limits (MDLs) since formal baseline monitoring started in 2006[20].

4.3.2 Temporal and Spatial Trends

Annual mean concentrations for each parameter were compared to triggers and effects-based thresholds according to the approach outlined in **Section 2.3.1**. If the annual mean concentration for a given parameter exceeds the trigger, BACI statistical comparisons to baseline conditions and reference location INUG were conducted.

Given the number of parameters routinely below laboratory MDLs, a conservative three-step assessment process was used to identify parameters to include in the formal trend assessment to streamline the interpretation of the results. Details of the three-step assessment process are provided in **Section 2.3.1** and the results are summarized in **Table 4-2**. This approach is summarized as follows:

- **Overall Detection Frequency** – Only those water quality parameters that exceeded MDLs in at least 10% of the samples were retained for discussion.
- **Control-Impact Detection Frequency Comparison** – Parameters with <10% detection frequency (i.e., those screened out in the first step) for which the proportion of detected values increased by 0.1 or more were added back into the trend assessment.
- **Apparent Detection Pattern Matching Mining Activity** – Trend plots for infrequently detected parameters were used to visually identify parameters with measured values associated with periods/locations of known mining activities.

Mean annual concentrations that exceeded trigger values were then compared to the Final Environmental Impact Statement (FEIS) water quality model predictions for Third Portage Lake, Second Portage Lake, and Wally Lake to highlight any deviations from predicted changes in water quality.

The results of the water chemistry parameter assessment process are presented in **Table 4-2**; shaded parameters were retained for further analysis. Monitoring results showing spatial (all NF, MF, FF, and REF areas) and temporal (all monitoring years) trends for surface water (samples collected from a depth of 3 meters) for retained parameters are shown in **Figure 4-7** to **Figure 4-11**. The red dashed line is the

[20] While formal baseline water quality monitoring started in 2006, reconnaissance baseline monitoring started in the mid-1990s and served as the foundation for designing the formal monitoring program.

trigger value specific to the parameter and area. Blue dashed lines have been added for TPN, TPE, SP, and WAL for parameters that have FEIS model predictions (see **Section 2.3.1**). Parameters with no clear spatial or temporal trends related to mining activities or natural variability were excluded from further consideration (see **Table 4-2**). For completeness and transparency, water chemistry plots for all parameters are included in **Appendix B1**.

Each parameter/area that exceeded the trigger in 2022 was assessed in the BACI model (one-tailed; looking for uni-directional changes [i.e., increases]). In this analysis, the model interaction term (or BACI effect term) represents the change at the test area in 2022 (*after* period) relative to baseline (*before* period) after accounting for natural temporal changes (i.e., temporal changes at the reference area that account for regional factors expected to influence all the lakes). For simplicity, changes are noted *relative to baseline/reference* conditions whereas the BACI analysis statistics and p-value evaluate significance in the context of the observed natural temporal changes.

Parameters for which the 2022 yearly mean exceeded the trigger values in NF areas are shown in **Table 4-3**. Parameter/area trigger exceedances were similar to 2021 and included measures and indicators of conductivity, hardness, alkalinity, major ions, and silicon. The results of BACI analyses for exceeding parameter/area combinations are provided in **Table 4-4**. Note that it was not possible to complete a BACI analysis on silicon due to a lack of *control* data. BACI analysis results in 2022 were largely the same as last year, with statistically-significant increases relative to baseline/reference conditions ($p < 0.05$) in conductivity, hardness, major ions, and other non-threshold parameters for all NF lakes.

A literature review was completed in 2019 focusing on toxicity studies for major ions and other parameters that have routinely exceeded the 95th percentile of baseline concentrations during the operations phase. That summary report was prepared as a technical appendix in the 2020 CREMP report (Azimuth, 2021). Water chemistry results for parameters that exceeded their respective trigger values are discussed in the sections that follow.

Conventional Parameters (Conductivity, Hardness, and Alkalinity)

Conductivity and Hardness – Conductivity is a composite variable that increases in response to higher concentrations of ionic compounds such as chlorides, sulphates, carbonates, sodium, magnesium, calcium, potassium, and metallic ions. Conductivity and hardness at all areas were similar to 2021. At TPE, TPN, and WAL these parameters appear to be stable which is consistent with results from previous years and expected, given that discharge to these lakes stopped in 2014 at TPE and TPN, and 2017 at WAL. In 2022, conductivity and hardness were elevated at TPN, TPE, and SP relative to baseline/reference conditions (**Figure 4-7**).

Alkalinity – The concentrations of bicarbonate and total alkalinity were elevated in SP in 2022 relative to baseline/reference conditions. Bicarbonate (HCO_3-) comprised 100% of the total alkalinity fraction, typical of surface water with pH in the range of 6.5 to 9. The trigger value for both bicarbonate and total alkalinity is 8.7 mg/L. Bicarbonate alkalinity at SP has consistently exceeded the trigger since 2011 and in 2022 the mean concentration at SP was 11.1 mg/L (as $CaCO_3$), which is within the range of 11 to 13 mg/L observed in 2016–2021. No other areas exceeded triggers for mean bicarbonate concentrations.

From a potential-effects perspective, alkalinity measures the buffering capacity of water (i.e., how much acid can be added without changing pH) and low values are typically of concern for aquatic life. For example, the working water quality guidelines for British Columbia (BC MOE, 2017) have three categories of sensitivity to acid inputs based on alkalinity: highly sensitive (<10 mg/L), moderately sensitive (10 to 20 mg/L) and low sensitivity (>20 mg/L). Consequently, the temporal trend of slightly increasing alkalinity relative to baseline/reference conditions is unlikely to adversely affect biota at TPE or SP and would decrease the potential sensitivity of TPE and SP to acidic inputs (e.g., low pH snow melt and rain).

Total Dissolved Solids and Major Ions

Total Dissolved Solids – Concentrations of total dissolved solids (TDS) were elevated at SP and WAL in 2022 relative to baseline/reference conditions but have been stable for the past several years (**Figure 4-8**). In a review of TDS toxicity to aquatic life, Weber-Scannell and Duffy (2007) recommended deriving ion-specific limits for aquatic life (i.e., rather than for TDS). However, none of the literature studies they compiled showed effects to aquatic life at TDS concentrations less than 250 mg/L and they reported the average TDS in the world's rivers was approximately 120 mg/L. There are no federal water quality guidelines for TDS in Canada. In Alaska, TDS may not exceed 500 mg/L without a special permit and 1,000 mg/L at any time (ADEC, 2012). A site-specific TDS aquatic receiving environment benchmark of 500 mg/L was adopted at Diavik (WLWB, 2013). The TDS concentrations measured at SP and WAL ranging from around 21 to 42 mg/L are, therefore, very low and unlikely to pose risks to aquatic receptors.

Major Ions – Similar to 2021, concentrations of one or more of the major ions calcium, magnesium, and potassium were elevated relative to baseline/reference conditions at Meadowbank study area lakes in 2022 (**Table 4-3**, **Table 4-4**, and **Figure 4-8**). Concentrations appeared to be stable and were consistent with the ranges observed in 2021. In 2022, the mean concentration of potassium at TPE (0.60 mg/L) slightly exceeded the trigger value of 0.58 mg/L whereas mean concentrations at SP and TPN were below the trigger. At the NF areas TPN, TPE and SP, mean 2022 concentrations were slightly lower than in 2021, ranging from 2.8 to 4.0 mg/L for calcium, and from 0.98 to 1.3 mg/L for magnesium.

Slight increases of these cations above triggers in the Meadowbank study lakes for the *after* period are unlikely to adversely affect biota. These major cations are essential elements, and all species of aquatic life, from algae to fish, have evolved to actively regulate their osmotic, ionic, and acid-base balance by taking up ions from their surrounding environment (Martemyanov and Mavrin, 2012). Furthermore, adverse effects on primary producers and secondary consumers (e.g., zooplankton) are more commonly associated with deficiency rather than enrichment of major cations in oligotrophic freshwater lake environments (Alstad, et al., 1999). Calcium deficient waters are defined for some species of algae at concentrations <10 mg Ca/L (Wetzel, 1983) and effects on zooplankton communities are more common in freshwater lakes that are calcium-depleted as a result of acidification and logging (Arnott et al., 2017).

Metals

Silicon – In absence of *control* data and a threshold, an early warning trigger for silicon was derived for the Meadowbank study area lakes in 2019 based on data from all lakes (except WAL). There is evidence of temporal trends in silicon concentrations across all Meadowbank study area lakes, (i.e., peak concentrations in 2012 followed by a decrease through 2017 and then have remained stable since then) including reference areas that suggest regional influence. There also appears to be differences in concentrations among lakes. This is clearly evident at SP where concentrations have always been relatively high compared to reference area INUG yet the temporal patterns are very similar between the two areas (**Figure 4-10**). Given the similar trends observed in reference area INUG and distinct difference in concentrations among lakes, it is unlikely that elevated silicon concentrations compared to the trigger are related to mining activities.

Other metals – Concentrations of other metals (total and dissolved) were consistently low or below their respective MDLs at the NF, MF, and FF locations in 2022 (**Appendix B1**). None of these parameters have exceeded trigger or effects-based threshold values in the formal BACI analysis. In 2022, the same metals were measured above laboratory detection limits (MDLs) as in previous years. This is important to note in relation to ongoing discharge from dike seepage from the East Dike to Second Portage Lake.

In 2020, dissolved zinc[21] showed unusual annual mean trigger exceedances in TPN, TPE, and SP, however, the annual mean has been below the trigger in years following. In 2022, dissolved zinc showed two discrete samples slightly exceeding the trigger in September 2022 at TPN and WAL (**Figure 4-11**). This parameter will continue to be monitored in 2023.

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[21] It is worth noting that the trigger for dissolved zinc is uncertain and perhaps overly conservative because the hardness levels used to calculate the WQG for trigger development are often much lower than the data range used to develop the long-term WQG (CCME, 2018; see Appendix I in Azimuth, 2020a).

Reactive Silica

The first trigger exceedance for reactive silica occurred in 2020 at WAL. The yearly mean concentrations of reactive silica exceeded the trigger again in 2021 and 2022 (**Figure 4-9**). Given that the mean concentration of reactive silica at WAL (1.23 mg/L) in 2022 was only slightly over the trigger value (1.08 mg/L) and that the exceedance occurred in a NF area that was not exposed to any mining activity since 2020, it is unlikely mine-related and will continue to be monitored in 2023.

Long-term Trend Analysis

In addition to the routine BACI analysis, a more detailed assessment of temporal changes for key physical/ionic parameters in NF areas was completed for the first time in 2021 using the long-term Meadowbank water quality dataset (Azimuth, 2022a). The assessment used a mixed-effects modelling approach to compare three different long-term patterns in conductivity, hardness, calcium, magnesium, total alkalinity, and TDS, which have consistently exceeded triggers and/or FEIS predictions. The BACI analysis is designed to test for changes in parameters for a particular year relative to baseline/reference conditions; it is not designed to test for longer-term trends in key parameters over time. The mixed-effects trend analysis was conducted to provide a statistically supported understanding of long-term trends in key water chemistry parameters.

The analysis specifically looked at relative differences between NF areas TPN, TPE, and SP and the reference lake INUG for each of the aforementioned analytes. The three patterns tested were: (1) a constant linear trend over time (*Trend* model), (2) variable, year-specific differences without an increasing trend (*Year* model), or (3) an increasing, but variable, trend during operations to a peak followed by a stabilization of conditions since 2014 (*Stable* model). The *Stable* model fit the data best for nearly all area-analyte combinations; the only exception was for total alkalinity at TPN where the *Trend* model showed a slightly better fit. These results indicate that concentrations of conductivity, hardness, calcium, magnesium, total alkalinity, and TDS have generally been stable from 2014 to 2021. A full description of the long-term trend analysis and results is provided in the *2021 CREMP report* (Azimuth, 2022a).

Since this analysis focused on long-term trends, it is not intended to be repeated annually. Rather, the BACI will continue to be used routinely to test for changes in a particular year relative to baseline/reference conditions.

4.3.3 Comparison to FEIS Model Predictions

The CREMP continues to detect changes in some general water quality parameters related to mining activity. These changes are also reflected in higher concentrations of some parameters when compared to the model predictions in the FEIS (Cumberland, 2005). The FEIS water quality predictions are estimates of water quality changes in Third Portage Lake, Second Portage Lake, and Wally Lake, assuming different mixing scenarios and loading estimates from water releases and dike leaching:

- **Third Portage Lake** – the model for Third Portage Lake includes treated water released from the project in years 1 to 4 and long-term loading of metals from the Bay-Goose dike material. Two mixing scenarios (upper range [169 Mm^3] and mid-range [92 Mm^3] mixing) are evaluated for Third Portage Lake with and without dike leaching.
- **Second Portage Lake** – The Second Portage Lake water quality model includes loading of parameters from the Third Portage and East dikes and inflow from Third Portage and Wally lakes. Changes in water quality in Second Portage Lake were modelled for the two different mixing scenarios for water released into Third Portage Lake listed above.
- **Wally Lake** – The water quality model for Wally incorporates long-term loadings from the Vault dike and effluent releases from the Vault Attenuation Pond.

As discussed in the 2019 report, the assessment of Meadowbank water chemistry results against FEIS predictions only includes comparison to mean concentrations (Azimuth, 2020a). The full screening results are for Third Portage Lake, Second Portage Lake, and Wally Lake and are summarized in **Appendix B1**. For perspective, the screening results against mean concentrations are provided in **Table 4-6**.

Overall, the same list of parameters that exceed the Meadowbank trigger values typically exceed the concentrations predicted in the FEIS, namely hardness, total alkalinity, and ionic compounds (calcium, magnesium, and potassium; **Appendix B1**). Concentrations for most metals are below the predictions for Third Portage Lake, Second Portage Lake, and Wally Lake, except for total silicon at SP. Constituents such as silicon that were not reported in the 2003 baseline dataset were assumed to not be present in the receiving environment in the FEIS mixing models (V. Bertrand, pers comm, March 30, 2020). The full suite of analytes currently included in the CREMP water quality analysis were not available in the early stages of the program, hence, the absence of concentration data for silicon during the baseline phase. As a result, the predicted silicon concentrations are an underestimate of the actual baseline concentrations. Silicon is therefore not suitable for evaluating the accuracy of the FEIS predictions (see Azimuth, 2020a).

At the time the FEIS was issued in 2005, the freshwater aquatic life guideline for cadmium was lower than the MDL for the baseline data. A thorough review of the ecological significance of the predicted cadmium concentrations was presented in the FEIS, and the probability of cadmium causing toxicity was considered *extremely low* (Cumberland, 2005). Arsenic was also predicted to exceed the freshwater aquatic life guideline in Wally Lake (0.006 mg/L in the FEIS). Similar to cadmium, the MDL for arsenic was equal to the guideline (i.e., 0.005 mg/L) in 2005. The models were considered conservative because the MDLs were used as the baseline concentrations. The MDLs for arsenic and cadmium in the 2022 data are

0.0001 mg/L and 0.000005 mg/L, respectively. All the samples collected in 2022 from Meadowbank study area lakes were below the MDL for cadmium, as they were in 2021 (**Appendix B1**). In the case of arsenic, the concentrations are below the trigger values for the Meadowbank study area lakes, and more than an order of magnitude lower than the CCME water quality guideline of 0.005 mg/L in all samples.

Overall, the FEIS predicted the magnitude of potential effect on water quality in each of the lakes as *low* (see **Section 2.3.1** for more details on the decision criteria for effect magnitude). It is important to note that none of the parameters that exceeded trigger values or FEIS model predictions in 2022 had trigger values set in the context of effects-based threshold values (e.g., CCME water quality guidelines). Thus, CREMP water quality results are consistent with the *low* significance (i.e., <1x CCME WQG) rating applied to model predictions in the FEIS (Cumberland, 2005).

4.3.4 Summary and Implications

Water quality results were evaluated according to the decision criteria outlined in **Section 2.2.3** to determine the effort level and sampling frequency required at the MF and FF areas in 2023. The assessment strategy interprets the water quality assessment results from the NF areas in the current year (in this case 2022) to inform sampling at MF and FF areas the following year (i.e., 2023) (**Figure 4-12**).

Trigger screening results for the Meadowbank study areas are presented in **Table 4-5** according to the degree of change interpretation framework:

- no trigger exceedance,
- minor changes = trigger exceeded for parameters without effects-based thresholds,
- moderate changes = trigger exceeded for parameters with effects-based thresholds, or
- major changes = exceedance of the effects-based threshold.

The outcome of the assessment for sampling at NF, MF, and FF areas in 2022 is summarized below.

Reference Areas (INUG, PDL)

- Trigger exceedances of the mean concentrations were documented for total and dissolved silicon at INUG and for hardness, calcium, and alkalinity (total and bicarbonate) at PDL. INUG and PDL are reference areas located beyond the influence of activities at the Mine related influence.
- The sampling strategy for 2023 is to complete a full CREMP program for reference areas.

Near-field (TPE, TPN, SP, and WAL)

- Trigger exceedances were documented for parameters without effects-based thresholds (i.e., conductivity, hardness, TDS, alkalinity, and cations).
- The mean reactive silica concentration exceeded the trigger in WAL.
- The mean total and dissolved silicon concentrations exceeded the trigger in SP.
- The full program will be completed at the NF locations in 2023.

Mid-field and Far-field (TE, TPS, and TEFF)

- One through-ice sampling event was conducted at MF and FF areas TPS, TE, and TEFF in March 2022.
- Some parameters without effects-based thresholds (i.e., conductivity, hardness, TDS, alkalinity, and cations) exceeded trigger values at TPS, TE, and TEFF.
- The mean concentration of fluoride exceeded the trigger at TE.
- Metals concentrations in all samples were below their respective trigger values except for total and dissolved silicon at TE and TEFF.
- Any potential exceedance of trigger values observed at the MF and FF areas are a snapshot of potential conditions at that moment. Samples collected in March confirm that concentrations are relatively stable at the MF and FF areas compared to previous years.
- Additional sampling during the open-water period in 2022 was deemed unnecessary. Formal BACI analysis of the results was not completed, given the new sampling and analysis framework.
- Given there were no trigger exceedances for parameters with effects-based thresholds at the NF areas in 2022, no sampling is required at the MF and FF areas in 2023. No other sampling (e.g., sediment chemistry or benthic invertebrate community) is required at MF and FF areas in 2023.

4.4 Phytoplankton Community

In 2022, phytoplankton samples collected in May were archived as per the 2022 CREMP Plan Update (Azimuth, 2022b). Results of the open-water season are discussed below and did not warrant analysis of the May phytoplankton samples (see text for more details).

4.4.1 General Observations

The diversity in types and sizes of phytoplankton in the study lakes is large and their abundance is great. In summer, abundance typically exceeds 1 million individuals per liter with a total biomass of approximately 200 mg/m^3. Six major taxonomic groups of phytoplankton are present in the study lakes, namely blue-green algae (Cyanophyta), green algae (Chlorophyta), golden-brown algae (Chrysophyta), Diatoms, Cryptophytes, and Dinoflagellates.

Chrysophytes (golden-brown algae) are small, usually unicellular phytoplankton that are consistently the most abundant taxonomic group in the Meadowbank study area lakes. Chrysophytes also dominate phytoplankton biomass in all study area lakes, typically representing 65% or more of total phytoplankton biomass in summer samples, with smaller proportions (usually <10% each) from the other five major groups. The dominant chrysophyte genera for the Meadowbank study area lakes are *Chrysococcus, Kephyrion, Chrysochromulina, Dinobryon,* and *Chrysolkos*. Dominant genera for the other groups are *Oocystis* for chlorophytes, *Planktolyngbya* for cyanophytes, *Cyclotella* for diatoms, *Rhodomonas* and *Cryptomonas* for cryptophytes, and *Gymnodinium* and *Peridinium* for dinoflagellates (Azimuth, 2012a, 2011b, 2010a, 2009c, 2008a, and 2008b).

Mean phytoplankton biomass in the Meadowbank study area lakes typically ranges from 100 to 250 mg/m^3 during summer with diminishing biomass in fall through winter. This range in biomass is typical for oligotrophic, central Arctic Canadian lakes. Biomass estimates from lakes sampled in the 1980s in the Kivalliq Region generally ranged between 100 and 300 mg/m^3 (McKee et al., 1989). Other studies on arctic lake phytoplankton communities have reported similar ranges of phytoplankton biomass at Snap Lake (266 mg/m^3; De Beers, 2002), Char Lake (166 mg/m^3, Kalff et al., 1975), and Spring Lake (120 mg/m^3, Welch et al., 1989).

4.4.2 Temporal and Spatial Trend Interpretation

The approach for identifying potential mine-related impacts involved visually searching for temporal-spatial patterns that might be associated with mine-related activities (see **Table 1-1** for details), augmented by statistical analyses of annual data to test for changes relative to baseline/reference conditions using the BACI model (see **Section 2.3.3** for details). Both methods look for evidence of temporal-spatial patterns that might be associated with the mine-related activities.

The primary metrics used in the assessment were chlorophyll-a concentration (a surrogate for overall primary productivity), total biomass (mg/m^3), relative biomass of major taxonomic groups, and species richness (total # species). Biomass, not abundance, was examined because biomass and abundance tend to be reasonably well correlated and, ultimately, biomass is a much better approximation of actual lake productivity or food availability for zooplankton. The BACI statistical testing focused on total biomass and species richness because these reflect ecologically relevant information about the phytoplankton community (i.e., total mass of community and community composition, respectively). The trigger and threshold effect sizes for total biomass and species richness are 20% and 50%.

Expected response patterns in phytoplankton biomass and species richness are dictated by the nature of the physical and/or chemical changes caused by mine-related activities. For example, dike construction or dewatering may introduce turbidity, leading to a reduction in phytoplankton biomass/diversity. In contrast, introducing other substances, such as nitrogen associated with blasting by-products, could increase primary production. We therefore look for both reductions and increases (i.e., two-tailed statistical tests) in phytoplankton-related metrics coinciding with mining activities (i.e., focusing primarily on data for SP, TPE, TPN, and WAL).

An important consideration when working with phytoplankton data is the naturally high variability of control data. This potentially confounding *noise* effect can make it difficult to identify mining-related influences or *signals* at impact areas, unless the signals are quite large.

Density and biomass results for phytoplankton samples collected from the Meadowbank study lakes are provided in **Appendix D1**. The 2012 CREMP (Azimuth, 2013) provided a detailed description of historical trends in phytoplankton-related metrics. The current report emphasizes results for 2022, but retains the historical context by showing the results of all monitoring years. Trend data for chlorophyll-a, total biomass, major taxa composition, and species richness are presented from **Figure 4-13** to **Figure 4-17**. Plots for all other phytoplankton metrics are presented in **Appendix D1**. The BACI statistical test results of changes in the phytoplankton community in 2022 compared to baseline/reference conditions are provided in **Table 4-7**; key results are described below.

Key Results for the Visual and BACI Analyses

Chlorophyll-a

Concentrations in the reference area samples typically range between 0.11 and 0.72 µg/L in summer months, reflecting the oligotrophic, nutrient poor condition of these lakes. Temporal patterns at the reference areas INUG and PDL have been fairly consistent, with some inter-annual variability but no apparent trends. This suggests a lack of regional changes in this metric.

Chlorophyll-a concentrations at the NF exposure areas TPN, TPE, SP, and WAL show no evidence of abnormal seasonal or longer-term temporal trends (**Figure 4-13**) and generally remain less than 1 µg/L, which is consistent with oligotrophic conditions (Kasprzak et al. 2008). The 2022 results are consistent with this conclusion.

Total Biomass

The total phytoplankton biomass results for 2022 were very similar to 2017–2021. Biomass results followed the same seasonal trends, with higher biomass reported in the summer months (July to September) compared to early spring. Winter under-ice biomass has been naturally very low at most locations, and, generally, the same pattern was noted in 2022.

- For reference lakes, summer biomass estimates at INUG in 2022 ranged from 108 to 251 mg/m^3, which was within the range observed historically. The peak biomass at PDL was 219 mg/m^3 in

July, which was similar to 2021. Overall, these results point to the expected seasonal variability and are consistent with the range of total biomass observed in previous years for the reference areas (**Figure 4-14**).

- Peak total biomass in 2022 for NF areas TPE, TPN, and WAL ranged slightly higher than in 2021. For all NF areas, total biomass was largely within the range observed historically.
- BACI analysis demonstrated apparent increases ranging from 19% to 49% at the NF areas in 2022 relative to reference area INUG. The increases in total biomass exceeded the trigger (> 20% effect size) at TPN (49%), SP (31%), and WAL (39%). None of the observed increases at NF areas were statistically significant (p-value > 0.1; **Table 4-7**). As the results are similar to previous years, the apparent increases in 2022 are likely due to natural variability as biomass at the NF areas is consistent with historical results.

Major Taxa Composition

Chrysophytes tend to dominate in the study lakes in all open-water months, a pattern that has been consistent since monitoring began in 2006 (**Figure 4-15**). The continued dominance of chrysophytes provides an additional line of evidence suggesting any *potential* incremental increase in nutrients or changes in water quality has not resulted in major structural changes to the community. Among the major taxa, chlorophytes are typically the first to respond to nutrient enrichment in freshwater systems (Holmgren, 1984). The direct positive effect of nutrient enrichment on chlorophytes has been shown to have an indirect negative effect on chrysophytes, which compete with chlorophytes for nutrients (Klug and Cottingham, 2001). In the same study by Klug and Cottingham, chrysophytes were among the dominant taxa prior to artificial fertilization of the study lakes. These observations from the primary literature substantiate findings from the CREMP that the structure of the phytoplankton community is consistent with pre-development oligotrophic conditions (**Figure 4-16**).

Taxa Richness

Seasonal profiles for all areas were as expected, with a general increase from low richness in under-ice months to peak richness of approximately 30 to 40 taxa during the open-water season (**Appendix D1**). The seasonal pattern of taxa richness at the exposure areas was similar to the reference areas and consistent with previous years (**Figure 4-17**). The estimated changes relative to baseline/reference conditions were small (<20% effect size) and none of the changes were statistically significant (p-values >0.1; **Table 4-7**). Taxa richness appeared to be similar to historical results at all NF areas.

4.4.3 Summary and Implications

The seasonal trends in phytoplankton community taxa biomass and taxa richness data from 2022 are generally similar to previous years and largely appear within the range of historical baseline/reference conditions. For most areas, chlorophyll-a concentrations peaked in May and total biomass and richness peaked in the summer months.

Total biomass was relatively higher at NF areas TPN, SP, and WAL (p-values > 0.1), while total richness showed only minor differences relative to historical baseline/reference conditions. Results for 2022 for NF areas were within the historical range for both metrics. It is difficult to determine in a single year whether these changes are related to mining but when compared to the trends observed over the years, and given the lack of mining-related activities occurring in 2022, natural variability is considered to be the most likely driver. Notwithstanding, this trend will continue to be monitored in 2023 to verify whether future patterns are consistent with this conclusion or whether they provide stronger evidence of mine-related causality.

4.5 Sediment Chemistry

4.5.1 General Observations

Natural sedimentation rates in the Meadowbank study lakes are considered low, due to the headwater nature of the watersheds and the lack of any substantial riverine or tributary inflow. Thus, very little sediment is carried into the lakes other than what erodes off the nearby tundra during spring run-off or heavy rain events, or from dust deposition. The only site discharge in 2022 was from East Dike seepage into Second Portage Lake (**Table 1-1**).

Based on historical bulk sampling of sediment using grab samples, we have observed reasonably large, within-basin or within-lake differences in surface sediment (i.e., top 3–5 cm) concentrations for various metals, indicating natural spatial heterogeneity driven by localized mineralization. Several processes can affect the pattern of metals distribution to sediments, including differential deposition of different grain size materials according to wind direction and speed, water depth, water currents, basin morphometry, bioturbation (i.e., vertical mixing of sediment by burrowing insect larvae), and patchy, heterogeneous distribution of metals in mineralized areas. Metals concentrations are highly dependent on grain size, with coarse grain size (i.e., sandier) typically correlating with lower metals concentrations. Therefore, our sediment programs target low energy, depositional areas that are dominated by silt/clay sediment in areas of similar water depth (6–10 m), where grain size tends to be finer and more consistent.

Sediment chemistry samples are collected using grab samplers (targeting top 3–5 cm) or coring devices (targeting top 1.5 cm). Grab samples are used to characterize the chemical and physical conditions of sediments paired with the benthic invertebrate community samples. While grab samples can provide insights into temporal changes in sediment chemistry, core samples are more sensitive and are used in the CREMP to formally test for changes in sediment chemistry related to mining. Core samples are collected every three years to match the timing of EEM studies required under the Metal and Diamond Mining Effluent Regulations (MDMER); the next event will be in 2023.

In 2022, sediment grab sampling was completed at the NF and REF areas only. Grabs for sediment chemistry and habitat characteristics and benthic invertebrates were collected at the same locations (**Figure 4-2**). Sediment grab samples for habitat characteristics were analyzed for pH, moisture, total organic carbon (TOC), and grain size; samples for chemistry were either archived (metals) or analyzed for aggregate organics, hydrocarbons and polycyclic aromatic hydrocarbons (PAHs).

An overview of the various sediment sampling programs at Meadowbank dating back to baseline sampling in 2008 is provided in **Appendix C1**.

4.5.2 Temporal and Spatial Trend Interpretation

Grain size and organic content (TOC) are important sediment analytes relevant for benthic invertebrate community habitat characteristics. Results from this year's CREMP are provided in **Appendix C1**. Grain size results were similar to previous years, with generally finer-grained sediment often dominated by the silt fraction (**Figure 4-18**). TOC concentrations were also similar to previous results, with most areas having < 5 % TOC and the highest seen at WAL (6.7 to 11 % in 2022).

Grab sampling results for analysis of organic compounds are also provided in **Appendix C1**. As in previous years, most results were not detectable. The only identified detectable concentrations were naphthalene in the INUG composite sample and mineral oil and grease in the TPN and WAL composite samples. These detectable concentrations appear to be due to natural causes rather than mining activity.

Verification of the sediment chemistry trends observed in previous years using sediment coring will be conducted in 2023.

4.6 Benthos Community

4.6.1 General Observations

The abundance and species composition of benthic invertebrates are influenced by water depth, substrate grain size, and organic carbon. Other physical factors, such as water temperature, can influence larval development rates and, ultimately, timing of hatching for insect larvae. Consequently, even if sampling can be conducted simultaneously in all lakes (which is not practical), this would still not overcome differential timing of hatching of particular species between lakes. This is partly overcome in the CREMP by sampling during August, after most groups have emerged, but it is still a source of some variability.

Benthic invertebrate communities in the Meadowbank study lakes are characterized by relatively few taxa and low abundance. Abundance is generally less than 2,000 organisms/m^2 and is often less than 1,000 organisms/m^2 at reference and exposure areas (e.g., **Table 4-8** and **Figure 4-19**). Despite abundance generally being low at the study lakes, values above 5,000 organisms/m^2 are not uncommon, and on occasion abundance has exceeded 10,000 organisms/m^2. Relatively large total benthic invertebrate abundance values were periodically observed in samples collected prior to mine development (e.g., one replicate had 26,000 organism/m^2 at WAL in 2006) and in more recent sampling events (e.g., one replicate had 31,000 organism/m^2 at WAL in 2016). The high variability in total abundance within an area has also recently been observed at lakes sampled for the Whale Tail mine during the baseline period (i.e., the *before* period). Total abundance at Lake A76 in 2017 was between 3,000 and >24,000 organisms/m^2 (Azimuth, 2018a). Whale Tail Lake – South Basin also showed comparatively large variance in abundance in 2017, ranging from 1,800 to over 10,000 organisms/m^2. Abundance data for the Meadowbank study lakes between 2006 and 2021, as well as more recent baseline data from the Whale Tail program, demonstrates that benthos abundance is naturally variable, both spatially (i.e., among areas) and temporally (i.e., between years).

Taxa richness typically ranged from 8–12 for most area-year combinations (**Figure 4-22**). Typical of most Arctic lakes, the benthic invertebrate community has been dominated by the aquatic larval stages of insects, especially chironomids (Family Chironomidae), both in terms of abundance and taxa richness (e.g., **Figure 4-20** and **Figure 4-23**). The next most abundant group was Mollusca (clams), particularly *Cyclocalyx* / *Neopisidium* genera of the family Sphaeriidae (fingernail clams). Oligochaete worms were also relatively common in the lake sediments; generally, at least one oligochaete taxon was present at most area-year combinations.

4.6.2 Temporal and Spatial Trend Interpretation

Benthic invertebrate abundance and richness results from the reference (INUG and PDL) and NF (TPE, TPN, SP, and WAL) Meadowbank study lakes in 2022 are provided in **Appendix E1**, by major taxonomic group (i.e., Insecta, Mollusca, Oligochaeta, and other taxa). Geometric means of total abundance and total richness for the entire data set dating back to 2006 are provided in **Table 4-8**.

Time-series plots showing abundance and richness endpoints are presented in **Figure 4-19** to **Figure 4-24**. Below are descriptions of the endpoints, based on Environment Canada EEM guidance (2012):

- Total abundance – the number of individual organisms per m^2. This metric is a measure of community density.
- Total richness – the number of different taxa (identified to the lowest practical taxonomic level, usually species) per grab.
- Abundance of major taxa (absolute and relative abundance of each major taxon).
- Richness of major taxa (absolute and proportional richness of each major taxon).

Other benthic invertebrate community results presented in **Appendix E1,** but not discussed in detail, include time-series plots of abundance and richness within each major taxon, Simpson's Diversity, and Bray-Curtis Index values.

Identifying potential mine-related impacts generally involved visually examining the data for spatial/temporal patterns that matched mine-related events. This was followed up with formal statistical analyses of the data to test for changes relative to baseline/reference conditions using the BACI model (see **Section 2.3.3** for details). The BACI comparisons involved testing for single-year (i.e., 2022) and multi-year (i.e., up to four years) trends and focused on benthic invertebrate total abundance and taxa richness. This report focuses on the 2022 results and discusses temporal and spatial trends over the last four years (i.e., dating back to 2019). As discussed in **Section 2.2.3**, MF (TPS and TE) and FF (TEFF) areas were not sampled in 2022. BACI model results for benthic invertebrate abundance and richness are presented in **Table 4-9** and **Table 4-10**, respectively. Key results are described below.

Total Abundance

Total abundance at INUG was slightly lower in 2022 compared to 2021. INUG is the main reference area used for the BACI comparisons, so it is noteworthy that total abundance has been generally higher for INUG from 2015 to 2021 compared to earlier years (**Table 4-8**). However, the range in abundance since monitoring began is generally lower at INUG relative to the NF areas, with maximum abundance of 2,100 organisms/m^2 (2016) relative to SP (2,796 in 2014), TPN (3,025 in 2015), TPE (5,556 in 2008), and WAL (14,253 in 2016).

Yearly total abundance is plotted in **Figure 4-19**. Visually, the plots suggest higher abundance at WAL and slightly lower abundance at TPN, compared to 2021. Overall, the BACI results in **Table 4-9** show negative effect sizes (i.e., reduction) in abundances for TPN and TPE sampling areas and positive effects sizes (i.e., increases) for SP and WAL compared to reference area INUG in 2022, though none of the results are statistically significant ($p > 0.1$). The effect size for TPE in 2022 exceeded the 20% trigger (ES = -27%), and the effect size for WAL exceeded the 20% trigger and 50% threshold (ES = 63%). These results appear to be influenced by natural inter-annual variability rather than mining activities.

Interpreting the BACI analysis results can be challenging for two reasons: 1) because natural variability exists between years and areas and 2) because there is heterogeneity within areas. For example, total abundance at TPE continues to be fairly stable with relatively minor variability between years (**Figure 4-19**). However, the BACI assessment of total abundance at TPE in each time period assessed over the past four years showed a relative reduction ranging from 22% to 32% compared to INUG, though none of these changes was statistically significant (**Table 4-9**). These results are driven by a number of years with higher abundance at INUG rather than on any actual reduction in abundance at TPE.

A further challenge is accounting for heterogeneity within sites and the influence that differing abundance in replicates can have on the yearly mean for an area. For example, in 2022, abundance at replicate TPE-5 had a low total abundance of 870 organisms/m^2 compared to replicate TPE-1 which had a high abundance of 3,739 organisms/m^2. An even larger difference between replicates was observed in 2020, where the lowest total abundance was 2,065 organisms/m^2 at replicate WAL-4 compared to the highest total abundance of 24,261 organisms/m^2 at replicate WAL-5.

In recent years, estimated effect sizes have fluctuated but generally remained small for total abundance at the Meadowbank study area lakes. In 2022, and for all *after* periods up to four years, the effect size at TPE was negative and not statistically significant (i.e., reduced abundance, see **Table 4-9**). As discussed previously, the apparent reductions in abundance are not supported by the temporal trends for total benthic abundance for TPE shown in **Figure 4-19**. The time-series plots highlight that abundance at TPE has remained remarkably consistent over the last seven years and is similar to baseline results. The apparent reduction in abundance at TPE in the BACI analysis is related to the combined effect of two factors: 1) high abundance at TPE during the baseline period and 2) increased abundance at INUG in recent years (relative to baseline). In this context, the BACI results for TPE are interpreted strictly as a *relative* reduction in abundance compared to INUG rather than an absolute reduction in benthos abundance. The BACI results, while important for identifying potential temporal changes in benthos metrics, need to be interpreted in the broader context of the absolute change in the benthos community over time. Overall, the abundance data do not suggest that there are changes to benthic invertebrate abundance in the NF areas that are attributable to mining activity.

Major Taxa Abundance

Insects were the dominant taxon with generally over 60% relative abundance followed by molluscs with roughly between 10–35% relative abundance (**Figure 4-20** and **Figure 4-21**). While there were no apparent trends in composition changes related to mining at most areas, it is notable that most peaks or valleys in total abundance over the years appear to be driven by changes in abundance of insects, predominantly chironomids. Notable examples are WAL in 2016, 2018, 2020, and 2022, or TPE in 2008. Given the large inter-annual changes in total abundance, it is not unexpected to see a change in the relative dominance of major taxa groups.

Taxa Richness

Taxa richness in 2022 was generally within the range of other sampling years (**Figure 4-22**). Mean taxa at the reference areas was 12.2 at INUG and 9 at PDL, which were around the mid-range of reported number of taxa at PDL since monitoring began in 2009 (**Table 4-8**). Results of the BACI suggested there was an apparent increase in taxa richness at SP in the 2019-22 time period (p-value = 0.092). Otherwise, there were no statistically significant changes in taxa richness in 2022 or in the other time periods (i.e., 2021-22, 2020-22). Apparent effect sizes showed an increase for all areas (**Table 4-10**). Overall, taxa richness was within range of richness observed over the duration of sampling years. Despite some within-year variability in taxa richness, the NF areas show either stable or slightly increasing taxa richness.

Major Taxa Richness

Insects were dominant in terms of absolute and proportional richness (generally between five to ten taxa), followed by molluscs (~one to three taxa) (**Figure 4-23** and **Figure 4-24**). The 2022 results are similar to previous years and show that there were no apparent trends in composition related to mining.

4.6.3 Summary and Implications

The benthic invertebrate metrics (total abundance and taxa richness) for the NF and reference areas were generally within the range reported for previous years. Furthermore, other than an apparent increase in taxa richness at SP in the 2019-22 time period, the BACI analysis did not detect any significant changes in abundance or taxa richness in 2022, nor in the three longer-term time periods assessed (i.e., 2021-22, 2020-22, 2019-22). While there were apparent reductions in abundance at TPE relative to INUG for all time periods assessed, the reductions were not statistically significant. Total abundance at TPE has been remarkably stable over the past ten years. Importantly, the richness of the benthic invertebrate community at TPE is consistent with previous CREMP years, indicating the benthic community at TPE remains functionally diverse. In summary, the apparent changes in benthic community observed in 2022 are likely due to natural variability rather than to mining activities, and will continue to be monitored in 2023.

4.7 Meadowbank Tables and Figures

The tables and figures for the Meadowbank CREMP are provided in this section, except for the large tabulated datasets and figures for parameters not included in the detailed analysis (see in-text references to appropriate Appendices). Subsections are provided for each of the CREMP components (e.g., limnology, water chemistry, phytoplankton, sediment chemistry, and benthic invertebrates).

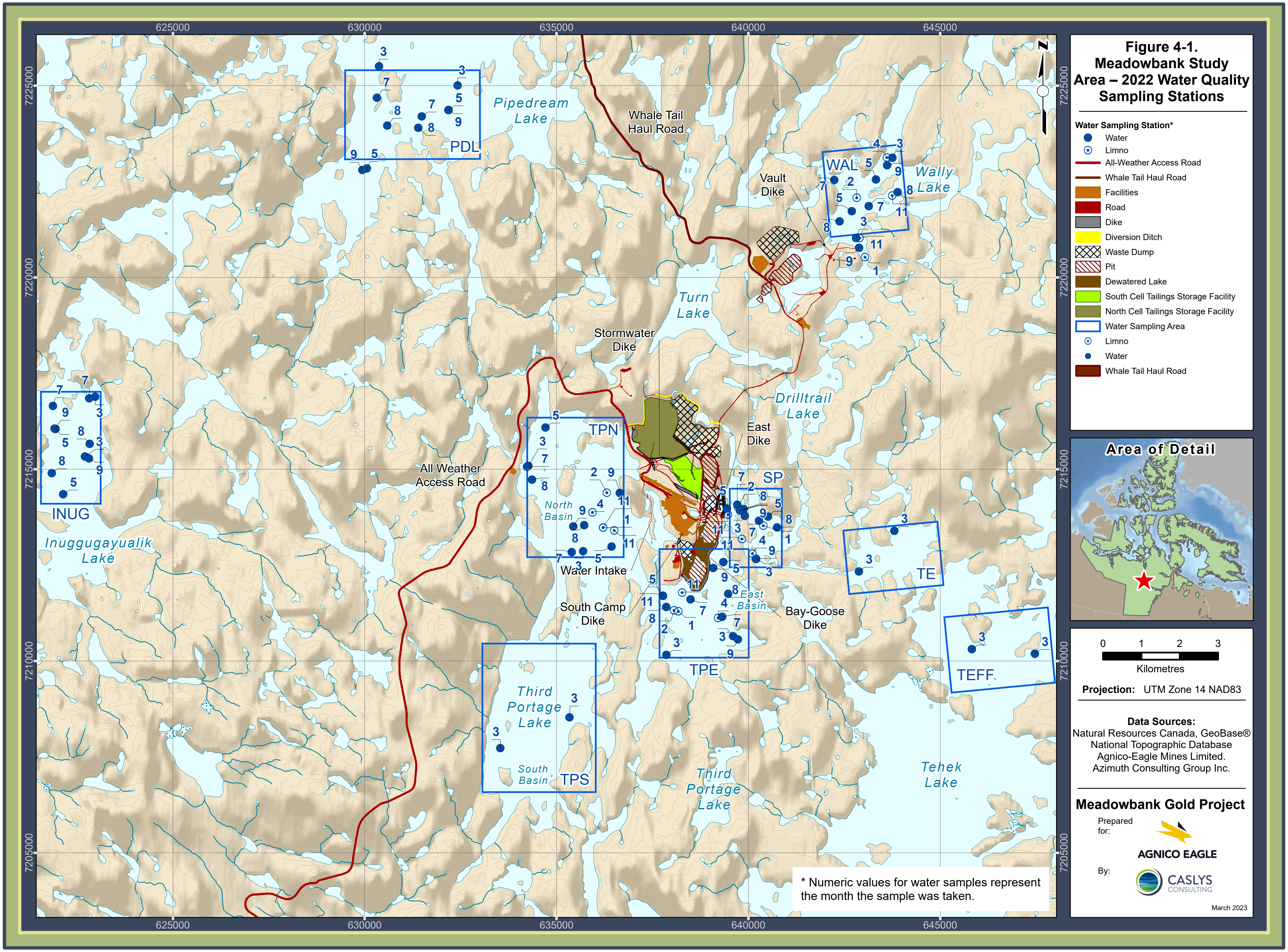


Figure 4-1. Meadowbank Study Area – 2022 Water Quality Sampling Stations

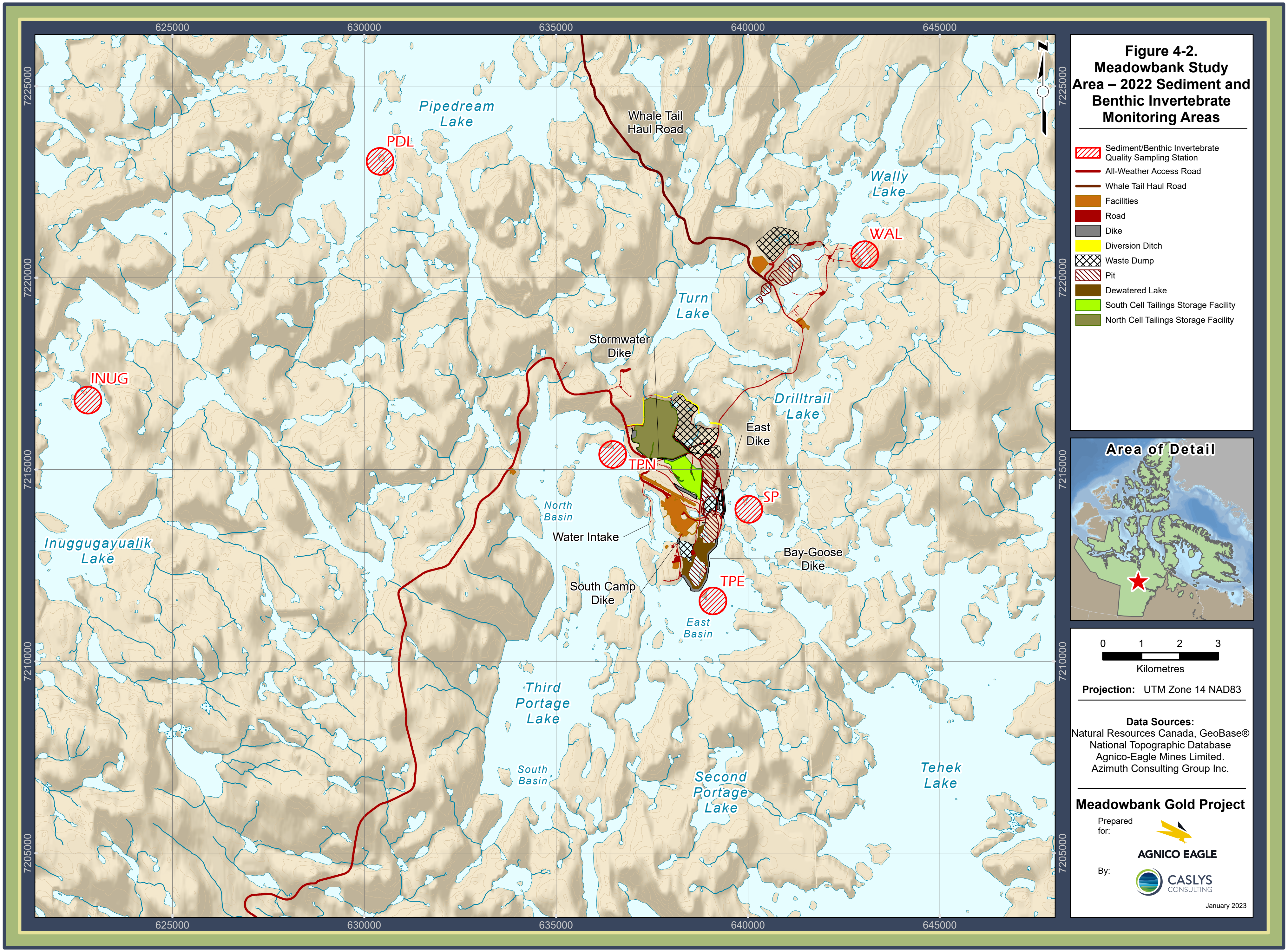


Figure 4-2. Meadowbank Study Area – 2022 Sediment and Benthic Invertebrate Monitoring Areas

Limnology Tables and Figures

Figure 4-3. Mean monthly field-measured temperature (°C) at 3 m depth since 2006, Meadowbank study area lakes.

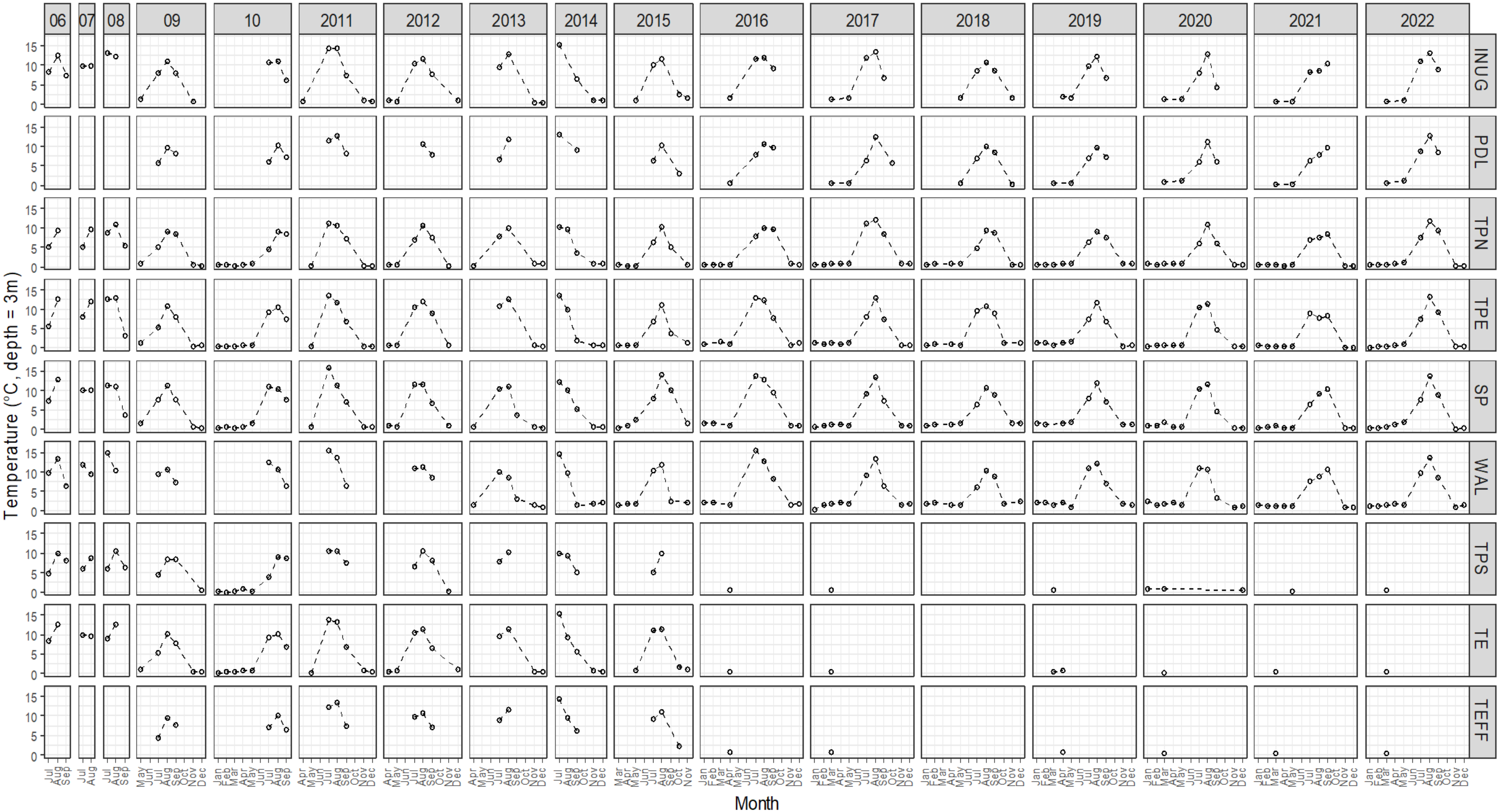


Figure 4-4. Meadowbank – Field-measured temperature profiles, 2022.

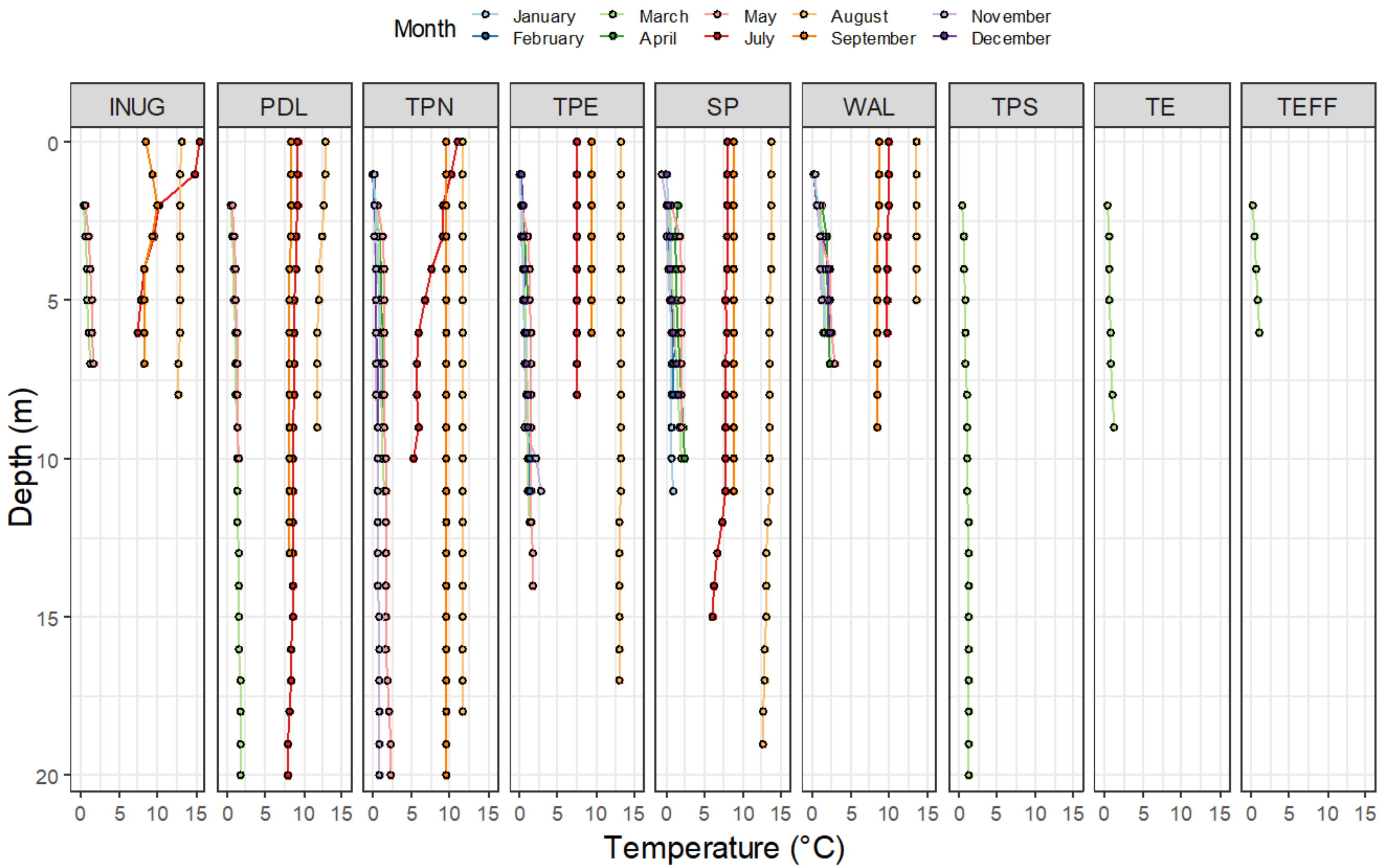


Figure 4-5. Meadowbank – Field-measured dissolved oxygen profiles, 2022.

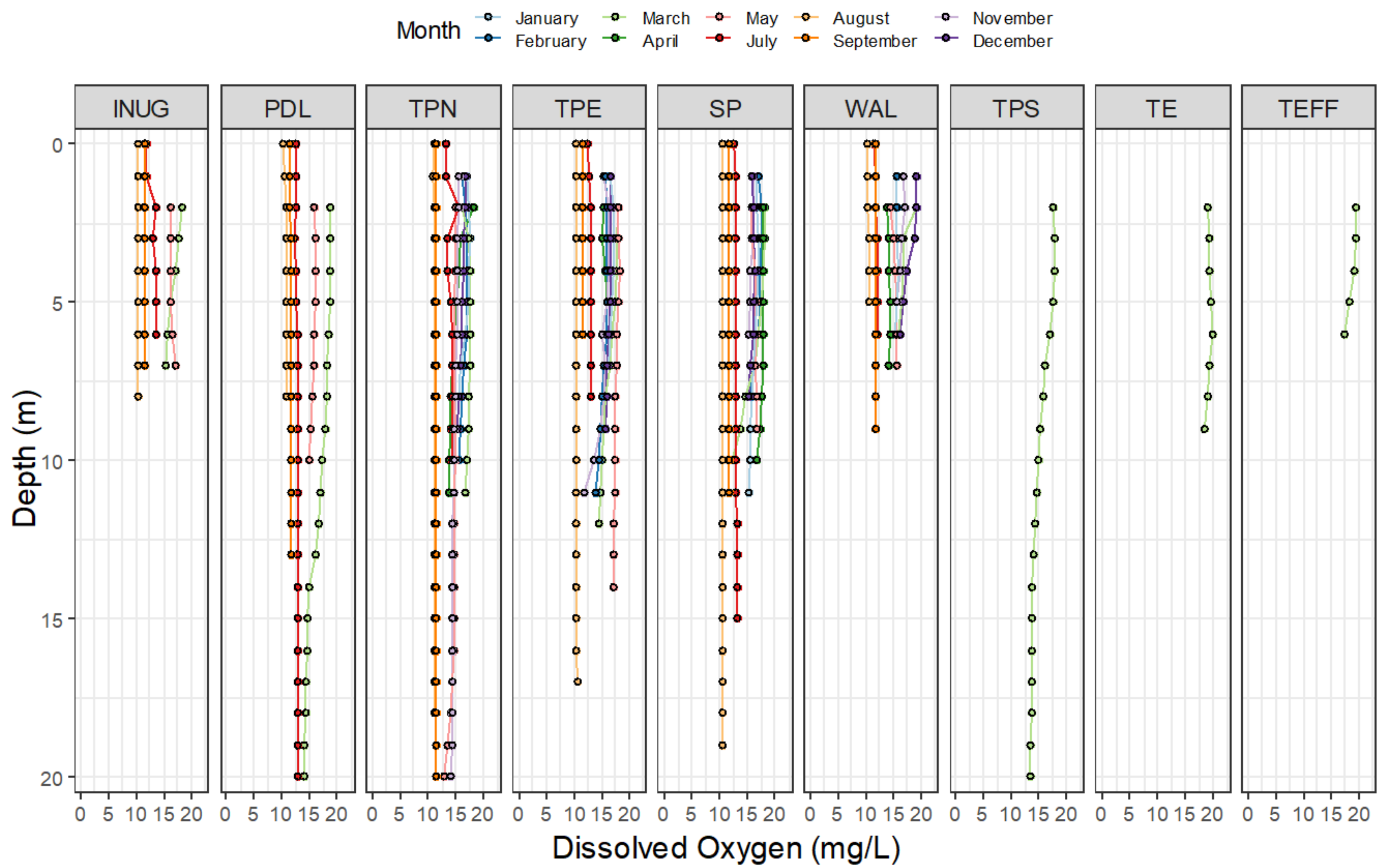
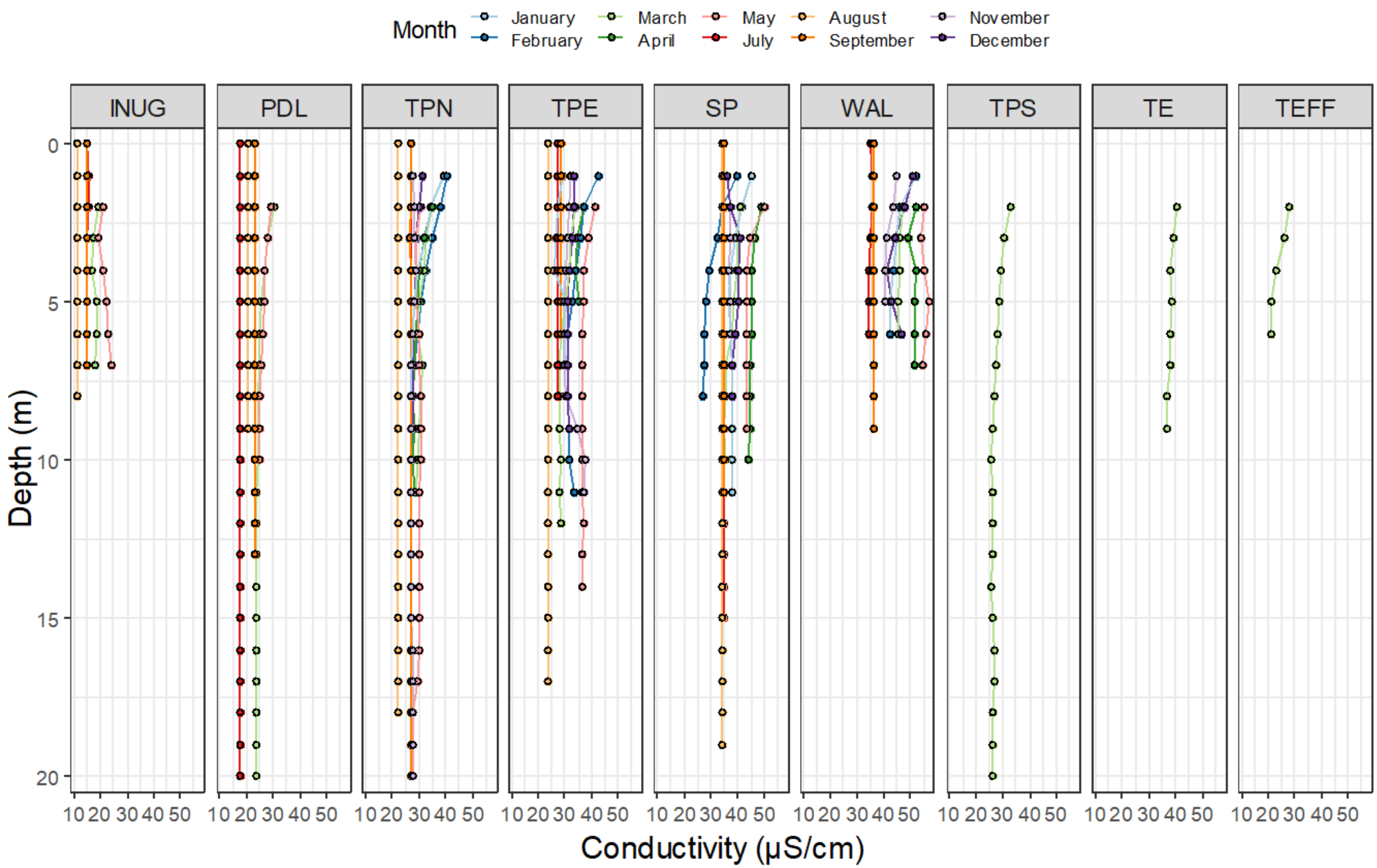


Figure 4-6. Meadowbank – Field-measured conductivity profiles, 2022.



Water Chemistry Tables and Figures

Table 4-2. Assessment process for water quality parameters, Meadowbank study area lakes, 2022.

Parameters	Trigger Exceedance[2]	Screening Level and Rule[1] 1: >DL ≥ 10% Frequency	2: C-I > 0.1 Frequency	3: Pattern = Activity
CONVENTIONALS				
Conductivity	All stations except INUG	Yes	Yes	
TSS	-	No	No	No
Hardness	All stations except INUG	Yes	Yes	
T-Alkalinity	All stations except TPN and TEFF	Yes	Yes	
B-Alkalinity	All stations except TPN and TEFF	Yes	Yes	
C-Alkalinity	-	No	No	No
pH -Field	INUG, PDL, TPE, SP, WAL, and TEFF	Yes	Yes	
pH -Lab	-	Yes	Yes	
TDS & MAJOR IONS				
TDS	All stations except INUG and TEFF	Yes	Yes	
Calcium	All stations except INUG	Yes	Yes	
Chloride	-	Yes	Yes	
Fluoride	SP, TE, TPE, TPS, and WAL	Yes	Yes	
Magnesium	All stations	Yes	Yes	
Potassium	All stations except INUG and PDL	Yes	Yes	
Sodium	TPE, TPN, TPS, and WAL	Yes	Yes	
Sulphate	-	Yes	Yes	
NUTRIENTS & OTHERS				
Ammonia-N	-	Yes	Yes	
Nitrate-N	-	Yes	Yes	
Nitrite-N	-	No	No	No
TKN	WAL and TE	Yes	Yes	
T-phosphorus	SP and WAL	Yes	Yes	
Ortho-phosphate	-	No	No	No
DOC	INUG, SP, WAL, and TE	Yes	Yes	
TOC	INUG, SP	Yes	Yes	
Reactive silica	WAL	Yes	Yes	
T-Cyanide	-	No	No	No
Free Cyanide	-	No	No	No

Parameters	Trigger Exceedance[2]	Screening Level and Rule[1] 1: >DL ≥ 10% Frequency	2: C-I > 0.1 Frequency	3: Pattern = Activity
TOTAL METALS				
Aluminum	-	Yes	Yes	
Antimony	-	No	No	No
Arsenic	-	Yes	Yes	
Barium	-	Yes	Yes	
Beryllium	-	No	No	No
Boron	-	No	No	No
Cadmium	-	No	No	No
Chromium	-	Yes	Yes	
Copper	WAL	Yes	Yes	
Iron	-	Yes	Yes	
Lead	-	No	No	No
Lithium	-	No	No	No
Manganese	-	Yes	Yes	
Mercury	-	No	No	No
Molybdenum	-	Yes	Yes	
Nickel	-	Yes	Yes	
Selenium	-	No	No	No
Silicon	INUG, PDL, SP, TPN, WAL, TE, and TEFF	Yes	Yes	
Silver	-	No	No	No
Strontium	-	Yes	Yes	
Thallium	-	No	No	No
Tin	-	No	No	No
Titanium	-	No	No	No
Uranium	-	Yes	Yes	
Vanadium	-	No	No	No
Zinc	-	No	No	No

Parameters	Trigger Exceedance[2]	Screening Level and Rule[1] 1: >DL ≥ 10% Frequency	2: C-I > 0.1 Frequency	3: Pattern = Activity
DISSOLVED METALS				
Aluminum	-	Yes	Yes	
Antimony	-	No	No	No
Arsenic	-	Yes	Yes	
Barium	-	Yes	Yes	
Beryllium	-	No	No	No
Boron	-	No	No	No
Cadmium	-	No	No	No
Chromium*	All stations	No	No	No
Copper	SP and WAL	Yes	Yes	
Iron	-	No	No	No
Lead	-	No	No	No
Lithium	-	No	No	No
Manganese	-	Yes	Yes	
Mercury	-	No	No	No
Molybdenum	-	Yes	Yes	
Nickel	-	Yes	No	No
Selenium	-	No	No	No
Silicon	INUG, PDL, SP, WAL, TE, and TEFF	Yes	Yes	
Silver	-	No	No	No
Strontium	-	Yes	Yes	
Thallium	-	No	No	No
Tin	-	No	No	No
Titanium	-	No	No	No
Uranium	-	Yes	Yes	
Vanadium	-	No	No	No
Zinc	TPN and WAL	No	No	No

Notes:

1. A three-step assessment process was used to identify parameters to include in the formal temporal and spatial trend assessment (**Section 2.3.1** and **Section 4.3.2**).
   Parameters were assigned a "Yes" if the following assessment was true:

(1) **>DL ≥ 10% Frequency**: parameters that exceeded MDLs in at least 10% of the samples.
(2) **C-I > 0.1 Frequency**: parameters that were detected more often in impact areas and the proportion of detected values increased by 0.1 or more.
(3) **Pattern = Activity**: additional step to avoid screening out potentially important parameters. Based on the trend plots, is there a trend for infrequently detected parameters and/or are there values > 5 x DL in at least one sampling event at NF areas?

2. Indicates that a trigger exceedance occurred at the listed Whale Tail study area lakes in one or more sampling event.

Shaded parameters are included in the temporal and spatial trend assessment.

* Dissolved chromium had elevated MDLs that were above trigger values in 2022. See **Section 3.3** for more details.

Plots for all individual parameters are presented in **Appendix B1**.

Table 4-3. Water quality variables at the Meadowbank study areas for which the 2022 mean concentration exceeded the trigger.

Meadowbank Study Areas

Parameter	Trigger	2022 Mean		
		TPN	TPE	SP
		NF	NF	NF
Conductivity	27.4	29.7	31.9	39.0
Hardness	9.5	10.0	11.5	15.4
TDS	19	-	-	24.3
Total alkalinity	8.7	-	-	11.1
HCO_3 alkalinity	8.7	-	-	11.1
Calcium	2.39	-	2.8	4.0
Magnesium	0.93	0.98	1.1	1.3
Potassium	0.58	-	0.60	-
T. Silicon	0.2	-	-	0.31
D. Silicon	0.18	-	-	0.28

Wally Lake

Parameter	Trigger	2022 Mean
Conductivity	36.6	43.5
Hardness	16.7	18.4
TDS	25.3	28.8
Calcium	4.88	5.0
Magnesium	1.36	1.5
Reactive silica	1.08	1.2

Notes:

"-" indicates no threshold available, and/or mean annual concentration was < the trigger value.
Reported mean values are all in units of mg/L except for conductivity (µS/cm).

Table 4-4. Results of BACI tests for selected water variables at Meadowbank study areas in 2022.

Parameter	Test Area	n(B)	n(A)	Estimate	SE	F	DF	P-value[1]	Proportional change exp(Est)	Proportional change LCI	Proportional change UCI
Conductivity	TPN	6	5	0.53	0.034	249	9	**< 0.001**	1.7	1.6	1.8
	TPE	8	5	0.58	0.044	176	11	**< 0.001**	1.8	1.6	2.0
	SP	5	5	0.38	0.026	201	8	**< 0.001**	1.5	1.4	1.5
	WAL	18	5	0.14	0.072	3.9	21	**0.031**	1.2	0.99	1.3
Hardness	TPN	6	5	0.38	0.11	11.8	9	**0.0037**	1.5	1.1	1.9
	TPE	8	5	0.52	0.059	77.7	11	**< 0.001**	1.7	1.5	1.9
	SP	5	5	0.30	0.069	18.4	8	**0.0013**	1.3	1.1	1.6
	WAL	18	5	0.13	0.069	3.5	21	**0.038**	1.1	0.99	1.3
HCO_3 alkalinity	SP	5	5	0.22	0.074	8.8	8	**0.0089**	1.2	1.1	1.5
Total alkalinity	SP	5	5	0.22	0.074	8.8	8	**0.0089**	1.2	1.1	1.5
TDS	SP	5	5	0.53	0.098	29.0	8	**< 0.001**	1.7	1.4	2.1
	WAL	18	5	0.21	0.15	2.1	21	0.083	1.2	0.91	1.7
Calcium	TPE	8	5	0.54	0.069	62.3	11	**< 0.001**	1.7	1.5	2.0
	SP	5	5	0.30	0.095	10.1	8	**0.0065**	1.4	1.1	1.7
	WAL	18	5	0.091	0.060	2.3	21	0.072	1.1	0.97	1.2
Magnesium	TPN	6	5	0.35	0.065	29.7	9	**< 0.001**	1.4	1.2	1.6
	TPE	8	5	0.46	0.054	73.7	11	**< 0.001**	1.6	1.4	1.8
	SP	5	5	0.29	0.046	38.8	8	**< 0.001**	1.3	1.2	1.5
	WAL	18	5	0.14	0.045	10.2	21	**0.0022**	1.2	1.1	1.3
Potassium	TPE	8	5	0.29	0.053	30.7	11	**< 0.001**	1.3	1.2	1.5
Reactive silica	WAL	16	5	0.52	0.23	5.3	19	**0.017**	1.7	1.0	2.7

Notes:
1. Bolded P-values are statistically significant ($p < 0.05$).
Test area = area compared to control (INUG).
N(B) = number of paired months in the *before* period.
N(A) = number of paired months in the *after* period (i.e., in 2022).
Estimate = BACI model estimate of the 2022 change in mean for log-transformed data.
SE = standard error of the estimate.
DF = degrees of freedom.
P-value = one-tailed test of the null hypothesis (no change or a decrease in mean [opposite for lower pH trigger]).
Exp(Est.) = estimated proportional change.
LCI = lower 95% confidence interval; UCI = upper 95% confidence interval.

Table 4-5. Sampling effort and frequency assessment results for the Meadowbank study area lakes, 2022.

Areas	Area Designation	Triggers Exceeded?	Minor Changes [1]		Moderate Changes [2]		Major Changes [3]		Plan for 2023
		Yes/No	Yes/No	Parameters	Yes/No	Parameters	Yes/No	Parameters	
Sampling Strategy for Reference Areas									
INUG	Ref	Yes	Yes	T.&D. Silicon	No	-	No	-	Full CREMP (reference area)
PDL	Ref	Yes	Yes	Alkalinity (HCO_3 & Total), Hard., Ca	No	-	No	-	Full CREMP (reference area)
Sampling Strategy for Near-field Areas									
TPE	NF	Yes	Yes	Cond., Hard., Ca, Mg, K	No	-	No	-	Full CREMP (near-field area)
TPN	NF	Yes	Yes	Cond., Hard., Mg	No	-	No	-	Full CREMP (near-field area)
SP	NF	Yes	Yes	Cond., Hard., TDS, Alkalinity (HCO_3 & Total), Ca, Mg, T.&D. Silicon	No	-	No	-	Full CREMP (near-field area)
WAL	NF	Yes	Yes	Cond., Hard., TDS, Reactive silica, Ca, Mg	No	-	No	-	Full CREMP (near-field area)
Sampling Strategy for Mid-field and Far-field Areas									
TE	MF	Yes	NA	-	NA	-	NA	-	Winter through-ice sampling
TEFF	FF	Yes	NA	-	NA	-	NA	-	Winter through-ice sampling
TPS	MF	Yes	NA	-	NA	-	NA	-	Winter through-ice sampling

Notes:
1. Minor = exceedance of the early warning trigger values for parameters without effects-based threshold values.
2. Moderate = exceedance of the early warning trigger values for parameters with effects-based thresholds.
3. Major = exceedance of the effects-based threshold values.

NA = MF and/or FF areas were not assessed using the formal BACI analysis in the current CREMP year.

Table 4-6. Meadowbank study area FEIS screening predictions compared to 2022 mean concentrations.

Parameter	Meadowbank Study Area							
	FEIS Screening Prediction				2022 Annual Mean			
	TPN	TPE	SP	WAL	TPN	TPE	SP	WAL
Hardness	5.7	5.7	8.9	17.2	10.0	11.5	15.4	18.4
Total Alkalinity	4.1	4.1	7.0	13.2	-	-	11.1	-
Calcium	1.3	1.3	2.3	4.7	-	2.8	4.0	5.0
Magnesium	0.60	0.60	0.80	1.3	0.98	1.1	1.3	1.5
Potassium	2.0	2.0	2.0	2.0	-	0.60	-	-
Silicon (T)	0.010	0.010	0.010	0.040	-	-	0.31	-

Notes:
Reported mean concentrations are all in units of mg/L.
"-" indicates mean annual concentration was < the trigger value.

Figure 4-7. Conventional parameters in water samples from Meadowbank study area lakes since 2006.

Note: Conductivity data from 2014 should be interpreted with caution (See Azimuth [2015c] for more details).

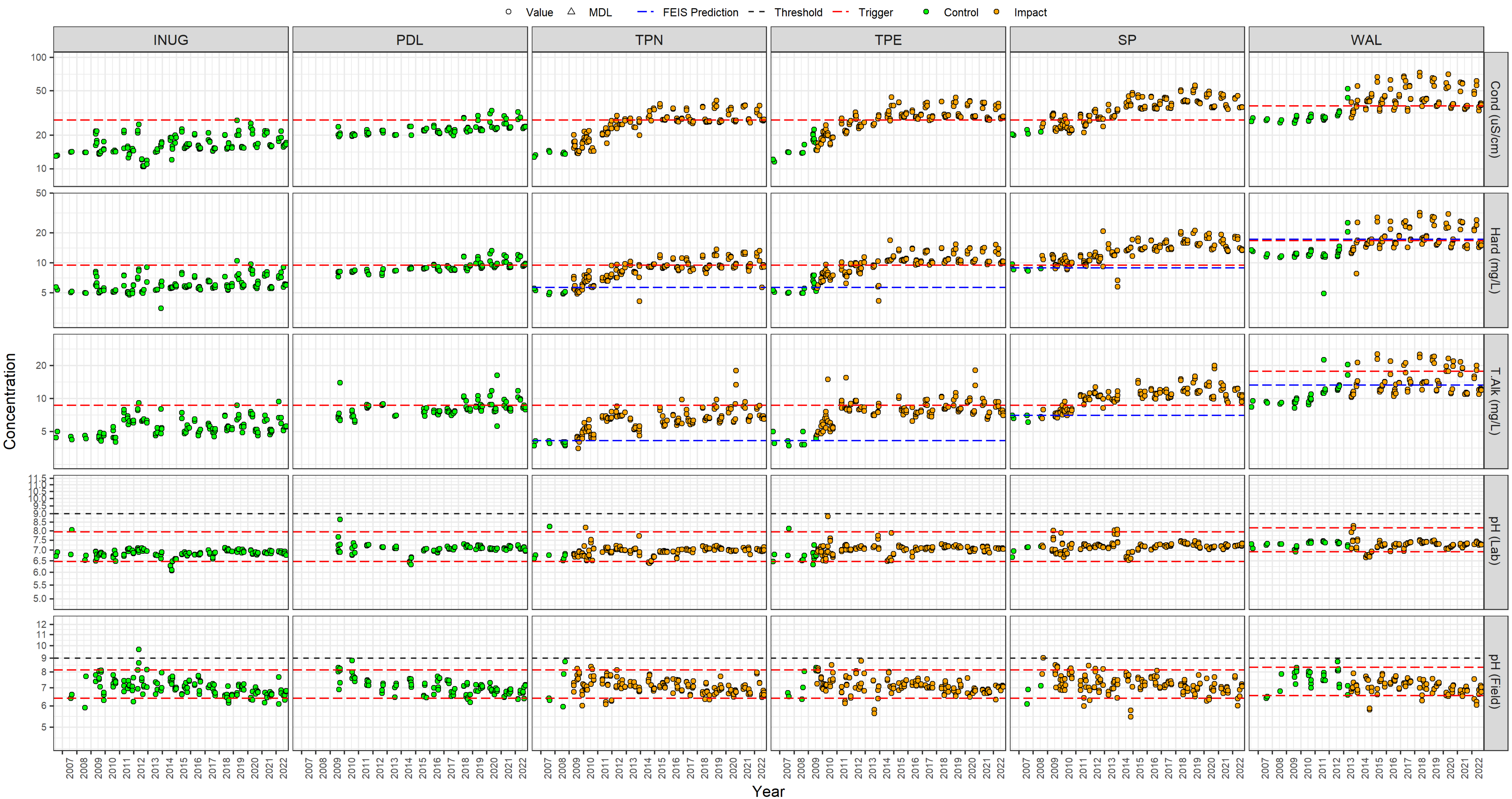


Figure 4-8. Major ions in water samples from Meadowbank study area lakes since 2006.

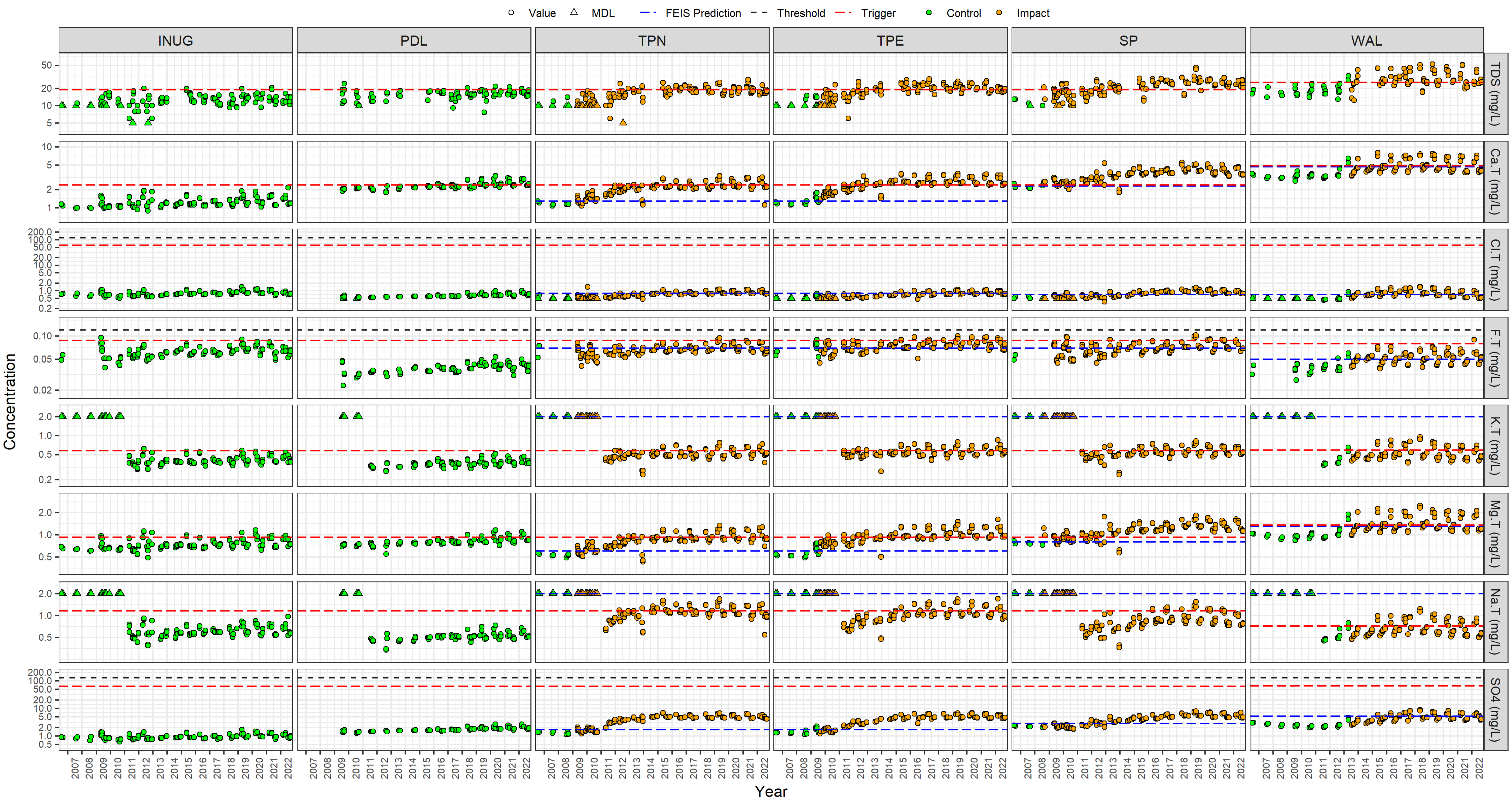


Figure 4-9. Nutrients in water samples from Meadowbank study area lakes since 2006.

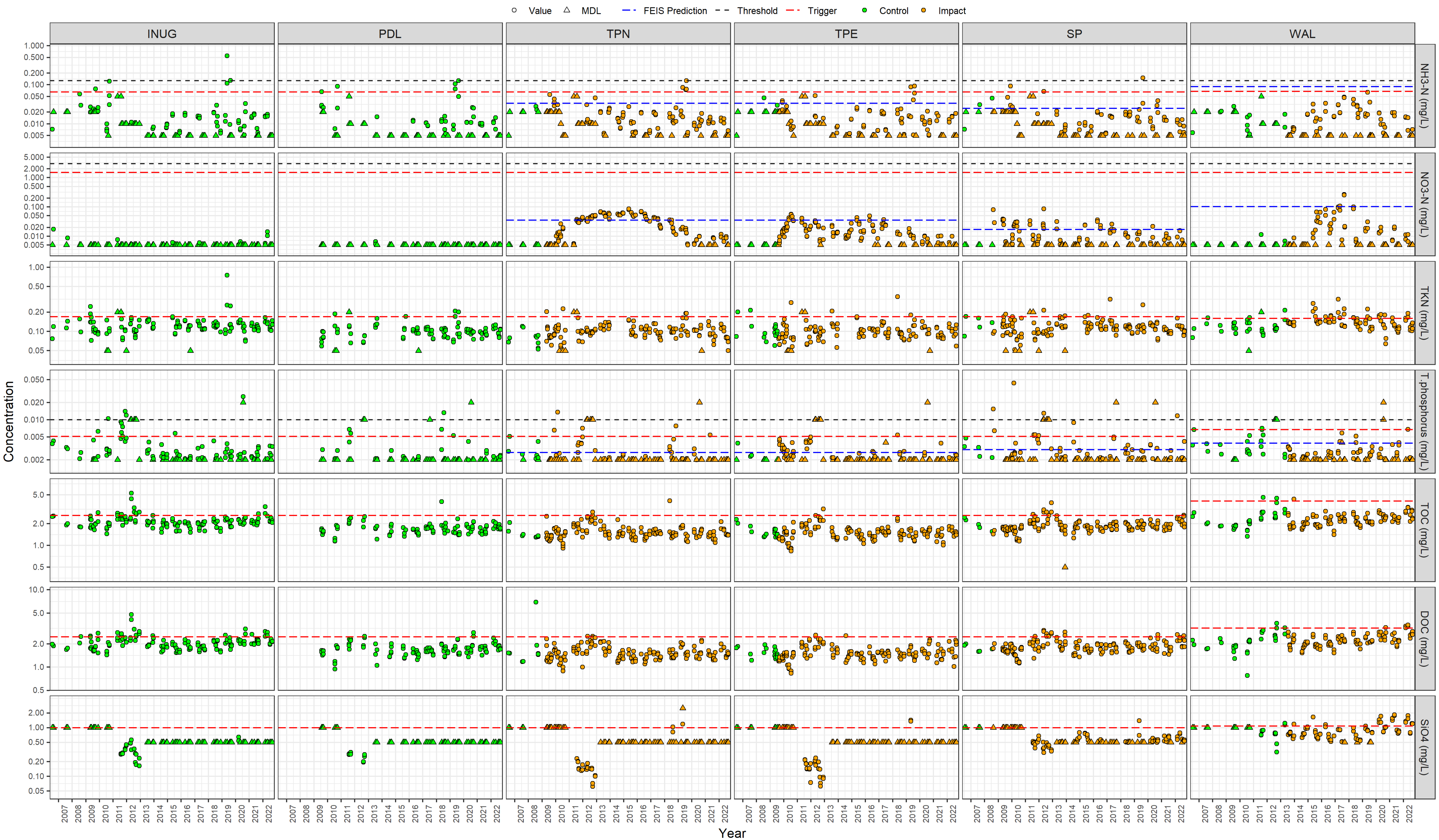


Figure 4-10. Metals in water samples from Meadowbank study area lakes since 2006.

Note: The FEIS prediction is equal to the threshold value for total arsenic at WAL.

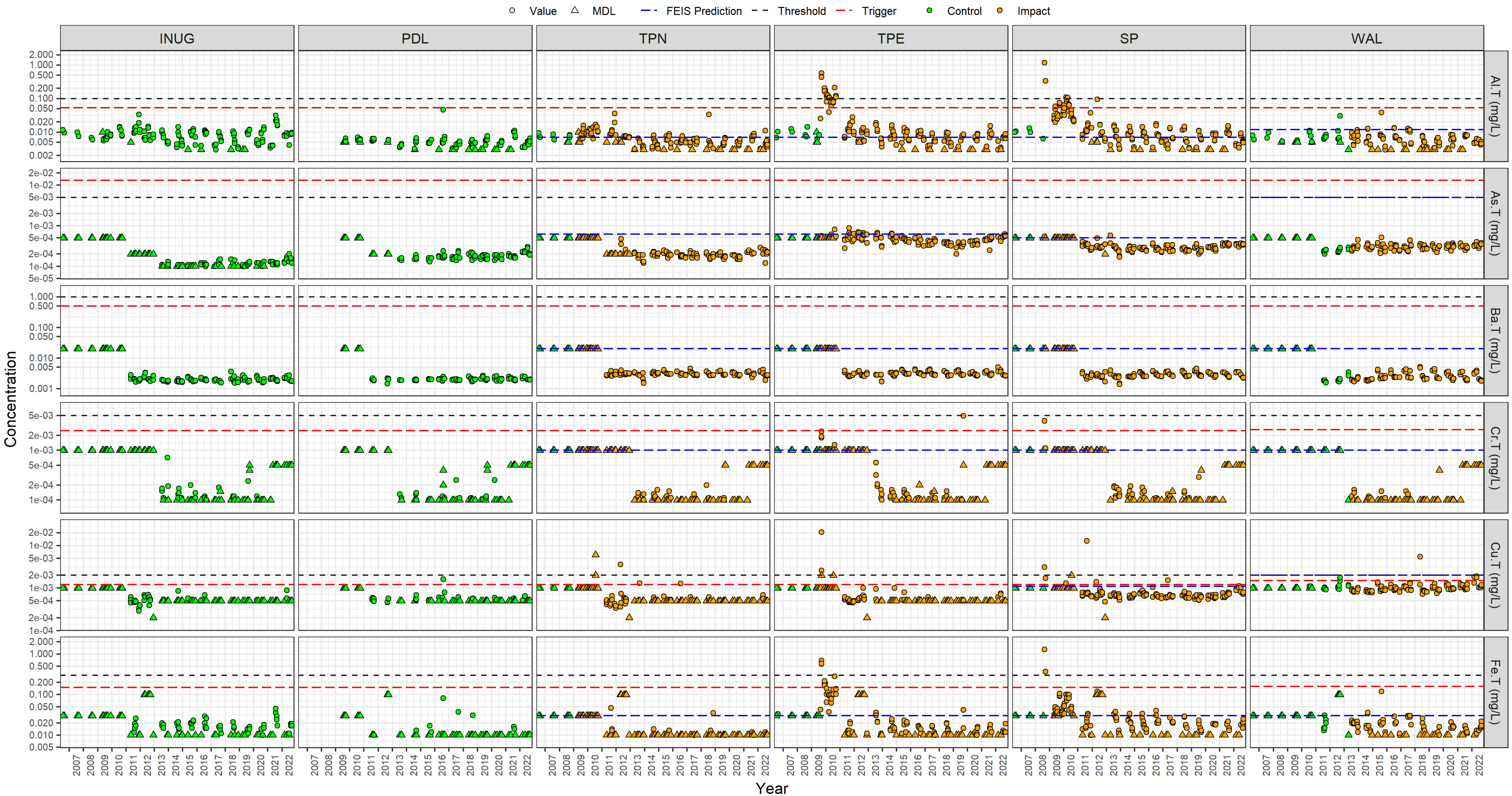


Figure 4-11. Metals in water samples from Meadowbank study lakes since 2006.

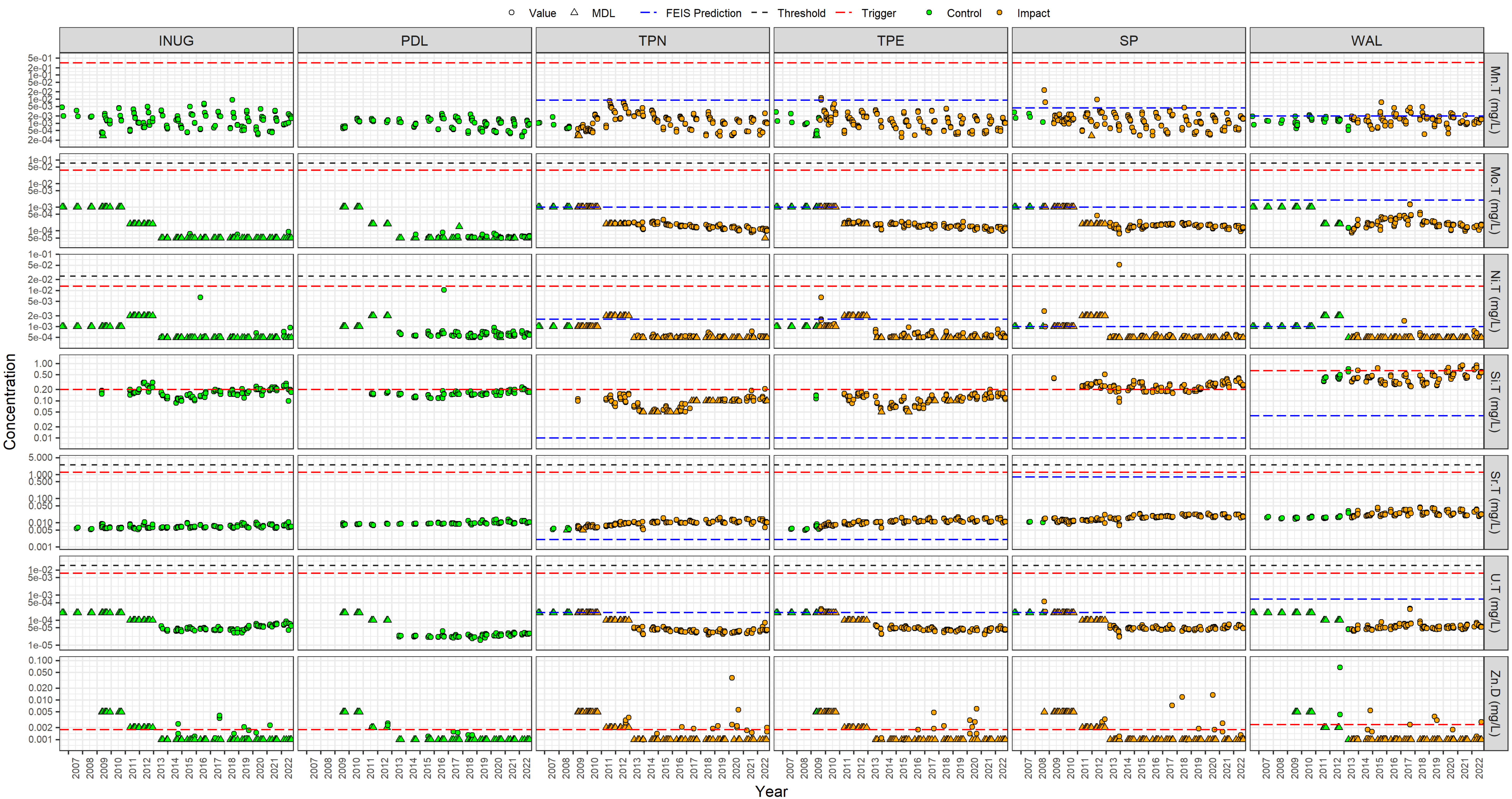
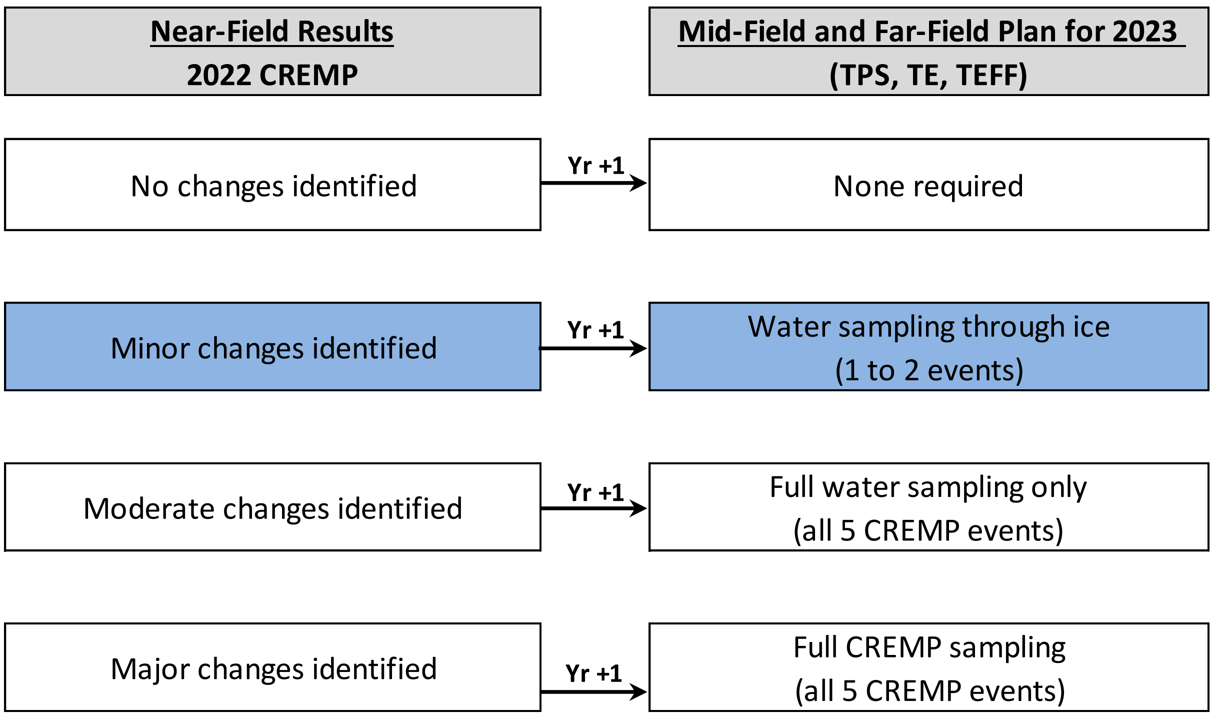


Figure 4-12. Flow chart showing sampling effort and frequency plan for mid-field and far-field sampling in 2023.

Note: Blue-shaded cells show the linkage between 2022 CREMP results and the sampling effort and frequency for mid-field and far-field sampling in 2023. *Minor changes* refer to statistically significant increased concentrations for parameters without effects-based threshold values that exceed the early warning trigger values. Refer to **Section 2.2.3** for more information.



Phytoplankton Tables and Figures

Table 4-7. Results of the BACI test for phytoplankton variables at Meadowbank areas, 2022.

Parameter Measured	Test Area	n(B)	n(A)	Estimate	SE	P-value*	Effect size (%)		
							ES	LCI	UCI
Total Biomass	TPN	7	4	0.40	0.39	0.336	49	-39	262
	TPE	8	4	0.18	0.21	0.424	19	-26	92
	SP	6	4	0.27	0.37	0.492	31	-45	211
	WAL	19	4	0.33	0.22	0.156	39	-13	122
Taxa Richness	TPN	7	4	0.05	0.12	0.670	6	-20	40
	TPE	8	4	-0.01	0.09	0.888	-1	-19	21
	SP	6	4	0.06	0.10	0.566	6	-16	34
	WAL	19	4	0.04	0.08	0.584	4	-11	22

Notes:

* **Bolded** values are P-values < 0.1.

Shaded cells indicate positive (increased) or negative (reduced) effect sizes of 20% or more.

Test area = area compared to control (INUG).

N(B) = number of months in the "before" period.

N(A) = number of months in the "after" period (i.e., in 2022).

Estimate = BACI model estimate of the 2022 change in mean for log-transformed data.

SE = standard error of the estimate.

P-value = two-tailed test of the null hypothesis of no change.

ES = estimated effect size (i.e., 100%*(exp[Estimate]-1)).

LCI = lower 95% confidence interval; UCI = upper 95% confidence interval.

Figure 4-13. Chlorophyll-a (μg/L) in water samples from Meadowbank study area lakes since 2006.

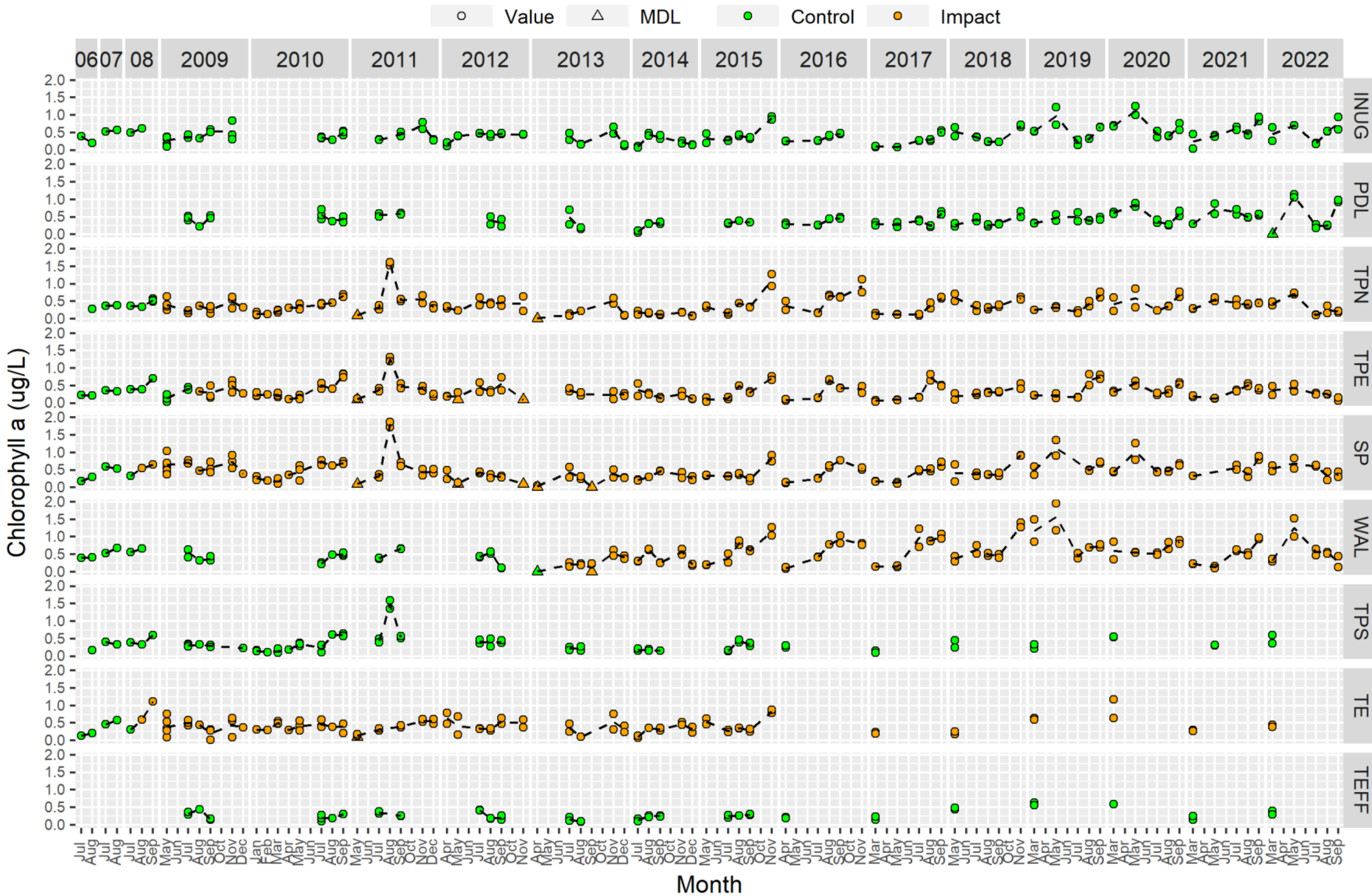


Figure 4-14. Total phytoplankton biomass (mg/m³) from Meadowbank study area lakes since 2006.

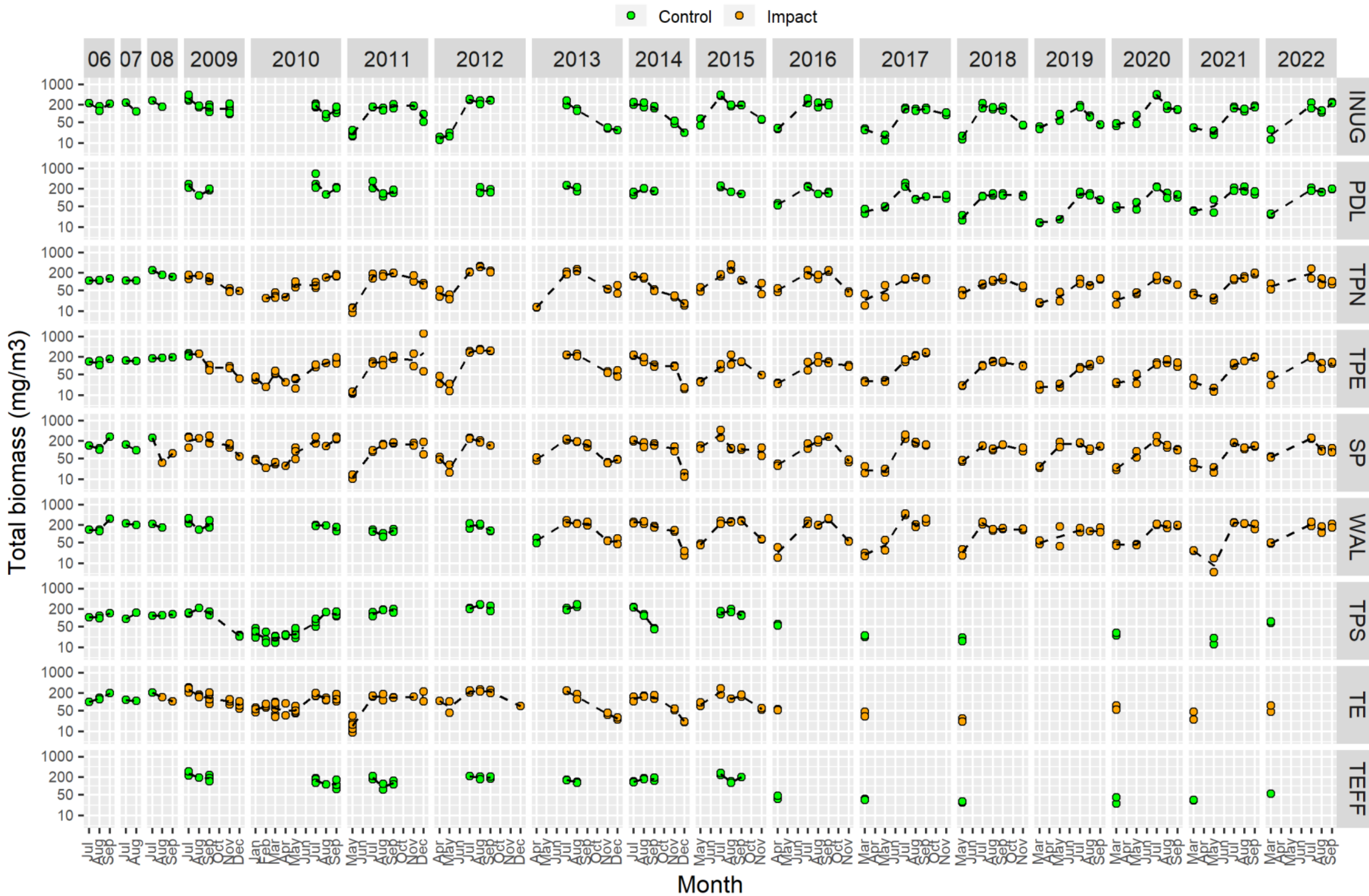


Figure 4-15. Phytoplankton biomass (mg/m³) by major taxa from Meadowbank study area lakes since 2006.

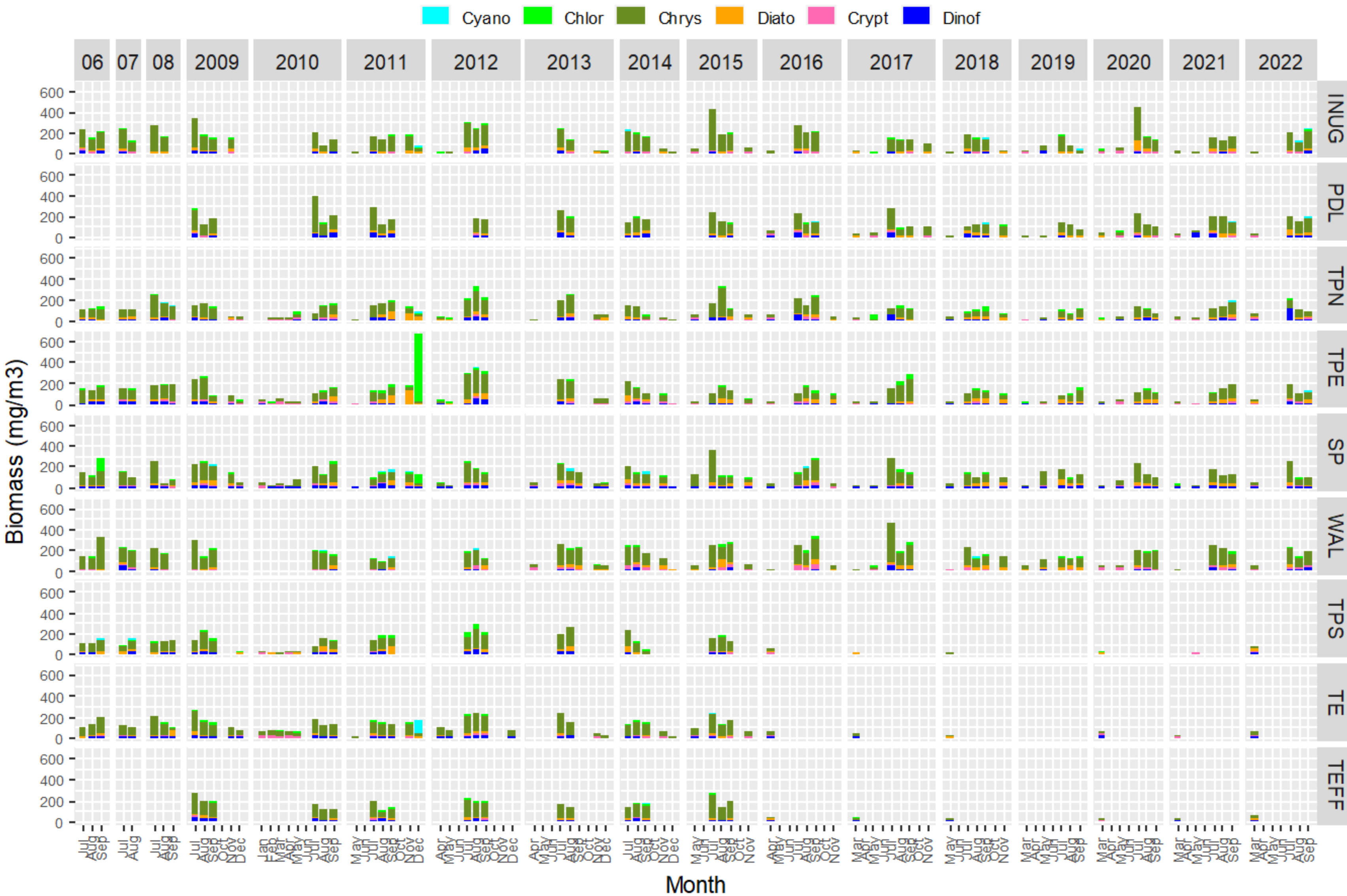
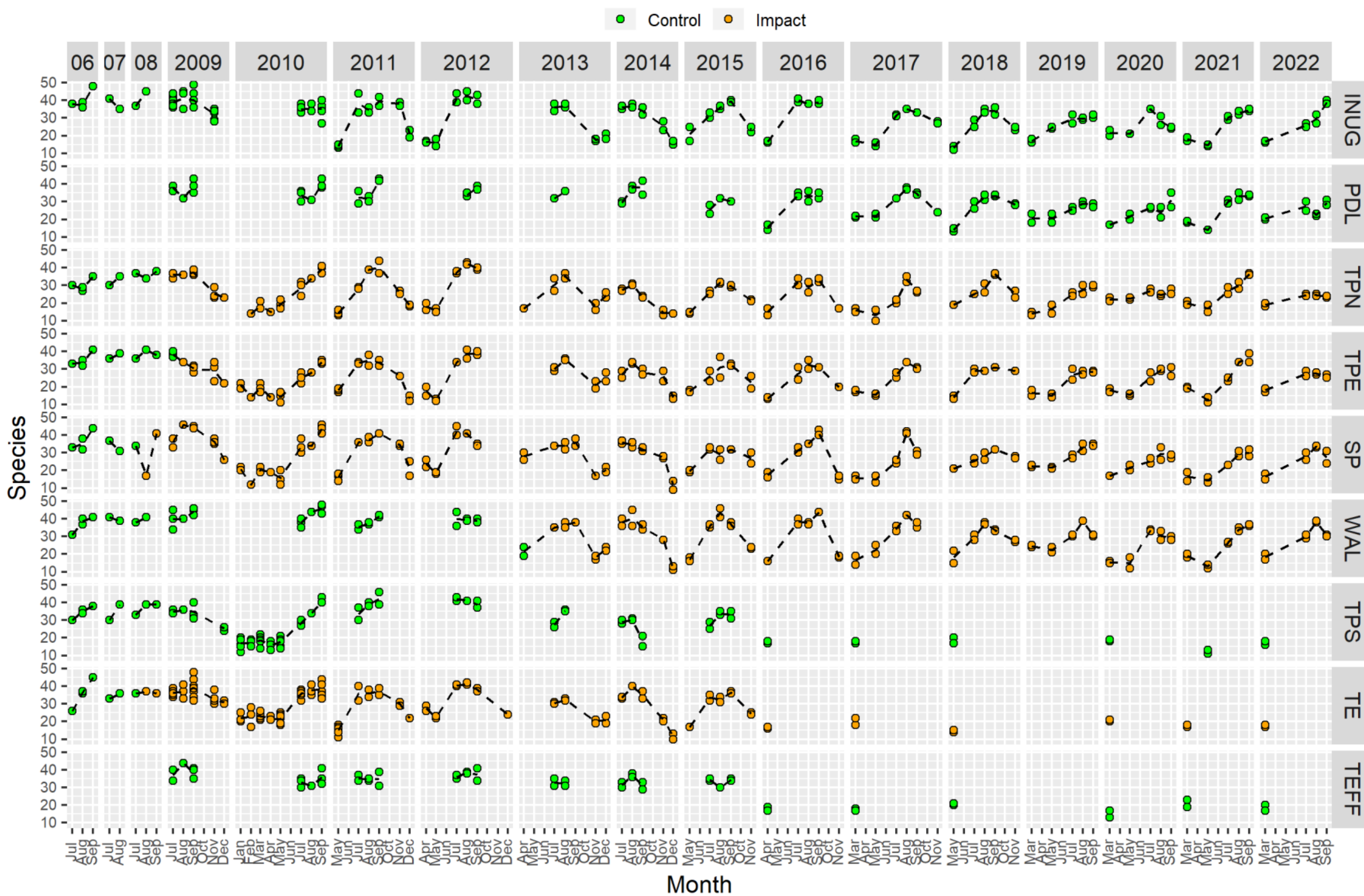


Figure 4-16. Relative phytoplankton biomass by major taxa group from Meadowbank study area lakes since 2006.

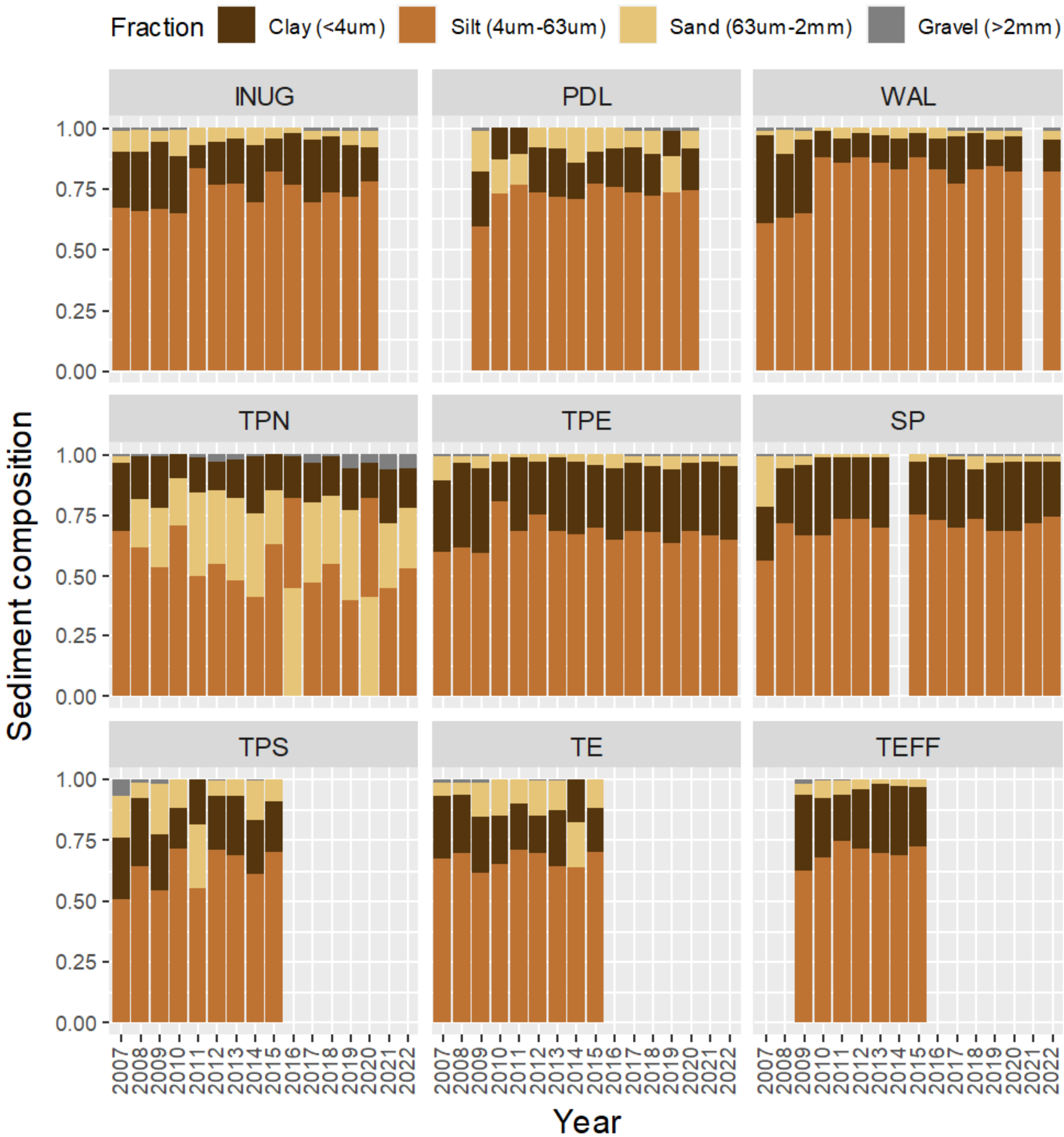
Figure 4-17. Phytoplankton species richness from Meadowbank study area lakes since 2006.



Sediment Chemistry Tables and Figures

Figure 4-18. Sediment grain size in sediment samples from Meadowbank study lakes since 2007.

Notes: No grain size was analyzed for INUG and PDL in 2022 due to high moisture content in the samples. Grain size was not analyzed in WAL in 2021 as the sediment was discarded prior to analysis (see **Appendix A2** in Azimuth 2022a).



Benthic Invertebrate Tables and Figures

Table 4-8. Geometric means for total abundance and total richness, Meadowbank study lakes.

Geometric means for total abundance[1]																	
Station	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
INUG	731 (15)	975 (13)	1300 (9)	1129 (10)	628 (16)	881 (14)	1042 (12)	1975 (3)	621 (17)	1648 (5)	2100 (1)	1712 (4)	1497 (6)	1452 (7)	2055 (2)	1398 (8)	1070 (11)
PDL	NA	NA	NA	1522 (1)	776 (12)	927 (9)	942 (8)	1279 (3)	473 (14)	1127 (4)	1373 (2)	748 (13)	779 (11)	990 (5)	951 (7)	829 (10)	963 (6)
WAL	12894 (2)	4357 (6)	1057 (16)	1834 (10)	1727 (12)	800 (17)	1874 (9)	1445 (15)	2222 (8)	1568 (13)	14253 (1)	4942 (5)	12035 (3)	1761 (11)	6117 (4)	1524 (14)	4065 (7)
TPN	NA	1359 (6)	864 (13)	1214 (8)	1029 (11)	498 (15)	1141 (9)	1407 (5)	373 (16)	3025 (1)	1696 (4)	1309 (7)	2051 (3)	594 (14)	1075 (10)	2283 (2)	917 (12)
TPE	3220 (6)	1563 (16)	5556 (1)	1663 (14)	1126 (17)	1584 (15)	3915 (2)	2244 (13)	2827 (8)	2765 (10)	2787 (9)	3147 (7)	2485 (11)	3490 (4)	3224 (5)	3505 (3)	2379 (12)
SP	619 (14)	842 (11)	395 (16)	771 (13)	241 (17)	563 (15)	1169 (9)	2279 (2)	2796 (1)	1927 (4)	1420 (6)	2058 (3)	1298 (7)	842 (12)	1631 (5)	1222 (8)	1055 (10)
TPS	935 (9)	1597 (4)	1501 (6)	1714 (3)	1130 (8)	932 (10)	1932 (2)	1581 (5)	1217 (7)	5939 (1)	NA	NA	NA	NA	NA	NA	NA
TE	913 (4)	930 (3)	743 (8)	757 (6)	517 (10)	725 (9)	747 (7)	819 (5)	1158 (2)	1548 (1)	NA	NA	NA	NA	NA	NA	NA
TEFF	NA	NA	NA	1215 (1)	886 (5)	615 (7)	921 (3)	955 (2)	891 (4)	816 (6)	NA	NA	NA	NA	NA	NA	NA

Geometric means for total richness																	
Station	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
INUG	10.1 (15)	12 (12)	13.5 (6)	13.2 (7)	8.1 (17)	10.5 (14)	10.7 (13)	15.4 (3)	9.3 (16)	12.4 (10)	15.7 (2)	13.6 (5)	14.2 (4)	13.1 (8)	16.2 (1)	13 (9)	12.1 (11)
PDL	NA	NA	NA	10.8 (1)	8.4 (8)	9.1 (5)	7.9 (11)	9.9 (3)	5 (14)	8.8 (6)	10.1 (2)	9.7 (4)	5.8 (13)	8.2 (9)	8.1 (10)	7.1 (12)	8.8 (7)
WAL	11.6 (7)	13.1 (4)	7.9 (16)	10.6 (12)	10.4 (14)	6.9 (17)	11.5 (8)	10.5 (13)	10.8 (11)	10.2 (15)	14.5 (3)	13.1 (4)	14.9 (2)	11.1 (10)	15.5 (1)	11.2 (9)	13.1 (6)
TPN	NA	9.3 (10)	7.5 (15)	9 (12)	10.3 (8)	7.8 (14)	10.1 (9)	12.4 (3)	5.7 (16)	10.7 (7)	12.4 (3)	12.2 (5)	12.5 (2)	8.7 (13)	9.1 (11)	14.9 (1)	11.5 (6)
TPE	8.2 (17)	10.7 (14)	14.2 (4)	11.3 (12)	9.7 (15)	9.3 (16)	12.5 (10)	14 (6)	10.9 (13)	14.1 (5)	13.7 (7)	12.5 (10)	12.9 (9)	15.6 (1)	15.6 (2)	14.7 (3)	13 (8)
SP	6.1 (16)	9.3 (13)	7.1 (15)	7.2 (14)	4.1 (17)	10.2 (12)	12.7 (6)	11.6 (7)	13.3 (4)	12.9 (5)	15.1 (1)	11.2 (8)	10.5 (9)	10.3 (11)	14.1 (2)	13.4 (3)	10.4 (10)
TPS	10.6 (5)	9.4 (8)	10.7 (3)	10.7 (3)	8.1 (9)	7.8 (10)	10.2 (6)	10.1 (7)	10.8 (2)	16.5 (1)	NA	NA	NA	NA	NA	NA	NA
TE	5 (10)	8.7 (5)	9.9 (2)	7.1 (7)	5.8 (9)	5.9 (8)	8.8 (4)	7.7 (6)	9 (3)	12.8 (1)	NA	NA	NA	NA	NA	NA	NA
TEFF	NA	NA	NA	10.3 (3)	10.6 (2)	8.5 (6)	8.3 (7)	9.5 (5)	10.3 (3)	11.4 (1)	NA	NA	NA	NA	NA	NA	NA

Notes:

1. Total abundance in organisms/m².

Rank order of abundance and richness shown in parentheses.

Red vertical lines mark the year that area designations switched from *control* to *impact.*

NA = Benthic invertebrate sampling was not completed for the given area/year.

Table 4-9. Results of the BACI tests for benthic invertebrate abundance at Meadowbank study lakes.

After Period	Test Area	n(B)	n(A)	Estimate	SE	P-value*	Effect size (%)		
							ES	LCI	UCI
2022	TPN	2	1	-0.12	0.47	0.84	-11	-100	32,843
	TPE	3	1	-0.32	0.67	0.68	-27	-96	1,191
	SP	2	1	0.14	0.31	0.73	15	-98	5,710
	WAL	7	1	0.49	0.98	0.64	63	-85	1,712
2021-22	TPN	2	2	0.21	0.49	0.72	23	-85	918
	TPE	3	2	-0.25	0.43	0.61	-22	-80	209
	SP	2	2	0.08	0.26	0.79	8	-65	233
	WAL	7	2	-0.14	0.72	0.86	-13	-84	376
2020-22	TPN	2	3	-0.07	0.48	0.90	-6	-80	334
	TPE	3	3	-0.38	0.36	0.35	-32	-75	86
	SP	2	3	0.03	0.22	0.91	3	-50	110
	WAL	7	3	-0.01	0.61	0.99	-1	-76	308
2019-22	TPN	2	4	-0.26	0.49	0.62	-23	-81	203
	TPE	3	4	-0.34	0.31	0.31	-29	-68	56
	SP	2	4	-0.08	0.21	0.74	-7	-48	66
	WAL	7	4	-0.17	0.54	0.76	-16	-75	185

Notes:

* **Bolded & underlined** values are P-values < 0.1.

Shaded cells indicate positive (increased) or negative (reduced) effect sizes of 20% or more.

Test area = area compared to control (INUG).

N(B) = number of years in the "before" period.

N(A) = number of years in the "after" period.

Estimate = BACI model estimate of the after-period change in mean for log-transformed data.

SE = standard error of the estimate.

P-value = two-tailed test of the null hypothesis of no change or an increase/decrease in mean.

ES = estimated effect size (i.e., 100%*(exp[Estimate]-1)).

LCI = lower 95% confidence interval; UCI = upper 95% confidence interval.

Table 4-10. Results of the BACI tests for benthic invertebrate taxa richness at Meadowbank study area lakes.

After Period	Test Area	n(B)	n(A)	Estimate	SE	P-value*	Effect size (%)		
							ES	LCI	UCI
2022	TPN	2	1	0.36	0.25	0.38	43	-94	3,200
	TPE	3	1	0.15	0.15	0.43	16	-39	122
	SP	2	1	0.22	0.18	0.44	25	-88	1,207
	WAL	7	1	0.17	0.31	0.60	18	-44	152
2021-22	TPN	2	2	0.45	0.19	0.14	57	-30	251
	TPE	3	2	0.17	0.12	0.24	19	-18	73
	SP	2	2	0.31	0.15	0.17	37	-29	162
	WAL	7	2	0.05	0.22	0.82	5	-37	76
2020-22	TPN	2	3	0.24	0.24	0.38	27	-40	169
	TPE	3	3	0.13	0.10	0.27	13	-14	49
	SP	2	3	0.29	0.13	0.11	33	-11	99
	WAL	7	3	0.05	0.18	0.80	5	-31	60
2019-22	TPN	2	4	0.18	0.22	0.46	20	-35	121
	TPE	3	4	0.16	0.09	0.14	17	-7	47
	SP	2	4	0.26	0.12	**0.09**	29	-6	79
	WAL	7	4	0.02	0.16	0.92	2	-29	45

Notes:

* **Bolded & underlined** values are P-values < 0.1.

Shaded cells indicate positive (increased) or negative (reduced) effect sizes of 20% or more.

Test area = area compared to control (INUG).

N(B) = number of years in the "before" period.

N(A) = number of years in the "after" period.

Estimate = BACI model estimate of the after-period change in mean for log-transformed data.

SE = standard error of the estimate.

P-value = two-tailed test of the null hypothesis of no change or an increase/decrease in mean.

ES = estimated effect size (i.e., 100%*(exp[Estimate]-1)).

LCI = lower 95% confidence interval; UCI = upper 95% confidence interval.

Figure 4-19. Benthic invertebrate total abundance (#/m²) from Meadowbank study area lakes since 2006.

Notes: Meadowbank areas TPS, TE, and TEFF have not been sampled since 2015. For results from these areas from 2006 to 2015 see Azimuth 2021.

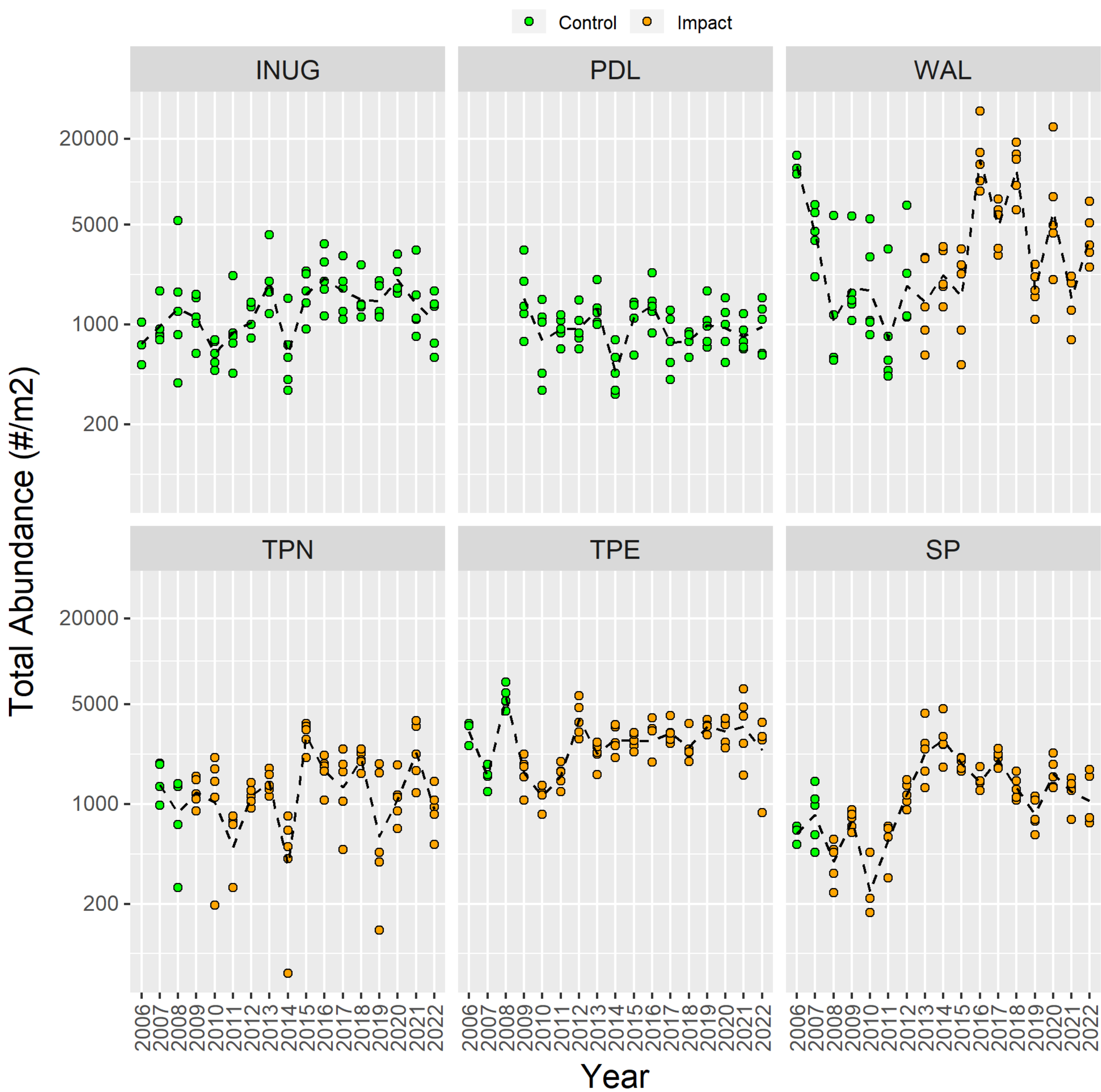


Figure 4-20. Benthic invertebrate abundance (#/m²) by major taxa from Meadowbank study area lakes since 2006.

Notes: Meadowbank areas TPS, TE, and TEFF have not been sampled since 2015. For results from these areas from 2006 to 2015 see Azimuth 2021.

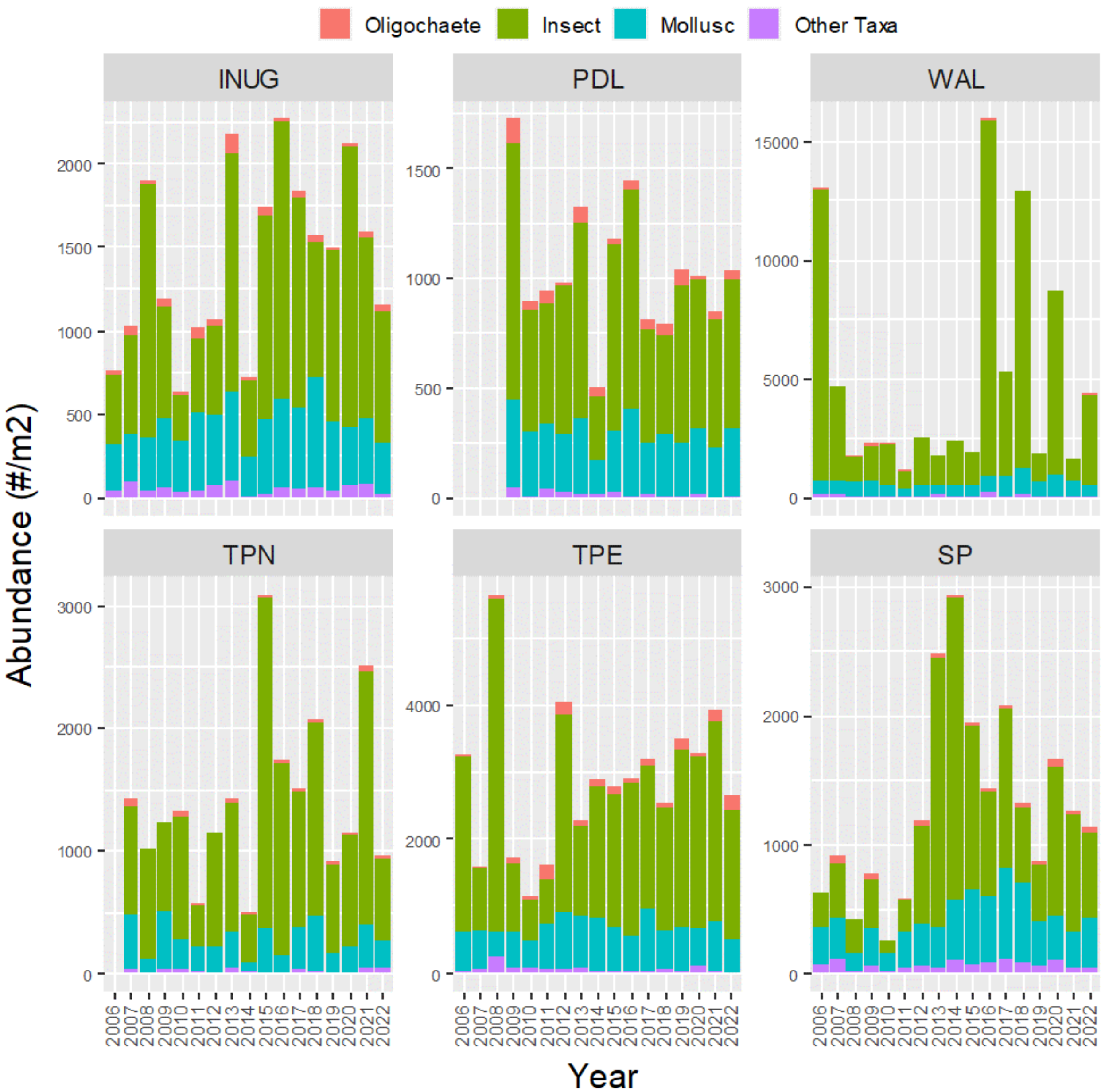


Figure 4-21. Benthic invertebrate relative abundance by major taxa from Meadowbank study area lakes since 2006.

Notes: Meadowbank areas TPS, TE, and TEFF have not been sampled since 2015. For results from these areas from 2006 to 2015 see Azimuth 2021.

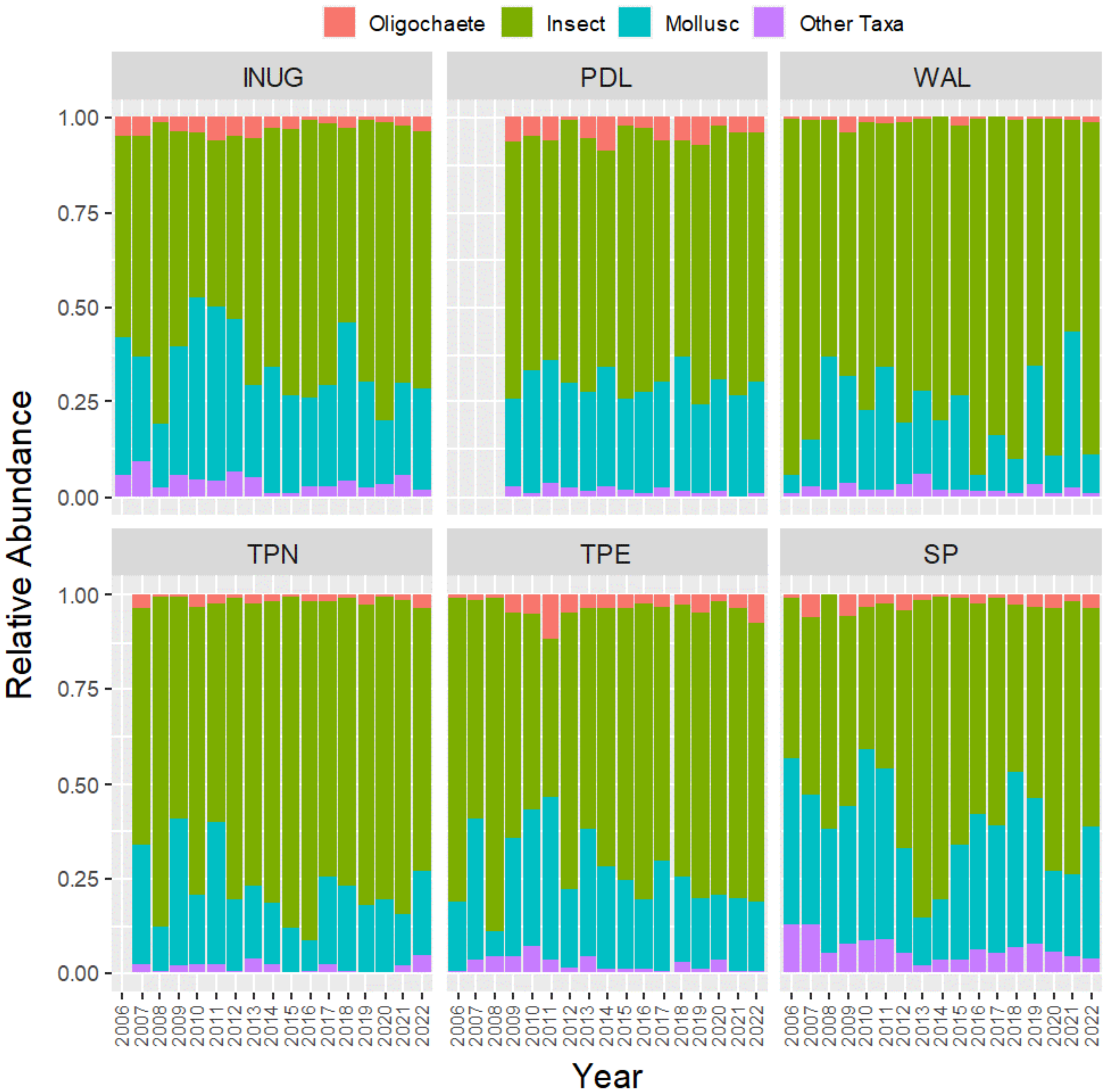


Figure 4-22. Benthic invertebrate total richness (# taxa) from Meadowbank study area lakes since 2006.

Notes: Meadowbank areas TPS, TE, and TEFF have not been sampled since 2015. For results from these areas from 2006 to 2015 see Azimuth 2021.

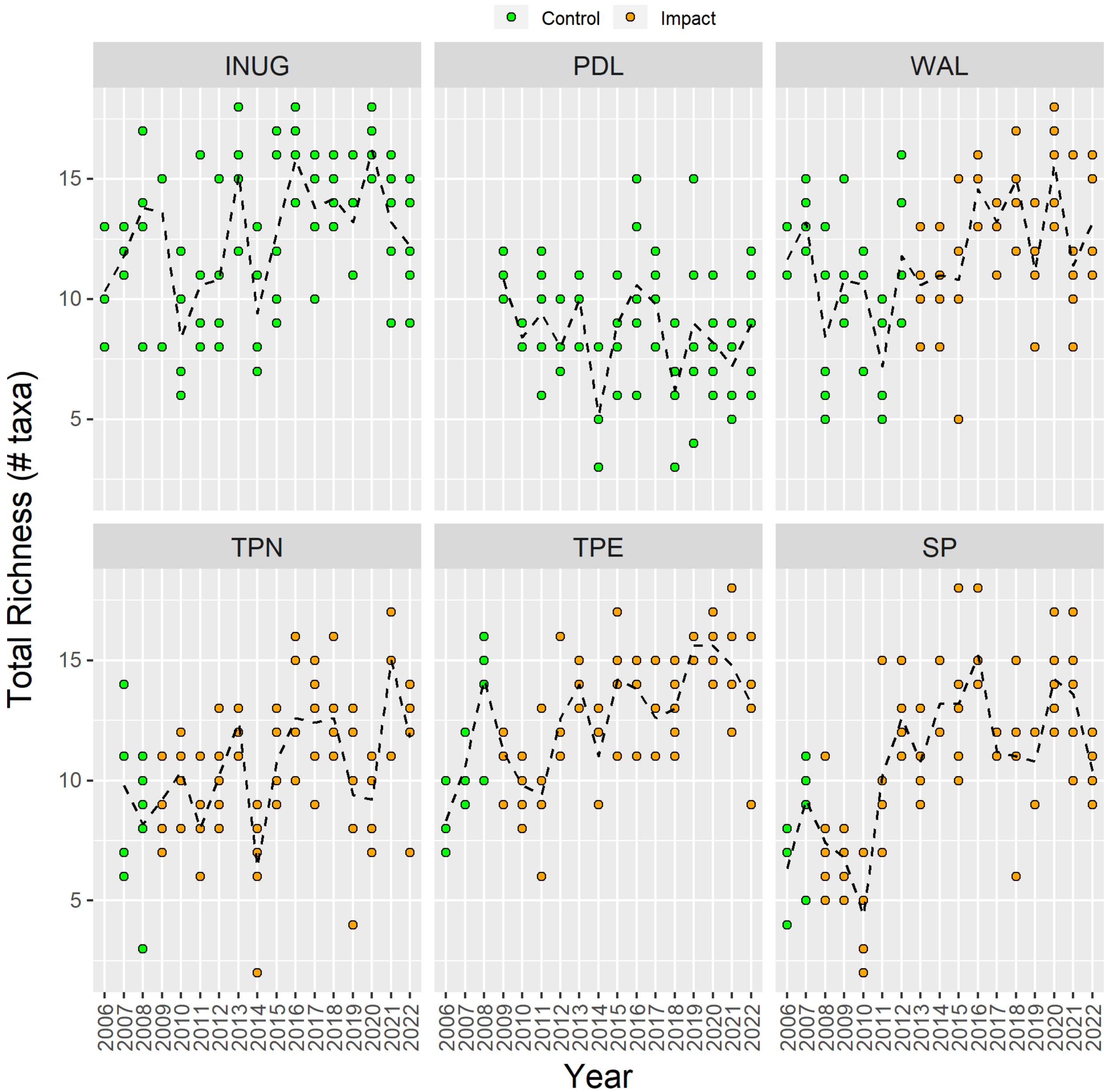


Figure 4-23. Benthic invertebrate richness (# taxa) by major taxa from Meadowbank study area lakes since 2006.

Notes: Meadowbank areas TPS, TE, and TEFF have not been sampled since 2015. For results from these areas from 2006 to 2015 see Azimuth 2021.

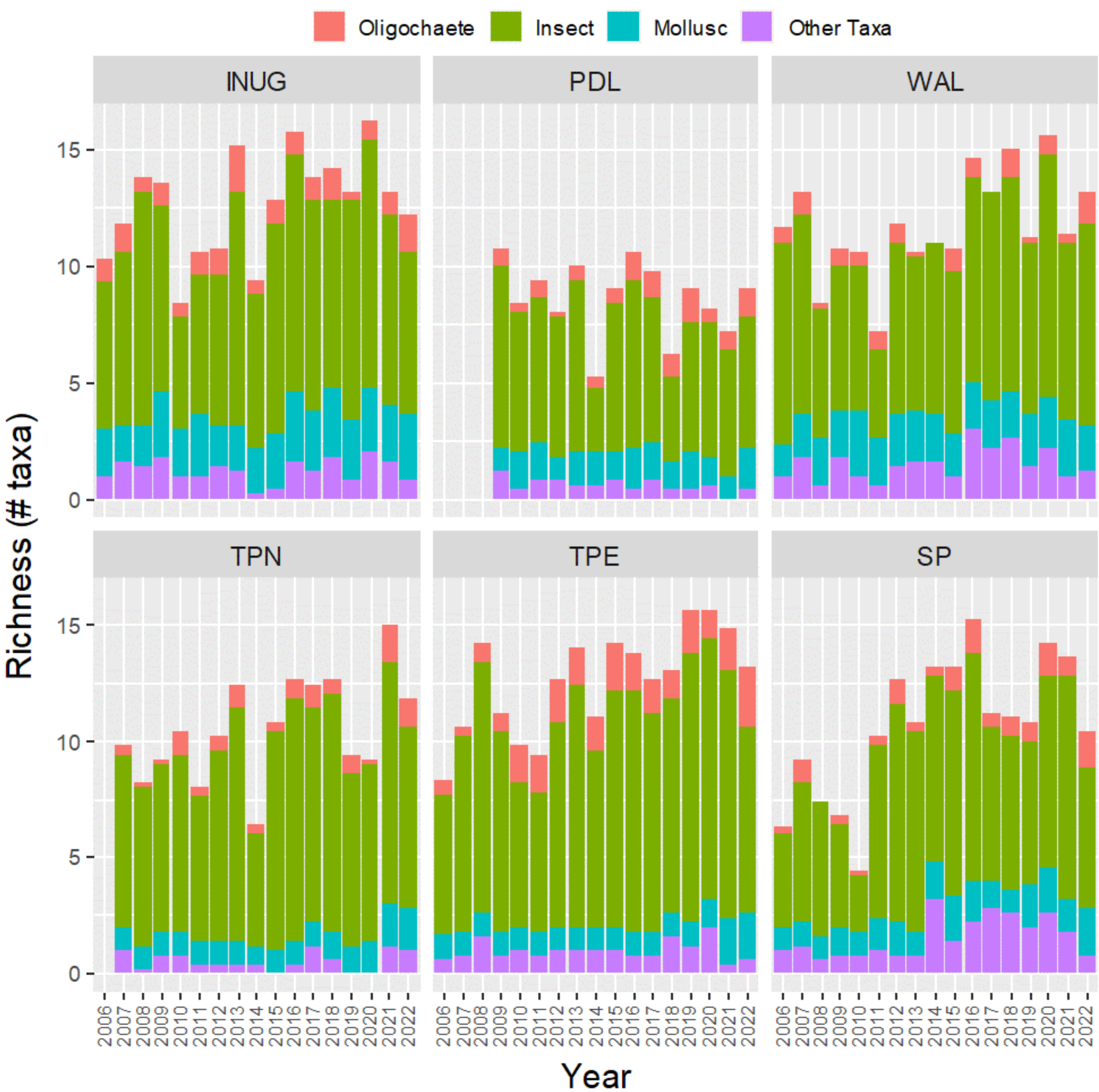
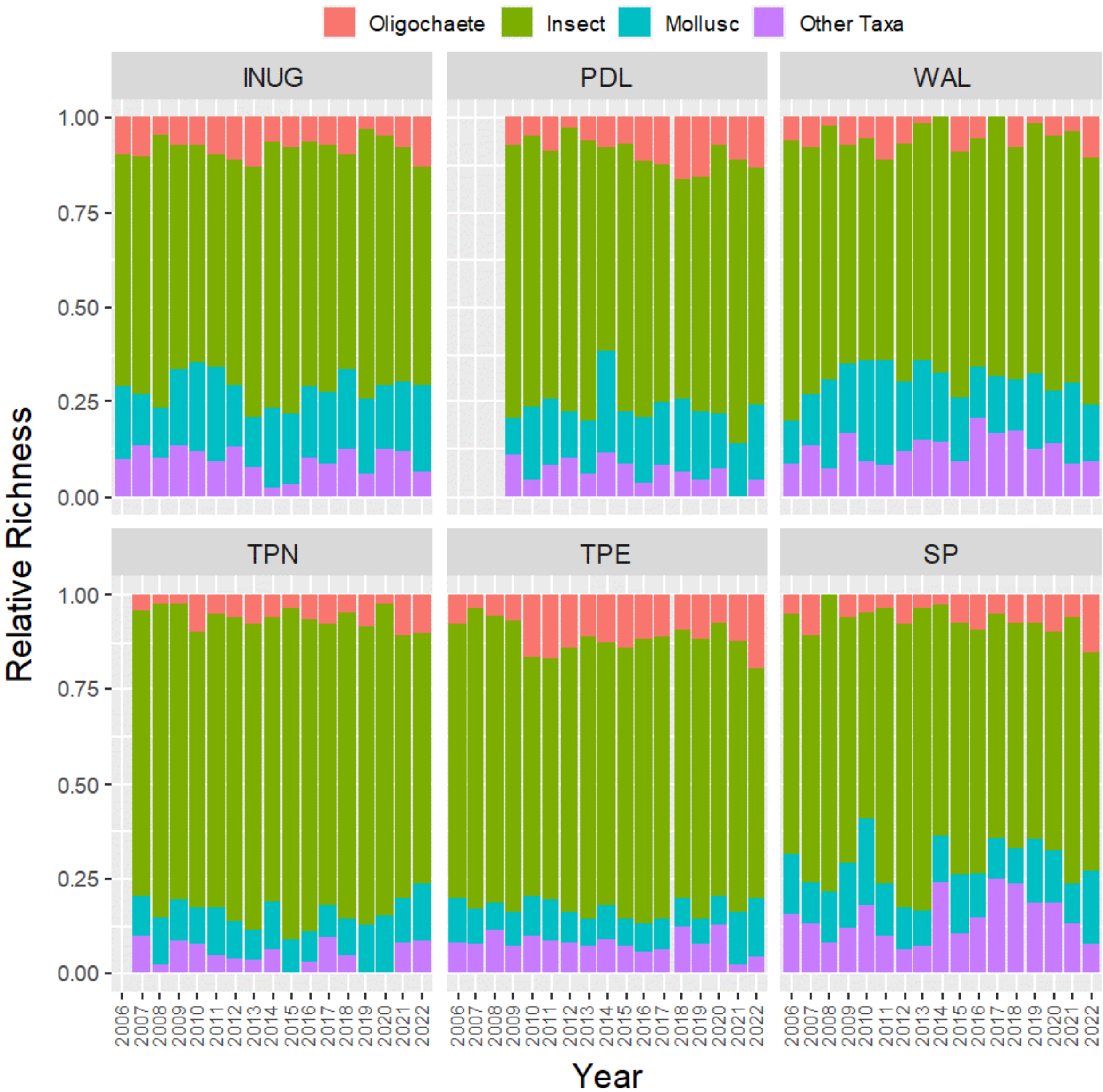


Figure 4-24. Benthic invertebrate relative richness by major taxa from Meadowbank study area lakes since 2006.

Notes: Meadowbank areas TPS, TE, and TEFF have not been sampled since 2015. For results from these areas from 2006 to 2015 see Azimuth 2021.



5 WHALE TAIL

5.1 Overview of the Whale Tail CREMP

This section presents findings from the 2022 CREMP for the Whale Tail mine study area lakes. The scope of the 2022 program included water quality, sediment chemistry, phytoplankton community, and benthic invertebrate community monitoring. Figures and tables relevant to the Whale Tail Mine are organized at the end of the section, by study component.

Six lakes are currently included in the study design for monitoring mining-related changes downstream of the Whale Tail mine:

- **Near-field**: Whale Tail Lake – South Basin (WTS), Mammoth Lake (MAM), and Nemo Lake (NEM)
- **Mid-field**: Lake A20 and Lake A76
- **Far-field**: Lake DS1.

INUG and PDL are the primary reference areas for the Whale Tail CREMP. Locations where water sampling was done in 2022 are shown in **Figure 5-1**. Sediment and benthic invertebrate sampling areas are shown in **Figure 5-2**.

The landscape around the Whale Tail mine consists of rolling hills and relief with low-growing vegetative cover and poor soil development. Numerous lakes are interspersed among boulder fields, eskers and bedrock outcrops. Except for Nemo Lake, all Whale Tail study area lakes are part of the *A* Watershed that flows from SE to NW and drains into Amur Lake (aka DS1). Nemo Lake is located north of Whale Tail mine in Watershed *C*, separated from WTS and MAM by a drainage divide to the north of Whale Tail Lake.

Construction of the Whale Tail Dike in 2018 to develop the Whale Tail Pit deposit altered the flow path and hydrology in the area to the south of Whale Tail Lake. Prior to construction of the Whale Tail Dike, water flowed from Lake A20 through WTS, MAM, Lake A76, and into Lake DS1. Construction of the dike and ensuing changes in the local hydrology raised the level of the south basin of Whale Tail Lake. Higher water levels flooded tributary lakes A20, A65, and A63, among others, and created an impoundment. Lake A20 is no longer *upstream*, as the channel between WTS and A20 flooded; however, the connection between WTS and A20 is shallow, and hydrostatic pressure from input sources to Lake A20 likely limits water exchange. To regulate water level in the impoundment, a diversion channel was constructed in 2019/2020 for water to flow from the north end Lake A20 to the south end of MAM. The changes to Whale Tail Lake and Lake A20 are shown in **Figure 5-1**.

Area designations changed from *control* to *impact* for WTS and MAM in 2018 as a result of the onset of construction activities. The other four lakes were unaffected by construction activities in 2018 and remained in the baseline (*control*) designation. Lakes A20, A76, and DS1 changed from *control* to *impact* at the start of 2019 as mine construction and mine activities continued to expand. Nemo Lake switched to *impact* after the July 2019 sampling event when heavy precipitation necessitated dewatering AP5 (sump) onto the tundra within the Nemo Lake watershed.

A chronology of construction activities relevant for interpreting results from the Whale Tail CREMP are provided in **Table 1-1**. Construction activities and onsite water management in 2021/2022 are summarized below:

- **Whale Tail Impoundment** – Construction of the Whale Tail Dike began in July 2018 (**Figure 5-3**). The impoundment caused water levels to rise in 2018/2019, resulting in Lakes A55, A20, and A18 being fully connected to the south basin of Whale Tail Lake by August 2019. Pumping from the north basin to the south was required throughout much of 2019 to address dike seepage and to create the Whale Tail Attenuation Pond. Up to May 2020, water transfer occurred from the north basin to the south basin. Construction activities (e.g., dike grouting) started late in 2019 to address seepage and continued until late March 2020. Currently, seepage water is directed to the Whale Tail Attenuation Pond and managed as part of this infrastructure. In 2022, construction of a thermal berm at the western abutment of Whale Tail Dike (Upstream) occurred in September.
- **IVR Expansion** – 2021 marked the first year of operation for the IVR diversion ditch along with the commissioning of the associated attenuation pond and the construction of IVR Dike D1 (**Figure 5-3**). Excavation of the IVR West Pit began on October 22 with the IVR waste rock storage facility now being actively used.
- **Effluent Discharge to Mammoth Lake** – Treated water meeting MDMER and Water License limits was discharged to Mammoth Lake between June 16 and September 20.
- **Effluent Discharge to Whale Tail South Basin** – Treated water was discharged intermittently to WTS between January 7 and June 16 and between October 3 and October 29. During this time, water met the MDMER and Water Licence limits except in April. On April 3, concentrations of total arsenic in treated discharge from the IVR Attenuation Pond exceeded the limits authorized for the maximum concentration in a grab sample. This led to an exceedance of the maximum monthly mean concentration for April. This exceedance along with effluent release estimates were reported to the relevant authorities. The arsenic exceedance is put into context with the CREMP water quality results at Whale Tail South Basin in **Section 5.3**.

5.2 Limnology

Limnology data provide an initial assessment of whether conditions are changing within a sampling area to a degree that may require additional investigation. The general timing of the limnology and water sampling program for Whale Tail coincided with the Meadowbank CREMP sampling program. Limnology profiles were conducted at locations shown in **Figure 5-1**. Each point shown on the map is labelled with a number corresponding to the month the profiles were collected (e.g., 5 = May). Results for each lake focus on the deepest location sampled per event; matching water chemistry sample IDs (where available) for 2022 are listed in **Table 5-1** for cross-reference.

Table 5-1. Samples included in the limnology profiles for the Whale Tail study area lakes in 2022.

Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
WTS	☑	☑	WTS-68	☑	WTS-69	Ice not safe for travel	WTS-72	WTS-74	WTS-75	Ice not safe for travel	☑	☑
MAM	☑	☑	MAM-68	☑	MAM-70		MAM-72	MAM-73	MAM-75		☑	☑
NEM	☑	☑	NEM-67	☑	NEM-70		NEM-72	NEM-74	NEM-75		☑	☑
A20	☑	☑	A20-61	☑	A20-63		A20-65	A20-67	A20-69		☑	☑
A76			A76-59		A76-62		A76-64	A76-66	A76-67			
DS1			DS1-57		DS1-59		DS1-61	DS1-63	DS1-66			

Notes:
☑ = One profile is collected from the near-field areas (and occasionally one mid-field area) in months where water sampling is not completed.
The sample IDs shown represent the deeper of the two locations sampled each month.

5.2.1 General Observations

The lakes in the Whale Tail study area are, for the most part, shallow and oligotrophic. DS1 is the deepest lake in the study area, with a maximum recorded depth of approximately 33 m. A20, A76, and NEM have areas of steep relief, but most of the surface area is less than 15 m deep.

Like the Meadowbank study area lakes, the ice-free season is short for lakes within the Whale Tail study area. Ice break-up usually occurs during mid to late June in the region and begins to form again in October. Sampling in June and October is avoided due to safety concerns surrounding ice conditions. Surface water temperatures measured at 3 m depth typically reach a yearly high between 10°C and 15°C sometime in August before cooling in the fall (**Figure 5-4**). Temperature, dissolved oxygen, and specific conductivity profiles for each of the 2022 sample events are shown in **Figure 5-5** to **Figure 5-7**. Profiles for reference areas INUG and PDL are included where available.

Temperature and Dissolved Oxygen

Lakes in the Whale Tail mine study area are typically unstratified for temperature and oxygen during the open-water season due to strong winds and shallow depths. This also ensures that the distribution of phytoplankton, and to a lesser extent, zooplankton is vertically more uniform than it would be without mixing. Thermal stratification, if any, is brief and water temperatures typically only differ 4°C to 5°C between surface and bottom during these times. In 2022, the strongest stratification occurred in July at MAM, A76, NEM, DS1, and control area INUG where water temperatures differed by 5°C to 9°C between surface and bottom; this pattern was no longer evident by August (**Figure 5-5**).

The lakes are well oxygenated throughout the year, with DO generally above 10 mg/L (**Figure 5-6**). In 2022, the lakes were mostly unstratified, with slight stratification observed during the spring ice-covered months: March, April, and May. Conditions were well mixed in the summer months (July, August, and September).

Temperature and DO concentrations in 2022 were consistent with previous years, and the seasonal patterns were typical of this Arctic area. Further, patterns were similar between the control lakes (INUG and PDL) and the NF and MF monitoring areas.

Conductivity

Specific conductivity profiling is a cost-effective way to monitor changes in water quality, particularly when the source is direct or indirect discharge of water. Conductivity is a surrogate parameter for total dissolved solids (TDS), which is a broad measure of the combined content of all dissolved inorganic and organic substances. Ice formation during winter, particularly in shallower lakes, can lead to seasonally higher conductivity measurements as the dissolved substances are largely excluded from the ice matrix; this process is referred to as 'cryoconcentration'. The conductivity results from the limnology profiles collected throughout the year at Whale Tail study area lakes are shown in **Figure 5-7** and discussed below by lake.

Whale Tail Lake – South Basin – In 2022, conductivity in WTS ranged from approximately 100 to 150 µS/cm with no evidence of vertical stratification across each month of sampling (**Figure 5-7**). The ice-covered months demonstrated the highest conductivities which increased slightly from January to May. The ice-free months (July to September) showed very similar profiles and were characterized by the lowest conductivities. Overall conductivities were comparable to 2021 except that peak conductivities in May were somewhat higher in 2022 (150 µS/cm versus 137 µS/cm in 2021). As with 2021, higher conductivities corresponded to discharging periods at WTS (January to June).

Mammoth Lake – Prior to November 2018, conductivity in MAM was characteristically unstratified, measuring below 60 µS/cm (Azimuth, 2019a). In November and December 2018, the conductivity in MAM increased to 150 µS/cm, following the discharge of treated contact water into MAM. Through 2021, there was an overall increase in conductivity with concentrations often exceeding 175 µS/cm and as high as 360 µS/cm.

Conductivities in 2022 were lower than in 2021 and generally ranged between 100 and 225 µS/cm. Since 2020, the highest conductivities have occurred during the winter months followed by declines during open-water periods (**Figure 5-7**). The conductivities observed during each monthly sampling event in 2022 were lower than 2021, except for September and December. In May (the month in which maximum conductivities typically occur), the 2022 results were approximately 20% lower than 2021. Maximum conductivity readings from each sampling event are provided in **Table 5-2**. A comparison of maximum conductivity readings from each sampling event in 2021 and 2022 is provided in **Table 5-3**.

Mammoth Lake is fairly shallow and somewhat hourglass shaped, with distinct east and west basins. Water chemistry sampling and limnology profiling targets water depths of more than 5 m. To meet these requirements, samples are collected in the deeper east and west basins of the lake. This practice provides good spatial coverage while meeting minimum depth requirements. For paired water samples, the conductivity observed in the east basin was higher than the conductivity in the west basin except for in July (**Table 5-2** and **Table 5-3**). The narrow portion in the middle of the lake is relatively shallow and creates a natural sill that slows water exchange between the basins, particularly during winter months when ice cover further limits water exchange between the basins. Thus, mine influences on water quality are temporarily concentrated in the east basin closest to the effluent discharge point, a pattern which has been confirmed by plume delineation surveys (Portt and Associates and Kilgour & Associates, 2021).

Conductivity readings in both the east and west basins of Mammoth Lake decreased in 2022 compared to 2021. During the spring ice-covered months (March, April, May) when peak concentrations typically occur, concentrations fell by 18 to 32% compared to 2021 (**Table 5-3**). These findings are corroborated by the water chemistry results (**Section 5.3.2**) and are consistent with the changes in water quality predicted by the revised FEIS Approved Expansion Project (Golder, 2019).

Table 5-2. Maximum conductivity readings from each sampling event in Mammoth Lake, 2022.

Month	West Basin of Mammoth Lake		East Basin of Mammoth Lake	
	Sample ID	Max Conductivity (µS/cm)	Sample ID	Max Conductivity (µS/cm)
January	-	-	MAM-JAN	189
February	-	-	MAM-FEB	187
March	MAM-68	198	MAM-67	253
April	-	-	MAM-APR	220
May	MAM-69	183	MAM-70	295
July	MAM-71	121	MAM-72	113
August	MAM-73	116	MAM-74	135
September	MAM-75	129	MAM-76	170
November	MAM-NOV	166	-	-
December	-	-	MAM-DEC	181
ANNUAL MEAN	**-**	**152**	**-**	**194**

Notes: "-" not collected as per the study design.

Table 5-3. Maximum conductivity readings from each sampling event in Mammoth Lake and relative percent difference (RPD) between readings from 2021 and 2022.

Month	West Basin			East Basin		
	2021	2022	RPD	2021	2022	RPD
January	-	-	na	258	189	-27%
February	-	-	na	286	187	-35%
March	242	198	-18%	333	253	-24%
April	244	-	na	-	220	na
May	271	183	-32%	360	295	-18%
July	122	121	-1%	135	113	-16%
August	121	116	-4%	157	135	-14%
September	118	129	9%	166	170	2%
November	-	166	na	154	-	na
December	-	-	na	154	181	18%

Notes: "-" not collected as per the study design. "na" = RPD not calculated.

Nemo Lake, Lake A20, Lake A76, and Lake DS1 – In 2019, field conductivity measurements at NEM after August showed evidence of an upward trend in response to temporary discharge of contact water to NEM. Since then, conductivity has stabilized showing similar seasonal patterns from 2020 to 2022. Conductivity remains elevated throughout the year at around 100 µS/cm and reaches a maximum conductivity of approximately 140 µS/cm near the end of the ice-covered period (May).

Lake A20 shows a continued trend of rising conductivity, with higher levels in 2022 than those seen in 2021 (**Figure 5-7**). This accelerated increasing trend began in 2019 when A20 was inundated and connected to nearfield lake WTS. Conductivity at Lake A20 is expected to track closely with WTS with increased water exchange between these lakes.

Conductivities in Lake A76 in 2022 were comparable to 2021, ranging between 75 to 100 µS/cm during the open-water season and up to 140 µS/cm in May. This suggests that the increases in conductivity at A76 observed between 2020 and 2021 are now stabilizing.

As seen in the *Control* (baseline) period in **Figure 5-7**, minor seasonal fluctuations in conductivity are normal across seasons and years, but since 2019, changes in conductivity observed in Mammoth Lake extend downstream to A76. Farther downstream at Lake DS1, conductivity is within the range of baseline conditions.

5.3 Water Chemistry

Water quality data for the Whale Tail CREMP were evaluated according to methods described in **Section 2.3.1** and followed the framework used for Meadowbank (**Section 4.3.2**) and Baker Lake (**Section 6.3.2**). This was the fourth year of formal BACI analyses to assess spatial and temporal changes in water quality at the Whale Tail study area lakes. The analysis also included comparing monitoring results to predicted water quality presented in the revised FEIS Approved Expansion Project (Golder, 2019) as well as reviewing results relative to Agnico Eagle's adaptive management strategy for water management (Agnico Eagle, 2021).

5.3.1 General Observations

Water chemistry samples were collected along with limnology monitoring for the months of March, May, July, August, and September; the results, screened against federal water quality guidelines and project-specific water quality triggers, are tabulated in **Appendix B2**.

As with the Meadowbank study area lakes, key lake characteristics were considered when interpreting water quality results from the Whale Tail study area:

- The study lakes are generally nutrient-poor, thermally un-stratified, and well-mixed (uniform temperature and oxygen profiles), with no hypoxic stratification beneath the ice cover.

- The study lakes are headwater lakes with no significant natural sources of nutrients or sediment. Limited contributions from local runoff sustain the oligotrophic food webs.
- Many parameters have been below laboratory detection limits (MDLs) since baseline monitoring started in 2014.

Water quality in the Whale Tail study area lakes is characteristic of northern headwater lakes. Surface water hardness is low, typically measuring less than 20 mg/L (as $CaCO_3$) during the baseline period (**Figure 5-9**). The buffering capacity of the surface water is also quite low, as evidenced by total alkalinity[22] concentrations typically below 6 mg/L (**Figure 5-9**). Based on total phosphorus, the lakes are ultra-oligotrophic (< 0.004 mg/L; CCME, 2004) and limited by low concentrations of phosphorus, nitrogen, or both (Ogbego et al., 2009). Concentrations of total phosphorus, nitrate, and nitrite were frequently below their respective detection limits during the baseline period; however, these parameters have increased somewhat in NF lakes since late 2018. Productivity is discussed in more detail in **Section 5.3.4**. Despite being situated in a region of mineralized geology, concentrations of metals are generally low or below MDLs; when measurable, most metals are associated with the particulate phase (i.e., total rather than dissolved).

5.3.2 Temporal and Spatial Trends

Parameters included in the temporal and spatial trends assessment are listed in **Table 5-6**. A total of 55 parameters out of 77 (approximately 70%) were retained for further examination in 2022. Of these, 54 were retained because the frequency of detected concentrations exceeded 10%. Dissolved selenium detection frequencies were less than 10%, but were retained for discussion because they were detected more frequently at impact areas compared to control (reference) areas.

Parameters retained in the analysis are plotted in **Figure 5-9** through **Figure 5-13**. Trigger values[23] are shown on the time series plots as a red dashed line. Water quality predictions were developed as part of the FEIS process for some parameters in Mammoth Lake and Whale Tail Lake – South Basin (see **Section 2.3.1** and Golder, 2019); these are depicted as a blue dashed line in the plots. Water chemistry figures and raw data for all parameters, including those that were not retained for discussion based on the trend assessment are presented in **Appendix B2**.

BACI analyses were conducted for parameter/area combinations if the mean concentration in 2022 exceeded the trigger value. The BACI model tests for statistically significant increases (i.e., one-tailed test looking for uni-directional changes [i.e., increases]). In this analysis, the model interaction term (or

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[22] The term total alkalinity is used in place of bicarbonate alkalinity throughout the text, though the two can be used interchangeably. At the pH ranges encountered in the study lakes, the bicarbonate anion (HCO_3^-) effectively comprises 100% of the total alkalinity fraction.

[23] Refer to Appendix I in the 2019 CREMP report (Azimuth, 2020a) for a description of the methods used to establish triggers for each parameter.

BACI effect term) represents the change at the test area in 2022 (*after* period) relative to baseline (*before* period) after accounting for natural temporal changes (i.e., temporal changes at the reference area). For simplicity, changes are noted *relative to baseline/reference* conditions.

Parameter/area combinations for which the yearly mean exceeded the trigger are listed in **Table 5-7** and were carried forward for BACI analysis (**Table 5-8**). The results are discussed in terms of ecological significance and spatial context below, by parameter type.

Major Ions and Conventional Parameters

Major ions (dissolved salts) are the seven ionic compounds found in greatest abundance in freshwater systems. They include the cations: calcium, magnesium, potassium, and sodium; as well as the anions: chloride, bicarbonate, and sulphate. These seven ions are measured directly or are important in a number of composite conventional measures (e.g., total alkalinity, conductivity, TDS, and hardness) **Figure 5-9**. Collectively, these parameters have shown the greatest proportional changes in water chemistry since mining operations began (**Table 5-8**).

Most of the parameters in this group do not have effects-based thresholds (e.g., CCME water quality guidelines). As discussed in detail in **Section 4.3.2**, major ions are essential elements, and all species of aquatic life, from algae to fish, have evolved to actively regulate their osmotic, ionic, and acid-base balance by uptake of ions from their environment (Martemyanov and Mavrin, 2012). Furthermore, in oligotrophic freshwater lake environments adverse effects on primary producers and secondary consumers (e.g., zooplankton) are more commonly associated with major cation deficiency than enrichment (Alstad et al., 1999; Arnott et al., 2017).

The only parameters in this group to have an effects-based threshold are chloride, fluoride and sulphate. While all of these parameters have shown increased concentrations since mining activities started, none of them have had mean annual concentrations exceeding their respective triggers at any sampling area.

These results indicate that mine-related changes have occurred, but that these changes would not be expected to result in adverse effects to aquatic life (see similar discussion in **Section 4.3.2**).

Nutrients

Four nutrient-related parameters had mean annual concentrations exceeding their respective triggers (**Table 5-7**): Total Kjeldahl Nitrogen (TKN), total phosphorus, and total and dissolved carbon (TOC and DOC). All of these parameters were significantly ($p < 0.05$) higher at WTS, MAM, and A20 in 2022 compared to baseline/reference conditions.

Nitrogen-containing compounds – TKN is one of four nitrogen-containing compounds in the CREMP. It is a composite parameter that includes both organic and inorganic forms including ammonia, nitrate, nitrite, and organic nitrogen compounds. While TKN does not have an effects-based threshold, all three of the other nitrogen-containing compounds in the CREMP do. Although each of these compounds have increased due to mining activity, they are now stable or decreasing and all were below their respective triggers. This indicates that nitrogen-containing compounds are not a concern at the Whale Tail study lakes.

Total phosphorus – Total phosphorus is one of the main constituents of concern for the Whale Tail mine. It is important as a key macronutrient for plants and is often limiting in freshwater ecosystems, making it one of the most important nutrients for primary productivity. The CCME provides guidance for site-specific application rather than a particular effects-based guideline for total phosphorus. While the CCME framework specifies <0.004 mg/L of total phosphorus for ultra-oligotrophic lakes, up to a 50% increase in concentrations over baseline is considered acceptable (Azimuth, 2020; see Appendix I). Since the 95th percentile baseline concentrations of total phosphorus for Meadowbank, Wally, Baker, and Whale Tail exceeded 0.004 mg/L, the lake-specific triggers were set to those 95th percentile concentrations and the threshold was set to 0.01 mg/L (higher end of the range for oligotrophic lakes; CCME 2004).

The trigger was exceeded in all *impact* Whale Tail study area lakes at least once in 2022, except for A76 (**Figure 5-11**). The annual mean total phosphorus concentrations at WTS, MAM, and A20 all exceeded the trigger (**Table 5-7**) and the BACI analysis indicated that observed changes were statistically significant at all three of these lakes (**Table 5-8**). Across 2021 and 2022, total phosphorus concentrations appear to be stable at WTS and A20. At MAM, large fluctuations in concentrations make it challenging to visualize trends, however in 2022 both the maximum and minimum concentrations increased by 1.9- and 1.3-fold respectively. Despite this, the annual mean total phosphorus concentration at MAM remains close to the trigger value (0.0045 mg/L) and has generally remained stable since 2021.

The increase in nutrients at WTS, MAM, and A20 since 2019/2020 combined with occasional exceedances in other lakes downstream is likely contributing towards an increase in primary productivity, as predicted in the FEIS (**Table 5-4**; Golder, 2018). Of particular importance is the observed increases at MF areas with concentrations now beginning to exceed triggers. This shows that nutrient concentrations are elevated beyond MAM and WTS. In 2022, BACI analysis showed an increase in phytoplankton productivity (in terms of total biomass) at MF area Lakes A20 and A76 that exceeded the 20% effect size trigger; however, the results were not statistically significant.

Phosphorus is discussed further as it relates to the Adaptive Management Plan (AMP) in **Section 5.3.4**.

Table 5-4. FEIS predictions and trigger values compared to mean concentrations of total phosphorus in Mammoth Lake and Whale Tail Lake (South Basin), 2022.

Area	2022 FEIS predictions		Trigger	2022 Mean
	Minimum	Maximum		
MAM	0.0076	0.009	0.0045	0.0047
WTS	0.0065	0.0079	0.0045	0.0059

Notes: Reported values are all in units of mg/L.

TOC and DOC – In 2022, TOC and DOC concentrations exceeded the triggers for all samples collected in WTS, MAM, and A20. Triggers were also exceeded at least once in all of the other *impact* lakes (**Figure 5-9**). Mean annual concentrations exceeded the triggers (TOC trigger = 2.42 mg/L; DOC trigger = 2.43 mg/L) in WTS, MAM, A20, and DS1 (**Table 5-7**). The increases in mean TOC and DOC were statistically significant for WTS, MAM, and A20, but not significant for DS1.

Increasing TOC and DOC in WTS at the end of 2019 was likely related to the flooding of terrestrial habitat with impoundment of the south basin and dewatering inputs from WTN; this also explains the increases in Lake A20, which experienced flooding and has been joined to WTS since 2019. MAM and A76 occur downstream of WTS and increases in TOC/DOC at these locations may be the results of inputs from WTS.

Since 2018, a muted increase in TOC and DOC also appears to be occurring in reference lake INUG. This pattern suggests organic carbon inputs to lakes in the region may be increasing which would also contribute to the changes observed at the mine influenced lakes. In a pan-Arctic assessment of lake DOC, Stolpmann and colleagues (2021) linked higher DOC levels to rates of evaporation, lake connectivity, and permafrost extent. It is possible that regional multi-year climactic changes or global climate change could contribute to broad changes in organic carbon across the study lakes over time. Parallel increases in TOC/DOC in the Meadowbank lakes may also be occurring, with increasing patterns at WAL and SP most evident (**Figure 4-9**). Regional changes in organic carbon are further discussed for Baker Lake in **Section 6.3.2**.

There are no effects-based thresholds for TOC or DOC, but increases in these parameters can be related to increased productivity or allochthonous carbon inputs. While changes in TOC and DOC at WTS were likely due to inputs from flooded terrestrial areas, changes observed at far-field Lake DS1 were likely due to natural inputs (e.g., terrestrial organic matter; BC MOE, 1998).

Metals

A number of metals show trends of increasing concentrations associated with mining activities. These include: antimony, arsenic, barium, copper, iron, lithium, manganese, molybdenum, nickel, selenium, silicon, strontium, titanium, and uranium (**Figure 5-12** and **Figure 5-13**). Of these, lithium, silicon, and titanium exceeded triggers at least once in 2022. However, none of the metals with effects-based thresholds have increased above their respective trigger values. Only lithium and titanium, which do not have effects-based thresholds, had annual mean concentration exceeding triggers (**Table 5-7**).

Lithium – Total and dissolved lithium, were the only metal parameters where annual mean concentrations exceeded trigger values at MAM in 2022 (total and dissolved lithium trigger = 0.0020 mg/L). Peak concentrations at MAM occurred in 2019 and since then, annual mean concentrations have dropped by a third (from 0.0037 to 0.0024 mg/L). The BACI analysis indicated that the change in total and dissolved lithium relative to INUG was statistically significant at MAM.

Note that lithium does not have an effects-based threshold. The USEPA does have a factsheet on lithium toxicity in freshwater (MDEQ, 2008), but does not have a formal water quality guideline. The factsheet includes chronic toxicity results for zooplankton (water flea *Ceriodaphnia dubia*) and fish (fathead minnow *Pimephales promelas*). The no observable effect concentration (NOEC) for a 6-day test targeting *C. dubia* reproduction was 1.97 mg/L, while 3.6 mg/L was the lowest observable effect concentration (LOEC). The NOEC for the 7-day *P. promelas* test targeting growth was 3.6 mg/L, while the LOEC was 6.9 mg/L.

These toxicity test results are two to three orders of magnitude higher than the lithium concentrations observed in the Whale Tail study lakes.

Titanium – Samples collected from WTS during July and August 2022 exceeded the applicable titanium trigger (0.00041 mg/L). Exceedances were marginal (<2-fold above the trigger value) with an unusually high detection limit occurring in July due to matrix effects (flagged in lab QA/QC procedures) which contributes to the higher annual mean in 2022. Temporal trends in titanium at WTS are challenging to interpret due to variability, but concentrations have generally declined since 2018. The highest concentrations observed in 2022 at WTS are comparable to peak concentrations occurring in the reference lakes during previous sampling events (e.g., July 2021 at INUG).

5.3.3 Comparison to FEIS Model Predictions

A number of water quality changes have been identified in the Whale Tail mine area as a result of development-related activities and/or effluent discharge to the downstream environment. The FEIS water quality predictions are estimates of water quality changes in Mammoth Lake and Whale Tail Lake (South Basin). The monthly mean results for water quality parameters were screened against the FEIS monthly predictions for MAM and WTS and a summary of exceedances is provided in **Table 5-10**. Water quality data for 2022 were screened against the FEIS predictions and are tabulated in **Appendix B2**.

Often, parameters that exceed their trigger also exceed the FEIS predictions in one or more sampling events. In 2022, the yearly mean concentrations for total phosphorus, total alkalinity, TDS, and the ionic compounds calcium, magnesium, potassium, and sodium exceeded both their respective triggers and the monthly FEIS predictions in WTS. At MAM, the same parameters with the addition of lithium exceeded both triggers and FEIS predictions. Of the parameters that exceeded their respective trigger values and FEIS model predictions in 2022, only total phosphorus at WTS had trigger values set in the context of effects-based thresholds (e.g., CCME water quality guidelines). Phosphorus, along with several other COPCs (e.g., nitrate, arsenic) were predicted by the FEIS to exceed baseline conditions following the discharge of treated effluent into WTS and MAM. Phosphorus was the only COPC that was also predicted to exceed water quality guidelines (Golder, 2018).

Overall, the FEIS predicted the magnitude of potential effects on water quality in each of the lakes as *low* (i.e., <1x CCME WQG) for all parameters except for total phosphorus, which was rated as *medium* (i.e., between 1 and 10-times CCME WQG; see **Section 2.3.1** for more details on the decision criteria for effects magnitude). Thus, the Whale Tail study area water quality results are consistent with FEIS predictions.

5.3.4 Comparison to Adaptive Management Thresholds

For parameters identified as the main COPCs for the Whale Tail mine (i.e., total phosphorus and arsenic), there are associated AMP water quality thresholds that correspond to adaptive management 'Levels' as described in **Section 2.3.1**. The adaptive management thresholds and corresponding adaptive management levels and strategies that are applied at mine discharge areas WTS and MAM are summarized in **Table 2-4**. The water quality data collected as part of the annual CREMP were used to assess adaptive management levels going into 2023. The mean concentrations of paired monthly sampling results were compared to AMP thresholds. Findings are summarized in **Table 5-5** and described below.

Whale Tail South

- Mean total phosphorus concentrations remained at Level 0 for each month of sampling at WTS in 2022.
- Mean total arsenic concentrations remained at Level 0 for each sampling event at WTS in 2022.
- Conclusion –Level 0 is in effect for both total phosphorus and total arsenic based on the results of the September 2022 sampling event.

Mammoth Lake

- Mean total phosphorus concentrations remained at Level 0 for each month of sampling at MAM in 2022.
- Mean total arsenic remained at Level 0 for each sampling event at MAM in 2022.

- Conclusion – Mammoth Lake is within the normal operating range and Level 0 water management strategy is in effect based on the results of the September 2022 sampling event.

It is important to note that the 2022 water quality data were compared to thresholds that are based on the 2019 FEIS predictions. The 2019 FEIS model predictions do not consider changes in water management activities that occurred on Site from 2020 to 2022.

Table 5-5. Water chemistry data compared to AMP thresholds for total phosphorus and arsenic for Whale Tail Lake (South Basin) and Mammoth Lake, 2021 and 2022.

Lake & Area	AMP Benchmark	WTS FEIS Predictions										Whale Tail Lake South Basin (Impoundment) – Mean Monthly Concentrations (mg/L)										Current Mgmt Level
Year		2021					2022					2021					2022					
Month		Mar	May	Jul	Aug	Sep	Mar	May	Jul	Aug	Sep	Mar	May	Jul	Aug	Sep	Mar	May	Jul	Aug	Sep	
Phosphorus (mg/L)	0.01	0.0051	0.0051	0.0055	0.0059	0.0063	0.0065	0.0067	0.0070	0.0074	0.0079	0.0067	0.0037	0.0046	0.0042	**0.0083**	0.0076	0.0051	0.0053	0.0063	0.0054	Level 0
Arsenic (mg/L)	0.025	0.00020	0.00020	0.0024	0.0031	0.0041	0.0047	0.0047	0.0067	0.0076	0.0087	0.00079	0.00074	0.0017	0.0011	0.0010	0.00087	0.0022	0.0016	0.0011	0.00087	Level 0

Lake & Area	AMP Benchmark	MAM FEIS Predictions										Mammoth Lake – Mean Monthly Concentrations (mg/L)										Current Mgmt Level
Month		2021					2022					2021					2022					
Area-Replicate ID		Mar	May	Jul	Aug	Sep	Mar	May	Jul	Aug	Sep	Mar	May	Jul	Aug	Sep	Mar	May	Jul	Aug	Sep	
Phosphorus (mg/L)	0.01	0.013	0.013	0.0096	0.0096	0.0093	0.0090	0.0090	0.0077	0.0077	0.0076	0.0039	0.0022	0.0030	0.0056	0.0052	0.0083	0.0051	0.0037	0.0037	0.0029	Level 0
Arsenic (mg/L)	0.025	0.013	0.013	0.0085	0.0085	0.0081	0.0077	0.0077	0.0063	0.0063	0.0063	0.00076	0.00088	0.0012	0.0015	0.0023	0.0013	0.0013	0.0011	0.0014	0.0013	Level 0

Notes:

The AMP Benchmark for total phosphorus guideline is the upper limit of oligotrophic status from CCME (2004); The AMP Benchmark for arsenic is the site-specific water quality objective (Golder, 2019).

Formatting aligns with the AMP thresholds in the *Whale Tail Expansion Project – Adaptive Management Plan* (Agnico Eagle, 2021):

Level 0	Normal conditions	<= 20% FEIS predictions.
Level 1	Area of concern	>= 20% FEIS predictions AND < 80% water quality guideline.
Level 2	Area of concern	>= 20% FEIS predictions AND between 80% and 100% water quality guideline.
Level 3	High risk	>= 20% FEIS predictions AND between 100% and 120% water quality guideline.
Level 4	Emergency situation	>= 20% FEIS predictions AND > 120% water quality guideline.

5.3.5 Summary and Implications

Following the assessment strategy for MF and FF areas outlined in the *CREMP Plan Update* (Azimuth, 2022b), the 2022 trigger exceedances were evaluated and applied to the decision criteria outlined in **Section 2.2.3** to determine the effort level and sampling frequency required at the MF and FF areas in 2023. The assessment strategy interprets the water quality assessment results from the NF areas in the current year (in this case 2022) to inform sampling at MF and FF areas the following year (i.e., 2023) (**Figure 5-8**).

A summary of the trigger screening results for the Whale Tail study areas are presented in **Table 5-9** according to their corresponding degree of change based on mean annual concentrations:

- no trigger exceedance,
- minor changes = trigger exceeded for parameters without effects-based thresholds,
- moderate changes = trigger exceeded for parameters with effects-based thresholds, or
- major changes = exceedance of the effects-based threshold.

In 2022, most observed water quality differences and trigger exceedances classified as *minor changes* (**Table 5-9**). The one exception was mean annual total phosphorus at WTS, MAM, and A20 which is classified as a *moderate change* because there were increases above the early warning trigger in 2022. The threshold for total phosphorus is 0.01 mg/L, which corresponds to the upper bound value for oligotrophic lakes (CCME, 2004). The CCME guideline is not associated with adverse effects to aquatic life, rather the framework is meant to protect against secondary effects to aquatic life from eutrophication and oxygen depletion. Based on this *moderate change*, the full suite of CREMP water sampling is scheduled for 2023.

5.4 Phytoplankton Community

2022 was the third full year in which all Whale Tail study area lakes were designated as *impact*. Areas WTS and MAM have been classified as *impact* areas since mid-2018. Areas A20, A76, and DS1 were classified as *impact* areas from the beginning of 2019, and NEM switched to *impact* in August 2019[24].

5.4.1 General Observations

The general description of phytoplankton taxa in Meadowbank project lakes (**Section 4.3.3**) applies equally to the lakes within the Whale Tail study area. Six major taxonomic groups of phytoplankton are present in the Whale Tail study lakes. These are blue-green algae (Cyanophyta), green algae

[24] Baseline phytoplankton taxonomy data for the Whale Tail study area lakes was summarized in Azimuth (2018b). The baseline report focused on describing the dominant species and seasonal variability in taxonomy metrics (e.g., biomass and richness) within and between areas.

(Chlorophyta), golden-brown algae (Chrysophyta), diatoms (Bacillariophyta), cryptophytes (Cryptophyta), and dinoflagellates (Dinoflagellata). Species composition varies throughout the year depending on water temperature, nutrient concentration, time of year, water clarity and amount of sunlight, and predation by zooplankton. In general, the biomass of the phytoplankton community during the baseline period or at the reference areas was comprised predominately of chrysophytes (golden-brown algae) (**Figure 5-16**).

5.4.2 Temporal and Spatial Trends

The approach for identifying potential mine-related impacts involved visually searching for temporal-spatial patterns that might be associated with mine-related activities (outlined in **Section 5.1** and summarized in **Table 1-1**), augmented by statistical analyses of the 2022 data to test for changes relative to baseline/reference conditions using the BACI model (see **Section 2.3.3** for details). Both methods look for evidence of temporal-spatial patterns that might be associated with the mine-related activities.

Tabulated phytoplankton community data from the 2022 CREMP are presented in **Appendix D2**. The metrics used to assess changes in the community were chlorophyll-a (**Figure 5-14**), total phytoplankton biomass (**Figure 5-15** to **Figure 5-17**), and species richness (**Figure 5-18**). Supplemental plots showing major taxa biomass (mg/m^3) and density (mg/L) are included in **Appendix D2**. The BACI statistical test results of changes in the phytoplankton community (total biomass and total species richness) in 2022 relative to baseline/reference conditions are provided in **Table 5-11**; key results are discussed below.

Chlorophyll-a

Chlorophyll-a is an indicator of primary productivity and is often used as a surrogate for phytoplankton biomass. Given the direct measure of total phytoplankton biomass (see below), statistical analysis is not completed for chlorophyll-a. However, the time series plots provided in **Figure 5-14** show that chlorophyll-a concentrations in the latter half of 2022 were generally higher at WTS than in baseline samples. In WTS, the upper range of chlorophyll-a was lower than the peak observed in 2019 and followed a similar pattern to that observed in 2021. The 2022 mean annual concentration of chlorophyll-a at WTS slightly exceeded 1 µg/L which is considered characteristic of oligotrophic systems (Kasprzak et al., 2008). At the other Whale Tail study area lakes, chlorophyll-a concentrations were typically less than 1 µg/L with some seasonal increase above 1 µg/L in May, and were generally representative of baseline trophic status in the lakes. Chlorophyll-a in Nemo Lake appeared to be higher than the range of historical baseline reaching a maximum concentration of 2.2 µg/L in May (NEM-70). Possible factors influencing the patterns of chlorophyll-a and phytoplankton biomass are discussed in more detail below.

Phytoplankton Biomass

Time series plots for total phytoplankton biomass (mg/m^3) are provided in **Figure 5-15**[25]. Overall, seasonal patterns are evident, with peak biomass occurring during the open water period. While total biomass at WTS during this period remained elevated in 2022, results for MAM, A20, and A76 were lower than those seen in 2021. The largest contributor to community biomass at each of the study lakes were chrysophytes, with the exception of MAM where diatoms dominated in 2022 (**Figure 5-16** and **Figure 5-17**).

In the BACI analysis, the model interaction term (or BACI effect term) represents the change at the test area in 2022 (*after* period) relative to baseline (*before* period) after accounting for natural regional temporal changes observed at reference area INUG. For simplicity, changes are noted *relative to baseline/reference* conditions. In 2022, total phytoplankton biomass was elevated relative to baseline/reference conditions at WTS (77%), MAM (32%), A20 (128%), A76 (73%), and NEM (43%). While these changes exceeded the trigger of 20%, they were not statistically significant ($p > 0.1$) and showed high variability (as seen in the confidence intervals for the effect size estimate in **Table 5-11**). It is important to note that with the exception of WTS, these effect size estimates are all substantially lower than they were in 2021. These results are discussed further in the summary at the end of the phytoplankton section.

The increases in phytoplankton biomass identified at NF and MF areas since the onset of mining activities are consistent with predictions made in the FEIS regarding increasing nutrient concentrations in these lakes (Golder, 2018).

Community Composition

The number of taxa varies by season, with a more diverse community typically present during the open-water season than when ice covers the lakes (**Figure 5-18**). Typically, more than 30 different species of phytoplankton are present during the open-water season. At WTS, richness in July through September 2022 ranged from 28 to 32 taxa, which was similar to the range of taxa observed in summer months in 2021 and during baseline. In MAM, richness ranged from 18 to 28 in 2022, which was comparable to 2021, but reached the lower end of the range when biomass dropped in August and September. The ranges of taxa richness observed at WTS and MAM throughout the year were within the ranges observed at reference area lakes (i.e., total richness in 2022 at INUG and PDL ranged from 16 to 40 and 20 to 31, respectively).

[25] The time series plot uses a log-scale for total biomass as mg/m^3. This is a common approach for data that ranges broadly within or across years. While the approach reduces emphasis on extreme values, it could also lessen the appearance of certain mine-related trends.

The BACI results for 2022 showed that effect size estimates for taxa richness were below the trigger (20%) at all areas and none of the changes were statistically significant (**Table 5-11**). Further discussion related to the ecological significance of these results is presented in the summary below.

5.4.3 Summary and Implications

Though there were no statistically significant changes in phytoplankton biomass in 2022, changes at WTS, MAM, A20, A76, and NEM exceeded the 20% effect size trigger for phytoplankton outlined in **Section 2.3.3**. No statistically significant changes in richness were observed for the Whale Tail study area lakes in 2022.

The response patterns observed in phytoplankton biomass suggest a combination of mining influence and natural variability. As described in **Section 5.3**, mining-related changes in water quality have been identified at Whale Tail at all NF and MF areas. Nutrients are generally a limiting factor for phytoplankton growth in oligotrophic systems and any inputs can lead to changes in productivity. In 2022, there was a general correspondence between increases in nutrient levels at WTS, MAM, and A20 and increased phytoplankton biomass. According to the FEIS, phosphorus and nitrate levels are predicted to increase at both WTS and MAM until 2026, after which concentrations are predicted to decline. With these predicted increases in nutrients, phytoplankton biomass is expected to increase over the next four years of CREMP sampling. Although FEIS predictions are limited to WTS and MAM, it is expected that effects will extend into the MF lakes. Despite these predictions, phytoplankton communities respond to a host of natural seasonal factors such as sunlight, and water temperature. The influence of nutrient inputs on the phytoplankton community is challenging to interpret given these natural seasonal fluctuations which contributes to lower statistical power (BACI results were not significant). Phytoplankton productivity, biomass and richness, as well as associated patterns in key nutrients will continue to be tracked in 2023.

The Whale Tail phytoplankton program will follow the same schedule as the routine water quality monitoring component of the program in 2023.

5.5 Sediment Chemistry

Trends in sediment chemistry are monitored as follows (*CREMP Plan*; Azimuth, 2022b):

- Sediment cores are used to assess changes in sediment metals. Coring is conducted on a three-year cycle matching the MDMER EEM schedule. The next event is in 2023.
- Sediment grabs are used to characterize sediment from a habitat perspective for benthic invertebrates each year. Samples are collected at the same locations as benthic invertebrates and are analyzed for grain size and TOC.

Notwithstanding, sediment grabs are also sometimes used to characterize sediment chemistry (metals and organic compounds) in between coring events. While the grab sediment chemistry results are not used formally to statistically test for changes relative to baseline, they can help to better understand spatial and temporal variability between coring events. In 2022, sediment grab chemistry samples were collected and analyzed to support this understanding. However, since formal testing of changes in sediment chemistry is conducted using the coring results, no BACI analyses were conducted. Visual assessment of temporal-spatial patterns that might be associated with mine-related activities was conducted.

Tabulated sediment quality data for 2022 data are provided in **Appendix C**.

In 2022, some of the sediment samples collected in August 2022 had high water content resulting in insufficient sediment for grain size analysis. For Whale Tail study area lakes, this only affected samples collected at Lake A76 (**Section 3.4**).

5.5.1 General Observations

Lake sediments in the Project area are generally similar to those described for the Meadowbank study area lakes in **Section 4.5.1**. Key points are:

- Natural sedimentation rates in these headwater lakes are low. However, there are several development-related activities that can increase sediment loading to the lakes.
- Sediments are generally dominated by silt and clay fractions. Particle size distribution in sediment grab samples (top 3–5 cm of sediment surface) is predominantly silt and clay, characteristic of depositional areas in all the lakes sampled in this region. Nemo Lake, historically, has a higher percentage of sand than the other Whale Tail study area lakes (**Figure 5-19**).
- Lakes within the Project area are naturally enriched in some metals compared to CCME sediment quality guidelines (SQGs). Arsenic, cadmium, chromium, copper, mercury, and zinc exceeded the interim sediment quality guideline (ISQG[26]) in at least one sample collected during the baseline period. Lake-specific[27] triggers were developed (due to strong natural spatial trends among the lakes) in 2019 based on the 2017 sediment core results.

[26] The ISQG is equivalent to the threshold effect level (TEL): calculated as the geometric mean of the lower 15th percentile of the effect data set and the 50th percentile of the no-effect data set (CCME, 1999).

[27] Note that triggers for Meadowbank and Baker Lake were generally applied across all sampling areas; WAL was the only location to have lake-specific triggers. Lake-specific triggers were developed for all Whale Tail study area lakes.

5.5.2 Temporal and Spatial Trends

For the purpose of interpreting the 2022 sediment data, all Whale Tail study area lakes (WTS, MAM, NEM, A20, A76, DS1) are considered *impact* starting in 2019 except for WTS, which was designated as *impact* in 2018. Note that there are missing results for 2021 (INUG, PDL, MAM, A20, and DS1) on those figures; these samples were inadvertently discarded prior to analysis due to a laboratory error.

Metals

Metals concentrations are shown by area/basin for the different sampling methods (grab [data points] vs core samples [box and whisker plots]) since 2015; **Figure 5-20** to **Figure 5-27**). The red dashed line represents the lake-specific trigger value, where available. The box and whisker plots illustrate the statistical distribution of core samples within each area, as follows:

- The horizontal line inside the box represents the median concentration.
- The upper and lower margins of the box represent the upper (75th) and lower (25th) percentile concentrations, respectively (the interquartile range).
- The vertical lines extend to the maximum and/or minimum concentrations, or up to 1.5 times the interquartile range when there are concentrations outside this range.
- 'x's are the concentrations that fall outside 1.5 times the interquartile range.

Overall, the sediment grab results generally show no obvious mining-related increases in metals concentrations across any of the study lakes. While there were a number of trigger exceedances of individual samples in the 2022 data, the results appear to be driven more by unrepresentative trigger values than by actual changes in sediment chemistry. Trigger values may be unrepresentative if the 2017 sediment coring data do not fully represent the prevailing conditions in a particular lake. For example, the trigger values for arsenic were exceeded at WTS, MAM, and A20, but the observed concentrations were within the range of baseline grab/core results in all cases; the same generally applies for cadmium, copper, and zinc. The only exception may be chromium, which shows possible increases at the NF lakes (WTS, MAM and NEM); this pattern will be formally tested next year using the 2023 coring results. Note at the Meadowbank study lakes, chromium concentrations increased in TPE after construction of the East Dike at Third Portage Lake. Targeted studies, conducted to assess potential effects, found no unacceptable risks to the benthic community (see 2019 CREMP report [Azimuth, 2020a] for details).

Organic Compounds

Hydrocarbon concentrations were less than the detection limits for most parameters measured in the 2022 samples (**Appendix C2**). Analytes that had detectable concentrations did not exceed their respective CCME screening values. Similar to previous years, elevated detection limits were reported for several analytes due to high moisture content in the sediment samples, making them less informative;

most were still below the most conservative screening value (ISQG) and all were below the least conservative screening value (PEL). Notwithstanding, hydrocarbons are not considered a significant COPC based on the mining activities occurring at either the Whale Tail or the Meadowbank mine sites.

5.5.3 Summary and Implications

Sediment chemistry in the Whale Tail study area is naturally elevated in several metals. Concentrations of these metals can be highly variable as the sediment chemistry of the lakes is spatially heterogenous. Results for 2022 were consistent with previous years and generally demonstrated patterns consistent with the baseline period. Possible increases in chromium were noted at WTS, MAM, and NEM in 2022; these potential changes will be assessed formally next year using the 2023 coring results.

5.6 Benthos Community

Summary results for abundance and richness of major taxa in 2022 are presented in **Appendix E2,** along with supplemental plots showing abundance and richness at the major taxonomic group level since the start of baseline sampling.

5.6.1 General Observations

Benthic invertebrate (benthos) abundance in the Whale Tail study area can vary widely for a given lake on an annual basis, though multiple years of baseline data helps to characterize variability in abundance among the areas. Richness tends to be relatively stable year-over-year. While the relative proportions of various taxa may vary, the number of total taxa was consistent throughout the baseline period and start of construction. Abundance (organisms/m^2) and richness (# unique taxa) of benthic invertebrates in Whale Tail study area lakes during baseline were characteristic of depositional areas in northern lakes with low productivity and nutrient cycling with insects, primarily chironomids in the subfamilies Chironominae and Tanypodinae, and fingernail clams (Sphaeriidae) being the dominant benthic invertebrates.

5.6.2 Temporal and Spatial Trends

The methods and approaches used to assess benthos community metrics described for the Meadowbank CREMP also apply to the Whale Tail study area. Changes in benthos total abundance and richness were evaluated in 2022 using the BACI study design outlined in **Section 2.3.3**. Dike construction started on July 27, 2018, approximately three weeks prior to benthos sampling at WTS. While changes to the benthic community as a result of dike construction were considered unlikely, the area designation was changed from *control* to *impact* in 2018 due to the proximity to construction activities. In contrast, MAM was considered to have changed to *impact* after the 2018 benthos sampling (i.e., thus providing an extra annual event in the baseline period; this decision was supported by an assessment of water quality results from construction monitoring). The remaining Whale Tail lakes (A20, A76, DS1, NEM) were designated *impact* beginning with the 2019 August sampling event (**Table 2-3**).

Time-series plots showing total abundance and richness endpoints were used to assess spatial and temporal trends for the Whale Tail lakes (**Figure 5-28** to **Figure 5-33**). Identifying potential mine-related impacts generally involved visually examining the data for spatial/temporal patterns that matched mine-related events. This was augmented with formal statistical analyses of the data to test for changes in total abundance and total taxa richness relative to baseline/reference conditions using the BACI model (see **Section 2.3.3** for details). Key results are described below.

Abundance (Density)

Total benthos abundance is highly variable within the lakes and among years (**Table 5-12**). In 2022, high levels of abundance occurred in the impact lakes, where totals for each lake were within the top three highest abundances observed since monitoring started in 2015. In the reference lakes, these increasing patterns were not observed, rather the lowest mean abundance since 2015 occurred at INUG with only minor increases at PDL. Although mining activity could explain the abundance response at impacted lakes, the larger surface area and deeper depths of the reference lakes create unique limnological conditions which could also result in the divergent patterns.

Densities at the impact lakes ranged from 2,969 to 13,066 organisms/m^2 in 2022 at DS1 and MAM, respectively. The range of benthos densities observed during the baseline period was from 1,675 to 6,312 organisms/m^2 at WTS and A76, respectively. Densities similar to that seen at MAM this year have been observed at the Meadowbank study area lakes; Wally Lake (WAL), the shallowest of those lakes, has historically had the highest benthic densities, with measures up to 14,253 organisms /m^2.

From a BACI context, where change is measured relative to the reference lakes, an overall decline in abundance at reference will mean a relative increase at NF and MF lakes, even if annual abundance at the study lakes remained constant. For clarity, we refer to those cases as *apparent* increases or changes. Abundances at WTS, MAM, A20, A76, and NEM in 2022 were all above baseline and also higher than 2021 levels (**Figure 5-28**). The BACI results for WTS, MAM, A76, and NEM showed high effect sizes (>200%), though these were not significant at WTS and A76 (**Table 5-13**). Results of the BACI suggested there was an apparent increase in taxa richness at MAM in each of the time periods 2019-22, 2020-22, and 2021-22 (p-value <0.1) highlighting the comparative increase relative to the other years since MAM was designated *impact*. Note that in 2022 the BACI was run as a two-tailed test, to better define the significance of enriching effects (**Section 2.3.3**).

Based on 17 years of monitoring benthic communities at the Meadowbank study lakes, the most likely explanation for the observed spike in density in 2022 is a regional climate trend rather than a mine-related change. While increases in nutrients (**Section 5.3.2**) and primary productivity (**Section 5.4.2**) have been observed, these have not resulted in notable changes to sediment quality that would explain the sharp increases seen in 2022. Further, the densities observed in 2021, under a similar nutrient and primary production regime, were among the lowest observed across the Whale Tail impact lakes since 2015. The relative abundance results provide some insights into the 2022 results (**Figure 5-29** and **Figure 5-30**); they show that increased insect abundance was largely responsible for the elevated total densities, which is the same pattern seen with high densities in the Meadowbank study area results (**Section 4.6.2**). Thus, while these results are unlikely due to mining activity, additional data should help verify the cause of the increased densities observed in 2022.

Taxa Richness

The same taxa observed at the Meadowbank lakes were documented during the baseline period for the Whale Tail lakes. Unlike abundance, taxa richness was less variable within and among areas on an annual and inter-annual basis (**Figure 5-31**). Taxa richness is typically between 10 and 15 taxa in the Whale Tail lakes, with insects dominating in both number of taxa (**Figure 5-32**) and proportion of the total sample richness (**Figure 5-33**). Molluscs were the next most dominant taxonomic group in terms of the number species and relative richness.

The overall pattern of the 2022 taxa richness results is somewhat similar to that described previously for total density; the impact lakes all had high richness relative to the previous sampling years with this pattern absent for the reference lakes. Annual average richness at INUG was lower than any other time since sampling started in 2015. At the impacted lakes, 2022 mean taxa richness ranged from 13 (NEM) to 18 (MAM) taxa, which was higher than the range observed over the baseline period (10 to 17 taxa). Given the discussion previously for density (i.e., that the 2022 results were likely due to natural variability), the slight increase in taxa richness is not unexpected (i.e., in an oligotrophic setting, higher densities are generally associated with higher taxa richness).

The BACI analysis found statistically significant increases in taxa richness in 2022 at MAM and NEM (**Table 5-14**). The analyses, considering multiple years of data, also identified increases at A20. While these changes are real, their cause is uncertain but is most likely natural, as discussed previously for abundance. Additional data are needed to verify whether the underlying cause of the changes identified to date is natural or mine-related.

5.7 Whale Tail Tables and Figures

The tables and figures for the Whale Tail study areas provided in this section follow, except for the large tabulated datasets and figures for parameters that are not included in the detailed analysis (see in-text references to appropriate Appendices). Subsections are provided for each of the CREMP components (e.g., limnology, water chemistry, phytoplankton, sediment chemistry, and benthos).

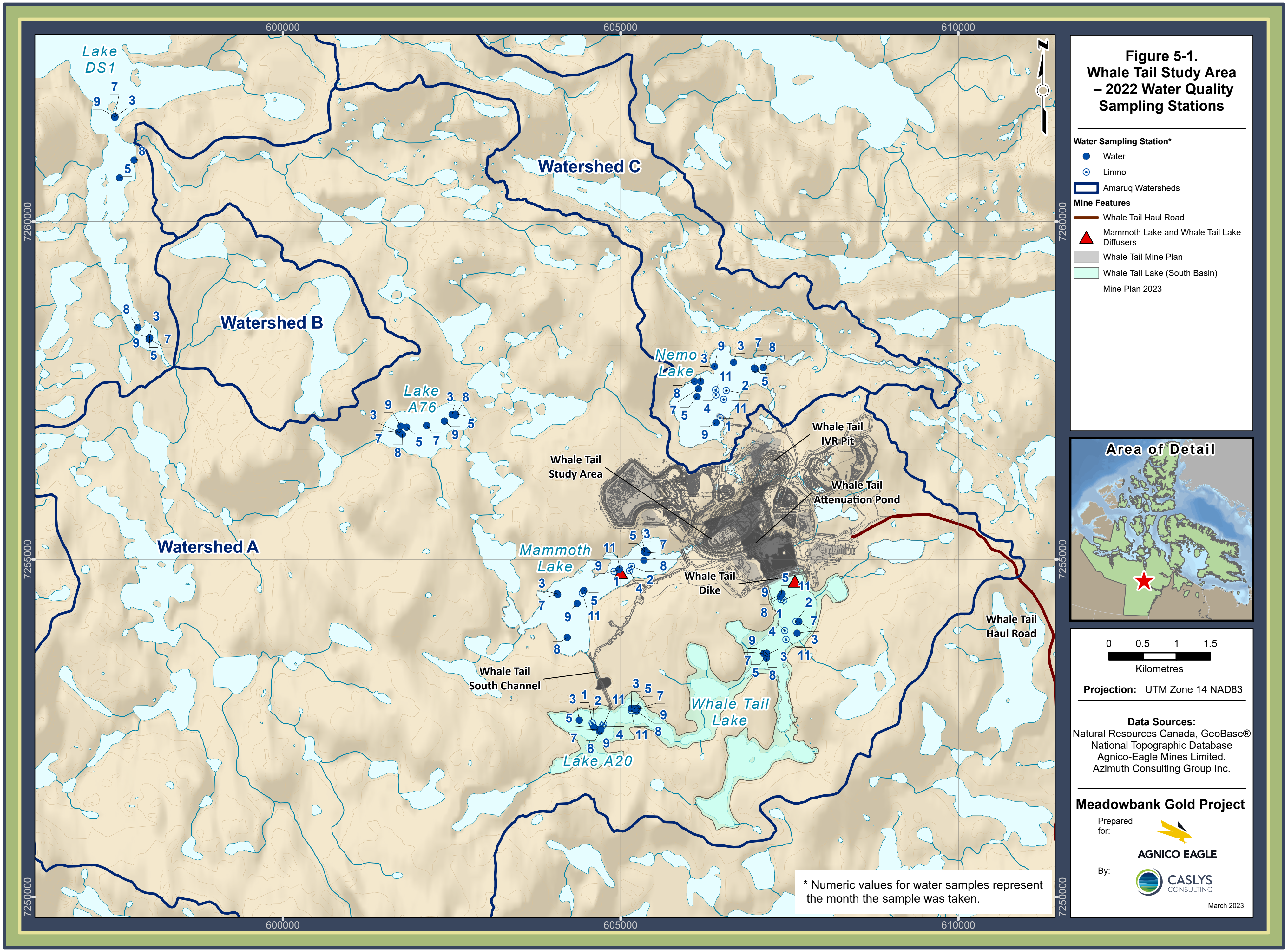


Figure 5-1.
Whale Tail Study Area – 2022 Water Quality Sampling Stations
Water Sampling Station*
Water
Limno
Amaruq Watersheds
Mine Features
Whale Tail Haul Road
Mammoth Lake and Whale Tail Lake Diffusers
Whale Tail Mine Plan
Whale Tail Lake (South Basin)
Mine Plan 2023
Area of Detail
0 0.5 1 1.5
Kilometres
Projection: UTM Zone 14 NAD83
Data Sources:
Natural Resources Canada, GeoBase®
National Topographic Database
Agnico-Eagle Mines Limited.
Azimuth Consulting Group Inc.
Meadowbank Gold Project
Prepared for:
AGNICO EAGLE
By:
CASLYS CONSULTING
March 2023
* Numeric values for water samples represent the month the sample was taken.
Lake DS1
Watershed A
Watershed B
Watershed C
Lake A76
Nemo Lake
Mammoth Lake
Whale Tail Lake
Lake A20
Whale Tail Study Area
Whale Tail IVR Pit
Whale Tail Attenuation Pond
Whale Tail Dike
Whale Tail South Channel
Whale Tail Haul Road
600000
605000
610000
7260000
7255000
7250000

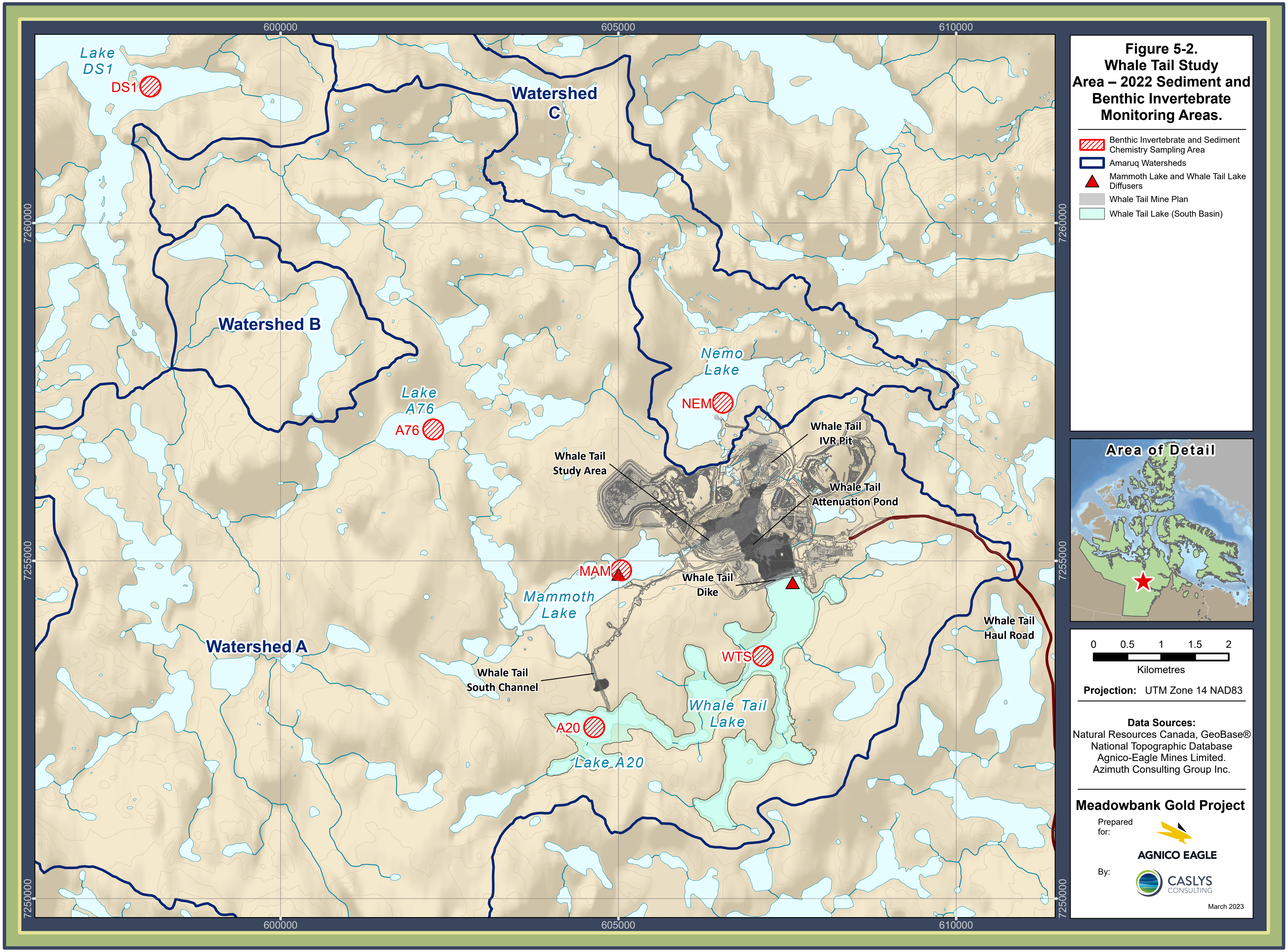
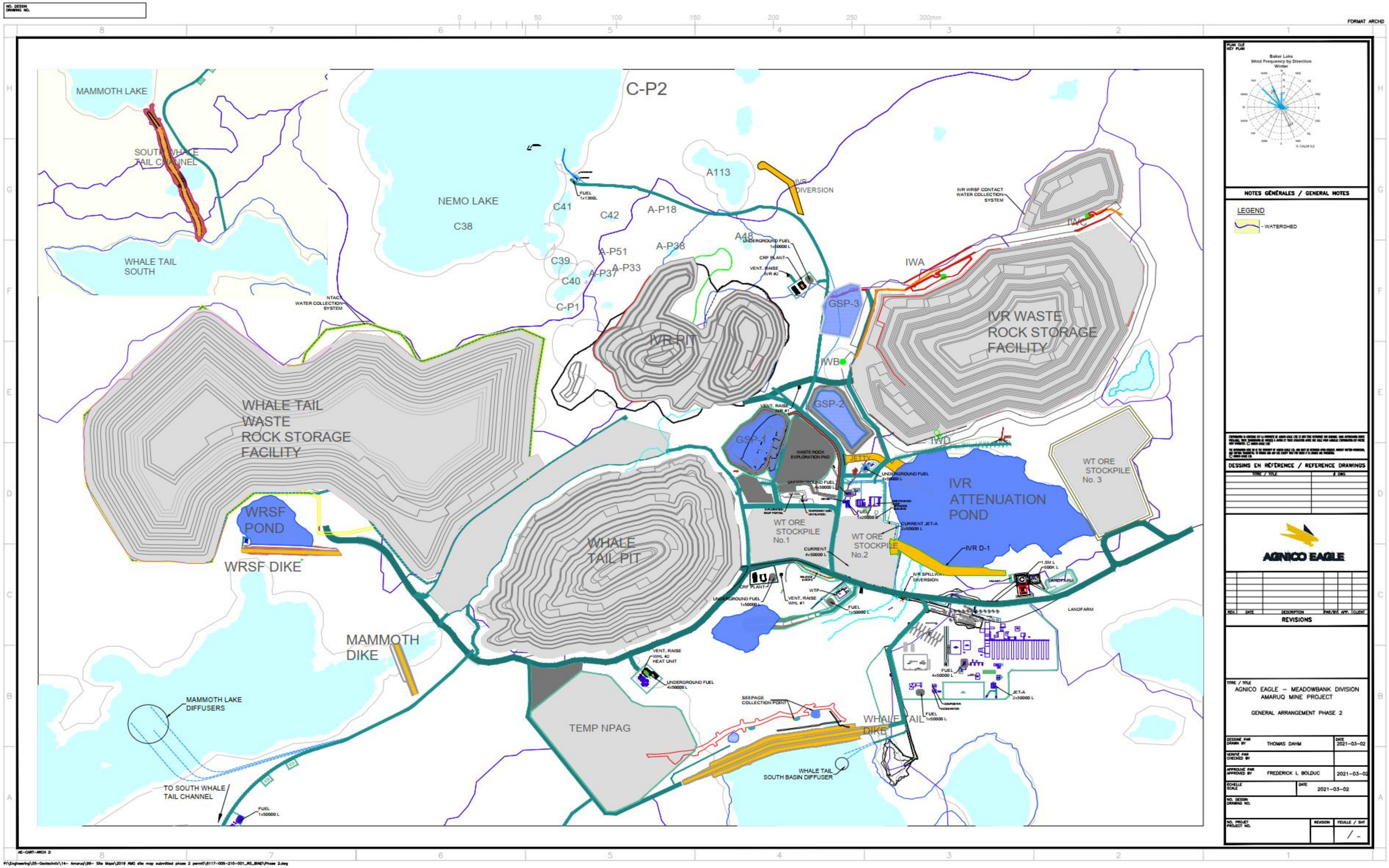


Figure 5-2. Whale Tail Study Area – 2022 Sediment and Benthic Invertebrate Monitoring Areas.

Figure 5-3. Whale Tail mine plan showing the location of the Whale Tail Dike and other site infrastructure (Phase 2).



Limnology Tables and Figures

Figure 5-4. Mean monthly field-measured temperature (°C) at 3 m depth since 2014, Whale Tail study area lakes.

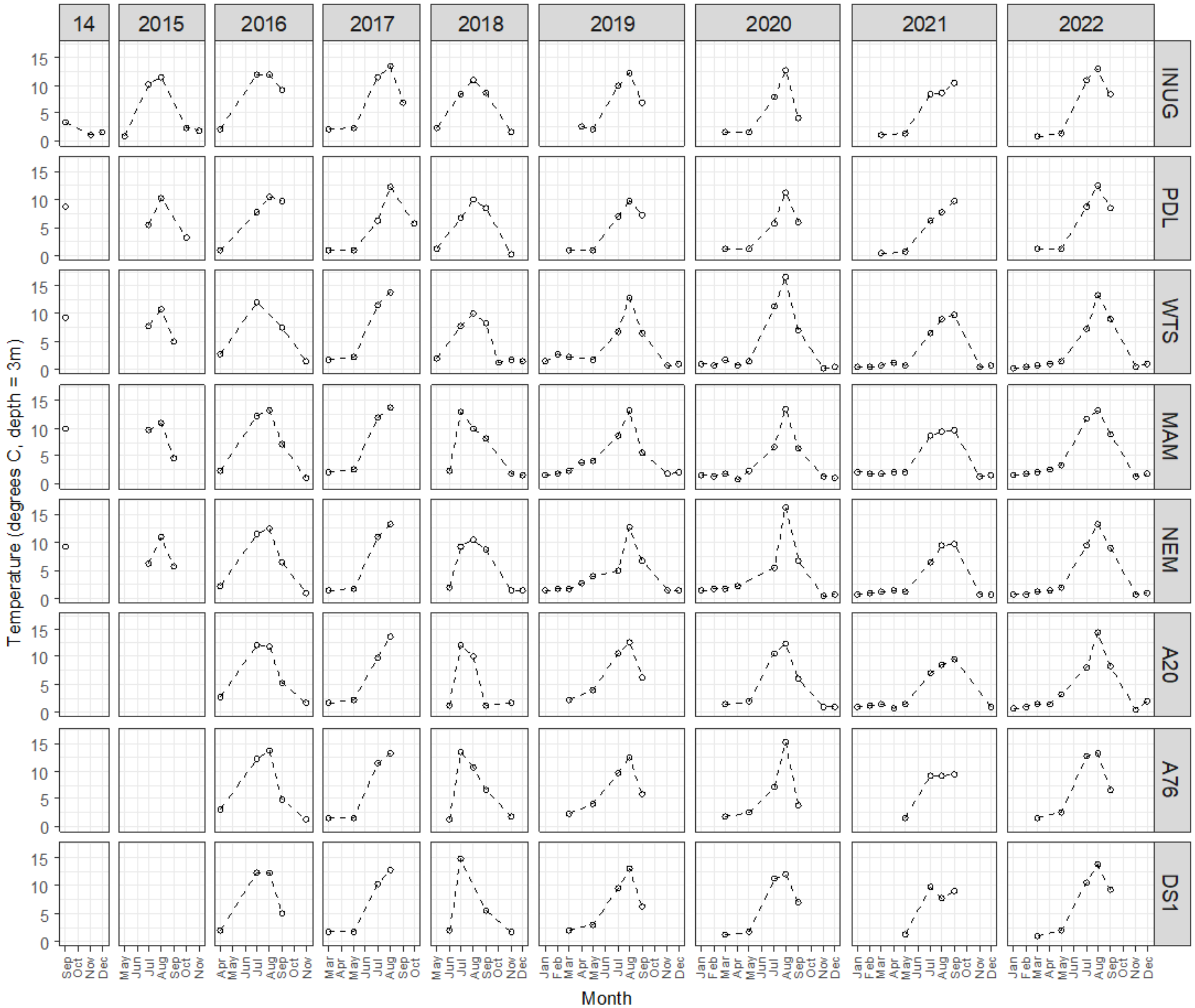


Figure 5-5. Whale Tail – Field-measured temperature profiles, 2022.

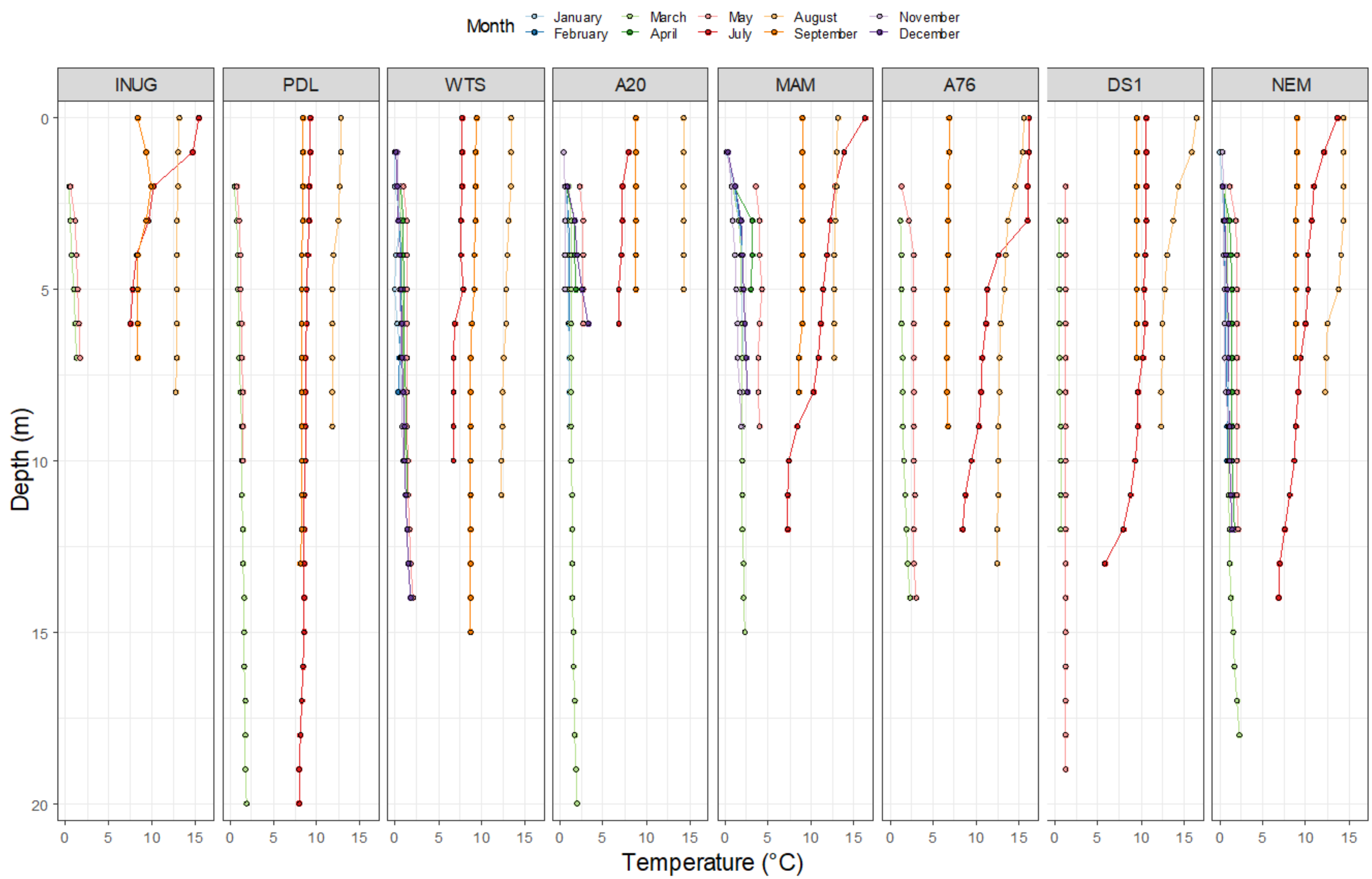


Figure 5-6. Whale Tail – Field-measured dissolved oxygen profiles, 2022.

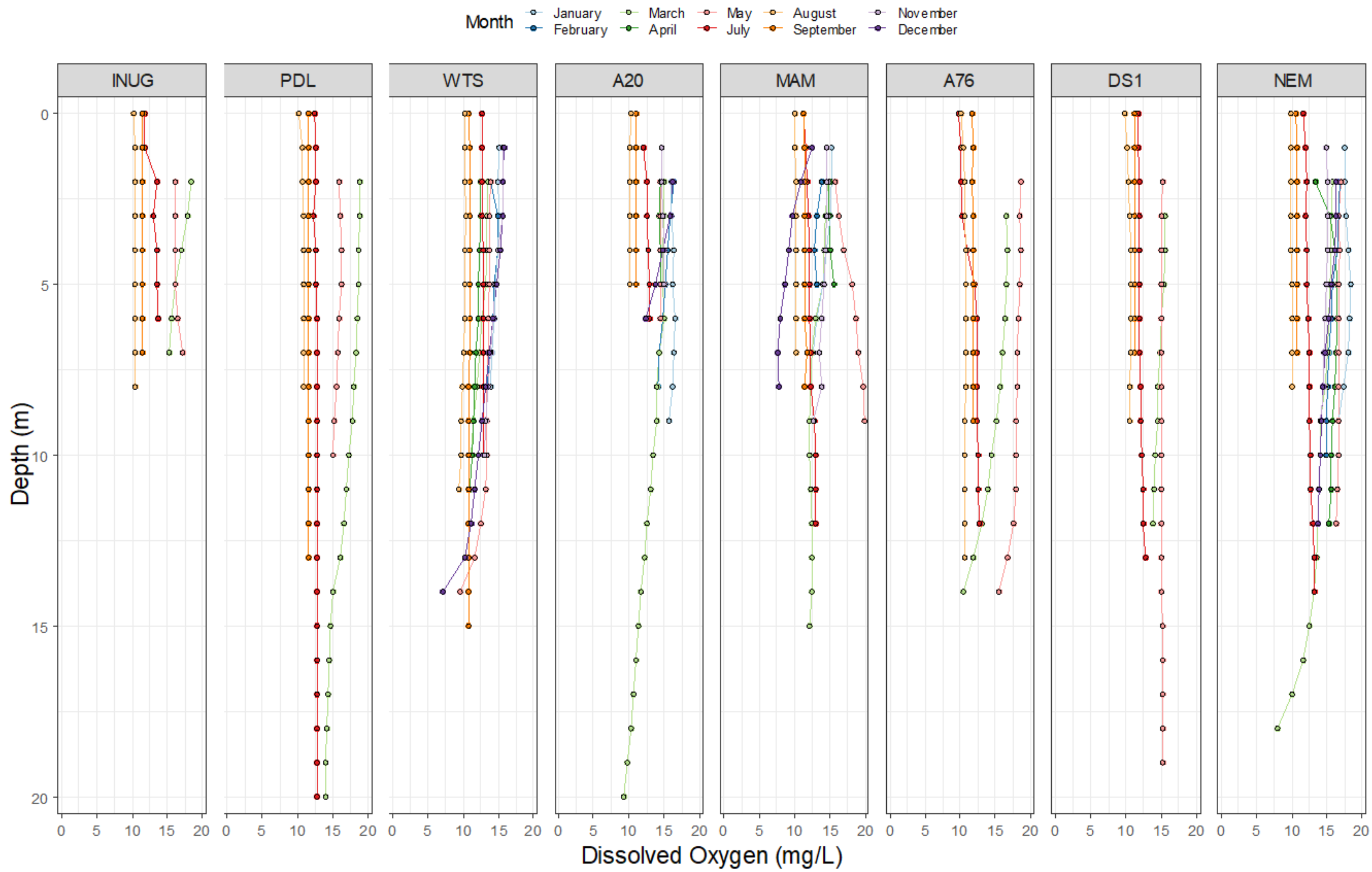
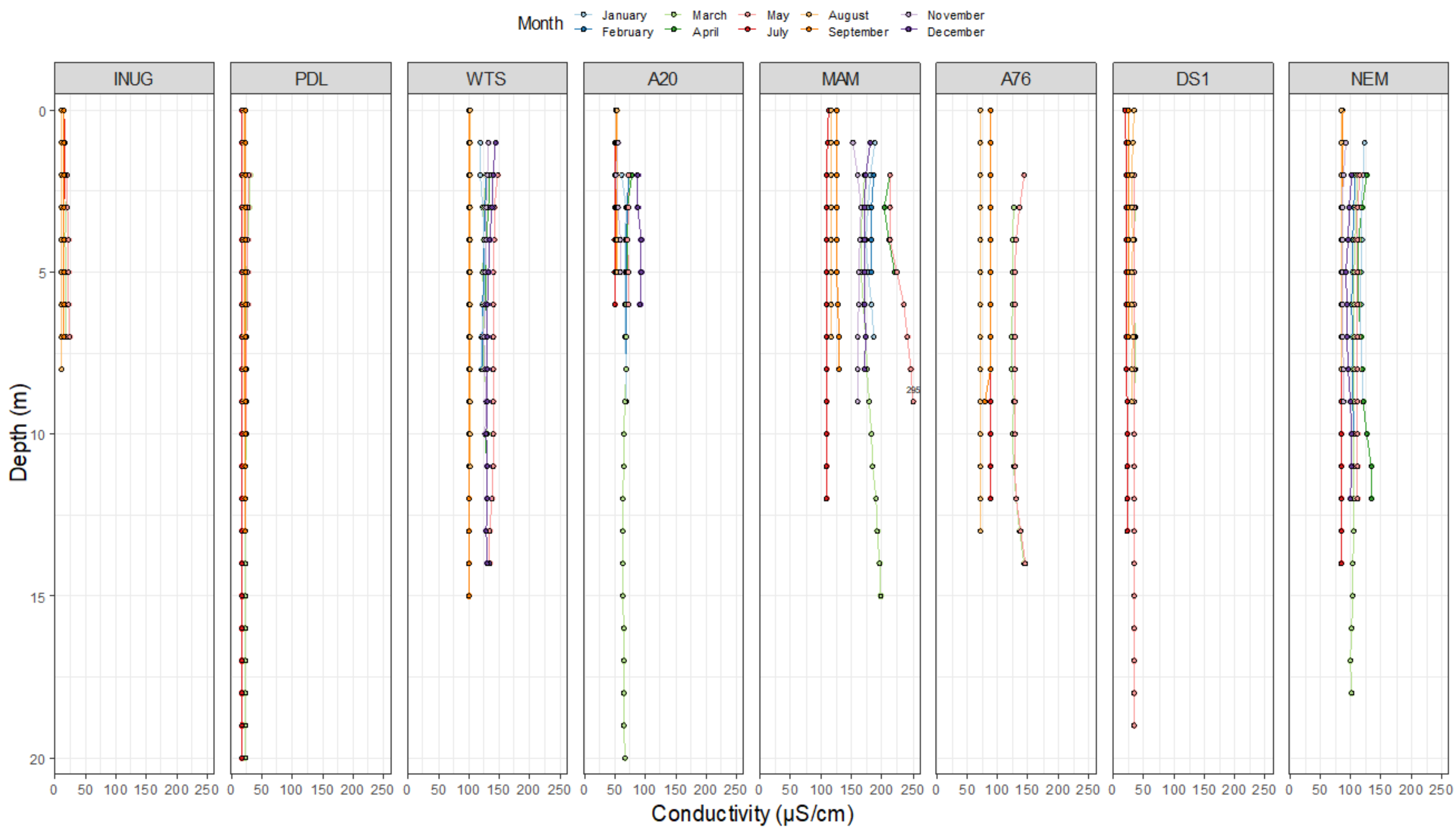


Figure 5-7. Whale Tail – Field-measured conductivity profiles, 2022.



Water Chemistry Tables and Figures

Table 5-6. Screening process for water quality parameters, Whale Tail study area lakes, 2022.

Parameters	Trigger Exceedance[2]	Screening Level and Rule[1] 1 >DL ≥ 10% Frequency	2 C-I > 0.1 Frequency	3 Pattern = Activity
CONVENTIONALS				
Conductivity	all stations except INUG and PDL	**Yes**	**Yes**	
TSS	-	No	No	No
Hardness	all stations except INUG and PDL	**Yes**	**Yes**	
T-Alkalinity	all stations except INUG	**Yes**	**Yes**	
B-Alkalinity	all stations except INUG	**Yes**	**Yes**	
C-Alkalinity	-	No	No	No
pH -Field	INUG, A76, and DS1	**Yes**	**Yes**	
pH -Lab		**Yes**	**Yes**	
TDS & MAJOR IONS				
TDS	WTS, MAM, A20, A76, and NEM	**Yes**	**Yes**	
Calcium	all stations except INUG and PDL	**Yes**	**Yes**	
Chloride	-	**Yes**	**Yes**	
Fluoride	-	**Yes**	**Yes**	
Magnesium	all stations except INUG and PDL	**Yes**	**Yes**	
Potassium	all stations except INUG and PDL	**Yes**	**Yes**	
Sodium	all stations except INUG and PDL	**Yes**	**Yes**	
Sulphate	-	**Yes**	**Yes**	
NUTRIENTS & OTHERS				
Ammonia-N	NEM	**Yes**	**Yes**	
Nitrate-N	-	**Yes**	**Yes**	
Nitrite-N	-	**Yes**	**Yes**	
TKN	WTS, MAM, A20, A76, NEM	**Yes**	**Yes**	
T-phosphorus	WTS, MAM, A20, DS1, NEM	**Yes**	**Yes**	
Ortho-phosphate	-	**Yes**	**Yes**	
DOC	all stations except PDL and NEM	**Yes**	**Yes**	
TOC	all stations except PDL	**Yes**	**Yes**	
Reactive silica	WTS and DS1	**Yes**	**Yes**	
T-Cyanide		*Not measured since 2019*		
Free Cyanide		*Not measured since 2019*		

Parameters	Trigger Exceedance[2]	Screening Level and Rule[1] 1 >DL ≥ 10% Frequency	2 C-I > 0.1 Frequency	3 Pattern = Activity
TOTAL METALS				
Aluminum	-	**Yes**	**Yes**	
Antimony	-	**Yes**	**Yes**	
Arsenic	-	**Yes**	**Yes**	
Barium	-	**Yes**	**Yes**	
Beryllium	-	No	No	No
Boron	-	No	No	No
Cadmium	-	No	No	No
Chromium	-	**Yes**	**Yes**	
Copper	-	**Yes**	**Yes**	
Iron	-	**Yes**	**Yes**	
Lead	-	**Yes**	**Yes**	
Lithium	WTS and MAM	**Yes**	**Yes**	
Manganese	-	**Yes**	**Yes**	
Mercury	-	No	No	No
Molybdenum	-	**Yes**	**Yes**	
Nickel	-	**Yes**	**Yes**	
Selenium	-	**Yes**	**Yes**	
Silicon	WTS and DS1	**Yes**	**Yes**	
Silver	-	No	No	No
Strontium	-	**Yes**	**Yes**	
Thallium	-	No	No	No
Tin	-	No	No	No
Titanium	WTS	**Yes**	**Yes**	
Uranium	-	**Yes**	**Yes**	
Vanadium	-	No	No	No
Zinc	-	No	No	No

Parameters	Trigger Exceedance[2]	Screening Level and Rule[1] 1 >DL ≥ 10% Frequency	2 C-I > 0.1 Frequency	3 Pattern = Activity
DISSOLVED METALS				
Aluminum	-	**Yes**	**Yes**	
Antimony	-	**Yes**	**Yes**	
Arsenic	-	**Yes**	**Yes**	
Barium	-	**Yes**	**Yes**	
Beryllium	-	No	No	No
Boron	-	No	No	No
Cadmium	-	No	No	No
Chromium	-	No	No	No
Copper	-	**Yes**	**Yes**	
Iron	-	**Yes**	**Yes**	
Lead	-	No	No	No
Lithium	WTS and MAM	**Yes**	**Yes**	
Manganese	-	**Yes**	**Yes**	
Mercury	-	No	No	No
Molybdenum	-	**Yes**	**Yes**	
Nickel	-	**Yes**	**Yes**	
Selenium	-	No	**Yes**	No
Silicon	WTS and DS1	**Yes**	**Yes**	
Silver	-	No	No	No
Strontium	-	**Yes**	**Yes**	
Thallium	-	No	No	No
Tin	-	No	No	No
Titanium	-	No	No	No
Uranium	-	**Yes**	**Yes**	
Vanadium	-	No	No	No
Zinc	-	**Yes**	**Yes**	

Notes:

1. A three-step assessment process was used to identify parameters to include in the formal temporal and spatial trend assessment (**Section 2.3.1** and **Section 4.3.2**).
   Parameters were assigned a "Yes" if the following assessment was true:

(1) **>DL ≥ 10% Frequency**: parameters that exceeded MDLs in at least 10% of the samples.
(2) **C-I > 0.1 Frequency**: parameters that were detected more often in impact areas and the proportion of detected values increased by 0.1 or more.
(3) **Pattern = Activity**: additional step to avoid screening out potentially important parameters. Based on the trend plots, is there a trend for infrequently detected parameters and/or are there values > 5 x DL in at least one sampling event at NF areas?

2. Indicates that a trigger exceedance occurred at the listed Whale Tail study area lakes in one or more sampling event.

Shaded parameters are included in the temporal and spatial trend assessment.
Plots for all individual parameters are presented in **Appendix B2**.

Table 5-7. Water quality variables at the Whale Tail study area lakes for which 2022 mean concentrations exceeded the trigger.

Parameter	Trigger	Threshold	2022 Mean					
			WTS	MAM	NEM	A20	A76	DS1
			NF	NF	NF	MF	MF	FF
Conventionals								
Conductivity	48.6	-	114	154	95.0	67.7	102	
Hardness	17.4	-	40.3	54.5	35.4	24.7	37.8	
HCO_3 Alkalinity	9.6	-	17.9	19.5	11.8	12.8	13.2	
Total Alkalinity	9.6	-	17.9	19.5	11.8	12.8	13.2	
TDS & Major Ions								
TDS	38.5	-	75.6	99.0	70.7	47.0	66.6	
Calcium	4.6	-	11.0	15.3	10.5	6.7	10.6	
Magnesium	1.4	-	3.1	3.9	2.2	2.0	2.8	
Potassium	0.84	-	2.9	3.8	1.7	1.7	2.3	
Sodium	1.0	-	2.4	3.0	1.0	1.5	1.7	1.1
Nutrients								
TKN	0.17	-	0.25	0.26		0.23		
Total phosphorus	0.0045	-	0.0059	0.0047		0.0051		
TOC	2.4	-	3.7	3.3		3.6		2.8
DOC	2.4	-	3.8	3.6		3.6		2.9
Metals								
T. Lithium	0.0020	-		0.0024				
D. Lithium	0.0020	-		0.0024				
T. Titanium	0.00041	-	0.00048					

Notes:
"-" indicates mean annual concentration was < the trigger value.
Reported mean values are all in units of mg/L except for conductivity (µS/cm).

Table 5-8. Results of BACI tests for selected water variables at the Whale Tail study area lakes in 2022.

							Proportional change		
Parameter	**Test Area**	**n(B)**	**n(A)**	**Estimate**	**SE**	**P-value[1]**	**exp(Est)**	**LCI**	**UCI**
Conventionals									
Conductivity	WTS	14	5	1.3	0.15	**< 0.001**	3.8	2.8	5.2
	MAM	15	5	1.3	0.16	**< 0.001**	3.7	2.7	5.1
	A20	13	5	1.4	0.076	**< 0.001**	4.0	3.4	4.7
	A76	13	5	1.0	0.088	**< 0.001**	2.8	2.3	3.4
	NEM	20	5	1.2	0	**< 0.001**	3.3	3.3	3.3
Hardness	WTS	14	5	1.2	0.14	**< 0.001**	3.5	2.6	4.6
	MAM	15	5	1.2	0.15	**< 0.001**	3.3	2.4	4.6
	A20	13	5	1.4	0.090	**< 0.001**	3.9	3.2	4.7
	A76	13	5	0.97	0.087	**< 0.001**	2.6	2.2	3.2
	NEM	20	5	1.1	0	**< 0.001**	3.0	3.0	3.0
HCO_3 alkalinity	WTS	13	5	1.2	0.066	**< 0.001**	3.3	2.9	3.8
	MAM	14	5	1.1	0.078	**< 0.001**	3.1	2.7	3.7
	A20	13	5	0.76	0.076	**< 0.001**	2.1	1.8	2.5
	A76	13	5	0.57	0.050	**< 0.001**	1.8	1.6	2.0
	NEM	19	5	0.30	0.051	**< 0.001**	1.4	1.2	1.5
Total alkalinity	WTS	13	5	1.2	0.066	**< 0.001**	3.3	2.9	3.8
	MAM	14	5	1.1	0.078	**< 0.001**	3.1	2.7	3.7
	A20	13	5	0.76	0.076	**< 0.001**	2.1	1.8	2.5
	A76	13	5	0.57	0.050	**< 0.001**	1.8	1.6	2.0
	NEM	19	5	0.30	0.051	**< 0.001**	1.4	1.2	1.5
TOC	WTS	14	5	0.29	0.055	**< 0.001**	1.3	1.2	1.5
	MAM	15	5	0.31	0.073	**< 0.001**	1.4	1.2	1.6
	A20	13	5	0.47	0.077	**< 0.001**	1.6	1.4	1.9
	DS1	13	5	-0.02400	0.063	0.65	0.98	0.85	1.1
DOC	WTS	14	5	0.34	0.050	**< 0.001**	1.4	1.3	1.6
	MAM	15	5	0.41	0.068	**< 0.001**	1.5	1.3	1.7
	A20	13	5	0.48	0.076	**< 0.001**	1.6	1.4	1.9
	DS1	13	5	0.057	0.073	0.22	1.1	0.91	1.2
Nutrients									
TKN	WTS	13	5	0.57	0.094	**< 0.001**	1.8	1.4	2.2
	MAM	14	5	0.66	0.092	**< 0.001**	1.9	1.6	2.4
	A20	13	5	0.69	0.13	**< 0.001**	2.0	1.5	2.6
Total phosphorus	WTS	14	5	0.78	0.23	**0.0020**	2.2	1.4	3.5
	MAM	15	5	0.63	0.16	**< 0.001**	1.9	1.3	2.6
	A20	13	5	0.65	0.17	**< 0.001**	1.9	1.3	2.8
TDS & Major Ions									
TDS	WTS	13	5	1.2	0.18	**< 0.001**	3.4	2.3	5.0
	MAM	14	5	1.2	0.21	**< 0.001**	3.3	2.1	5.0
	A20	13	5	1.2	0.15	**< 0.001**	3.3	2.4	4.4
	A76	13	5	0.99	0.13	**< 0.001**	2.7	2.1	3.5
	NEM	19	5	1.3	0.12	**< 0.001**	3.7	2.9	4.8
Calcium	WTS	14	5	1.3	0.18	**< 0.001**	3.5	2.4	5.1
	MAM	15	5	1.2	0.19	**< 0.001**	3.4	2.3	5.0
	A20	13	5	1.4	0.099	**< 0.001**	4.0	3.2	4.9
	A76	13	5	1.0	0.094	**< 0.001**	2.8	2.3	3.4
	NEM	20	5	1.3	0	**< 0.001**	3.8	3.8	3.8
Magnesium	WTS	14	5	1.2	0.11	**< 0.001**	3.2	2.6	4.0
	MAM	15	5	1.2	0.11	**< 0.001**	3.2	2.5	4.1
	A20	13	5	1.3	0.097	**< 0.001**	3.5	2.9	4.3
	A76	13	5	0.82	0.071	**< 0.001**	2.3	2.0	2.7
	NEM	20	5	0.58	0.040	**< 0.001**	1.8	1.7	2.0
Potassium	WTS	14	5	1.7	0.11	**< 0.001**	5.5	4.4	6.9
	MAM	15	5	1.6	0.12	**< 0.001**	5.0	3.9	6.4
	A20	13	5	1.4	0.10	**< 0.001**	4.0	3.2	4.9
	A76	13	5	1.1	0.077	**< 0.001**	3.0	2.5	3.5
	NEM	20	5	0.87	0.054	**< 0.001**	2.4	2.1	2.7
Sodium	WTS	14	5	1.2	0.084	**< 0.001**	3.5	2.9	4.1
	MAM	15	5	1.4	0.11	**< 0.001**	4.0	3.2	5.0
	A20	13	5	0.75	0.11	**< 0.001**	2.1	1.7	2.7
	A76	13	5	0.84	0.081	**< 0.001**	2.3	2.0	2.8
	DS1	13	5	0.086	0.12	0.24	1.1	0.84	1.4
	NEM	20	5	0.53	0.056	**< 0.001**	1.7	1.5	1.9
Metals									
T. Lithium	MAM	15	5	0.62	0.15	**< 0.001**	1.9	1.4	2.6
D. Lithium	MAM	15	5	0.67	0.14	**< 0.001**	2.0	1.5	2.6
T.Titanium	WTS	14	5	0.33	0.14	**0.016**	**1.4**	1.0	1.9

Notes:
1. Bolded P-values are statistically significant (p < 0.05).
Test area = area compared to control (INUG).
N(B) = number of paired months in the *before* period.
N(A) = number of paired months in the *after* period (i.e., in 2022).
Estimate = BACI model estimate of the 2022 change in mean for log-transformed data.
SE = standard error of the estimate.
DF = degrees of freedom.
P-value = one-tailed test of the null hypothesis (no change or a decrease in mean [opposite for lower pH trigger]).
Exp(Est.) = estimated proportional change.
LCI = lower 95% confidence interval; UCI = upper 95% confidence interval.

Table 5-9. Sampling effort and frequency assessment results for the Whale Tail study area lakes, 2022.

Areas	Area Designation	Triggers Exceeded?	Minor Changes [1]		Moderate Changes [2]		Major Changes [3]		Plan for 2023
		Yes/No	Yes/No	Parameters	Yes/No	Parameters	Yes/No	Parameters	
Sampling Strategy for Near-field Areas									
WTS	NF	Yes	Yes	Cond., Hard., TDS, Alkalinity (HCO_3 & Total), TKN, TOC, DOC, Ca, Mg, K, Na, T. Titanium.	Yes	T. Phosphorus	No	-	Full CREMP (near-field area)
MAM	NF	Yes	Yes	Cond., Hard., TDS, Alkalinity (HCO_3 & Total), TKN, TOC, DOC, Ca, Mg, K, Na, T.&D. Lithium.	Yes	T. Phosphorus	No	-	Full CREMP (near-field area)
NEM	NF	Yes	Yes	Cond., Hard., TDS, Alkalinity (HCO_3 & Total), Ca, Mg, K, Na.	No	-	No	-	Full CREMP (near-field area)
Sampling Strategy for Mid-field and Far-field Areas									
A20	MF	Yes	Yes	Cond., Hard., TDS, Alkalinity (HCO_3 & Total), TKN, TOC, DOC, Ca, Mg, K, Na.	Yes	T. Phosphorus	No	-	Full water sampling
A76	MF	Yes	Yes	Cond., Hard., TDS, Alkalinity (HCO_3 & Total), Ca, Mg, K, Na.	No	-	No	-	Full water sampling
DS1	FF	Yes	Yes	TOC, DOC, Na.	No	-	No	-	Full water sampling

Notes:
1. Minor = exceedance of the early warning trigger values for parameters without effects-based threshold values.
2. Moderate = exceedance of the early warning trigger values for parameters with effects-based thresholds.
3. Major = exceedance of the effects-based threshold values.

NA = MF and/or FF areas were not assessed using the formal BACI analysis in the current CREMP year.

Table 5-10. Number of monthly mean concentrations exceeding monthly FEIS screening predictions, annual mean trigger exceedances and trend directions for parameters in Mammoth Lake and Whale Tail South in 2022.

	Number of Monthly Exceedances of FEIS Predictions [1]		Annual Mean Exceeds Trigger		Direction of Change [2]	
Parameter	**Whale Tail South**	**Mammoth Lake**	**Whale Tail South**	**Mammoth Lake**	**Whale Tail South**	**Mammoth Lake**
Conventionals						
Total Alkalinity	5	5	**Yes**	**Yes**	=	↑
TDS & Major Ions						
TDS	5	5	**Yes**	**Yes**	↑	↑
Chloride	5	2	No	No	=	↑
Fluoride	5	5	No	No	↑	↑
Calcium	5	5	**Yes**	**Yes**	=	↑
Potassium	5	5	**Yes**	**Yes**	↓	↑
Magnesium	5	5	**Yes**	**Yes**	↓	↑
Sodium	4	4	**Yes**	**Yes**	↓	↑
Sulphate	5	5	No	No	=	↑
Nutrients						
Nitrate (as N)	2	2	No	No	↓	↑
Total Phosphorus	1	0	**Yes**	**Yes**	↓	↓
Total Metals						
Aluminum	5	5	No	No	↓	↑
Antimony	5	5	No	No	↓	=
Barium	5	5	No	No	↓	=
Iron	4	0	No	No	↓	↑
Lithium	5	5	No	**Yes**	↑	↑
Manganese	1	0	No	No	↓	=
Molybdenum	4	1	No	No	↓	↑
Nickel	4	0	No	No	↓	↑
Strontium	5	5	No	No	=	↑
Tin[3]	0	1	No	No	=	=
Uranium	2	0	No	No	↓	↑
Total	**87**	**69**	**-**	**-**		

Notes:

1 In all cases, five months of data were available.

2 Qualitative direction of trend according to 2022 water quality plots.

Shaded values indicate parameter exceeded FEIS prediction during all 2022 monthly sampling events.

Bolded and underlined values indicate yearly mean exceeded trigger.

Bolded arrows indicate parameter concentrations appeared to be increasing in last sampling events of 2022.

"-" indicates mean annual concentration was < the trigger value.

Reported mean values are all in units of mg/L.

Figure 5-8. Flow chart showing sampling effort and frequency plan for mid-field and far-field sampling at the Whale Tail study area lakes in 2023.

Note: Blue-shaded cells show the linkage between 2022 CREMP results and the sampling effort and frequency for mid-field and far-field sampling in 2023. *Moderate changes* refer to statistically significant increased concentrations for parameters with effects-based threshold values that exceed the early warning trigger values. Refer to **Section 2.2.3** for more information.

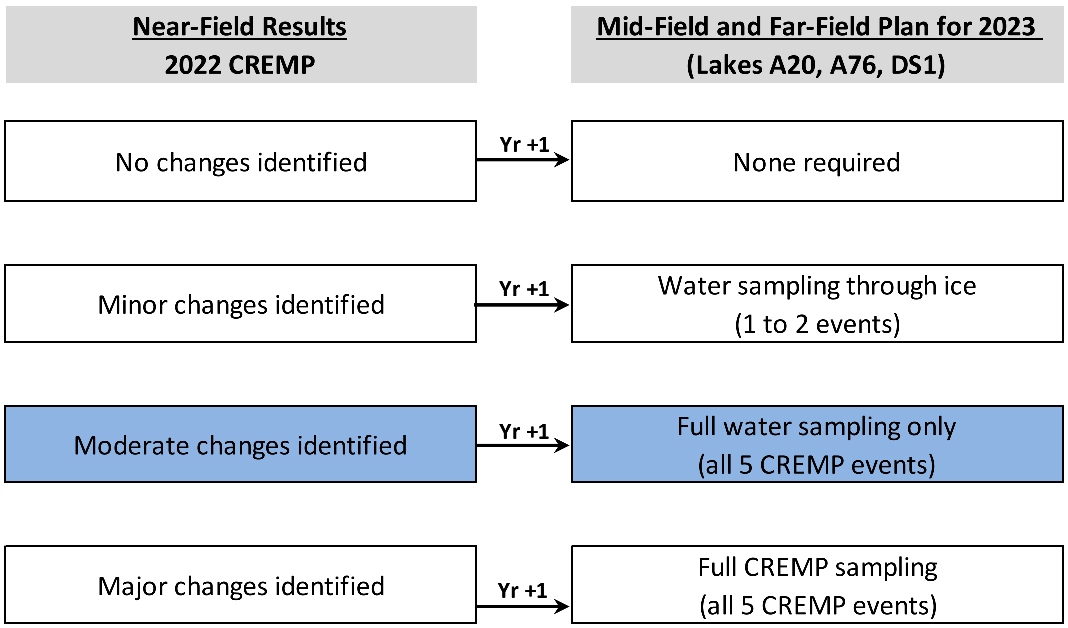


Figure 5-9. Conventional parameters measured in water samples from Whale Tail study area lakes since 2014.

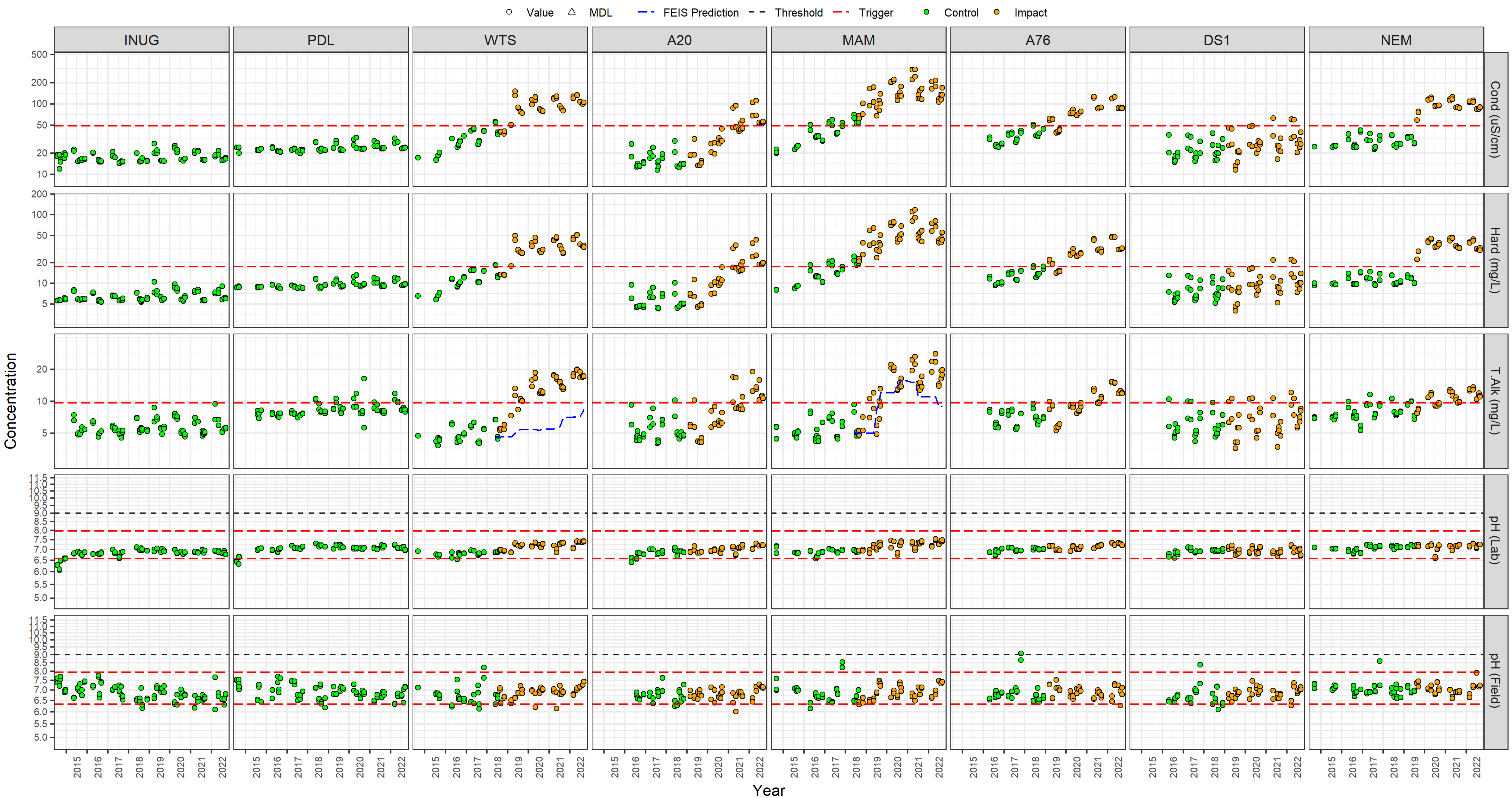


Figure 5-10. Major ions (mg/L) measured in water samples from Whale Tail study area lakes since 2014.

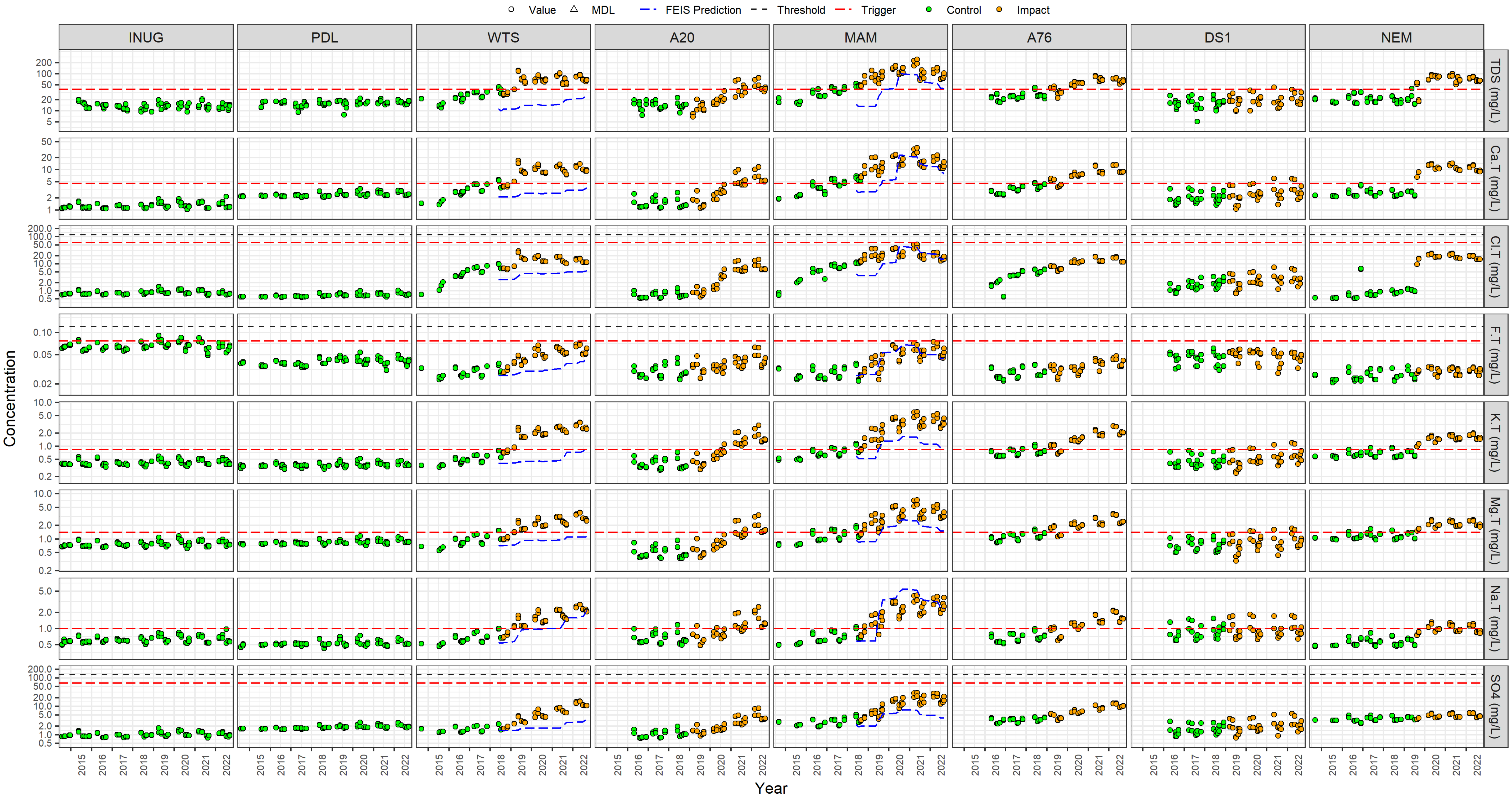


Figure 5-11. Nutrient parameters measured in water samples from Whale Tail study area lakes since 2014.

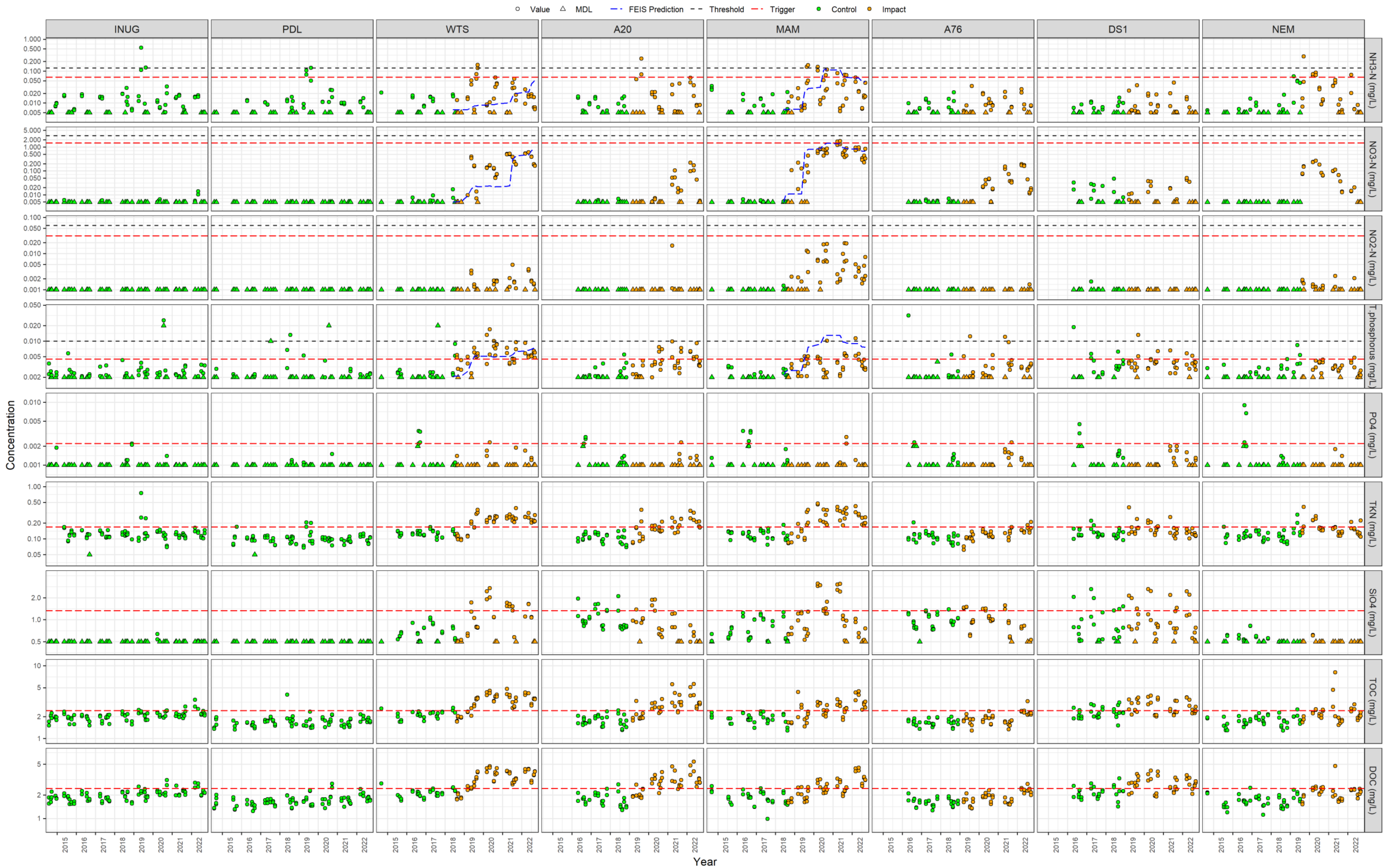


Figure 5-12. Metals measured in water samples from Whale Tail study area lakes since 2014.

Note: The detection limit for total chromium was adjusted from 0.0001 mg/L to 0.0005 mg/L for samples collected since May 2021.

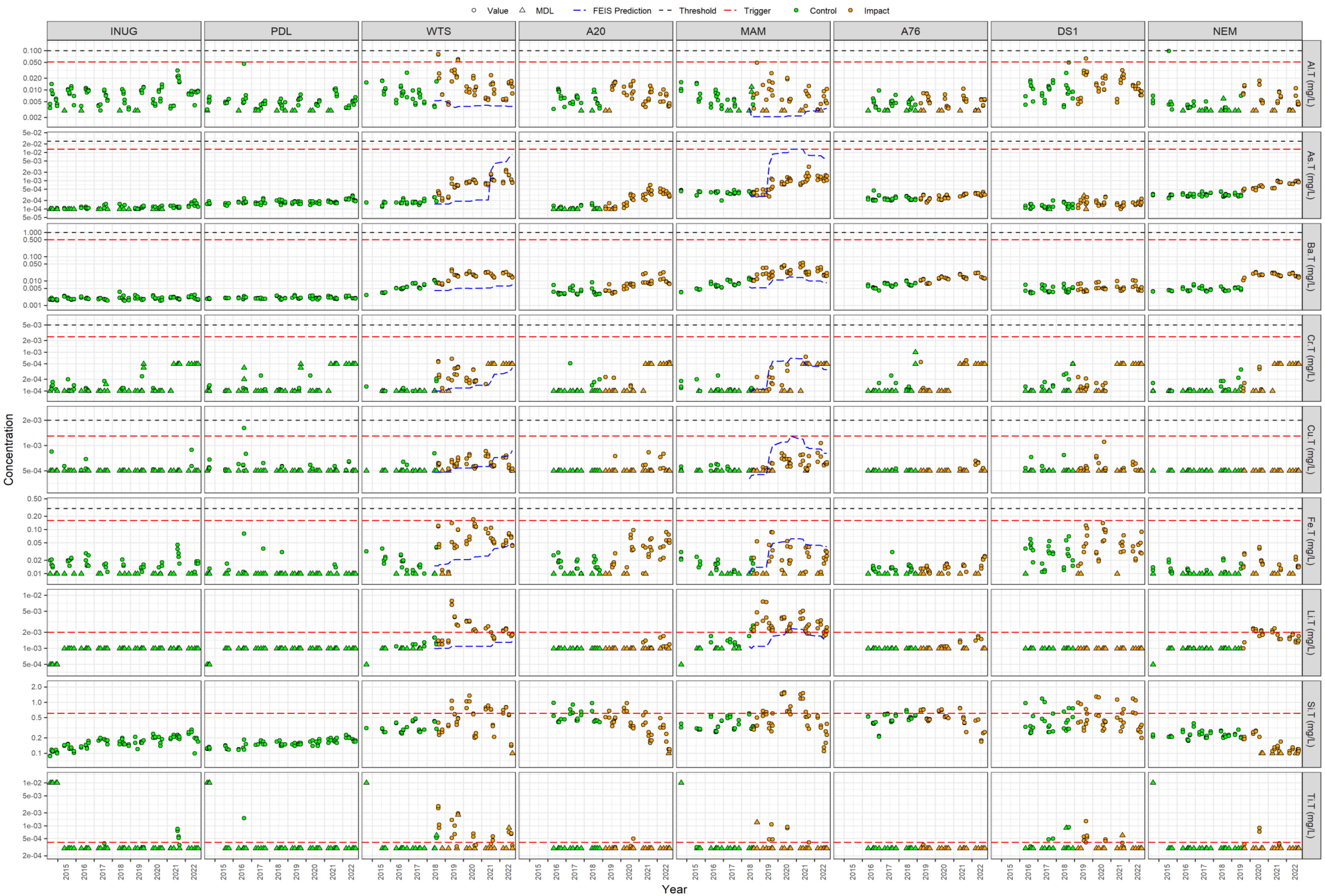
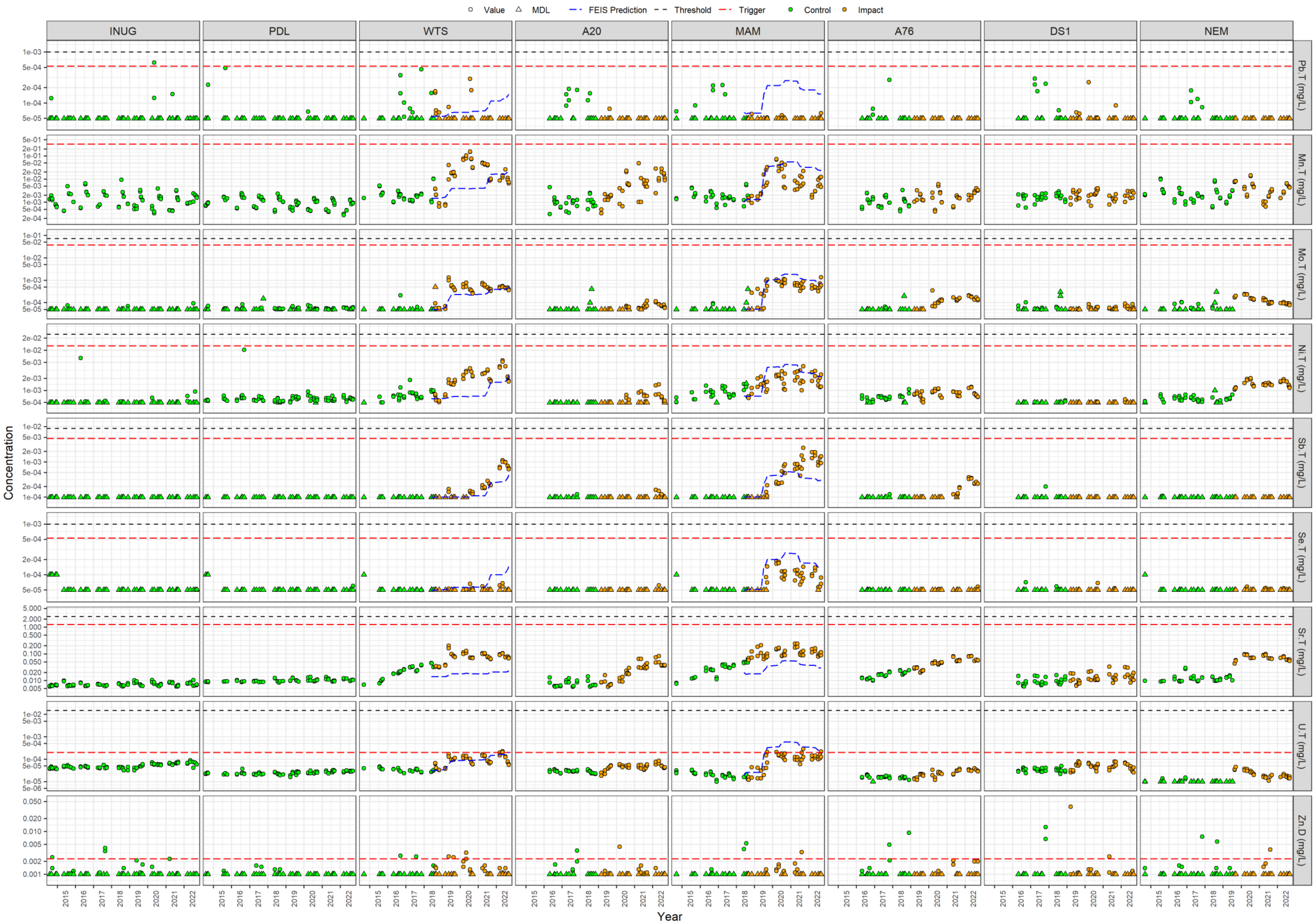


Figure 5-13. Metals measured in water samples from Whale Tail study area lakes since 2014.



Phytoplankton Tables and Figures

Table 5-11. Results of the BACI test for phytoplankton variables at Whale Tail study area lakes, 2022.

Parameter Measured	Test Area	n(B)	n(A)	Estimate	SE	P-value*	Effect size (%)		
							ES	LCI	UCI
Total Biomass	WTS	15	4	0.57	0.33	0.103	77	-12	255
	MAM	16	4	0.28	0.64	0.671	32	-66	411
	A20	14	4	0.82	0.58	0.177	128	-34	685
	A76	14	4	0.55	0.56	0.344	73	-47	469
	DS1	14	4	0.05	0.63	0.935	5	-72	299
	NEM	21	4	0.36	0.49	0.470	43	-48	295
Taxa Richness	WTS	15	4	-0.05	0.10	0.661	-4	-23	19
	MAM	16	4	-0.17	0.21	0.427	-16	-46	31
	A20	14	4	0.15	0.20	0.450	17	-23	78
	A76	14	4	-0.06	0.19	0.774	-5	-37	42
	DS1	14	4	-0.10	0.18	0.590	-9	-37	32
	NEM	21	4	-0.13	0.14	0.364	-12	-34	17

Notes:
* **Bolded** values are P-values < 0.1.
Shaded cells indicate positive (increased) or negative (reduced) effect sizes of 20% or more.
Test area = area compared to control (INUG).
n(B) = number of months in the "before" period.
n(A) = number of months in the "after" period (i.e., in 2022).
Estimate = BACI model estimate of the 2022 change in mean for log-transformed data.
SE = standard error of the estimate.
P-value = two-tailed test of the null hypothesis of no change.
ES = estimated effect size (i.e., 100%*(exp[Estimate]-1)).
LCI = lower 95% confidence interval; UCI = upper 95% confidence interval.

Figure 5-14. Chlorophyll-a (µg/L) in water samples from Whale Tail study area lakes since 2014.

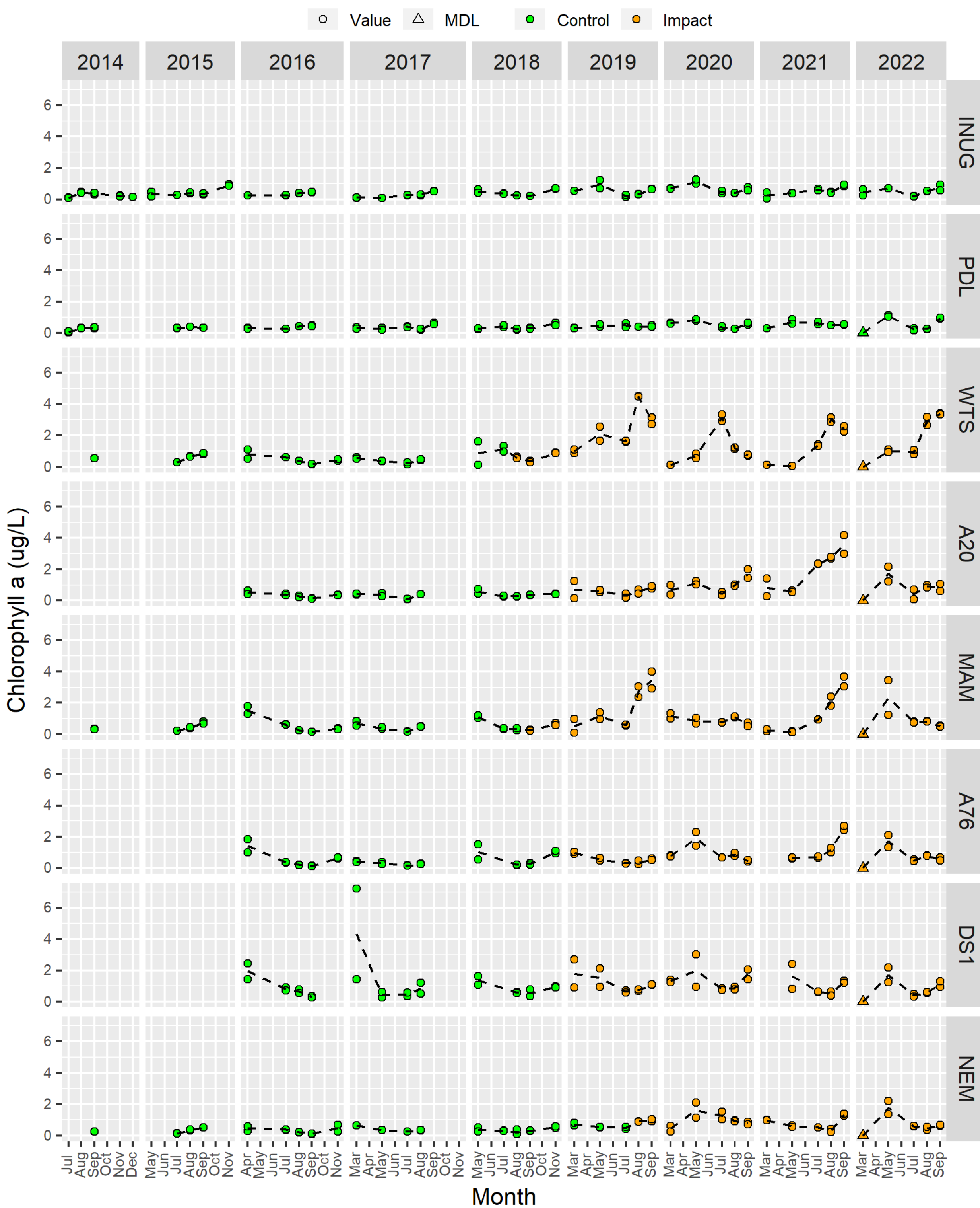


Figure 5-15. Total phytoplankton biomass (mg/m³) from Whale Tail study area lakes since 2014.

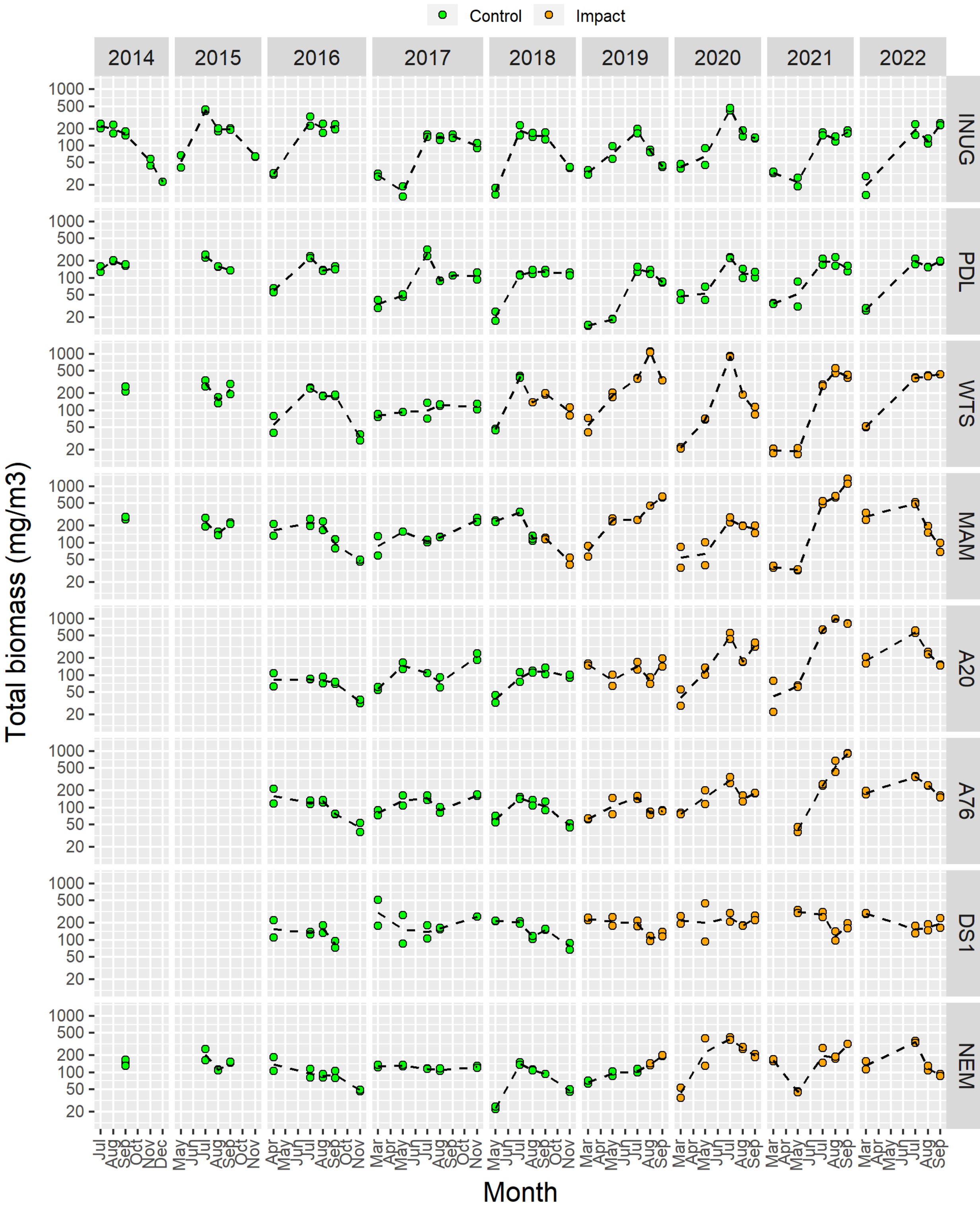


Figure 5-16. Phytoplankton biomass (mg/m^3) by major taxa group from Whale Tail study area lakes since 2014.

Figure 5-17. Relative phytoplankton biomass by major taxa from Whale Tail study area lakes since 2014.

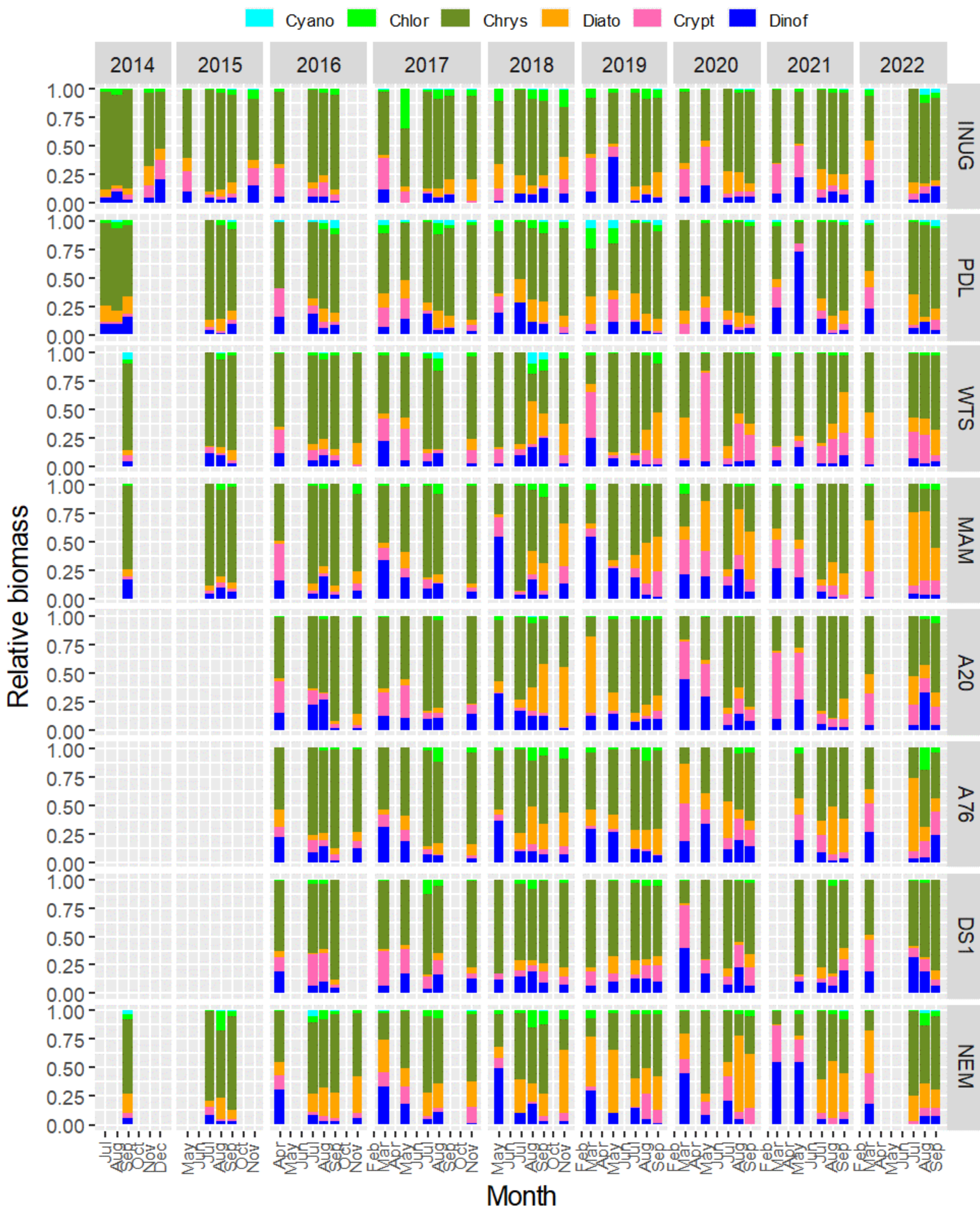
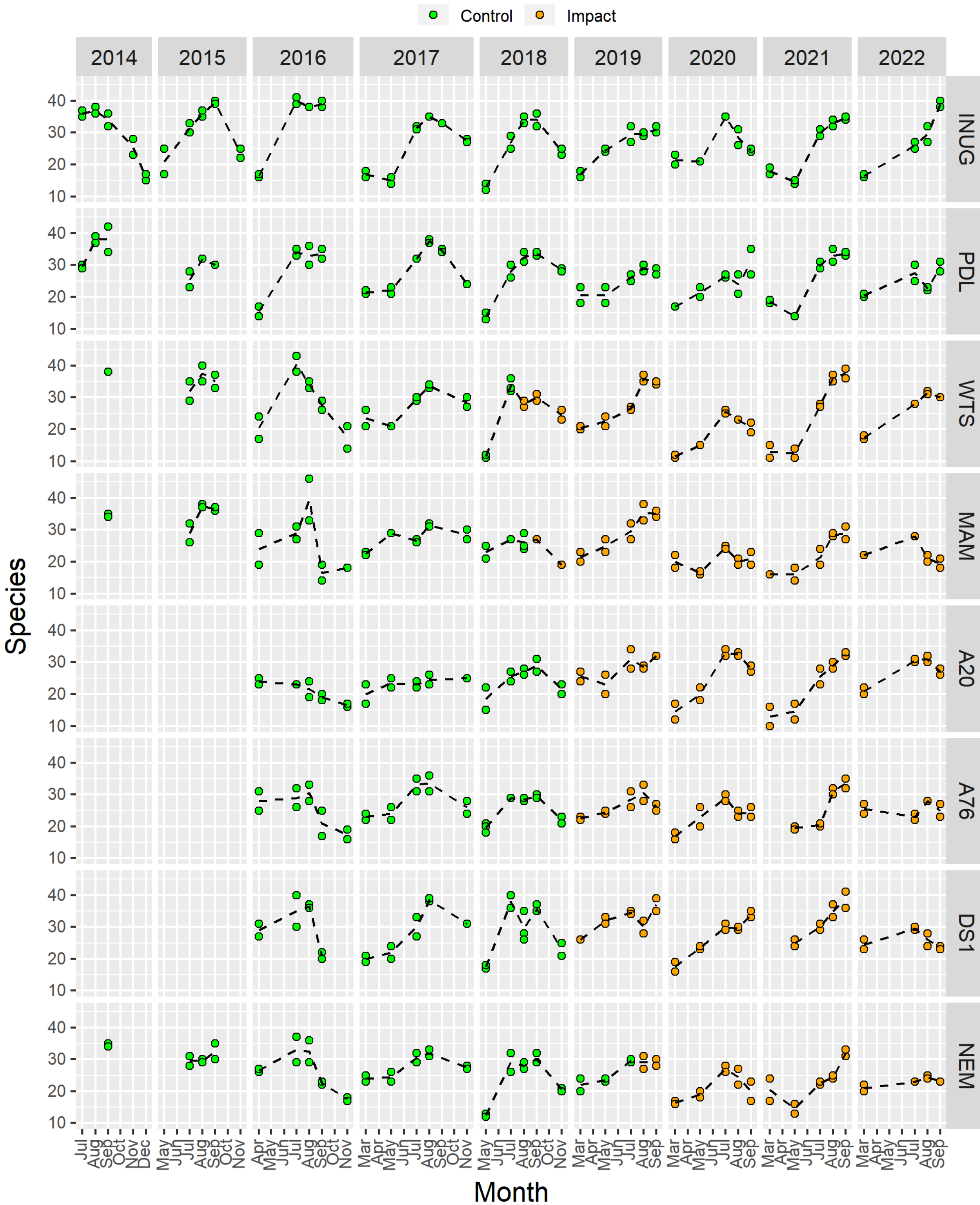


Figure 5-18. Phytoplankton species richness from Whale Tail study area lakes since 2014.



Sediment Chemistry Tables and Figures

Figure 5-19. Grain size composition in sediment from the Whale Tail study area lakes.

Note: In 2021, a batch of sediment samples were not analyzed due to a sample receipt error by the laboratory. Missing results in 2021 correspond to samples that were discarded prior to analysis. In 2022, samples collected at INUG, PDL, and A76 had high water content so grain size composition could not be completed.

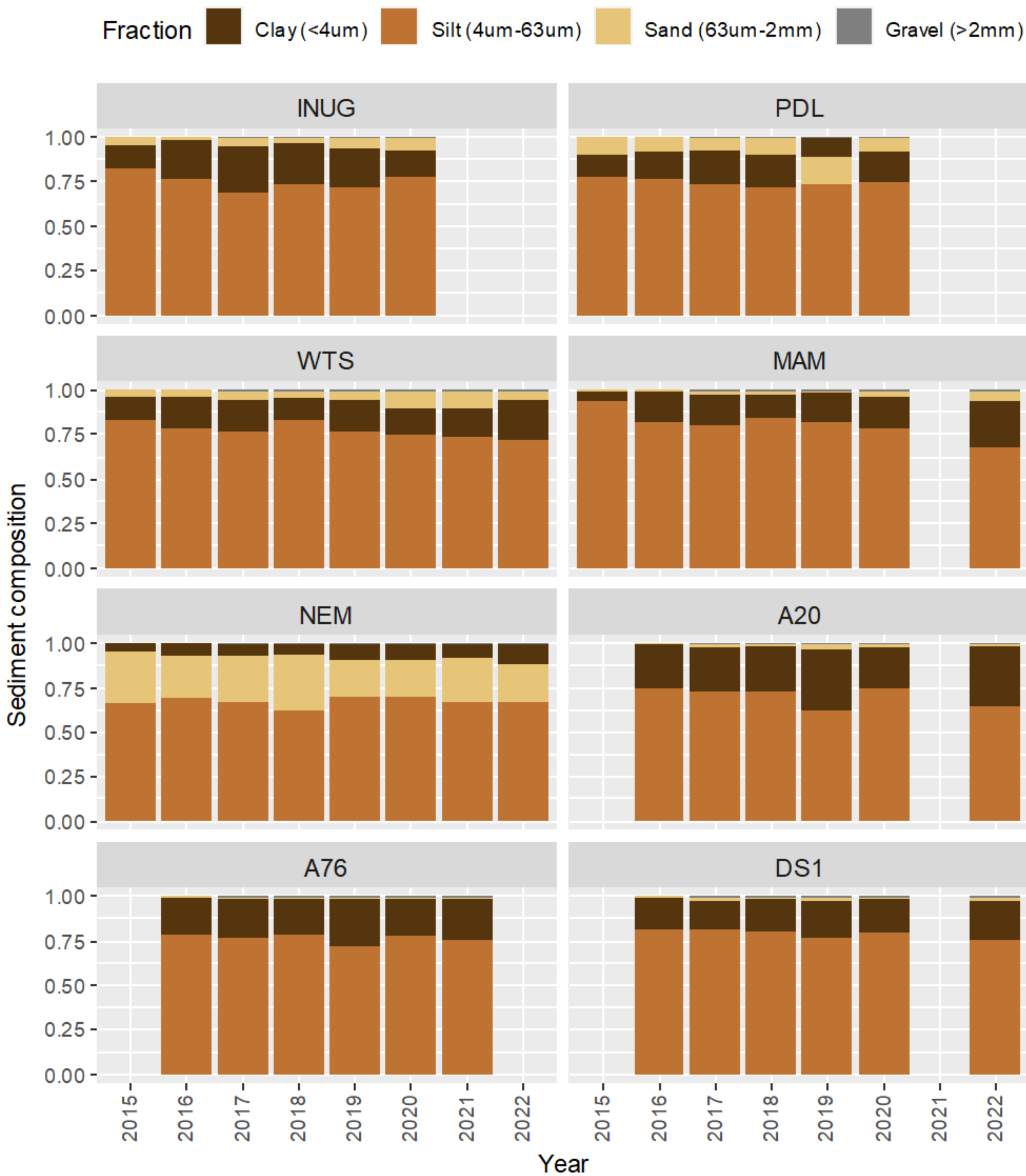


Figure 5-20. Aluminum (mg/kg dw) in sediment samples (grabs & cores) from Whale Tail study area lakes since 2015.

Note: Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines are maximum and/or minimum concentrations, 'x's beyond vertical lines are outlier concentrations.

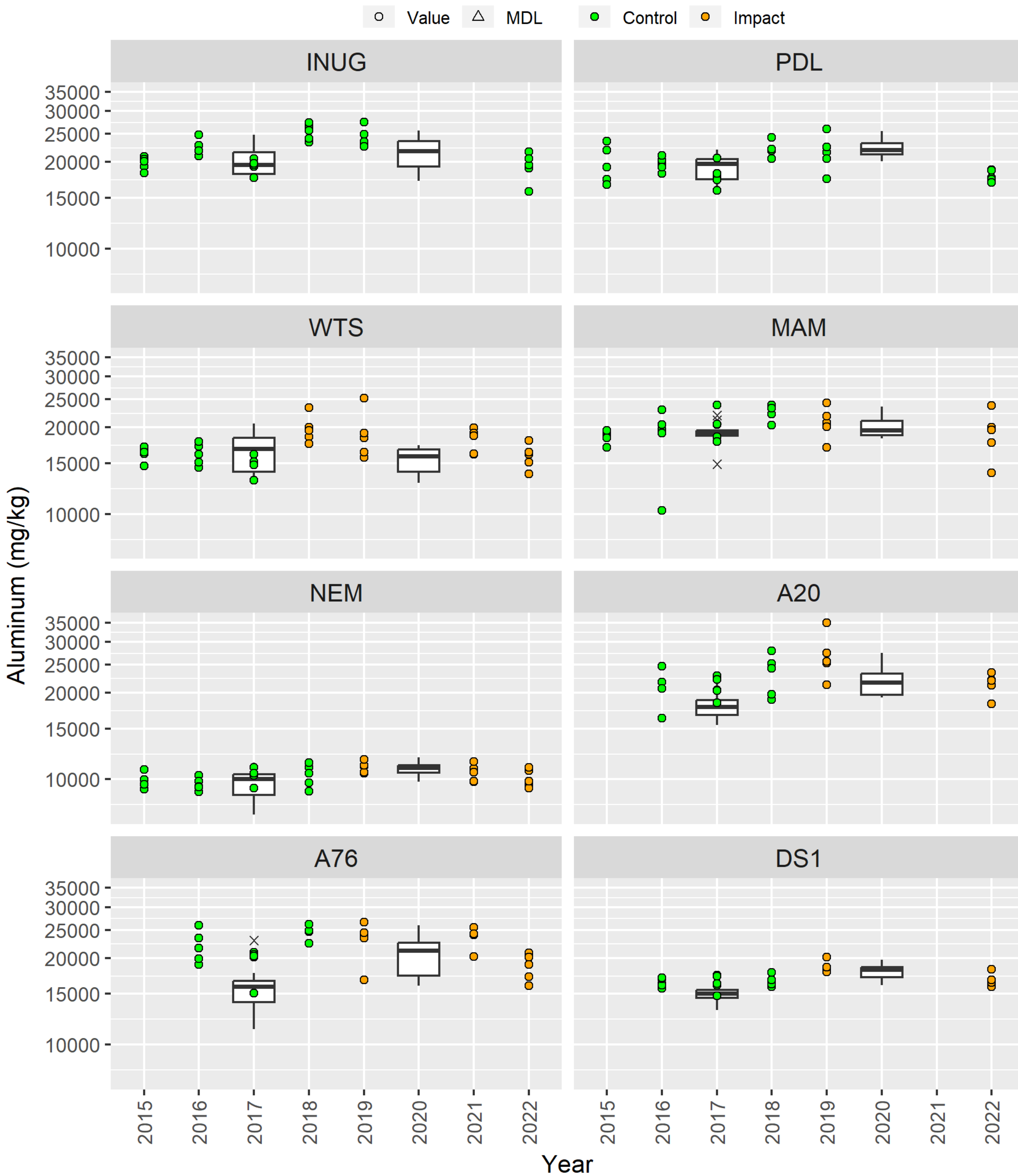


Figure 5-21. Arsenic (mg/kg dw) in sediment samples (grab & cores) from Whale Tail study area lakes since 2015.

Note: The red dashed line represents the trigger value for the Whale Tail study area lakes. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines extend to either the maximum and/or minimum concentrations or up to 1.5 times the interquartile range, with 'x's for any points outside that range.

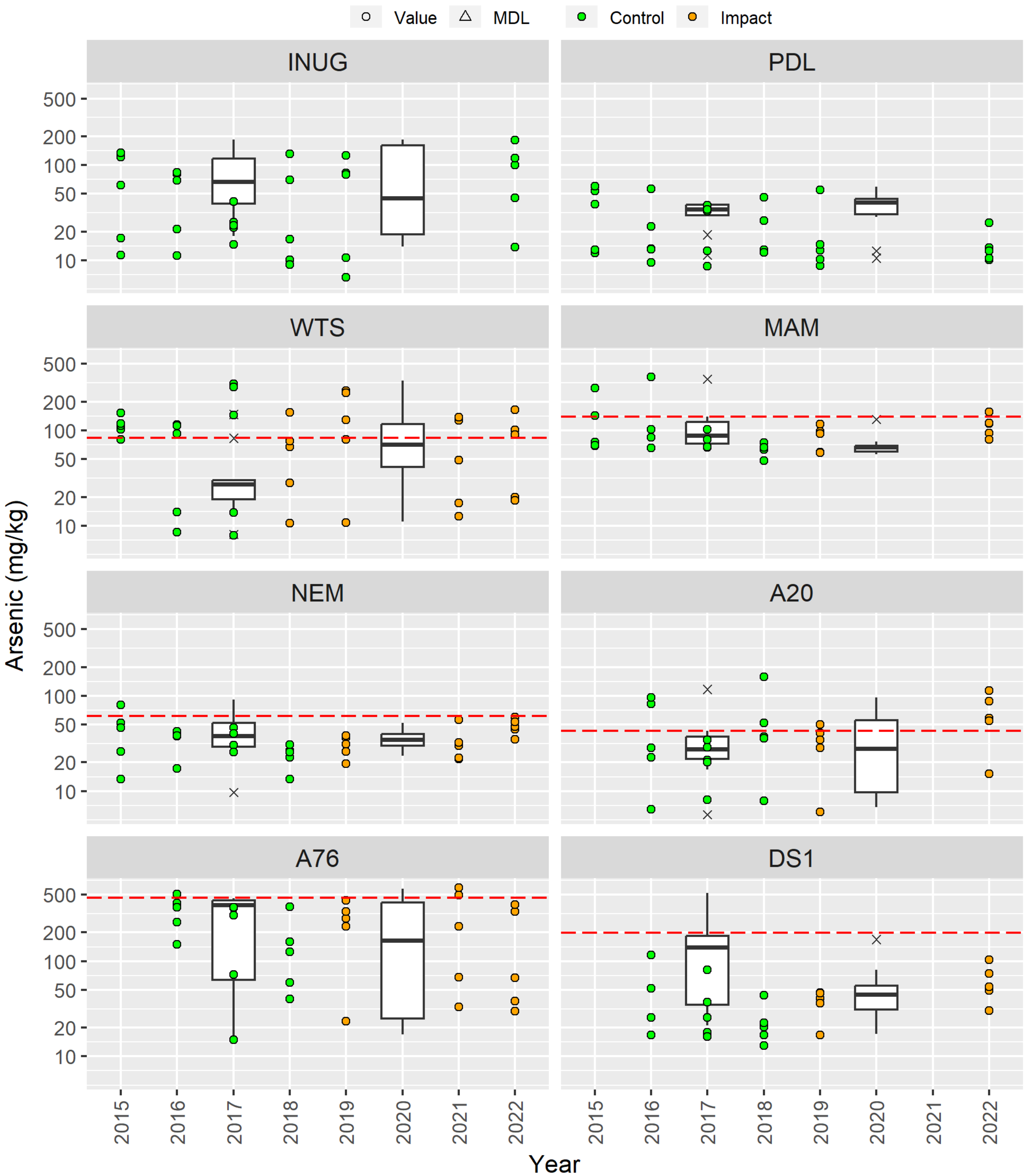


Figure 5-22. Cadmium (mg/kg dw) in sediment samples (grab & cores) from Whale Tail study area lakes since 2015.

Note: The red dashed line represents the trigger value for the Whale Tail study area lakes. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines extend to either the maximum and/or minimum concentrations or up to 1.5 times the interquartile range, with ‘x’s for any points outside that range.

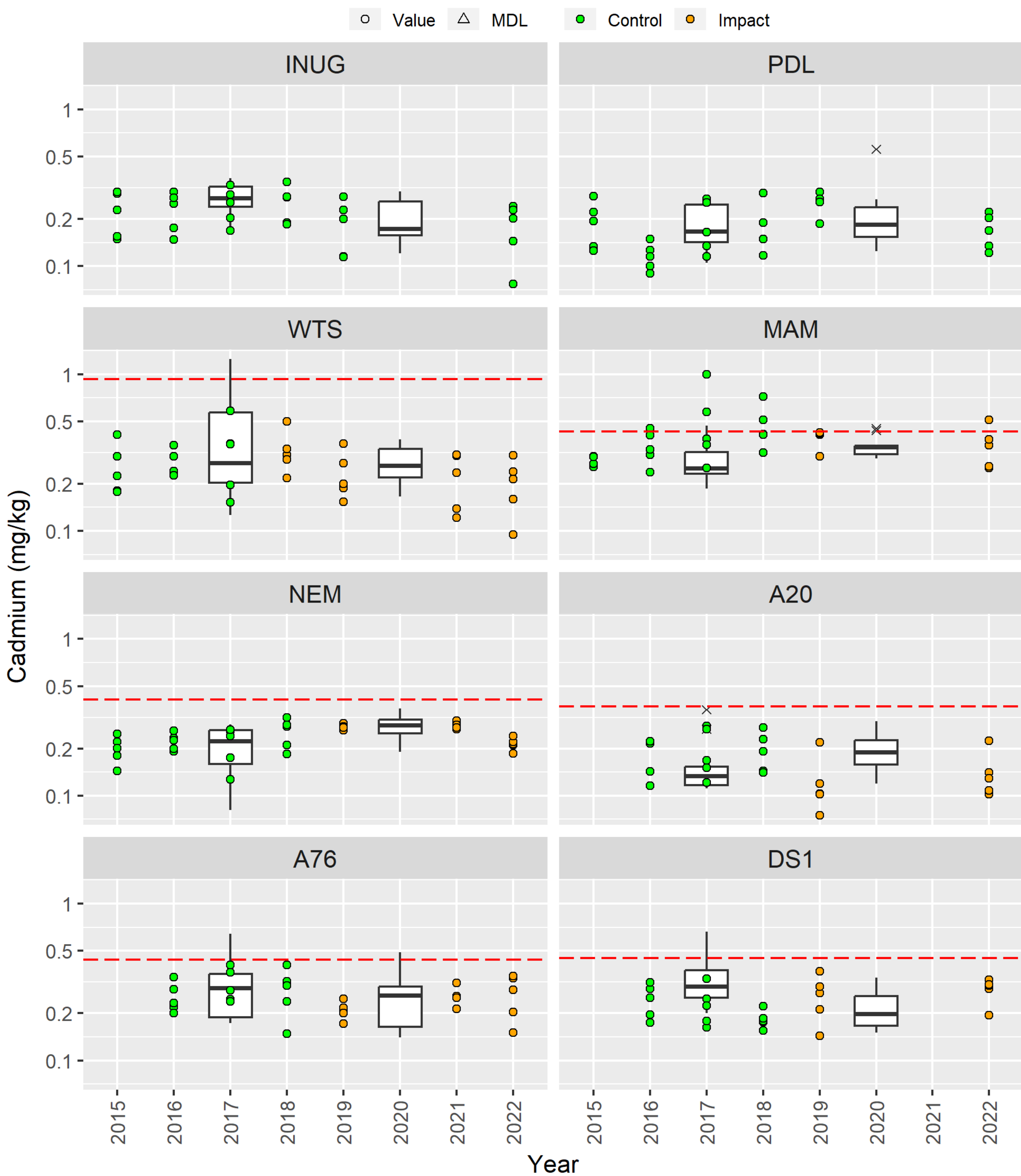


Figure 5-23. Chromium (mg/kg dw) in sediment samples (grab & cores) from Whale Tail study area lakes since 2015.

Note: The red dashed line represents the trigger value for the Whale Tail study area lakes. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines extend to either the maximum and/or minimum concentrations or up to 1.5 times the interquartile range, with 'x's for any points outside that range.

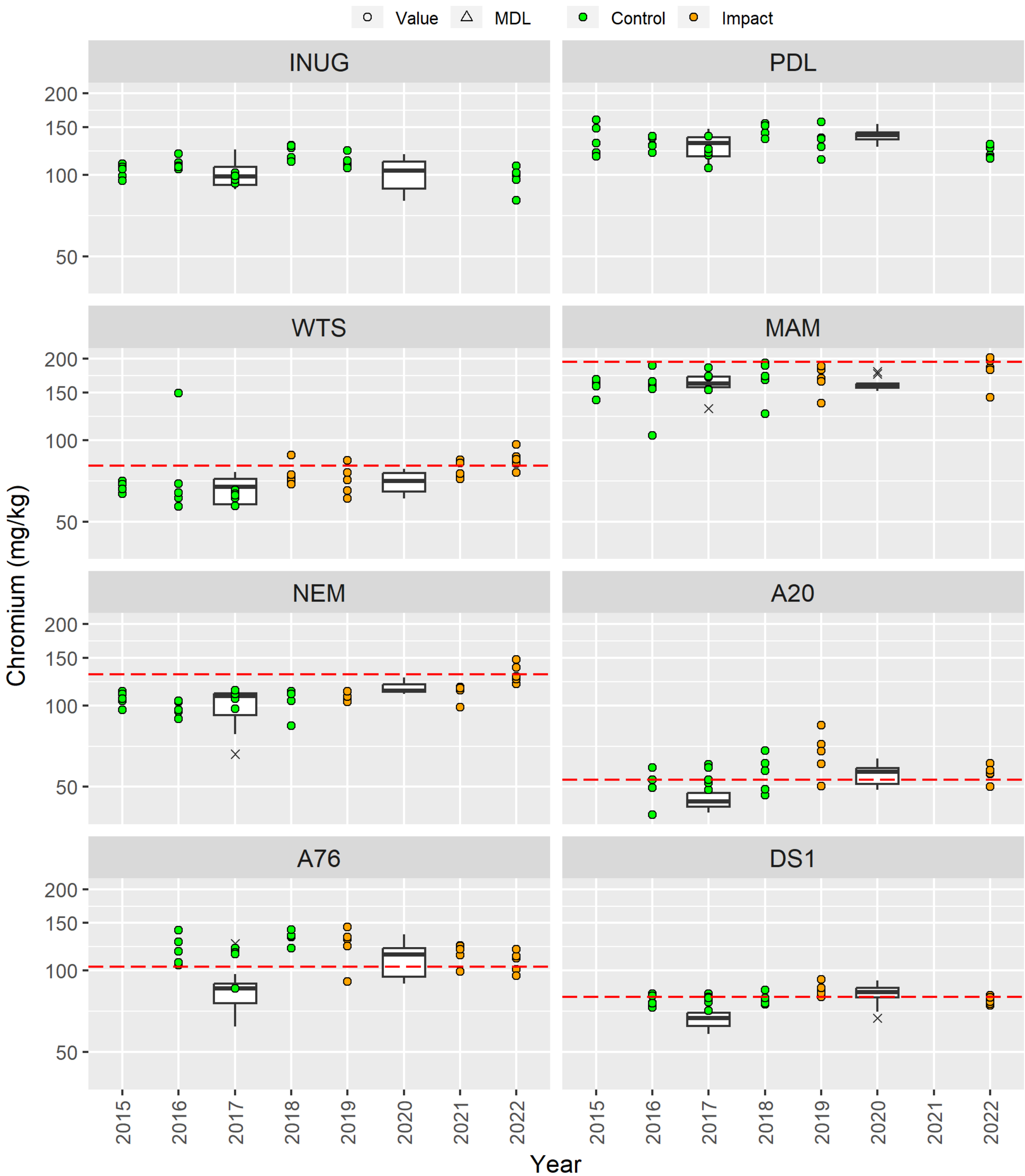


Figure 5-24. Copper (mg/kg dw) in sediment samples (grab & cores) from Whale Tail study area lakes since 2015.

Note: The red dashed line represents the trigger value for the Whale Tail study area lakes. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines extend to either the maximum and/or minimum concentrations or up to 1.5 times the interquartile range, with ‘x’s for any points outside that range.

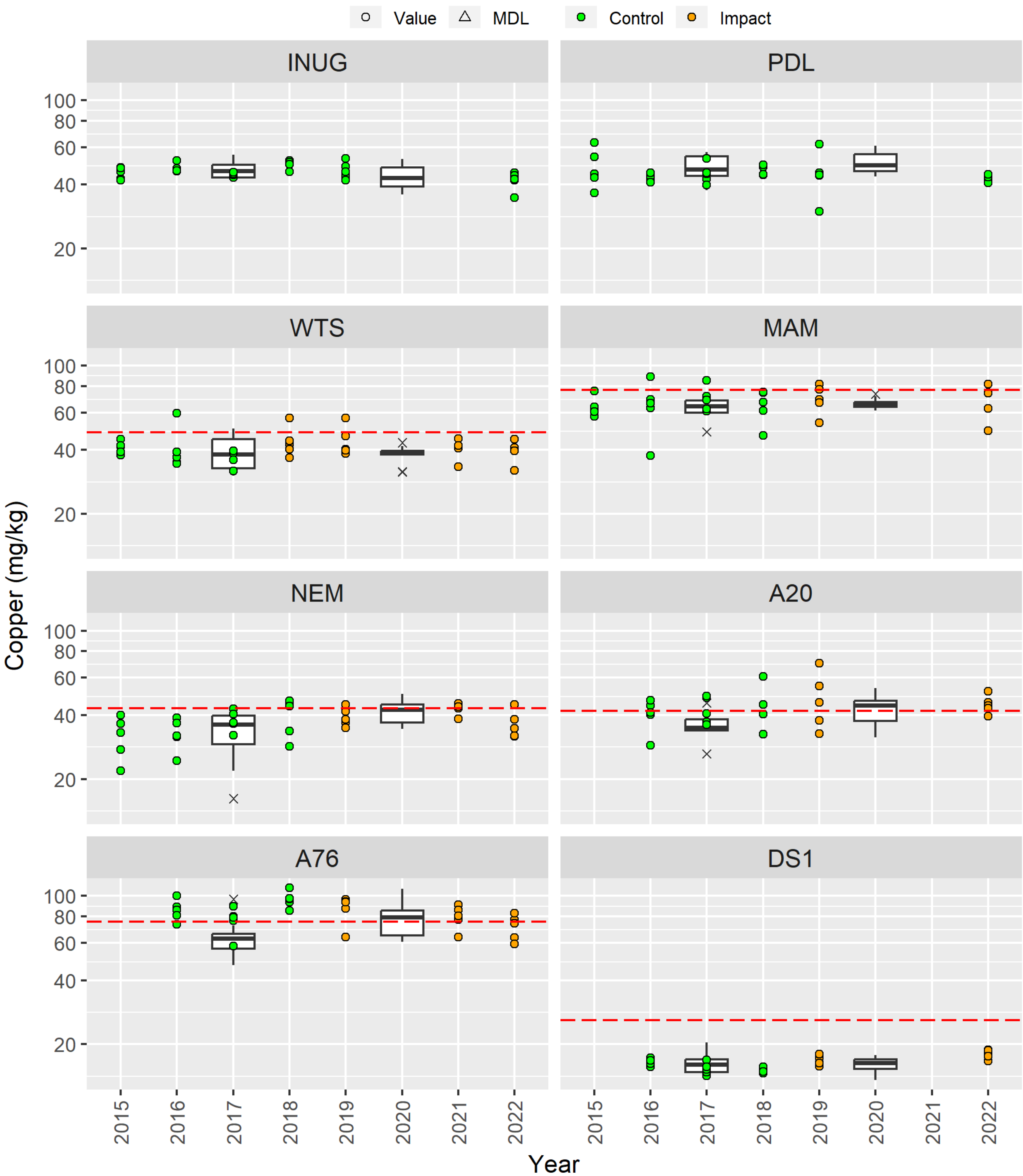


Figure 5-25. Lead (mg/kg dw) in sediment samples (grab & cores) from Whale Tail study area lakes since 2015.

Note: The red dashed line represents the trigger value for the Whale Tail study area lakes. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines extend to either the maximum and/or minimum concentrations or up to 1.5 times the interquartile range, with 'x's for any points outside that range.

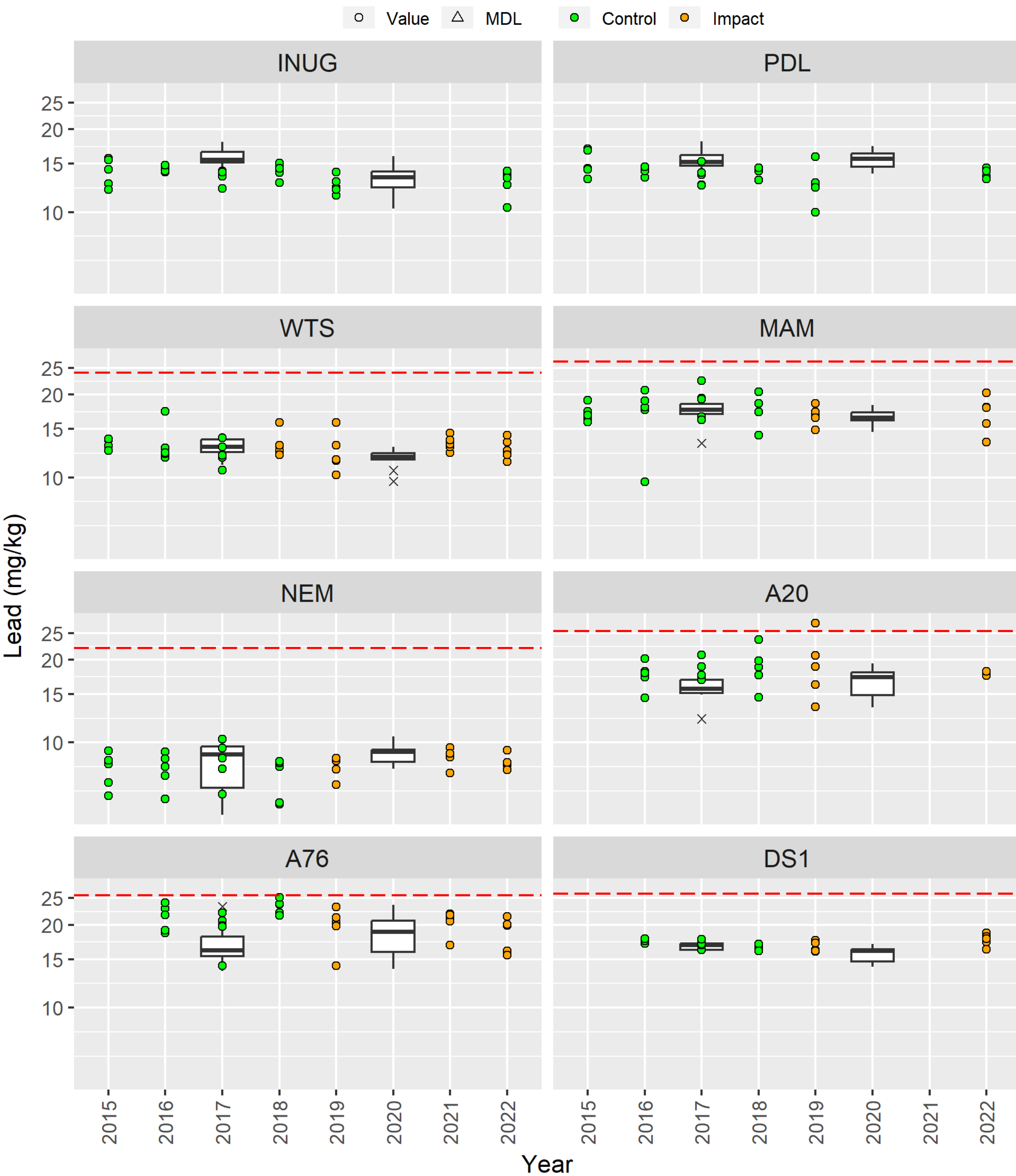


Figure 5-26. Mercury (mg/kg dw) in sediment samples (grab & cores) from Whale Tail study area lakes since 2015.

Note: The red dashed line represents the trigger value for the Whale Tail study area lakes. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines extend to either the maximum and/or minimum concentrations or up to 1.5 times the interquartile range, with 'x's for any points outside that range.

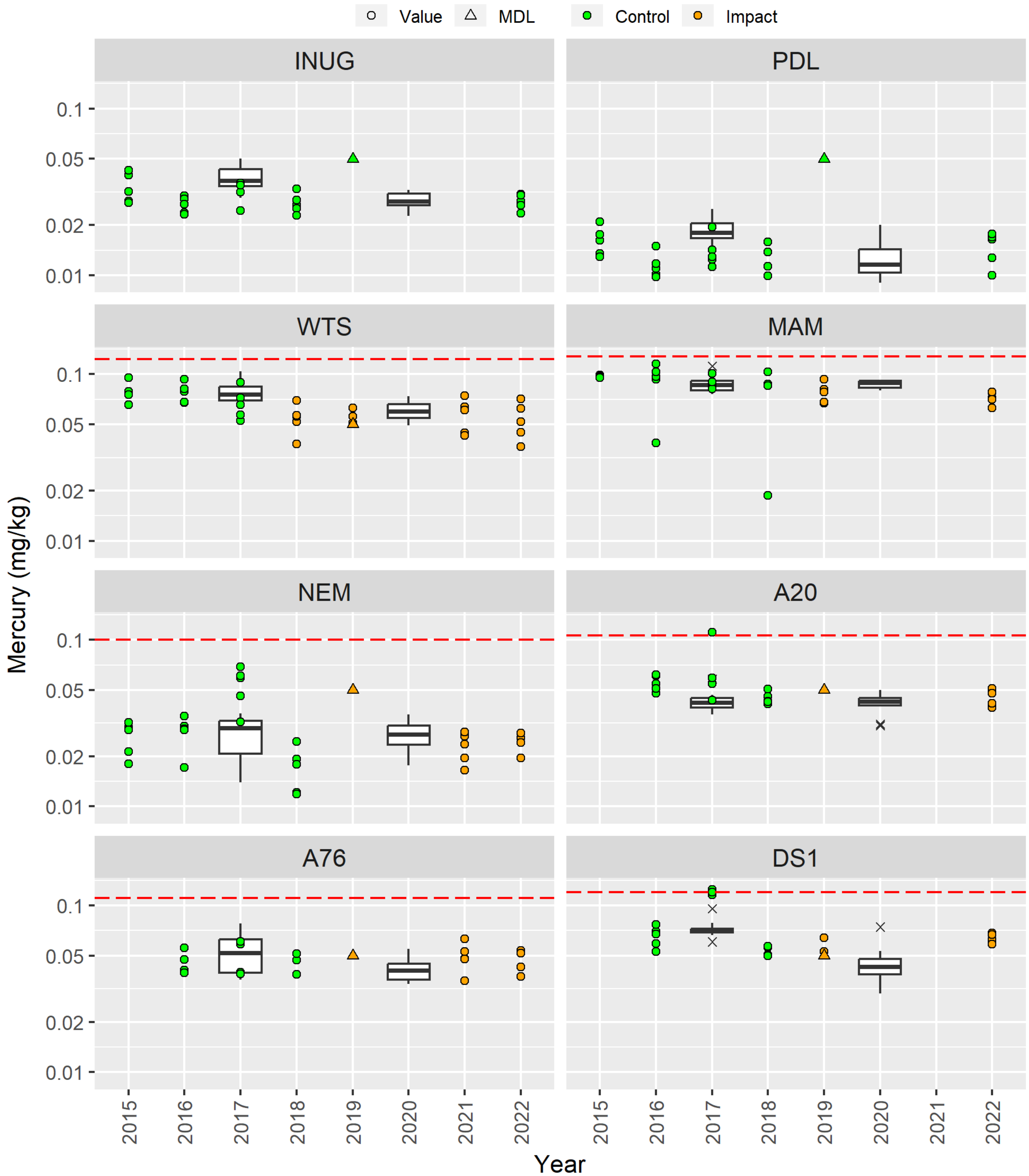
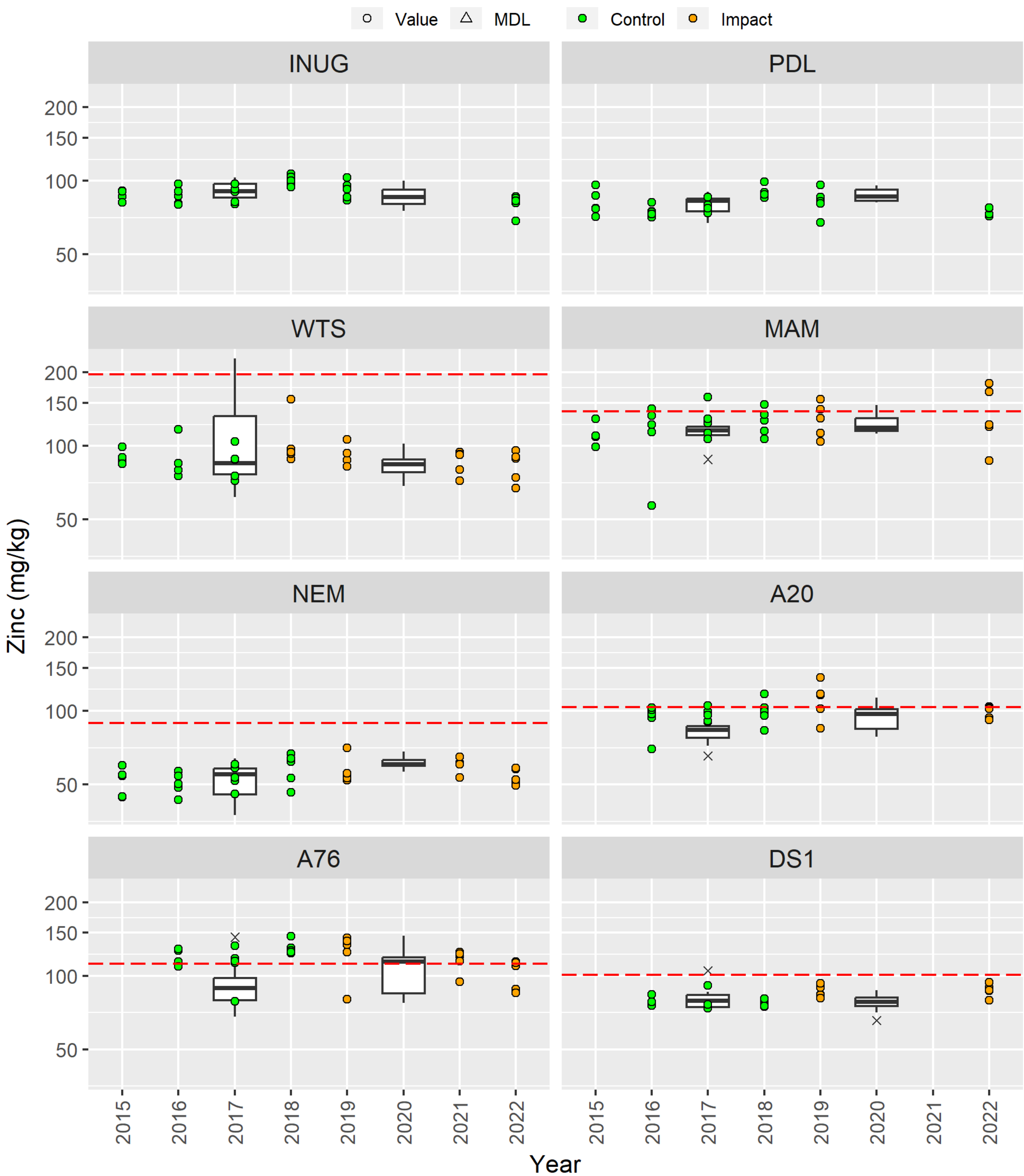


Figure 5-27. Zinc (mg/kg dw) in sediment samples (grab & cores) from Whale Tail study area lakes since 2015.

Note: The red dashed line represents the trigger value for the Whale Tail study area lakes. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines extend to either the maximum and/or minimum concentrations or up to 1.5 times the interquartile range, with 'x's for any points outside that range.



Benthic Invertebrate Tables and Figures

Table 5-12. Geometric means for total abundance and total richness, Whale Tail study area lakes since 2015.

Geometric means for total abundance[1]									
Control/Impact	Area	2015	2016	2017	2018	2019	2020	2021	2022
Control	INUG	1648 (4)	2100 (1)	1712 (3)	1497 (5)	1452 (6)	2055 (2)	1398 (7)	1070 (8)
	PDL	1127 (2)	1373 (1)	748 (8)	779 (7)	990 (3)	951 (5)	829 (6)	963 (4)
Impact	WTS	1675 (8)	2102 (6)	3546 (3)	4005 (2)	2757 (4)	2356 (5)	1911 (7)	5017 (1)
	MAM	3964 (5)	3050 (8)	4236 (4)	3444 (7)	7235 (2)	6133 (3)	3878 (6)	13066 (1)
	A20	NA	2562 (5)	4246 (1)	2793 (3)	2546 (6)	2662 (4)	2146 (7)	3353 (2)
	A76	NA	2525 (6)	6312 (2)	3094 (3)	2823 (4)	2794 (5)	2269 (7)	12072 (1)
	DS1	NA	3090 (2)	1919 (7)	2564 (5)	2205 (6)	2619 (4)	3095 (1)	2969 (3)
	NEM	2897 (4)	2744 (5)	1712 (8)	2708 (6)	5278 (1)	3945 (3)	2374 (7)	4619 (2)

Geometric means for total richness									
Control/Impact	Area	2015	2016	2017	2018	2019	2020	2021	2022
Control	INUG	13 (7)	16 (2)	14 (4)	15 (3)	14 (5)	17 (1)	13 (6)	13 (8)
	PDL	9 (3)	11 (1)	10 (2)	6 (8)	9 (5)	8 (6)	7 (7)	9 (4)
Impact	WTS	15 (4)	15 (3)	15 (6)	18 (1)	13 (7)	15 (5)	11 (8)	15 (2)
	MAM	13 (8)	14 (7)	15 (4)	15 (6)	15 (5)	19 (1)	17 (3)	18 (2)
	A20	NA	14 (6)	13 (7)	15 (4)	15 (5)	18 (1)	17 (2)	16 (3)
	A76	NA	16 (4)	17 (2)	15 (7)	15 (6)	17 (3)	15 (5)	18 (1)
	DS1	NA	12 (5)	15 (2)	14 (3)	14 (4)	10 (7)	11 (6)	16 (1)
	NEM	12 (6)	12 (4)	10 (8)	10 (7)	12 (5)	13 (3)	14 (1)	13 (2)

Notes:
1. Total abundance in organisms/m^2.
Rank order of abundance and richness shown in parentheses.
Red vertical lines mark the year that area designations switched from *control* to *impact.*
NA = Benthic invertebrate sampling was not completed for the given area/year.

Table 5-13. Results of the BACI tests for benthic invertebrate abundance from Whale Tail study area lakes.

After Period	Test Area	n(B)	n(A)	Estimate	SE	P-value*	Effect Size (%)		
							ES	LCI	UCI
2022	WTS	3	1	1.30	0.47	0.11	266	-51	2654
	MAM	4	1	1.76	0.33	**0.01**	479	102	1556
	A20	3	1	0.57	0.37	0.26	76	-64	761
	A76	3	1	1.69	0.59	0.10	440	-57	6716
	DS1	3	1	0.68	0.28	0.14	96	-41	553
	NEM	4	1	1.11	0.31	**0.04**	203	12	717
2021-22	WTS	3	2	0.68	0.48	0.25	98	-57	812
	MAM	4	2	1.01	0.41	**0.07**	176	-12	762
	A20	3	2	0.21	0.31	0.55	23	-54	227
	A76	3	2	0.72	0.74	0.40	105	-80	2034
	DS1	3	2	0.56	0.23	**0.09**	75	-15	261
	NEM	4	2	0.64	0.31	0.10	90	-19	343
2020-22	WTS	3	3	0.42	0.42	0.38	52	-53	388
	MAM	4	3	0.79	0.36	**0.08**	121	-12	453
	A20	3	3	0.03	0.29	0.92	3	-54	134
	A76	3	3	0.33	0.63	0.63	40	-76	707
	DS1	3	3	0.34	0.26	0.26	40	-32	189
	NEM	4	3	0.53	0.29	0.12	69	-19	252
2019-22	WTS	3	4	0.41	0.35	0.30	51	-39	273
	MAM	4	4	0.81	0.30	**0.04**	124	7	370
	A20	3	4	0.02	0.25	0.94	2	-46	93
	A76	3	4	0.23	0.54	0.69	26	-69	408
	DS1	3	4	0.27	0.23	0.29	31	-28	138
	NEM	4	4	0.63	0.26	**0.05**	87	-1	256

Notes:

* **Bolded & underlined** values are P-values < 0.1.

Shaded cells indicate positive (increased) or negative (reduced) effect sizes of 20% or more.

Test area = area compared to control (INUG).

n(B) = number of years in the "before" period.

n(A) = number of years in the "after" period.

Estimate = BACI model estimate of the after-period change in mean for log-transformed data.

SE = standard error of the estimate.

P-value = two-tailed test of the null hypothesis of no change.

ES = estimated effect size (i.e., 100%*(exp[Estimate]-1)).

LCI = lower 95% confidence interval; UCI = upper 95% confidence interval.

Table 5-14. Results of the BACI tests for benthic invertebrate taxa richness from Whale Tail study area lakes.

After Period	Test Area	n(B)	n(A)	Estimate	SE	P-value*	Effect Size (%)		
							ES	LCI	UCI
2022	WTS	3	1	0.16	0.14	0.35	18	-34	110
	MAM	4	1	0.38	0.12	**0.05**	46	-1	115
	A20	3	1	0.28	0.14	0.18	32	-26	137
	A76	3	1	0.30	0.13	0.15	34	-24	137
	DS1	3	1	0.35	0.17	0.17	42	-31	192
	NEM	4	1	0.35	0.13	**0.07**	42	-5	112
2021-22	WTS	3	2	-0.02	0.14	0.91	-2	-37	54
	MAM	4	2	0.32	0.09	**0.03**	37	6	78
	A20	3	2	0.28	0.11	**0.08**	33	-6	88
	A76	3	2	0.16	0.11	0.25	18	-18	69
	DS1	3	2	0.11	0.19	0.60	11	-39	102
	NEM	4	2	0.33	0.09	**0.02**	39	7	81
2020-22	WTS	3	3	-0.07	0.13	0.65	-6	-35	35
	MAM	4	3	0.26	0.09	**0.03**	30	4	62
	A20	3	3	0.24	0.09	**0.06**	27	-1	64
	A76	3	3	0.09	0.12	0.50	10	-22	55
	DS1	3	3	-0.08	0.20	0.71	-8	-47	60
	NEM	4	3	0.22	0.11	0.11	25	-7	66
2019-22	WTS	3	4	-0.07	0.11	0.57	-6	-30	24
	MAM	4	4	0.23	0.08	**0.03**	25	3	52
	A20	3	4	0.22	0.08	**0.05**	24	0	54
	A76	3	4	0.07	0.11	0.52	8	-18	42
	DS1	3	4	-0.03	0.17	0.86	-3	-38	51
	NEM	4	4	0.21	0.10	**0.08**	23	-3	56

Notes:

* **Bolded & underlined** values are P-values < 0.1.

Shaded cells indicate positive (increased) or negative (reduced) effect sizes of 20% or more.

Test area = area compared to control (INUG).

n(B) = number of years in the "before" period.

n(A) = number of years in the "after" period.

Estimate = BACI model estimate of the after-period change in mean for log-transformed data.

SE = standard error of the estimate.

P-value = two-tailed test of the null hypothesis of no change.

ES = estimated effect size (i.e., 100%*(exp[Estimate]-1)).

LCI = lower 95% confidence interval; UCI = upper 95% confidence interval.

Figure 5-28. Benthic invertebrate total abundance (#/m²) from Whale Tail study area lakes since 2015.

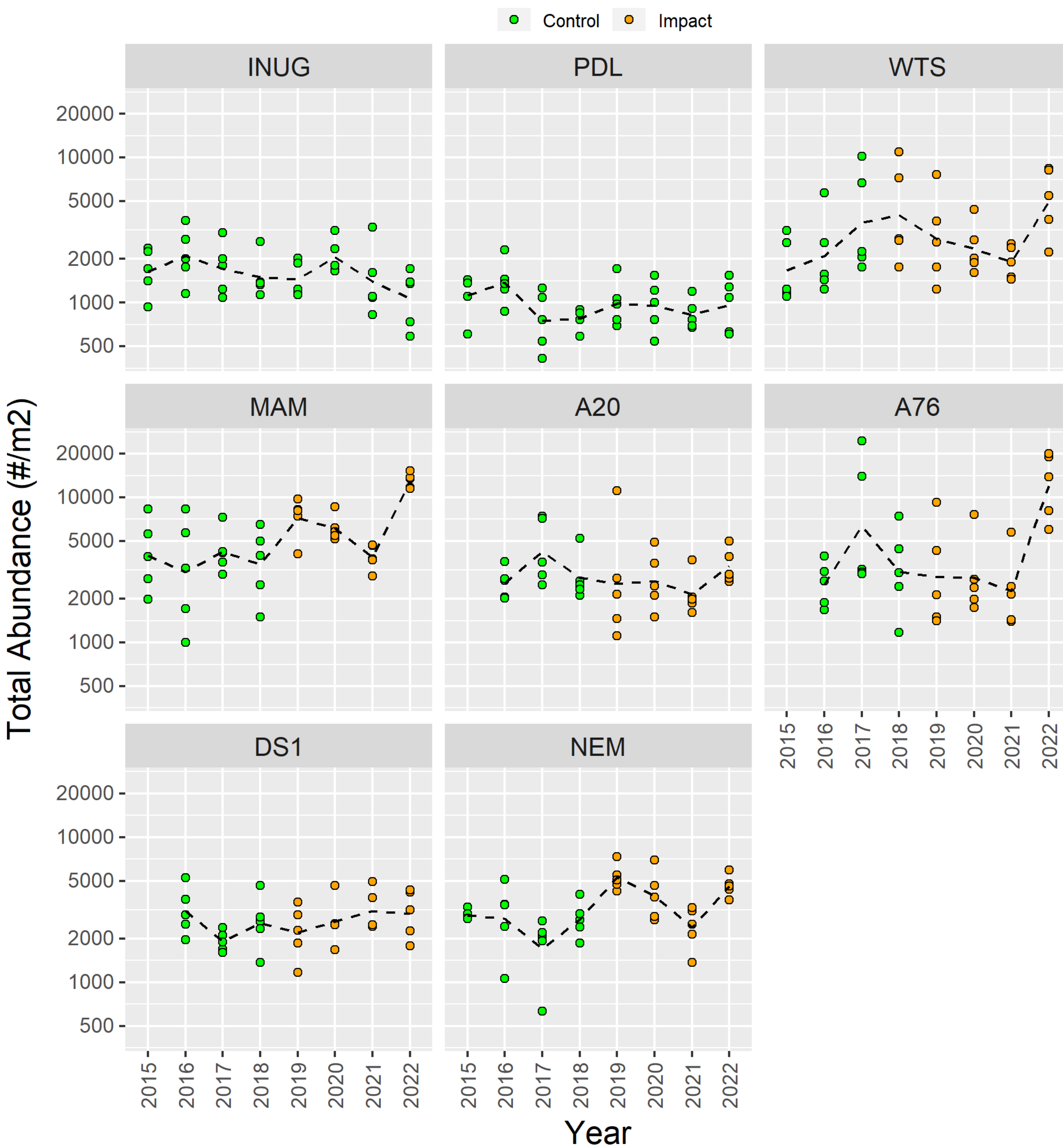


Figure 5-29. Benthic invertebrate abundance (#/m²) by major taxa group from Whale Tail study area lakes since 2015.

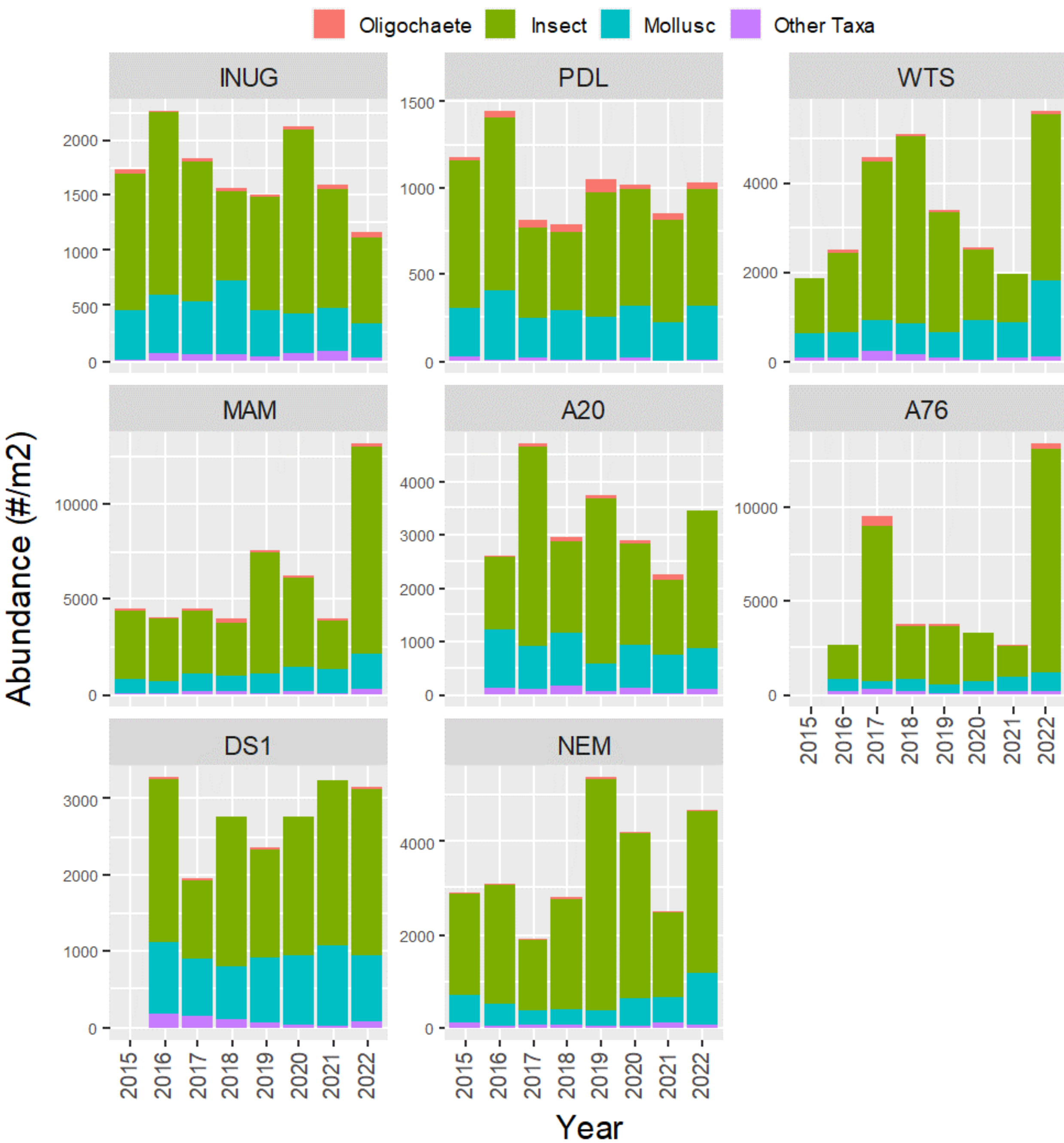


Figure 5-30. Benthic invertebrate relative abundance by major taxa from Whale Tail study area lakes since 2015.

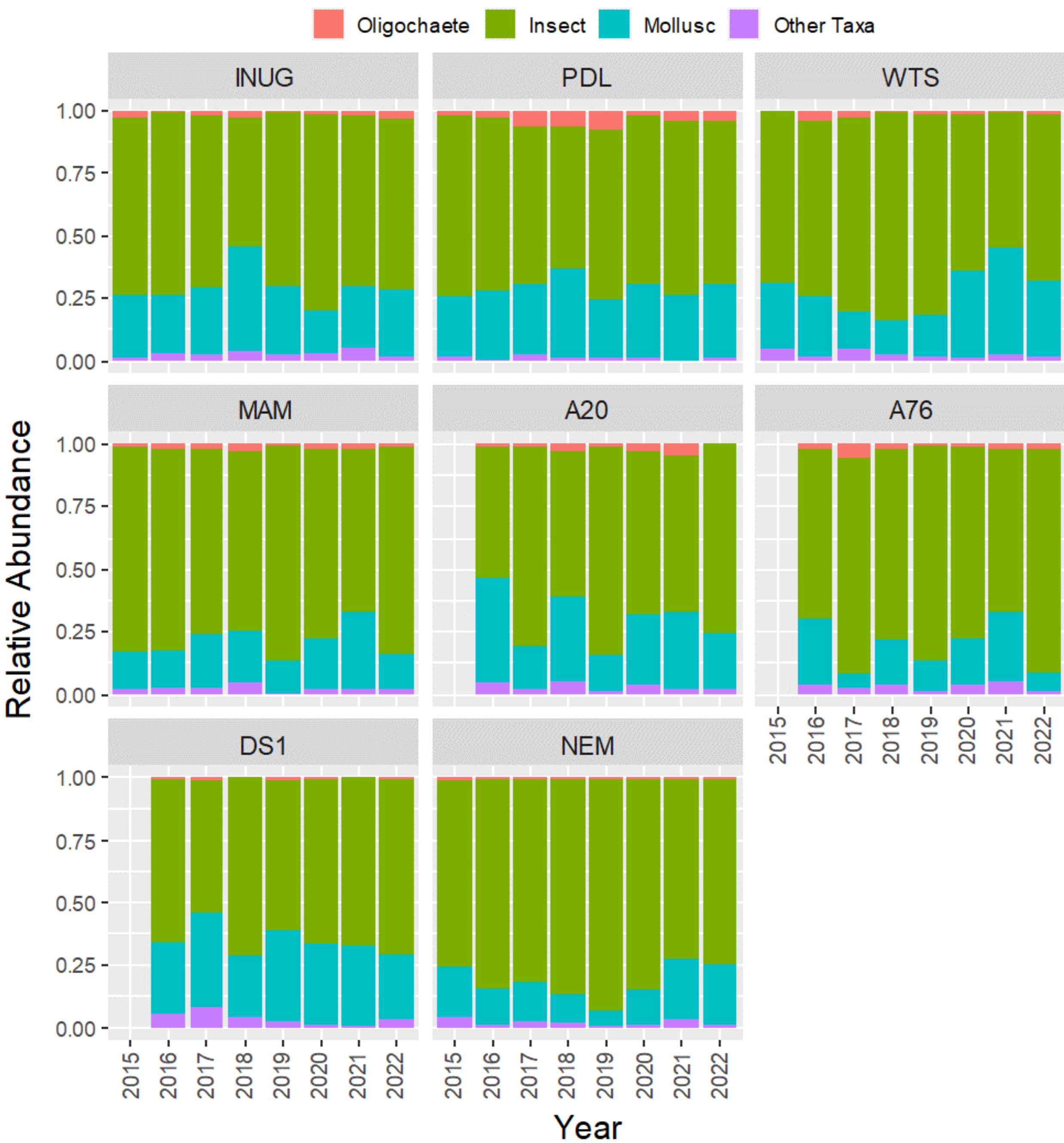


Figure 5-31. Benthic invertebrate total richness (# taxa) from Whale Tail study area lakes since 2015.

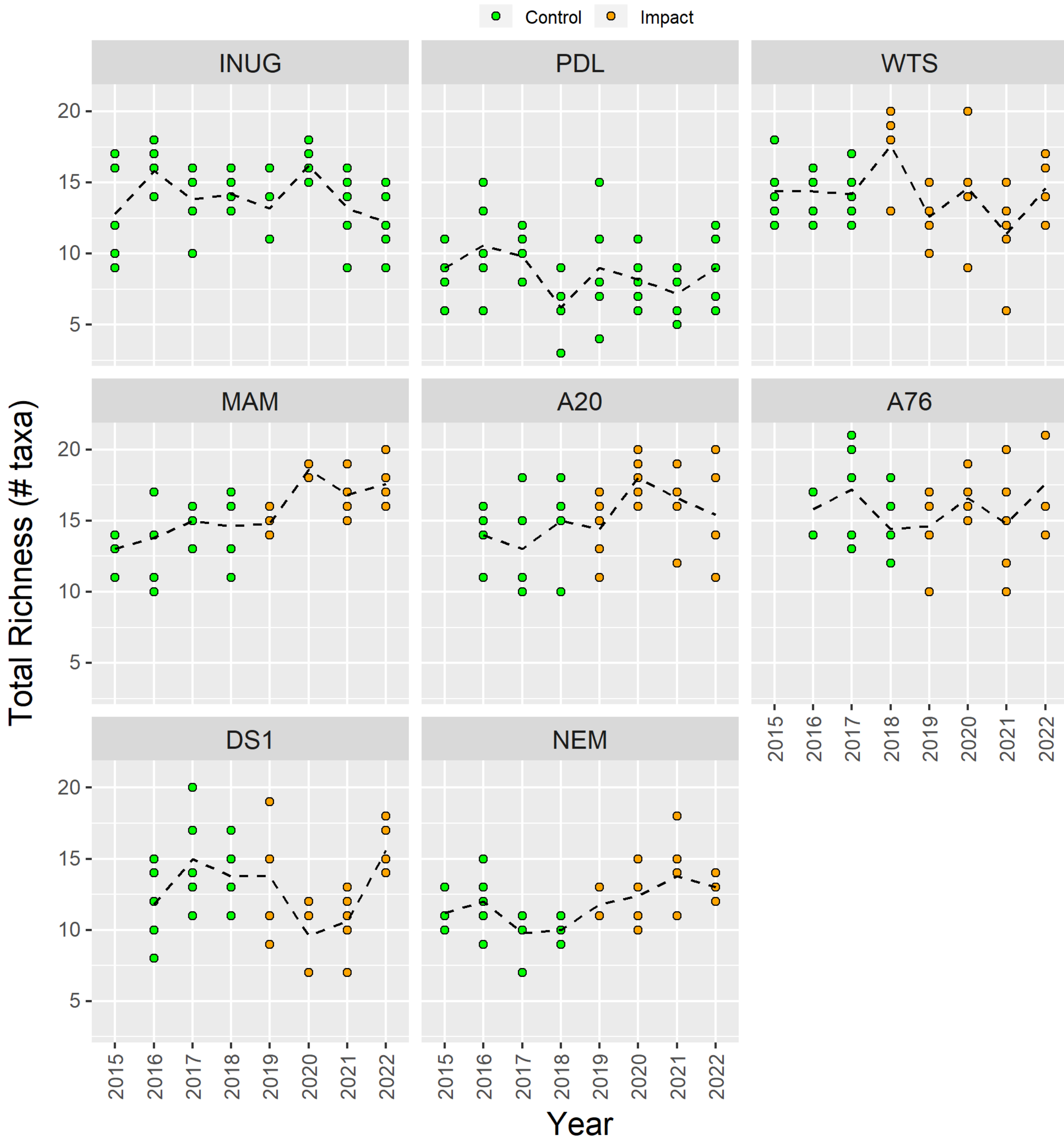


Figure 5-32. Benthic invertebrate richness (# taxa) by major taxa group from Whale Tail study area lakes since 2015.

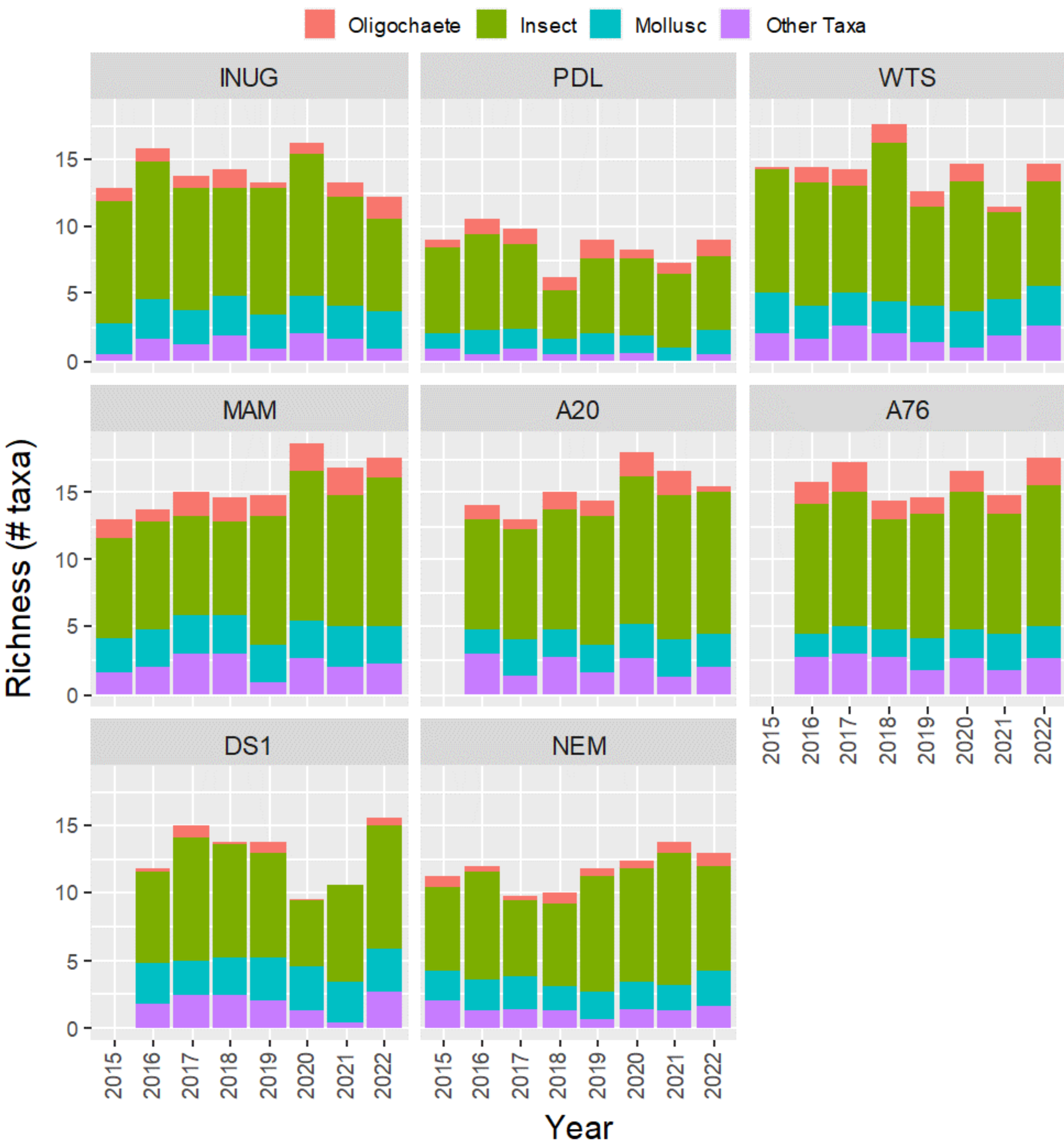
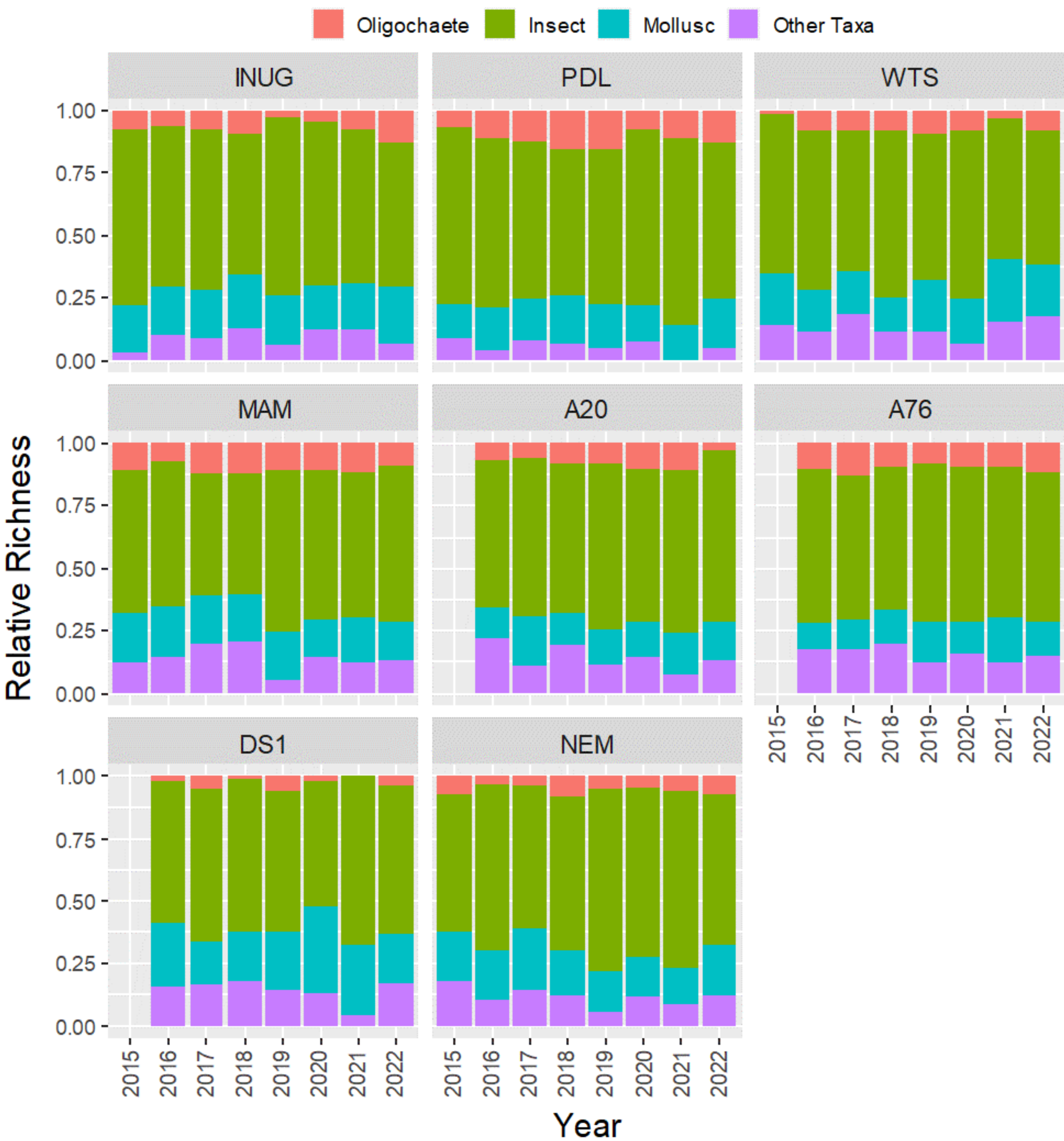


Figure 5-33. Benthic invertebrate relative richness by major taxa from Whale Tail study area lakes since 2015.



6 BAKER LAKE

6.1 Overview of the Baker Lake CREMP

This section summarizes the 2022 CREMP results for water chemistry and the phytoplankton community in Baker Lake. Sediment chemistry and benthos sampling for this study area was not completed in 2022 as per the revised *CREMP Plan Update* (Azimuth, 2022b).

Baker Lake monitoring was added to the core program in 2008 to ensure activities related primarily to barge traffic and shipping in the area were tracked (**Table 1-1**). There are two near-field impact areas, one targeting the hamlet's barge landing area (BBD) and the other Agnico Eagle's fuel storage facility (BPJ). The initial (since 2008) reference area (BAP) is several kilometers to the east of the hamlet along the north shore of the lake. A second reference area (BES) was added in 2011 to provide a broader perspective for temporal patterns in sediment chemistry and benthic community structure (it is not monitored for water quality or phytoplankton community). Sampling locations are shown in **Figure 6-1**.

Barge trips from Chesterfield Inlet to Baker Lake in 2022 numbered 35 for general cargo and 40 for fuel (**Figure 6-2**). With the expansion at the Whale Tail mine, traffic increased in 2018 and 2019 compared to previous years (e.g., from < 40 in 2016 and 2017 to ~ 55 in 2018). Trips were down in 2020 due to COVID 19, but increased sharply in 2021 and remained similar in 2022.

Since monitoring began in 2008, there has been no evidence of impacts to water, sediment, phytoplankton, or benthic communities attributed to barge traffic or other Agnico activities in Baker Lake. As such, sediment chemistry and benthos sampling has been reduced to occur on a three-year cycle beginning in 2023, which coincides with the EEM program.

6.2 Limnology

6.2.1 General Observations

Baker Lake is large with much greater wind fetch than the Meadowbank or Whale Tail study area lakes and has a unique set of limnological characteristics. Factors that contribute to the unique limnology include the lake's proximity to the tidally-influenced Chesterfield Inlet, the influence of the Thelon River, and deep water that is naturally elevated in dissolved solids. These natural complexities interact, leading to the *competing* influences of Thelon River water, which is less-saline and Baker Lake water, which is more-saline. Freshet on the Thelon River coupled with shifts in north/south wind speed and direction lead to variable degrees of horizontal and vertical mixing of the water column. When sampling near the north shore, these factors may combine to confound the detection of potential subtle changes in water quality related to barge activity, with the *signal* getting lost in the *noise* of natural variability in this dynamic location.

Parameters associated with more-saline or higher conductivity water that appears to be present in deep water (>10–15 m) and which demonstrate considerable fluctuations within and between years include conductivity, hardness, calcium, chloride, magnesium, sodium, and TDS. Other parameters that have a high level of natural variability and appear to be correlated with these deep-water parameters in Baker Lake include ammonia, nitrate, TKN, total phosphorus, sulphate, and TOC/DOC. A deep limnology survey was conducted in August 2012 to explore this situation specifically. While it provided a single *snapshot* of this dynamic limnological process, all parameters measured (temperature, conductivity, dissolved oxygen, pH, total dissolved solids, and salinity) showed a strong and abrupt stratification from 8–12 m depth at areas BBD 1 and 2, and BPJ. For example, conductivity increased from <20 µS/cm in shallow, near-shore water, to >200 µS/cm between 8 and 12 m, depending on location. Conductivity remained uniformly high to the maximum depth sampled (40 m). The implication of this is that results for any event will reflect the relative influence of the deeper, brackish Baker Lake water and the less-saline Thelon River water on the day of the event.

6.2.2 Temporal and Spatial Trends

In addition to the Thelon-Baker influence, several other factors have potential to affect the limnology. Seasonal barge traffic is the major mine-related activity in the area, occurring during the summer months when Baker Lake is ice-free. The hamlet of Baker Lake's sewage lagoons and landfill are situated in a watershed that discharges seasonally into Baker Lake between BBD and BPJ. And locally, propeller wash may cause vertical mixing in very discrete areas when there is active traffic. Otherwise, except for spills and occasional discharge from commercial vessels etc., no other activities have the potential for altering limnological parameters.

Limnological conditions at Baker Lake are similar to the Meadowbank study area lakes, except that water temperatures are cooler, typically reaching no more than 10°C in mid-summer. Mean temperatures at all locations ranged between 5.4 and 9.5°C (**Figure 6-3**).

In 2022, summer stratification is visible to varying degrees in August at each of the Baker Lake sampling areas. The August profile from BBD demonstrated the strongest thermal and saline stratification patterns due to its proximity to the Thelon River, similar to previous years. Warmer freshwater transitioned to colder saline water over a thermocline at approximately 2m. This pattern progressively diminishes moving away from the river mouth at BPJ and BAP (**Figure 6-4**).

Although vertical stratification was absent from the July and September profiles, the relative influence of low salinity Thelon River water and Baker Lake deep water can be observed throughout the open-water season (**Figure 6-4**). In September, BAP (furthest east from the Thelon River outflow) was influenced least by freshwater, while BPJ tended to follow more closely with the patterns observed at BBD.

6.3 Water Chemistry

6.3.1 General Observations

As discussed in **Section 6.2**, Baker Lake is large and exposed to high winds and wind-generated currents. Adding to the complexity, monitoring areas along the north shore are exposed to two different water masses: the less-saline Thelon River, which discharges into Baker Lake at its western end, and the saline-influenced deeper water in Baker Lake. Depending on wind speed and direction, water from these two sources (e.g., individually or mixed) can strongly influence some surface water chemistry parameters (conductivity, salts, and dissolved solids). Consequently, certain parameters can display pronounced spatial (horizontal and vertical) and temporal variability. This variability is evident mainly in the *conventional* parameters (described above); in contrast, concentrations of metals in the Baker Lake samples are typically below laboratory MDLs.

On June 7th2022, turbid water runoff was observed flowing from the Marshalling Facilities towards the Baker Lake shoreline. Silt fences and wood-chip booms were used to intercept flows. There were no elevated concentrations of total suspended solids (TSS) observed in Baker study areas in the subsequent sampling events in July and August (**Figure 6-5**).

6.3.2 Temporal and Spatial Trends

CREMP monitoring results since 2008 were used to assess temporal and spatial trends related to mining activities (**Table 1-1**). The general rationale for assessing these trends discussed in **Section 1.5** was tailored slightly for the water chemistry assessment in Baker Lake, as described below.

Baker Lake water chemistry results for 2022, screened against site-specific triggers and effects-based thresholds, are tabulated in **Appendix B3**. Most water quality parameters in Baker Lake, across all years, are routinely below laboratory MDLs, similar to the results for the Meadowbank study lakes. Data screening at Baker Lake followed the same methodology as Meadowbank and Whale Tail (**Section 2.3.1**) except that matching patterns in mining activity was not conducted as it is not relevant to this study area.

The results for all parameters that were screened into the assessment process are summarized in **Table 6-1** and plotted in **Figure 6-5** through **Figure 6-9**. The red dashed line in each of these figures is the trigger value specific to Baker Lake for that parameter[28]. All parameters not retained for the trend assessment were assumed to have no spatial or temporal trends related to barge activities or to natural

[28] See Appendix I in the 2019 CREMP report (Azimuth, 2020a) for details on trigger updates and derivation for Baker Lake.

variability and were excluded from further consideration (for completeness and transparency, plots for these parameters are included in **Appendix B3**).

During the three sampling events in 2022 (July, August, September) ortho-phosphate, TOC, and DOC exceeded trigger values. However, ortho-phosphate only marginally exceeded the trigger during one sampling event in September at BJP when concentrations were also elevated at reference station BAP. Mean annual TOC and DOC concentrations exceeded their respective trigger values at both impact areas (BBD, BPJ) in 2022. These same parameters also exceeded triggers at the reference area BAP (**Figure 6-5**). Mean annual concentrations for no other parameters exceeded triggers at Baker Lake. The BACI analysis showed that increases in TOC and DOC were not significantly different from reference area BAP (**Table 6-3**).

Across all three areas (BBD, BPJ, BAP), similar temporal trends occurred for the carbon parameters in 2022. TOC concentrations at each sampling area peaked at a similar concentration (4.5 mg/L) in August and DOC concentrations were similarly elevated above the trigger in all three sampling events. The common patterns suggest that TOC and DOC concentrations are being influenced by regional environmental factors. If local anthropogenic activities were impacting TOC/DOC a distinct signature would be expected at impact areas (BBD, BPJ) compared to the reference area BAP.

Mean annual TOC/DOC concentrations have increased at all three Baker Lake sampling areas since 2018 and there are indications that longer term increasing trends may be occurring. Similar patterns also exist between Baker Lake and the Meadowbank study area lakes (**Figure 4-9**). In 2012, a peak in TOC and DOC at all three Baker Lake stations corresponded to peaks across the Meadowbank study area lakes. The similar patterns observed across the study areas suggests that regional climactic factors, rather than mining activity, may be responsible for changes in TOC/DOC concentrations. The idea of a regional change is supported by various studies examining the effects of climate change on organic carbon fluxes in Arctic rivers and lakes. Permafrost thawing, primary production, increased precipitation, and atmospheric deposition have all been identified as contributing to enhanced organic carbon flux (Nguyen et al., 2022; Stolpmann et al., 2021).

The increase in TOC and DOC at Baker Lake appears to be related to natural causes and is not related to Agnico Eagle’s activities in Baker Lake. There are no follow-up measures for management beyond routine CREMP water quality sampling during the open-water season.

6.4 Phytoplankton Community

6.4.1 General Observations

The phytoplankton community of Baker Lake is relatively similar to the Meadowbank study area lakes, despite some seasonal differences in water quality due to the competing influences of less saline water from the Thelon River and more saline water from the deeper portion of Baker Lake (see **Section 6.2**). Taxonomic composition and biomass in Baker Lake were similar to the Meadowbank study lakes, with chrysophytes (golden algae, e.g., *Chrysococcus, Kephyrion, Dinobryon*) having been the dominant taxonomic group since monitoring began in 2008. Mean summer phytoplankton biomass in Baker Lake is generally similar to the Meadowbank study area lakes, reaching a maximum between 200 to 300 mg/m^3.

6.4.2 Temporal and Spatial Trends

Sampling at the Baker Lake areas is only conducted during the summer open-water period, which coincides with barge activity. Because of Baker Lake's large size, it is unlikely that barge traffic (in the absence of a substantial fuel or chemical spill) could influence the phytoplankton community of the whole lake.

The 2022 density and biomass results for phytoplankton are tabulated in **Appendix D3**. The results for the BACI model statistical tests of the 2022 results against baseline/reference conditions are provided in **Table 6-4**. Major findings at Baker Lake areas in 2022 for chlorophyll-a, total biomass, taxa richness, and group composition of major taxa were as follows:

- **Chlorophyll-a** – Concentrations at reference area BAP historically ranged between 0.4 to 1.5 µg/L (**Figure 6-10**). In 2022, the range and pattern of chlorophyll-a concentrations at the three Baker Lake areas were similar relative to previous years.
- **Total biomass** – Phytoplankton biomass was comparable to previous years. Annual variation in biomass generally co-varies between the BAP reference area and BPJ. However, in 2022, the trend in biomass at BAP showed a decrease in September, while at BPJ the biomass slightly increased in September. In 2022, biomass at BBD and BPJ were both somewhat elevated compared to BAP, particularly in September (**Figure 6-11** to **Figure 6-13**). The BACI analysis identified a statistically significant apparent increase in phytoplankton biomass at impact areas BBD and BPJ, both of which had effect sizes greater than 20% (p-value<0.1; **Table 6-4**). However, given that biomass at both impact areas was within historical levels and was the lowest ever seen at reference area BAP, this *change* is more reflective of natural variability at the reference area than of local activities at the impact areas.
- **Major taxa composition** – There were no apparent differences in relative composition of phytoplankton communities between BAP and impact areas BBD and BPJ in 2022, except that diatoms were dominant at BBD in September (**Figure 6-13**). Chrysophytes are typically the dominant taxa at all sampling areas, making up from 50 to 66% of the total phytoplankton biomass in each area. Diatoms and cryptophytes generally make up about 25 and 10%, respectively. The remainder of the biomass is made up of chlorophytes and dinoflagellates (**Appendix D3**).

- **Taxa richness** – Richness in Baker Lake phytoplankton samples was within the historical range for the impact and reference areas, except for a reduction in taxa observed in the September sampling event at BBD (**Figure 6-14**). This coincided with the relative increase in diatoms at that area/event. However, mean richness across the three open water sampling events showed little difference between BBD and BPJ relative to BAP in 2022, and the BACI analysis showed these differences were not statistically significant (**Table 6-4**).

Phytoplankton biomass will continue to be monitored for potential temporal trends, but no follow-up measures other than routine monitoring is recommended for 2023.

6.5 Baker Lake Tables and Figures

The tables and figures for the Baker Lake CREMP are provided in this section except for the large tabulated datasets and figures for parameters that are not included in the detailed analysis (see in-text references to appropriate Appendices). Subsections are provided for each of the CREMP components (e.g., limnology, water chemistry, phytoplankton, and benthos).