Manitoba/Manitoba Hydro
Coordinated Aquatic Monitoring Pilot Program (CAMPP):
Three Year Summary Report (2008-2010) - Volume 3

Results of the Three Year Program
Section 5.2: Saskatchewan River Region

VOLUME 3

SECTION 5.2: SASKATCHEWAN RIVER REGION

Reference listing:

Coordinated Aquatic Monitoring Program (CAMP). 2014. Three Year Summary Report (2008-2010). Report prepared for the Manitoba/Manitoba Hydro MOU Working Group by North/South Consultants Inc., Winnipeg, MB.

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5.2 SASKATCHEWAN RIVER REGION

The following presents the results of the Coordinated Aquatic Monitoring Pilot Program (CAMPP) conducted over the period of 2008/2009 through 2010/2011 in the Saskatchewan River Region.

5.2.1 Climate

Climatological data were compiled for two stations in the Saskatchewan River Region: (1) The Pas, MB; and (2) Grand Rapids, MB. The data record for Grand Rapids was incomplete; no data were available for a number of days in most months in each of 2008, 2009, and 2010. Therefore, total precipitation values likely represent underestimates of actual precipitation on a monthly and annual basis. In addition, due to missing data points, monthly mean and annual mean temperatures may not be accurately depicted using the available data.

5.2.1.1 The Pas

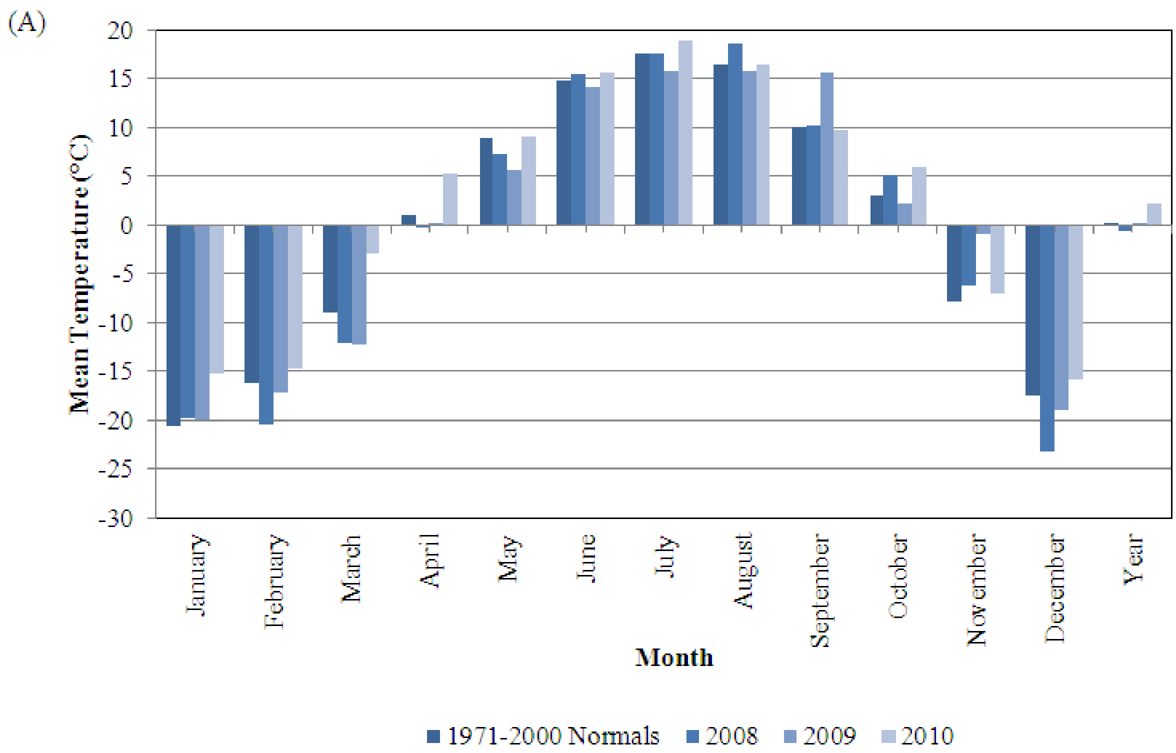
The mean annual temperatures were similar to the 1971-2000 normals in 2008 and 2009, but the annual mean temperature was above normal in 2010 (Figure 5.2.1-1). All months in 2010, with the exception of September, were warmer than the monthly temperature normals. In the open-water season, temperatures were generally similar to the monthly normal; notable exceptions include September 2009 and August 2008, which were warmer than normal.

Total annual precipitation was lower in 2008 and 2009, and higher in 2010, than the normal (Figure 5.2.1-1). Monthly precipitation was lower than the normal in all months in 2008 with the exception of July, when it was noticeably higher. August and September 2010 precipitation levels were approximately double the precipitation normals for those months. Precipitation peaked in July 2008 and 2009 at 131 mm and 83 mm, respectively, and in August 2010 at 154 mm.

5.2.1.2 Grand Rapids

The mean annual temperatures in 2008 and 2009 were similar to the 1971-2000 annual temperature normal, whereas the mean annual temperature was slightly above normal in 2010 at Grand Rapids (Figure 5.2.1-2). Mean monthly temperatures at Grand Rapids were generally similar to the 1971-2000 temperature normals with the exception of March 2010, and September and November 2009 where temperatures were noticeably higher than the normals and February and December 2008, where temperatures were lower than the normals.

Total annual precipitation was slightly lower than the annual normal precipitation level in 2008 and 2009, and higher than the normal in 2010 (Figure 5.2.1-2). However, as noted above, the data record for this station was incomplete and actual precipitation was likely underestimated for most months in each of these years. Recorded total precipitation was notably above normal in June and July 2008 and April through August 2010.



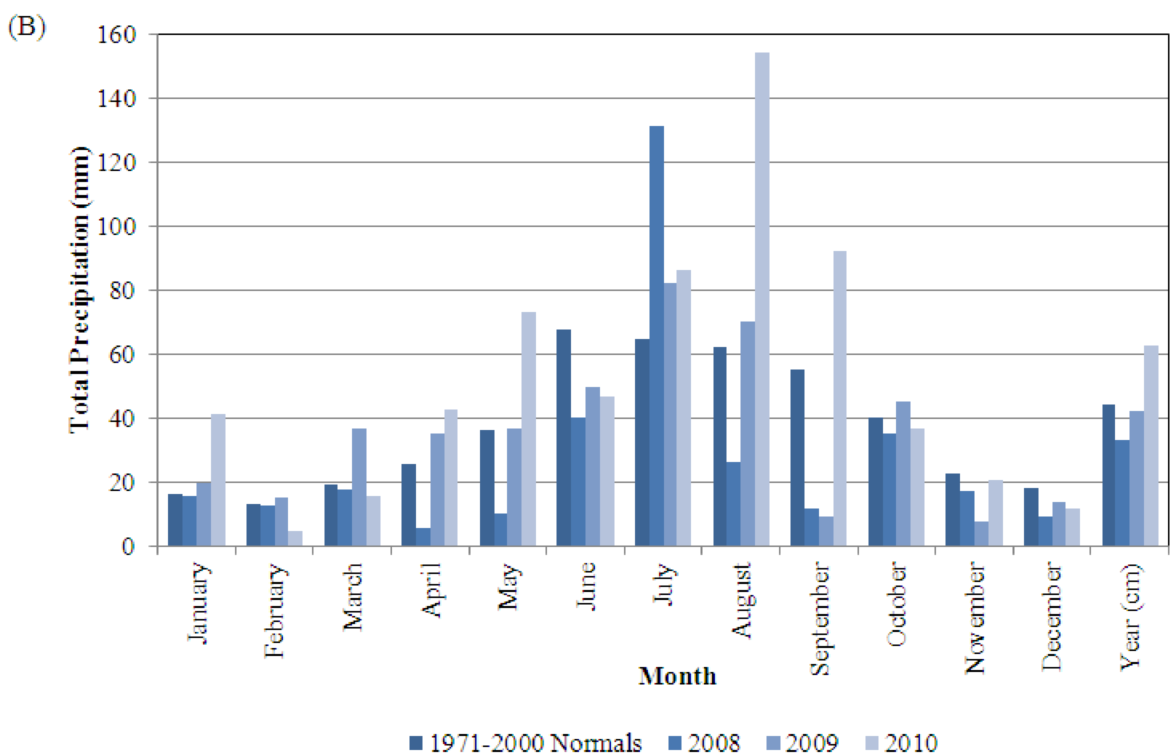
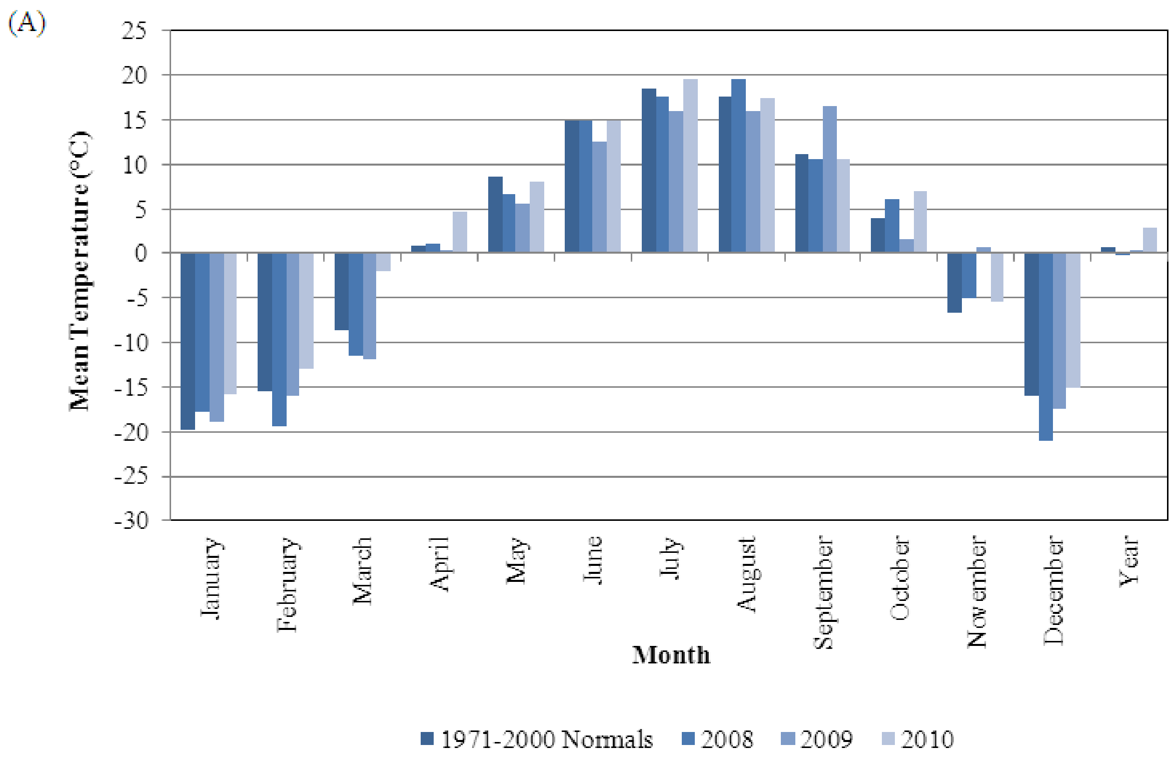


Figure 5.2.1-1. Monthly (A) mean air temperature and (B) total precipitation for 2008-2010 compared to climate normals (1971-2000), The Pas, MB.



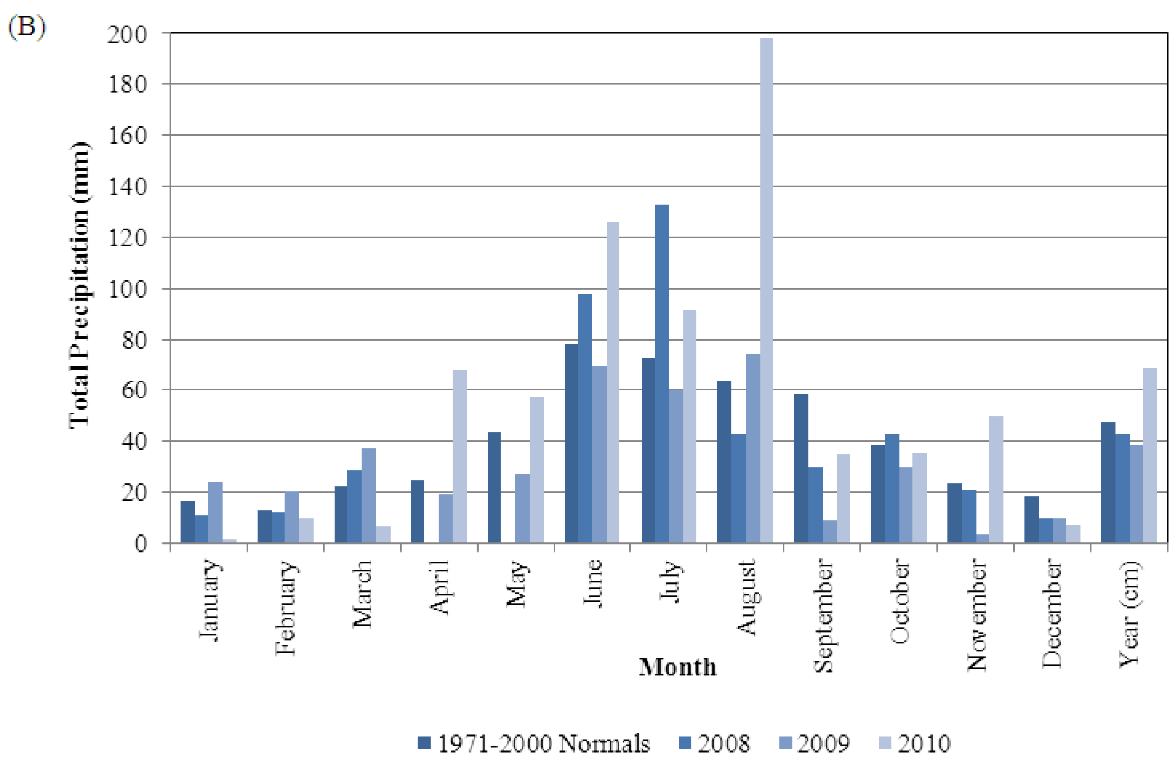


Figure 5.2.1-2. Monthly (A) mean air temperature and (B) total precipitation for 2008-2010 compared to climate normals (1971-2000), Grand Rapids, MB.

5.2.2 Hydrology

The Saskatchewan River flows entering Manitoba are influenced by both precipitation and water use across the Saskatchewan River watershed. Flows originate from as far west as the foot of the Rocky Mountains and are affected by various operations along the way to Manitoba including municipal and recreational use, hydroelectric generation, irrigation and flood control. Between 2008 and 2010, CAMPP monitoring occurred along the Saskatchewan River and on Cedar Lake which acts as a hydroelectric reservoir for the Grand Rapids Generating Station (GS). Monitoring also occurred on South Moose Lake, which is influenced by levels on Cedar Lake. Flows for this region are reported based on the Saskatchewan River gauge at The Pas and the Grand Rapids GS. Cormorant Lake is the off-system waterbody for this region.

Saskatchewan River flows enter Manitoba at The Pas and between 2008 and 2010, flows were generally between the upper and lower quartile since snowpack and precipitation across the drainage basin was generally close to average. The exceptions were in 2009 where flows dropped below the lower quartile from May to September due to below average precipitation and in 2010 when above average precipitation led to flows above the upper quartile from mid-September through the end of the year (Figures 5.2.2-1). Flows remained near the upper quartile from January through March 2011.

The Grand Rapids GS outflows tended to fluctuate around the average between the upper and lower quartile for most of 2008 to 2010 with a few notable exceptions. Outflows were above average in early 2008, below average during most of 2009, and significantly above average from July 2010 throughout the end of the year (Figure 5.2.2). Flows were close to average in January and February and above average in March of 2011.

Cedar Lake water levels were generally below average in 2008, slightly above average in 2009, and near the upper quartile for most of 2010. Cedar Lake water levels also reached record lows in March 2008 due to above average discharge at Grand Rapids Generating Station in early 2008 (Figure 5.2.2-3). Cedar Lake water levels were well above the upper quartile from January through March 2011.

CAMPP monitoring was conducted on South Moose Lake in 2009 and during that year, the water level was generally below average, at times (May to mid-July) below the lower quartile (Figure 5.2.2-4). In early 2010, South Moose Lake water levels dropped from average in January to lower quartile by the end of March.

Cormorant Lake water levels were generally above average for 2008 and slightly below average for most of 2009 and 2010 before rising to upper quartile levels between September and

December 2010 (Figures 5.2.2-5). Water levels stayed close to the upper quartile from January through March 2011.

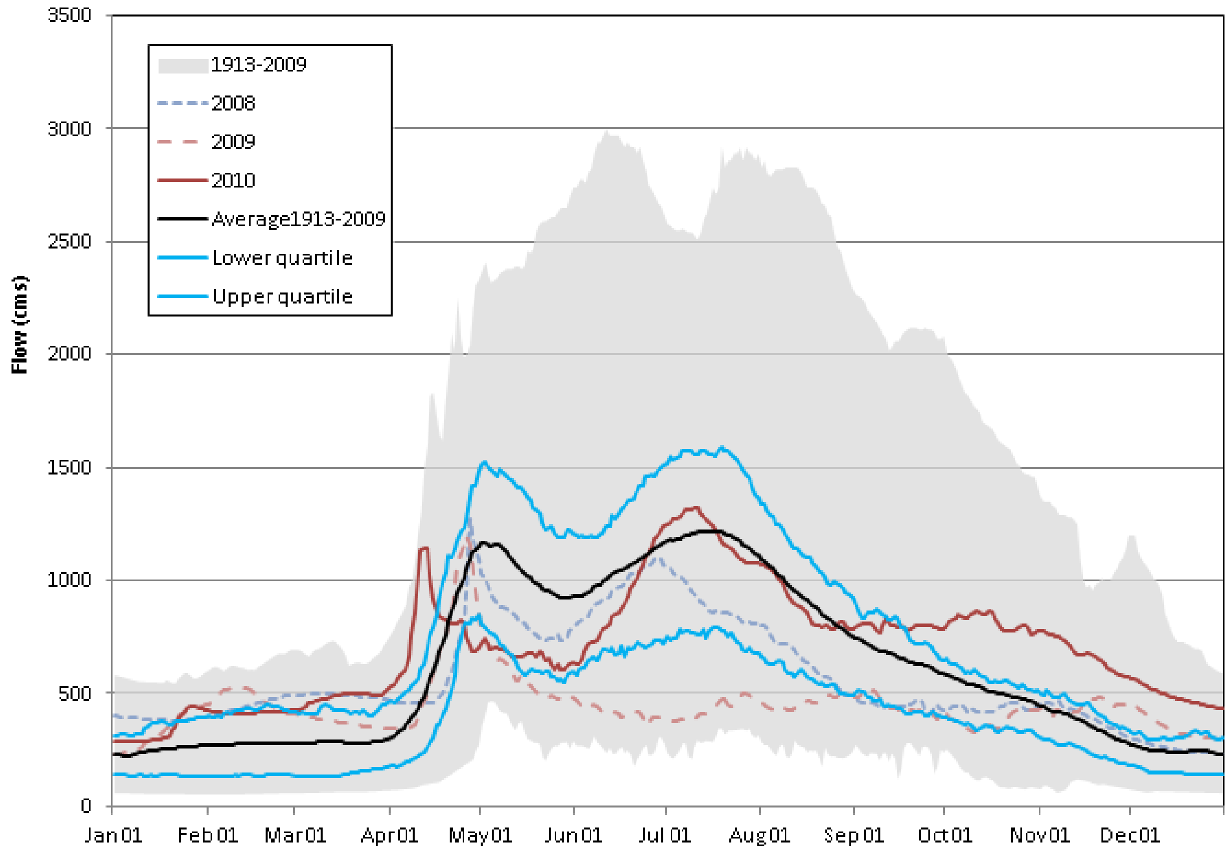


Figure 5.2.2-1. 2008-2010 Saskatchewan River (05KJ001) flow at The Pas.

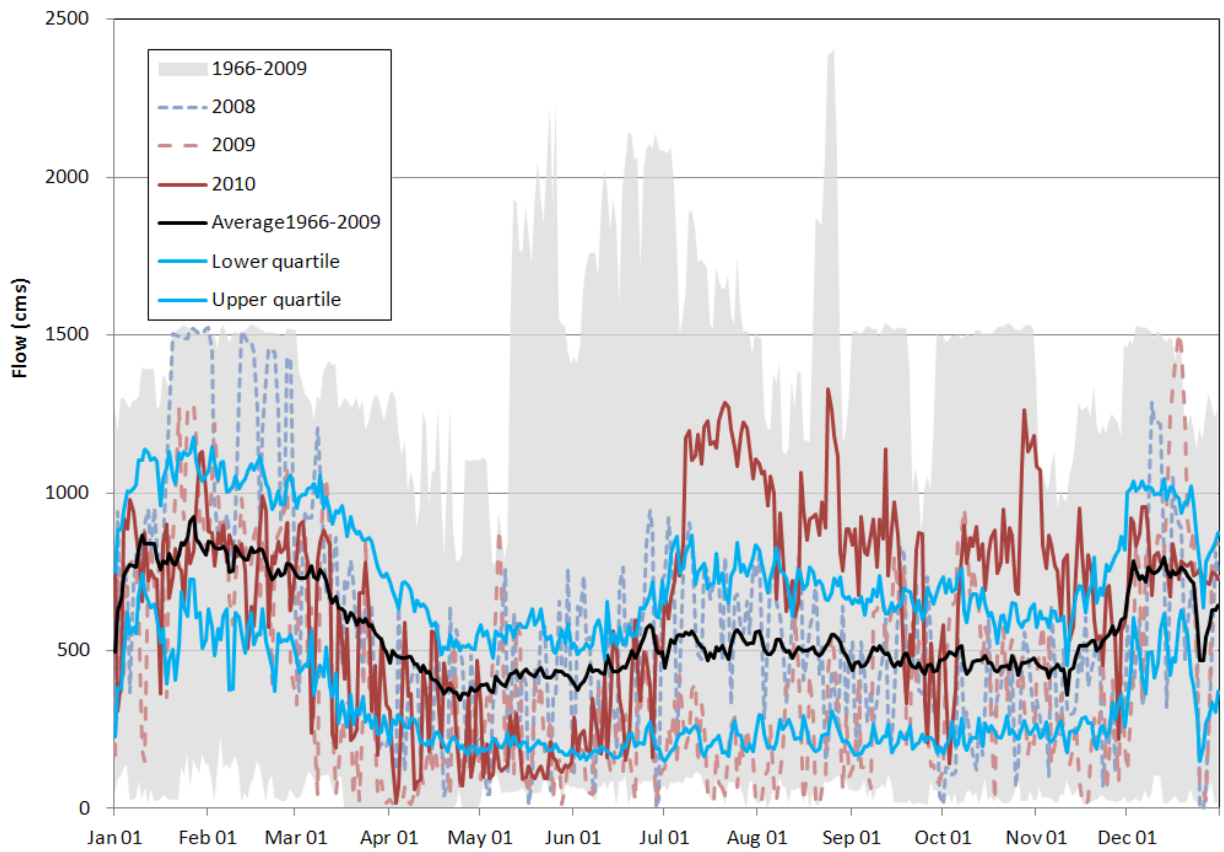


Figure 5.2.2-2. 2008-2010 Grand Rapids GS outflow.

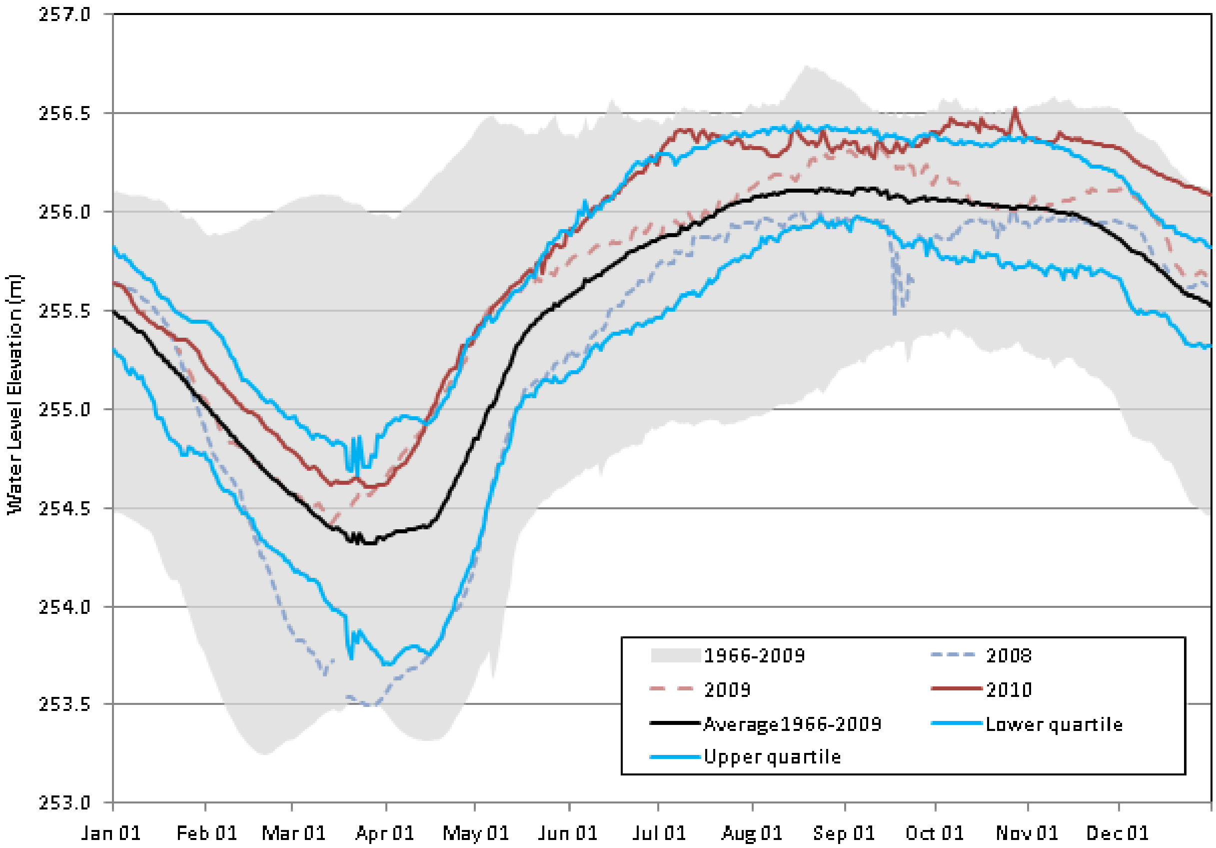


Figure 5.2.2-3. 2008-2010 Cedar Lake (05KL005) water level elevation.

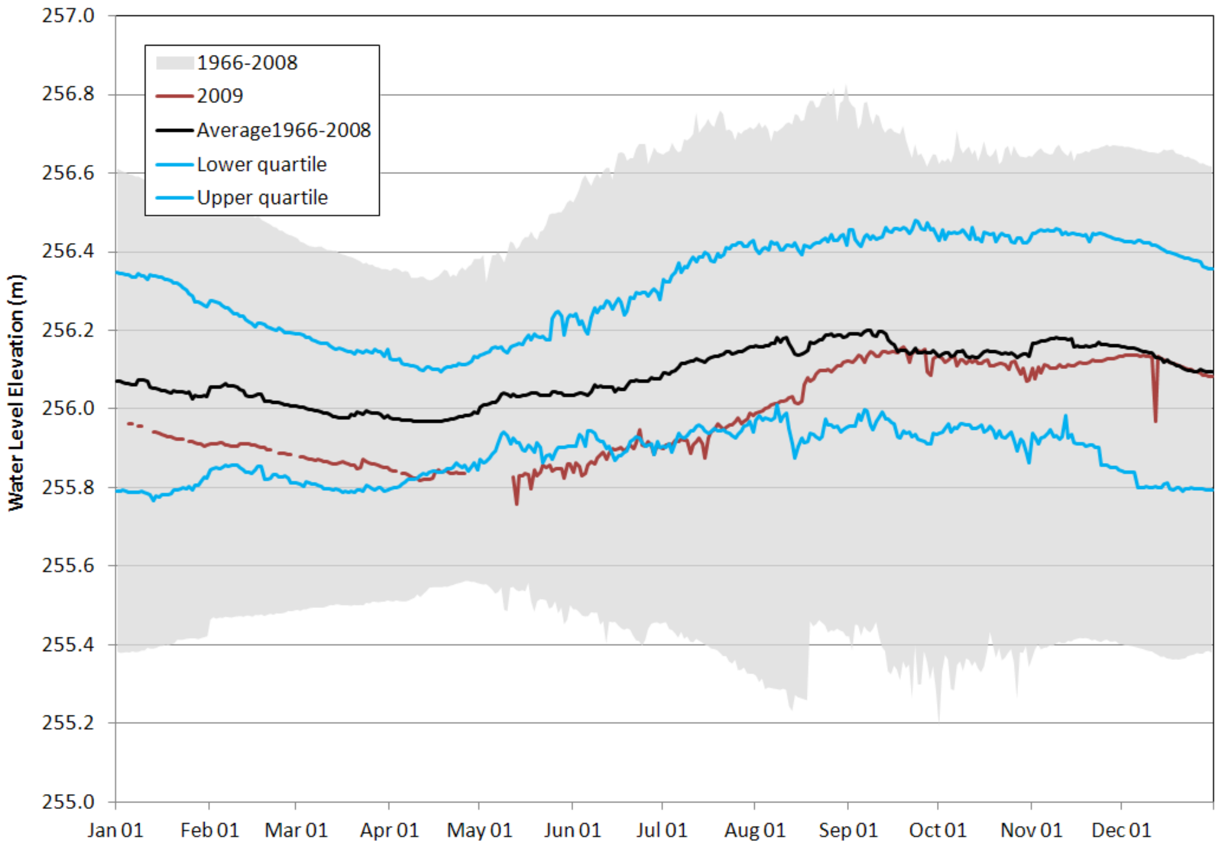


Figure 5.2.2-4. 2009 South Moose Lake (05KK006) water level elevation.

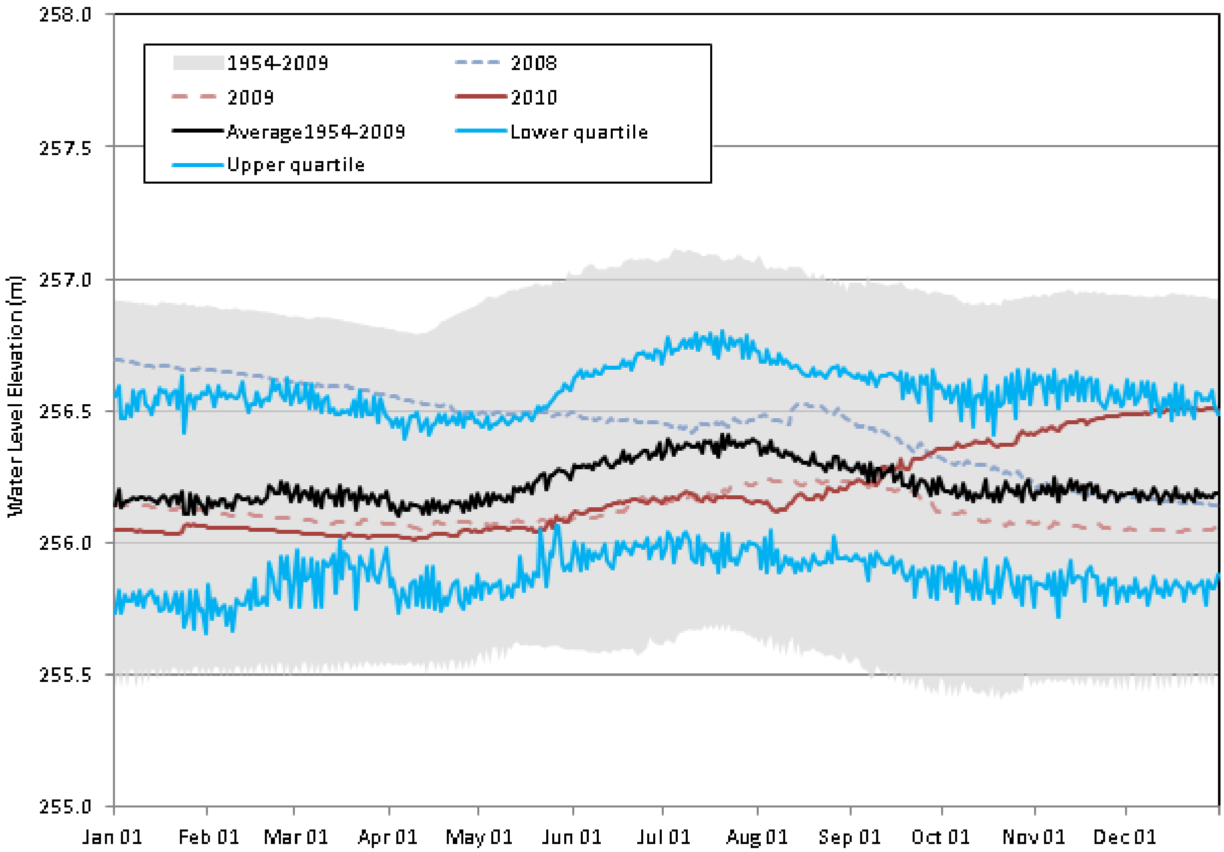


Figure 5.2.2-5. 2008-2010 Cormorant Lake (05KK002) water level elevation.

5.2.3 Aquatic Habitat

Aquatic habitat surveys were not conducted in the Saskatchewan River Region in years 1 to 3 of CAMPP.

5.2.4 Water Quality

The following provides an overview of water quality conditions measured over the three year Pilot Program in the Saskatchewan River Region. Waterbodies sampled annually included one on-system waterbody (Cedar Lake) and one off-system waterbody (Cormorant Lake). Discussions with the Chemawawin Cree Nation were ongoing in 2008/2009; therefore, Cedar Lake was only sampled in spring of that year. Water quality was also measured at South Moose lake in 2009/2010, and the Saskatchewan River at a site approximately 30 km upstream of Cedar Lake in 2010/2011 (Figure 5.2.4-1). Sampling times relative to air temperature are presented in Figure 5.2.4-2.

Water quality is described below for waterbodies located on the Saskatchewan River, which includes three on-system waterbodies affected by Manitoba Hydro's hydraulic system (South Moose and Cedar lakes and the Saskatchewan River), and one off-system waterbody (Cormorant Lake). The discussion below includes results of statistical analyses conducted to evaluate seasonal variation, spatial differences, and temporal (i.e., interannual) differences. Water quality is also characterized through comparisons to Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOGs) for the protection of aquatic life (PAL; MWS 2011) to evaluate overall ecosystem health.

Several water quality parameters frequently vary seasonally in north-temperate freshwater ecosystems, most notably between the open-water and the ice-cover seasons, in relation to changes in water temperature, biological productivity (e.g., algal abundance), and differences in physical conditions such as the presence of ice or variability in tributaries or inflows over the year. For example, concentrations of the inorganic forms of nitrogen which are readily used by primary producers are typically higher in winter due to relatively lower algal abundance. Dissolved oxygen (DO) concentrations also vary with water temperature as warmer water holds less oxygen than colder water and because ice cover may reduce or eliminate atmospheric re-aeration of surface waters. It is of interest to identify seasonal variability as it may affect aquatic biota and because it is important to consider when assessing differences or changes in water quality conditions over time.

The primary objective of spatial comparisons (i.e., comparison between waterbodies) was to evaluate whether water quality conditions differ between sites on the Saskatchewan River as it flows along the length of the river. Comparisons were also made between sites located along the Saskatchewan River and the off-system waterbody not affected by Manitoba Hydro's hydraulic system (Cormorant Lake). Water quality would be expected to differ between on- and off-system waterbodies due to fundamental, inherent differences associated with the watersheds and waterbodies. The objective of the comparisons between the on- and off-system waterbodies was to formally identify differences between these areas to assist with interpretation of results of CAMP as the program continues.

Temporal comparisons were undertaken for each waterbody sampled annually in order to provide a preliminary assessment of temporal variability. As additional data are acquired, more formal trend analyses will be undertaken to evaluate potential longer-term changes.

Results of water quality monitoring conducted under CAMPP in the Saskatchewan River Region were also compared to MWQSOGs for PAL to provide a snap-shot assessment of ecosystem health. These comparisons are not intended to identify cause associated with a water quality variable being outside of the MWQSOGs. In addition, as these comparisons were restricted to the three years of data collected under CAMPP, they do not address historical conditions in the waterbodies.

5.2.4.1 Overview

Water quality of the Saskatchewan River from 30 km upstream of Cedar Lake to the south-east basin of Cedar Lake can be generally described as relatively nutrient-rich, slightly alkaline, hard or very hard, and generally well-oxygenated with a low water clarity. The exceptions occurred in March 2011 in Cedar and South Moose lakes when DO concentrations were below the MWQSOGs for PAL (MWS 2011). South Moose Lake was stratified in winter, while Cedar Lake was stratified during one spring (2010) sampling period. On average, both of these on-system lakes are classified as mesotrophic on the basis of mean open-water total phosphorus (TP), total nitrogen (TN), and chlorophyll *a* concentrations. The Saskatchewan River upstream of Cedar Lake is eutrophic on the basis of TP, but is oligotrophic on the basis of TN and chlorophyll *a*.

Most routine or conventional water quality parameters (e.g., pH) and metals were within the MWQSOGs for PAL in waterbodies on the Saskatchewan River system; exceptions included aluminum, iron, and TP. TP concentrations exceeded the Manitoba narrative nutrient guideline in 22 and 100% of the samples collected in Cedar Lake and the Saskatchewan River, respectively, although no exceedances occurred at South Moose Lake.

Some differences in water quality were observed between sites sampled in the region. Nutrients and TSS decreased between the Saskatchewan River and Cedar Lake and a number of metals were higher in the Saskatchewan River than in either South Moose or Cedar lakes. For some variables (chloride and sulphate), water quality in South Moose Lake more closely resembled that of Cormorant Lake than sites located along the main flow of the Saskatchewan River.

As expected, water quality of Cormorant Lake (the off-system lake), while similar to the Saskatchewan River in some respects, exhibits some notable differences. Cormorant Lake thermally stratifies in the open-water season, experiences DO depletion across depth with concentrations sometimes dropping below MWQSOGs for PAL, and is generally less coloured, more dilute, and clearer than waterbodies on the Saskatchewan River system. The trophic status of Cormorant Lake based on average open-water TP and TN ranked as mesotrophic, which is consistent with lakes on the Saskatchewan River system. However, unlike the on-system South Moose and Cedar lakes, which ranked as mesotrophic on the basis of chlorophyll *a*, Cormorant Lake ranked as oligotrophic indicating relatively lower productivity. In addition, a number of metals are present in lower concentrations in Cormorant Lake than the Saskatchewan River. Differences in water quality between the on- and off-system lakes are not unexpected due to inherent differences in the lakes' drainage basins, morphometries, and hydrological conditions.

Assessment of seasonality was only possible at Cormorant Lake because of limited data at Cedar Lake; however, several water quality variables exhibited differences between one or more sampling periods, most notably when comparing open-water sampling periods to the winter period. As is commonly observed in north temperate freshwater ecosystems, DO was highest in winter due to the inherent capacity of water to hold more DO at lower water temperatures; however, other seasonal differences commonly observed in north temperate lakes (e.g., higher concentrations of nutrients used by algae, lower chlorophyll *a*) were not observed, possibly owing to the relatively limited data set.

There were few and inconsistent differences in water quality conditions between the three sampling years within the annual waterbodies, indicating that water quality conditions in the Saskatchewan River Region remained generally stable during the monitoring program and/or temporal differences were not large enough to be detected statistically. Future evaluations of temporal variability or trends will be undertaken when additional data are acquired for the region.

5.2.4.2 Limnology and In Situ Variables

Water temperatures were generally near zero degrees Celsius in the ice-cover season and ranged up to approximately 22 ^{o}C over the study period in waterbodies of the Saskatchewan River Region. The annual mean air temperatures at Grand Rapids were similar to the 1971-2000 normal in 2008 and 2009 and above normal in 2010 (Figure 5.2.1-1). Air temperature was notably above normal in September 2009, although this was not reflected in higher water temperatures than other years at any of the waterbodies in the region.

Saskatchewan River

The Saskatchewan River did not thermally stratify during the period of study, which is typical of riverine systems (Figure 5.2.4-3), but stratification was observed during one sampling event in each of South Moose (winter 2011; Figure 5.2.4-4) and Cedar (spring 2010; Figure 5.2.4-5) lakes.

Although the waterbodies on the Saskatchewan River system were typically isothermal, vertical differences in DO concentrations developed during the ice-cover season in some years (Figures 5.2.4-6 to 5.2.4-8). Specifically, there was a slight decrease in DO across depth within the upper 4 m of water at the Saskatchewan River site in March 2011, a more pronounced decrease in DO with depth, particularly within the bottom 1 m, in March 2010 at South Moose Lake when the lake was thermally stratified, and DO decreased with depth in the both winters when sampling was conducted (2009/2010 and 2010/2011) in Cedar Lake. DO also decreased with depth in spring and summer 2009 in Cedar Lake (Figure 5.2.4-8). The latter occurrences do not appear to be related to either water levels, which were near average in the open-water season of 2009 (see Section 5.2.2 for discussion), or local air temperatures, which were slightly below the climate normal for this period (see Section 5.2.1 for discussion).

DO concentrations were below the MWQSOGs for the protection of aquatic life during some sampling periods in South Moose and Cedar lakes (Figures 5.2.4-7 and 5.2.4-8). DO concentrations dropped below the most stringent objective for the protection of cold-water aquatic life (9.5 mg/L) in the lower portion of the water column in winter 2010/11 in Cedar Lake (Figure 5.2.4-8). In addition, DO concentrations dropped below both the 30-day cold-water and cool-water objectives (9.5 mg/L and 5.5 mg/L, respectively) in the bottom 1 m in South Moose Lake in March 2010 (Figure 5.2.4-7). DO was within the MWQSOGs for PAL at all other sites and times.

With a few exceptions, other *in situ* variables including specific conductance (Figures 5.2.4-9 to 5.2.4-11), pH (Figures 5.2.4-12 to 5.2.4-14), and turbidity (Figures 5.2.4-15 to 5.2.4-17) were similar across depth in each of the waterbodies. Exceptions included: specific conductance increased with depth in winter (2010 and 2011) in Cedar Lake (Figures 5.2.4-11); and pH decreased with depth at all sites in winter (Figures 5.2.4-12 to 5.2.4-14). Slight increases in turbidity also occurred in the lower portion of the water column during the open-water season at some sites (Figures 5.2.4-15 to 5.2.4-17).

Secchi disk depths varied between sites within the region (Figures 5.2.4-18 to 5.2.4-20). The lakes were quite clear, with Secchi disk depths ranging from 1.5 to 3.0 m at Cedar and South Moose lakes. Secchi disk depth was notably lower in the Saskatchewan River site averaging only 0.4 m. Water clarity of South Moose and Cedar lakes would be classified as low, based on the

Swedish Environmental Protection Agency (Swedish EPA 2000) classification schemes for lakes.

Off-system Waterbody: Cormorant Lake

Limnological conditions of Cormorant Lake differ from on-system waterbodies within the region. Specifically, the large, deep basin of Cormorant Lake allows for the development of thermal stratification, and temperature differences between the upper and lower water column at this site develop quickly following spring melt as solar radiation warms the surface waters. In 2008 and 2010, Cormorant Lake was thermally stratified in the spring, and although a change of 1°C within 1 m of water was not observed in 2009, there was evidence of the initiation of thermal stratification as temperature consistently decreased with depth (Figure 5.2.4-21). During some years thermal stratification is short-lived in Cormorant Lake; in 2008 and 2009, the water column was isothermal by the summer, and only in 2010 did the stratification hold. Stronger stratification occurred in 2010, when the epilimnion reached a depth of 20 m. This occurrence does not appear to be related to water levels as water levels were similar in 2008 and 2010 (see Section 5.2.2 for discussion).

Although temperature is slightly higher at depth in winter in comparison to surface waters, thermal stratification did not develop in the three winters over which monitoring was conducted. DO concentrations decreased across depth in the summer and winter of each year, and in spring 2009 (Figure 5.2.4-22).

Like waterbodies on the Saskatchewan River system, DO concentrations in Cormorant Lake were generally above the PAL but during some sampling periods fell below PAL objectives (Figure 5.2.4-22). DO concentrations dropped below the most stringent objective for the protection of cold-water aquatic life (9.5 mg/L) in the lower portion of the water column in winter 2009/10 and 2010/11 and DO was below both the cold-water and cool-water objectives (6.5 mg/L and 6.0 mg/L, respectively) in the lower portion of the water column in summer 2010.

As noted for waterbodies on the Saskatchewan River system, specific conductance (Figure 5.2.4-23), pH (Figure 5.2.4-24), and turbidity (Figure 5.2.4-25) were relatively similar across depth, although pH occasionally decreased with depth and turbidity increased in the lowest portion of the water column. Cormorant Lake is clearer than the on-system sites, with Secchi disk depths ranging between 2.3 and 5.8 m (Figure 5.2.4-26). Water clarity of Cormorant Lake would be ranked as moderate, based on the Swedish EPA (2000) classification scheme for lakes.

Seasonal Differences

As only two years of data are available for Cedar Lake, seasonal differences could not be analysed statistically (n=2 per season). Seasonal analyses for the Saskatchewan River Region were therefore restricted to Cormorant Lake.

Of the *in situ* water quality variables measured under CAMPP in Cormorant Lake, Secchi disk depth (Figure 5.2.4-27), oxidation-reduction potential (ORP; Figure 5.2.4-28), pH (Figure 5.2.4-29), and specific conductance (Figure 5.2.4-30) did not differ significantly across the sampling periods. Qualitatively, *in situ* turbidity appeared to be lower in winter at Cormorant Lake but statistical comparisons between the open-water sampling periods and winter could not be made due to data limitations (Figure 5.2.4-31). DO was significantly higher in winter than fall in Cormorant Lake (Figure 5.2.4-32). It is common for DO concentrations to be highest in winter due to the higher inherent capacity of water to hold more DO at lower water temperatures. The lack of significant differences for other variables may reflect the relatively limited quantity of data.

Spatial Comparisons

As anticipated, several water quality variables differed significantly between Cedar and Cormorant lakes, including *in situ* turbidity (Figure 5.2.4-33) and specific conductance (Figure 5.2.4-34) – both of which were lower in the off-system lake. Secchi disk depth was also significantly higher in Cormorant Lake (Figure 5.2.4-35). Due to the size of the drainage basin, clearer and more dilute (i.e., lower conductivity) conditions on Cormorant Lake are not unexpected.

While statistical analyses did not incorporate the Saskatchewan River or South Moose Lake due to limited data (i.e., only one year of data), some variables qualitatively indicated potential differences between the Saskatchewan River and the more lacustrine sites, including turbidity (Figure 5.2.4-33), Secchi disk depth (Figure 5.2.4-35), and pH (Figure 5.2.4-36). Statistical differences will be re-assessed in the future when additional data are acquired for the region.

Temporal Comparisons

Only one *in situ* water quality variable monitored in Cedar and Cormorant Lakes was statistically different between sampling years, indicating that these parameters remained generally stable during the monitoring program and/or temporal differences were not large enough to be detected statistically. Specifically, oxidative reductive potential (ORP) at Cedar Lake was higher in 2010 compared to 2009 (Figure 5.2.4-37). Future evaluations of temporal variability or trends will be undertaken when additional data are acquired for the region.

5.2.4.3 Routine Laboratory Variables

Routine laboratory variables described below include nutrients, such as nitrogen and phosphorus, pH, alkalinity, total dissolved solids (TDS)/conductivity, total suspended solids (TSS), turbidity, and true colour.

Saskatchewan River

All measurements of laboratory pH (Figure 5.2.4-38; MWQSOG: 6.5-9), ammonia (Figure 5.2.4-39; MWQSOGs vary with pH and temperature), and nitrate/nitrite (Figure 5.2.4-40; MWQSOG: 2.93 mg N/L) were within MWQSOGs for PAL at all sites and sampling times in waterbodies on the Saskatchewan River. TP concentrations were generally below the Manitoba narrative guideline for TP for lakes, reservoirs, ponds, and tributaries at the point of entry to such waterbodies (0.025 mg/L; Figure 5.2.4-41); however, TP concentrations exceeded the guideline in summer and fall 2010 in the Saskatchewan River and Cedar Lake. Acid sensitivity of the Saskatchewan River Region is classified as least based on pH, total alkalinity, and calcium, and low based on TDS (Table 5.2.4-1).

On average, dissolved phosphorus (DP) comprised a greater fraction of TP than the particulate fraction in South Moose and Cedar lakes but total particulate phosphorus (TPP) was on average higher than DP in the Saskatchewan River (Figure 5.2.4-42). TN (Figure 5.2.4-43) was dominated by organic nitrogen at all sites on the Saskatchewan River system (Figure 5.2.4-44). Of the dissolved inorganic nitrogen (DIN) pool, nitrate/nitrate was present in higher concentrations than ammonia in the Saskatchewan River and Cedar Lake, but the two forms of inorganic nitrogen were present in similar amounts in South Moose Lake (Figure 5.2.4-44). Molar TN:TP ratios indicate that phosphorus limitation occurred at all sites during most sampling events (Figure 5.2.4-45).

Water samples collected at depth (1 m above the sediment-water interface) in Cedar Lake in spring 2010 during a period of thermal stratification indicated that TPP and TP were higher at depth than near the water surface (Figure 5.2.4-46) whereas DP, DIN, nitrate/nitrite, and TN were present in similar concentrations (Figures 5.2.4-46 and 5.2.4-47). No bottom sample was collected from South Moose Lake in winter 2009/2010 during stratification.

Off-system Waterbody: Cormorant Lake

Like the Saskatchewan River sites, pH, ammonia, and nitrate/nitrite were within MWQSOGs for PAL in the surface waters of Cormorant Lake (Figures 5.2.4-38 to 5.2.4-40). Acid sensitivity ranked as least in terms of pH, alkalinity, and calcium, and moderate based on TDS (Table 5.2.4-

1). Like South Moose Lake, none of the samples from Cormorant Lake were in exceedance of the narrative Manitoba guideline for TP (Figure 5.2.4-41).

The composition of TN and TP in Cormorant Lake was also relatively similar to that observed at the on-system sites. Specifically, TP was dominated by phosphorus in dissolved form (Figure 5.2.4-42) while TN was dominated by organic nitrogen (Figure 5.2.4-44). Nitrate/nitrite was also typically present in higher concentrations than ammonia and TN:TP ratios (Figure 5.2.4-45) indicate phosphorus limitation in Cormorant Lake.

Water samples collected at depth (1 m above the sediment-water interface) in Cormorant Lake during periods of thermal stratification indicate that TP and TN concentrations were generally similar at depth to samples collected near the surface (Figures 5.2.4-48 and 5.2.4-49). The exception occurred in spring 2010, when DP and TPP were elevated in the bottom sample and resulted in higher TP concentrations at depth compared to the surface water.

Seasonal Variability

As only two years of data are available for Cedar Lake, seasonal differences could not be analysed statistically (n=2 per season). Seasonal analyses for the Saskatchewan River Region were therefore restricted to Cormorant Lake.

Total Kjeldahl nitrogen (TKN), organic nitrogen, TN, DP, TPP, dissolved and total organic carbon (DOC and TOC), TSS, and true colour did not differ significantly across the sampling periods in Cormorant Lake. Carbonate alkalinity (Figure 5.2.4-50) in Cormorant Lake was significantly lower in winter than spring and fall while total inorganic carbon (TIC; Figure 5.2.4-51) was higher in winter compared to all other seasons. Qualitative review of data for Cormorant Lake indicates some additional parameters (i.e., laboratory pH, total and bicarbonate alkalinity, laboratory conductivity, nitrate/nitrite, ammonia, TP, laboratory turbidity, TDS, and chlorophyll *a*) may follow a seasonal pattern, but no statistically significant differences were found for this data set (Figures 5.2.4-52 to 5.2.4-61).

Spatial Comparisons

Similar to the *in situ* water quality conditions, statistical differences were observed for a number of routine laboratory water quality variables between Cormorant and Cedar lakes. Water quality variables that were significantly higher in Cormorant Lake than Cedar Lake include: total, bicarbonate, and carbonate alkalinity (Figures 5.2.4-62 to 5.2.4-64); and TIC (Figure 5.2.4-65). Routine water quality variables that were significantly lower in Cormorant Lake than Cedar Lake include: TP (Figure 5.2.4-41); true colour (Figure 5.2.4-66); laboratory turbidity (Figure 5.2.4-67); TDS (Figure 5.2.4-68); and laboratory conductivity (Figure 5.2.4-69). As previously discussed, differences in water quality between the on- and off-system waterbodies would be expected due to inherent differences in the drainage basins, morphometries, and hydrological conditions.

While statistical analyses did not include the Saskatchewan River or South Moose Lake due to limited data, some variables qualitatively indicate decreases in concentrations between the Saskatchewan River and Cedar Lake, including turbidity (Figure 5.2.4-67), TSS (Figure 5.2.4-70), true colour (Figure 5.2.4-66), TKN (Figure 5.2.4-71), organic nitrogen (Figure 5.2.4-72), TN (Figure 5.2.4-43), DP (Figure 5.2.4-73), TPP (Figure 5.2.4-74), DOC (Figure 5.2.4-75), and TOC (Figure 5.2.4-76).

Qualitatively, some water quality parameters measured in South Moose Lake are more similar to the off-system Cormorant Lake than sites located along the main flow of the Saskatchewan River, including alkalinity (Figures 5.2.4-62 to 5.2.4-64), true colour (Figure 5.2.4-66), TIC (Figure 5.2.4-65), DOC (Figure 5.2.4-75), and TOC (Figure 5.2.4-76). Statistical differences will be re-assessed in the future when additional data are acquired for this upstream waterbody.

Temporal Comparisons

Statistical comparisons between sampling years for annual waterbodies revealed few significant differences. The only significant inter-annual difference observed was a higher concentration of DOC in 2010 relative to 2009 in Cedar Lake. No differences were found in Cormorant Lake.

5.2.4.4 Trophic Status

Saskatchewan River

Cedar and South Moose lakes are classified as mesotrophic on the basis of mean open-water TP concentrations (Table 5.2.4-2). Application of trophic categorization schemes for lakes based on chlorophyll *a* (Table 5.2.4-3) and TN (Table 5.2.4-4) also indicate that both on-system lakes were mesotrophic on average. The Saskatchewan River was eutrophic on the basis of mean open-water TP concentrations in 2010/2011 but was oligotrophic based on TN and chlorophyll *a* concentrations (Table 5.2.4-5). Neither TP nor TN was significantly related to chlorophyll *a* in Cedar Lake, suggesting that factors other than nutrients may be important in governing phytoplankton production (Figure 5.2.4-78). However, the lack of a correlation may reflect the relatively limited number of data points.

Off-system Waterbody: Cormorant Lake

On average, the trophic status of Cormorant Lake was mesotrophic on the basis of nutrient (i.e., TN and TP) concentrations but was oligotrophic on the basis of chlorophyll *a* concentrations

(Tables 5.2.4-2 to 5.2.4-4). Like Cedar Lake, neither TN nor TP were significantly correlated to chlorophyll *a* in Cormorant Lake (Figure 5.2.4-79).

5.2.4.5 Escherichia coli

Saskatchewan River

E. coli was not detected in Cedar or South Moose lakes over the period of 2008-2010, but was detected at low concentrations (1-16 colony forming units [CFU]/100 mL) in 75% of samples from the Saskatchewan River (Table 5.2.4-5). All *E. coli* measurements were well below the Manitoba water quality objective for primary recreation of 200 CFU/100 mL.

Cormorant Lake: Off-system Waterbody

E. coli was not detected in Cormorant Lake over the period of 2008-2010 (Table 5.2.4-5).

5.2.4.6 Metals and Major Ions

Saskatchewan River

The dominant major cation in waterbodies on the Saskatchewan River system was calcium (Figure 5.2.4-80). The second most dominant major cation varied between waterbodies; magnesium was the second highest cation in South Moose Lake, whereas sodium and magnesium were present on average in similar concentrations in the Saskatchewan River and Cedar Lake. Hardness measurements indicate that waters are hard to very hard (Figure 5.2.4-81).

Chloride concentrations in waterbodies along the Saskatchewan River (i.e., 1.0 to 16.2 mg/L; Figure 5.2.4-82), were on the lower range reported for the central and western regions of Canada (< 1 mg/L to approximately 500 mg/L; Canadian Council of Resource and Environment Ministers [CCREM] 1987). Concentrations of chloride were also well below the Canadian Council of Ministers of the Environment (CCME) PAL guideline of 120 mg/L for a long-term exposure (CCME 1999; updated to 2013). Sulphate concentrations were less than 22 mg/L at South Moose Lake and ranged between 32 and 87 mg/L in the Saskatchewan River and Cedar Lake (Figure 5.2.4-82); these concentrations fell on the lower range of concentrations reported across Canada (< 1 mg/L to approximately 3,000 mg/L; CCREM 1987). While there is currently no Manitoba or CCME PAL guideline for sulphate, concentrations in the region were consistently below the British Columbia Ministry of Environment (BCMOE) guidelines which range from 128 to 429 mg/L for waters ranging from soft to very hard (Meays and Nordin 2013).

Of the 38 metals/metalloids measured in surface waters at the sites along the Saskatchewan River, only eight were never detected (beryllium, bismuth, mercury, selenium, silver, tellurium, thallium and tungsten; Table 5.2.4-6). Metals that were consistently detected at all sites and times included: arsenic; barium; calcium; lithium; magnesium; manganese; molybdenum; potassium; rubidium; silicon; sodium; strontium; and, uranium. Additionally, aluminum was detected in all but one sample (South Moose Lake in winter 2009/10). The remaining metals were detected at varying frequencies, although cesium, chromium, and tin were detected in less than 30% of samples in each waterbody.

Most metals were present in concentrations below the MWQSOGs for PAL at all sites and sampling times in waterbodies along the Saskatchewan River; the exceptions included aluminum and iron (Table 5.2.4-7). The majority (75% and 100%) of samples collected in the Saskatchewan River exceeded the PAL guideline for aluminum (0.1 mg/L; Figure 5.2.4-83) and iron (0.3 mg/L), respectively (Figure 5.2.4-84). Additionally, 22% of surface samples collected from Cedar Lake exceeded the aluminum PAL.

The analytical detection limits (DLs) for mercury varied over the study period and were typically above the current MWQSOG PAL guideline (0.000026 mg/L). Therefore comparison of analytical results to the PAL guideline could not be undertaken for all samples. Considering only the results of analyses where the analytical detection limit was sufficiently low to facilitate this comparison, all measurements from waterbodies along the Saskatchewan River were below the current MWQSOG PAL.

Concentrations of total aluminum, iron, and manganese were higher in samples collected near the sediment-water interface relative to surface grabs in Cedar Lake in spring 2010 (Figure 5.2.4-85) when the lake was thermally stratified (Figure 5.2.4-5). Aluminum was above the MWQSOG PAL (0.1 mg/L) in the near surface and bottom sample collected from Cedar Lake at this time (Figure 5.2.4-85).

Off-system Waterbody: Cormorant Lake

The dominant cation in Cormorant Lake was calcium, followed by magnesium (Figure 5.2.4-80), and hardness measurements indicate that waters were hard (Figure 5.2.4-81). Chloride concentrations were lower than at on-system sites (i.e., < 1.9 mg/L; Figure 5.2.4-82) and were well below the CCME PAL guideline of 120 mg/L for a long-term exposure (CCME 1999; updated to 2013). Sulphate concentrations were also low (consistently less than 5 mg/L; Figure 5.2.4-82) and well below the BCMOE PAL guidelines (Meays and Nordin 2013).

Of the 38 metals/metalloids measured in Cormorant Lake, 12 were never detected in any of the surface samples (beryllium, bismuth, cesium, mercury, selenium, silver, tellurium, thallium, thorium, tin, tungsten, and zirconium; Table 5.2.4-6). Metals that were consistently detected included: aluminum; arsenic; barium; calcium; lithium; magnesium; manganese; potassium; rubidium; silicon; sodium; strontium; and, uranium. The remaining metals were detected at varying frequencies, although boron, chromium, cobalt, lead, nickel, and zinc were detected in less than 30% of samples collected in Cormorant Lake.

All metals were present in concentrations below the MWQSOGs for PAL in surface samples collected from Cormorant Lake (Table 5.2.4-7). Considering only the results of analyses where the analytical DL was sufficiently low to facilitate this comparison, all measurements of mercury from Cormorant Lake were below the current MWQSOG PAL.

As observed for some forms of nutrients, concentrations of aluminum and iron were higher in samples collected near the sediment-water interface relative to surface grabs in Cormorant Lake in spring 2008 and spring and summer 2010 (Figure 5.2.4-86), when the lake was thermally stratified (Figure 5.2.4-21). In addition, manganese was higher at depth in spring and summer 2010, most notably in the latter period when hypoxic conditions occurred in the hypolimnion (Figure 5.2.4-86). These metals are commonly elevated in freshwater ecosystems at depth under stratification and/or low DO concentrations. Despite being higher at depth than near the surface, only one bottom sample contained aluminum marginally above the MWQSOG PAL (0.1 mg/L; Figure 5.2.4-86). In addition, one bottom sample (spring 2008) contained silver at a concentration marginally above the analytical DL which is also equivalent to the PAL guideline (i.e., 0.0001 mg/L). However, measurements that are at or near analytical DLs are associated with relatively high uncertainty and there is low confidence that an actual exceedance of a PAL guideline has occurred when the guideline is at or near the analytical DL.

Seasonal Variability

As only two years of data are available for Cedar Lake, seasonal differences could not be analysed statistically (n=2 per season). Seasonal analyses for the Saskatchewan River Region were therefore restricted to Cormorant Lake.

Several metals exhibited statistically significant seasonal differences at Cormorant Lake. Barium (Figure 5.2.4-87), calcium (Figure 5.2.4-88), and potassium (Figure 5.2.4-89) were higher in the winter than the spring or summer and manganese (Figure 5.2.4-90) and titanium (Figure 5.2.4-91) were lower in the winter than spring or fall.

Spatial Comparisons

While statistical analyses did not incorporate the Saskatchewan River or South Moose Lake due to limited data, aluminum (Figure 5.2.4-83), cobalt (Figure 5.2.4-92), iron (Figure 5.2.4-84), lead (Figure 5.2.4-93), manganese (Figure 5.2.4-94), nickel (Figure 5.2.4-95), rubidium (Figure 5.2.4-96), thorium (Figure 5.2.4-97), titanium (Figure 5.2.4-98), vanadium (Figure 5.2.4-99), and zirconium (Figure 5.2.4-100) were qualitatively higher in the Saskatchewan River than at any other sites in the region. Statistical differences will be re-assessed in the future when additional data are acquired for this upstream waterbody.

Aluminum (Figure 5.2.4-83), calcium (Figure 5.2.4-103), chloride (Figure 5.2.4-82), iron (Figure 5.2.4-84), magnesium (Figure 5.2.4-110), molybdenum (Figure 5.2.4-105), potassium (Figure 5.2.4-106), sodium (Figure 5.2.4-107), strontium (Figure 5.2.4-108), sulphate (Figure 5.2.4-82), and uranium (Figure 5.2.4-109) concentrations measured in South Moose Lake were qualitatively more similar to Cormorant Lake than lakes on the main flow of the Saskatchewan River.

Similar to other water quality variables discussed above, a number of metals and major ions were significantly lower in Cormorant Lake than at Cedar Lake, including: barium (Figure 5.2.4-101); boron (Figure 5.2.4-102); calcium (Figure 5.2.4-103); chloride (Figure 5.2.4-82); iron (Figure 5.2.4-84); lithium (Figure 5.2.4-104); manganese (Figure 5.2.4-94); molybdenum (Figure 5.2.4-105); potassium (Figure 5.2.4-106); sodium (Figure 5.2.4-107); strontium (Figure 5.2.4-108); sulphate (Figure 5.2.4-82); and uranium (Figure 5.2.4-109). Conversely, magnesium (Figure 5.2.4-110) and silicon (Figure 5.2.4-111) were higher in Cormorant Lake than Cedar Lake.

Temporal Comparisons

Statistical comparisons between sampling years for annual waterbodies (Cedar and Cormorant lakes) revealed few significant differences. The small number of exceptions included: iron and rubidium were higher in 2010 than 2009 in Cedar Lake (Figures 5.2.4-112 and 5.2.4-113); and antimony and chloride were higher in 2009 at Cormorant Lake (Figures 5.2.4-114 and 5.2.4-115). Lead concentrations (Figure 5.2.4-116) in Cedar Lake were also statistically lower in 2010; however, the differences were at least partly due to reductions in the analytical DLs in 2010.

The lack of consistent year-to-year differences indicates that water quality conditions in the Saskatchewan River Region remained generally stable during the monitoring program and/or temporal differences were not large enough to be detected statistically. Future evaluations of temporal variability or trends will be undertaken when additional data are acquired for the region.

Table 5.2.4-1. Saffran and Trew (1996) categorization of acid sensitivity of aquatic ecosystems and sensitivity ranking for the Saskatchewan River Region.

Parameter	Units	Acid Sensitivity							
		High	Moderate	Low	Least	Saskatchewan River	South Moose Lake	Cedar Lake	Cormorant Lake
pH	-	<6.5	6.6-7.0	7.1-7.5	>7.5	Least	Least	Least	Least
Total Alkalinity (as $CaCO_3$)	mg/L	0-10	11-20	21-40	>40	Least	Least	Least	Least
Calcium	mg/L	0-4	5-8	9-25	>25	Least	Least	Least	Least
Total Dissolved Solids	mg/L	0-50	51-200	201-500	>500	Low	Low	Low	Moderate

Table 5.2.4-2. Total phosphorus concentrations (open-water season and annual means) measured in the Saskatchewan River Region and CCME (1999; updated to 2013) trophic categorization: 2008-2010.

Waterbody	Period	Trophic Status Based on TP (mg/L)						Years Sampled
		Ultra-oligotrophic <0.004	Oligotrophic 0.004 - 0.010	Mesotrophic 0.010 - 0.020	Meso-eutrophic 0.020 - 0.035	Eutrophic 0.035 - 0.100	Hyper-eutrophic > 0.100	
Saskatchewan River	Open-water season					0.050		2010
	Annual					0.042		2010/2011
South Moose Lake	Open-water season			0.018				2009
	Annual			0.017				2009/2010
Cedar Lake	Open-water season			0.011 [1]				2008
	Annual			0.011 [1]				2008/2009
	Open-water season			0.019				2009
	Annual			0.019				2009/2010
	Open-water season				0.023			2010
	Annual				0.021			2010/2011
	Open-water season			0.019				2008/2009-2010/2011
	Annual			0.019				2008/2009-2010/2011
Cormorant Lake	Open-water season			0.011				2008
	Annual			0.011				2008/2009
	Open-water season			0.014				2009
	Annual			0.013				2009/2010
	Open-water season		0.010					2010
	Annual		0.010					2010/2011
	Open-water season			0.012				2008/2009-2010/2011
	Annual			0.011				2008/2009-2010/2011

[1] In 2008, Cedar Lake was only sampled in the spring (i.e., n=1).

Table 5.2.4-3. Chlorophyll *a* concentrations (open-water season and annual means) measured in the Saskatchewan River Region and the OECD (1982) trophic categorization scheme for lakes: 2008/2009-2010/2011.

Waterbody	Period	Lake Trophic Status Based on Chlorophyll *a* (µg/L)						Years Sampled
		Ultra-oligotrophic	Oligotrophic	Mesotrophic	Meso-eutrophic	Eutrophic	Hyper-eutrophic	
		-	<2.5	2.5 - 8	-	8 - 25	> 25	
South Moose Lake	Open-water season			4.6				2009
	Annual			3.7				2009/2010
Cedar Lake	Open-water season		<1[1]					2008
	Annual		<1[1]					2008/2009
	Open-water season					9.2		2009
	Annual			7.2				2009/2010
	Open-water season			6.0				2010
	Annual			4.8				2010/2011
	Open-water season			6.6				2008/2009-2010/2011
	Annual			5.4				2008/2009-2010/2011
Cormorant Lake	Open-water season		2.3					2008
	Annual		2.3					2008/2009
	Open-water season		1.4					2009
	Annual		1.2					2009/2010
	Open-water season		1.2					2010
	Annual		1.2					2010/2011
	Open-water season		1.7					2008/2009-2010/2011
	Annual		1.6					2008/2009-2010/2011

[1]In 2008, Cedar Lake was only sampled in the spring (i.e., n=1).

Table 5.2.4-4. Total nitrogen concentrations (open-water season and annual means) measured in lakes and reservoirs in the Saskatchewan River Region and comparison to a trophic categorization scheme (Nurnberg 1996): 2008/2009-2010/2011.

Waterbody	Period	Lake Trophic Status Based on Total Nitrogen (mg/L)						Years Sampled
		Ultra-oligotrophic	Oligotrophic	Mesotrophic	Meso-eutrophic	Eutrophic	Hyper-eutrophic	
		-	<0.350	0.350-0.650	-	0.651-1.2	>1.2	
South Moose Lake	Open-water season			0.49				2009
	Annual			0.50				2009/2010
Cedar Lake	Open-water season			0.43 [1]				2008
	Annual			0.43 [1]				2008/2009
	Open-water season		0.28					2009
	Annual			0.38				2009/2010
	Open-water season			0.43				2010
	Annual			0.46				2010/2011
	Open-water season			0.37				2008/2009-2010/2011
	Annual			0.42				2008/2009-2010/2011
Cormorant Lake	Open-water season			0.52				2008
	Annual			0.47				2008/2009
	Open-water season			0.34				2009
	Annual			0.36				2009/2010
	Open-water season		0.29					2010
	Annual		0.29					2010/2011
	Open-water season			0.38				2008/2009-2010/2011
	Annual			0.37				2008/2009-2010/2011

[1] In 2008, Cedar Lake was only sampled in the spring (i.e., n=1).

Table 5.2.4-5. Mean (open-water season and annual) concentrations of TP, TN, and chlorophyll *a* in the Saskatchewan River and comparison to trophic categorization schemes for rivers/streams.

Parameter	Period	Ultra-oligotrophic	Oligotrophic	Mesotrophic	Meso-eutrophic	Eutrophic	Hyper-eutrophic	Reference
Total Phosphorus (mg/L)	Trophic Categories	<0.004	0.004-0.010	0.010-0.020	0.020-0.035	0.035-0.100	> 0.100	CCME (1999; updated to 2012)
	Open-water 2010					0.050		
	Annual 2010/2011					0.042		
Chlorophyll *a* (µg/L)	Trophic Categories		<10	10-30		>30		Dodds et al. (1998)
	Open-water 2010		3.6					
	Annual 2010/2011		2.9					
Total Nitrogen (mg/L)	Trophic Categories		<0.7	0.7-1.5		>1.5		Dodds et al. (1998)
	Open-water 2010		0.57					
	Annual 2010/2011		0.57					

Table 5.2.4-6. Detection frequency and summary statistics for *E. coli* (CFU/100 mL) measured in the Saskatchewan River Region.

Waterbody	Sample Years	# Detected	n	% Detected	Mean	Median	Max
Saskatchewan River	2010	3	4	75	6	4	16
South Moose Lake	2009	0	3	0	<1	<1	<1
Cedar Lake	2008-2010	0	8	0	<1	<1	<1
Cormorant Lake	2008-2010	0	11	0	<1	<1	<1

Table 5.2.4-7. Frequency of detection of metals and major ions measured in the Saskatchewan River Region: 2008-2010. Values in bold indicate annual sites where detection frequencies ≥30%.

Waterbody	Sample Years		Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chloride-Dissolved	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Mercury	Molybdenum
Saskatchewan River	2010	n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		# Detected	4	1	4	4	0	0	4	3	4	1	4	1	3	4	4	4	4	4	4	0	4
		% Detected	**100**	25	**100**	**100**	0	0	**100**	**75**	**100**	25	**100**	25	**75**	**100**	**100**	**100**	**100**	**100**	**100**	0	**100**
South Moose Lake	2009	n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0	4	4	3	4
		# Detected	3	1	4	4	0	0	1	2	4	0	4	1	1	1	3	0	-	4	4	0	4
		% Detected	**75**	25	**100**	**100**	0	0	25	**50**	**100**	0	**100**	25	25	25	**75**	0	-	**100**	**100**	0	**100**
Cedar Lake -Surface	2008-2010	n	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	4	9	9	8	9
		# Detected	9	4	9	9	0	0	5	6	9	0	9	2	1	7	9	3	4	9	9	0	9
		% Detected	**100**	**44**	**100**	**100**	0	0	**56**	**67**	**100**	0	**100**	22	11	**78**	**100**	**33**	**100**	**100**	**100**	0	**100**
Cedar Lake -Bottom	2010	n	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		# Detected	1	0	1	1	0	0	1	0	1	0	1	0	0	1	1	1	1	1	1	0	1
		% Detected	**100**	0	**100**	**100**	0	0	**100**	0	**100**	0	**100**	0	0	**100**	**100**	**100**	**100**	**100**	**100**	0	**100**
Cormorant Lake -Surface	2008-2010	n	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	4	12	12	11	12
		# Detected	12	5	12	12	0	0	3	8	12	0	12	2	2	10	5	2	4	12	12	0	5
		% Detected	**100**	**42**	**100**	**100**	0	0	25	**67**	**100**	0	**100**	17	17	**83**	**42**	17	**100**	**100**	**100**	0	**42**
Cormorant Lake -Bottom	2008, 2010	n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3
		# Detected	3	0	3	3	0	0	2	1	3	0	3	1	0	3	3	1	2	3	3	0	2
		% Detected	**100**	0	**100**	**100**	0	0	**67**	**33**	**100**	0	**100**	**33**	0	**100**	**100**	**33**	**100**	**100**	**100**	0	**67**

Table 5.2.4-7. continued.

Waterbody	Sample Years		Nickel	Potassium	Rubidium	Selenium	Silicon	Silver	Sodium	Strontium	Sulphate-Dissolved	Tellurium	Thallium	Thorium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
Saskatchewan River	2010	n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		# Detected	3	4	4	0	4	0	4	4	4	0	0	3	1	4	0	4	4	3	3
		% Detected	**75**	**100**	**100**	0	**100**	0	**100**	**100**	**100**	0	0	**75**	25	**100**	0	**100**	**100**	**75**	**75**
South Moose Lake	2009	n	4	4	4	4	0	4	4	4	4	4	4	0	4	4	4	4	4	4	4
		# Detected	0	4	4	0	-	0	4	4	4	0	0	-	0	1	0	4	0	0	0
		% Detected	0	**100**	**100**	0	-	0	**100**	**100**	**100**	0	0	-	0	25	0	**100**	0	0	0
Cedar Lake	2008-2010	n	9	9	9	9	4	9	9	9	9	9	9	4	9	9	9	9	9	9	9
-Surface		# Detected	0	9	9	0	4	0	9	9	9	0	0	0	1	6	0	9	4	1	0
		% Detected	0	**100**	**100**	0	**100**	0	**100**	**100**	**100**	0	0	0	11	**67**	0	**100**	**44**	11	0
Cedar Lake	2010	n	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
-Bottom		# Detected	0	1	1	0	1	0	1	1	1	0	0	0	1	1	0	1	1	0	0
		% Detected	0	**100**	**100**	0	**100**	0	**100**	**100**	**100**	0	0	0	**100**	**100**	0	**100**	**100**	0	0
Cormorant Lake	2008-2010	n	12	12	12	12	4	12	12	12	12	12	12	4	12	12	12	12	12	12	12
-Surface		# Detected	1	12	12	0	4	0	12	12	12	0	0	0	0	9	0	12	6	1	0
		% Detected	8	**100**	**100**	0	**100**	0	**100**	**100**	**100**	0	0	0	0	**75**	0	**100**	**50**	8	0
Cormorant Lake	2008, 2010	n	3	3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	3	3
-Bottom		# Detected	0	3	3	0	2	1	3	3	3	0	0	0	2	3	0	3	3	1	0
		% Detected	0	**100**	**100**	0	**100**	**33**	**100**	**100**	**100**	0	0	0	**67**	**100**	0	**100**	**100**	**33**	0

Table 5.2.4-8. Frequency of exceedances of MWQSOGs for PAL for metals measured in the Saskatchewan River Region: 2008-2010. Values in bold indicate exceedances occurred at a given site.

Waterbody	Years		Aluminum	Arsenic	Boron	Cadmium	Chromium	Copper	Iron	Lead	Mercury [1]	Molybdenum	Nickel	Selenium	Silver	Thallium	Uranium	Zinc
		MWQSOGs for PAL (mg/L)	0.1	0.15	1.5	0.00034-0.00049	0.112-0.166	0.0122-0.0184	0.3	0.00475-0.00878	0.000026	0.073	0.068-0.102	0.001	0.0001	0.0008	0.015	0.156-0.235
Saskatchewan River	2010	n	4	4	4	4	4	4	4	4	0	4	4	4	4	4	4	4
		# Exceedances	3	0	0	0	0	0	4	0	.	0	0	0	0	0	0	0
		% Exceedances	**75**	0	0	0	0	0	**100**	0	-	0	0	0	0	0	0	0
South Moose Lake	2009	n	4	4	4	4	4	4	4	4	2	4	4	4	4	4	4	4
		# Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		% Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cedar Lake	2008-2010	n	9	9	9	9	9	9	9	9	2	9	9	9	9	9	9	9
-Surface		# Exceedances	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		% Exceedances	**22**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cedar Lake	2010	n	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
-Bottom		# Exceedances	1	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0
		% Exceedances	**100**	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0
Cormorant Lake	2008-2010	n	12	12	12	12	12	12	12	12	2	12	12	12	12	12	12	12
-Surface		# Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		% Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cormorant Lake	2008, 2010	n	3	3	3	3	3	3	3	3	0	3	3	3	3	3	3	3
-Bottom		# Exceedances	1	0	0	0	0	0	0	0	-	0	0	0	1	0	0	0
		% Exceedances	**33**	0	0	0	0	0	0	0	-	0	0	0	**33**	0	0	0

[1] includes only water quality samples with an analytical detection limit of less than 0.000026 mg/L.

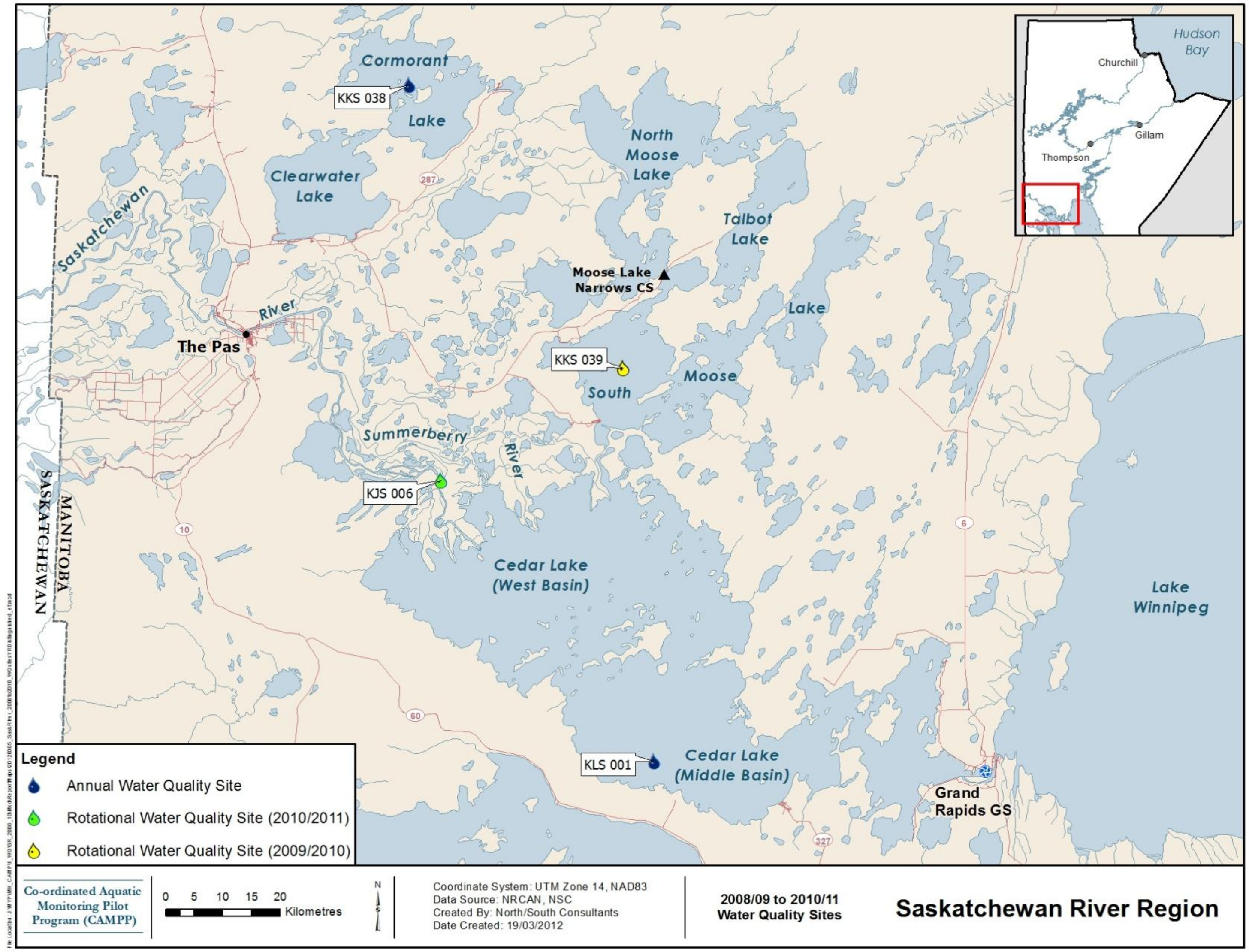


Figure 5.2.4-1. Water quality and phytoplankton monitoring sites in the Saskatchewan River Region.

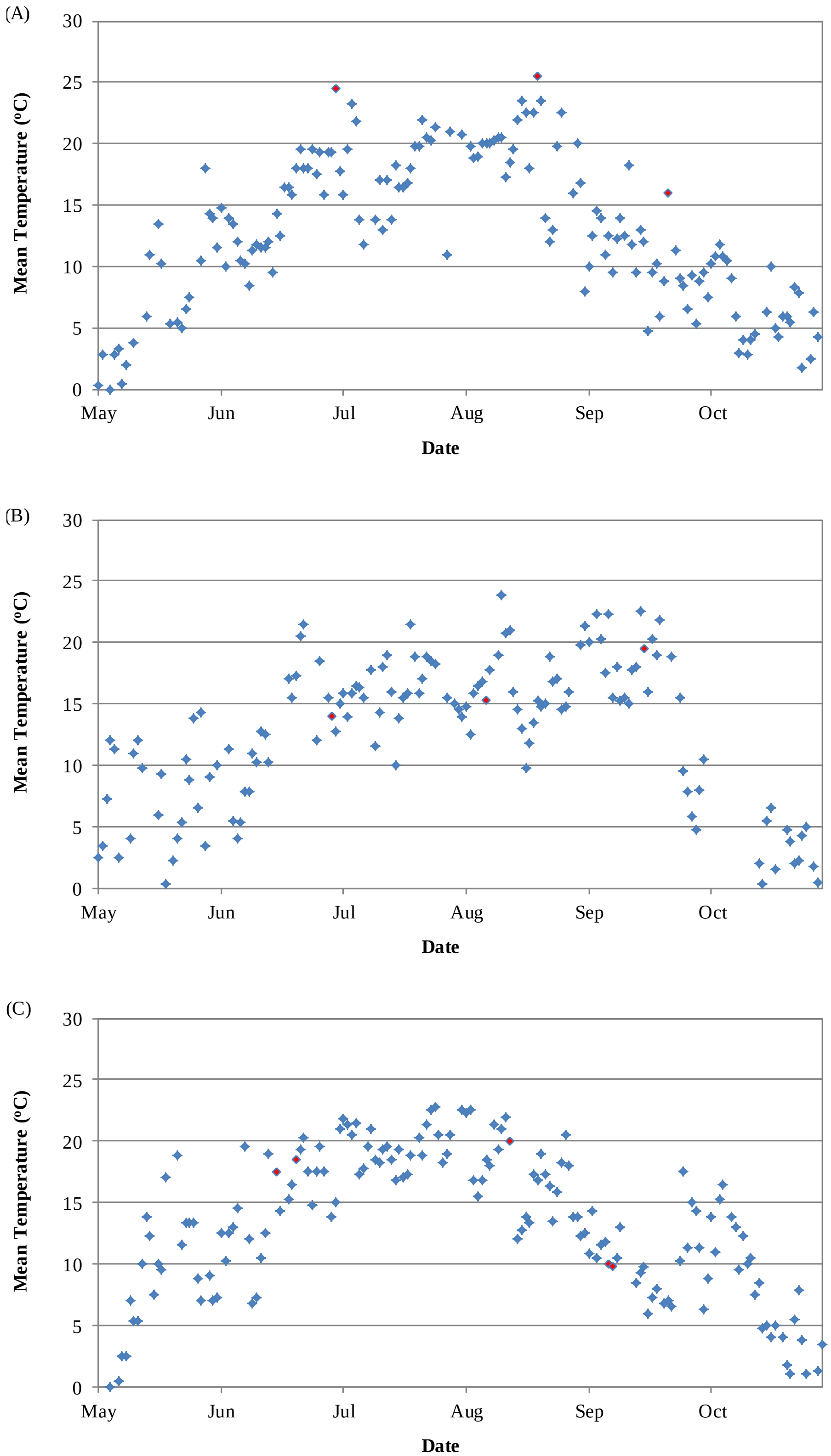


Figure 5.2.4-2. Mean daily air temperatures and water quality sampling dates (indicated in red) for the Saskatchewan River Region: (A) 2008; (B) 2009; and (C) 2010.

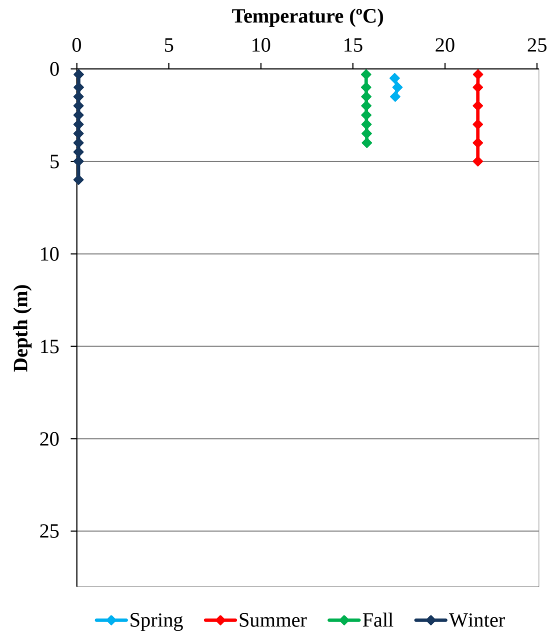


Figure 5.2.4-3. Water temperature profiles measured in the Saskatchewan River 2010/2011.

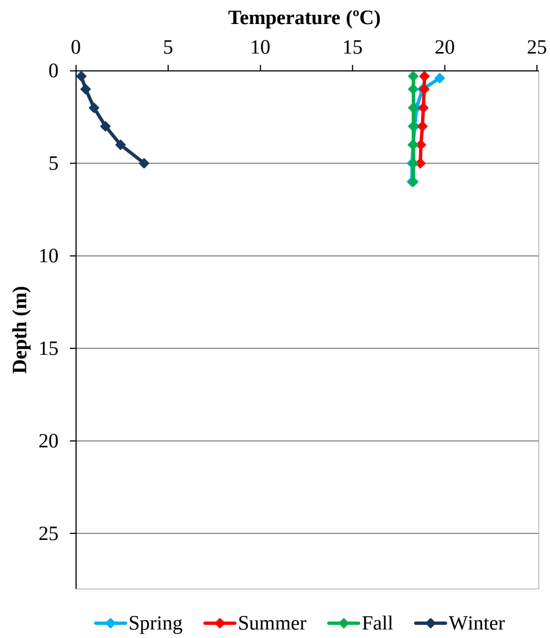


Figure 5.2.4-4. Water temperature profiles measured in South Moose Lake 2009/2010.

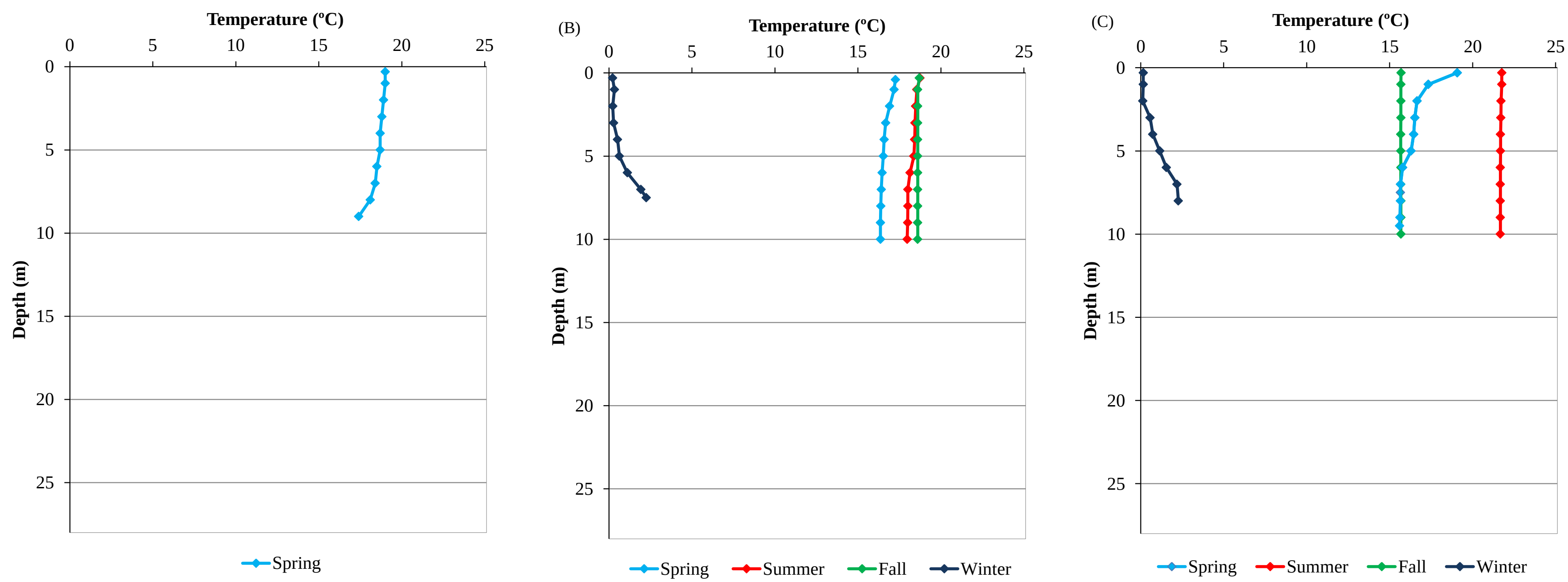


Figure 5.2.4-5. Water temperature profiles measured in Cedar Lake: (A) 2008/2009; (B) 2009/2010; and (C) 2010/2011.

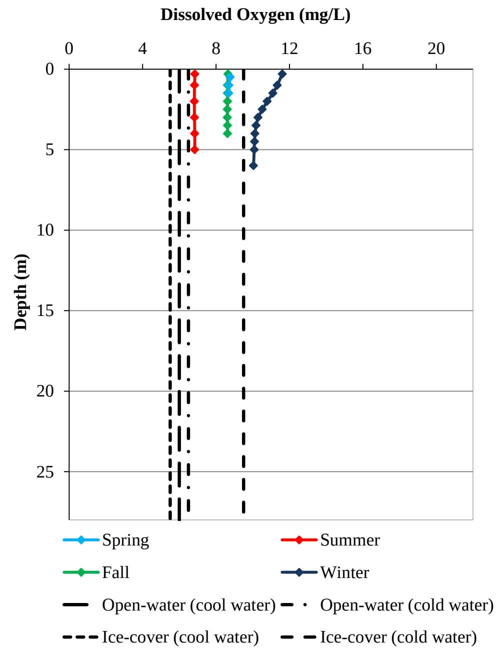


Figure 5.2.4-6. Dissolved oxygen depth profiles measured in the Saskatchewan River 2010/2011.

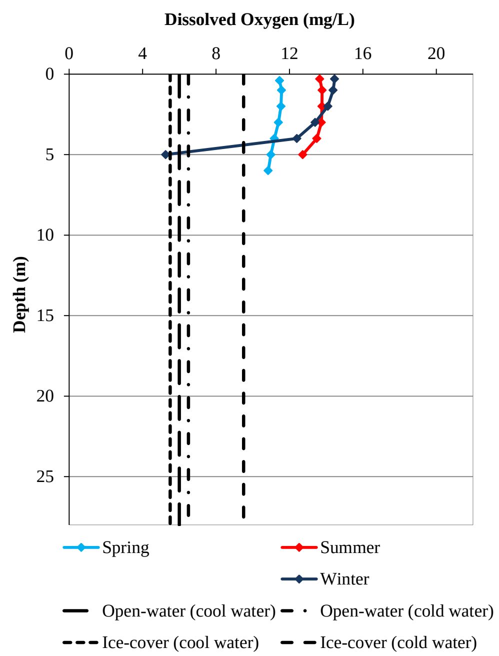


Figure 5.2.4-7. Dissolved oxygen depth profiles measured in South Moose Lake 2009/2010.

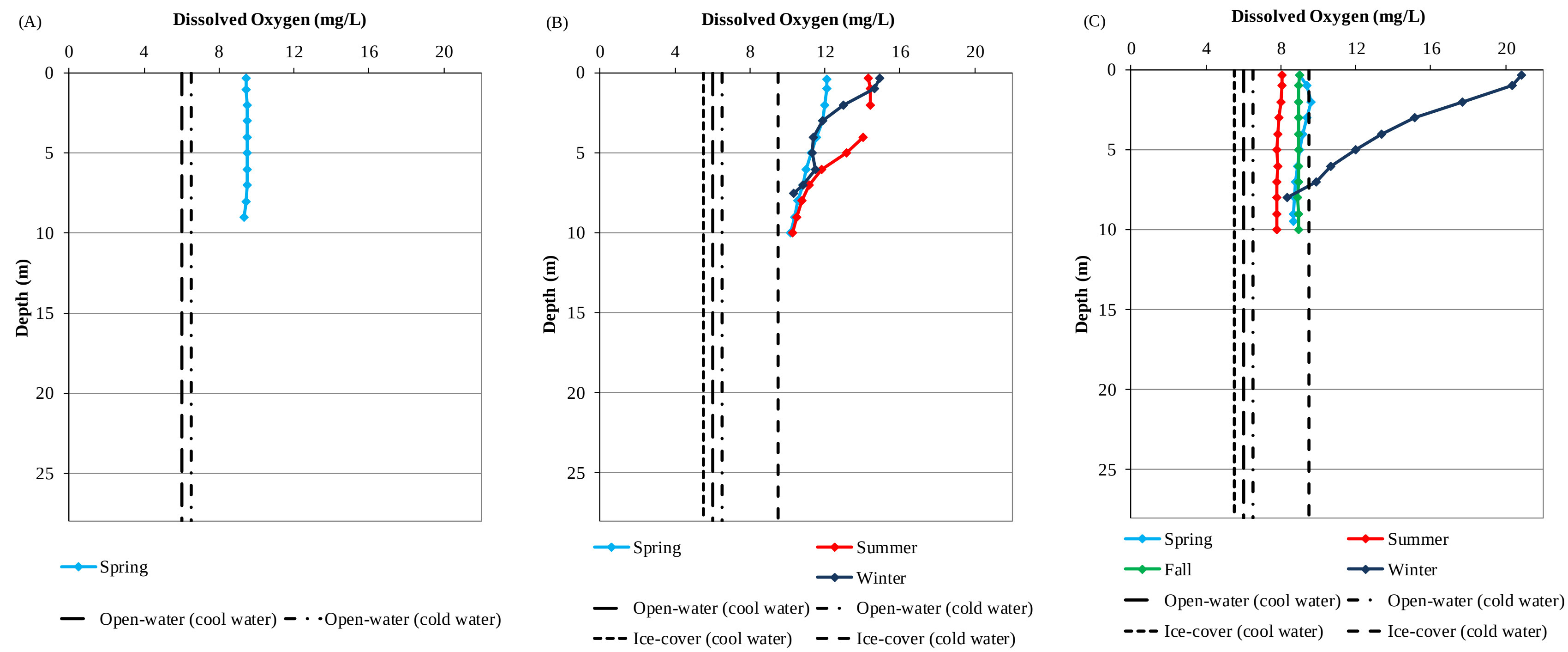


Figure 5.2.4-8. Dissolved oxygen depth profiles measured in Cedar Lake: (A) 2008/2009; (B) 2009/2010; and (C) 2010/2011.

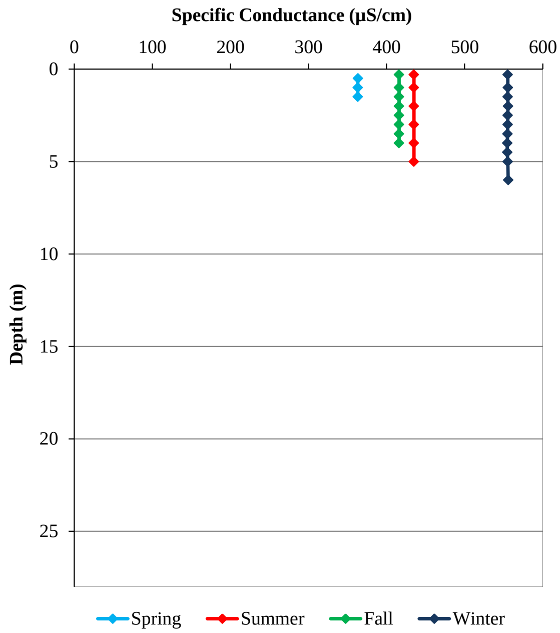


Figure 5.2.4-9. Specific conductance depth profiles measured in the Saskatchewan River 2010/2011.

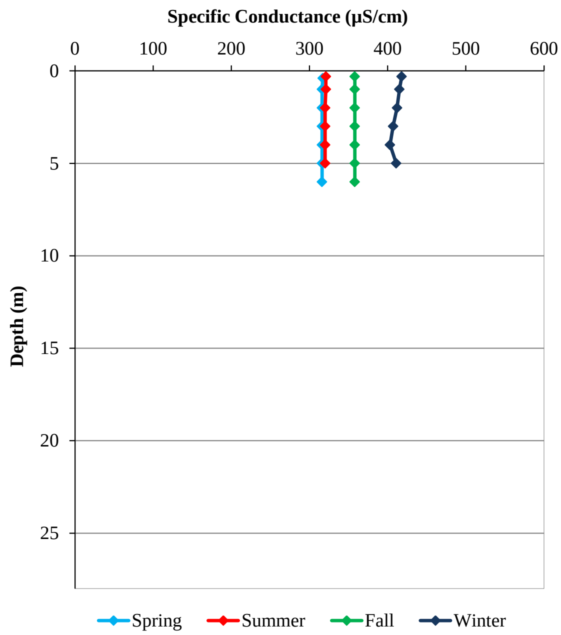


Figure 5.2.4-10. Specific conductance depth profiles measured in South Moose Lake 2009/2010.

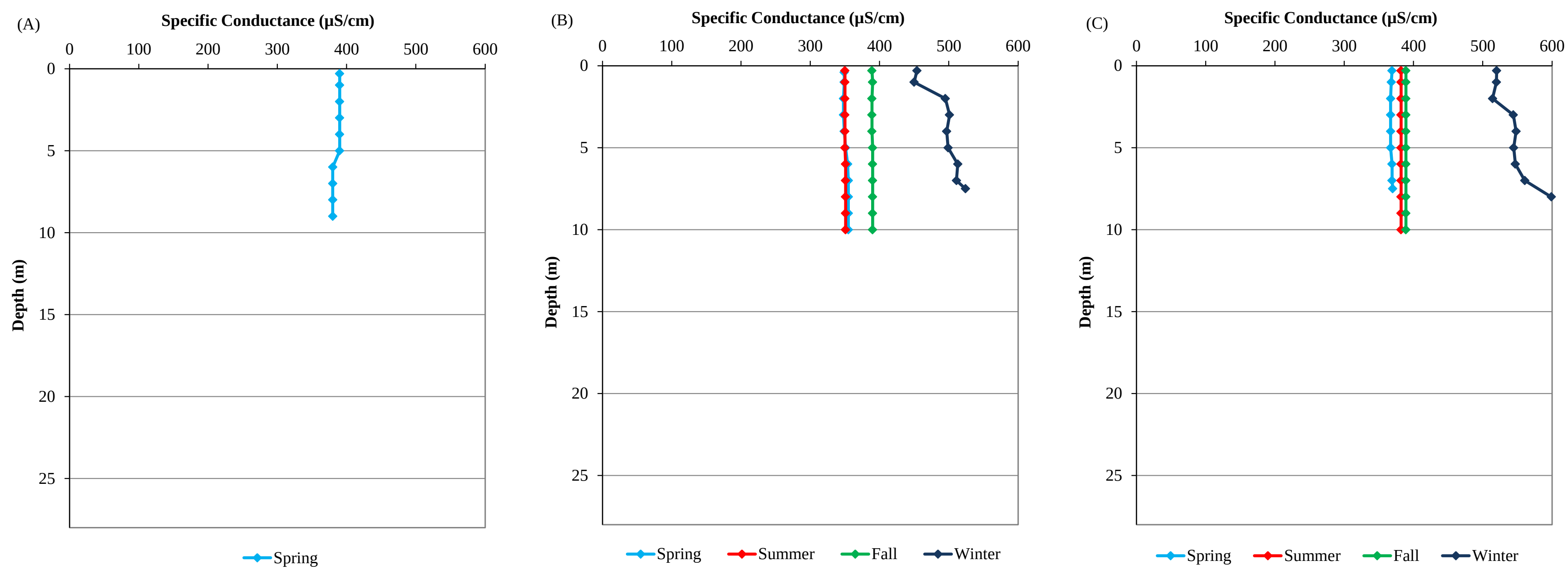


Figure 5.2.4-11. Specific conductance depth profiles measured in Cedar Lake: (A) 2008/2009; (B) 2009/2010; and (C) 2010/2011.

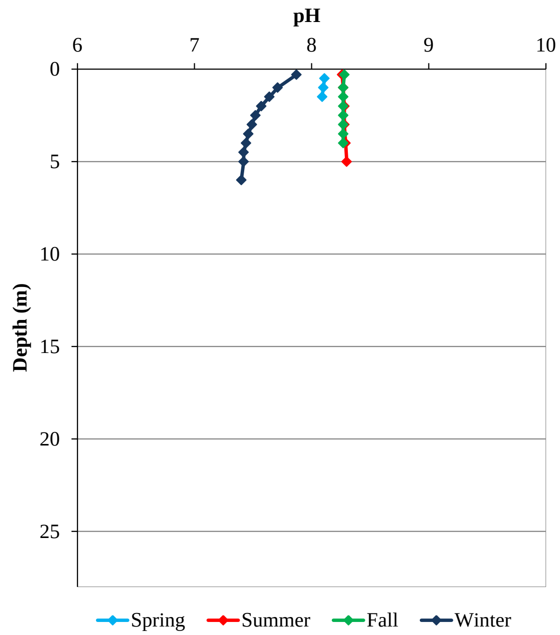


Figure 5.2.4-12. pH depth profiles measured in the Saskatchewan River 2010/2011.

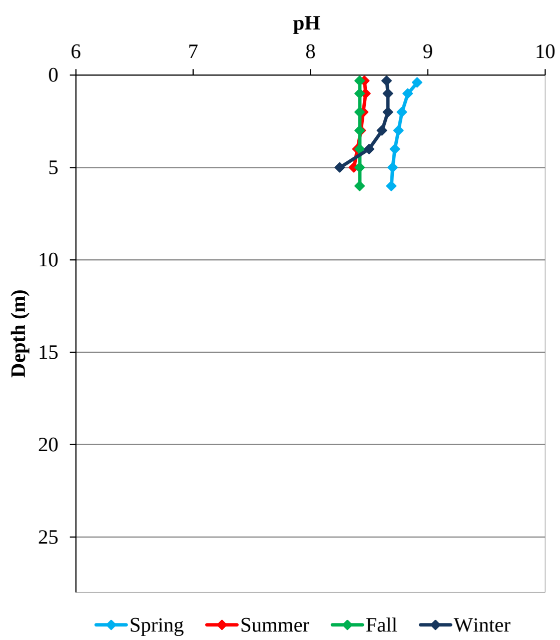


Figure 5.2.4-13. pH depth profiles measured at South Moose Lake 2009/2010.

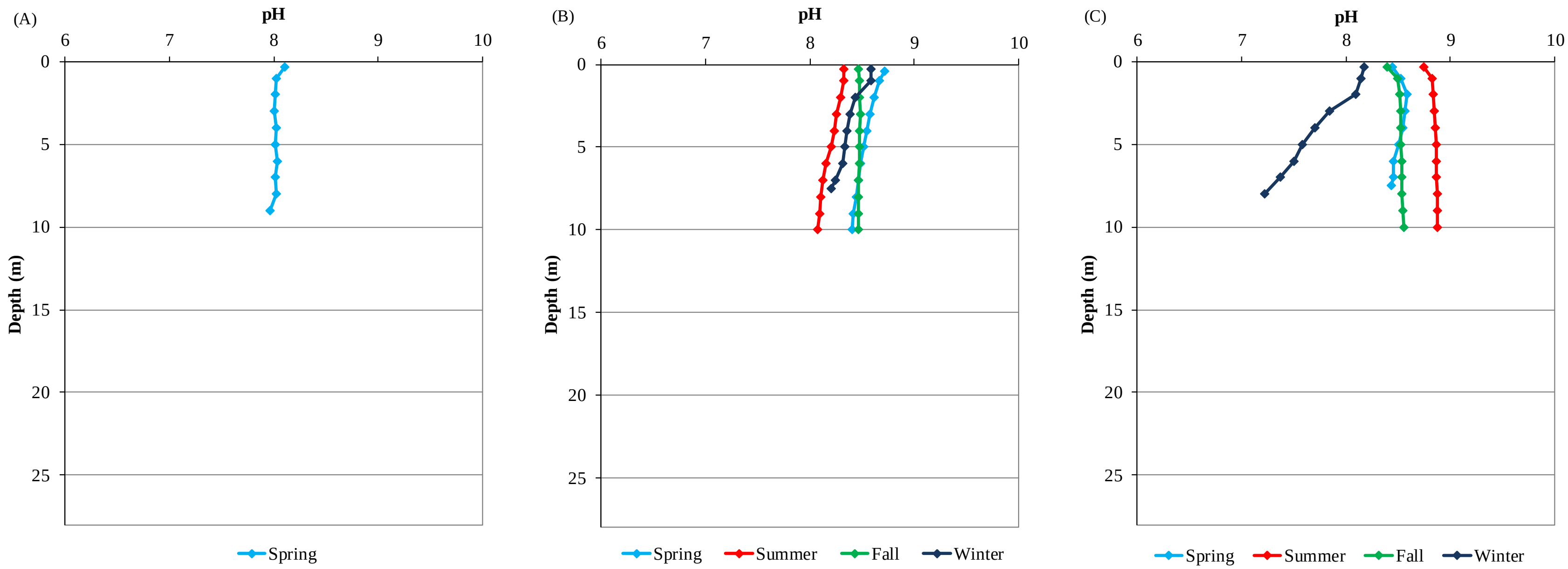


Figure 5.2.4-14. pH depth profiles measured at Cedar Lake: (A) 2008/2009; (B) 2009/2010; and (C) 2010/2011.

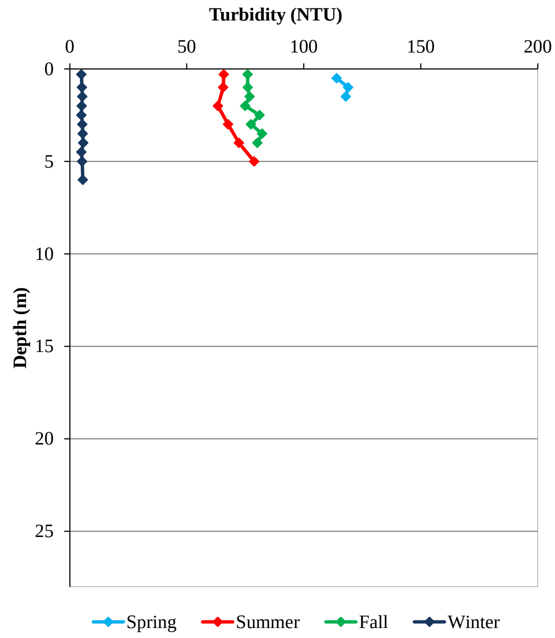


Figure 5.2.4-15. Turbidity depth profiles measured in the Saskatchewan River 2010/2011. Note that the scale differs from that of the other sites in the Saskatchewan River Region.

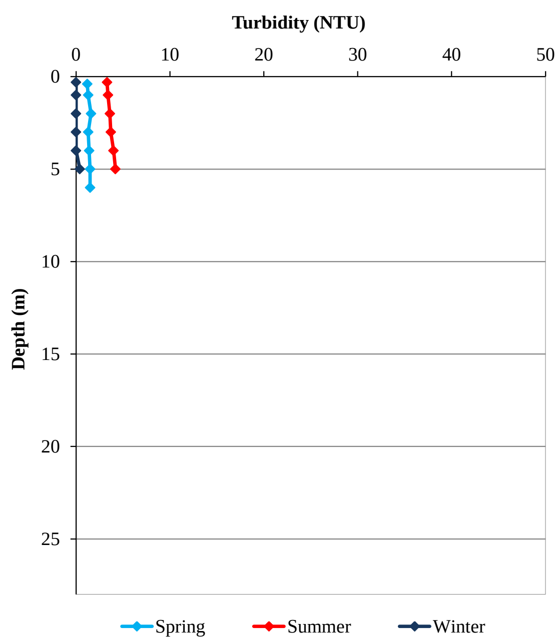


Figure 5.2.4-16. Turbidity depth profiles measured in South Moose Lake 2009/2010.

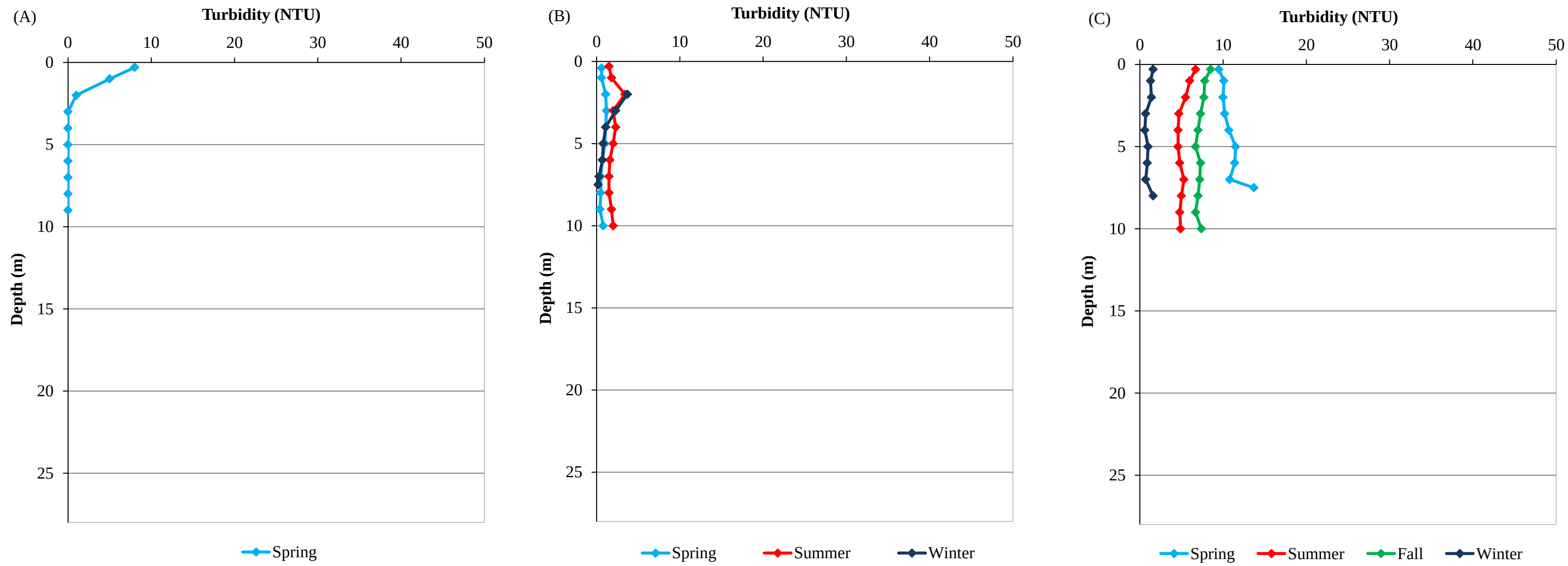


Figure 5.2.4-17. Turbidity depth profiles measured in Cedar Lake: (A) 2008/2009; (B) 2009/2010; and (C) 2010/2011.

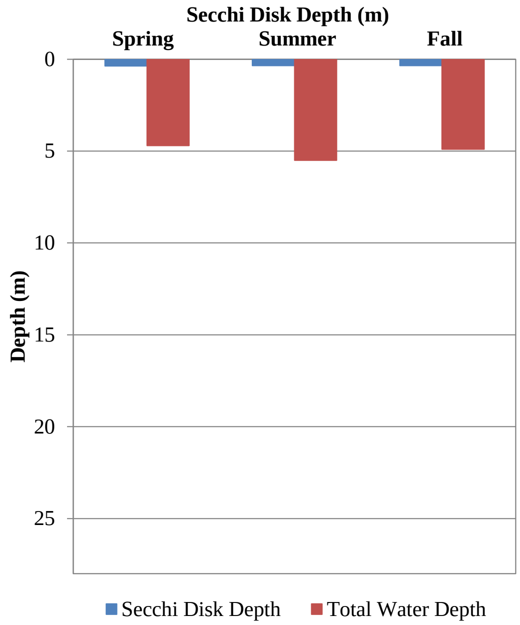


Figure 5.2.4-18. Secchi disk depths measured in the Saskatchewan River 2010/2011.

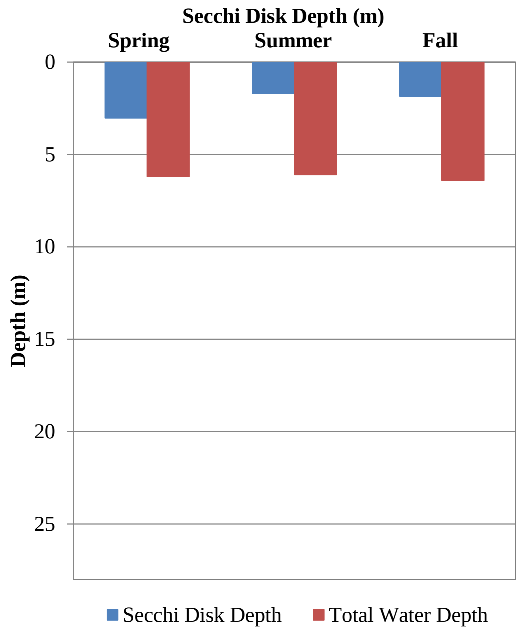


Figure 5.2.4-19. Secchi disk depths measured in South Moose Lake 2009/2010.

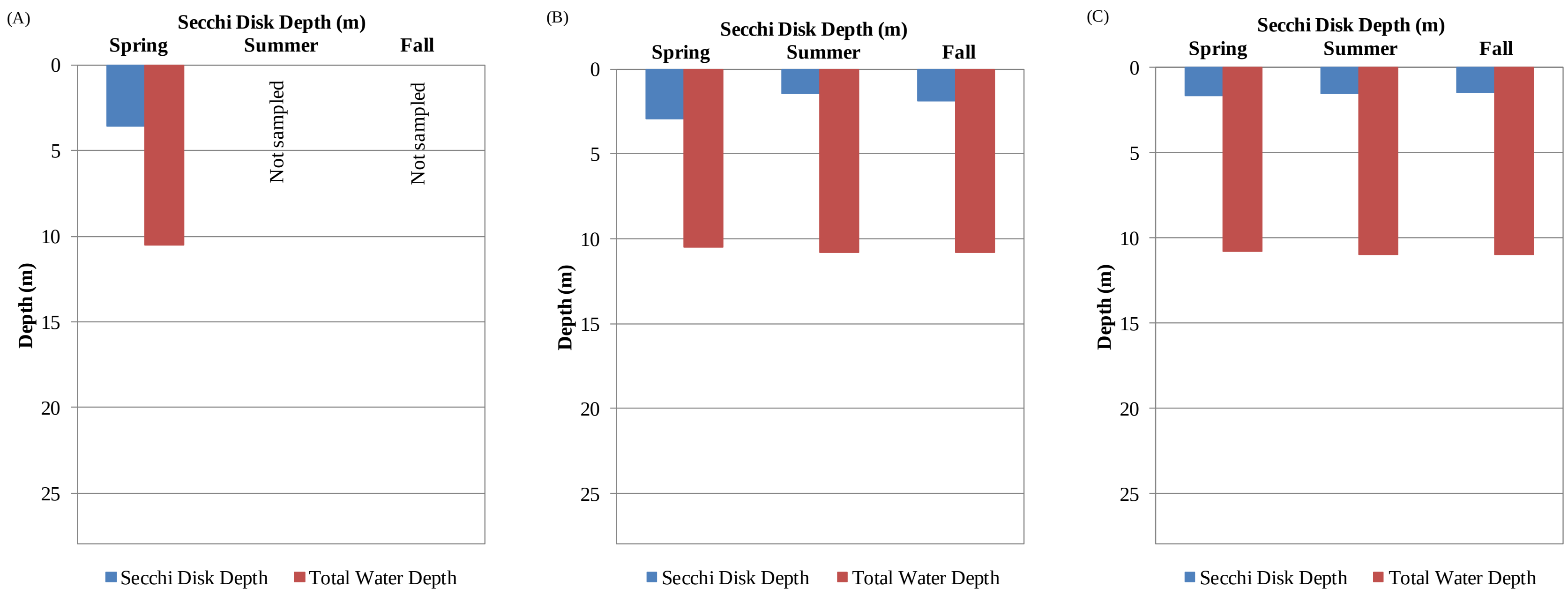


Figure 5.2.4-20. Secchi disk depths measured in Cedar Lake: (A) 2008/2009; (B) 2009/2010; and (C) 2010/2011.

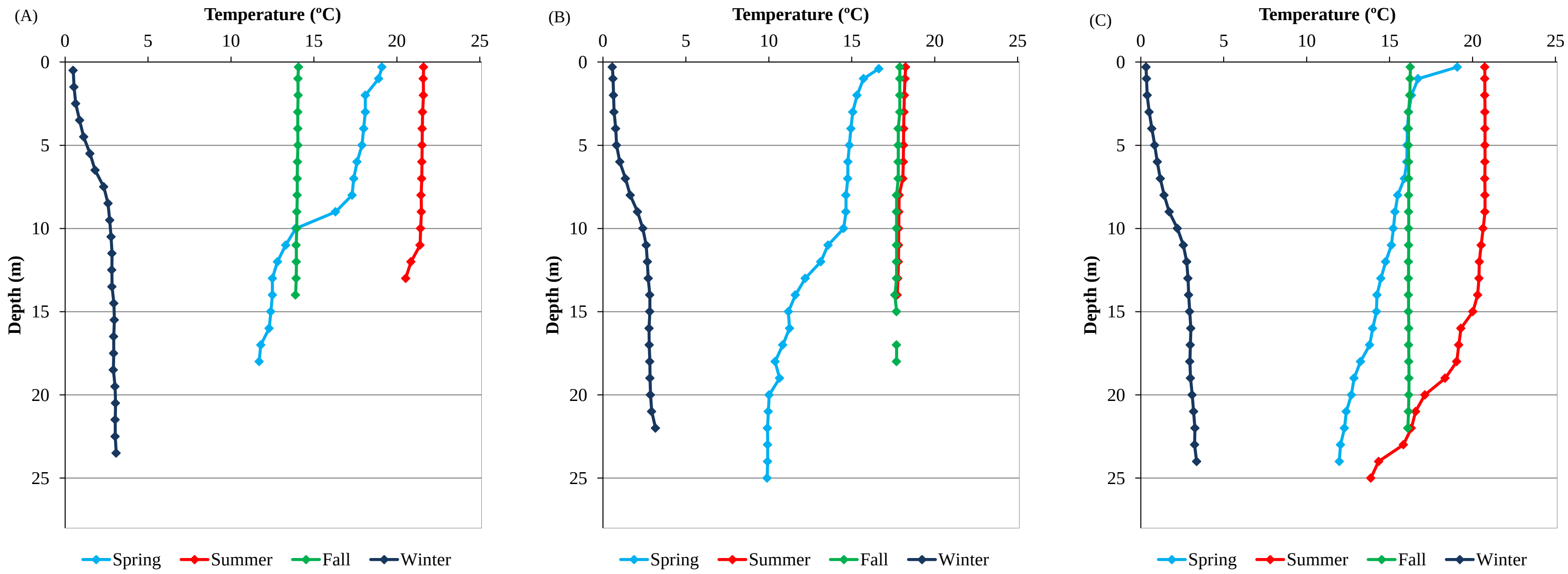


Figure 5.2.4-21. Water temperature profiles measured in Cormorant Lake: (A) 2008/2009; (B) 2009/2010; and (C) 2010/2011.

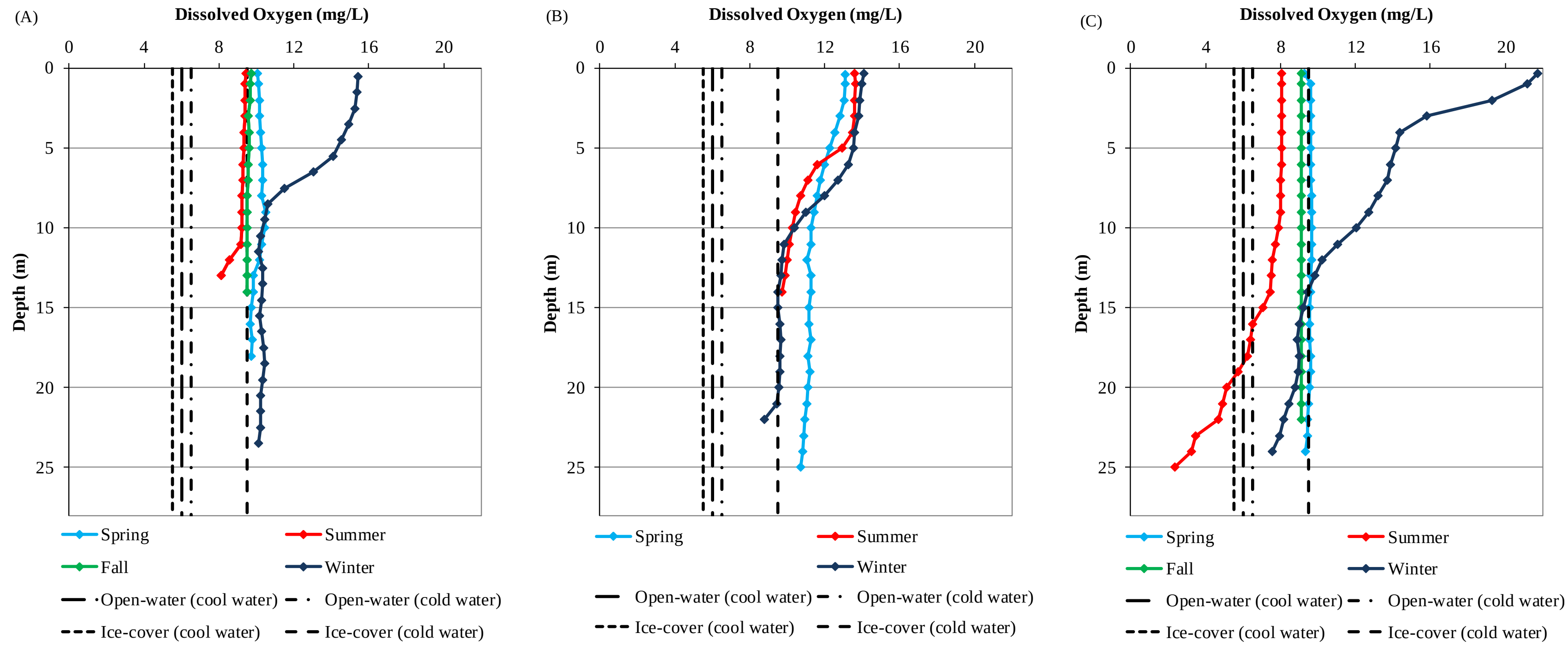


Figure 5.2.4-22. Dissolved oxygen depth profiles measured in Cormorant Lake: (A) 2008/2009; (B) 2009/2010; and (C) 2010/2011.

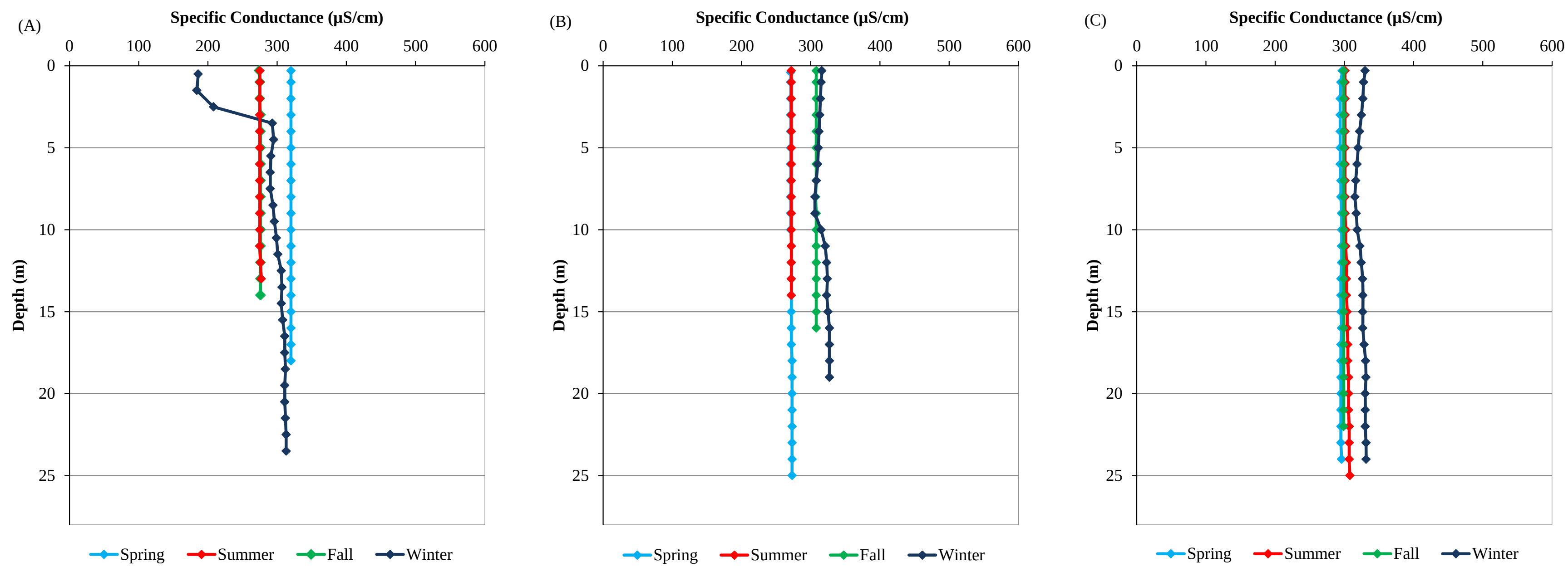


Figure 5.2.4-23. Specific conductance depth profiles measured at Cormorant Lake: (A) 2008/2009; (B) 2009/2010; and (C) 2010/2011.

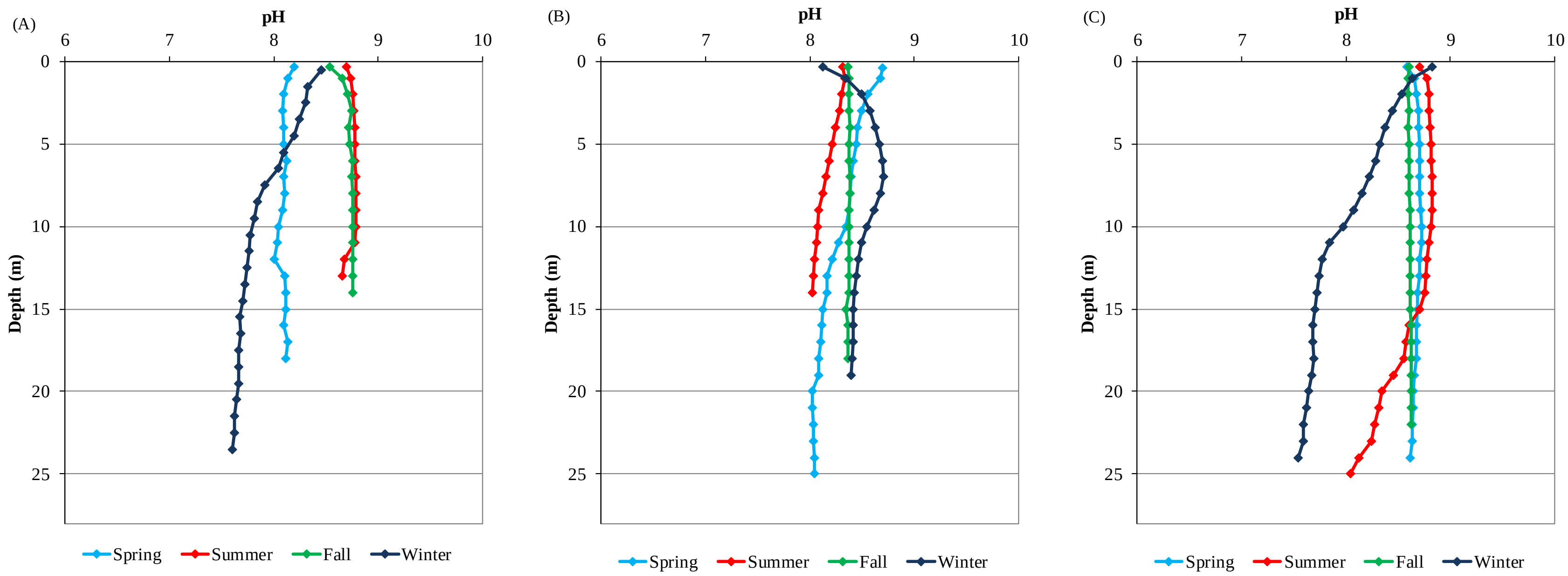


Figure 5.2.4-24. pH depth profiles measured in Cormorant Lake: (A) 2008/2009; (B) 2009/2010; and (C) 2010/2011.

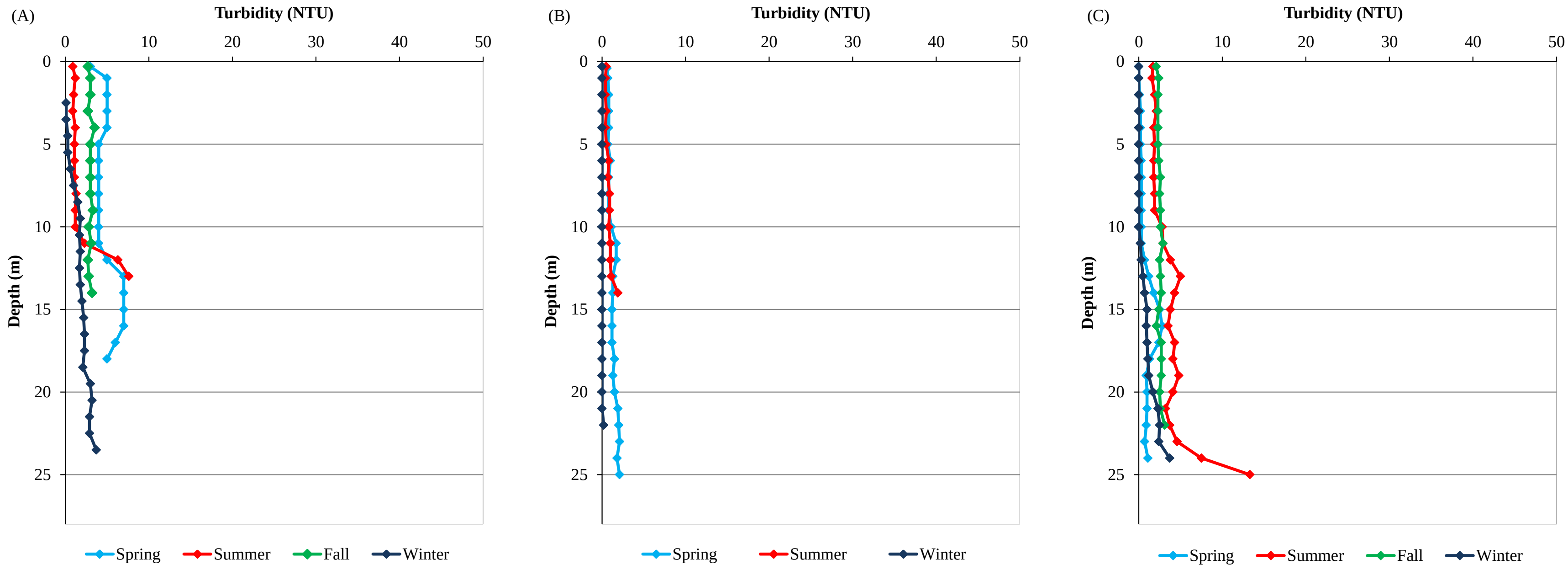


Figure 5.2.4-25. Turbidity depth profiles measured in Cormorant Lake: (A) 2008/2009; (B) 2009/2010; and (C) 2010/2011.

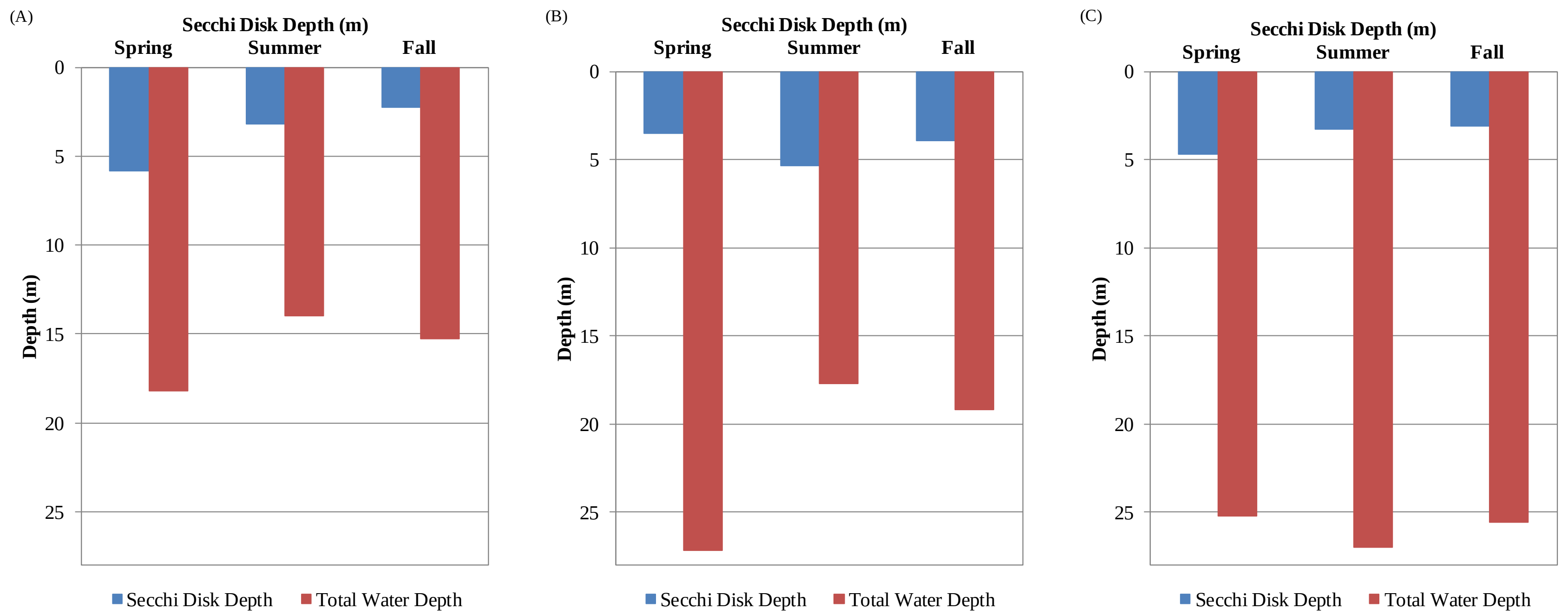


Figure 5.2.4-26. Secchi disk depths measured in Cormorant Lake: (A) 2008/2009; (B) 2009/2010; and (C) 2010/2011.

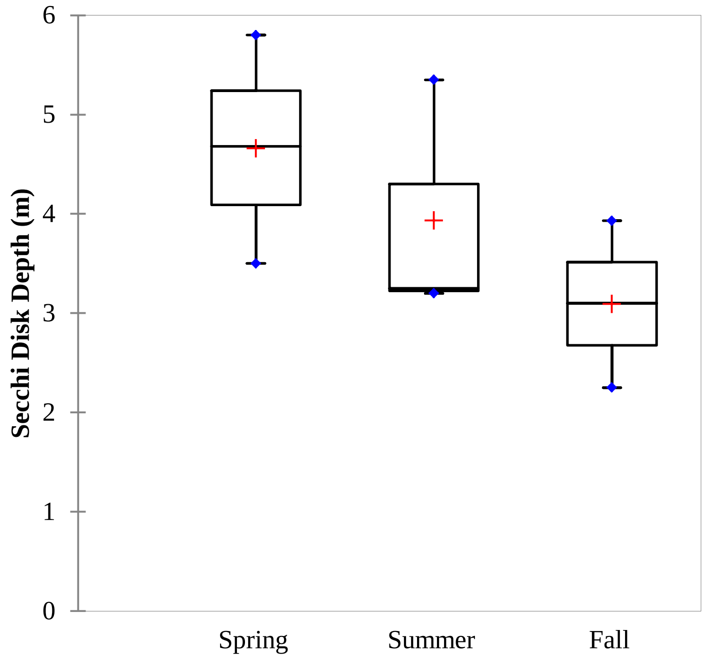


Figure 5.2.4-27. Secchi disk depth at Cormorant Lake by season. There were no significant differences between seasons.

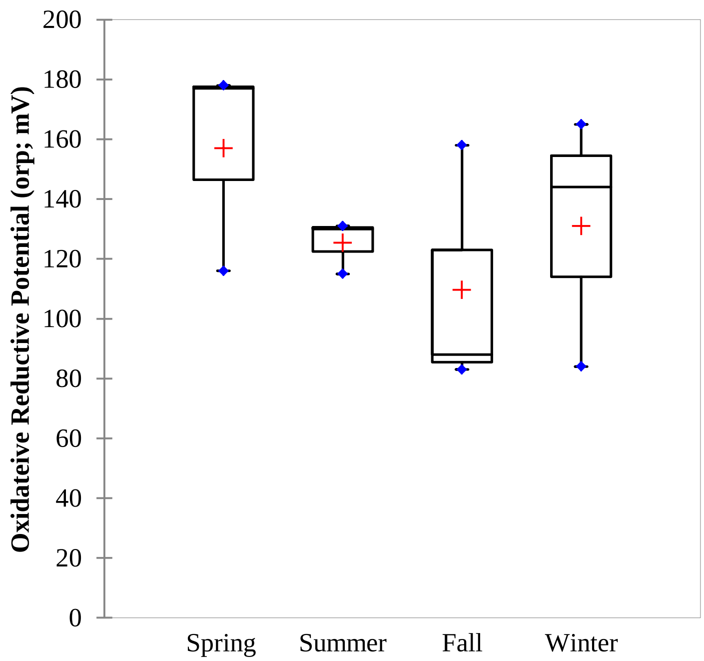


Figure 5.2.4-28. Oxidation-reduction potential at Cormorant Lake by season. There were no significant differences between seasons.

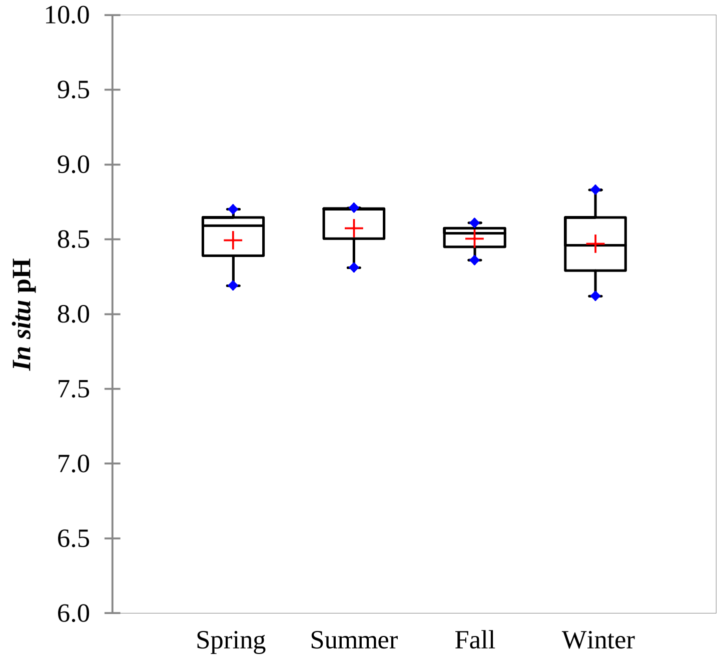


Figure 5.2.4-29. *In situ* pH at Cormorant Lake by season. There were no significant differences between seasons.

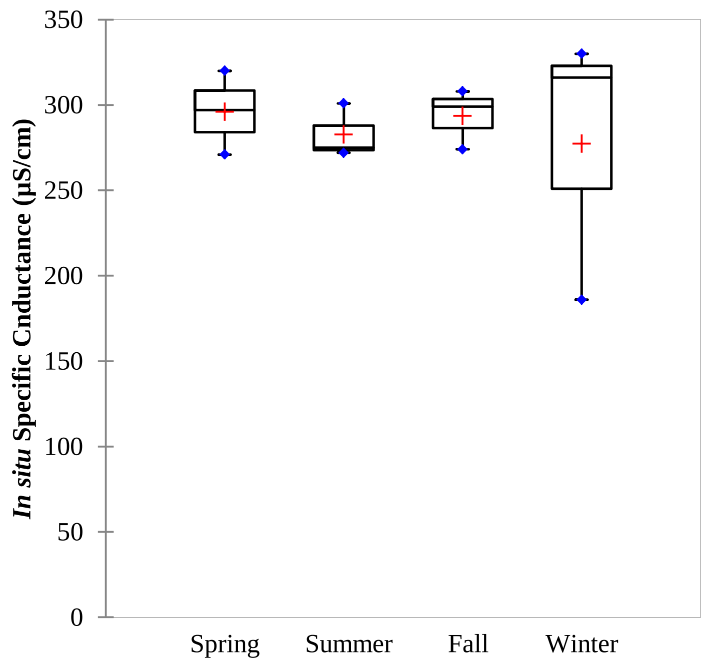


Figure 5.2.4-30. *In situ* specific conductance at Cormorant Lake by season. There were no significant differences between seasons.

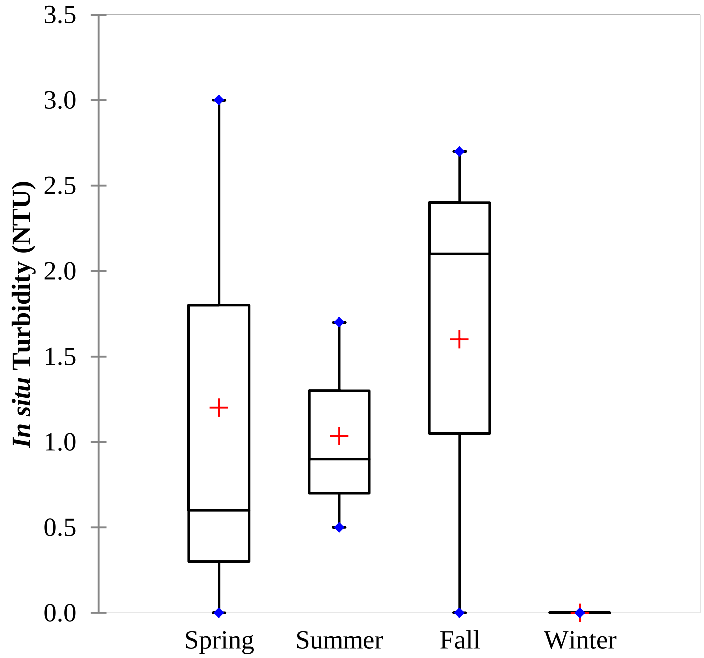


Figure 5.2.4-31. *In situ* turbidity at Cormorant Lake by season. There were no significant differences between seasons.

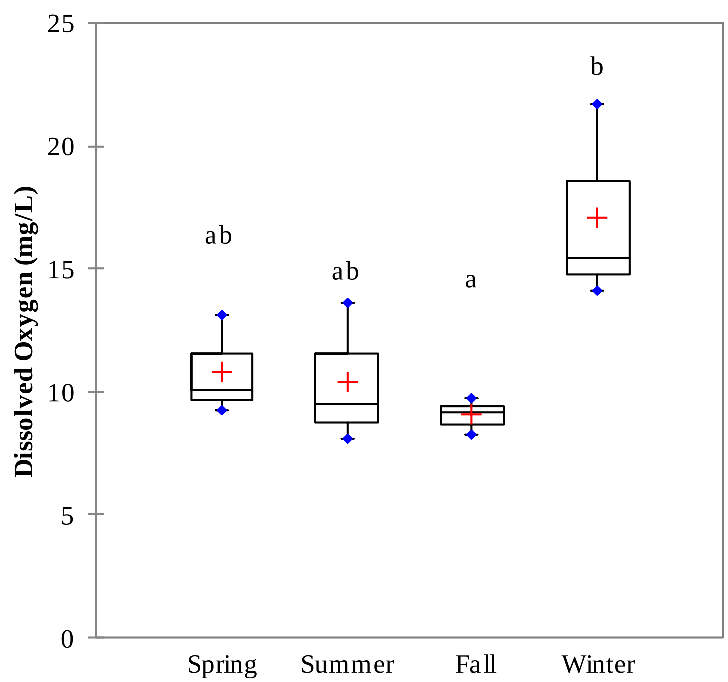


Figure 5.2.4-32. Dissolved oxygen in Cormorant Lake by season. Statistically significant seasonal differences are denoted with different superscripts.

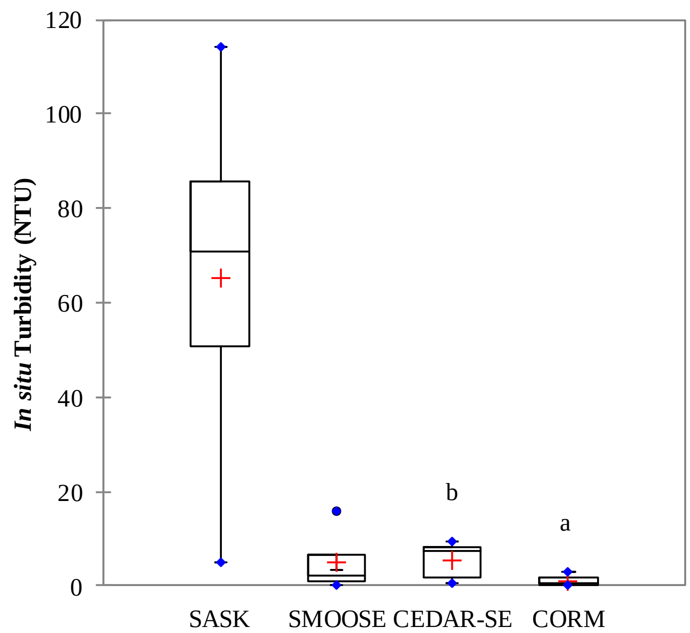


Figure 5.2.4-33. *In situ* turbidity in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

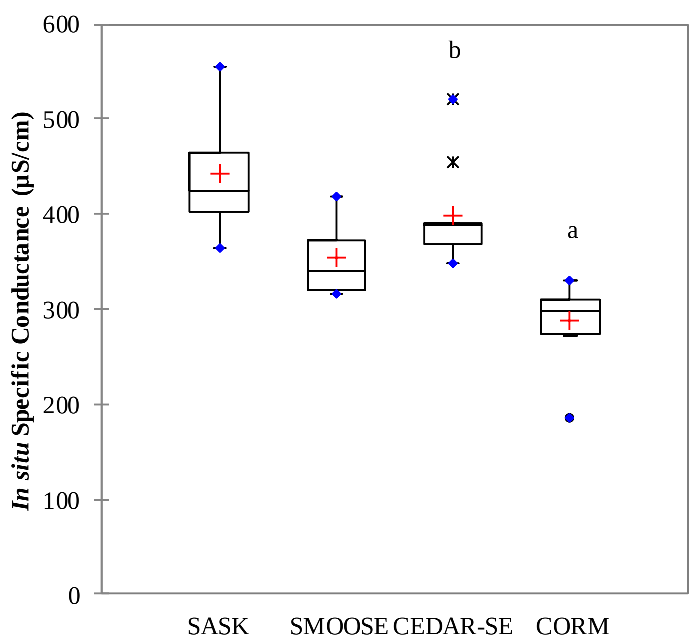


Figure 5.2.4-34. *In situ* specific conductance in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

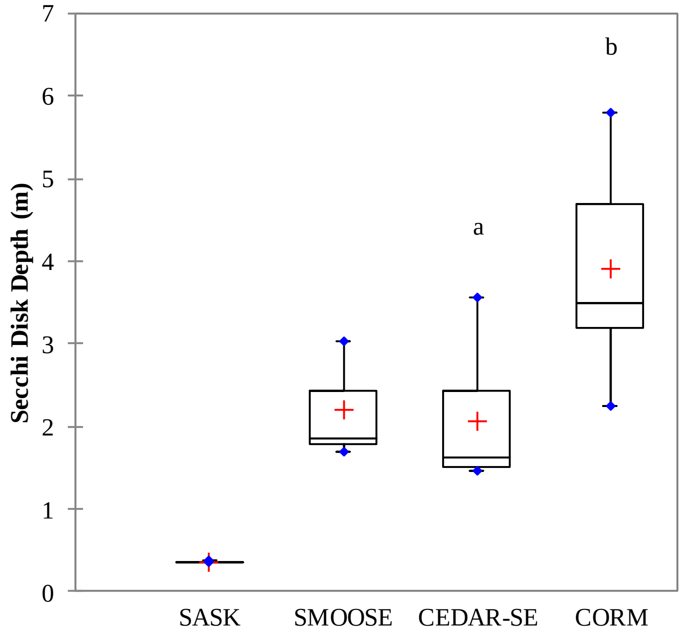


Figure 5.2.4-35. Secchi disk depths in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

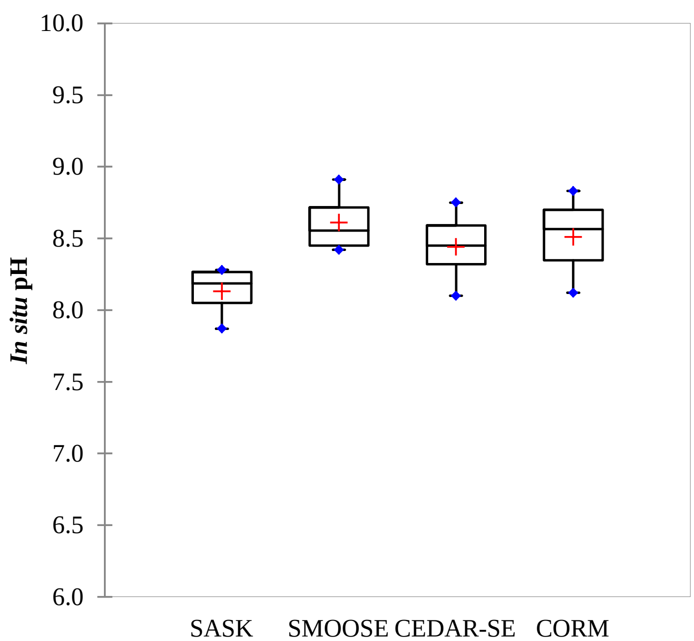


Figure 5.2.4-36. *In situ* pH in the Saskatchewan River Region: 2008-2010. There were no significant differences between sites.

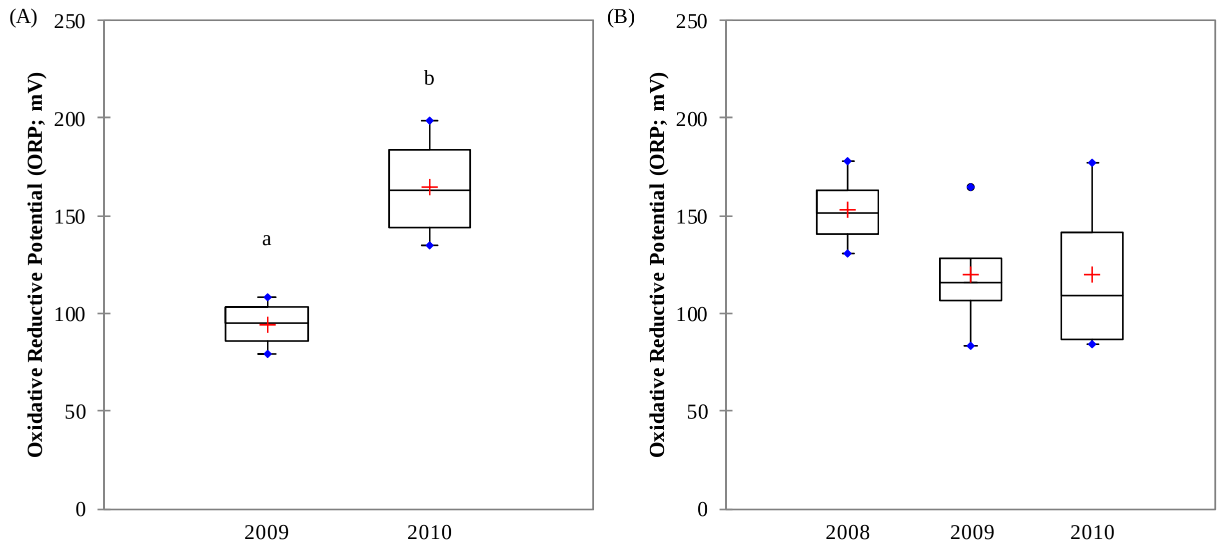


Figure 5.2.4-37. Oxidative reductive potential in the Saskatchewan River Region by year: (A) Cedar Lake; and (B) Cormorant Lake. Statistically significant differences are denoted with different superscripts.

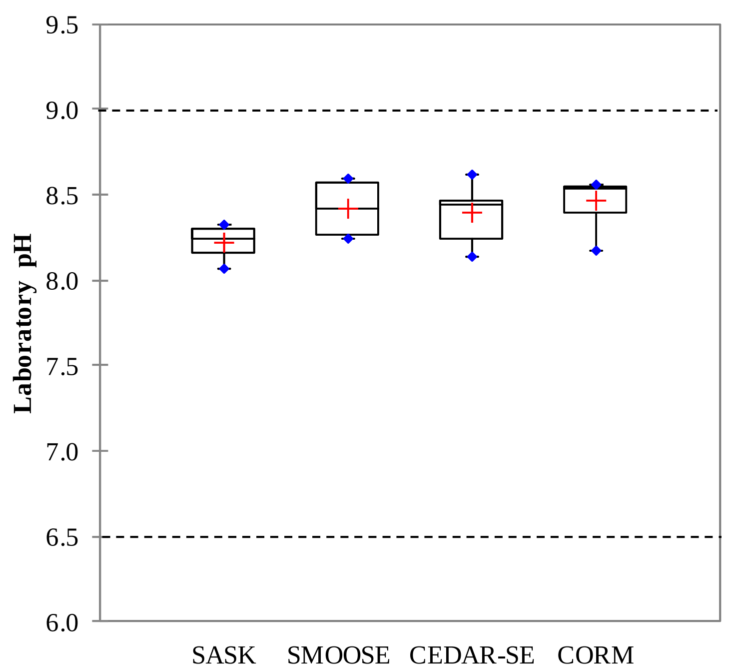


Figure 5.2.4-38. Laboratory pH in the Saskatchewan River Region: 2008-2010. Area between the dashed lines indicates the MWQSOG PAL guideline (6.5-9).

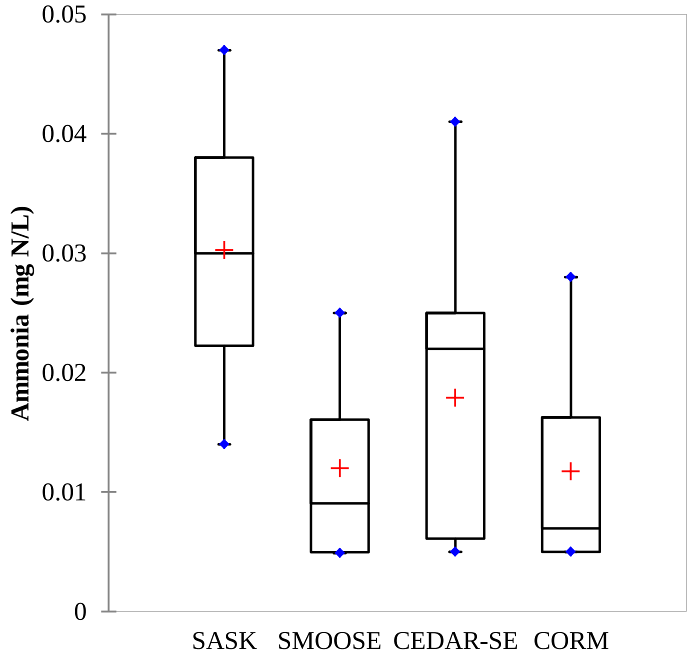


Figure 5.2.4-39. Ammonia in the Saskatchewan River Region: 2008-2010. The most stringent site-specific PAL objective is 0.56 mg N/L.

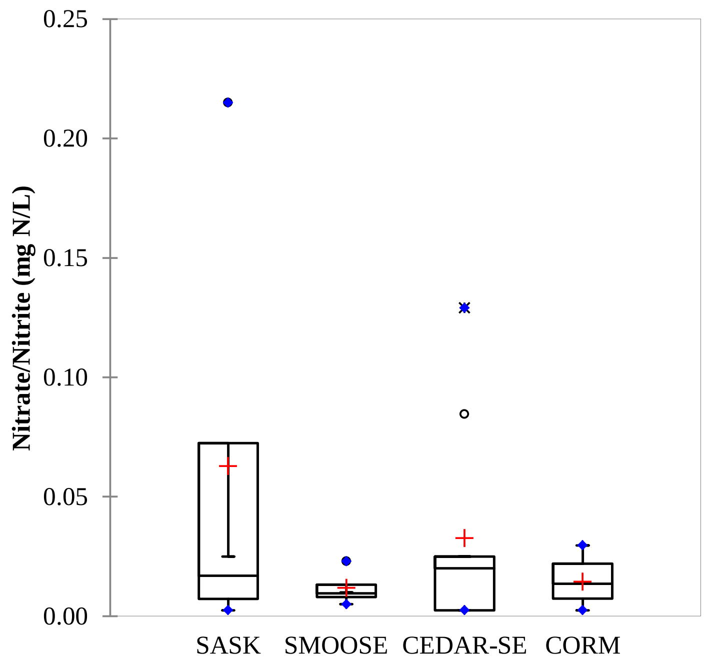


Figure 5.2.4-40. Nitrate/nitrite in the Saskatchewan River Region: 2008-2010. The MWQSOG PAL guideline is 2.93 mg N/L.

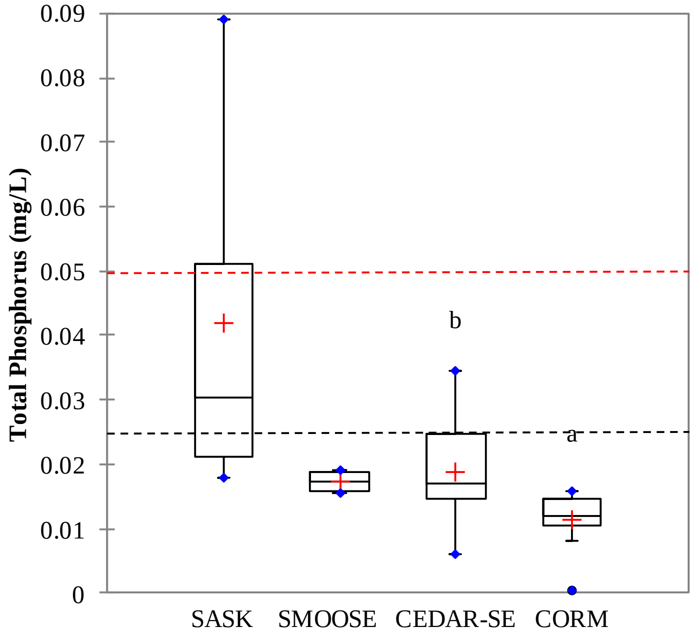


Figure 5.2.4-41. Total phosphorus in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts. The black dashed line represents the Manitoba narrative guideline for lakes, ponds, reservoirs, and tributaries to such waterbodies; the red dashed line is the guideline for streams and rivers.

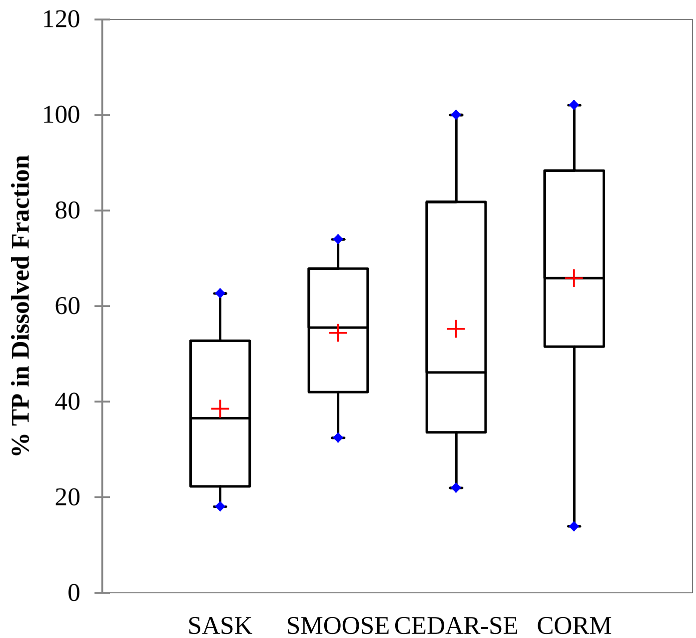


Figure 5.2.4-42. Fraction of total phosphorus in dissolved form in the Saskatchewan River Region.

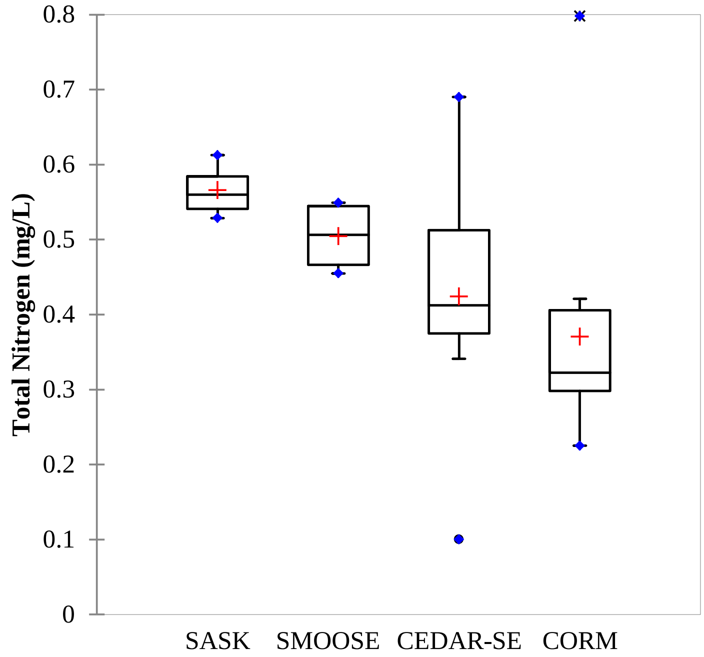


Figure 5.2.4-43. Total nitrogen in the Saskatchewan River Region: 2008-2010.

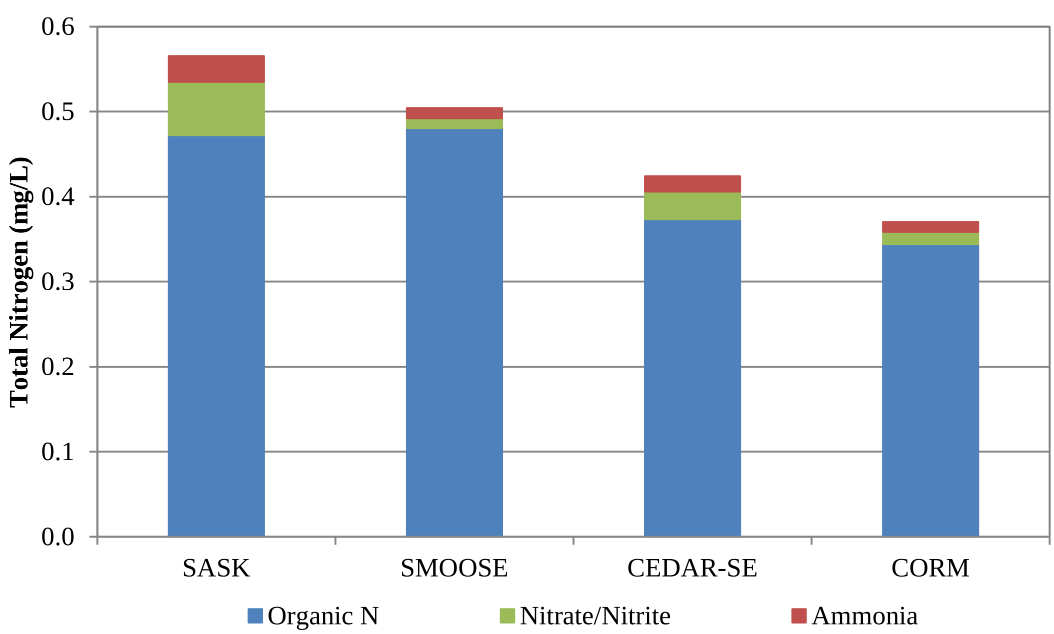


Figure 5.2.4-44. Composition of total nitrogen as organic nitrogen, nitrate/nitrite, and ammonia in the Saskatchewan River Region.

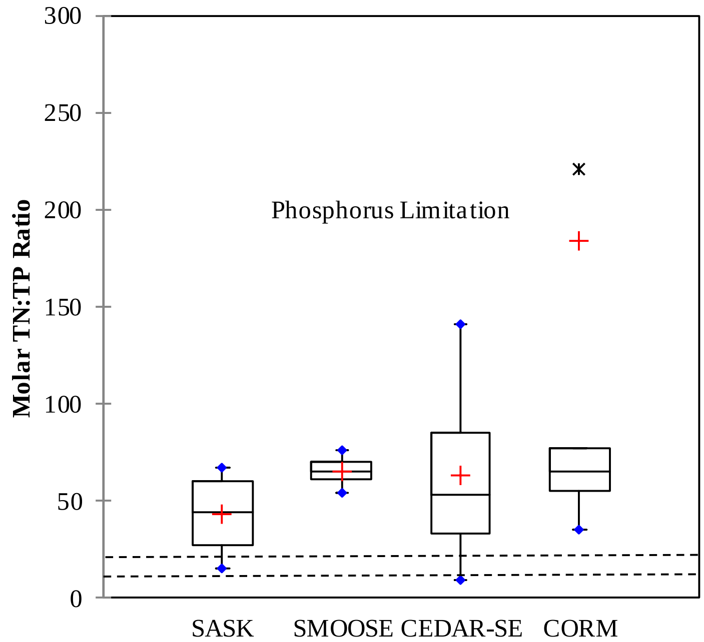


Figure 5.2.4-45. Total nitrogen to total phosphorus molar ratios in the Saskatchewan River Region. Areas represent the limits for nitrogen limitation (0-10), co-limitation (10-20), and phosphorus limitation (>20).

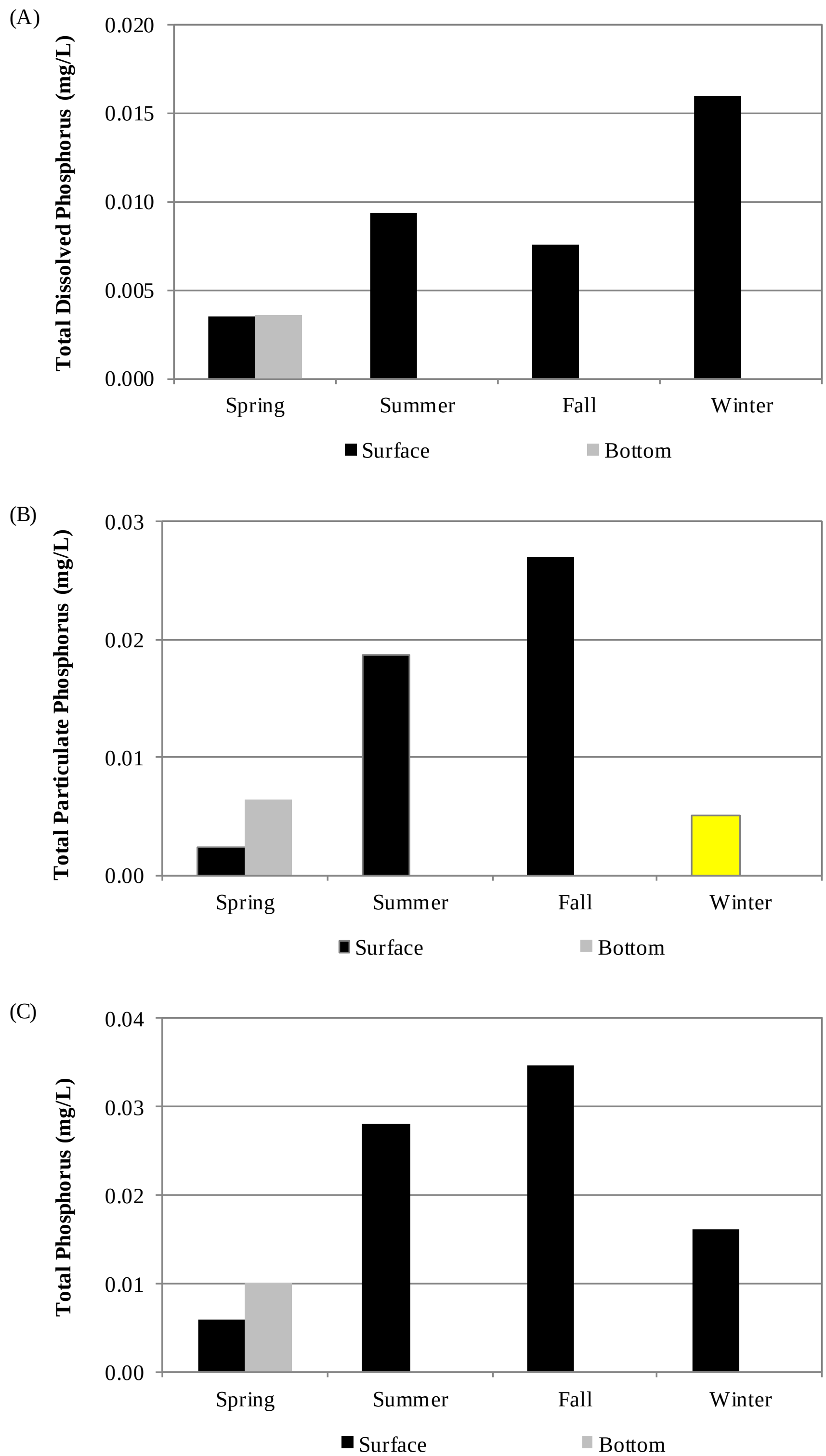


Figure 5.2.4-46. Total dissolved phosphorus (A), total particulate phosphorus (B), and total phosphorus (C) measured in surface grabs and bottom samples in Cedar Lake, 2010/2011. Values in yellow were below the analytical detection limit.

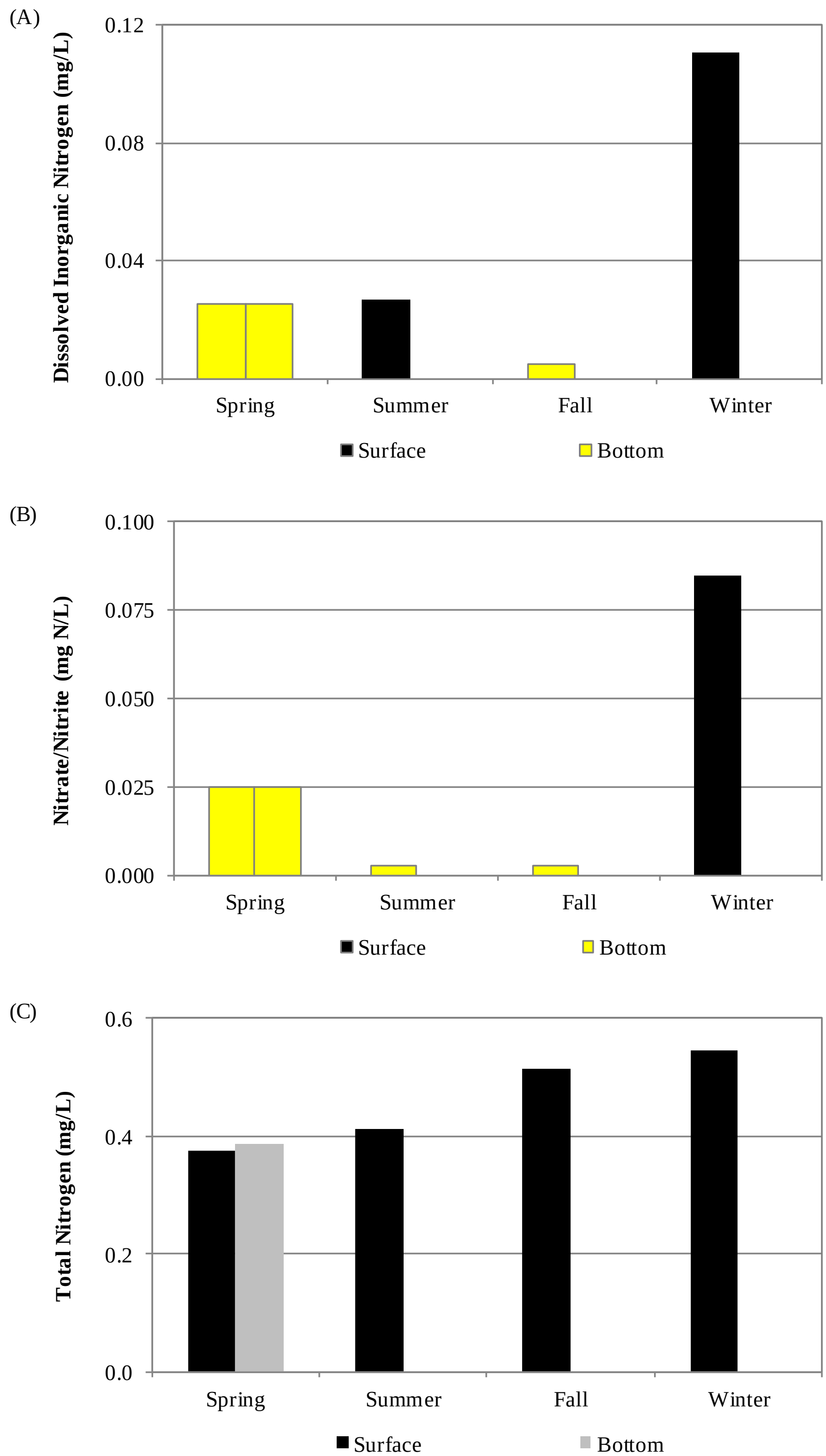


Figure 5.2.4-47. Dissolved inorganic nitrogen (DIN; A), nitrate/nitrite (B), and total nitrogen (C) measured in surface grabs and bottom samples in Cedar Lake, 2010/2011. Values in yellow were below the analytical detection limit.

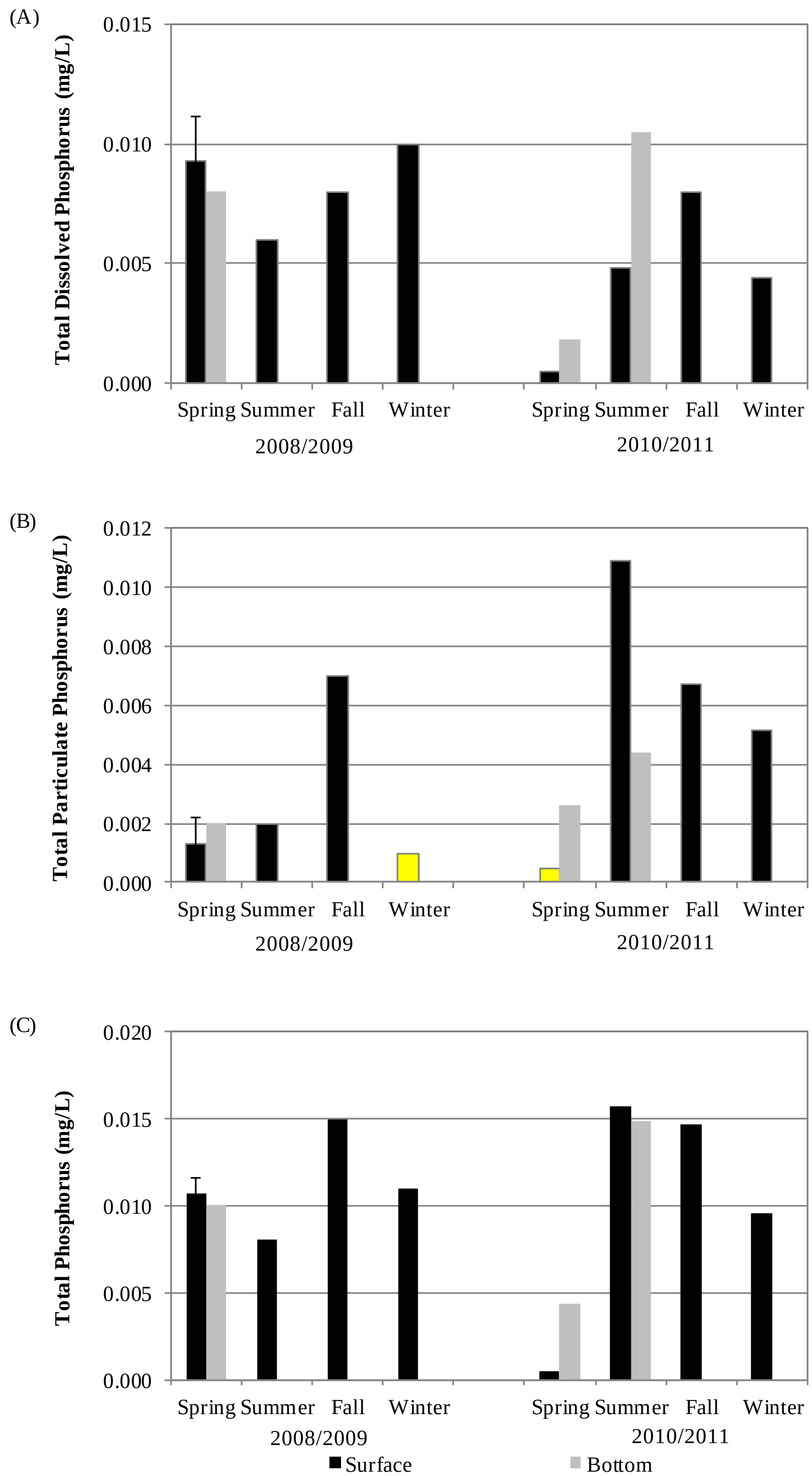


Figure 5.2.4-48. Total dissolved phosphorus (A), total particulate phosphorus (B), and total phosphorus (C) measured in surface grabs and bottom samples in Cormorant Lake, 2008/2009 and 2010/2011. Values in yellow were below the analytical detection limit.

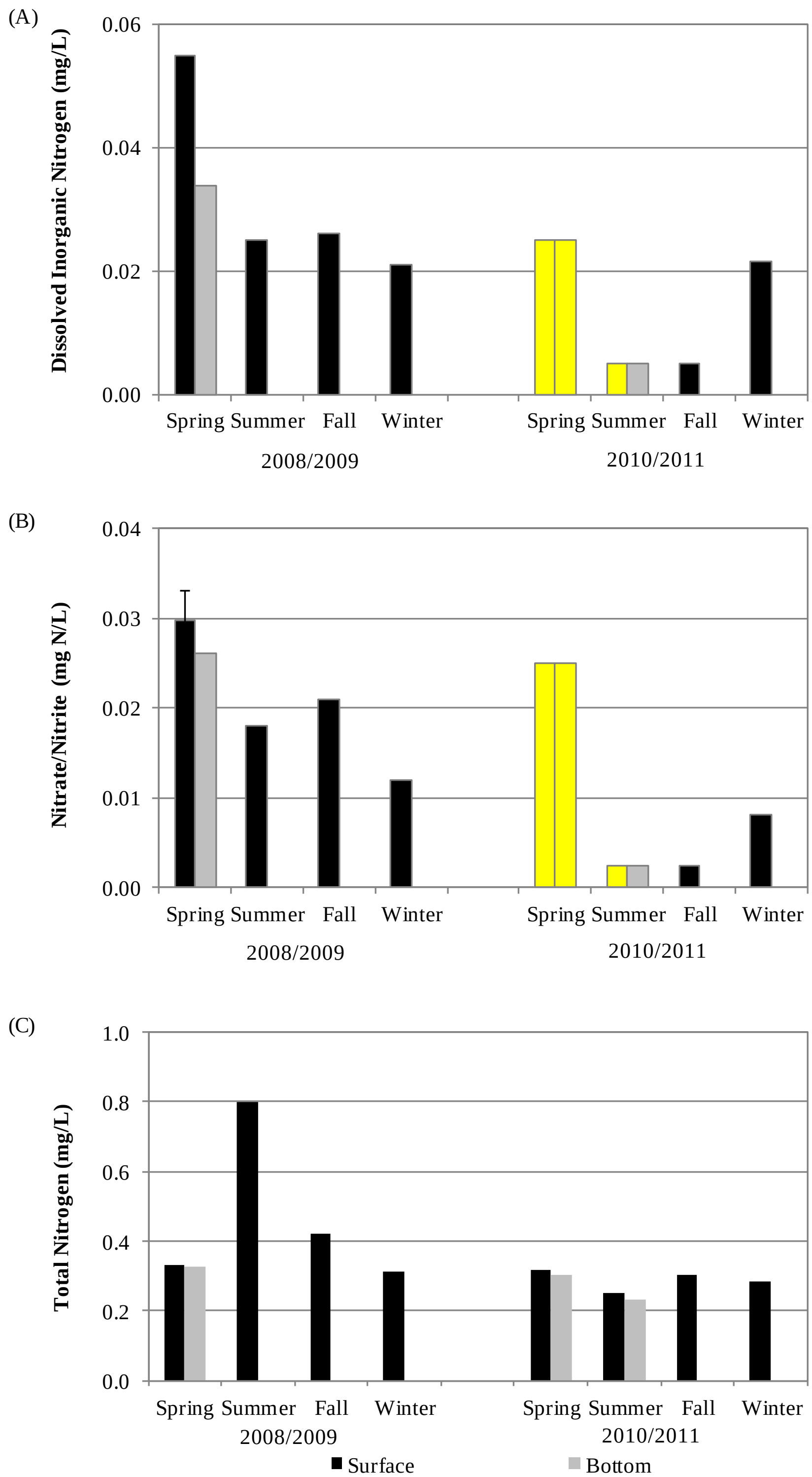


Figure 5.2.4-49. Dissolved inorganic nitrogen (DIN; A), nitrate/nitrite (B), and total nitrogen (C) measured in surface grabs and bottom samples in Cormorant Lake, 2008/09 and 2010/2011. Values in yellow were below the analytical detection limit.

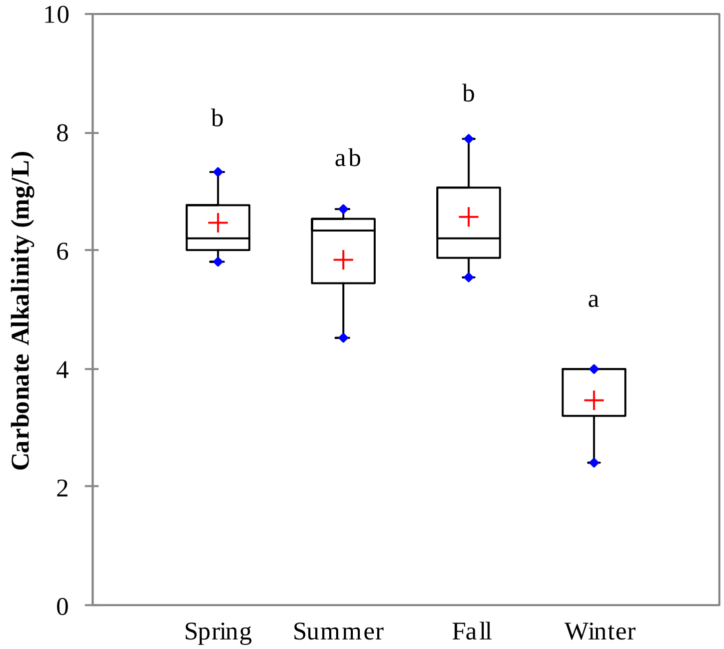


Figure 5.2.4-50. Carbonate in Cormorant Lake by season. Statistically significant seasonal differences are denoted with different superscripts.

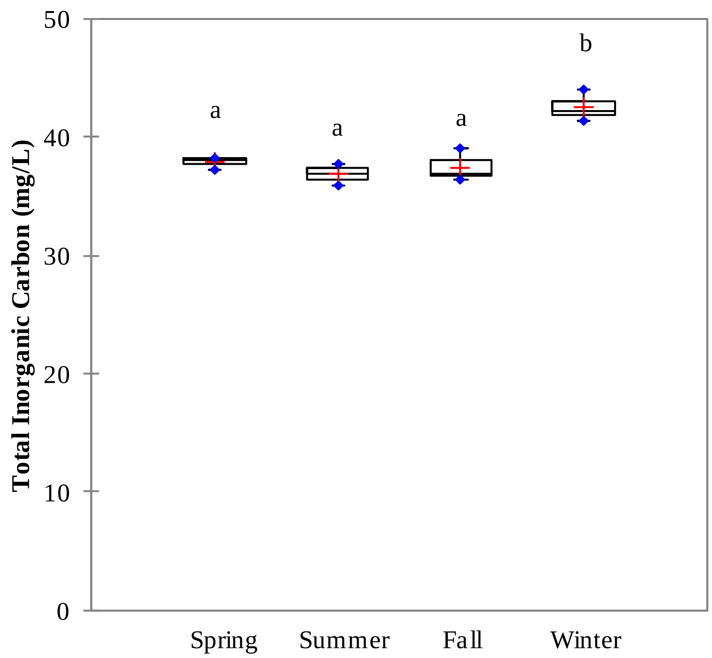


Figure 5.2.4-51. Total inorganic carbon (TIC) in Cormorant Lake by season. Statistically significant seasonal differences are denoted with different superscripts.

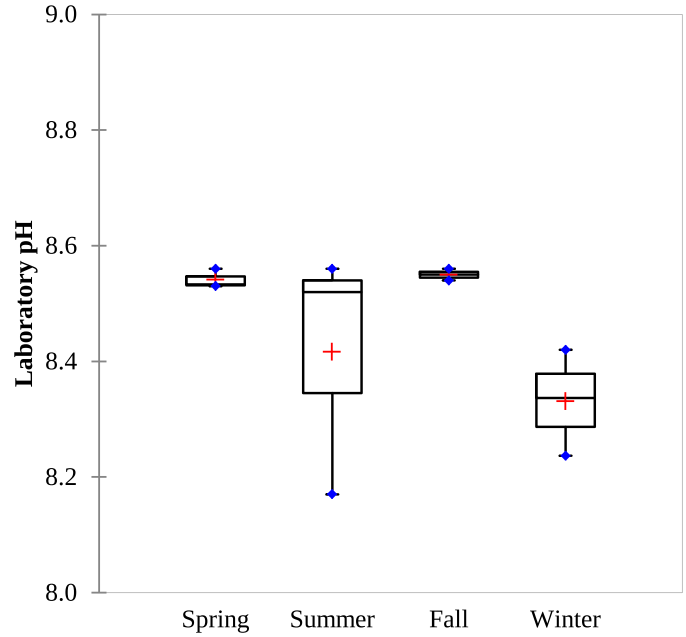


Figure 5.2.4-52. Laboratory pH in Cormorant Lake by season.

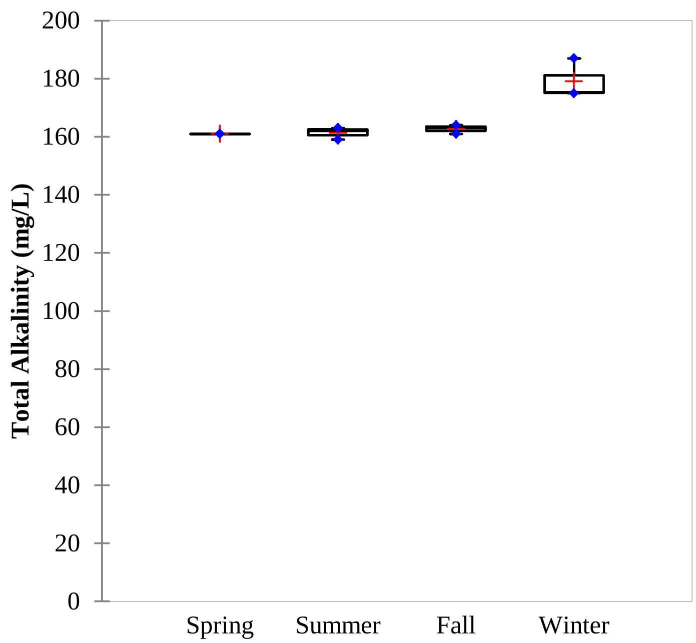


Figure 5.2.4-53. Total alkalinity in Cormorant Lake by season.

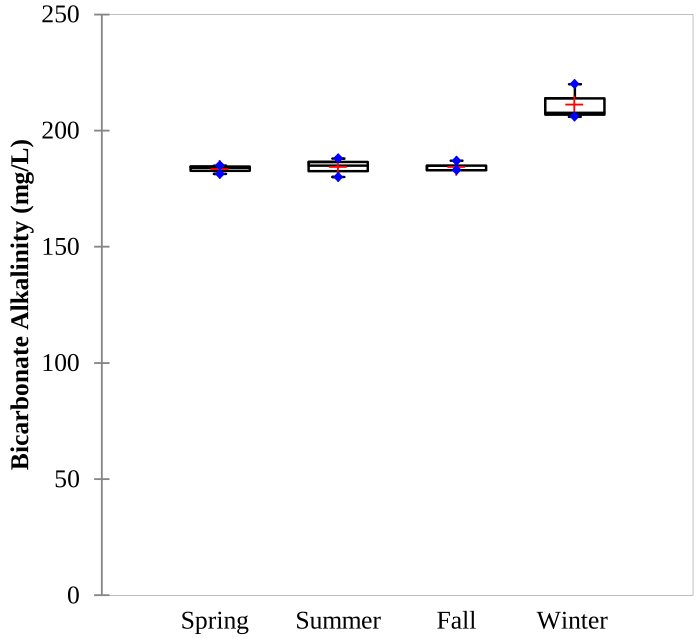


Figure 5.2.4-54. Bicarbonate alkalinity in Cormorant Lake by season.

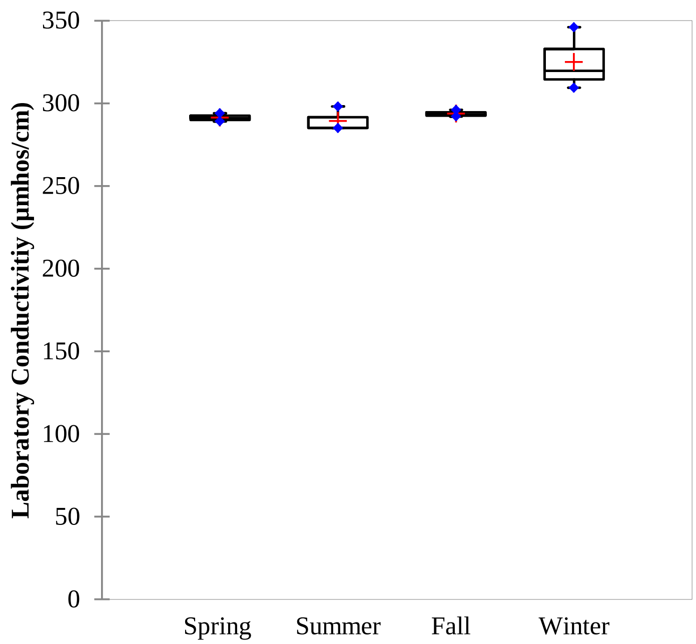


Figure 5.2.4-55. Laboratory conductivity in Cormorant Lake by season.

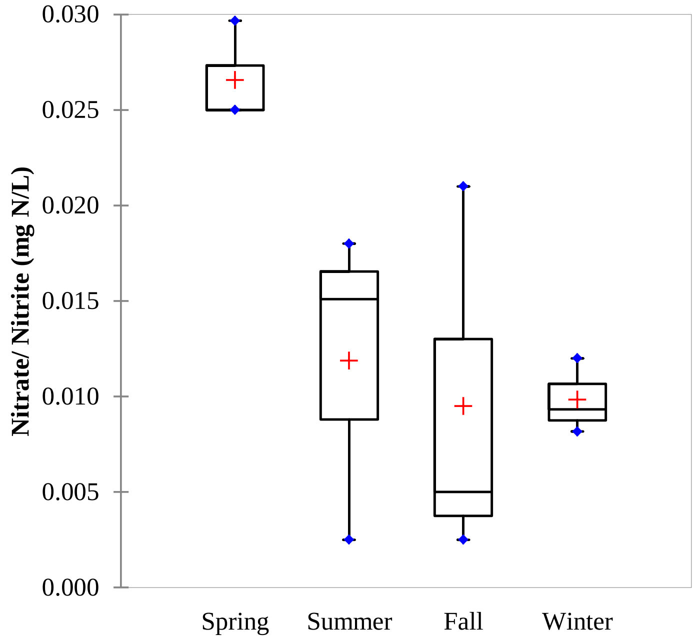


Figure 5.2.4-56. Nitrate/nitrite in Cormorant Lake by season. Statistically significant seasonal differences were noted in ANOVA but not with the Tukey pairwise test.

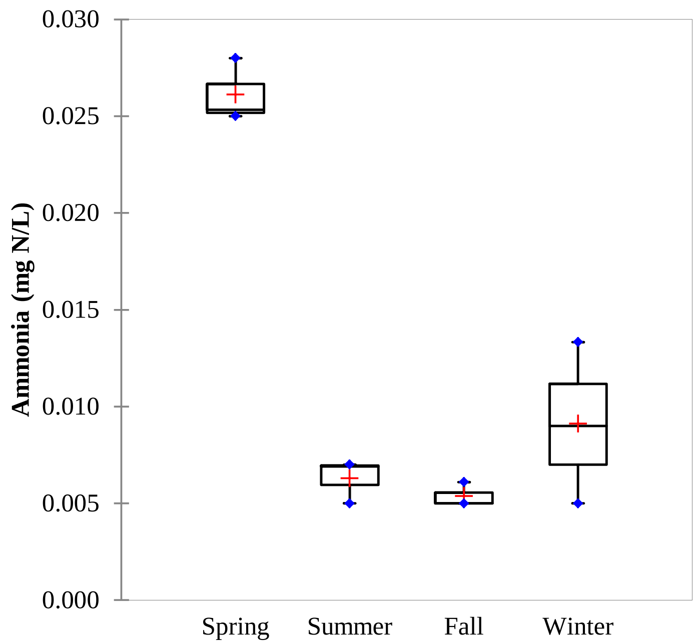


Figure 5.2.4-57. Ammonia in Cormorant Lake by season.

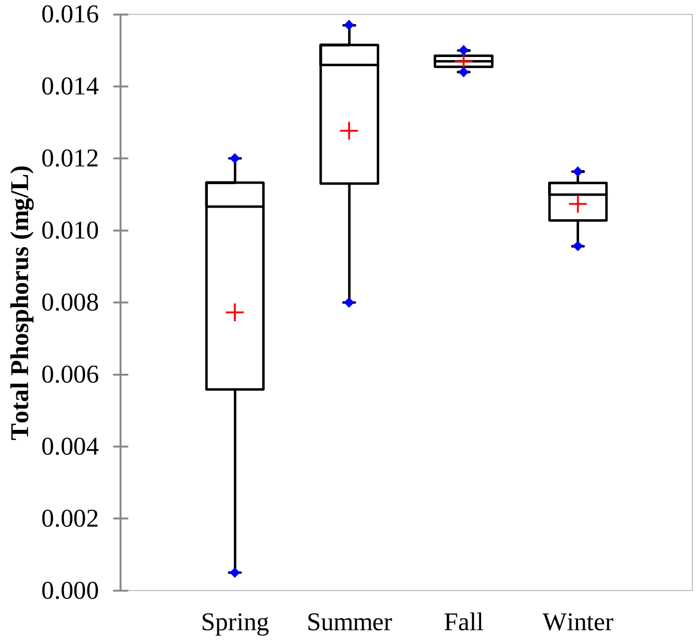


Figure 5.2.4-58. Total phosphorus in Cormorant Lake by season.

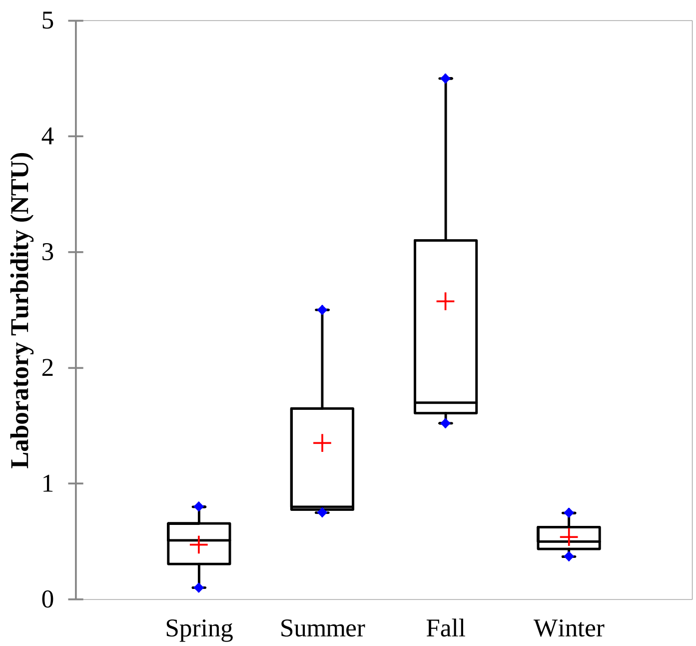


Figure 5.2.4-59. Laboratory turbidity in Cormorant Lake by season.

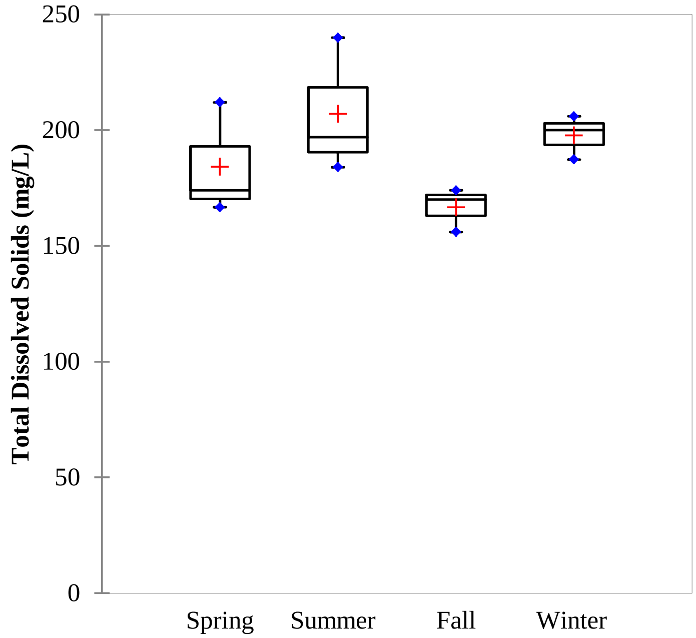


Figure 5.2.4-60. Total dissolved solids (TDS) in Cormorant Lake by season.

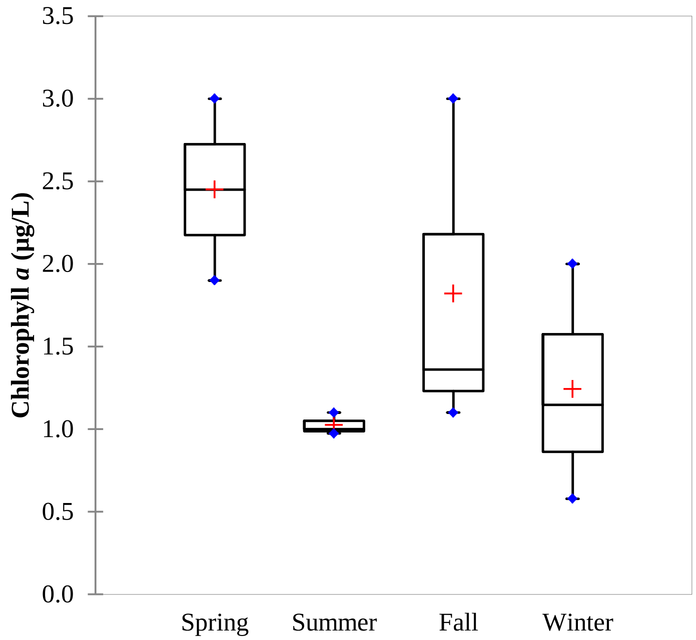


Figure 5.2.4-61. Chlorophyll *a* in Cormorant Lake by season.

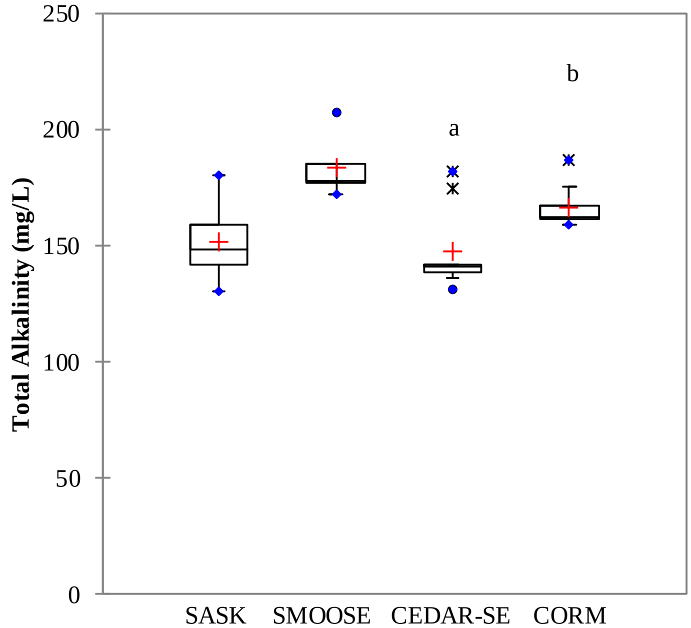


Figure 5.2.4-62. Total alkalinity in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

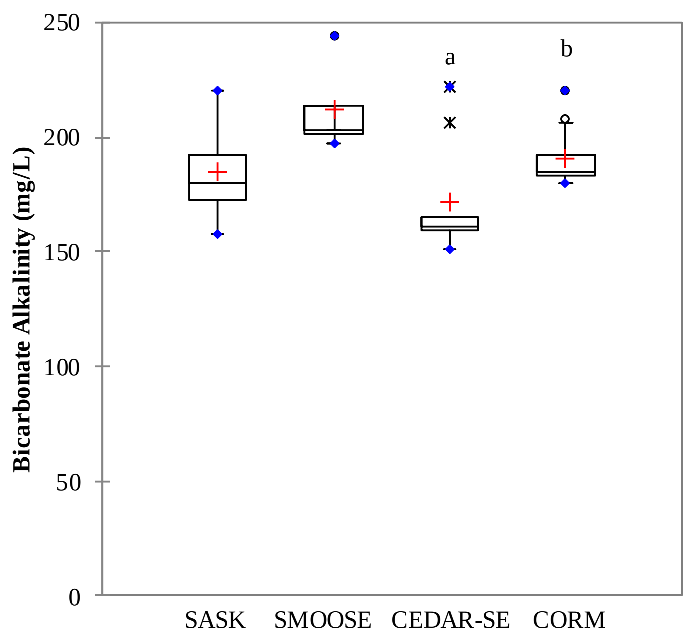


Figure 5.2.4-63. Bicarbonate alkalinity in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

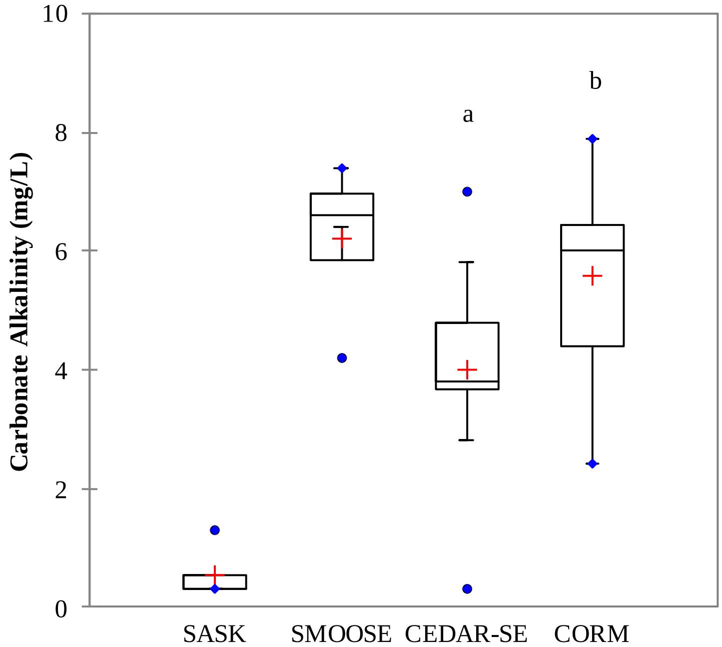


Figure 5.2.4-64. Carbonate alkalinity in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

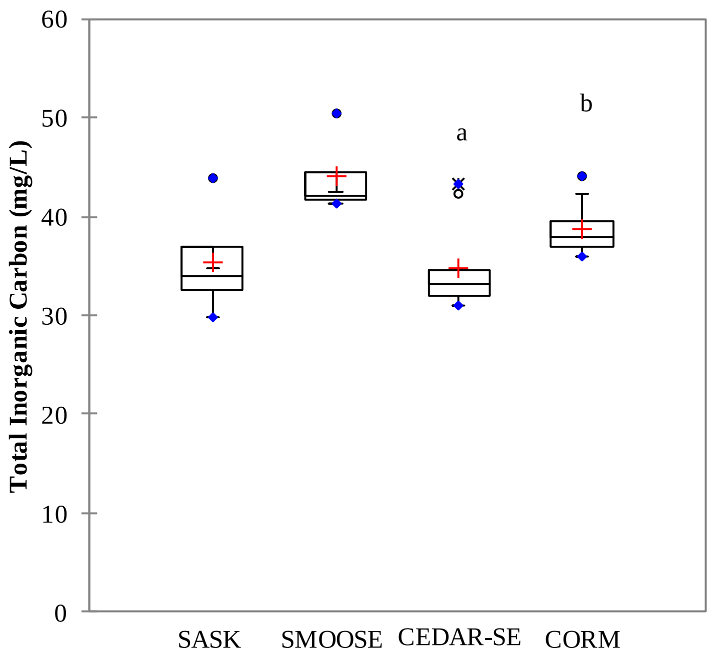


Figure 5.2.4-65. Total inorganic carbon in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

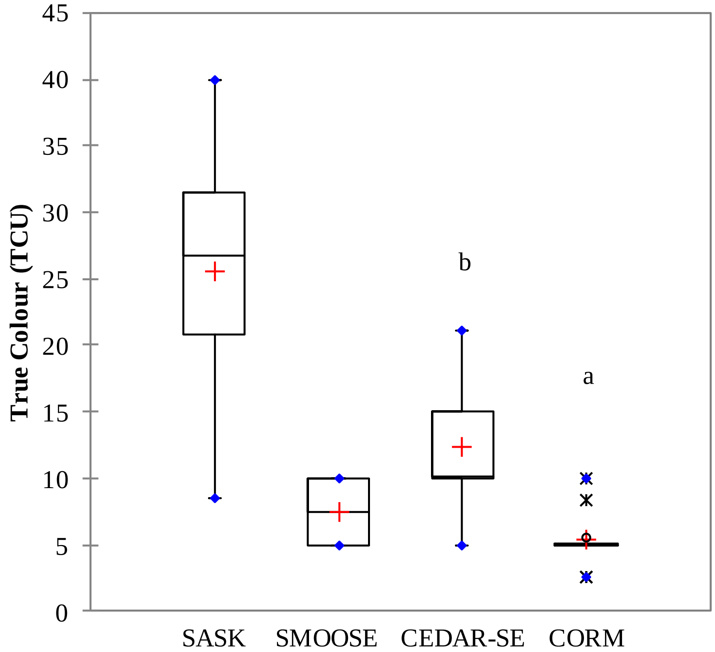


Figure 5.2.4-66. True colour in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

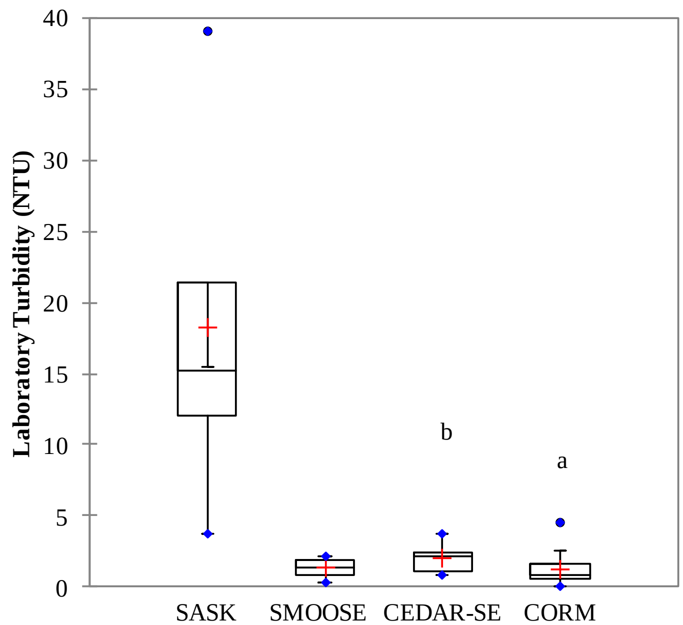


Figure 5.2.4-67. Laboratory turbidity in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

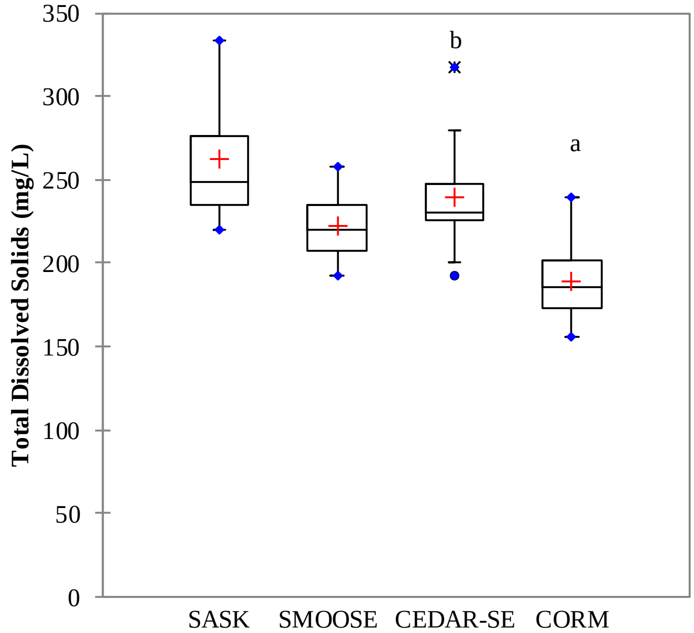


Figure 5.2.4-68. Total dissolved solids (TDS) in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

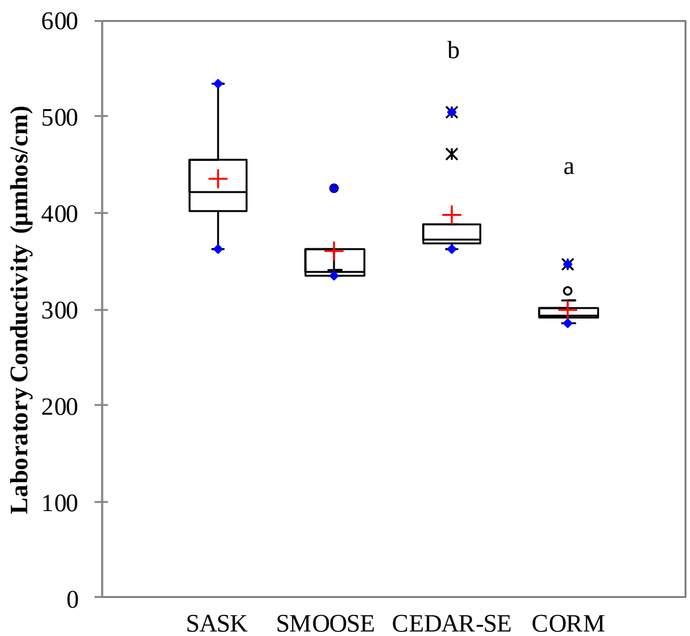


Figure 5.2.4-69. Laboratory conductivity in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

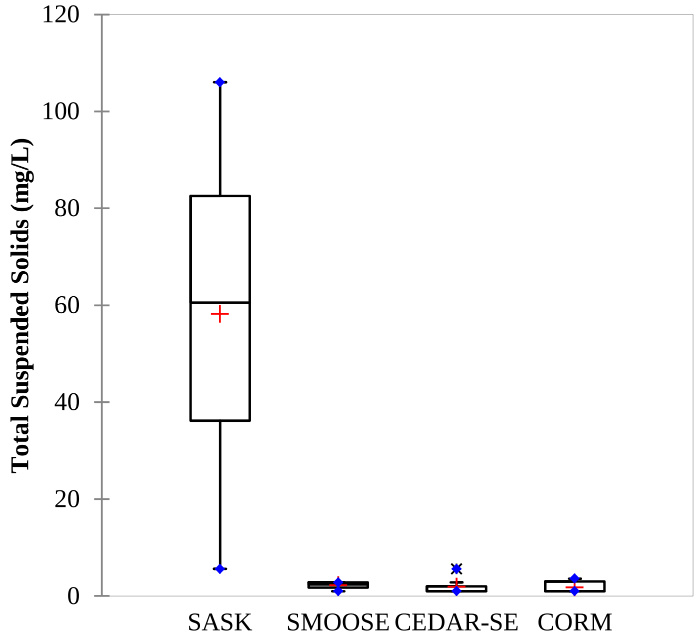


Figure 5.2.4-70. Total suspended solids in the Saskatchewan River Region: 2008-2010.

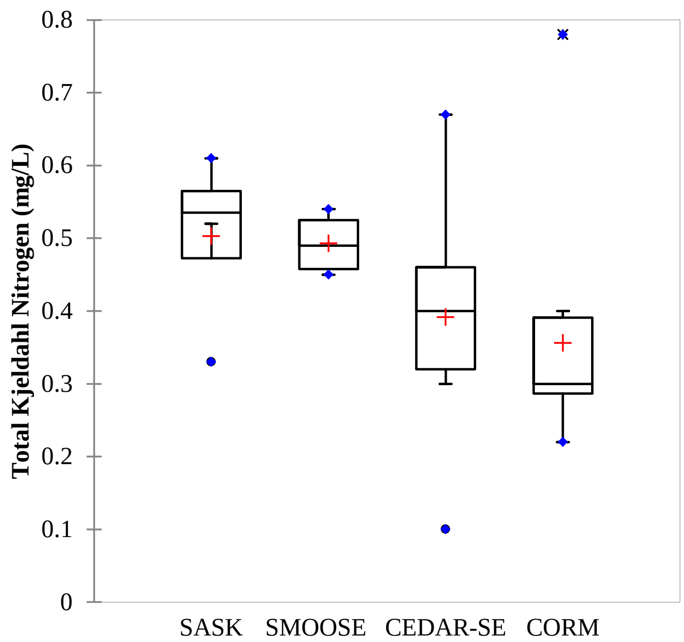


Figure 5.2.4-71. Total Kjeldahl nitrogen in the Saskatchewan River Region: 2008-2010.

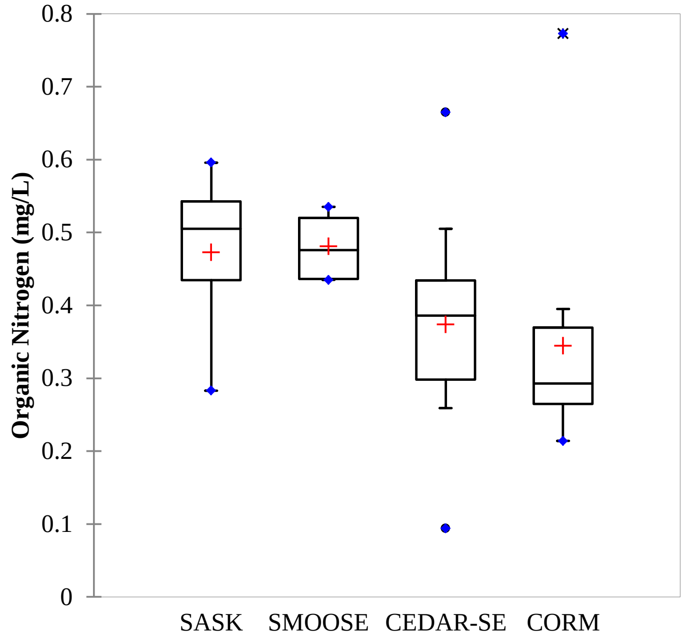


Figure 5.2.4-72. Organic nitrogen in the Saskatchewan River Region: 2008-2010.

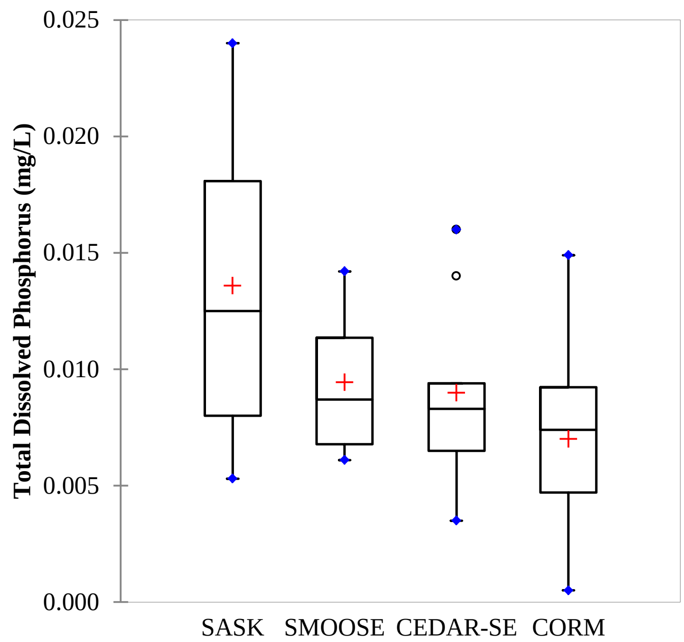


Figure 5.2.4-73. Total dissolved phosphorus in the Saskatchewan River Region: 2008-2010.

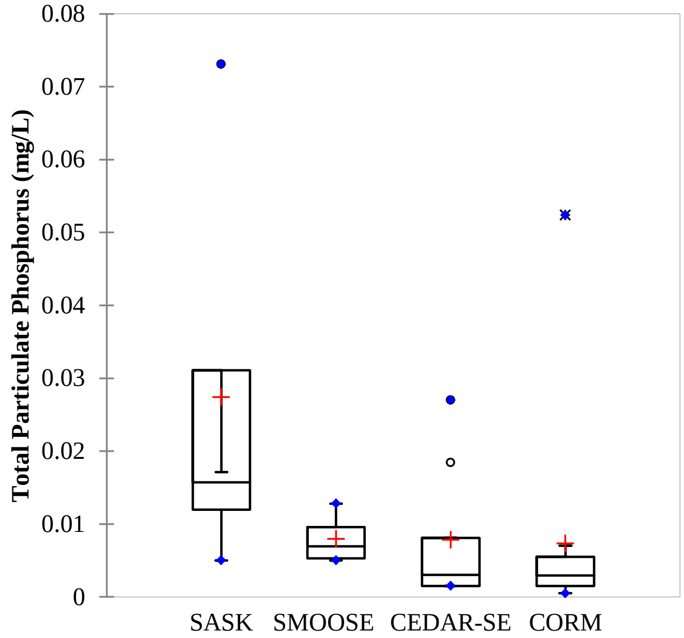


Figure 5.2.4-74. Total particulate phosphorus in the Saskatchewan River Region: 2008-2010.

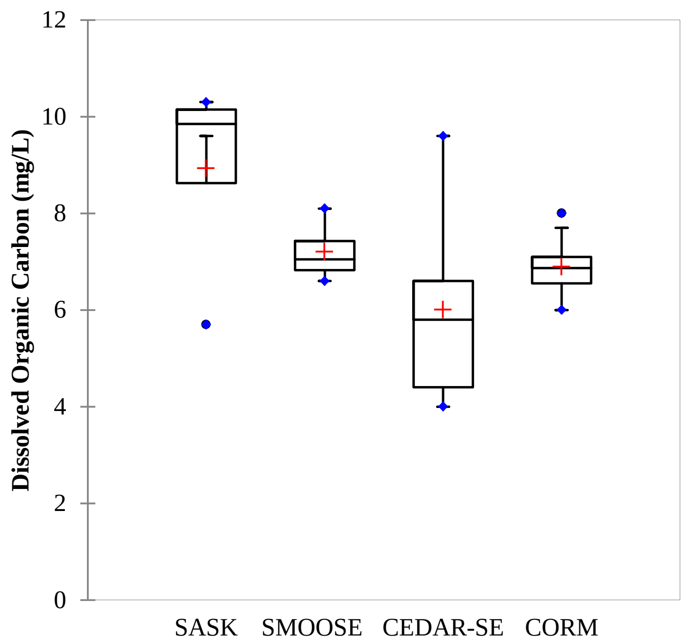


Figure 5.2.4-75. Dissolved organic carbon in the Saskatchewan River Region: 2008-2010.

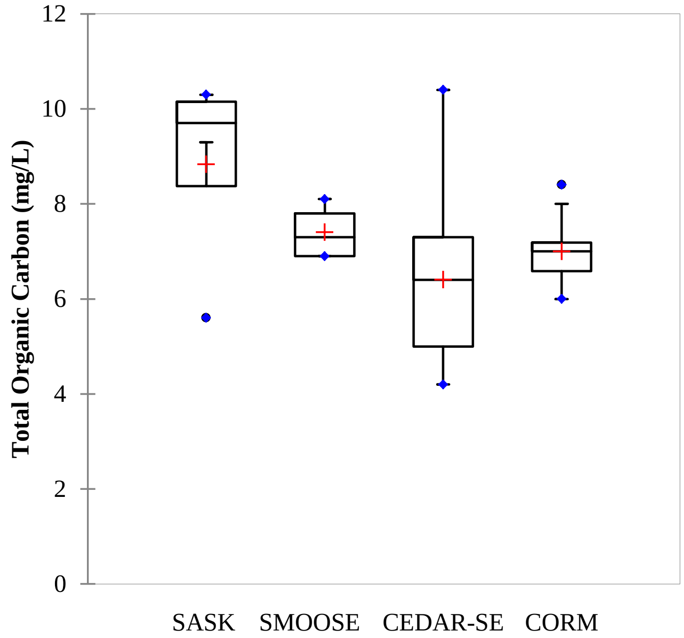


Figure 5.2.4-76 Total organic carbon in the Saskatchewan River Region: 2008-2010.

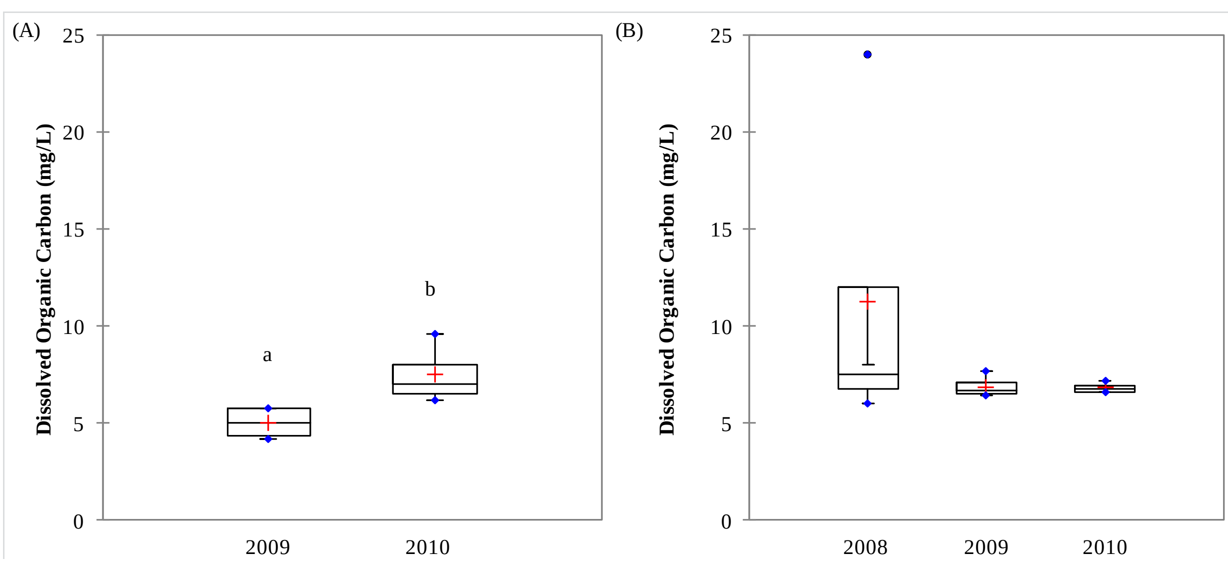


Figure 5.2.4-77. Dissolved organic carbon (DOC) measured in the Saskatchewan River Region by year: (A) Cedar Lake; and (B) Cormorant Lake. Statistically significant differences are denoted with different superscripts.

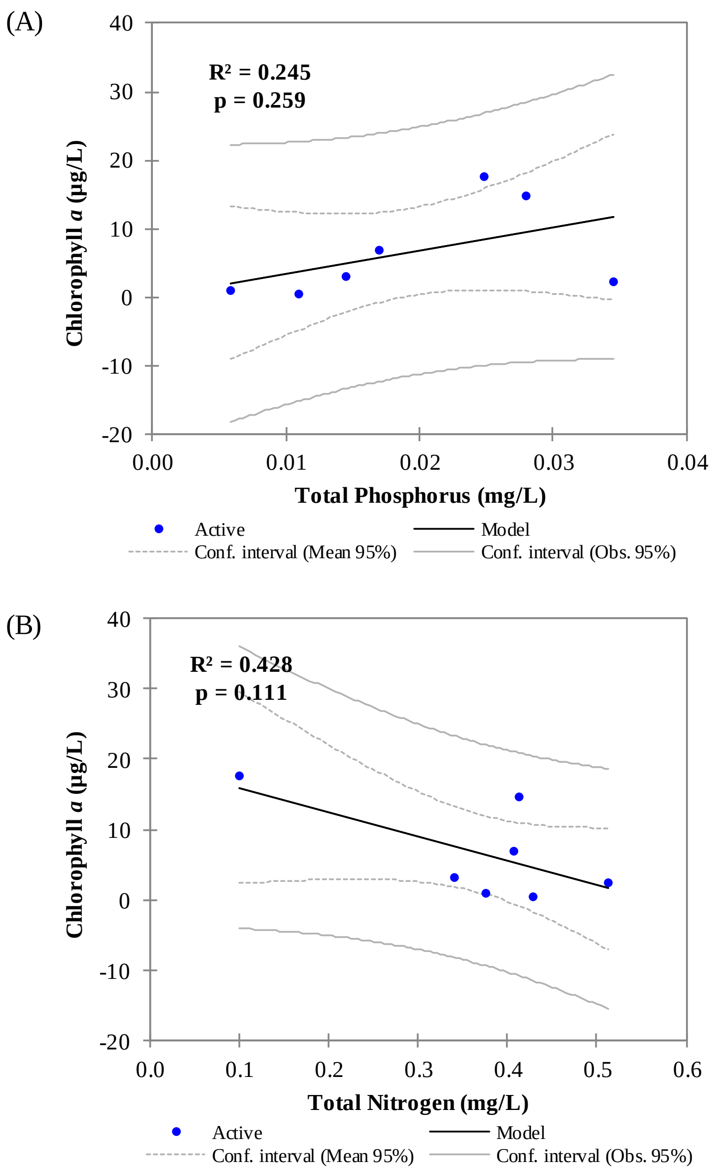


Figure 5.2.4-78. Linear regression between chlorophyll *a* and (A) total phosphorus and (B) total nitrogen in Cedar Lake: open-water seasons 2008-2010.

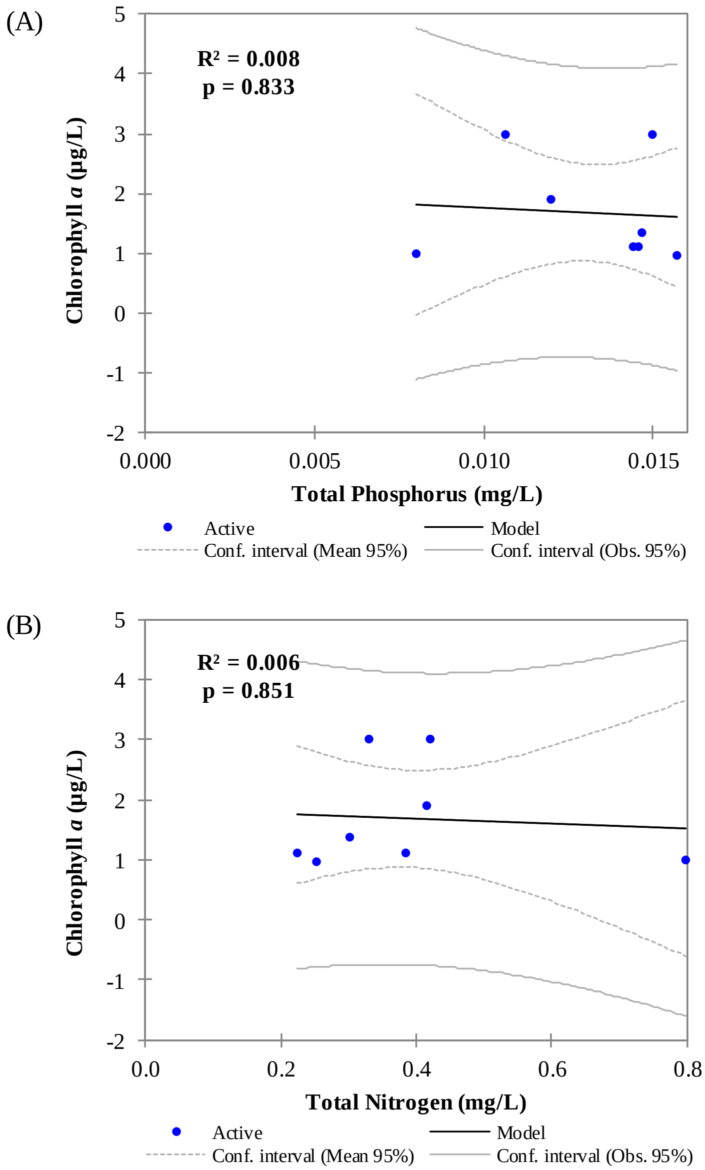


Figure 5.2.4-79. Linear regression between chlorophyll *a* and (A) total phosphorus and (B) total nitrogen in Cormorant Lake: open-water seasons 2008-2010.

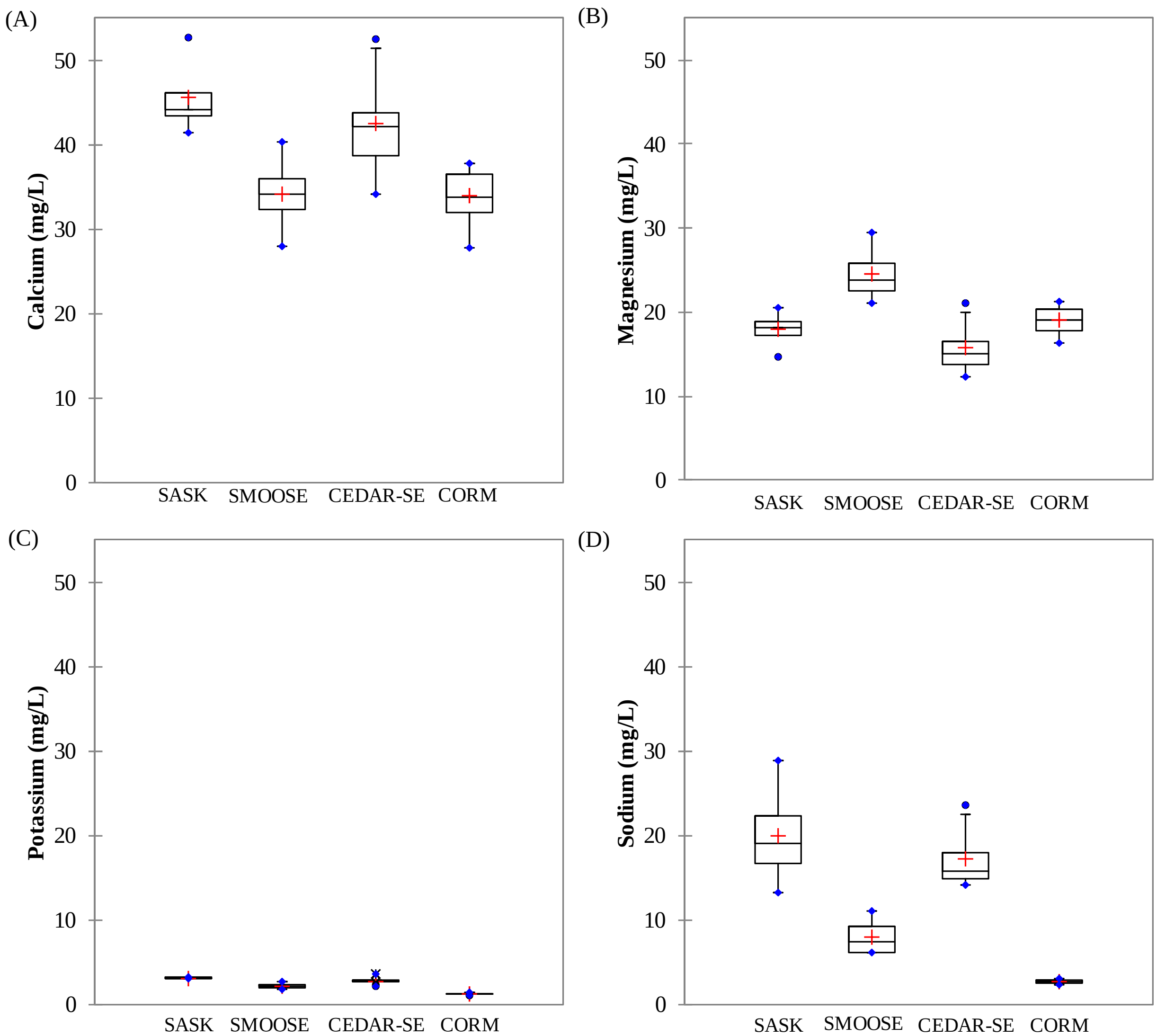


Figure 5.2.4-80. Concentrations of (A) calcium, (B) magnesium, (C) potassium, and (D) sodium measured in the Saskatchewan River Region by waterbody.

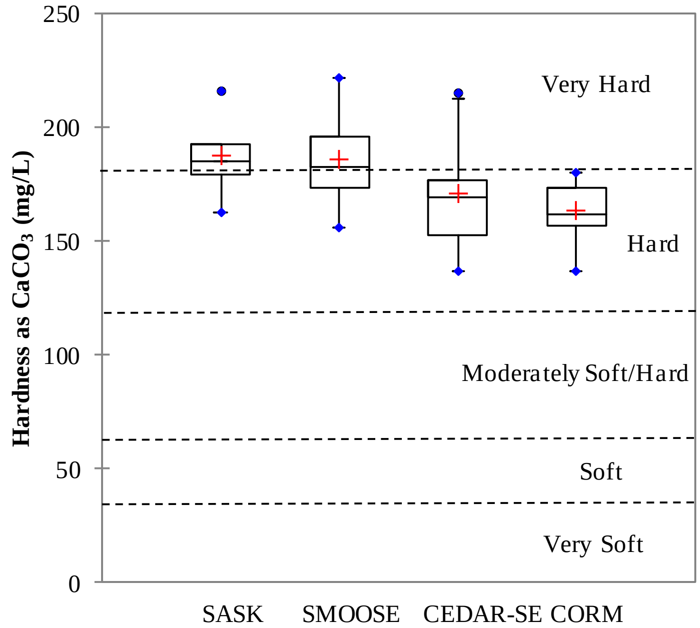


Figure 5.2.4-81. Water hardness measured in the Saskatchewan River Region by waterbody.

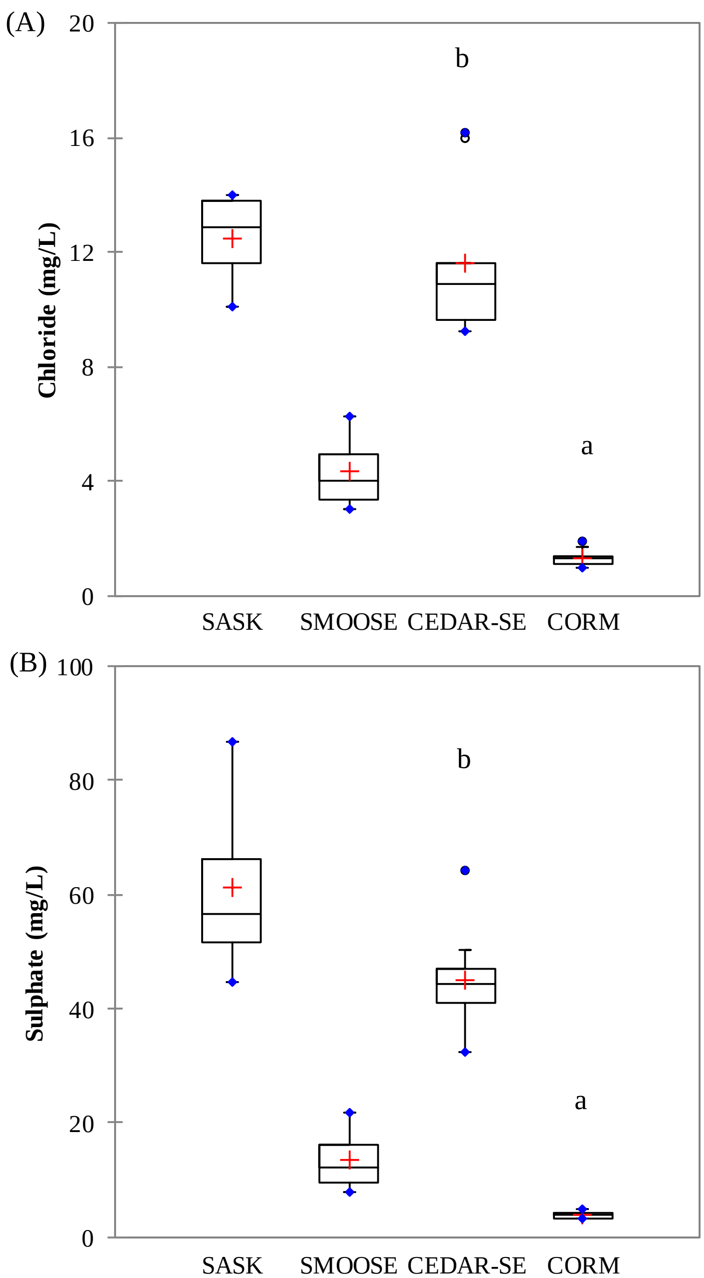


Figure 5.2.4-82. Concentrations of (A) chloride and (B) sulphate measured in the Saskatchewan River Region by waterbody. Statistically significant spatial differences are denoted with different superscripts.

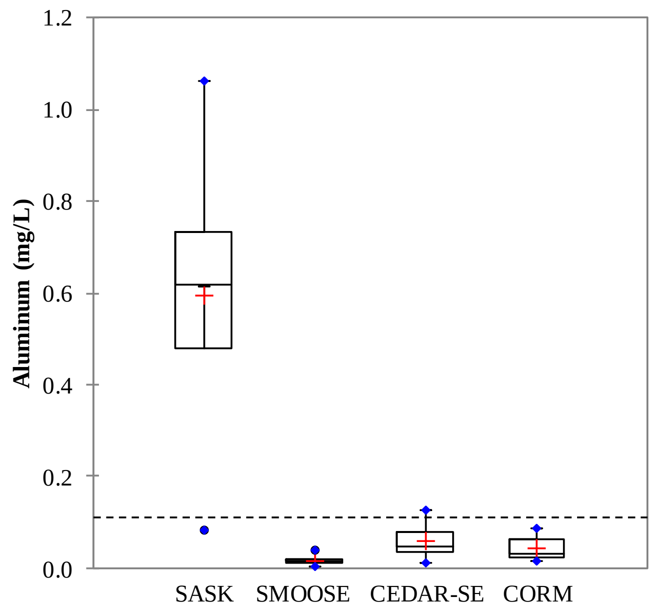


Figure 5.2.4-83. Aluminum in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts. The dashed line represents the Manitoba PAL guideline.

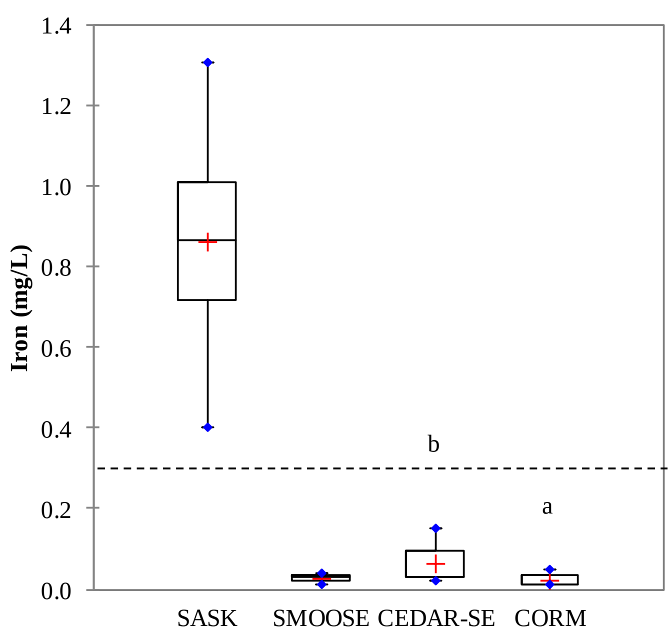


Figure 5.2.4-84. Iron in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts. The dashed line represents the Manitoba PAL guideline.

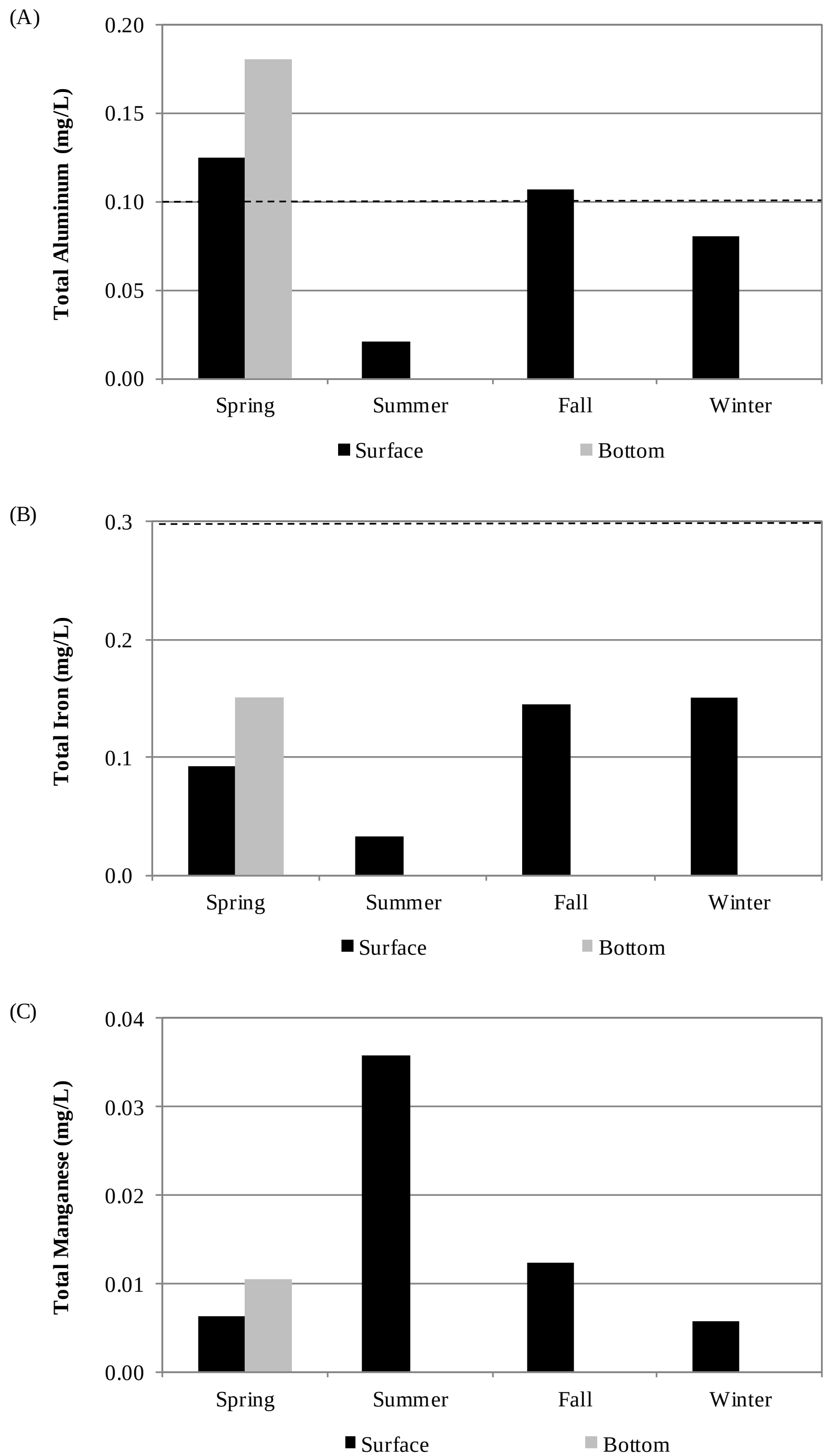


Figure 5.2.4-85. Total aluminum (A), iron (B), and manganese (C) measured in surface grabs and bottom samples in Cedar Lake, 2010/2011. The black dashed line indicates the MWQSOG for PAL for aluminum and iron.

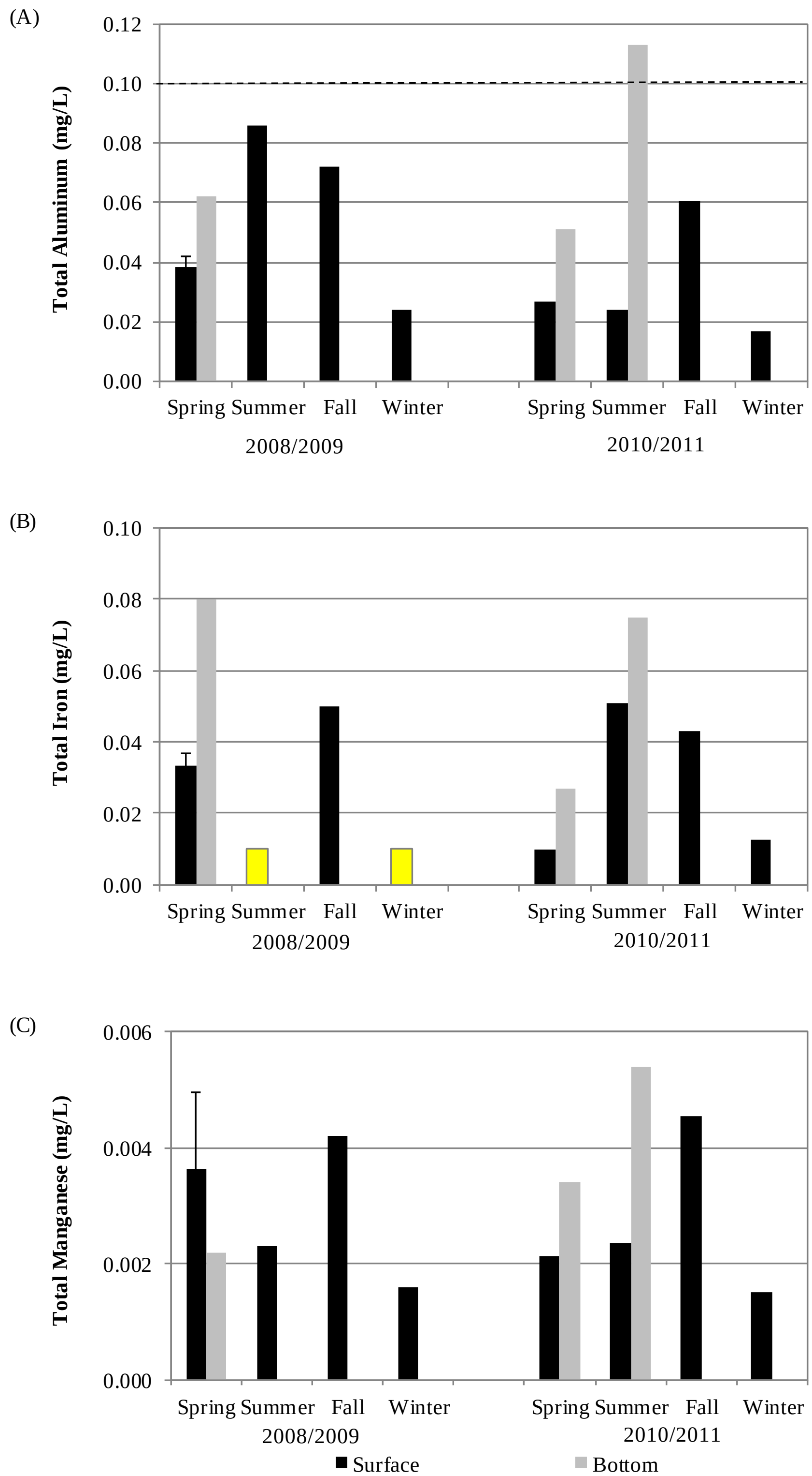


Figure 5.2.4-86. Total aluminum (A), iron (B), and manganese (C) measured in surface grabs and bottom samples in Cormorant Lake, 2008/2009 and2010/2011. The black dashed line indicates the MWQSOG for PAL for aluminum. Values in yellow were below the analytical detection limit.

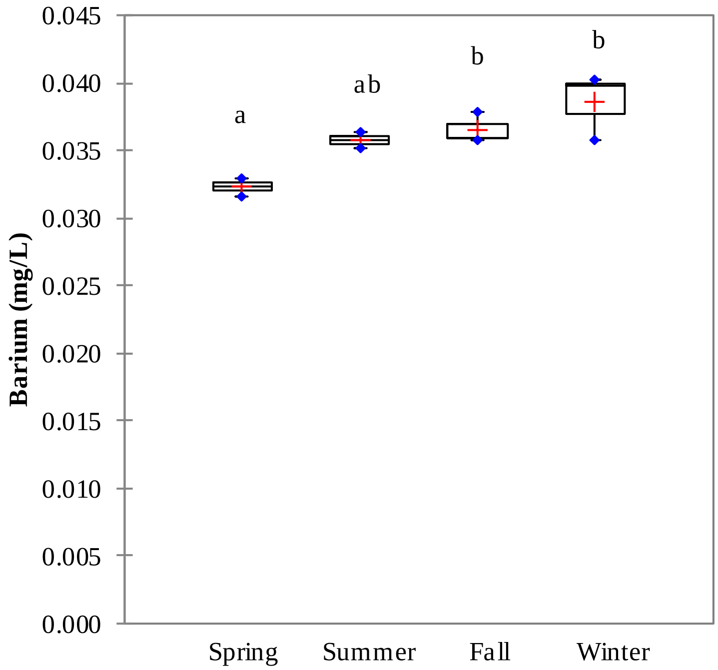


Figure 5.2.4-87. Barium in Cormorant Lake by season. Statistically significant seasonal differences are denoted with different superscripts.

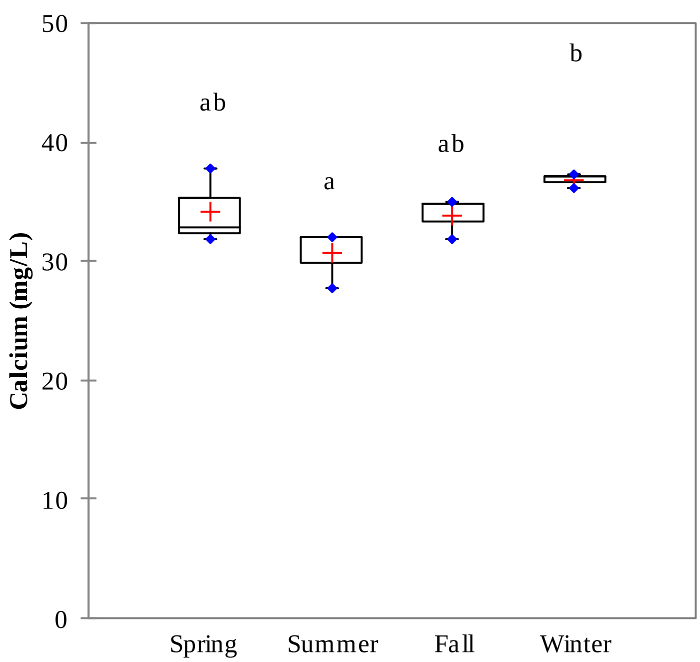


Figure 5.2.4-88. Calcium in Cormorant Lake by season. Statistically significant seasonal differences are denoted with different superscripts.

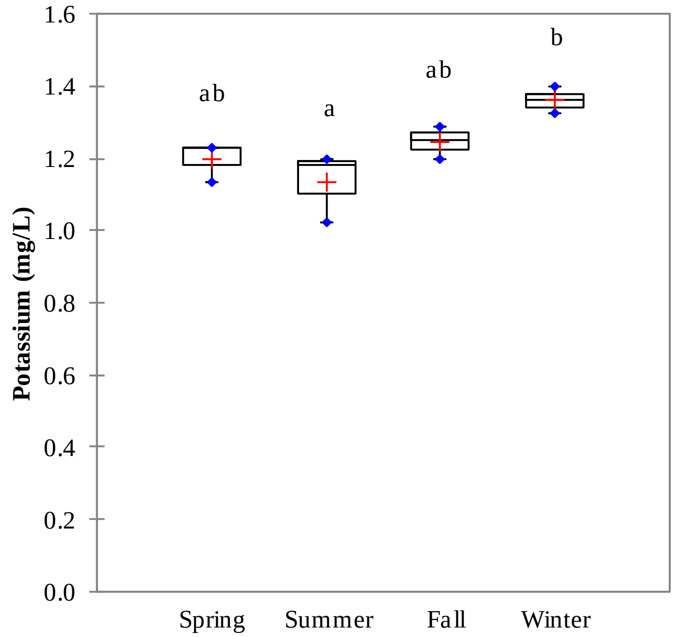


Figure 5.2.4-89. Potassium in Cormorant Lake by season. Statistically significant seasonal differences are denoted with different superscripts.

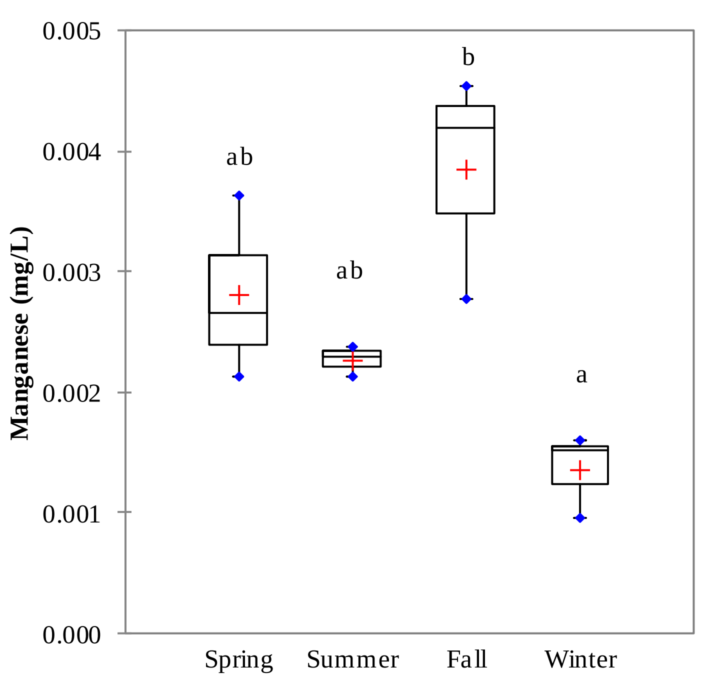


Figure 5.2.4-90. Manganese in Cormorant Lake by season. Statistically significant seasonal differences are denoted with different superscripts.

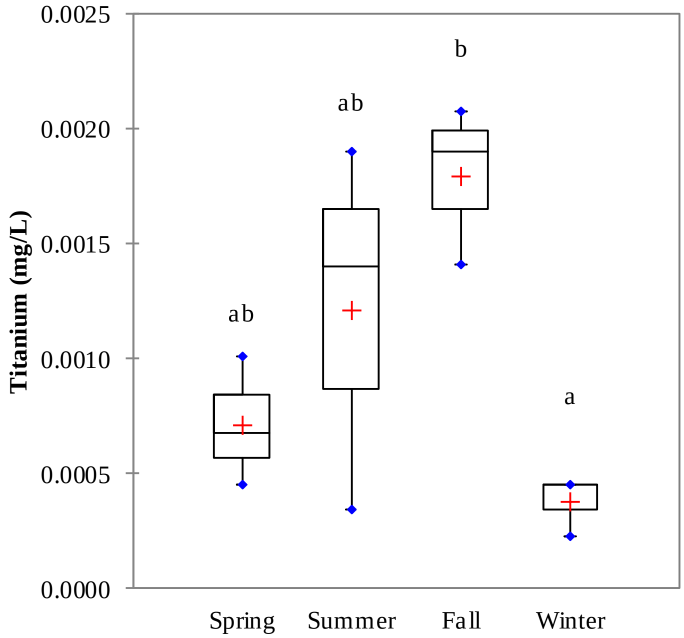


Figure 5.2.4-91. Titanium in Cormorant Lake by season. Statistically significant seasonal differences are denoted with different superscripts.

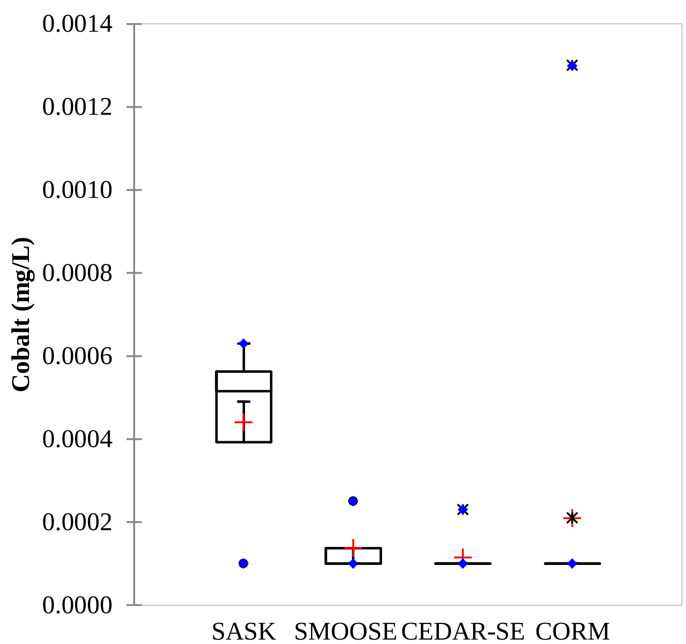


Figure 5.2.4-92. Cobalt in the Saskatchewan River Region: 2008-2010.

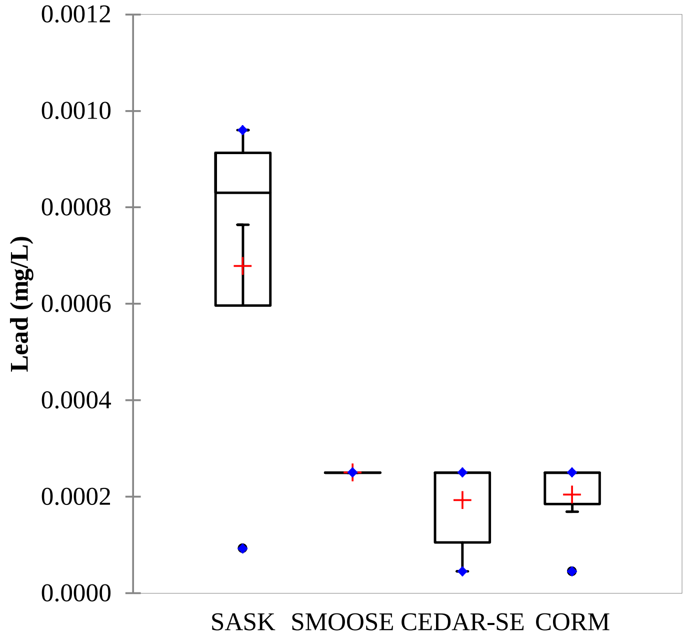


Figure 5.2.4-93. Lead in the Saskatchewan River Region: 2008-2010.

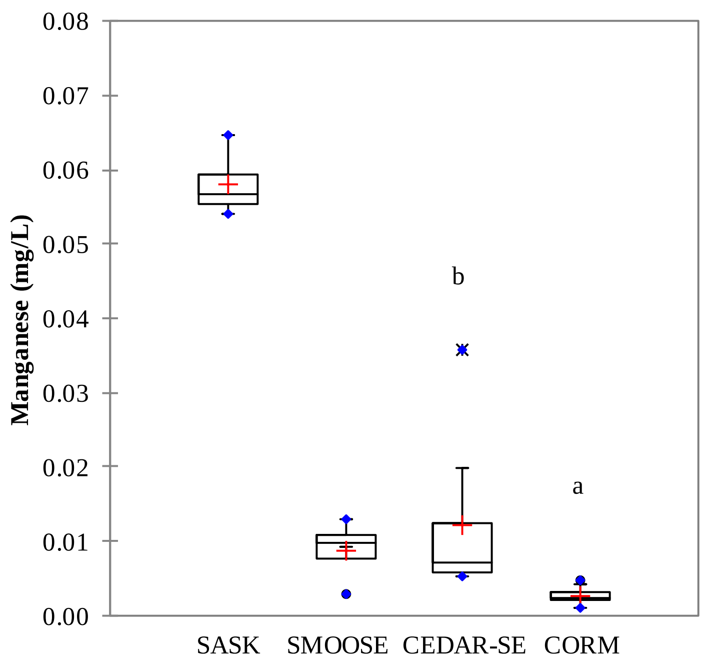


Figure 5.2.4-94. Manganese in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

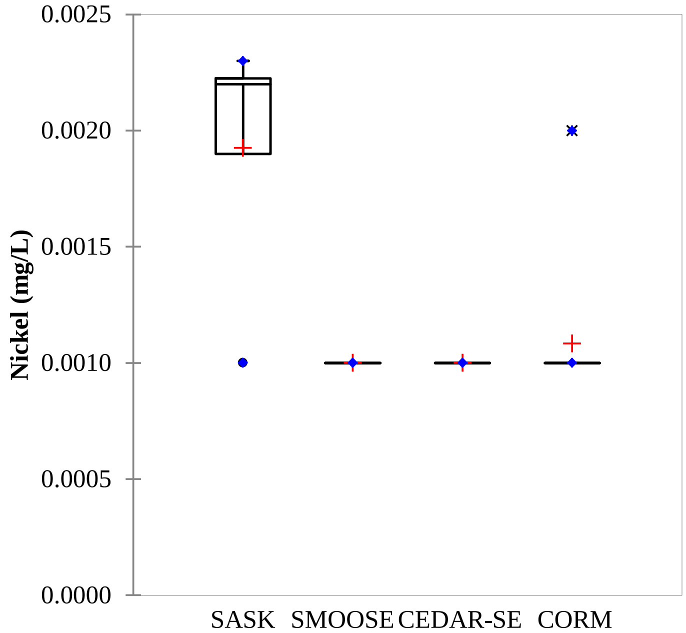


Figure 5.2.4-95. Nickel in the Saskatchewan River Region: 2008-2010.

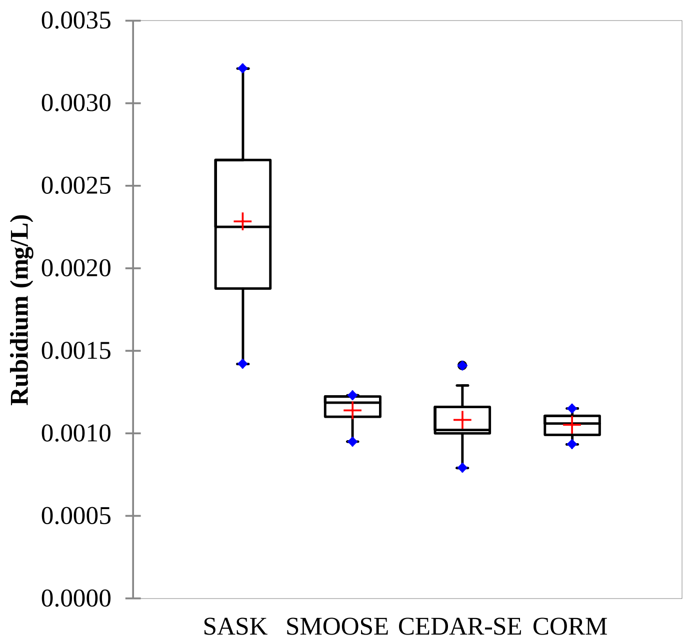


Figure 5.2.4-96. Rubidium in the Saskatchewan River Region: 2008-2010.

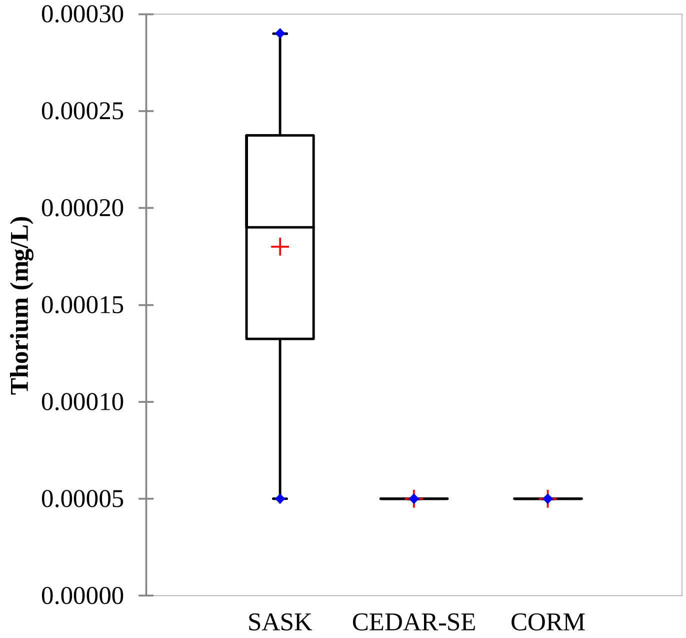


Figure 5.2.4-97. Thorium in the Saskatchewan River Region: 2008-2010. This parameter was not measured in South Moose Lake.

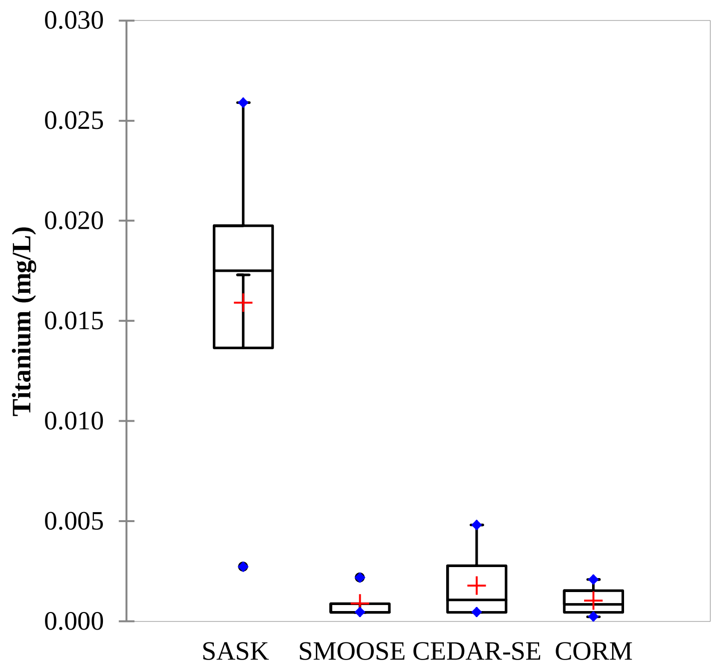


Figure 5.2.4-98. Titanium in the Saskatchewan River Region: 2008-2010.

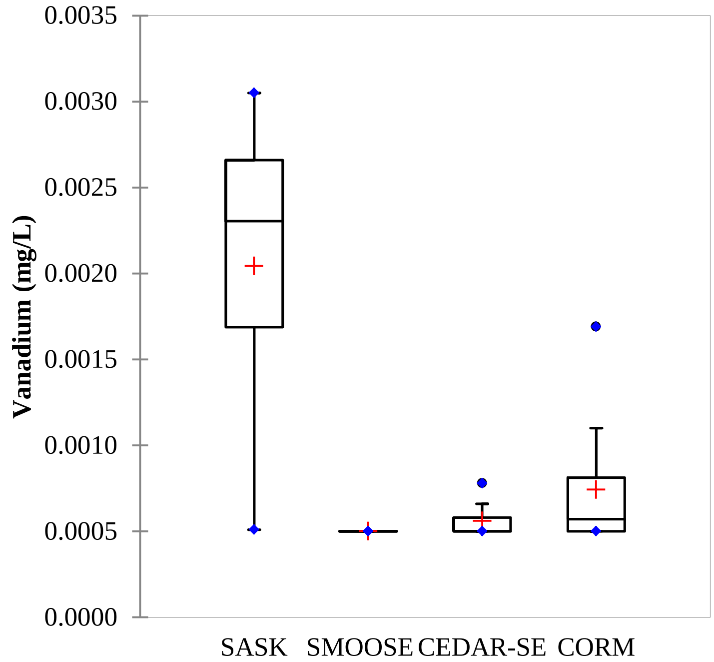


Figure 5.2.4-99. Vanadium in the Saskatchewan River Region: 2008-2010.

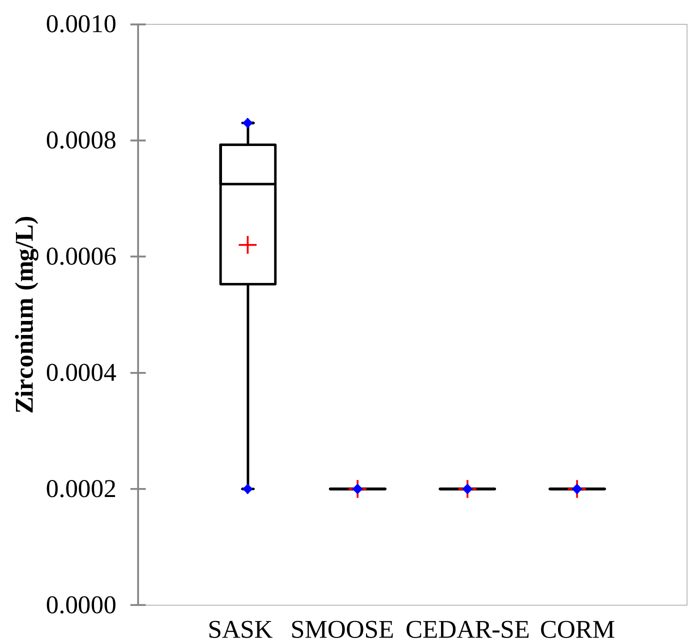


Figure 5.2.4-100. Zirconium in the Saskatchewan River Region: 2008-2010.

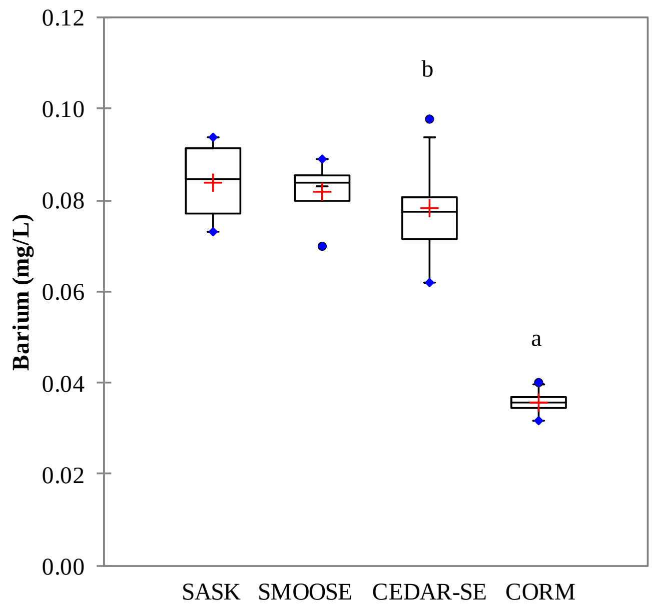


Figure 5.2.4-101. Barium in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

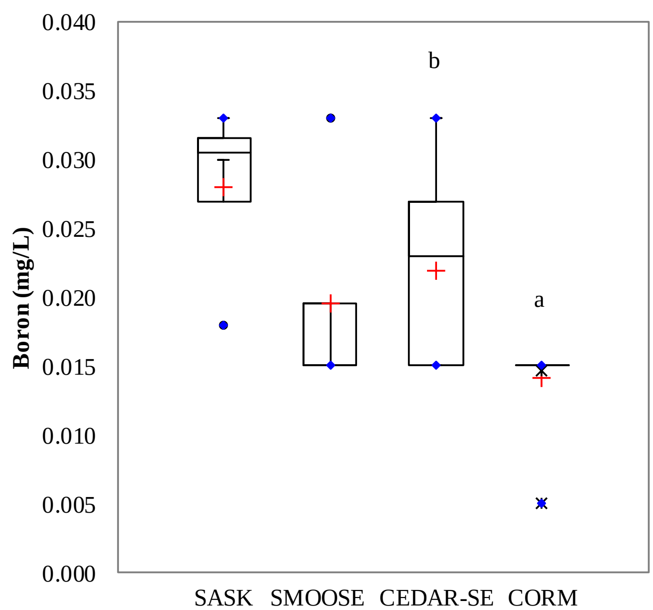


Figure 5.2.4-102. Boron in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

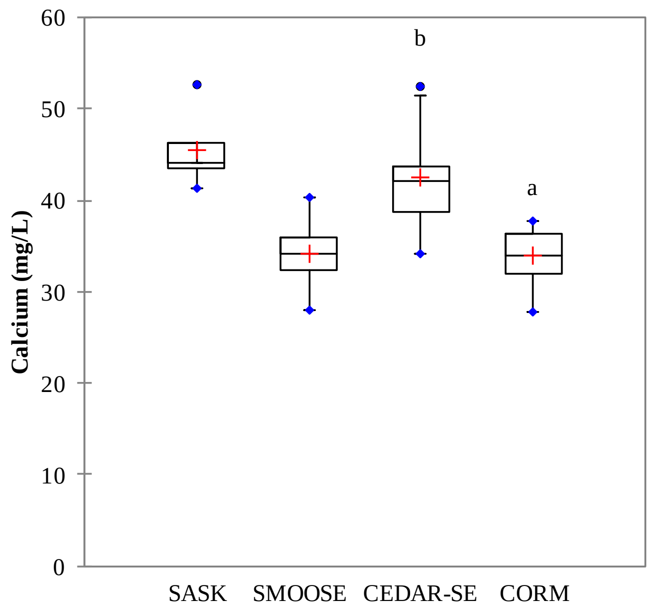


Figure 5.2.4-103. Calcium in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

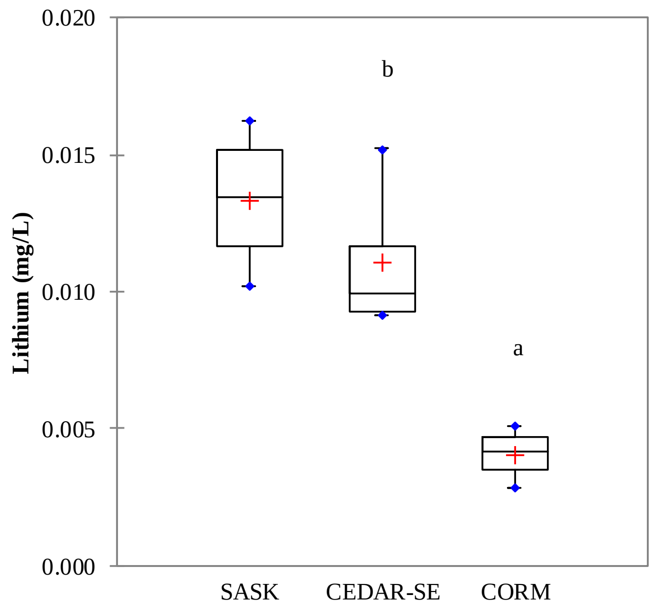


Figure 5.2.4-104. Lithium in the Saskatchewan River Region: 2008-2010 (this parameter was not measured at South Moose Lake). Statistically significant spatial differences are denoted with different superscripts.

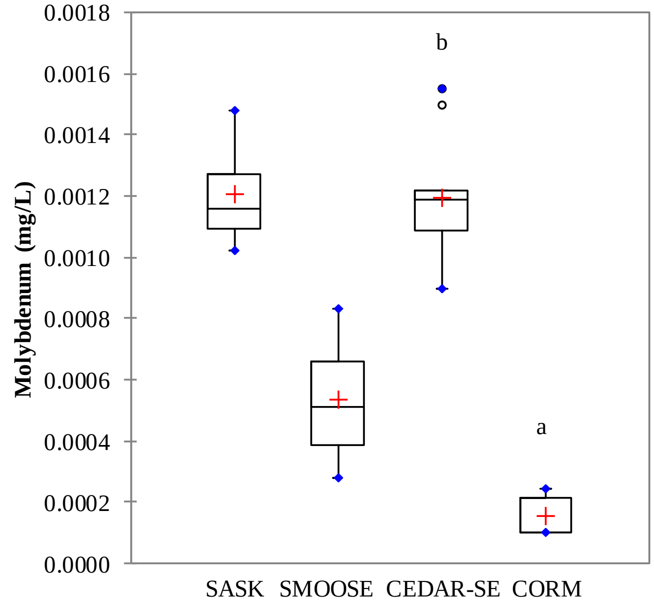


Figure 5.2.4-105. Molybdenum in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

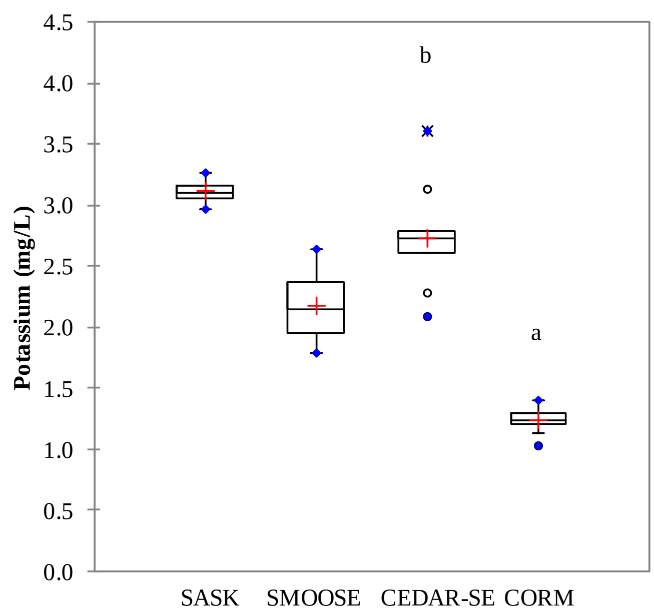


Figure 5.2.4-106. Potassium in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

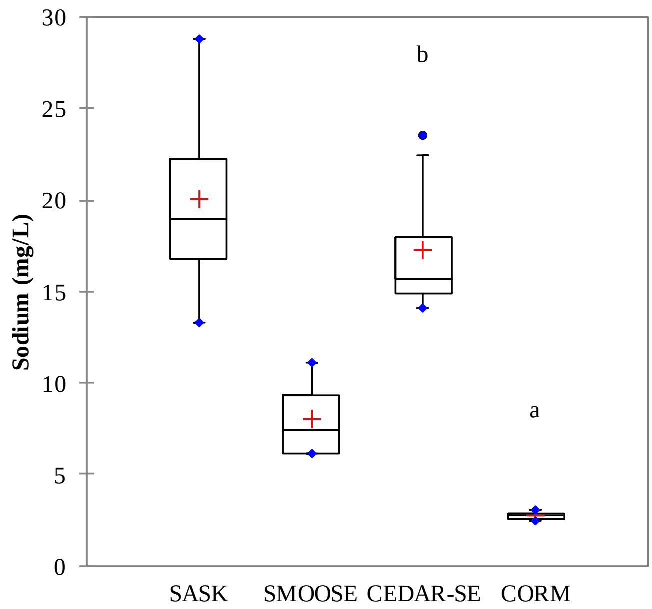


Figure 5.2.4-107. Sodium in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

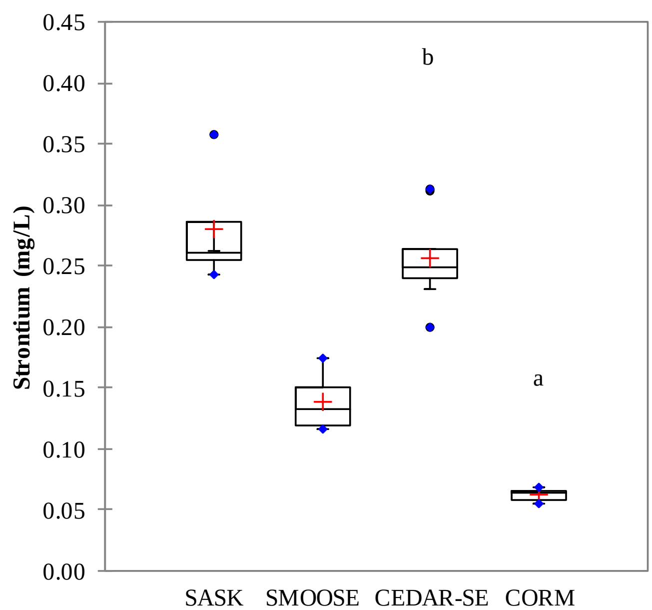


Figure 5.2.4-108. Strontium in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

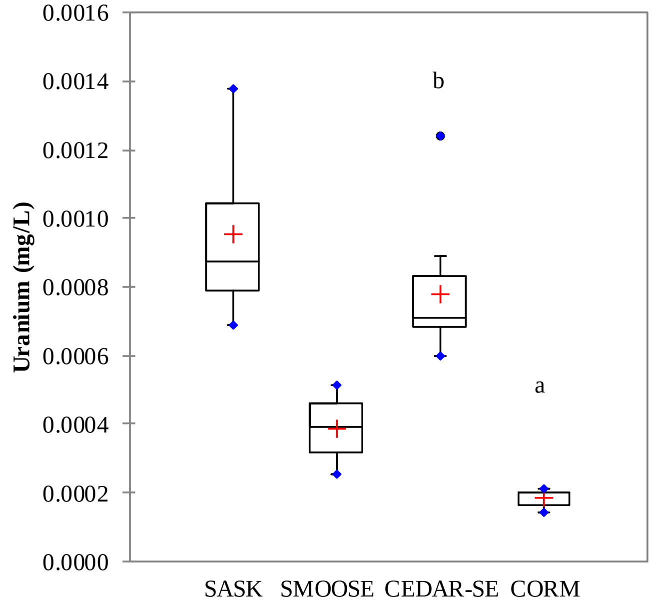


Figure 5.2.4-109. Uranium in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

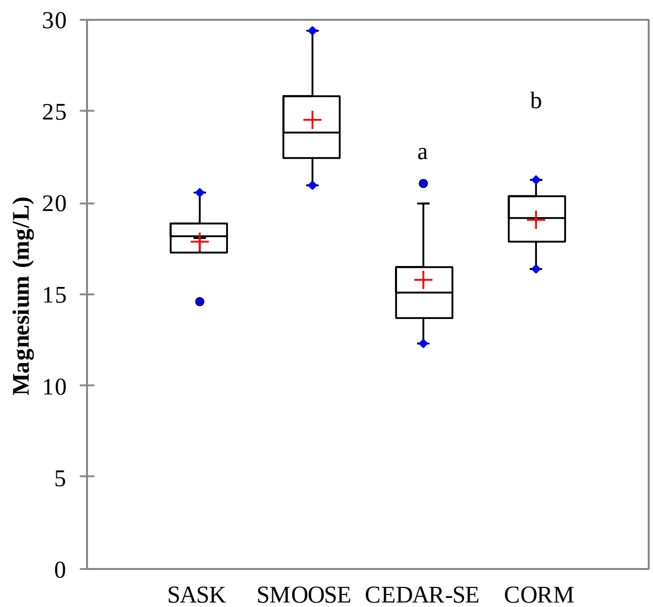


Figure 5.2.4-110. Magnesium in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

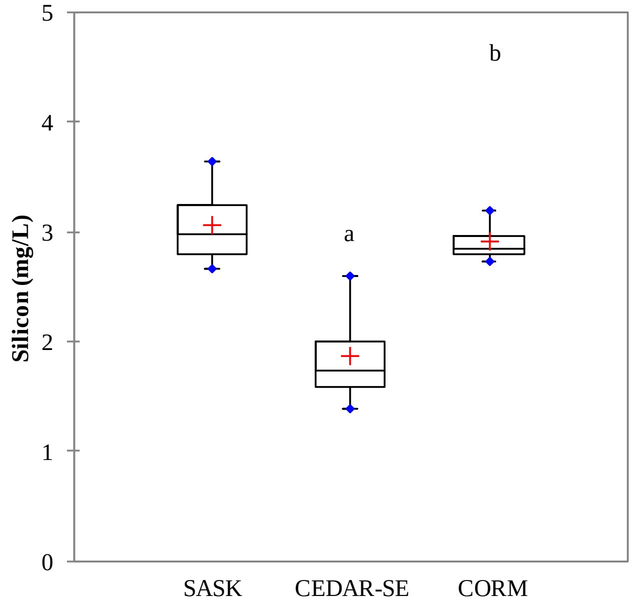


Figure 5.2.4-111. Silicon in the Saskatchewan River Region: 2008-2010. Statistically significant spatial differences are denoted with different superscripts.

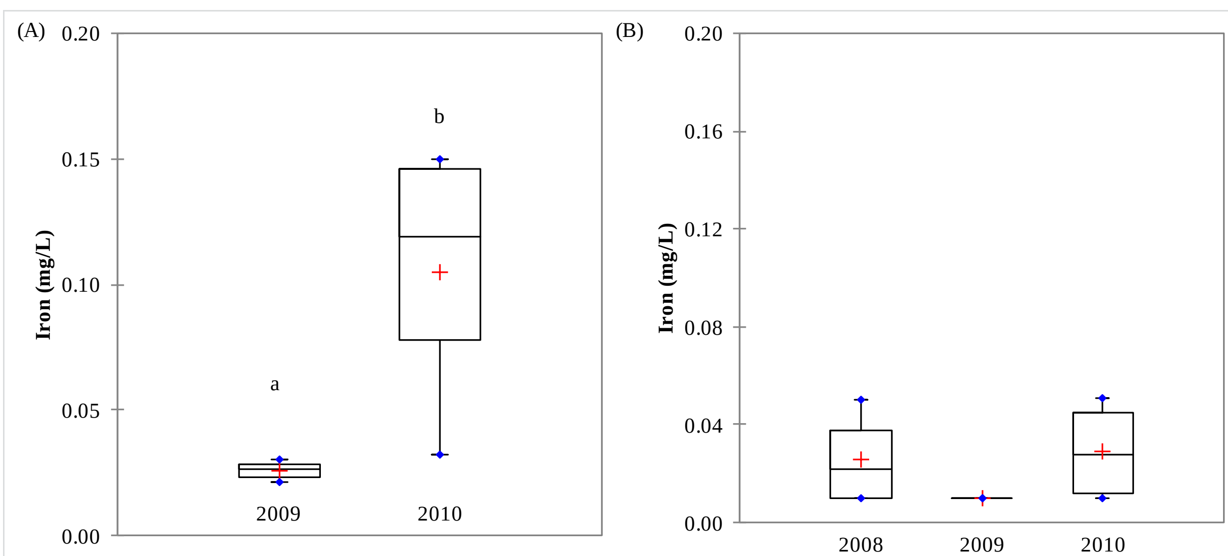


Figure 5.2.4-112. Iron measured in the Saskatchewan River Region by year: (A) Cedar Lake; and (B) Cormorant Lake. Statistically significant differences are denoted with different superscripts.

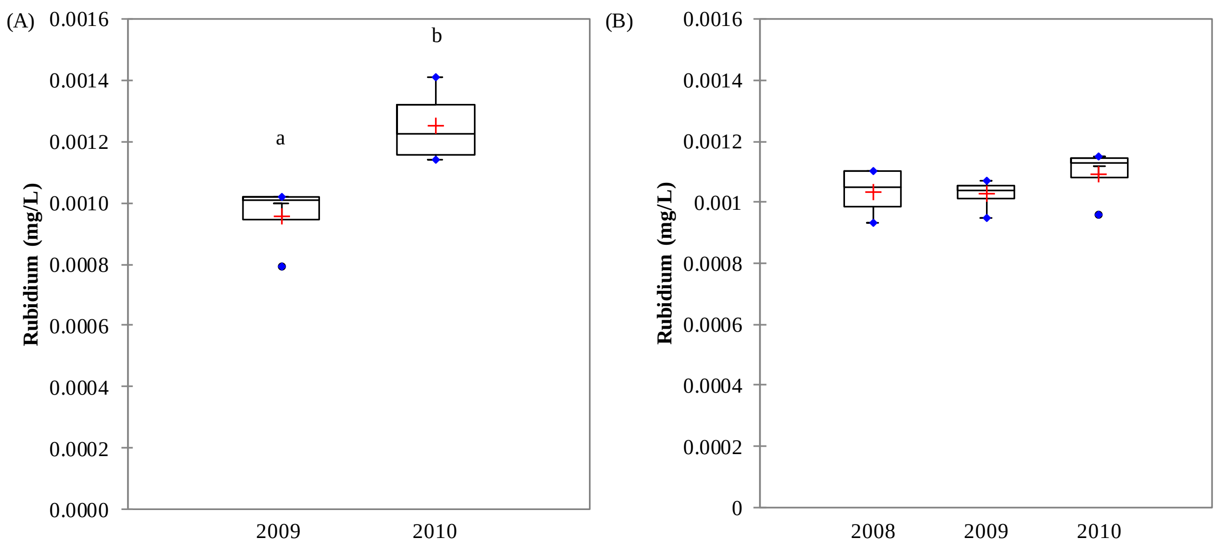


Figure 5.2.4-113. Rubidium measured in the Saskatchewan River Region by year: (A) Cedar Lake; and (B) Cormorant Lake. Statistically significant differences are denoted with different superscripts.

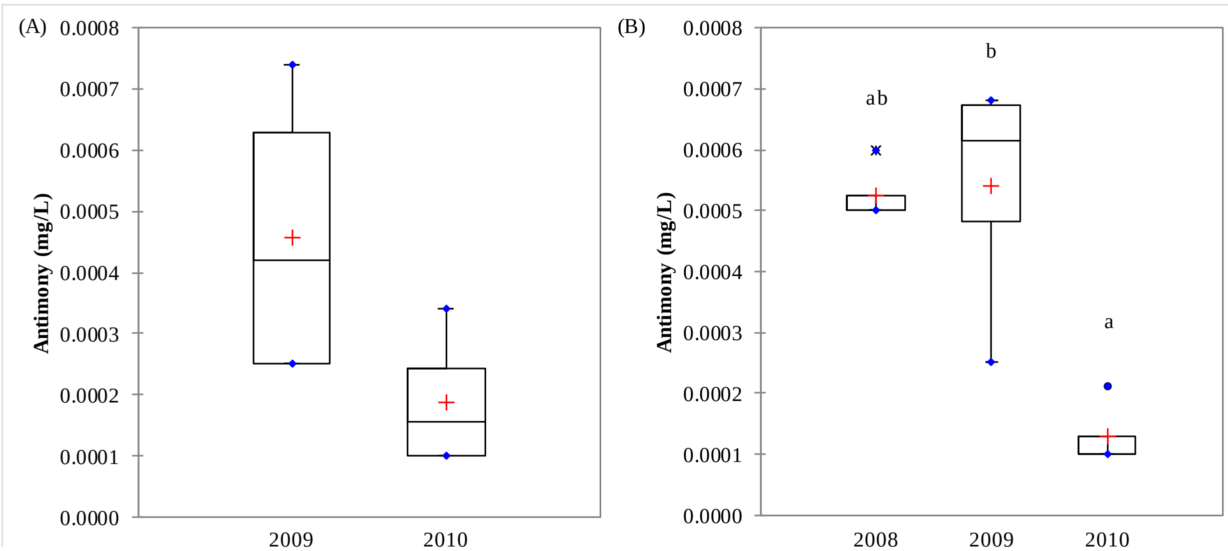


Figure 5.2.4-114. Antimony measured in the Saskatchewan River Region by year: (A) Cedar Lake; and (B) Cormorant Lake. Statistically significant differences are denoted with different superscripts.

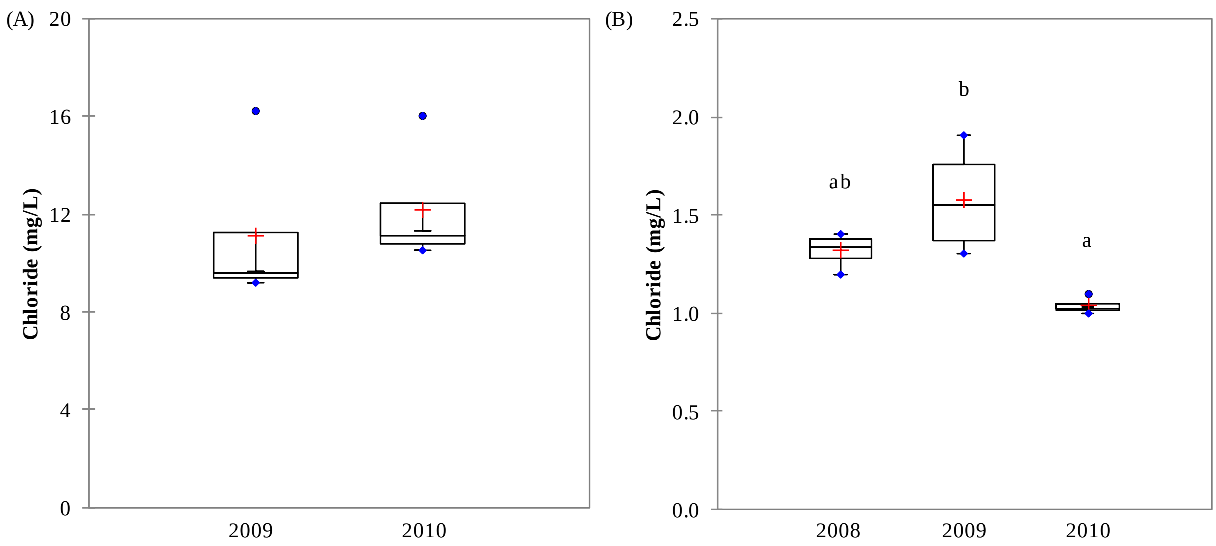


Figure 5.2.4-115. Chloride measured in the Saskatchewan River Region by year: (A) Cedar Lake; and (B) Cormorant Lake. Statistically significant differences are denoted with different superscripts.

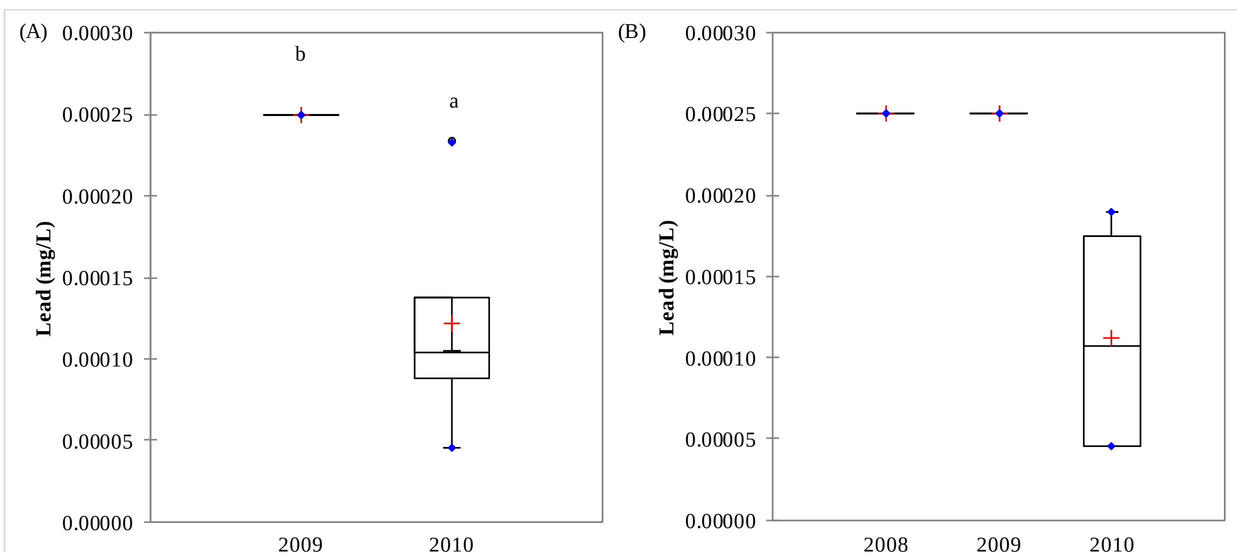


Figure 5.2.4-116. Lead measured in the Saskatchewan River Region by year: (A) Cedar Lake; and (B) Cormorant Lake. Statistically significant differences are denoted with different superscripts.

5.2.5 Phytoplankton

5.2.5.1 Overview

The following provides an overview of phytoplankton monitoring results for the Saskatchewan River Region over the three years of CAMPP. Sampling sites and periods were consistent with the water quality monitoring program and included annual monitoring at one on-system waterbody (Cedar Lake) and one off-system waterbody (Cormorant Lake; Figure 5.2.4-1). Water quality and phytoplankton were also monitored at two rotational waterbodies: South Moose Lake (on-system; 2009/2010) and the Saskatchewan River (on-system; 2010/2011). Sampling times relative to air temperature are presented in Figure 5.2.4-2.

Chlorophyll *a* was measured at all sites and sampling times in conjunction with the water quality sampling program. Data are therefore sufficient for statistical analysis and seasonal, temporal, and spatial variability was assessed for this parameter.

Phytoplankton biomass and taxonomic composition were measured in South Moose, Cedar, and Cormorant lakes in 2009/2010, and in the Saskatchewan River in 2010/2011. Due to limited data, phytoplankton biomass, composition and community metrics were not assessed statistically; analyses will be conducted in future when additional data are collected.

Chlorophyll *a* samples collected from Cedar Lake in fall 2009 and summer 2010 exceeded the bloom monitoring trigger of 10 µg/L; therefore, phytoplankton biomass and taxonomic composition, as well as microcystin-LR (an algal toxin), were also analysed during those periods at this site. An additional microcystin-LR sample was also analysed for South Moose Lake in spring 2009 although chlorophyll *a* had not exceeded the bloom monitoring trigger in this sample.

5.2.5.2 Chlorophyll a

Over the three years of CAMPP, chlorophyll *a* concentrations were low to moderate in the Saskatchewan River Region. During the ice-cover season, chlorophyll *a* never exceeded 2 µg/L whereas concentrations ranged up to 17.6 µg/L during the open-water season. In spring and winter, chlorophyll *a* concentrations were similar in all four waterbodies in the region but concentrations in Cedar Lake were higher than the other waterbodies in summer and fall (Figure 5.2.5-1).

5.2.5.3 Taxonomic Composition and Biomass

Phytoplankton biomass measured during the open-water season varied between the four waterbodies in the Saskatchewan River Region. Of the sites sampled in the same year, the most notable differences were the higher biomass measured in summer and fall in Cedar Lake, relative to South Moose and Cormorant lakes (Figure 5.2.5-2). Although higher biomass also occurred in fall in the Saskatchewan River, this site was sampled in a different year (2010) than the other waterbodies (2009), and these differences may reflect temporal and not spatial differences.

Phytoplankton biomass was highest in fall in all waterbodies, but the minimum biomass occurred in spring in Cedar Lake and summer in all other waterbodies (Figure 5.2.5-2). Phytoplankton biomass measured at the off-system waterbody (Cormorant Lake) was relatively similar to that of South Moose Lake, but was markedly lower than that measured at the on-system annual sampling waterbody (Cedar Lake) during all seasons.

Phytoplankton community composition also varied between the waterbodies in the region (Figure 5.2.5-3). Lakes in region had generally high abundances of blue-green algae than the Saskatchewan River. The phytoplankton community in South Moose Lake was dominated by blue-green algae whereas the community was generally dominated by diatoms, with blue-green algae as either the second-most dominant or co-dominant taxonomic group, in Cedar and Cormorant lakes. The phytoplankton community in the Saskatchewan River was dominated by diatoms or co-dominated by diatoms and green algae. However, as previously noted, because the Saskatchewan River was sampled in a different year, differences between this site and the lakes may reflect temporal and not spatial differences.

Metrics describing the phytoplankton community were calculated on a seasonal basis and are presented in Table 5.2.5-1. Overall, South Moose Lake had higher diversity, heterogeneity, and effective species richness than Cedar and/or Cormorant lakes.

5.2.5.4 Bloom Monitoring

Chlorophyll *a* exceeded the bloom monitoring trigger of 10 µg/L in Cedar Lake during fall 2009 and summer 2010. Phytoplankton biomass was moderate during both periods (8,675 mg/m^3 and 11,206 mg/m^3, respectively) and the community consisted primarily of blue-green algae and diatoms during both blooms (Figures 5.2.5-3 and 5.2.5-4).

5.2.5.5 Microcystin

Some forms of blue-green algae are capable of producing microcystins (liver toxins), including species of *Anabaena*, *Aphanizomenon*, *Microcystis*¸ *Nostoc* and *Planktothrix* (a.k.a. *Oscillatoria*;

Zurawell et al. 2005). Although not completely understood, several factors such as species, bacterial strain, and environmental conditions appear to affect production of microcystins. *Anabaena* and *Aphanizomenon* were identified in samples collected from every waterbody in the region. Additionally, *Planktothrix* was found in all three lakes (i.e., Cedar, Cormorant and South Moose lakes), but not in the Saskatchewan River.

During the three-year Pilot Program, microcystin-LR was analysed on two occasions when chlorophyll *a* results exceeded 10 µg/L (i.e., the threshold for microcystin-LR analysis) in Cedar Lake (southeast area) and in one sample from South Moose Lake although chlorophyll a was below the threshold of 10 µg/L. Microcystin-LR was not detected (<0.2 µg/L) in any of these samples.

5.2.5.6 Trophic Status

Based on trophic categorization schemes for lakes, Cedar and South Moose lakes are classified as mesotrophic on the basis of mean open-water chlorophyll *a* concentrations but Cormorant Lake is categorized as oligotrophic (Table 5.2.4-3). Using the trophic scheme for rivers, the Saskatchewan River is also categorized as oligotrophic (Table 5.2.4-5).

5.2.5.7 Seasonal Variability

At Cormorant Lake, the only annual waterbody where three full years of data are available, no statistically significant seasonal differences were found (Figure 5.2.5-1); however, chlorophyll *a* concentrations measured during the ice-cover season were often qualitatively lower than those measured during the open-water season in the region, regardless of the sampling location.

5.2.5.8 Spatial Comparisons

Mean annual chlorophyll *a* concentrations were not significantly different between the two annual waterbodies (Cedar and Cormorant lakes) in the Saskatchewan River Region (Figure 5.2.5-5).

5.2.5.9 Temporal Variability

Statistical comparisons between sampling years for the annual waterbodies (Cedar and Cormorant lakes) revealed that there were no significant differences in chlorophyll *a* concentrations over the monitoring period (Figure 5.2.5-6).

Table 5.2.5-1. Diversity, evenness, heterogeneity, and effective richness of the phytoplankton communities in the four waterbodies in the Saskatchewan River Region.

Waterbody	Season	Species Richness	Simpson's Diversity Index (1-G)	Simpson's Evenness (E_D)	Shannon-Weaver Index (H)	Evenness (E_H)	Hill's Effective Richness ($E^{H`}$)	Evenness ($E^{H`}/S$)
Saskatchewan River	Spring	21	0.62	0.13	1.40	0.46	4.06	0.19
	Summer	39	0.90	0.26	2.35	0.64	10.52	0.27
	Fall	30	0.34	0.05	0.88	0.26	2.41	0.08
South Moose Lake	Spring	-	-	-	-	-	-	-
	Summer	31	0.88	0.26	2.48	0.72	11.92	0.38
	Fall	34	0.89	0.27	2.62	0.74	13.70	0.40
Cedar Lake-Southeast	Spring 2009	36	0.78	0.13	1.95	0.54	7.03	0.20
	Summer 2009	20	0.82	0.27	2.01	0.67	7.45	0.37
	Fall 2009	30	0.82	0.18	2.19	0.64	8.93	0.30
	Summer 2010	31	0.85	0.21	2.27	0.66	9.70	0.31
Cormorant Lake	Spring	14	0.81	0.37	1.89	0.72	6.64	0.47
	Summer	15	0.84	0.42	2.21	0.82	9.13	0.61
	Fall	17	0.82	0.33	2.02	0.71	7.54	0.44

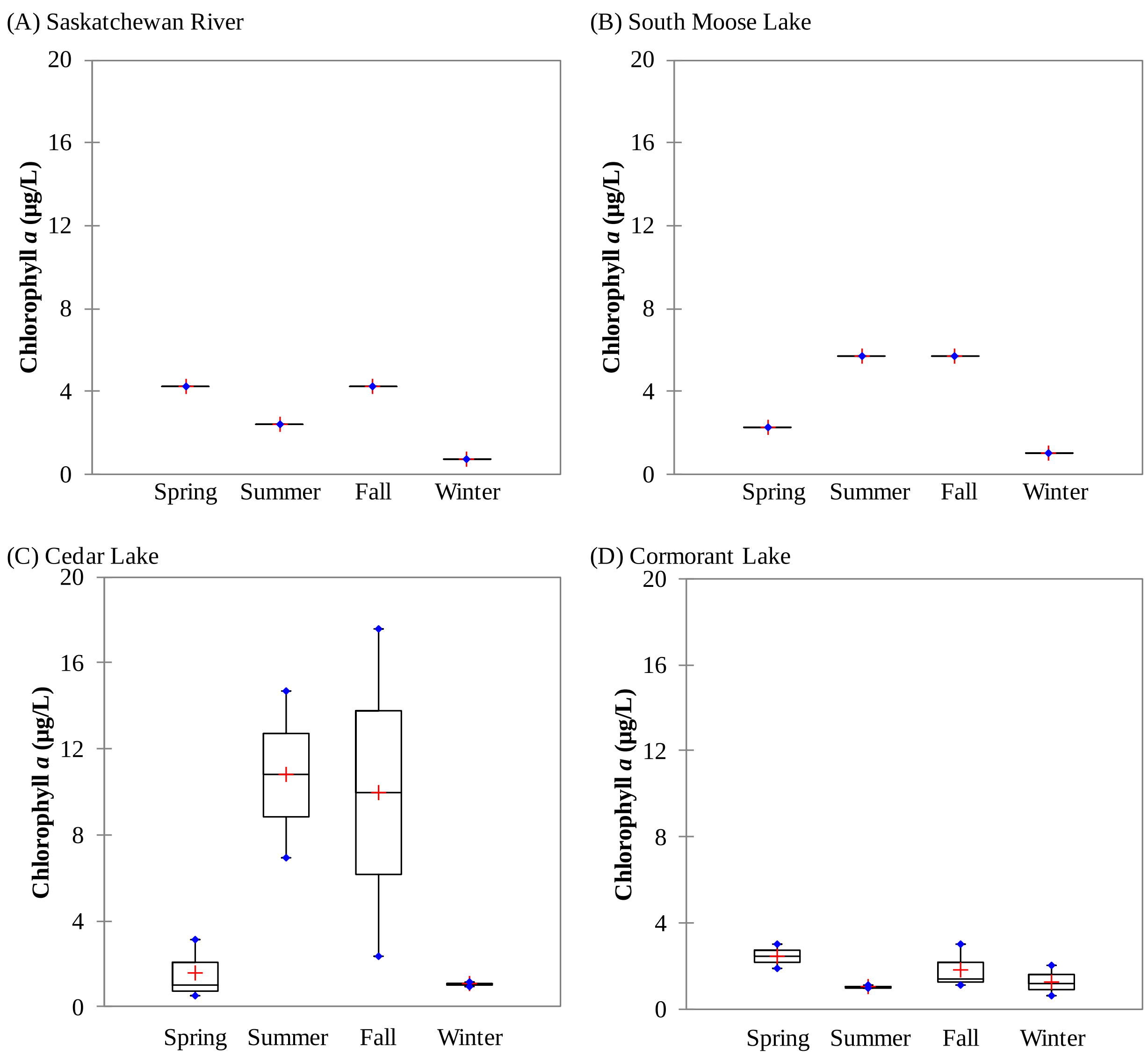


Figure 5.2.5-1. Chlorophyll a concentrations measured in the Saskatchewan River Region, 2008-2010 (Cormorant Lake), 2009-2010 (Cedar Lake; spring 2008 data excluded), 2009 (South Moose Lake), and 2010 (Saskatchewan River). No statistically significant seasonal differences were found at Cormorant Lake (i.e., the annual waterbody with three years of data).

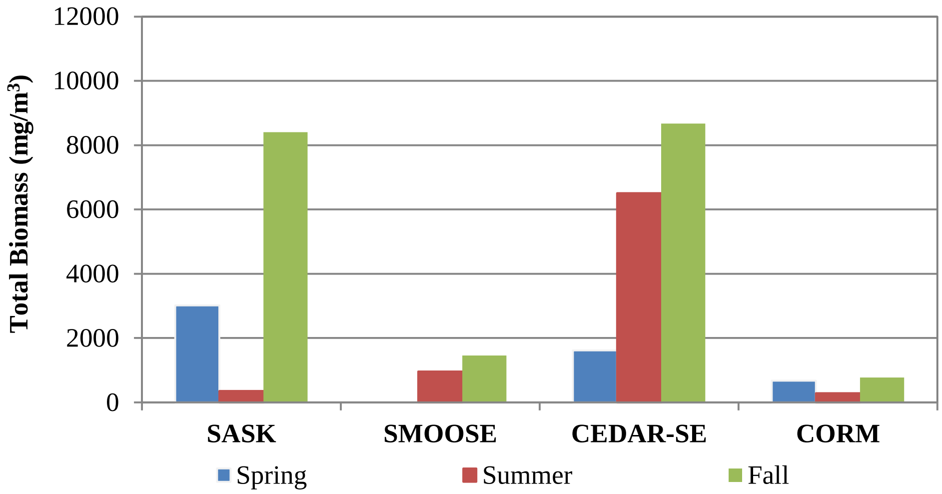


Figure 5.2.5-2. Phytoplankton biomass measured in the Saskatchewan River Region during the open-water seasons of 2009 (South Moose Lake, Cedar Lake, and Cormorant Lake) and 2010 (Saskatchewan River).

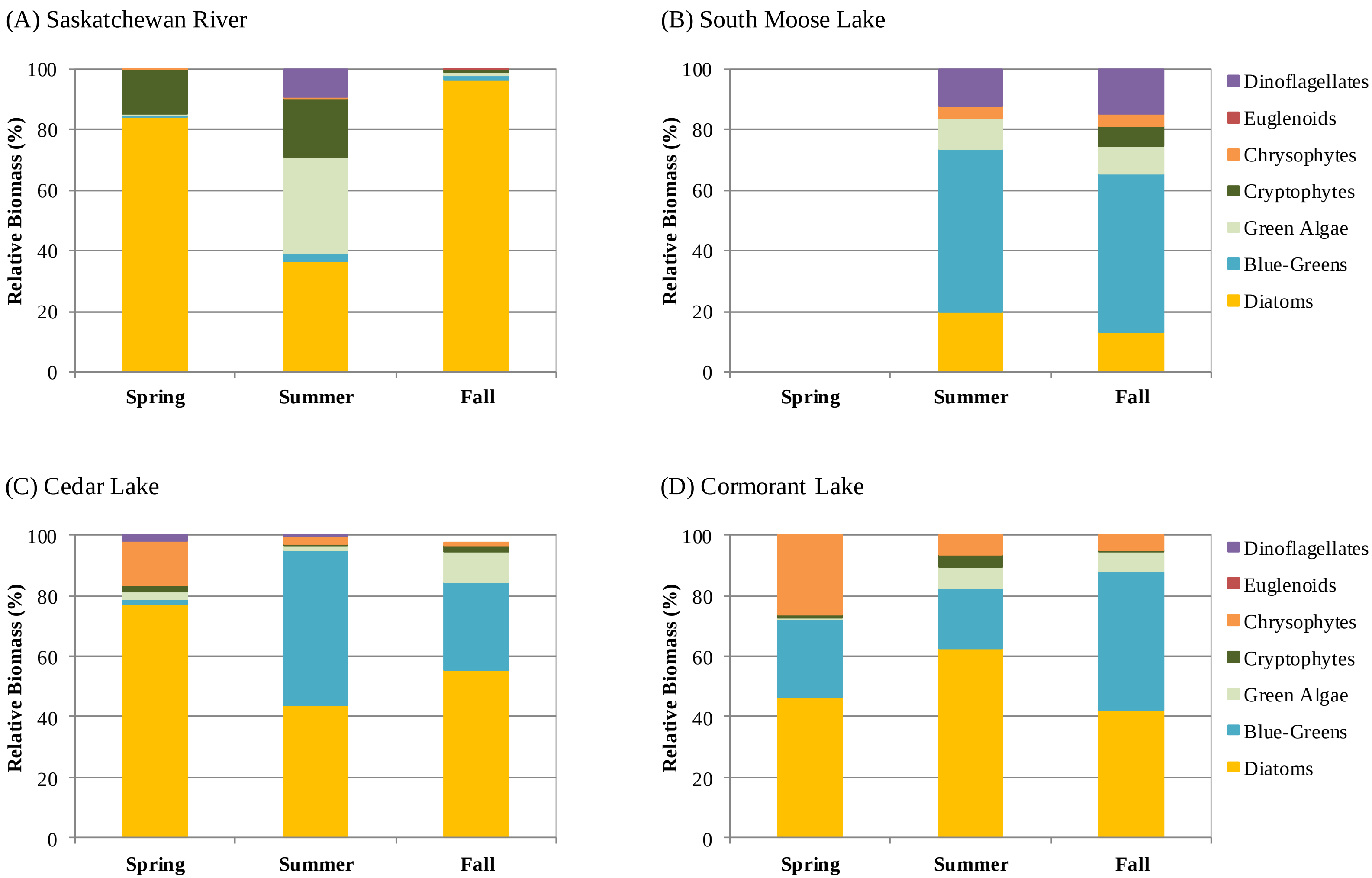


Figure 5.2.5-3. Phytoplankton community composition in the Saskatchewan River Region by season, as measured during the open-water seasons of 2009 (South Moose Lake, Cedar Lake, and Cormorant Lake) and 2010 (Saskatchewan River).

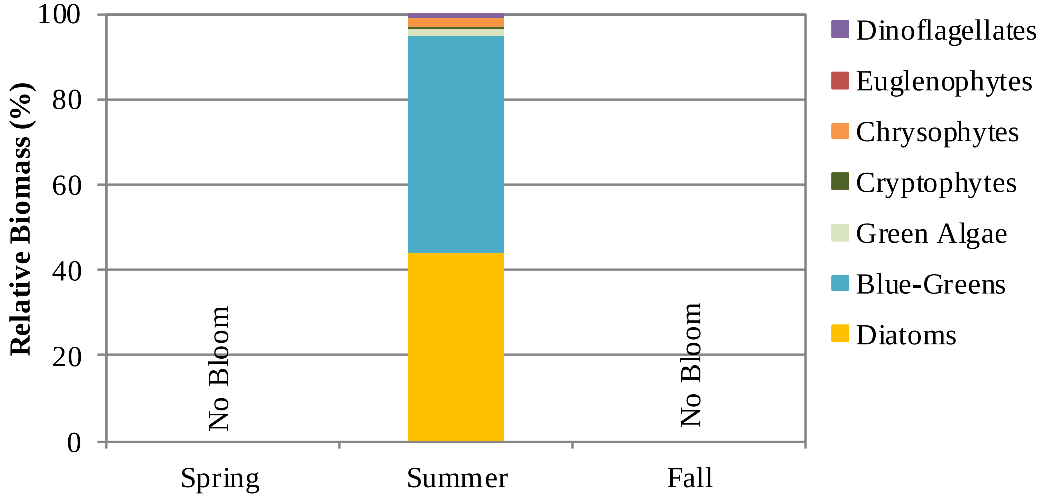


Figure 5.2.5-4. Phytoplankton community composition in Cedar Lake in 2010.

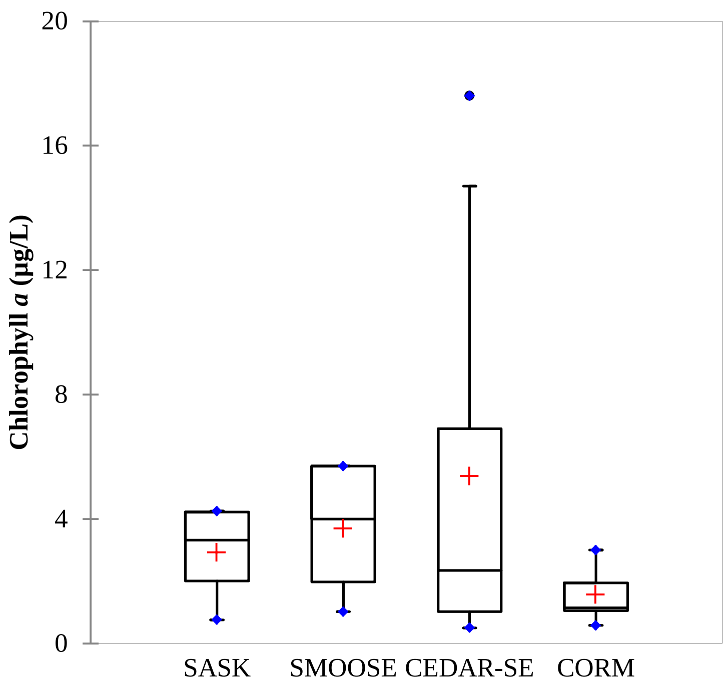


Figure 5.2.5-5. Chlorophyll *a* concentrations in the Saskatchewan River Region. No statistically significant spatial differences were found between the annual sites.

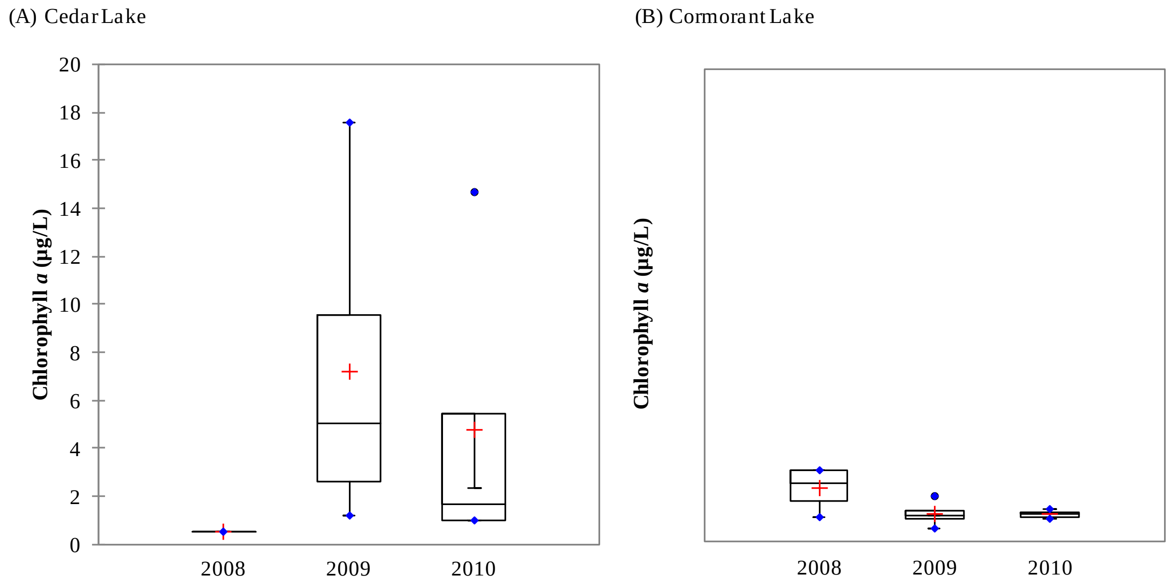


Figure 5.2.5-6. Chlorophyll *a* concentrations measured at the annual waterbodies in the Saskatchewan River Region by year. No statistically significant interannual differences were noted in either waterbody.

5.2.6 Benthic Macroinvertebrates

The following provides an overview of the benthic macroinvertebrate (BMI) community sampled over the three year CAMPP program in the Saskatchewan River Region (Figure 5.2.6-1). In 2008, BMI sampling was conducted in the annual, off-system waterbody, Cormorant Lake. In 2009, sampling was conducted in the on-system waterbodies, South Moose Lake and Cedar Lake-Southeast, and in the off-system waterbody, Cormorant Lake. Cedar Lake-Southeast is sampled annually, and South Moose Lake is sampled on a rotational basis (i.e., once every three years). In 2010, sampling was conducted in the on-system waterbodies, Cedar Lake-Southeast and Saskatchewan River, and in the off-system waterbody, Cormorant Lake. Saskatchewan River is sampled on a rotational basis. Nearshore and offshore habitat polygons were sampled in all waterbodies. BMI sampling was conducted from early to late-September each year.

BMI are described for waterbodies in the Saskatchewan River Region, including results of statistical analyses to evaluate spatial and temporal differences. In 2010, the sampling design was modified to incorporate kicknet sampling at all nearshore sites (intermittently wetted aquatic habitat). For this reason, a three year synthesis of the data for the predominantly wetted nearshore habitat was not possible and the 2010 nearshore data were described separately. Saskatchewan River nearshore was also described separately but sampled using a benthic grab; kicknet sampling was not possible at this site because the high, deep cut bank shorelines were not wadable/accessible. The sampling design for the offshore habitat was comparable among the three years and offshore data were summarized for all waterbodies.

The primary objective of spatial comparisons (i.e., comparison between waterbodies) was to evaluate whether the BMI community differ between on-system sites. Comparisons were also made between the on-system waterbodies and the off-system waterbody. The BMI community would be expected to differ between on- and off-system waterbodies due to fundamental, inherent differences associated with the watersheds and waterbodies. The objective of the comparisons between the on- and off-system waterbodies was to formally identify differences between these areas to assist with interpretation of results of CAMP as the program continues.

Temporal comparisons were undertaken for each waterbody sampled annually in order to provide a preliminary assessment of temporal variability. As additional data are acquired, more formal trend analyses will be undertaken to evaluate potential longer-term changes.

5.2.6.1 Supporting Environmental Variables

Supporting environmental variables (biophysical) were measured in the field within nearshore and offshore polygons (where applicable) at each waterbody and included water depth, water temperature, water velocity, Secchi depth, substrate type, type of riparian vegetation, and algal presence (Table 5.2.6-1). Benthic sediment samples were collected from BMI sampling sites and analyzed for particle size analysis (PSA) and total organic carbon (TOC). The nearshore habitat of Cedar-Southeast and Cormorant lakes (2010) consisted of mainly large, hard substrate, as such sediment samples were not collected for PSA and TOC analysis. In 2010, relative benchmarks were established along the shore at each waterbody to record the current water level and high water mark at the time of sampling.

In 2010, mean water depths in the intermittently wetted nearshore habitat were between 0.5 m (Cedar Lake-Southeast) and 0.9 m (Cormorant Lake) (Table 5.2.6-1). In the predominantly wetted nearshore habitat sampled in 2008 and 2009, mean water depths ranged from 1.3 m (South Moose Lake) and 4.2 (Cedar Lake-Southeast) (Table 5.2.6-1). Mean water depths within the offshore habitat (2008 to 2010) varied considerably, with values ranging between 6.1 m (South Moose Lake) and 14.5 m (Cormorant Lake) (Table 5.2.6-1).

In 2010, the mean TOC value for the intermittently wetted nearshore habitat at Saskatchewan River was 1.7% (Figure 5.2.6-2). The mean TOC values for nearshore benthic sediment collected in 2008 to 2009 ranged between 0.6% (Cormorant Lake) and 20.0% (Cedar Lake-Southeast) (Figure 5.2.6-3). In the offshore habitat (2008 to 2010), mean TOC ranged from 1.3% (Saskatchewan River) to 16.8% (Cedar Lake-Southeast) (Figure 5.2.6-4).

Sediment composition (PSA) in the intermittently wetted and predominantly wetted nearshore habitats (2008 to 2010) varied considerably (Figures 5.2.6-2 and 5.2.6-3). South Moose Lake consisted of similar proportions of clay, silt, and sand; Cedar Lake-Southeast was composed primarily of clay and silt, Cormorant Lake was mainly sand; and silt dominated the sediment samples of Saskatchewan River. Benthic sediment within the offshore habitat of South Moose Lake mainly consisted of clay and silt; and clay, silt, and sand were present in comparable quantities in Saskatchewan River, Cedar Lake-Southeast and Cormorant Lake (Figure 5.2.6-4).

5.2.6.2 Species Composition, Distribution, and Relative Abundance

Saskatchewan River

Mean BMI abundance of grab samples (n=5; 2010) collected in the intermittently wetted nearshore habitat of the Saskatchewan River was 61 individuals (Table 5.2.6-2; Figure 5.2.6-5). Overall, insects dominated the BMI community and mainly consisted of Ephemeroptera (mayflies) and small numbers of Chironomidae (midges) (Figures 5.2.6-6 and 5.2.6-7). Of the non-insects, Oligochaeta (aquatic worms) and Bivalvia (clams) were proportionately most abundant though Gastropoda (snails) were also present (Figures 5.2.6-6 and 5.2.6-7). Mean BMI density in offshore grab samples (n=5; 2010) was 915 individuals/m^2 (Table 5.2.6-3; Figure 5.2.6-8). Insects dominated the BMI community and midges, Trichoptera (caddisflies), and mayflies were most abundant (Figures 5.2.6-9 and 5.2.6-10). Of the non-insects, oligochaetes were proportionately more abundant and bivalves were also present (Figures 5.2.6-7 and 5.2.6-10).

Total EPT (mean abundance of Ephemeroptera, Plecoptera, and Trichoptera) was 59% and 38% of the mean total BMI in the intermittently wetted nearshore and offshore habitats, respectively (Tables 5.2.6-2 and 5.2.6-3; Figures 5.2.6-11 and 5.2.6-12). Of the EPT, mayflies were the only group collected in the nearshore habitat; caddisflies were most abundant in the offshore (Tables 5.2.6-2 and 5.2.6-3). Of the mayflies, Ephemeridae (*Hexagenia* sp., burrowing mayfly) was dominant in both habitat types (Tables 5.2.6-2 and 5.2.6-3). Trichoptera and Plecoptera were both present in the offshore. Mean EPT:C (ratio of EPT to Chironomidae) was 10.73 and 2.60 in each of the near and offshore habitats, indicating an EPT-dominant community compared to chironomid abundance (Tables 5.2.6-2 and 5.2.6-3).

Three of the eight families identified in the intermittently wetted nearshore dominated the BMI community (notably, Ephemeridae) (Table 5.2.6-2; Figure 5.2.6-13). Three of the 14 families identified in the offshore were proportionately abundant, namely Oligochaeta, Trichoptera (Hydropsychidae), and Chironomidae (Table 5.2.6-3; Figure 5.2.6-14). Mean diversity (Simpson’s) was 0.60 in the nearshore and 0.55 in the offshore (Figures 5.2.6-15 and 5.2.6-16). Mean evenness (Simpson’s equitability) was 0.34 in the nearshore and 0.40 in the offshore (Figures 5.2.6-15 and 5.2.6-16).

South Moose Lake

Mean BMI density of benthic grab samples (n=15; 2009) collected in the predominantly wetted nearshore habitat of in South Moose Lake was 7,811 invertebrates/m^2 (Table 5.2.6-4; Figure 5.2.6-17). Insects dominated the BMI community and mainly consisted of Chironomidae and Ephemeroptera (Figures 5.2.6-18 and 5.2.6-19). Non-insects mainly consisted of Amphipoda, Bivalvia, Oligochaeta, and Gastropoda (Figure 5.2.6-19). Mean BMI density in offshore benthic grab samples (n=15, 2009) was 762 invertebrates/m^2 (Table 5.2.6-3; Figure 5.2.6-8). Non-insects dominated the offshore BMI community (Figure 5.2.6-9). Of the non-insects, Oligochaeta dominated followed by bivalves and gastropods; and within Insecta, chironomids predominated (Figure 5.2.6-10).

Mean EPT comprised 4% and 1% of the mean total BMI density in the nearshore and offshore, respectively (Figures 5.2.6-20 and 5.2.6-12). Ephemeridae (*Hexagenia* sp.) was the dominant genus in both nearshore and offshore benthic grab samples; it was the only mayfly genera identified in the offshore, a total of four genera were identified in the nearshore habitat (Tables 5.2.6-3 and 5.2.6-4). Mean EPT:C was 0.14 and 0.07 in the nearshore and offshore, respectively, indicating a chironomid-dominant community relative to EPT abundance (Tables 5.2.6-3 and 5.2.6-4).

Four of the 22 families identified in the nearshore dominated the BMI community (notably, Chironomidae and Hyallelidae (Amphipoda) (Table 5.2.6-4). Three of the seven families identified in the offshore were proportionally abundant (namely, Oligochaeta, Chironomidae, and Pisidiidae (peaclams) (Table 5.2.6-2). Mean diversity (Simpson's) was 0.59 in the nearshore and 0.61 (Figures 5.2.6-22 and 5.2.6-16). Mean evenness (Simpson's) was 0.28 in the nearshore and 0.65 in the offshore (Figures 5.2.6-22 and 5.2.6-16).

<u>Cedar Lake - Southeast</u>

Mean BMI abundance of kicknet samples (n=5; 2010) collected in the intermittently wetted nearshore habitat was 356 individuals per sample (Table 5.2.6-2; Figure 5.2.6-5). Non-insects dominated the BMI community and mainly consisted of Amphipoda; Gastropoda, Oligochaeta, and Bivalvia were also present (Figures 5.2.6-6 and 5.2.6-7). Insects mainly consisted of Ephemeroptera and Chironomidae, and small numbers of Trichoptera were also identified (Figure 5.2.6-7). Mean BMI density of benthic grab samples (n=15; 2009) collected in the predominantly wetted nearshore habitat of in Cedar Lake – Southeast was 1,434 invertebrates/m^2 (Table 5.2.6-4; Figure 5.2.6-17). Overall, non-insects dominated the BMI community and mainly consisted of Amphipoda and Bivalvia; though Oligochaeta and Gastropoda were also present (Figures 5.2.6-18 and 5.2.6-19). Insects mainly consisted of Chironomidae and a smaller number of Trichoptera (Figure 5.2.6-19). Mean total density for macroinvertebrates collected in offshore benthic grab samples (n=20; 2009 to 2010) in Cedar Lake was 2,701 individuals/m^2 (Table 5.2.6-3; Figure 5.2.6-8). Non-insects dominated the offshore community, with Oligochaeta and Amphipoda the most abundant taxa, followed by Bivalvia, and Gastropoda (Figures 5.2.6-9 and 5.2.6-10). Insects were dominated by Chironomidae, a few Ephemeroptera, and Trichoptera (Figure 5.2.6-10).

Mean EPT in nearshore kicknet samples comprised 9% of the total BMI community (Table 5.2.6-2; Figure 5.2.6-11). Caenidae (*Caenis* sp., small square-gill mayflies) was the dominant genus; Leptophlebiidae (prong-gilled mayflies), Heptageniidae (flat-headed or stream mayflies), Baetidae (small or minnow mayflies), and Leptohyphidae were also identified. Mean total EPT comprised $\leq$ 2% of the total BMI community in the predominantly wetted nearshore and offshore habitats (Tables 5.2.6-3 and 5.2.6-4; Figures 5.2.6-20 and 5.2.6-12). In the nearshore habitat, EPT was characterized solely of caddisflies; the offshore comprised mainly of mayflies, and a smaller number of caddisflies (Tables 5.2.6-3 and 5.2.6-4). Ephemeridae (*Hexagenia* sp.) was the only genus identified in offshore benthic samples (Table 5.2.6-3). Mean EPT: C in the intermittently wetted nearshore habitat was 2.04, indicating an EPT-dominant community with respect to chironomid abundance (Table 5.2.6-2).Mean EPT: C was 0.05 and 0.04 in the predominantly wetted nearshore and offshore, respectively (Tables 5.2.6-3 and 5.2.6-4). The ratio values indicated both habitats were dominated by chironomids relative to EPT abundance.

Six out of the 31 families identified from nearshore kicknet samples dominated the community (most notably Amphipoda: Hyalellidae) with a mean taxa richness of 20 families (Table 5.2.6-2; Figure 5.2.6-13). Four out of 10 macroinvertebrate families (Hill's effective and taxonomic richness) dominated the predominantly wetted nearshore habitat, namely Chironomidae, Amphipoda (Hyalellidae), Gastropoda (Pisidiidae), and Oligochaeta (Tables 5.2.6-4). Mean taxonomic richness for the nearshore habitat was 5 families (Figure 5.2.6-21). Four of 13 families identified dominated the offshore community, notably Chironomidae, Oligochaeta and Gastropoda (Pisidiidae) and mean taxa richness was 5 families (Table 5.2.6-3; Figure 5.2.6-14). Diversity and evenness values in the intermittently wetted nearshore habitat were 0.69 and 0.17, respectively (Figure 5.2.6-15).Mean diversity (Simpson's) was 0.55 in the predominantly wetted nearshore and 0.68 in the offshore (Figures 5.2.6-22 and 5.2.6-16). Mean evenness (Simpson's equitability) in the nearshore was 0.40; and 0.62 in the offshore (Figures 5.2.6-22 and 5.2.6-16).

Cormorant Lake

Mean BMI abundance of kicknet samples (n=5; 2010) collected in the intermittently wetted nearshore habitat was 215 individuals (Figure 5.2.6-5). Insects dominated the community, with Chironomidae being the most abundant taxon, followed by Ephemeroptera (Figures 5.2.6-6 and 5.2.6-7). Of the non-insects, Amphipoda was most abundant, followed by Oligochaeta (Figure 5.2.6-7). Mean BMI density of benthic grab samples (n= 30; 2008 to 2009) collected in the predominantly wetted nearshore habitat of Cormorant Lake was 3,406 individuals/m^2 (Table 5.2.6-4; Figure 5.2.6-17). Non-insects dominated the BMI community in abundance and mainly consisted of Amphipoda followed by Bivalvia, Oligochaeta, and Gastropoda (Figures 5.2.6-18 and 5.2.6-19). Insects mainly consisted of Chironomidae; Ephemeroptera and Trichoptera were also present (Figure 5.2.6-19). Mean BMI density in offshore benthic grab samples (n= 35; 2008 to 2010) in Cormorant Lake was 1,033 individuals/m^2 (Table 5.2.6-3; Figure 5.2.6-8). Non-insects marginally dominated the community, and comprised mainly of Amphipoda and Bivalvia, followed by Gastropoda and Oligochaeta (Figures 5.2.6-9 and 5.2.6-10). Chironomidae was the dominant taxon among the insects (Figure 5.2.6-10).

Mean EPT abundance in the intermittently wetted nearshore habitat was comparatively high, comprising 25% of the total BMI community and consisting mainly of mayflies (Table 5.2.6-2). Of the mayflies, Caenidae (*Caenis* sp.) was the predominant group (Table 5.2.6-2). Mean EPT was 2% and 7% of the total BMI density in the predominantly wetted nearshore and offshore habitats, respectively (Tables 5.2.6-4 and 5.2.6-3; Figures 5.2.6-20 and 5.2.6-12). Of the EPT, mayflies were most abundant in both habitats, with the dominant genus Ephemeridae (*Hexagenia* sp.) (Tables 5.2.6-4 and 5.2.6-3). Mean EPT:C in the intermittently wetted nearshore habitat was 0.56, indicating a chironomid-dominated community with respect to EPT abundance (Table 5.2.6-2). Mean EPT:C was 0.11 and 0.25 in the predominantly wetted nearshore and offshore polygon habitats, respectively; indicating a chironomid-dominated community with respect to EPT abundance in both habitat types. (Tables 5.2.6-4 and 5.2.6-3).

Eight of a total of 28 families were most abundant in the intermittently wetted nearshore habitat (Table 5.2.6-2). Mean taxa richness was 20 families (Figure 5.2.6-13). Five out the 22 families (Hill's effective and taxonomic richness) identified in the nearshore significantly contributed to the overall BMI composition, particularly Amphiopda (Hyallelidae), Chironomidae and Gastropoda (Pisidiidae) (Table 5.2.6-4). Mean taxonomic richness in the nearshore habitat was 7 families (Figure 5.2.6-21). Four of 17 families identified from the offshore dominated the community, notably Chironomidae and Gastropoda (Pisidiidae) (Table 5.2.6-3). Mean taxa richness in the offshore was 5 families (Figure 5.2.6-14). Mean diversity of the nearshore kicknet samples was 0.77 and evenness was 0.19 (Figure 5.2.6-15). Mean diversity index was 0.72 in the predominantly wetted nearshore and 0.65 in the offshore; evenness values were 0.57 and 0.62 in the near and offshore habitats, respectively (Figures 5.2.6-22 and 5.2.6-16).

5.2.6.3 Spatial Comparisons

Differences in BMI abundance and richness metrics for the nearshore habitat of Cedar Lake-Southeast (on-system) and Cormorant Lake (off-system) were detected. While statistical analysis only incorporated two years of data (2008 to 2009), it appears that abundances of non-insects, oligochaetes, amphipods, mayflies, EPT and taxa richness varied between sites (Figures 5.2.6-17 to 5.2.6-22). For all of these measures, Cormorant Lake appears to be significantly greater than Cedar Lake.

Statistical differences were detected for abundance and richness measures for the nearshore kicknet samples. While analysis only included one year of data, Cormorant and Cedar lakes appear to differ from each other with respect to abundances of non-insects, amphipods, gastropods, insects, chironomids, and EPT:C (Figures 5.2.6-5 to 5.2.6-7, 5.2.6-9, 5.2.6-11, 5.2.6-13, 5.2.6-15). For several of these measures, trends were difficult to summarize.

Differences in offshore BMI abundance and richness metrics were also detected. Analysis incorporated two years of data for Cedar Lake and three years of data for Cormorant Lake. It appears that abundances of macroinvertebrates, non-insects, oligochaetes, amphipods, bivalves, insects, and chironomids varied between sites (Figures 5.2.6-8 to 5.2.6-10, 5.2.6-12, 5.2.6-14, 5.2.6-16,). For all metrics, Cedar Lake was significantly greater than Cormorant Lake.

Future evaluations of spatial variability or trends will be undertaken when additional data are acquired for the region.

5.2.6.4 Temporal Variability

Preliminary power analysis of the initial CAMPP study design (implemented in 2008 and 2009) showed that the BMI community metrics differed considerably among samples within the same habitat type and the delineation between nearshore and offshore polygon locations was sometimes indistinct. The inherent variablilty of this data made it difficult to explain and relate "significant" results with confidence to other components of CAMPP (e.g., hydrology and water quality).

The initial BMI study design was refined and implemented in the 2010 field season. The study design was changed with respect to site selection within nearshore and offshore polygons, and nearshore sampling methods. The objective of the refined BMI program was to minimize the inherent variability and increase the power of the BMI data to detect statistically significant variabililty or trends over time. As additional data are acquired for the region under the refined program, analyses will be undertaken to evaluate potential long-term changes in BMI community metrics and to link significant trends to the other CAMP components.

Temporal differences in BMI abundance measures for the offshore habitat of Cedar Lake-Southeast were detected. While statistical analysis only included two years of data, there were no differences found only for abundances of bivalves, insects, and chironomids (Figures 5.2.6-23 to 5.2.6-28). All other measures were different with most being significantly greater in 2010 when compared to 2009.

Few temporal differences in BMI abundance measures for the nearshore habitat of Cormorant Lake were detected. While statistical analysis only included two years of data (2008 and 2009), no differences were found for abundances of gastropods, mayflies, caddisflies, EPT, EPT:C, taxa richness, and Simpson's diversity and evenness (Figures 5.2.6-29 to 5.2.6-34). Where differences occurred, all measures for 2009 were significantly greater than 2008 except for Simpson's evenness.

Temporal differences in BMI abundance measures for the offshore habitat of Cormorant Lake were detected. Statistical analysis incorporated three years of data (2008 to 2010) and the majority of metrics were found to be significantly greater in 2010 (Figures 5.2.6-35 to 5.2.6-40).

A few differences were detected between 2008 and 2009 (i.e., abundances of insects, amphipods, gastropods, and mayflies), while significantly different, the amount of differences were small in comparison to differences detected in 2010. No differences were only found for abundances of oligochaetes, bivalves, and chironomids.

Table 5.2.6-1. Habitat and physical characteristics recorded at benthic macro-invertebrate sites in the Saskatchewan River Region for CAMPP, 2008 to 2010.

Waterbody	Habitat Type	No. of Samples	Water Depth			Mean Water Velocity	Mean Secchi Depth	Water Temperature	Predominant Substrate	Riparian Vegetation	Canopy Cover	Algae
			Mean	Min	Max							
		(n)	(m)	(m)	(m)	(m/sec)	(m)	(ºC)			(%)	
Cormorant Lake (2008)	Nearshore	15	3.4	3	3.5	--	--	--	--	--	--	--
	Offshore	15	16.8	13	18	--	--	--	--	--	--	--
South Moose Lake (2009)	Nearshore	15	1.3	0.8	1.7	--	1.50	18.0	--	reeds, shrubs	--	--
	Offshore	15	6.1	5.3	6.3	--	1.50	17.0	--	--	--	--
Cedar Lake – SE (2009)	Nearshore	15	4.2	3.7	4.9	--	2.10	19.0	--	reeds, shrubs, conifers	--	--
	Offshore	15	10.6	10.4	10.8	--	1.50	16.0	--	--	--	--
Cormorant Lake (2009)	Nearshore	15	3.4	3.2	3.6	--	2.90	18.0	--	reeds, shrubs, mixed forest	--	--
	Offshore	15	14.6	13.5	15.2	--	3.50	17.0	--	--	--	--

Table 5.2.6-1. continued.

Waterbody	Habitat Type	No. of Samples	Water Depth			Mean Water Velocity	Mean Secchi Depth	Water Temperature	Predominant Substrate	Riparian Vegetation	Canopy Cover	Algae
			Mean	Min	Max							
		(n)	(m)	(m)	(m)	(m/sec)	(m)	(ºC)			(%)	
Saskatchewan River (2010)	Nearshore	5	0.8	0.8	0.9	1.00	0.29	15.0	clay, organic matter	shrubs, coniferous	0-24	--
	Offshore	5	6.4	5.3	7.7	0.42	0.31	15.0	clay, organic matter	--	--	--
Cedar Lake –SE (2010)	Nearshore	5	0.5	0.5	0.6	--	--	14.0	boulder, cobble	shrubs, mixed forest	0-24	slime/crust
	Offshore	5	6.2	6.1	6.5	--	1.17	--	clay, organic matter	--	--	floating
Cormorant Lake (2010)	Nearshore	5	0.9	0.7	1	--	--	15.0	boulder, cobble	mixed forest	0-24	slime/crust, attached
	Offshore	5	7.4	7.1	7.6	--	3.19	15.0	clay, organic matter	--	--	--

Table 5.2.6-2. Summary statistics calculated from the taxonomic analysis of benthic macroinvertebrate nearshore kicknet samples collected in the Saskatchewan River Region for CAMPP, 2010.

Waterbody and Habitat	Saskatchewan River Nearshore (2010)							Cedar Lake-Southeast Nearshore (2010)						
	Proportion (%)	Mean	SD	SE	Median	Min	Max	Proportion (%)	Mean	SD	SE	Median	Min	Max
No. of Samples (n)	5	--	--	--	--	--	--	5	--	--	--	--	--	--
Water Depth (m)	--	0.8	0.06	0.03	0.8	0.8	0.9	--	0.52	0.06	0.0	0.5	0.5	0.6
Abundance (no. per kicknet)														
Total Invertebrates	--	61	17.1	7.6	68	43	82	--	356	312.6	139.8	205	109	857
Non-Insecta	34	21	7.8	3.5	23	12	31	83	294	264.5	118.3	154	95	712
Oligochaeta	17	10	2.6	1.1	10	7	14	3	11	8.8	3.9	11	1	24
Amphipoda	0	0	0.2	0.1	0	0	0	60	215	167.5	74.9	128	64	408
Bivalvia	14	9	5.6	2.5	11	1	15	2	7	10.0	4.5	3	0	24
Gastropoda	3	2	1.1	0.5	2	0	3	17	61	110.0	49.2	7	3	256
Insecta	66	41	12.1	5.4	36	28	58	17	61	49.9	22.3	51	14	145
Chironomidae	7	4	2.8	1.3	4	1	9	5	18	12.0	5.4	15	3	32
Ephemeroptera	59	36	10.0	4.5	32	27	52	7	25	22.5	10.1	18	9	64
Plecoptera	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0
Trichoptera	0	0	0.0	0.0	0	0	0	2	7	8.3	3.7	4	2	21
EPT	59	36	10	4	32	27	52	9	32	30.6	13.7	23	10	85
EPT to Chironomidae Ratio	--	10.73	5.798	2.593	9.81	4.38	20.00	--	2.04	1.217	0.544	1.48	1.05	3.88
Genus analysis of Ephemeroptera	Ephemeridae: *Hexagenia*	--	--	--	--	--	--	Caenidae: *Caenis*	--	--	--	--	--	--
No. of Samples with No Aquatic Invertebrates	0	--	--	--	--	--	--	0	--	--	--	--	--	--
No. Samples with Only OLIGO +/or CHIRON	0	--	--	--	--	--	--	0	--	--	--	--	--	--
Taxonomic Richness (Family-level)	8	6	0.8	0.4	6	5	7	31	20	1.8	0.8	20	17	22
Simpson's Diversity Index	--	0.60	0.072	0.032	0.56	0.52	0.69	--	0.69	0.140	0.063	0.73	0.52	0.82
Evenness (Simpson's Equitability)	--	0.34	0.088	0.039	0.33	0.23	0.46	--	0.17	0.058	0.026	0.16	0.11	0.24
Shannon-Weaver Index	--	1.21	0.155	0.069	1.23	1.04	1.39	--	1.79	0.473	0.212	1.94	1.22	2.25
Evenness (Shannon’s Equitability)	--	0.60	0.062	0.028	0.58	0.53	0.68	--	0.58	0.137	0.061	0.62	0.42	0.71
Hill's Effective Richness	--	3	0.5	0.2	3	3	4	--	6	2.8	1.2	7	3	10
Evenness (Hill's)	--	0.44	0.073	0.032	0.45	0.34	0.54	--	0.30	0.104	0.047	0.30	0.19	0.42

Table 5.2.6-2. continued.

Waterbody and Habitat	Cormorant Lake Nearshore (2010)						
	Proportion (%)	Mean	SD	SE	Median	Min	Max
No. of Samples (n)	5	--	--	--	--	--	--
Water Depth (m)	--	0.9	0.10	0.05	0.9	0.7	1.0
Abundance (no. per kicknet)							
Total Invertebrates	--	215	78.2	35.0	189	151	351
Non-Insecta	17	37	27.9	12.5	24	19	86
Oligochaeta	5	10	6.8	3.0	6	5	21
Amphipoda	12	25	21.9	9.8	16	13	64
Bivalvia	0	0	0.5	0.2	0	0	1
Gastropoda	0	0	0.3	0.1	0	0	1
Insecta	83	178	51.4	23.0	169	128	265
Chironomidae	48	104	41.0	18.3	89	67	171
Ephemeroptera	20	44	10.2	4.6	46	31	54
Plecoptera	0	0	0.1	0.1	0	0	0
Trichoptera	4	9	4.6	2.0	9	3	15
EPT	25	53	13.0	5.8	49	39	69
EPT to Chironomidae Ratio	--	0.56	0.204	0.091	0.49	0.34	0.81
Genus analysis of Ephemeroptera	Caenidae: *Caenis*	--	--	--	--	--	--
No. of Samples with No Aquatic Invertebrates	0	--	--	--	--	--	--
No. Samples with Only OLIGO +/or CHIRON	0	--	--	--	--	--	--
Taxonomic Richness (Family-level)	28	20	2.3	1.0	20	16	22
Simpson's Diversity Index	--	0.77	0.056	0.025	0.78	0.68	0.83
Evenness (Simpson's Equitability)	--	0.19	0.063	0.028	0.17	0.13	0.29
Shannon-Weaver Index	--	2.05	0.154	0.069	2.11	1.79	2.17
Evenness (Shannon’s Equitability)	--	0.64	0.058	0.026	0.65	0.56	0.73
Hill's Effective Richness	--	8	1.1	0.5	8	6	9
Evenness (Hill's)	--	0.32	0.070	0.031	0.32	0.25	0.44

Table 5.2.6-3. Summary statistics calculated from the taxonomic analysis of benthic macroinvertebrate offshore grab samples collected in the Saskatchewan River Region for CAMPP, 2008 to 2010.

Waterbody and Habitat	Saskatchewan River Offshore (2010)							South Moose Lake Offshore						
	Proportion (%)	Mean	SD	SE	Median	Min	Max	Proportion (%)	Mean	SD	SE	Median	Min	Max
No. of Samples (n)	5	--	--	--	--	--	--	15	--	--	--	--	--	--
Water Depth (m)	--	6.4	1.07	0.48	6.8	5.3	7.7	--	6.1	0.23	0.06	6.1	5.3	6.3
Abundance (no. per m^2)														
Total Invertebrates	--	915	586.6	262.4	1212	260	1486	--	762	377.3	97.4	606	303	1601
Non-Insecta	38	343	380.7	170.2	231	58	1010	70	534	389.1	100.5	433	130	1472
Oligochaeta	26	242	400.0	178.9	29	0	938	43	326	275.1	71.0	260	43	952
Amphipoda	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0
Bivalvia	11	98	89.8	40.1	72	14	231	24	182	123.7	31.9	130	0	476
Gastropoda	0	0	0.0	0.0	0	0	0	3	26	48.5	12.5	0	0	173
Insecta	62	571	528.8	236.5	476	0	1154	30	228	154.7	40.0	216	43	693
Chironomidae	22	202	207.8	92.9	173	0	476	27	205	148.6	38.4	216	0	649
Ephemeroptera	13	115	88.4	39.5	115	0	245	1	6	15.2	3.9	0	0	43
Plecoptera	1	9	19.4	8.7	0	0	43	0	0	0.0	0.0	0	0	0
Trichoptera	25	228	319.1	142.7	0	0	664	0	0	0.0	0.0	0	0	0
EPT	38	352	335.7	150.1	245	0	794	1	6	15.2	3.9	0	0	43
EPT to Chironomidae Ratio	--	2.60	3.130	1.400	1.42	0.00	8.00	--	0.07	0.258	0.067	0.00	0.00	1.00
Genus analysis of Ephemeroptera	Ephemeridae: *Hexagenia*	--	--	--	--	--	--	1 sp. (*Hexagenia*)	--	--	--	--	--	--
No. of Samples with No Aquatic Invertebrates	0	--	--	--	--	--	--	0	--	--	--	--	--	--
No. Samples with Only OLIGO +/or CHIRON	0	--	--	--	--	--	--	0	--	--	--	--	--	--
Taxonomic Richness (Family-level)	14	6	2.1	0.9	6	3	9	7	4	0.8	0.2	4	2	5
Simpson's Diversity Index	--	0.55	0.201	0.090	0.63	0.20	0.71	--	0.61	0.113	0.029	0.60	0.42	0.74
Evenness (Simpson's Equitability)	--	0.40	0.137	0.061	0.42	0.25	0.57	--	0.65	0.144	0.037	0.64	0.38	0.86
Shannon-Weaver Index	--	1.15	0.408	0.182	1.30	0.43	1.40	--	1.15	0.270	0.070	1.14	0.61	1.54
Evenness (Shannon's Equitability)	--	0.61	0.148	0.066	0.60	0.39	0.77	--	0.80	0.099	0.026	0.82	0.61	0.94
Hill's Effective Richness	--	3	1.0	0.5	4	2	4	--	3	0.9	0.2	3	2	5
Evenness (Hill's)	--	0.52	0.120	0.054	0.51	0.37	0.66	--	0.76	0.112	0.029	0.77	0.53	0.93

Table 5.2.6-3. continued.

Waterbody and Habitat	Cedar Lake-Southeast Offshore (2009 to 2010)							Cormorant Lake Offshore (2008 to 2010)						
	Proportion (%)	Mean	SD	SE	Median	Min	Max	Proportion (%)	Mean	SD	SE	Median	Min	Max
No. of Samples (n)	20	--	--	--	--	--	--	35	--	--	--	--	--	--
Water Depth (m)	--	9.5	1.93	0.43	10.5	6.1	10.8	--	14.5	3.25	0.55	14.9	7.1	18.0
Abundance (no. per m^2)														
Total Invertebrates	--	2701	1943.1	434.5	1731	995	7531	--	1033	528.3	89.3	909	0	2179
Non-Insecta	66	1783	1772.0	396.2	1039	346	6334	53	552	350.6	59.3	476	0	1443
Oligochaeta	28	769	784.3	175.4	433	87	2727	10	101	136.0	23.0	43	0	563
Amphipoda	12	333	606.3	135.6	0	0	1775	21	212	297.8	50.3	130	0	1327
Bivalvia	24	643	515.5	115.3	541	29	2193	19	195	140.5	23.7	173	0	606
Gastropoda	1	24	40.1	9.0	0	0	130	4	41	101.9	17.2	0	0	476
Insecta	34	918	502.0	112.3	873	346	2597	47	481	285.9	48.3	476	0	1082
Chironomidae	33	888	506.5	113.3	772	346	2597	39	404	257.5	43.5	346	0	995
Ephemeroptera	1	23	45.2	10.1	0	0	144	6	57	105.5	17.8	0	0	375
Plecoptera	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0
Trichoptera	0	7	15.9	3.5	0	0	43	1	12	33.6	5.7	0	0	144
EPT	1	30	56.7	12.7	0	0	173	7	70	132.9	22.5	0	0	476
EPT to Chironomidae Ratio	--	0.04	0.077	0.017	0.00	0.00	0.21	--	0.25	0.415	0.070	0.00	0.00	1.41
Genus analysis of Ephemeroptera	Ephemeridae: *Hexagenia*	--	--	--	--	--	--	Ephemeridae: *Hexagenia*	--	--	--	--	--	--
No. of Samples with No Aquatic Invertebrates	0	--	--	--	--	--	--	1	--	--	--	--	--	--
No. Samples with Only OLIGO +/or CHIRON	0	--	--	--	--	--	--	0	--	--	--	--	--	--
Taxonomic Richness (Family-level)	13	5	2.7	0.6	4	3	10	17	5	3.3	0.6	4	0	14
Simpson's Diversity Index	--	0.68	0.096	0.021	0.68	0.42	0.83	--	0.65	0.169	0.029	0.67	0.00	0.89
Evenness (Simpson's Equitability)	--	0.62	0.167	0.037	0.67	0.35	0.90	--	0.62	0.198	0.033	0.63	0.00	0.95
Shannon-Weaver Index	--	1.33	0.324	0.072	1.24	0.80	2.08	--	1.31	0.474	0.080	1.31	0.00	2.37
Evenness (Shannon’s Equitability)	--	0.80	0.093	0.021	0.82	0.58	0.95	--	0.78	0.175	0.030	0.82	0.00	0.98
Hill's Effective Richness	--	4	1.4	0.3	3	2	8	--	4	2.2	0.4	4	1	11
Evenness (Hill's)	--	0.72	0.150	0.034	0.76	0.46	0.94	--	0.71	0.186	0.031	0.73	0.00	0.97

Table 5.2.6-4. Summary statistics calculated from the taxonomic analysis of benthic macroinvertebrate nearshore grab samples collected in the Saskatchewan River Region for CAMPP, 2008 to 2009.

Waterbody and Habitat	South Moose Lake Nearshore (2009)							Cedar Lake-Southeast Nearshore (2009)						
	Proportion (%)	Mean	SD	SE	Median	Min	Max	Proportion (%)	Mean	SD	SE	Median	Min	Max
No. of Samples (n)	15	--	--	--	--	--	--	15	--	--	--	--	--	--
Water Depth (m)	--	1.3	0.32	0.08	1.5	0.8	1.7	--	4.2	0.46	0.12	3.9	3.7	4.9
Abundance (no. per m²)														
Total Invertebrates	--	7811	3471.2	896.3	7834	3852	16707	--	1434	713.8	184.3	1515	346	2857
Non-Insecta	24	1838	1309.1	338.0	1255	519	4761	66	949	655.9	169.4	779	87	2424
Oligochaeta	4	280	408.6	105.5	43	0	1255	14	199	303.8	78.4	0	0	995
Amphipoda	14	1082	744.5	192.2	822	216	2337	25	361	278.4	71.9	346	0	909
Bivalvia	5	358	376.4	97.2	260	0	1342	20	291	171.2	44.2	346	0	606
Gastropoda	1	113	194.8	50.3	43	0	693	7	98	97.4	25.2	43	0	303
Insecta	76	5973	2765.4	714.0	5410	2684	12336	34	485	300.4	77.6	390	130	1082
Chironomidae	69	5393	2963.5	765.2	5064	1125	12033	32	459	294.8	76.1	346	130	1082
Ephemeroptera	3	254	327.1	84.5	87	0	995	0	0	0.0	0.0	0	0	0
Plecoptera	0	0	0.0	0.0	0	0	0	0	0	0.0	0.0	0	0	0
Trichoptera	1	87	54.3	14.0	87	0	173	2	23	36.1	9.3	0	0	87
EPT	4	340	334.4	86.3	173	0	1082	2	23	36.1	9.3	0	0	87
EPT to Chironomidae Ratio	--	0.14	0.255	0.066	0.03	0.00	0.96	--	0.05	0.088	0.023	0.00	0.00	0.29
Genus analysis of Ephemeroptera	5 spp. (DOM: *Hexagenia*)	--	--	--	--	--	--	--	--	--	--	--	--	--
No. of Samples with No Aquatic Invertebrates	0	--	--	--	--	--	--	0	--	--	--	--	--	--
No. Samples with Only OLIGO +/or CHIRON	0	--	--	--	--	--	--	0	--	--	--	--	--	--
Taxonomic Richness (Family-level)	22	9	2.2	0.6	10	5	12	10	5	1.6	0.4	5	3	8
Simpson's Diversity Index	--	0.59	0.186	0.048	0.61	0.21	0.80	--	0.68	0.122	0.032	0.74	0.41	0.85
Evenness (Simpson's Equitability)	--	0.28	0.136	0.035	0.26	0.16	0.63	--	0.63	0.139	0.036	0.64	0.42	0.90
Shannon-Weaver Index	--	1.32	0.414	0.107	1.34	0.50	1.86	--	1.39	0.359	0.093	1.45	0.74	2.00
Evenness (Shannon's Equitability)	--	0.56	0.169	0.044	0.61	0.24	0.84	--	0.81	0.092	0.024	0.84	0.62	0.95
Hill's Effective Richness	--	4	1.5	0.4	4	2	6	--	4	1.5	0.4	4	2	7
Evenness (Hill's)	--	0.39	0.145	0.037	0.40	0.21	0.71	--	0.74	0.104	0.027	0.76	0.54	0.95

Table 5.2.6-4. continued.

Waterbody and Habitat	Cormorant Lake Nearshore (2008 to 2009)						
	Proportion (%)	Mean	SD	SE	Median	Min	Max
No. of Samples (n)	30	--	--	--	--	--	--
Water Depth (m)	--	3.4	0.16	0.03	3.5	3.0	3.6
Abundance (no. per m^2)							
Total Invertebrates	--	3406	2533.4	462.5	3917	173	8743
Non-Insecta	72	2443	1853.4	338.4	2965	43	5930
Oligochaeta	10	351	274.1	50.0	346	0	1039
Amphipoda	38	1307	1052.3	192.1	1212	43	3203
Bivalvia	18	615	608.1	111.0	606	0	1861
Gastropoda	5	156	193.8	35.4	65	0	606
Insecta	28	964	764.7	139.6	779	0	2813
Chironomidae	26	889	731.8	133.6	736	0	2727
Ephemeroptera	1	48	52.5	9.6	43	0	173
Plecoptera	0	0	0.0	0.0	0	0	0
Trichoptera	0	12	22.5	4.1	0	0	87
EPT	2	59	59.6	10.9	43	0	216
EPT to Chironomidae Ratio	--	0.11	0.301	0.055	0.05	0.00	1.67
Genus analysis of Ephemeroptera	4 spp. (DOM: *Hexagenia*)	--	--	--	--	--	--
No. of Samples with No Aquatic Invertebrates	0	--	--	--	--	--	--
No. Samples with Only OLIGO +/or CHIRON	0	--	--	--	--	--	--
Taxonomic Richness (Family-level)	22	7	2.9	0.5	7	2	12
Simpson's Diversity Index	--	0.72	0.116	0.021	0.75	0.38	0.85
Evenness (Simpson's Equitability)	--	0.57	0.175	0.032	0.55	0.31	1.00
Shannon-Weaver Index	--	1.50	0.403	0.074	1.58	0.56	2.16
Evenness (Shannon’s Equitability)	--	0.80	0.085	0.016	0.80	0.63	1.00
Hill's Effective Richness	--	5	1.7	0.3	5	2	9
Evenness (Hill's)	--	0.67	0.156	0.028	0.67	0.40	1.00

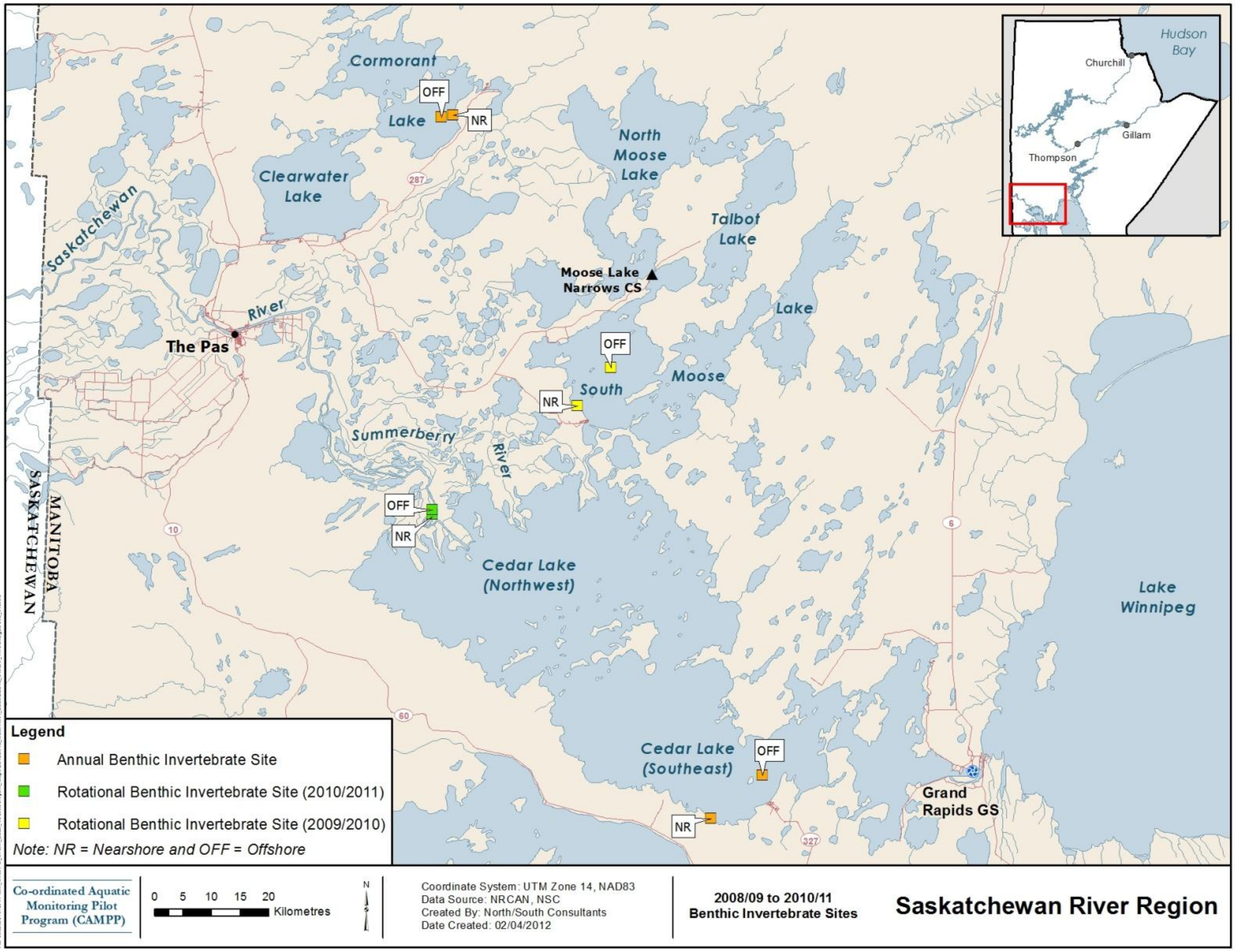


Figure 5.2.6-1. Benthic invertebrate sampling sites located in CAMPP waterbodies in the Saskatchewan River Region, 2008 to 2010.

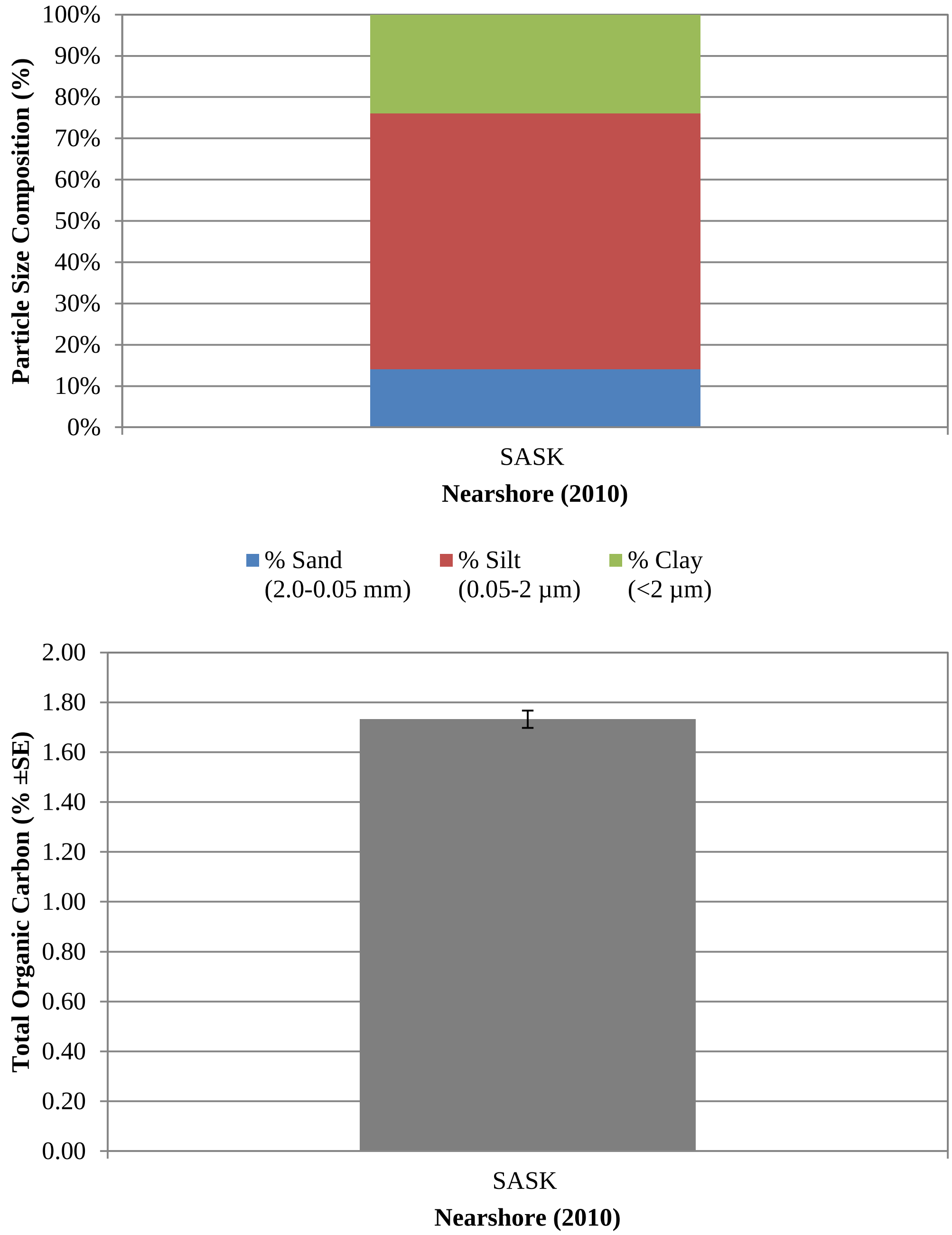
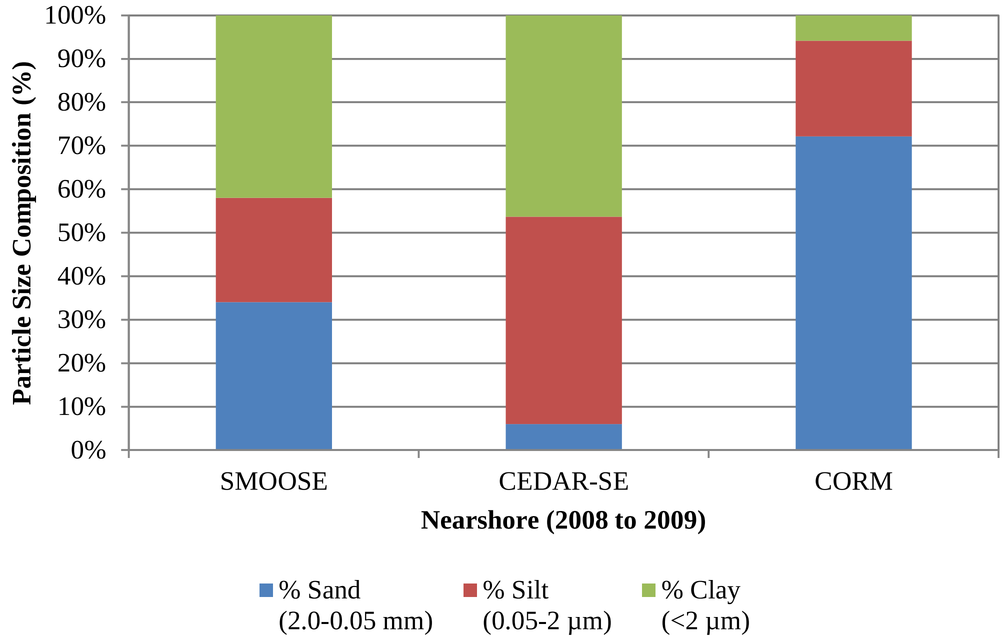


Figure 5.2.6-2. Sediment analyses (particle size composition and total organic carbon ± SE) of the benthic sediment collected in conjunction with nearshore invertebrate kicknet sampling in the Saskatchewan River Region for CAMPP, 2010.



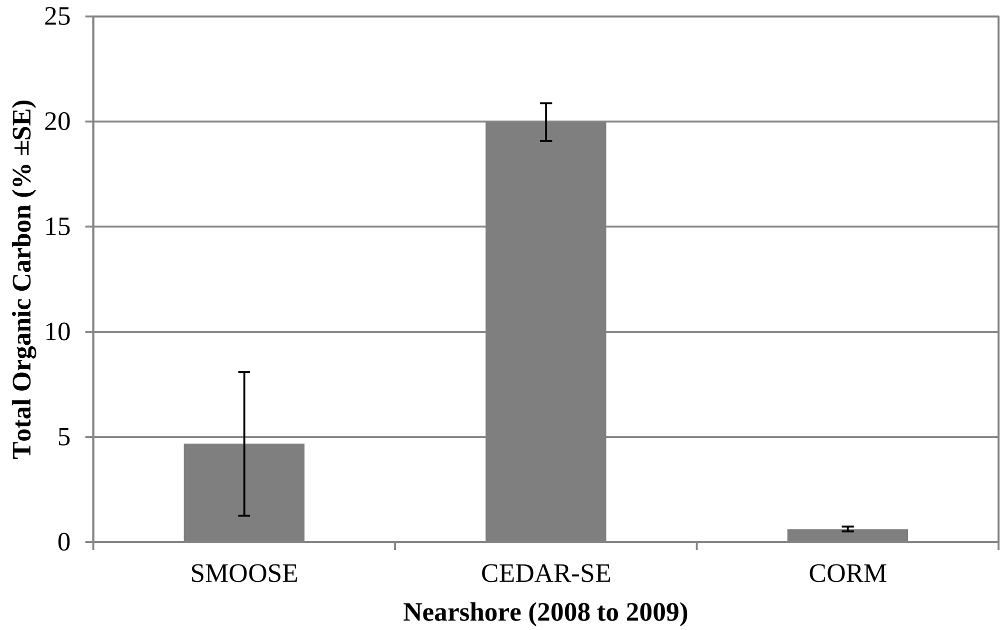
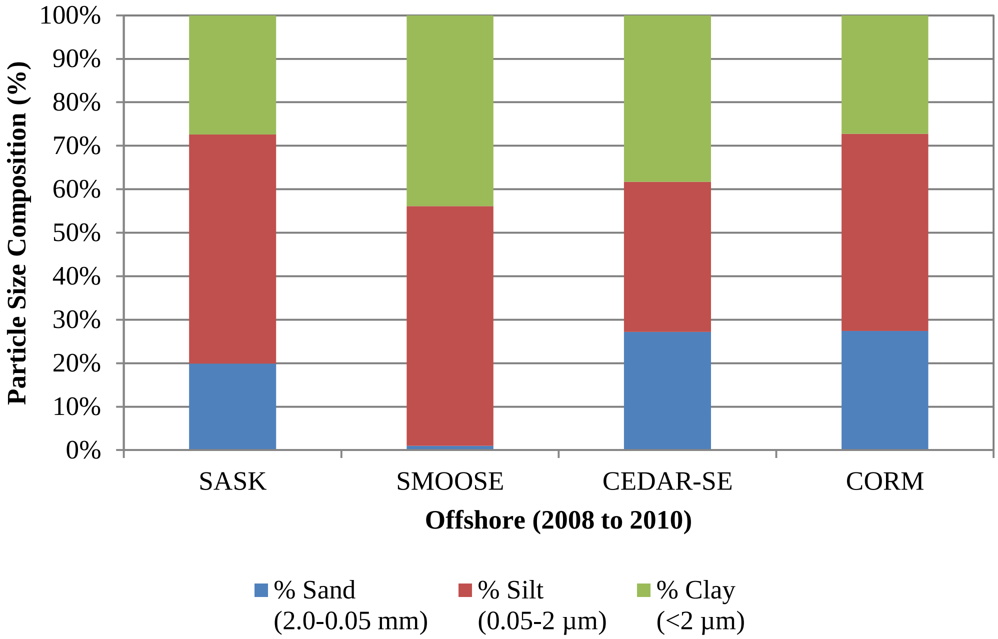


Figure 5.2.6-3. Sediment analyses (particle size composition and total organic carbon ± SE) of the benthic sediment collected in conjunction with nearshore invertebrate grab sampling in the Saskatchewan River Region for CAMPP, 2008 to 2009.



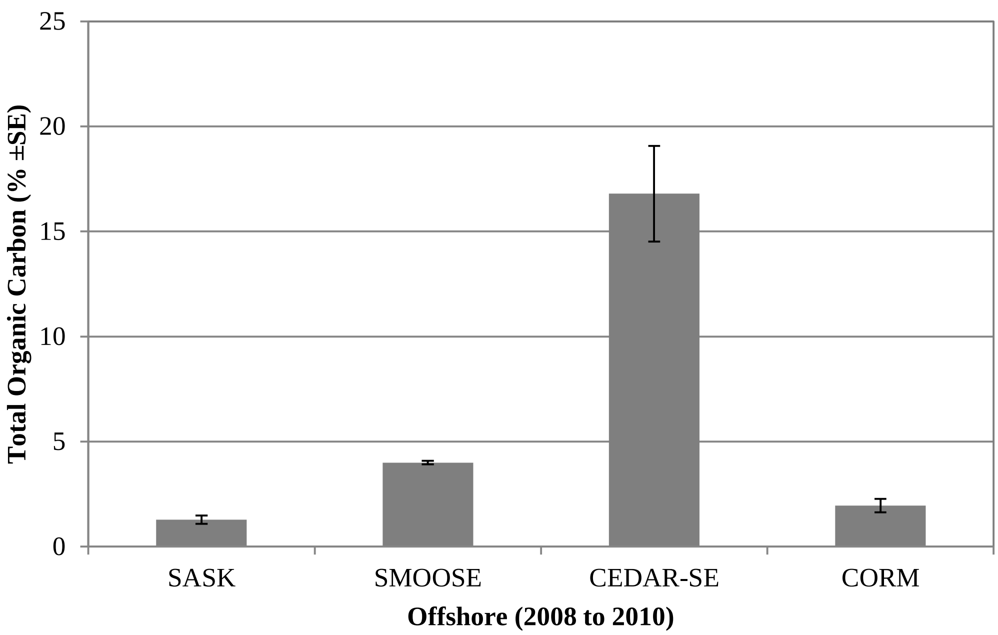


Figure 5.2.6-4. Sediment analyses (particle size composition and total organic carbon ± SE) of the benthic sediment collected in conjunction with offshore invertebrate grab sampling in the Saskatchewan River Region for CAMPP, 2008 to 2010.

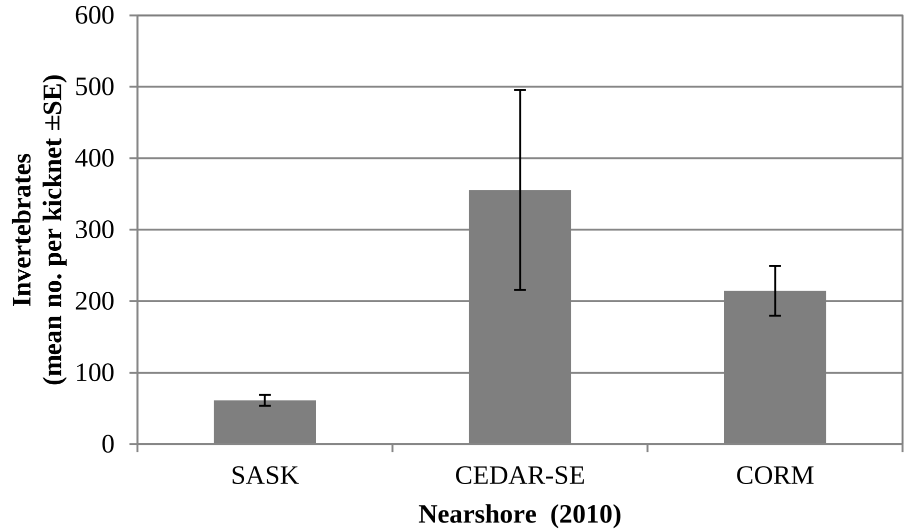


Figure 5.2.6-5. Abundances of benthic invertebrates (no. per kicknet ± SE) collected in the nearshore habitat of CAMPP waterbodies in the Saskatchewan River Region, 2010.

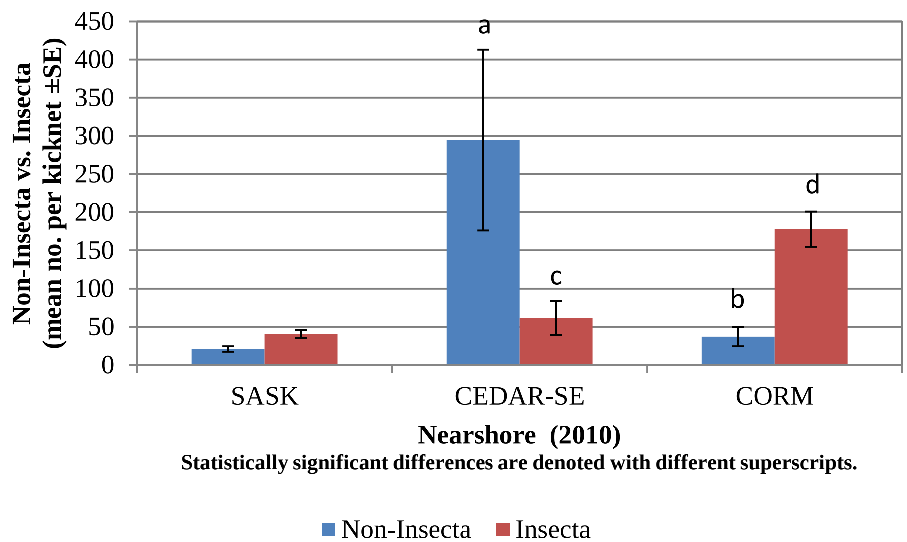


Figure 5.2.6-6. Abundances of non-insects and insects (no. per kicknet ± SE) collected in the nearshore habitat of CAMPP waterbodies in the Saskatchewan River Region, 2010.

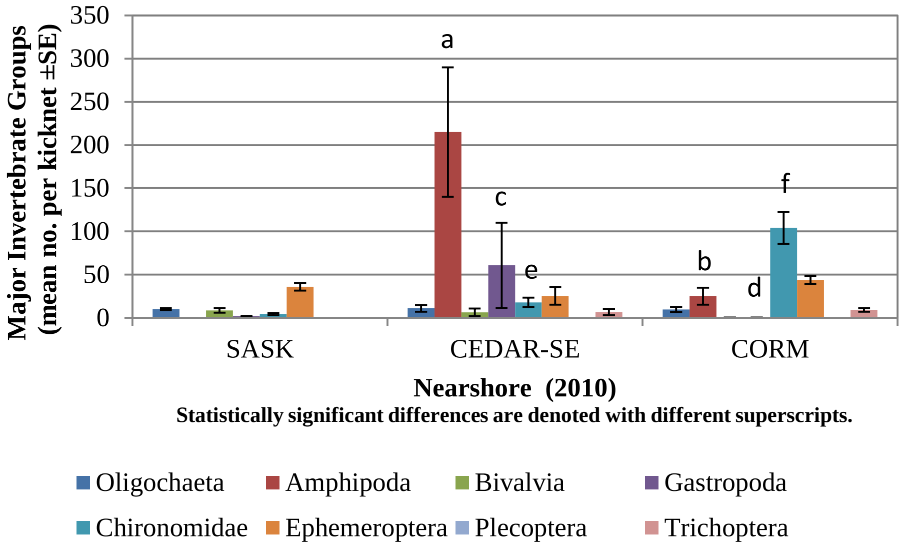


Figure 5.2.6-7. Abundances of the major invertebrate groups (no. per kicknet ± SE) collected in the nearshore habitat of CAMPP waterbodies in the Saskatchewan River Region, 2010.

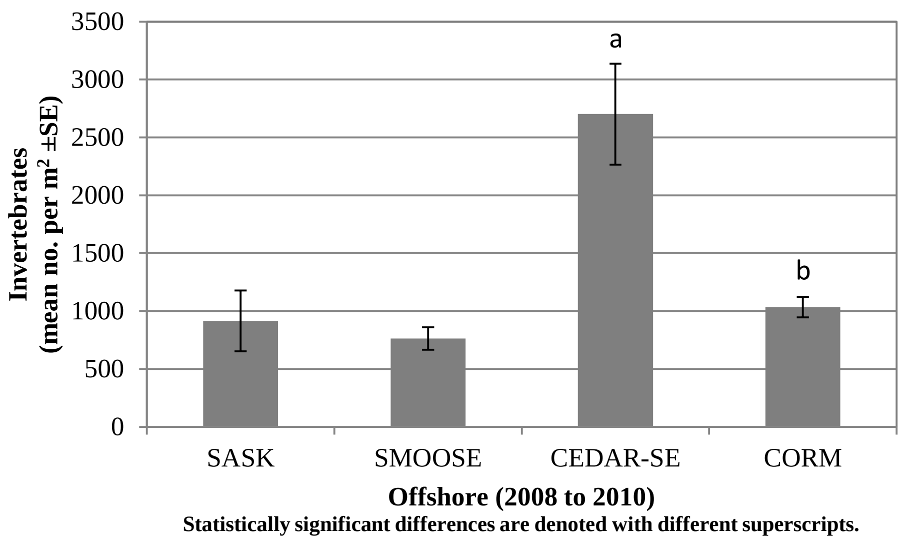


Figure 5.2.6-8. Abundances of benthic invertebrates (no. per m^2 ± SE) collected in the offshore habitat of CAMPP waterbodies in the Saskatchewan River Region, 2008 to 2010.

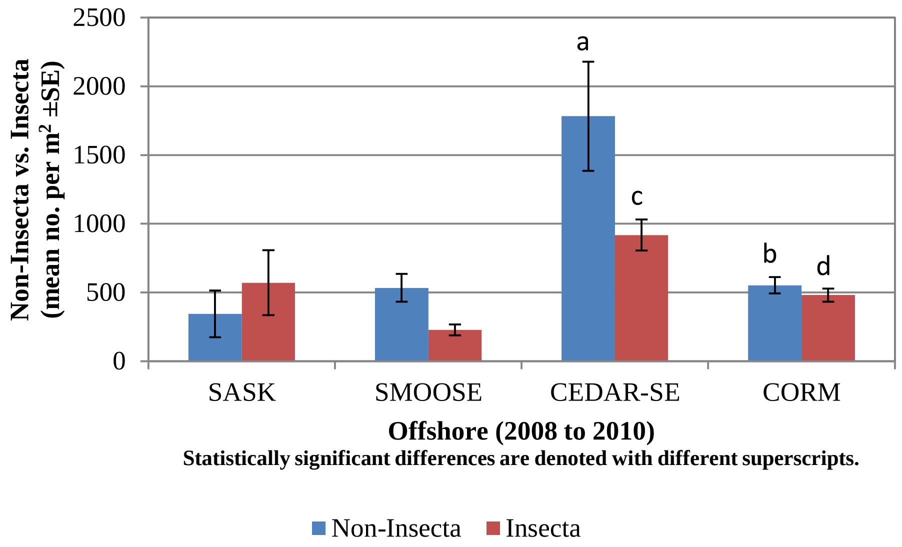


Figure 5.2.6-9. Abundances of non-insects and insects (no. per kicknet ± SE) collected in the offshore habitat of CAMPP waterbodies within the Saskatchewan River Region, 2008 to 2010.

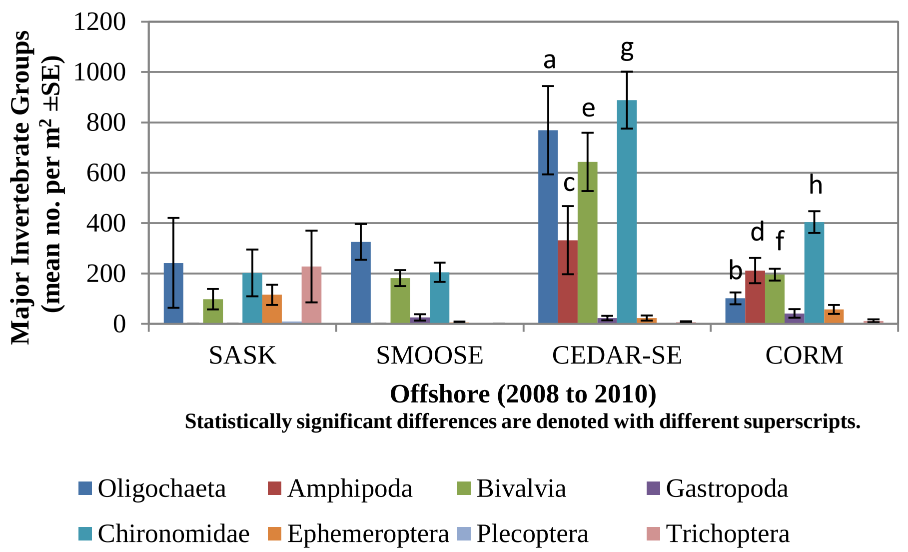


Figure 5.2.6-10. Abundances of the major invertebrate groups (no. per m^2 ± SE) collected in the offshore habitat of CAMPP waterbodies in the Saskatchewan River Region, 2008 to 2010.

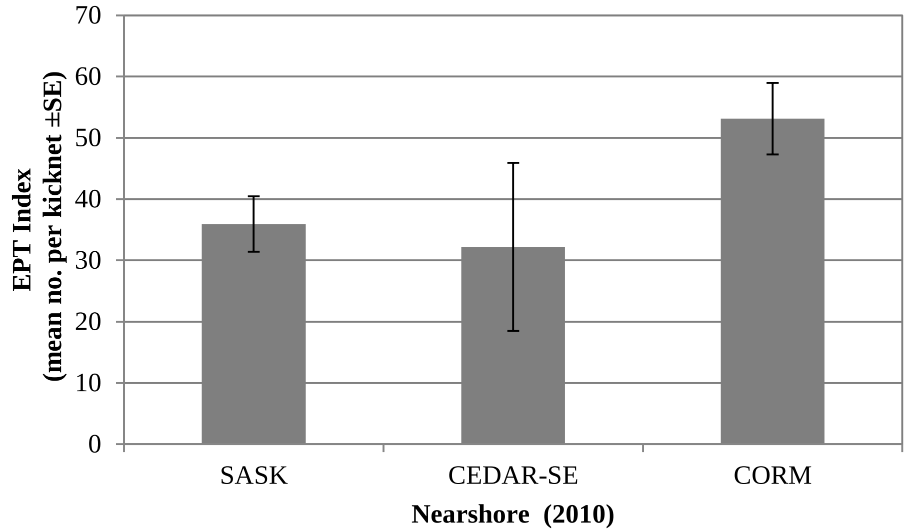


Figure 5.2.6-11. Total abundances of Ephemeroptera, Plecoptera, and Trichoptera (EPT Index) collected from nearshore kicknet samples in CAMPP waterbodies in the Saskatchewan River Region, 2010.

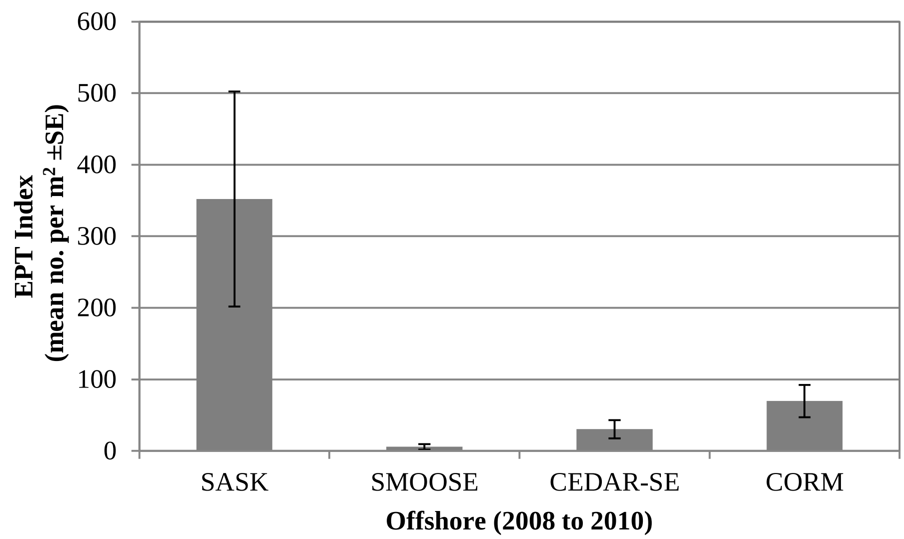


Figure 5.2.6-12. Total abundances of Ephemeroptera, Plecoptera, and Trichoptera (EPT Index) collected from offshore grab samples in CAMPP waterbodies in the Saskatchewan River Region, 2008 to 2010.

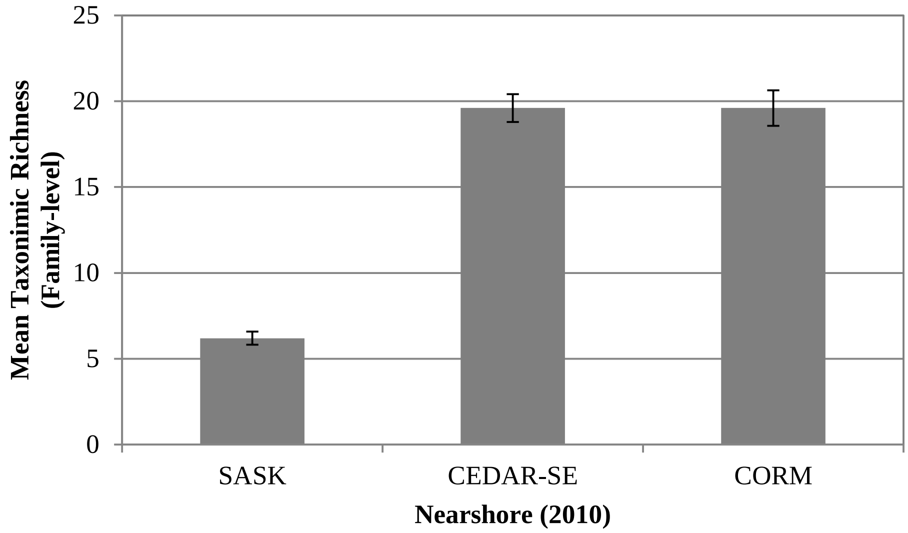


Figure 5.2.6-13. Taxa richness (mean no. of families/kicknet) from benthic invertebrate samples collected in the nearshore habitat of CAMPP waterbodies in the Saskatchewan River Region, 2010.

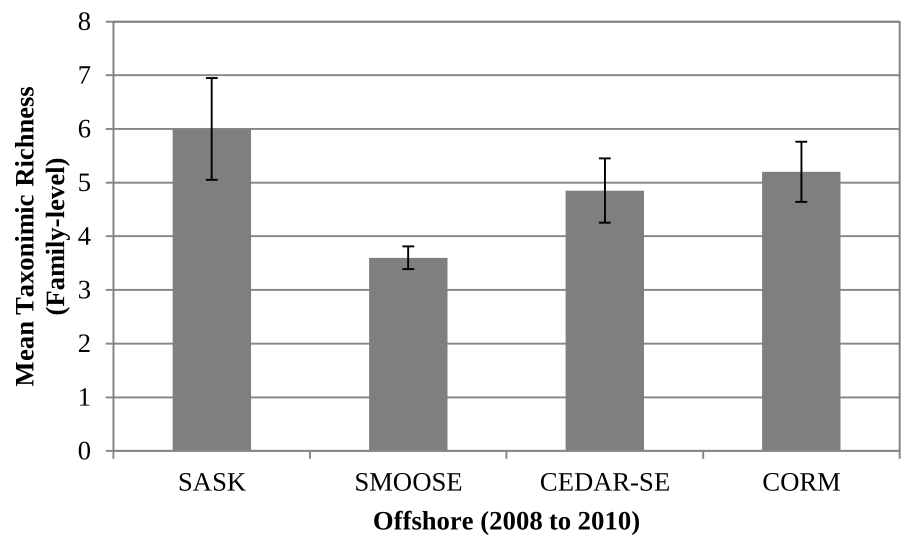


Figure 5.2.6-14. Taxa richness (mean no. of families/kicknet) from benthic invertebrate samples collected in the offshore habitat of CAMPP waterbodies in the Saskatchewan River Region, 2008 to 2010.

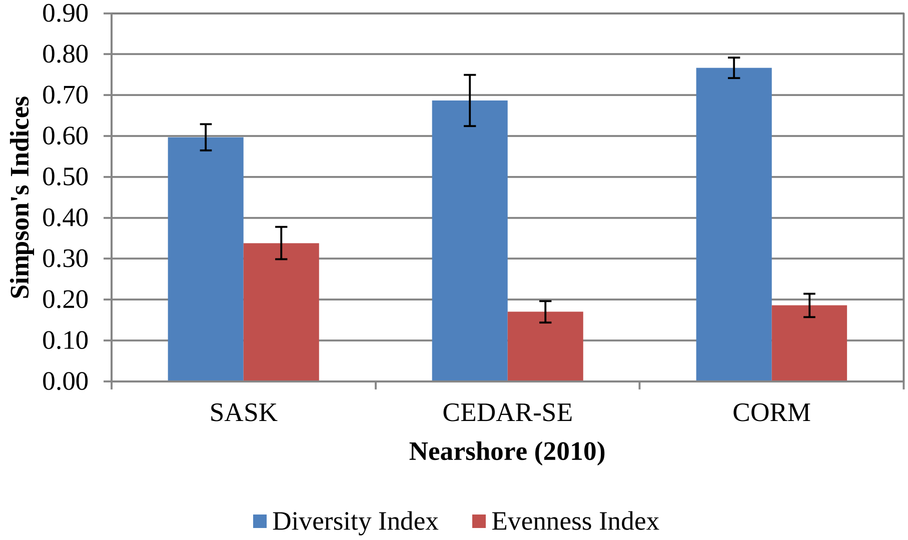


Figure 5.2.6-15. Diversity and evenness (Simpson's) indices calculated from nearshore kicknet samples of CAMPP waterbodies in the Saskatchewan River Region, 2010.

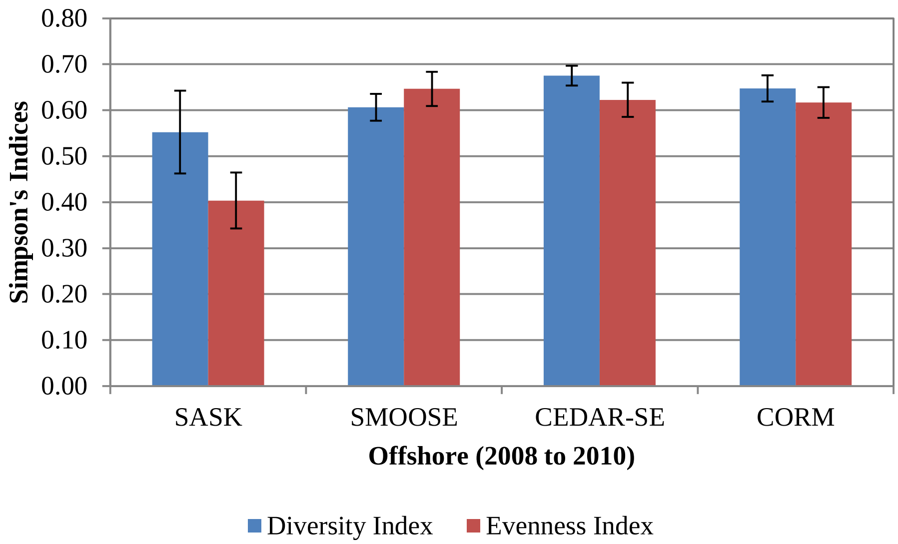


Figure 5.2.6-16. Diversity and evenness (Simpson's) indices calculated from offshore grab samples of CAMPP waterbodies within the Saskatchewan River Region, 2008 to 2010.

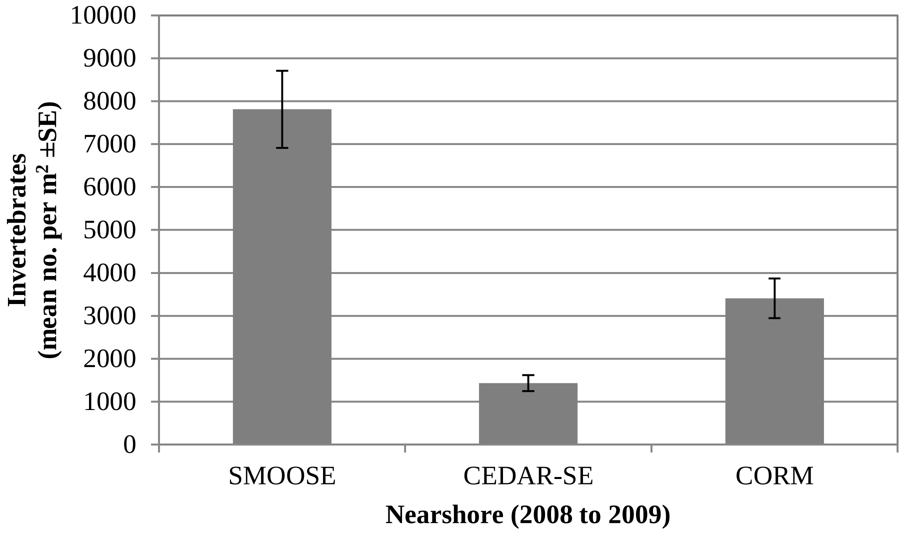


Figure 5.2.6-17. Abundances of benthic invertebrates (no. per m^2 ± SE) collected in the nearshore habitat of CAMPP waterbodies in the Saskatchewan River Region, 2008 to 2009.

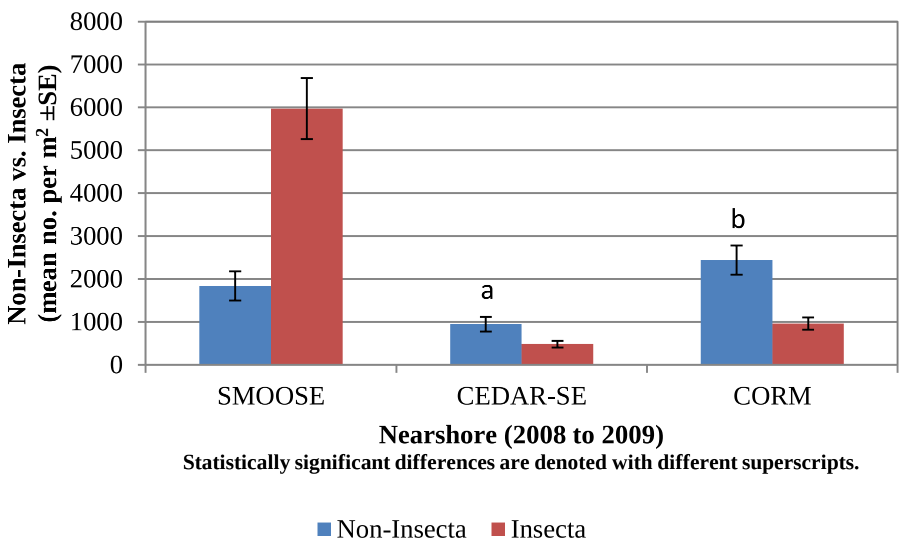


Figure 5.2.6-18. Abundances of non-insects and insects (no. per m^2 ± SE) collected in the nearshore habitat of CAMPP waterbodies in the Saskatchewan River Region, 2008 to 2009.

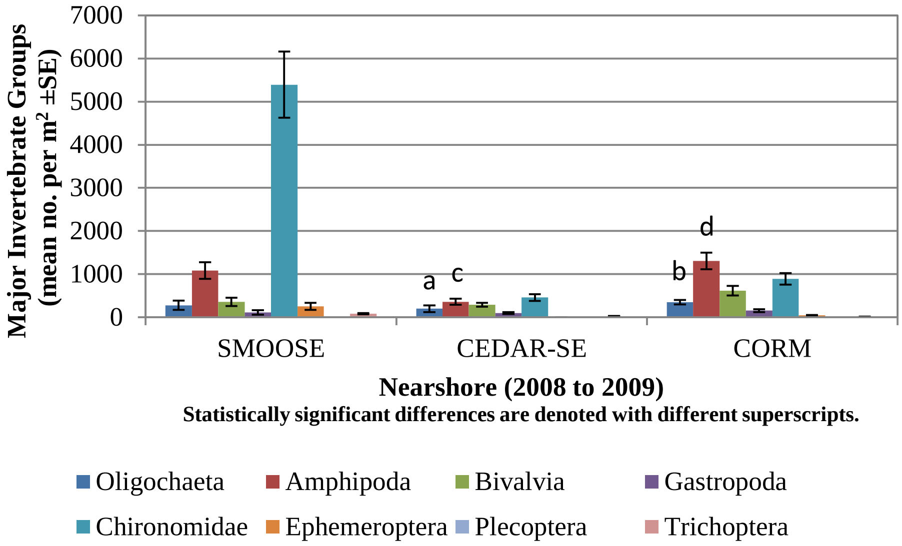


Figure 5.2.6-19. Abundances of the major invertebrate groups (no. per m^2 ± SE) collected in the nearshore habitat of CAMPP waterbodies in the Saskatchewan River Region, 2008 to 2009.

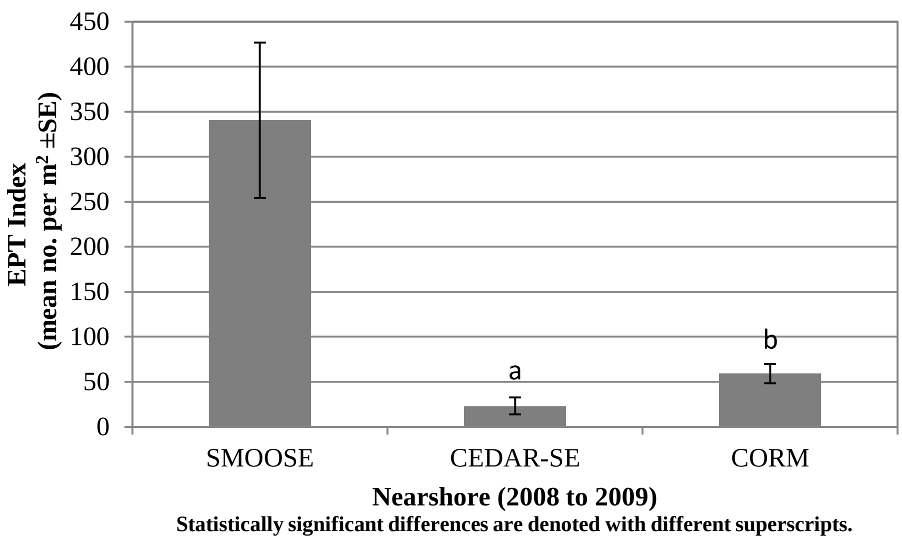


Figure 5.2.6-20. Total abundances of Ephemeroptera, Plecoptera, and Trichoptera (EPT Index) collected from nearshore grab samples in CAMPP waterbodies in the Saskatchewan River Region, 2008 to 2009.

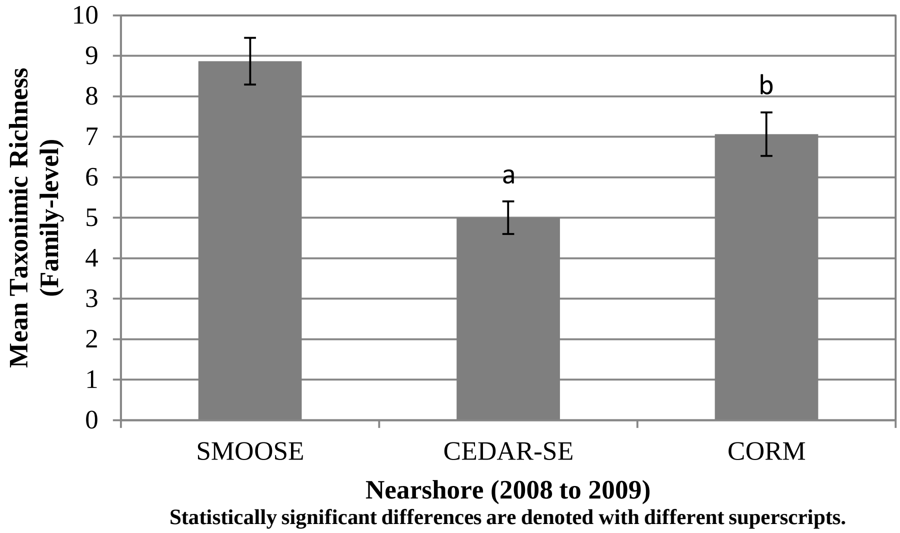


Figure 5.2.6-21. Taxa richness (mean no. of families) from benthic invertebrate grab samples collected in the nearshore habitat of CAMPP waterbodies in the Saskatchewan River Region, 2008 to 2009.

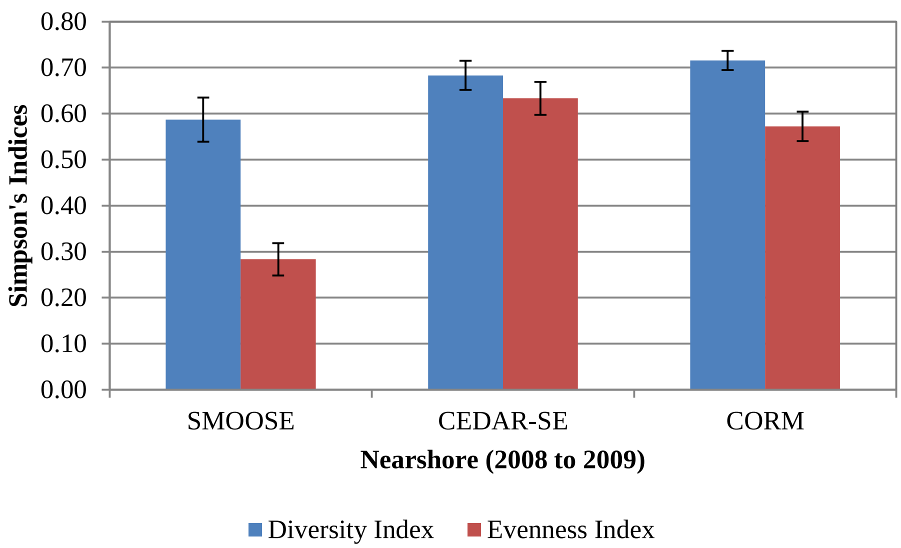


Figure 5.2.6-22. Diversity and evenness (Simpson's) indices calculated from nearshore grab samples of CAMPP waterbodies in the Saskatchewan River Region, 2008 to 2009.

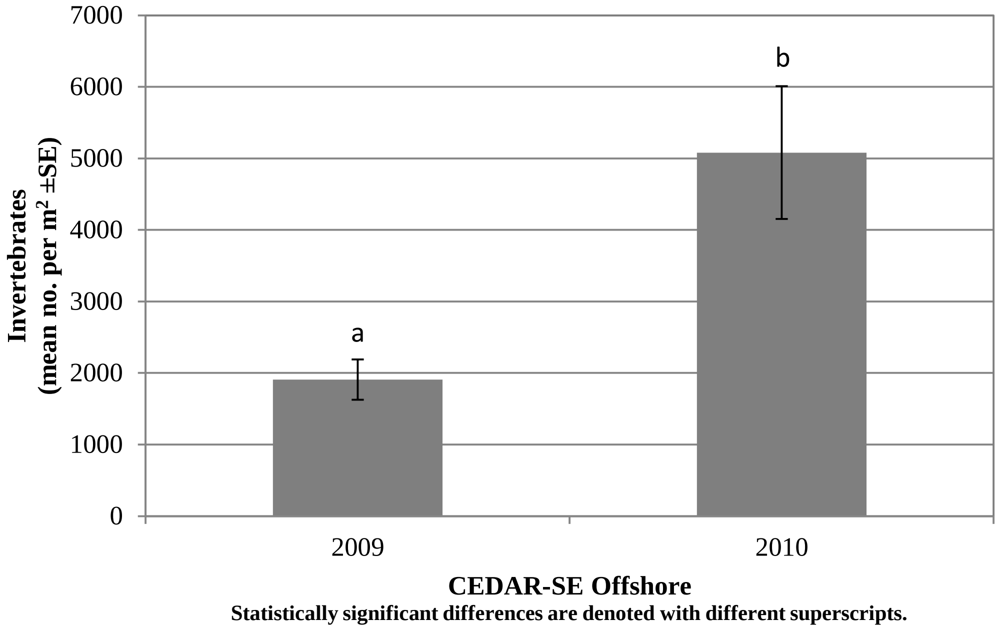


Figure 5.2.6-23. Temporal comparison of the benthic invertebrate abundances (no. per $m^2 \pm$ SE) collected in the offshore habitat of Cedar Lake-Southeast, 2009 and 2010.

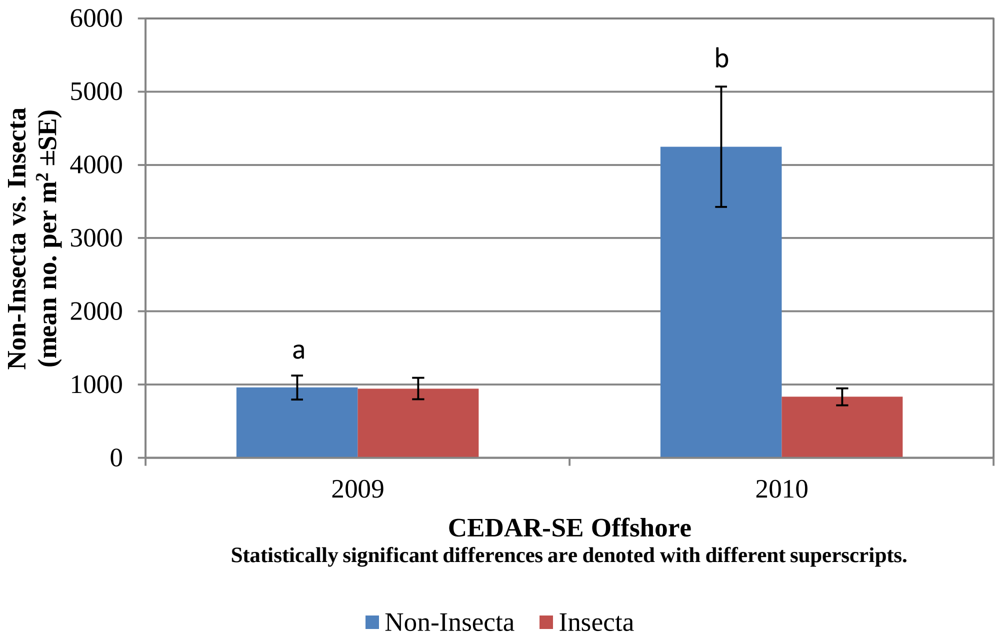


Figure 5.2.6-24. Temporal comparison of non-insect and insect abundances (no. per $m^2 \pm$ SE) collected in the offshore habitat of Cedar Lake-Southeast, 2009 and 2010.

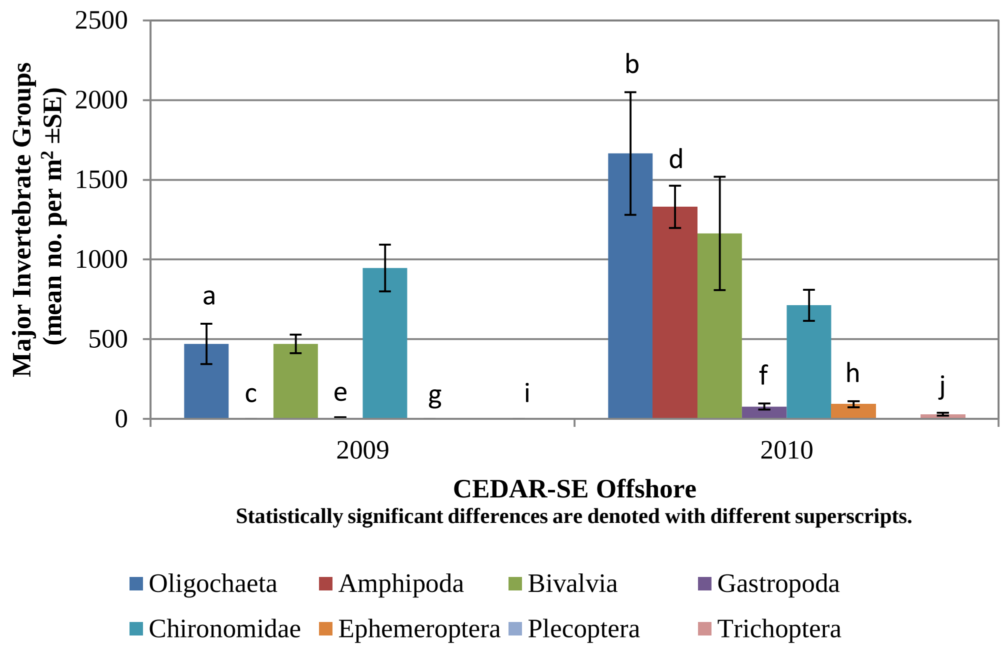


Figure 5.2.6-25. Temporal comparison of major invertebrate group abundances (no. per m^2 ± SE) collected in the offshore habitat of Cedar Lake-Southeast, 2009 and 2010.

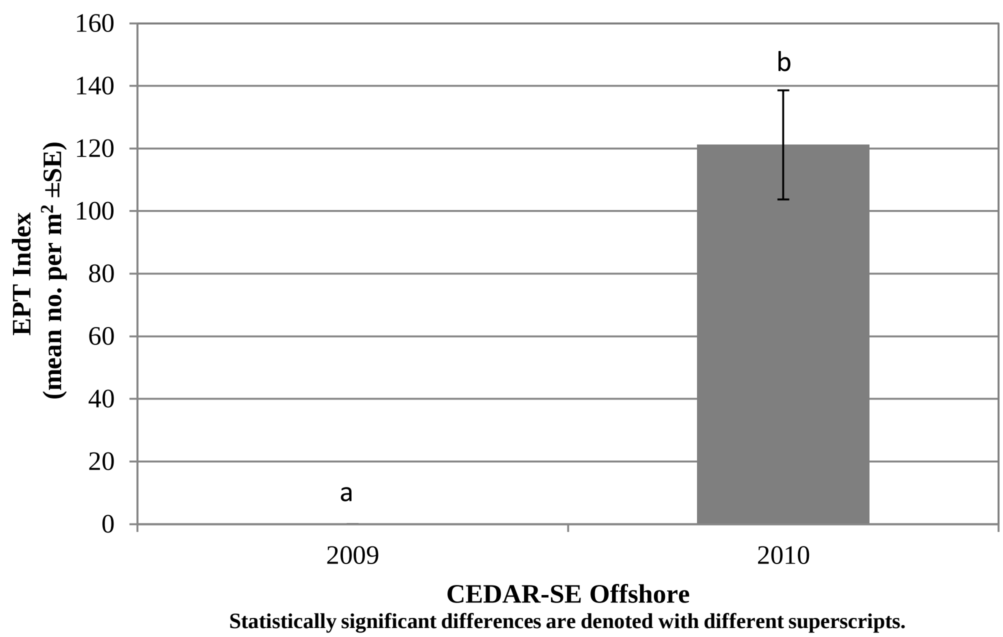


Figure 5.2.6-26. Temporal comparison of Ephemeroptera, Plecoptera, and Trichoptera abundances (EPT Index) of offshore grab samples from Cedar Lake-Southeast, 2009 and 2010.

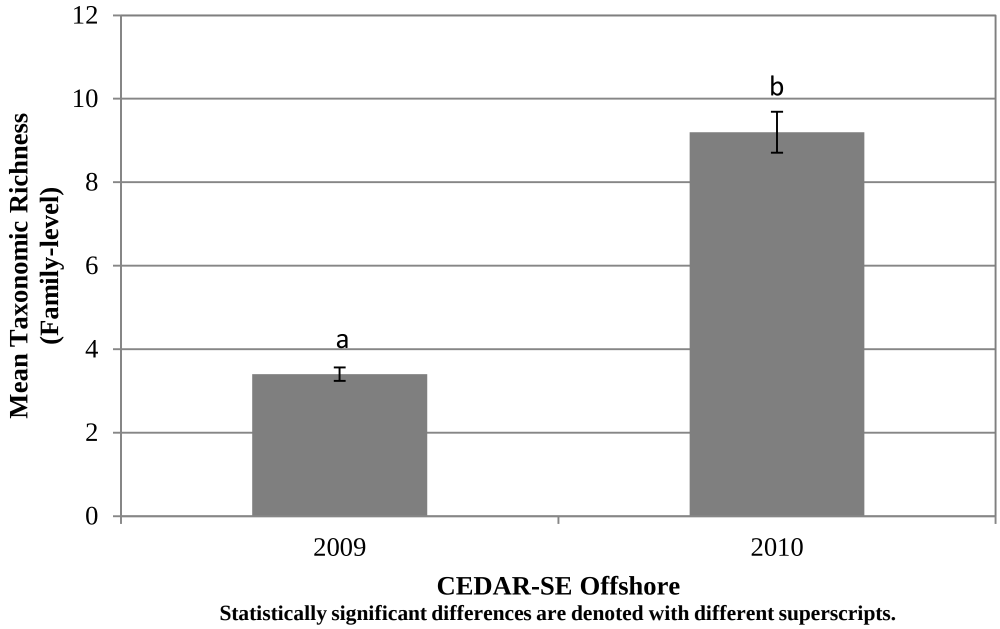


Figure 5.2.6-27. Temporal comparison of benthic invertebrate taxa richness (mean no. of families) of offshore grab samples from Cedar Lake-Southeast, 2009 and 2010.

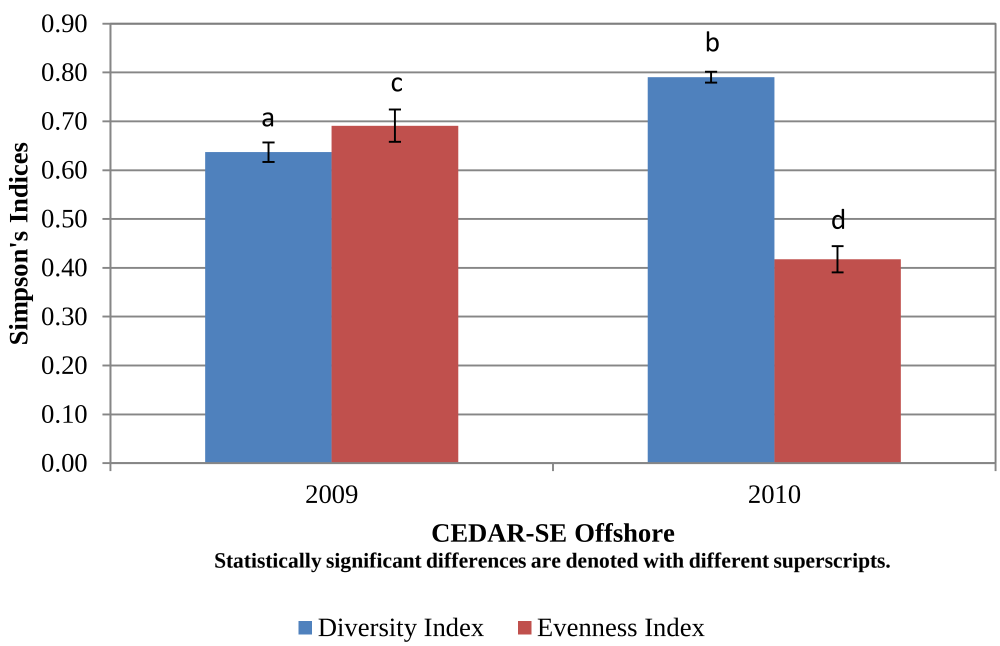


Figure 5.2.6-28. Temporal comparison of diversity and evenness (Simpson's) indices of offshore grab samples from Cedar Lake-Southeast, 2009 and 2010.

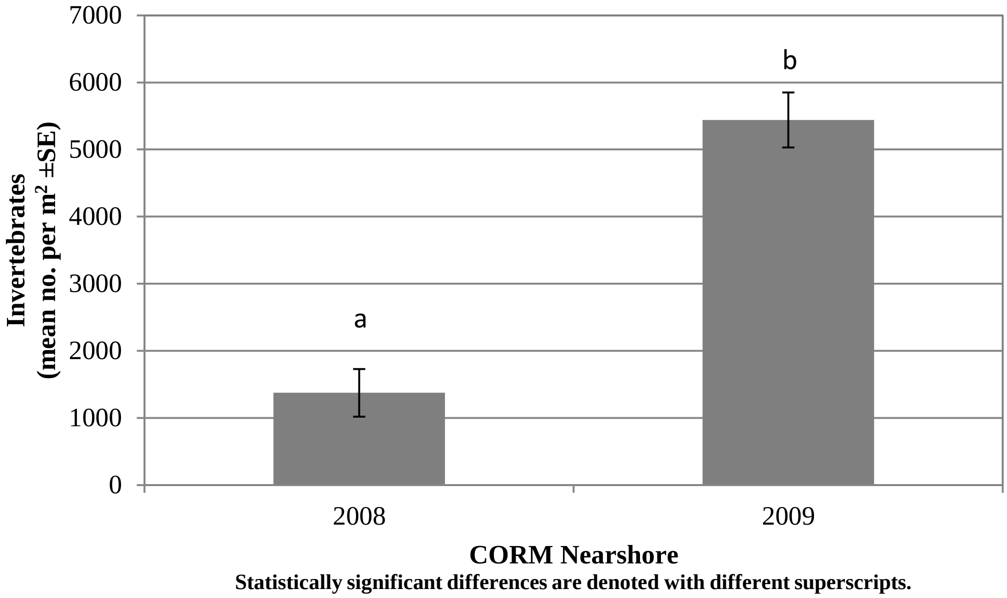


Figure 5.2.6-29. Temporal comparison of the benthic invertebrate abundances (no. per $m^2 \pm$ SE) collected in the nearshore habitat of Cormorant Lake, 2008 and 2009.

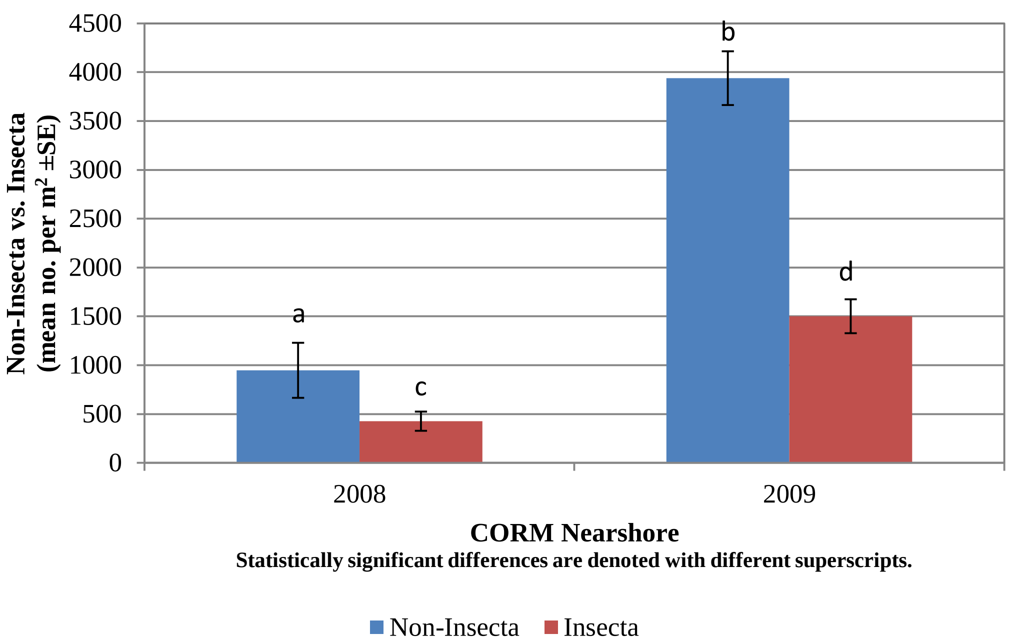


Figure 5.2.6-30. Temporal comparison of non-insect and insect abundances (no. per $m^2 \pm$ SE) collected in the nearshore habitat of Cormorant Lake, 2008 and 2009.

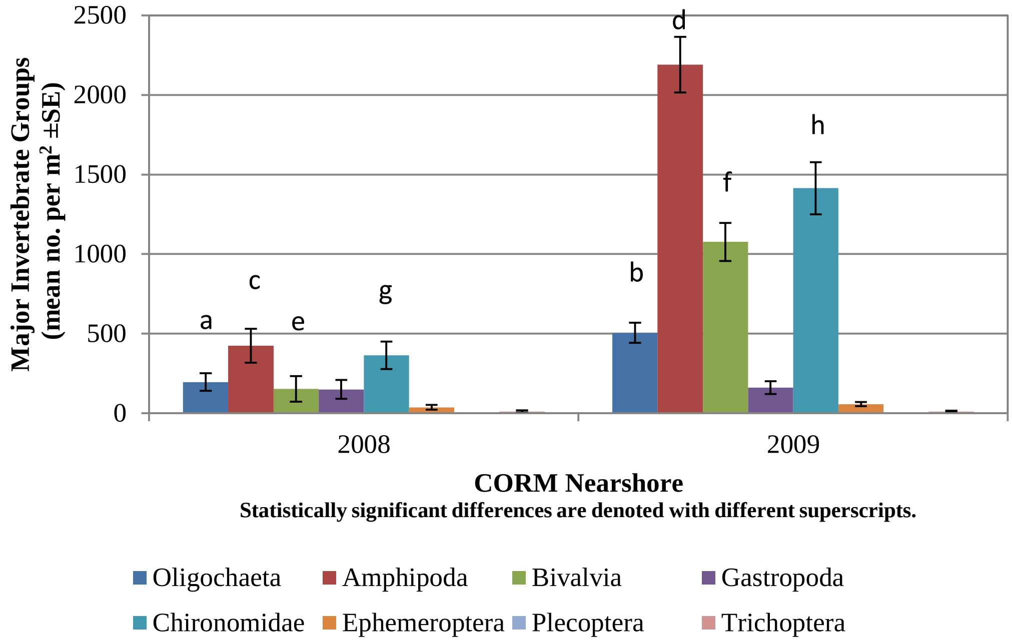


Figure 5.2.6-31. Temporal comparison of major invertebrate group abundances (no. per m^2 ± SE) collected in the nearshore habitat of Cormorant Lake, 2008 and 2009.

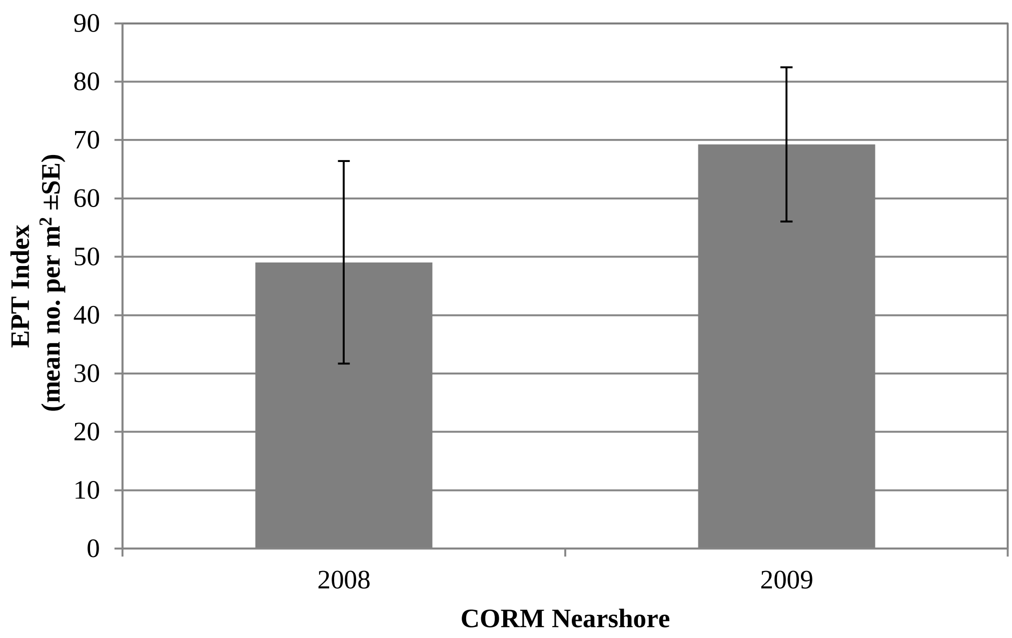


Figure 5.2.6-32. Temporal comparison of Ephemeroptera, Plecoptera, and Trichoptera abundances (EPT Index) of nearshore grab samples from Cormorant Lake, 2008 and 2009.

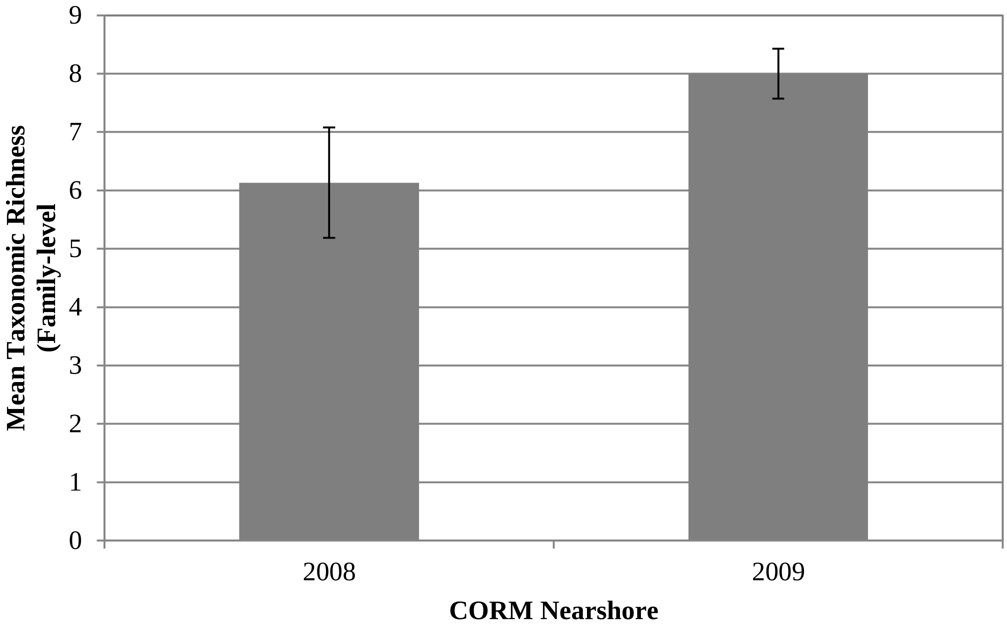


Figure 5.2.6-33. Temporal comparison of benthic invertebrate taxa richness (mean no. of families) of nearshore grab samples from Cormorant Lake, 2008 and 2009.

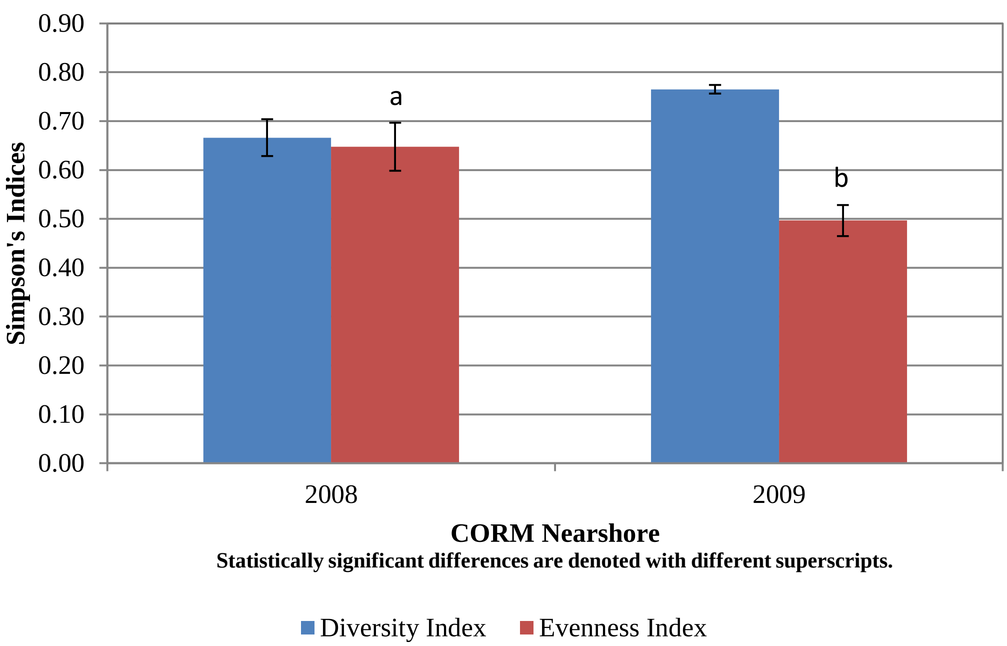


Figure 5.2.6-34. Temporal comparison of diversity and evenness (Simpson's) indices of nearshore grab samples from Cormorant Lake, 2008 and 2009.

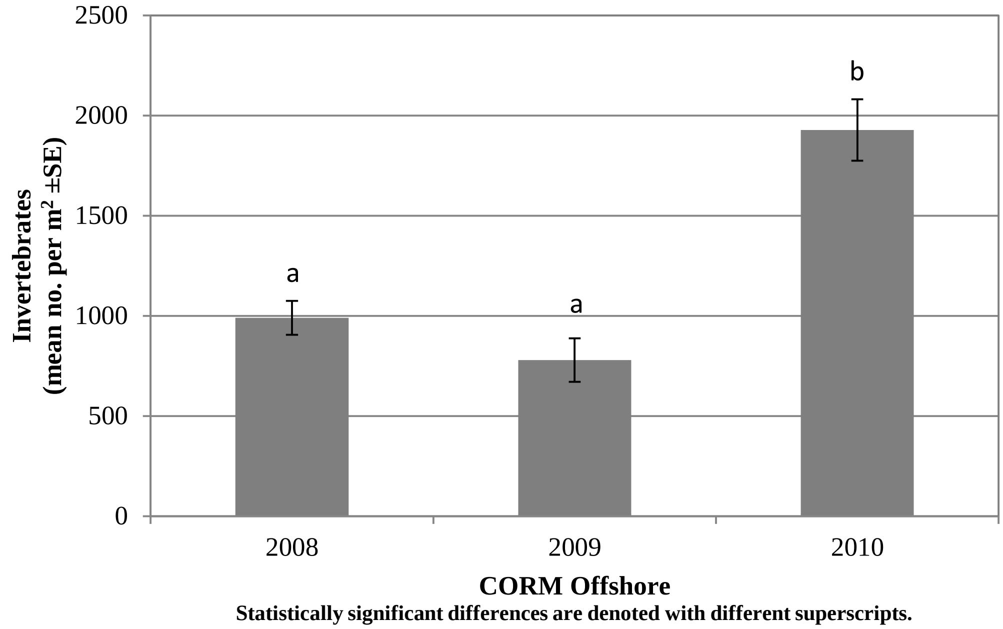


Figure 5.2.6-35. Temporal comparison of the benthic invertebrate abundances (no. per $m^2 \pm$ SE) collected in the offshore habitat of Cormorant Lake, 2008 to 2010.

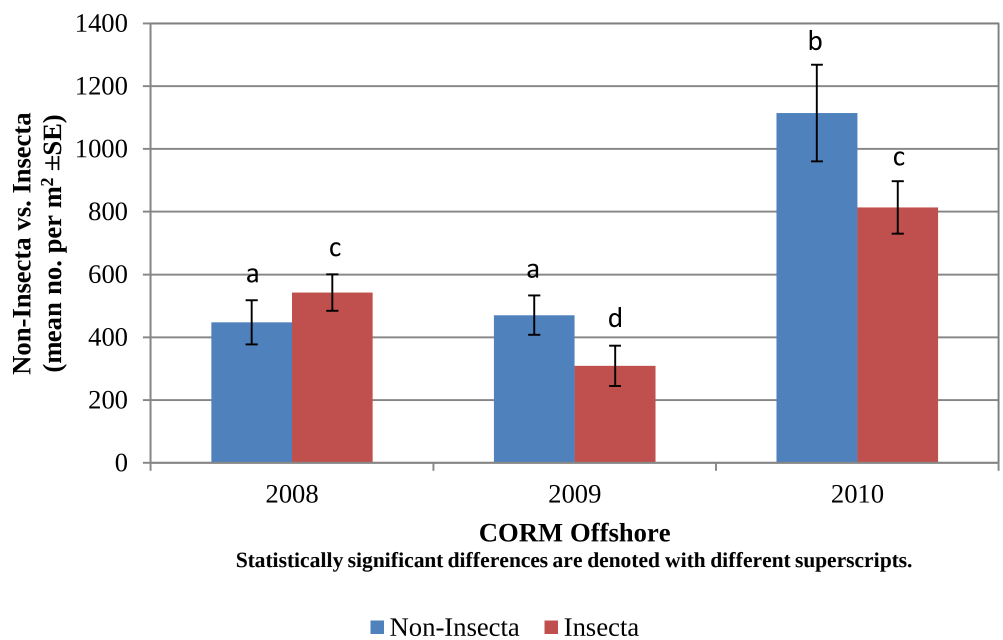


Figure 5.2.6-36. Temporal comparison of non-insect and insect abundances (no. per $m^2 \pm$ SE) collected in the offshore habitat of Cormorant Lake, 2008 to 2010.

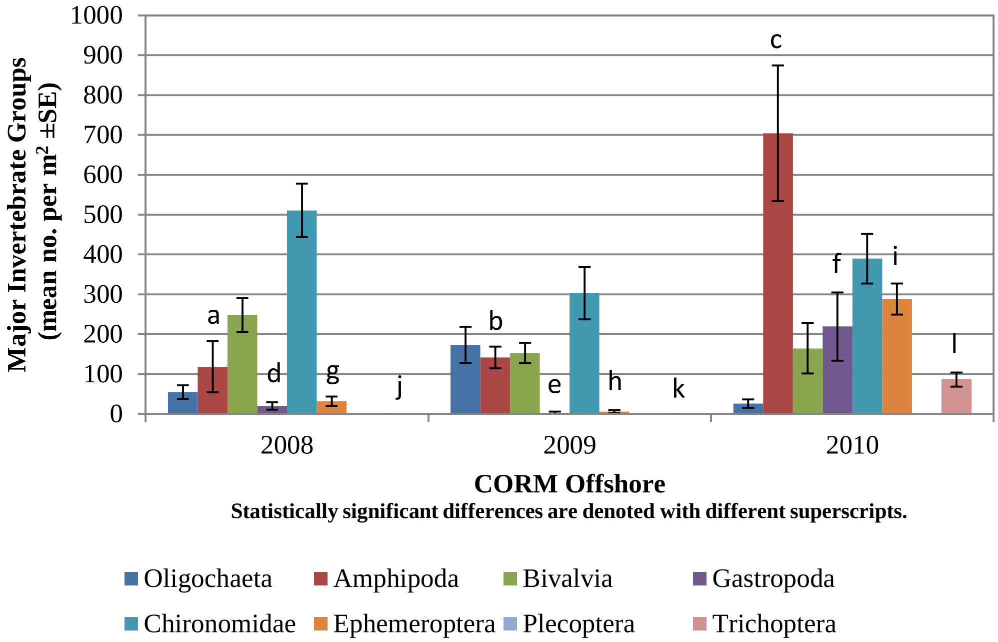


Figure 5.2.6-37. Temporal comparison of major invertebrate group abundances (no. per m^2 ± SE) collected in the offshore habitat of Cormorant Lake, 2008 to 2010.

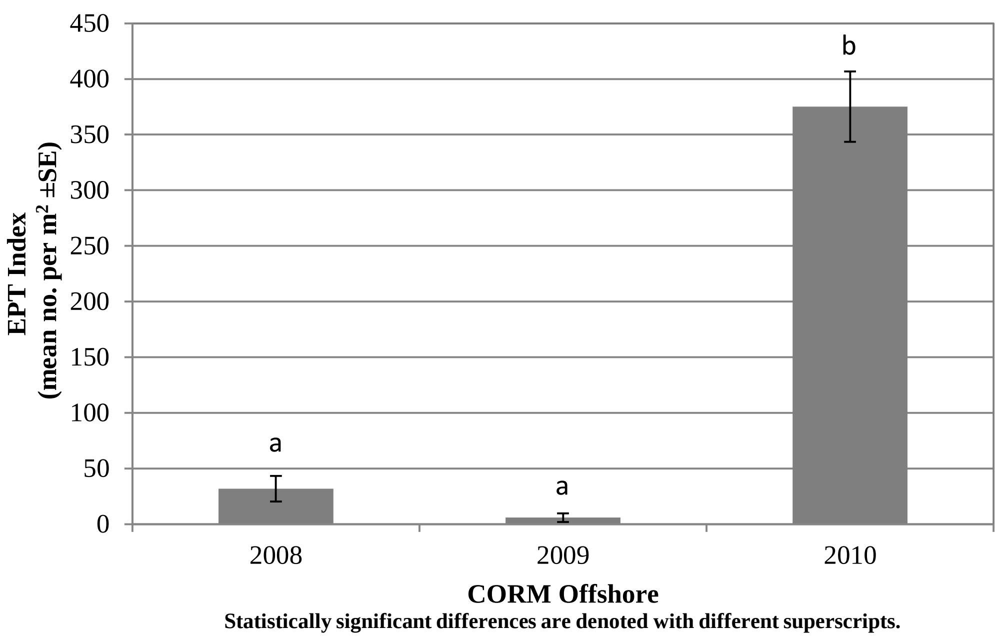


Figure 5.2.6-38. Temporal comparison of Ephemeroptera, Plecoptera, and Trichoptera abundances (EPT Index) of offshore grab samples from Cormorant Lake, 2008 to 2010.

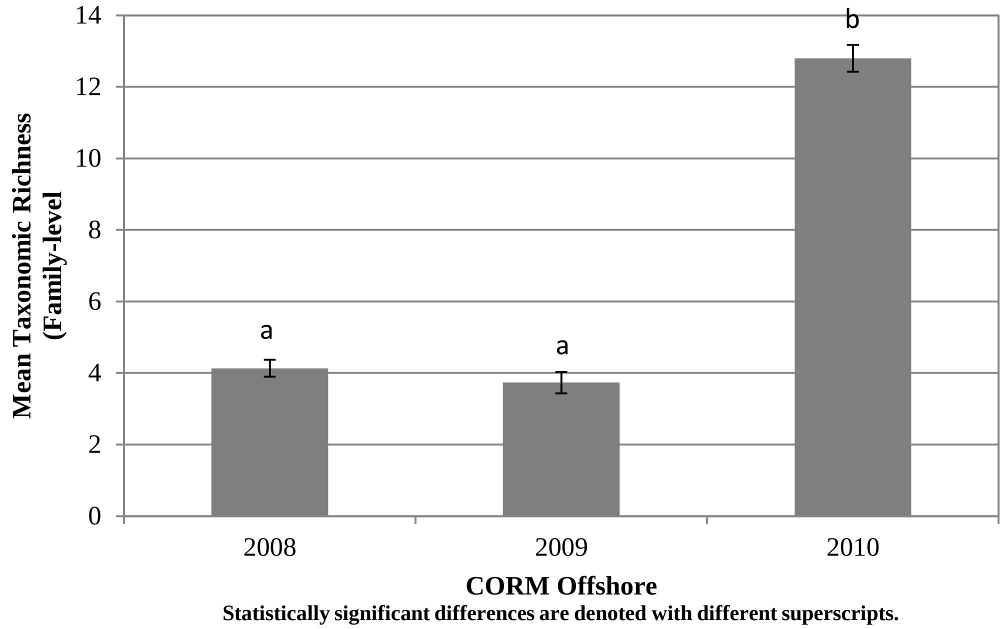


Figure 5.2.6-39. Temporal comparison of benthic invertebrate taxa richness (mean no. of families) of offshore grab samples from Cormorant Lake, 2008 to 2010.

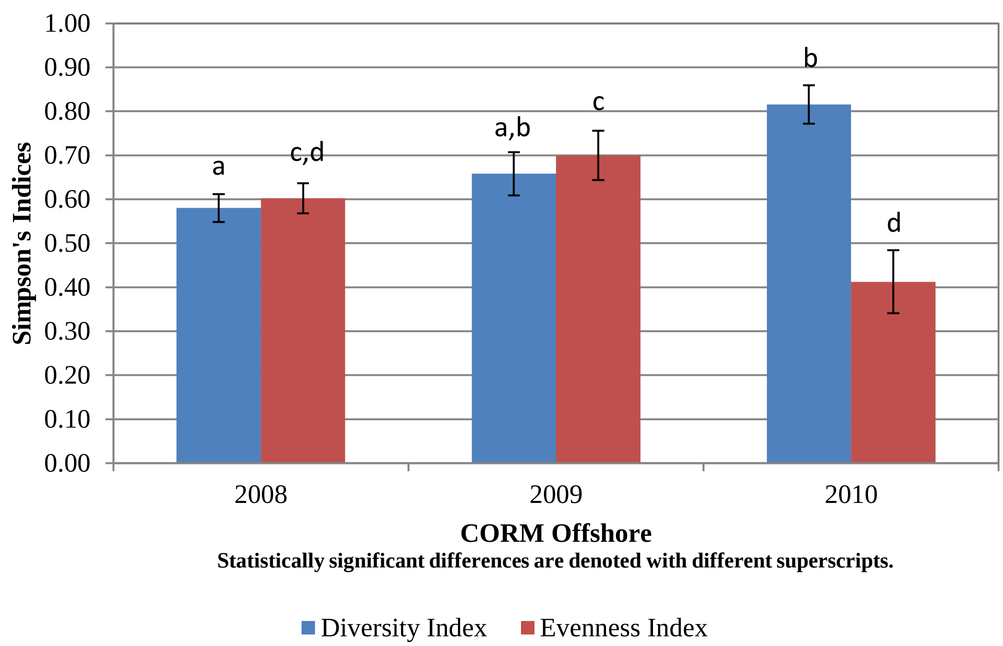


Figure 5.2.6-40. Temporal comparison of diversity and evenness (Simpson's) indices of offshore grab samples from Cormorant Lake, 2008 to 2010.

5.2.7 Fish Communities

5.2.7.1 Overview

The following provides an overview of the fish communities present in four waterbodies within the Saskatchewan River Region studied as part of the CAMPP program conducted from 2008 to 2010. Waterbodies sampled annually included one on-system waterbody (Cedar Lake Southeast) and one off-system waterbody (Cormorant Lake). Two rotational on-system waterbodies were also sampled, i.e., South Moose Lake in 2009 and Saskatchewan River in 2010. Eight of the 11 Saskatchewan River gillnet sites (sites GN-01 to GN-08 in Figure 5.2.8-1) were located downstream of the confluence with Cedar Lake in Cedar Lake (West). These sites have been considered as Saskatchewan River sites for the CAMPP synthesis report. Future sampling of the fish community of the Saskatchewan River will be restricted to the reach between the Saskatchewan/Manitoba border and Cedar Lake (West).

Gill netting, utilizing both standard gang and small mesh index gill nets was conducted in pre-established sites in each waterbody, and these were generally consistently sampled in each year of study. Individual fish from each site were identified to species, measured and weighed, with the exception that in some cases (particularly with respect to small-bodied fish species) bulk weights were taken.

Overall, the fish assemblage, as captured by standard gillnet sets in all Saskatchewan River Region waterbodies, was found to be dominated by White Sucker (*Catostomus commersoni*) and Walleye (*Sander vitreus*). Sauger (*Sander canadensis*) was also common in the on-system waterbodies. The fish assemblage of Cormorant Lake (tributary to South Moose Lake and Cedar Lake respectively in a downstream direction) was found to contain the highest number of fish species of all sampled waterbodies in the region.

Cormorant Lake and Cedar Lake (Southeast) were found to have relatively similar CPUE values for the total standard gang index gillnet catch, however CPUE values for White Sucker and Lake Whitefish (*Coregonus clupeaformis*) were noticeably higher in Cormorant Lake than elsewhere in the region, including Cedar Lake (Southeast). In the Saskatchewan River and South Moose Lake, the overall CPUE was approximately equal but was only about one-half of the overall CPUE recorded for Cormorant Lake and Cedar Lake (Southeast).

For the on-system waterbodies, Northern Pike (*Esox lucius*) showed consistent year-class strength in 2005 and 2006 and Walleye showed consistent year-class strength in 2005. Off-system, Northern Pike showed consistent year-class strength in 2004 and 2005.

The incidence rate for deformities, erosion, lesions and tumours in species of management interest was extremely low (0.0 – 0.1%) in all waterbodies with the exception of South Moose Lake where the overall incidence rate was 2.5%.

Temporal comparisons were undertaken for the two waterbodies sampled in multiple years. Cormorant Lake was sampled in each of 2008, 2009 and 2010 while Cedar Lake (Southeast) was sampled in 2009 and 2010 only. Both waterbodies displayed little variability in CPUE values from standard gang index gillnet catches between years. For Cedar Lake (Southeast), the same was true for the small mesh index gillnet CPUE as well, however in Cormorant Lake small mesh CPUE in 2008 was approximately twice as high as that in either 2009 or 2010. As additional data are acquired, more formal trend analysis will be undertaken to evaluate any potential long-term changes.

With respect to the Index of Biological Integrity, values were consistent between Cedar Lake (Southeast) and Cormorant Lake and these were only slightly lower than the IBI for Saskatchewan River. The IBI values suggest that, based on the metrics selected, the Saskatchewan River has the ecologically healthiest community condition amongst waterbodies examined in the region, with Cedar Lake (Southeast) and Cormorant Lake having only slightly poorer conditions. South Moose Lake had the lowest overall value and therefore the poorest community condition of all waterbodies sampled in the region.

5.2.7.2 Gill Netting

The Saskatchewan River, which also included Cedar Lake (West), was sampled with standard gang index gill nets in mid-September, 2010 (11 sites) (Table 5.2.7-1, Figure 5.2.7-1). Of the 11 sites sampled, three were located on the Saskatchewan River mainstem, and eight were located on Cedar Lake (West). The Cedar Lake (West) sites were distributed around Connolly Bay and the delta located where the Saskatchewan River enters Cedar Lake. In South Moose Lake, standard gang index gill nets were set in early to mid-September, 2009 (14 sites) (Table 5.2.7-1, Figure 5.2.7-2). A total of 15 sites were sampled in Cedar Lake (Southeast) in mid-August 2009, while 14 sites were sampled in early August 2010 (Table 5.2.7-1, Figure 5.2.7-3). Cormorant Lake was sampled at 20 sites in late August and mid-September in 2008, at 18 sites in mid-August in 2009 and at 17 sites in mid-August in 2010 (Table 5.2.7-1, Figure 5.2.7-4).

Small mesh index gill nets were set in the Saskatchewan River and South Moose Lake at two of 11 sites and four of 14 sites, respectively, to sample the small-bodied fish community. In Cedar Lake (Southeast), six of 15 sites were sampled with small mesh index gill nets in 2009 while three of 14 sites were sampled in 2010. In Cormorant Lake, five of 20 sites, six of 18 sites and four of 17 sites were sampled with small mesh index gill nets in 2008, 2009 and 2010 respectively.

5.2.7.3 Species Composition

A comprehensive list of all fish species captured, including common and scientific names, family, and identification code, for all Saskatchewan River waterbodies is provided in Table 5.2.7-2.

Saskatchewan River

In 2010, a total of 412 fish representing nine species were captured in standard gang index gill nets set in the Saskatchewan River (Table 5.2.7-3). The total catch corresponded to 354,128 g of biomass (Table 5.2.7-4). The most common species captured in standard gang index gill nets was Walleye (relative abundance = 50.7%) (Table 5.2.7-3; Figure 5.2.7-5). Walleye also accounted for the highest proportion of biomass (47.2%) (Table 5.2.7-4).

For the small mesh index gill nets, a total of 33 fish representing seven species were captured (Table 5.2.7-5). Of these 33 fish, a total of four large-bodied fish were weighed providing a biomass value of 1,205 g (Table 5.2.7-6). For small-bodied fish captured in the small mesh gillnet catch, Logperch (*Percina caprodes*) was the most common species captured (relative abundance = 69.7%) (Table 5.2.7-5; Figure 5.2.7-5). Biomass values for small-bodied fish species captured in the small mesh index gill nets set in the Saskatchewan River were not available (Table 5.2.7-6).

South Moose Lake

In 2009, a total of 547 fish (512,983 g) representing nine species were captured in standard gang index gill nets set in South Moose Lake (Tables 5.2.7-3 and 5.2.7-4). The most common species captured in standard gang index gill nets was White Sucker (relative abundance = 57.6%) (Table 5.2.7-3; Figure 5.2.7-6). White Sucker also accounted for the highest proportion of biomass (60.1%) (Table 5.2.7-4).

For the small mesh index gill nets, a total of 1,866 fish (26,015 g) representing seven species were captured (Tables 5.2.7-5 and 5.2.7-6). Yellow Perch (*Perca flavescens*) was the most common species (relative abundance = 83.3%) (Table 5.2.7-5; Figure 5.2.7-6). For small-bodied fish species captured in the small mesh index gill net, Yellow Perch accounted for the highest proportion of total biomass (55.8%) (Table 5.2.7-6).

Cedar Lake (Southeast)

A total of 1,848 fish (1,095,227 g) representing 10 species were captured in standard gang index gill nets set in Cedar Lake (Southeast) in 2009 and 2010 (Tables 5.2.7-3 and 5.2.7-4). A total of nine species were captured in each of 2009 and 2010 with Lake Whitefish captured only in 2009 and Burbot (*Lota lota*) captured only in 2010. The most common species captured in standard gang index gill nets in 2009 and 2010 combined was White Sucker (mean relative abundance = 24.0%) followed by Walleye (23.5%) and Cisco (*Coregonus artedi*) (23.3%) (Table 5.2.7-3; Figure 5.2.7-7). Walleye accounted for 42.4% of the total biomass, followed by White Sucker (32.6%) (Table 5.2.7-4).

For the small mesh index gill nets, a total of 1,200 fish (28,237 g) representing nine species were captured in 2009 and 2010 combined (Tables 5.2.7-5 and 5.2.7-6). A total of eight species were captured in each of 2009 and 2010 with Logperch captured only in 2009 and Longnose Sucker (*Catostomus catostomus*) captured only in 2010. Yellow Perch was the most common species captured (mean relative abundance = 39.9%) followed by Spottail Shiner (*Notropis hudsonius*) (29.8%) (Table 5.2.7-5; Figure 5.2.7-7). Yellow Perch also accounted for the highest proportion of total biomass (22.4%) followed by Spottail Shiner (6.3%) (Table 5.2.7-6).

Cormorant Lake

Overall, a total of 3,317 fish (2,523,059 g) representing nine species were captured in standard gang index gill nets set in Cormorant Lake (Tables 5.2.7-3 and 5.2.7-4). Overall, the most common species captured in standard gang index gill nets was White Sucker (mean relative abundance = 49.0%) followed by Walleye (19.2%) and Lake Whitefish (10.3%) (Table 5.2.7-3; Figure 5.2.7-8). The highest biomass values were for White Sucker (49.9%), followed by Walleye (24.3%) (Table 5.2.7-4).

Overall, for the small mesh index gill nets, a total of 1,578 fish (54,216 g) representing 13 species were captured (Tables 5.2.7-5 and 5.2.7-6). The number of species captured ranged from 11 in 2010 to 13 in 2009. Yellow Perch was the most common species captured overall (mean relative abundance = 41.1%) (Table 5.2.7-5; Figure 5.2.7-8). For small-bodied fish species captured in the small mesh gillnet catch, Yellow Perch accounted for the highest proportion of total biomass (17.8%) (Table 5.2.7-6).

5.2.7.4 Catch Per Unit of Effort (CPUE)/Biomass Per Unit Effort (BPUE)

Saskatchewan River

Total CPUE (BPUE) for 412 fish of nine species captured in standard index gill nets set in the Saskatchewan River in 2010 was 37.8 fish (32,278 g) /100m of net/24 h (Tables 5.2.7-7 and 5.2.7-8, Figures 5.2.7-9 and 5.2.7-10). The highest individual species' CPUE (BPUE) values were recorded for Walleye (18.0 [14,332]) (Tables 5.2.7-7 and 5.2.7-8, Figures 5.2.7-11 and 5.2.7-12).

For the small mesh index gill nets, total CPUE for 33 fish of seven species captured was 26.3 fish/30m of net/24 h (Table 5.2.7-9, Figure 5.2.7-9). The highest individual species' CPUE values were recorded for Logperch (18.3) (Table 5.2.7-9, Figure 5.2.7-11). No weights were taken from small-bodied fish species captured in small mesh index gill nets and as a result no BPUE values were available for these species in the Saskatchewan River. BPUE values for four individual large-bodied fish are provided in Table 5.2.7-10 and Figures 5.2.7-10 and 5.2.7-12.

CPUE and BPUE by site for Northern Pike, Walleye and all species combined captured in standard gang index gill nets are provided in Figures 5.2.7-13 and 5.2.7-14, respectively. Northern Pike were captured at nearly all sites and had similar values among sites for CPUE and BPUE with the exception of GN-08 which was higher than the others. Walleye were captured at nearly all sites and the CPUE/BPUE values varied among sites, particularly for GN-04 and GN-05 where values were notably higher. For all fish combined the CPUE values varied among sites from nearly 0 to over 80 while BPUE also varied considerably among sites from under 10,000 to over 70,000 kg.

South Moose Lake

Total CPUE (BPUE) for 547 fish of nine species captured in standard index gill nets set in South Moose Lake in 2009 was 38.4 fish (35,965 g) (Tables 5.2.7-7 and 5.2.7-8, Figures 5.2.7-9 and 5.2.7-10). The highest individual species' CPUE and BPUE values for the standard gang index gillnet catch were recorded for White Sucker (22.1 [21,670]) (Tables 5.2.7-7 and 5.2.7-8, Figures 5.2.7-11 and 5.2.7-12).

For the small mesh index gill nets, total CPUE (BPUE) values for 1,866 fish of seven species captured were 535.3 (7,430) (Tables 5.2.7-9 and 5.2.7-10, Figures 5.2.7-9 and 5.2.7-10). The highest CPUE values were recorded for Yellow Perch (445.3) followed by Spottail Shiner (69.0) (Table 5.2.7-9, Figure 5.2.7-11). Similarly, the highest values for BPUE (small-bodied fish species only) were also recorded for Yellow Perch (4,156) (Table 5.2.7-10, Figure 5.2.7-12).

CPUE and BPUE by site for Northern Pike, Walleye and all species combined captured in standard gang index gill nets are provided in Figures 5.2.7-15 and 5.2.7-16, respectively. Northern Pike were captured at nearly all sites and had similar CPUE and BPUE values among sites with the exception of GN-09 which had a much higher BPUE than other sites. Walleye were captured at most sites with similar CPUE and BPUE values between sites. The CPUE and BPUE values for all fish combined were consistent between sites with the exception of GN-01 which was considerably higher than the other sites.

Cedar Lake (Southeast)

Total overall CPUE (BPUE) for the standard gang index gillnet catch in Cedar Lake (Southeast) (overall) was 59.0 fish (29,150 g) (Tables 5.2.7-7 and 5.2.7-8). In 2009 and 2010, both total CPUE and total BPUE values showed little variation from year to year with the lowest total CPUE recorded in 2009 (55.2) while the lowest total BPUE was recorded in 2010 (25,470) (Tables 5.2.7-7 and 5.2.7-8, Figures 5.2.7-9 and 5.2.7-10). The highest overall individual species' CPUE and BPUE values for the standard gang index gillnet catch in Cedar Lake (Southeast) were recorded for White Sucker (14.3 [11,586]) and Walleye (14.1 [8,846]) (Tables 5.2.7-7 and 5.2.7-8, Figures 5.2.7-11 and 5.2.7-12).

Total overall CPUE (BPUE) for the small mesh index gillnet catch in Cedar Lake (Southeast) was 135.7 (3,498) (Tables 5.2.7-9 and 5.2.7-10). The higher total CPUE value (all fish) was recorded in 2009 at 154.8 as compared to 116.5 in 2010 (Table 5.2.7-9, Figure 5.2.7-9). The corresponding total BPUE values were in reverse order and were higher in 2010 (4,082) than 2009 (2,915) (Table 5.2.7-10, Figure 5.2.7-10). The highest overall CPUE value for individual species captured in the small mesh index gill nets was recorded for Yellow Perch (47.0), followed by Spottail Shiner (39.3) (Table 5.2.7-9 and Figure 5.2.7-11). With respect to small-bodied fish species only, BPUE values were also highest for Yellow Perch (667) followed by Spottail Shiner (200) (Table 5.2.7-10 and Figure 5.2.7-12).

CPUE and BPUE by site for Northern Pike, Walleye and all species combined captured in standard gang index gill nets are provided in Figures 5.2.7-17 and 5.2.7-18, respectively. Northern Pike were captured at nearly all sites and had low and consistent CPUE and BPUE values among sites and between years. Walleye were captured at all sites and were found to vary considerably for both CPUE and BPUE values among sites and between years. The CPUE/BPUE values for all fish combined mirrored the Walleye data showing variability both among sites and between years.

Cormorant Lake

Total overall CPUE (BPUE) for the standard gang index gillnet catch in Cormorant Lake was 62.9 fish (47,776 g) (Tables 5.2.7-7 and 5.2.7-8). Total CPUE and total BPUE values were similar between all years of study (Tables 5.2.7-7 and 5.2.7-8, Figures 5.2.7-9 and 5.2.7-10). Both the total CPUE and BPUE values for the standard gang index gill net were highest in 2009 (65.1 [49,883]). CPUE was lowest in 2008 (61.7) while the BPUE was lowest in 2010 (44,888). The highest individual species' CPUE and BPUE values for the standard gang index gillnet catch (overall) in Cormorant Lake were recorded for White Sucker (30.3 [23,333]) and Walleye (12.4 [11,840]) (Tables 5.2.7-7 and 5.2.7-8, Figures 5.2.7-11 and 5.2.7-12).

Total overall CPUE for the small mesh index gillnet catch (n = 1,578) in Cormorant Lake was 179.0 fish/30 m/25 h (Table 5.2.7-9). The BPUE value for 1,577 of these fish was 6,592 (Table 5.2.7-10). Total CPUE and BPUE values were highest in 2008 (277.1 [11,373]) and much lower in 2009 (129.6 [2,866]) (Tables 5.2.7-9 and 5.2.7-10, Figures 5.2.7-9 and 5.2.7-10). The 2010 values were similar to those in 2009 (130.3 [5,536]). The highest overall CPUE values were recorded for Yellow Perch (74.3) followed by Spottail Shiner (40.8) and Emerald Shiner (*Notropis atherinoides*) (22.5) (Figure 5.2.7-11). With respect to small-bodied fish species captured in small mesh index gill nets, BPUE mirrored CPUE, with the highest BPUE values being recorded for Yellow Perch (1,216), Spottail Shiner (210) and Emerald Shiner (108) (Figure 5.2.7-12).

CPUE and BPUE by site for Northern Pike, Walleye and all species combined as captured in standard gang index gill nets are provided in Figures 5.2.7-19 and 5.2.7-20, respectively. Northern Pike were captured at nearly all sites and had low and consistent CPUE and BPUE values among sites and between years. Walleye were captured at all sites and generally had similar CPUE and BPUE values, however some variation was present both among sites and also between years, particularly for GN-22. The CPUE/BPUE values for all fish combined were fairly consistent, however GN-21, GN-22, and GN-23 had somewhat higher CPUE values.

5.2.7.5 Size and Condition

Saskatchewan River

Fish length, weight and condition factor data were collected and analyzed (by mesh size and total catch) from 51 Northern Pike and 197 Walleye captured in standard gang and small mesh index gill nets from the Saskatchewan River in 2010 (Tables 5.2.7-11 and 5.2.7-12). Weights only were taken from an additional four Northern Pike and 12 Walleye. Mean (±SD) fork lengths were as follows: Northern Pike = 536 (±107) mm; Walleye = 406 (±45) mm.

The mean fork length of Northern Pike and Walleye captured by various mesh sizes is presented in Figures 5.2.7-21 and 5.2.7-22. Fork length frequency distributions for Northern Pike and Walleye are provided in Figures 5.2.7-23 and 5.2.7-24.

Mean (±SD) weights for Northern Pike and Walleye were 1,264 (±941) g and 800 (±264) g respectively. Mean (±SD) condition factors for these two species were 0.69 (±0.08) for Northern Pike and 1.16 (±0.10) for Walleye.

South Moose Lake

Fish length, weight and condition factor data were collected and analyzed (by mesh size and total catch) from 90 Northern Pike and 31 Walleye captured in standard gang and small mesh index gill nets from South Moose Lake in 2009 (Tables 5.2.7-11 and 5.2.7-12). Weights only were taken from an additional 10 Northern Pike. Mean (±SD) fork lengths were 582 (±102) mm for Northern Pike and 369 (±87) mm for Walleye.

The mean fork length of Northern Pike and Walleye captured by various mesh sizes is presented in Figures 5.2.7-21 and 5.2.7-22 respectively. Similarly, fork length frequency distributions for Northern Pike and Walleye are provided in Figures 5.2.7-23 and 5.2.7-24 respectively.

Mean (±SD) weights for Northern Pike and Walleye were 1,530 (±1,097) g and 771 (±473) g respectively. Mean (±SD) condition factors for these two species were 0.71 (±0.05) for Northern Pike and 1.14 (±0.14) for Walleye.

Cedar Lake (Southeast)

Fish length, weight and condition factor data were collected and analyzed (by mesh size and total catch) from 65 Northern Pike and 429 Walleye captured in standard gang and small mesh index gill nets from Cedar Lake (Southeast) during 2009 and 2010 (Tables 5.2.7-11 and 5.2.7-12). Fork lengths only were taken from an additional five Walleye and weights only were taken from an additional 44 Walleye. Mean (±SD) fork lengths for Northern Pike were relatively similar in 2009 and 2010 at 537 (±90) mm and 549 (±102) mm respectively. Mean (±SD) fork lengths for Walleye were also similar for these two years at 345 (±4) mm and 383 (±62) mm.

The mean fork length of Northern Pike and Walleye captured by various mesh sizes is presented in Figures 5.2.7-21 and 5.2.7-22. Fork length frequency distributions for Northern Pike and Walleye are provided in Figures 5.2.7-23 and 5.2.7-24.

Comparable to fork length, mean weights for both Northern Pike and Walleye from Cedar Lake (Southeast) were relatively similar in 2009 and 2010. For Northern Pike, mean (±SD) weights were 1,313 (±607) g and 1,436 (±740) g in 2009 and 2010, respectively; for Walleye these values were 578 (±347) g and 616 (±456) g respectively for the same years. Condition factors for both species also showed little variance from 2009 to 2010. Mean (±SD) condition factors in 2009 and 2010 were 0.80 (±0.13) and 0.79 (±0.07), respectively, for Northern Pike and 1.22 (±0.16) and 1.22 (±0.15), respectively, for Walleye.

Cormorant Lake

Fish length, weight and condition factor data were collected and analyzed (by mesh size and total catch) for 128 Northern Pike and 637 Walleye captured in standard gang and small mesh index gill nets from Cormorant Lake during 2008, 2009 and 2010 (Tables 5.2.7-11 and 5.2.7-12). Weights only were taken from an additional 64 Northern Pike and an additional 48 Walleye. Mean fork lengths for both species were similar from year to year. Mean (±SD) fork lengths for Northern Pike were 622 (±64) mm in 2008, 610 (±89) mm in 2009, and 604 (±80) mm in 2009. Mean fork lengths for Walleye from 2008, 2009 and 2010 were also similar at 446 (±93) mm, 415 (±112) mm and 406 (±95) mm, respectively.

The mean fork length of Northern Pike and Walleye captured by various mesh sizes is presented in Figures 5.2.7-21 and 5.2.7-22. Fork length frequency distributions for Northern Pike and Walleye are provided in Figures 5.2.7-23 and 5.2.7-24.

As was the case for fork length, mean weights for Northern Pike and Walleye from Cormorant Lake were relatively similar in 2008, 2009 and 2010. Mean (±SD, where calculated) weights for Northern Pike were 1,663 g, 1808 (±895) g and 1,683 (±795) g for these three years respectively. Mean (±SD) weights for Walleye were more variable for these three years at 1006 g, 920 (±657) g and 794 (±660) g respectively. Condition factors for Northern Pike and Walleye showed little variance from year to year. Mean (±SD) condition factors from 2008, 2009 and 2010 were 0.72 (±0.07), 0.75 (±0.08) and 0.73 (±0.08) respectively for Northern Pike and 1.07 (±0.12), 1.08 (±0.14) and 1.04 (±0.10) respectively for Walleye.

5.2.7.6 Age Composition

Saskatchewan River

Age frequency distributions were calculated for Northern Pike and Walleye captured in standard gang index gill nets in the Saskatchewan River during 2010. Age frequency distributions are presented by year-class cohort (Tables 5.2.7-13 and 5.2.7-14) and by age (Tables 5.2.7-15 and 5.2.7-16, Figures 5.2.7-25 and 5.2.7-26). Year-classes represented ranged from 2001 to 2009 for Northern Pike and from 1993 to 2008 for Walleye.

The Northern Pike data suggests a a peak in 2005 (5 years of age), and then a quick decline to the 2001 year-class (9 years of age), the oldest fish in the dataset. For Walleye, the 2002 and 2005 year-classes were strong with a peak in 2003. Length, weight and condition factor by age and year-class data for 2010 for Northern Pike and Walleye are provided in Tables 5.2.7-17 and 5.2.7-18. Fitted typical von Bertalanffy growth curves are provided in Figures 5.2.7-27 and 5.2.7-28.

<u>South Moose Lake</u>

Age frequency distributions were calculated for Northern Pike and Walleye captured in standard gang index gill nets in South Moose Lake during 2009. Age frequency distributions are presented by year-class cohort (Tables 5.2.7-13 and 5.2.7-14) and by age (Tables 5.2.7-15 and 5.2.7-16, Figures 5.2.7-25 and 5.2.7-26). Year-classes represented ranged from 1999 to 2008 for Northern Pike and from 2001 to 2008 for Walleye.

The data suggest a relatively strong 2005 Northern Pike year-class. Limited data for Walleye do not provide a sufficient basis for year-class strength determination.

Length, weight and condition factor by age and year-class data for 2010 for Northern Pike and Walleye are provided in Tables 5.2.7-17 and 5.2.7-18. Fitted typical von Bertalanffy growth curves are provided in Figures 5.2.7-27 and 5.2.7-28.

<u>Cedar Lake (Southeast)</u>

Age frequency distributions were calculated for Northern Pike and Walleye captured in standard gang index gill nets in Cedar Lake (Southeast) during 2009 and 2010. Age frequency distributions are presented by year-class cohort (Tables 5.2.7-13 and 5.2.7-14) and by age (Tables 5.2.7-15 and 5.2.7-16, Figures 5.2.7-25 and 5.2.7-26). Year-classes represented ranged from 2000 to 2008 for Northern Pike and from 1996 to 2008 for Walleye.

These data suggest that Northern Pike had a strong year class in 2003. The data for Walleye suggest strong cohorts in 2001, 2003 and 2005, with the 2003 year-class being particularly strong. The 2004 year-class was under-represented in both the 2009 and 2010 Walleye data.

Length, weight and condition factor by age and year-class data for 2010 for Northern Pike and Walleye are provided in Tables 5.2.7-17 and 5.2.7-18. Fitted typical von Bertalanffy growth curves are provided in Figures 5.2.7-27 and 5.2.7-28.

Cormorant Lake

Age frequency distributions were calculated for Northern Pike and Walleye captured in standard gang index gill nets in Cormorant Lake during 2008, 2009 and 2010. Age frequency distributions are presented by year-class cohort (Tables 5.2.7-13 and 5.2.7-14) and by age (Tables 5.2.7-15 and 5.2.7-16, Figures 5.2.7-25 and 5.2.7-26). Year-classes represented ranged from 1995 to 2008 for Northern Pike and from 1983 to 2010 for Walleye.

Based on the 2008 and 2009 data, Northern Pike had the strongest year-class in 2001. The 2005 year-class increases from 2008 to 2009 and then then becomes the strongest year-class based on 2010 data. The 2004 year-class, similar to the other regions, was underrepresented in the walleye data.

Length, weight and condition factor by age and year-class data for 2010 for Northern Pike and Walleye are provided in Tables 5.2.7-17 and 5.2.7-18 respectively. Fitted typical von Bertalanffy growth curves are provided in Figures 5.2.7-27 and 5.2.7-28.

5.2.7.7 Deformities, Erosion, Lesions and Tumours (DELTs)

Saskatchewan River

No DELTs were recorded from 319 (0.0%) individuals of three species of fish (i.e., 56 White Sucker, 54 Northern Pike and 209 Walleye) examined from the Saskatchewan River in 2010 (Table 5.2.7-19).

South Moose Lake

A total of five DELTs were recorded from 202 (2.5%) individuals of four species of fish examined from South Moose Lake in 2009 (Table 5.2.7-19). In all, five instances of lesions were found from a total of 57 White Sucker individuals examined (8.8%). Northern Pike (n = 92), Lake Whitefish (n = 22) and Walleye (n = 31) also were examined for DELTS but none were observed.

Cedar Lake (Southeast)

A total of one DELT was recorded from 794 (0.1%) individuals of five species of fish examined from Cedar Lake (Southeast) in 2009 and 2010 (Table 5.2.7-19). The only instance was of a tumour which was observed on one specimen (0.2%) of 434 Walleye examined. White Sucker (n = 270), Northern Pike (n = 65), Lake Whitefish (n = 1) and Sauger (n = 24) also were examined for DELTS but none were observed.

Cormorant Lake

No instances of DELTs were recorded from 742 White Sucker, 163 Northern Pike, 282 Lake Whitefish and 637 Walleye examined from Cormorant Lake in 2008, 2009 and 2010 (Table 5.2.7-19).

5.2.7.8 Index of Biotic Integrity (IBI)

Index of Biotic Integrity scores based on 10 metrics (excluding DELTs) were calculated for all Saskatchewan River Region waterbodies. The Saskatchewan River Region IBI scores varied from 43.5 (Moose Lake 2009) to 60.3 (Saskatchewan River 2010) (Table 5.2.7-20 and Figure 5.2.7-29). While all other waterbodies in the region had a number of species present ranging from 11 to 13, Cormorant Lake was found to have 15 species present in 2009. The proportion of tolerant and invasive species present was low for most waterbodies and years (13.5 to 17.3%) except for Cormorant Lake in 2008 and 2009 which had values of 38.6% and 32.1%, respectively. Cedar Lake (Southeast) in 2010 had the lowest number of insectivore species (six) while all other waterbodies and years had eight or nine species present except for Cormorant Lake in 2009 which had 11 species present. Evenness values ranged from 3.45 species contributing to the majority of information in South Moose Lake in 2009 and Cormorant Lake in 2010, to 7.25 species contributing to the majority of information in Cormorant Lake in 2008.

Biomass contributions varied considerably between waterbodies but were consistent for individual waterbodies with multiple years of data. The Saskatchewan River 2010 catches consisted primarily of piscivores (75%) with omnivores making up most of the remaining proportion. Moose Lake 2009 consisted of omnivores (58.5%) and piscivores (32.3%) with some insectivore biomass present (9.2%). Cedar Lake was made up of similar proportions of piscivores and omnivores with insectivores contributing the smallest proportion (7.3% in 2009 and 19% in 2010). Cormorant Lake consisted of mostly omnivore (49.6 to 58.5%) and piscivore (32.3 to 40%) biomass with approximately 10% insectivore biomass over all three years. The proportion of simple lithophilic spawners varied among and within waterbodies from 0.19% (Moose Lake 2009 and Cormorant Lake 2010) to 0.83% (Saskatchewan River 2010).

5.2.7.9 Spatial Comparisons

Overall, the fish assemblage as captured by standard gillnet sets in all Saskatchewan River Region waterbodies, was found to be dominated by White Sucker and Walleye (Table 5.2.7-3). On the Saskatchewan River mainstem (i.e., Saskatchewan River and Cedar Lake [Southeast]) Sauger were also common. Northern Pike were more common in the Saskatchewan River than in Cedar Lake (Southeast), while Cisco were less common. In South Moose Lake the relative abundance of fish captured closely resembled that of Cedar Lake (Southeast) with the exception that Northern Pike were more commonly captured in South Moose Lake than Cedar Lake (Southeast) and Sauger were less common. In Cormorant Lake the relative abundance of Lake Whitefish in particular was higher than that for South Moose Lake. With respect to small-bodied fish species captured in small mesh index gillnet catches, Spottail Shiner was common in all lakes sampled and Yellow Perch was common in all waterbodies except the Saskatchewan River where Logperch was common (Table 5.2.7-4). Emerald Shiner (*Notropis atherinoides*) was much more abundant in catches from Cormorant Lake than any of the other waterbodies sampled in the region and the species was absent from the Cedar Lake (Southeast) catch.

Moving downstream in the Saskatchewan River Region, the catch in the Saskatchewan River was comprised of 12 species, of which only Emerald Shiner and Goldeye (*Hiodon alosoides*) were not found in Cedar Lake (Southeast), further downstream. Notable absences from the catch in the Saskatchewan River (species captured downstream in Cedar Lake [Southeast]) were Lake Whitefish, Burbot and Troutperch (*Percopsis omiscomaycus*). The fish assemblage of Cormorant Lake to the north (off-system waterbody and tributary to South Moose Lake and Cedar Lake (Southeast) respectively in a downstream direction) was found to contain the highest number of fish species of all sampled waterbodies in the region (total of 15 fish species). Of these, Lake Chub (*Couesius plumbeus*) and Slimy Sculpin (*Cottus cognatus*) were not found in either South Moose Lake or Cedar Lake (Southeast) and Burbot and Logperch were not found in South Moose Lake but were present in Cedar Lake (Southeast). Notable absences in the catch from Cormorant Lake (species captured in either South Moose Lake or Cedar Lake [Southeast]) were Shorthead Redhorse (*Moxostoma macrolepidotum*) (found in both South Moose Lake and Cedar Lake) and Fathead Minnow (*Pimephales promelas*) (found in South Moose Lake only). A total of 13 and 12 species of fish were captured in South Moose Lake and Cedar Lake (Southeast), respectively.

A comparison of mean CPUE values for the catch from the standard gang and small mesh index gill nets from the annual Saskatchewan River Region waterbodies (Cedar Lake [Southeast] and Cormorant Lake) and the rotational waterbodies (Saskatchewan River and South Moose Lake) are presented in Tables 5.2.7-7 and 5.2.7-9 (all fish) and in Figures 5.2.7-13, 5.2.7-15, 5.2.7-17, and 5.2.7-19 (Northern Pike and Walleye) while both mean and median CPUE values for all fish are presented in Figure 5.2.7-9. Figure 5.2.7-11 provides mean CPUE values for select species for all sampled waterbodies in the region. The two annual Saskatchewan River Region waterbodies were found to have relatively similar CPUE values for total standard gang index gillnet catch however CPUE values for White Sucker and Lake Whitefish were noticeably higher in Cormorant Lake than elsewhere in the region, including Cedar Lake (Southeast). In the Saskatchewan River (riverine site, 2010 data) and South Moose Lake (2009 data) the overall

CPUE was approximately equal but was only about one-half of the overall CPUE recorded for Cedar Lake (Southeast) or Cormorant Lake. Notable differences in the CPUE values for the small mesh index gill nets were evident particularly with respect to Yellow Perch which were almost absent from the Saskatchewan River catch in 2010 but were extremely abundant in South Moose Lake in 2009 and were abundant in Cedar Lake (Southeast) and Cormorant Lake in all years. As well, Spottail Shiner were rarely caught in the Saskatchewan River but were abundant in all other waterbodies in all years.

A comparison of BPUE values for standard gang and small mesh index gillnet catches from all sampled waterbodies in the region is provided in Tables 5.2.7-8 and 5.2.7-10 (all fish) and in Figures 5.2.7-14, 5.2.7-16, 5.2.7-18, and 5.2.7-20 (Northern Pike and Walleye), Figure 5.2.7-10 (all fish) and Figure 5.2.7-12 (select species). Generally BPUE values for all fish were comparable between all sampled waterbodies. One exception was Cormorant Lake in 2008 which had an overall BPUE value from the small mesh index gillnet catch that was much higher than that recorded in other waterbodies (or in Cormorant Lake in other years). With regard to individual species', the BPUE values show a much higher biomass for White Sucker in the South Moose Lake and Cormorant Lake in standard gang index gillnet catch as compared to the Saskatchewan River and Cedar Lake (Southeast) as well as a much higher biomass for Yellow Perch in South Moose Lake compared to other waterbodies in the region.

For the standard gang index gillnet catch, both the mean CPUE and mean BPUE values for Northern Pike from all waterbodies in the region were relatively similar. This was generally also the case for Walleye however the CPUE for Walleye from South Moose Lake was much lower than that for all other waterbodies in the region.

Within each waterbody, site variability was examined by comparing mean CPUE values from the standard gang index gill nets for individual sites. With the exception of the Saskatchewan River and South Moose Lake, each of which only had one year of data, the two (Cedar Lake [Southeast]) or three (Cormorant Lake) years of collected data were pooled for individual sites. Total CPUE values are presented along with values for Northern Pike and Walleye. In the Saskatchewan River, total CPUE values ranged from approximately 5 fish/100m of net/24 h (Site GN-09) to nearly 90 for Site GN-04 (Figure 5.2.7-13) and in South Moose Lake from less than 10 (Site GN-12) to nearly 100 (Site GN-01) (Figure 5.2.7-15). In Cedar Lake (Southeast) the majority of sites had total CPUE values between 20 and 100, with an overall range of approximately 19 at Site GN-21 to nearly 140 at Site GN-10 (Figure 5.2.7-17). In Cormorant Lake the majority of sites had total CPUE values between 40 and 100 with an overall range of approximately 38 at Site GN-19 to approximately 120 at Site GN-23 (Figure 5.2.7-19).

With respect to IBI, values were consistent between Cedar Lake and Cormorant Lake and these were only slightly lower than the IBI for Saskatchewan River. The IBI values suggest that, based on the metrics selected, the Saskatchewan River has the optimum fish community condition amongst waterbodies examined in the region with Cedar Lake and Cormorant Lake having only slightly less than optimum conditions. South Moose Lake had the lowest overall value and therefore the poorest fish community condition of all waterbodies sampled in the region.

5.2.7.10 Temporal Variability

CPUE values were used to examine temporal variability within the two waterbodies within the Saskatchewan River Region that were sampled in multiple years. Both Cedar Lake (Southeast) and Cormorant Lake displayed little variability in CPUE in standard gang index gillnet catches between years. In Cedar Lake (Southeast) overall standard gang index gillnet CPUE varied from a low of 55.2 fish/100 m of net/24 h in 2009 to a high of 62.8 in 2010 (Table 5.2.7-7). In the case of Cormorant Lake, overall standard gang index gillnet CPUE varied from a low of 61.7 in 2008 to a high of 65.1 fish in 2009.

With respect to the catch from the small mesh index gill nets, Cedar Lake (Southeast) displayed little variability in CPUE between years. CPUE varied from a low of 116.5 fish/30 m of net/24 h in 2010 to a high of 154.8 in 2009 (Table 5.2.7-9). However, in Cormorant Lake the small mesh CPUE was approximately twice as high in 2008 (277.1) as in either 2009 (129.6) or 2010 (130.3).

The IBI for Cedar Lake was 53.3 in 2009 and 56.6 in 2010 (Table 5.2.7-20 and Figure 5.2.7-29). Insectivore biomass and proportion of simple lithophilic spawners were the main contributing metrics to the variation. Differences were due to sampling variation between years and likely not due to changes in the fish community. Cormorant Lake had three years of data and the IBI scores varied from 45.9 (2010) to 55.3 (2009). Despite having a lower proportion of tolerant and invasive species present in the 2010 sampling year, the overall IBI was lower in 2010. The metrics contributing to higher 2008 and 2009 values included the evenness index and the proportion of simple lithophilic spawners.

Water levels and flows did not appear to have any noticeable relationship to the differences in CPUE or IBI values noted for any of the Saskatchewn River Region waterbodies. Additional data will be collected over time and determine if any relationships are apparent in the future.

Table 5.2.7-1. Summary of site-specific physical measurements collected during CAMPP index gillnetting conducted in the Saskatchewan River Region, 2008-2010.

Location	Site	UTM Coordinates			Set Date	Set Duration (h)	Water Depth (m)		Water Temperature (ºC)
		Zone	Easting	Northing			Start	End	
Saskatchewan River	GN-01	14	389619	5917392	13-Sep-10	14.95	2.4	2.4	12.0
Saskatchewan River	GN-02	14	388862	5916739	13-Sep-10	15.03	2.5	2.4	-
Saskatchewan River	GN-03	14	387767	5916424	13-Sep-10	15.08	2.5	2.3	-
Saskatchewan River	GN-04	14	381370	5923255	14-Sep-10	22.47	1.8	3.4	-
Saskatchewan River	GN-05	14	374582	5923548	14-Sep-10	23.05	2.7	2.7	-
Saskatchewan River	GN-06	14	373001	5923841	14-Sep-10	23.53	2.4	2.3	-
Saskatchewan River	GN-07	14	400582	5923226	15-Sep-10	20.03	2.4	1.8	-
Saskatchewan River	GN-08	14	402499	5922347	15-Sep-10	19.67	1.8	1.8	-
Saskatchewan River	GN-09	14	364428	5962373	20-Sep-10	21.37	1.2	4.6	-
Saskatchewan River	GN-10	14	368119	5958505	20-Sep-10	24.15	0.9	4.2	-
Saskatchewan River	GN-11	14	366449	5952015	20-Sep-10	22.13	0.9	1.8	-
Saskatchewan River	SN-03	14	387767	5916424	13-Sep-10	15.08	2.5	2.3	-
Saskatchewan River	SN-09	14	364428	5962373	20-Sep-10	21.37	1.2	4.6	-
South Moose Lake	GN-01	14	408467	5964536	9-Sep-09	20.50	2.5	3.8	-
South Moose Lake	GN-02	14	410544	5964358	9-Sep-09	21.32	5.5	4.5	-
South Moose Lake	GN-03	14	424671	5975209	10-Sep-09	21.70	1.8	2.2	-
South Moose Lake	GN-04	14	421004	5969754	10-Sep-09	22.00	3.0	2.0	-
South Moose Lake	GN-05	14	426127	5962144	11-Sep-09	21.42	4.5	4.7	-
South Moose Lake	GN-06	14	424091	5961138	11-Sep-09	19.45	6.1	6.0	-
South Moose Lake	GN-07	14	427866	5961258	12-Sep-09	22.68	4.7	5.7	-
South Moose Lake	GN-08	14	426193	5958815	12-Sep-09	20.75	8.9	8.8	-
South Moose Lake	GN-09	14	442518	5970693	13-Sep-09	22.87	8.7	8.7	-

Table 5.2.7-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h)	Water Depth (m)		Water Temperature (ºC)
		Zone	Easting	Northing			Start	End	
South Moose Lake	GN-10	14	434716	5966204	13-Sep-09	19.58	1.3	5.9	-
South Moose Lake	GN-11	14	438028	5955121	14-Sep-09	21.75	3.9	4.5	18.0
South Moose Lake	GN-12	14	427032	5951284	14-Sep-09	22.55	3.3	3.3	19.0
South Moose Lake	GN-13	14	420736	5952749	15-Sep-09	20.92	1.0	1.3	18.0
South Moose Lake	GN-14	14	416124	5950831	15-Sep-09	20.33	1.7	1.5	18.0
South Moose Lake	SN-01	14	408467	5964536	9-Sep-09	20.50	2.5	3.8	-
South Moose Lake	SN-04	14	421004	5969754	10-Sep-09	22.00	3.0	2.0	-
South Moose Lake	SN-05	14	426127	5962144	11-Sep-09	21.42	4.5	4.7	-
South Moose Lake	SN-08	14	426193	5958815	12-Sep-09	20.75	8.9	8.9	-
Cedar Lake-Southeast	GN-01	14	449887	5895326	14-Aug-09	21.25	-	-	-
Cedar Lake-Southeast	GN-02	14	445892	5891153	14-Aug-09	21.93	2.3	2.0	-
Cedar Lake-Southeast	GN-03	14	442185	5887567	15-Aug-09	17.85	-	-	-
Cedar Lake-Southeast	GN-04	14	445549	5887524	16-Aug-09	22.02	8.6	8.4	17.2
Cedar Lake-Southeast	GN-05	14	438027	5895432	17-Aug-09	20.73	9.9	9.8	17.5
Cedar Lake-Southeast	GN-06	14	437011	5886227	15-Aug-09	21.22	12.3	12.0	17.1
Cedar Lake-Southeast	GN-07	14	430477	5890926	14-Aug-09	20.63	6.0	6.2	18.3
Cedar Lake-Southeast	GN-14	14	455231	5901393	18-Aug-09	22.10	8.7	8.8	17.2
Cedar Lake-Southeast	GN-15	14	431768	5894910	16-Aug-09	19.18	7.8	7.8	19.1
Cedar Lake-Southeast	GN-16	14	428397	5887127	16-Aug-09	22.33	-	-	-
Cedar Lake-Southeast	GN-17	14	451422	5892957	17-Aug-09	21.62	-	-	-
Cedar Lake-Southeast	GN-18	14	439949	5888343	15-Aug-09	22.12	7.0	7.4	17.2
Cedar Lake-Southeast	GN-19	14	440306	5885378	17-Aug-09	20.45	6.5	6.4	16.7
Cedar Lake-Southeast	GN-20	14	435329	5897042	18-Aug-09	21.30	9.9	10.6	17.4
Cedar Lake-Southeast	GN-21	14	435279	5900308	18-Aug-09	21.85	7.2	2.7	17.3

Table 5.2.7-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h)	Water Depth (m)		Water Temperature (ºC)
		Zone	Easting	Northing			Start	End	
Cedar Lake-Southeast	SN-02	14	445892	5891153	16-Aug-09	21.93	2.3	2.0	-
Cedar Lake-Southeast	SN-04	14	445549	5887524	16-Aug-09	22.02	8.6	8.4	17.2
Cedar Lake-Southeast	SN-06	14	437011	5886227	15-Aug-09	21.22	12.3	12.0	17.1
Cedar Lake-Southeast	SN-18	14	439949	5888343	15-Aug-09	22.12	7.0	7.4	17.2
Cedar Lake-Southeast	SN-20	14	435329	5897042	18-Aug-09	21.30	9.9	10.6	17.4
Cedar Lake-Southeast	SN-21	14	435279	5900308	18-Aug-09	21.85	7.2	2.7	17.3
Cedar Lake-Southeast	GN-01	14	450391	5895322	7-Aug-10	24.80	6.2	7.7	19.0
Cedar Lake-Southeast	GN-02	14	445841	5891537	7-Aug-10	24.57	10.5	10.5	19.0
Cedar Lake-Southeast	GN-03	14	441852	5887384	4-Aug-10	24.23	2.8	3.2	20.0
Cedar Lake-Southeast	GN-04	14	445257	5886828	4-Aug-10	26.03	7.9	7.5	20.0
Cedar Lake-Southeast	GN-05	14	439933	5891981	6-Aug-10	24.75	9.4	9.3	21.0
Cedar Lake-Southeast	GN-06	14	434854	5884052	4-Aug-10	22.68	6.5	6.9	20.0
Cedar Lake-Southeast	GN-07	14	431936	5891452	5-Aug-10	25.23	11.6	11.3	23.0
Cedar Lake-Southeast	GN-08	14	424069	5889128	5-Aug-10	25.07	5.6	7.0	23.0
Cedar Lake-Southeast	GN-09	14	437062	5895716	6-Aug-10	22.60	8.6	8.7	21.0
Cedar Lake-Southeast	GN-10	14	416071	5891302	5-Aug-10	24.50	7.9	7.9	23.0
Cedar Lake-Southeast	GN-11	14	452785	5889995	7-Aug-10	24.45	12.1	12.5	19.0
Cedar Lake-Southeast	GN-12	14	431258	5898598	6-Aug-10	22.42	11.9	11.8	21.0
Cedar Lake-Southeast	GN-13	14	451930	5897254	8-Aug-10	24.13	10.9	9.0	19.0
Cedar Lake-Southeast	GN-14	14	456929	5900995	8-Aug-10	23.35	4.5	4.5	19.0
Cedar Lake-Southeast	SN-04	14	445222	5886829	4-Aug-10	25.90	8.4	7.5	20.0
Cedar Lake-Southeast	SN-05	14	439906	5891987	6-Aug-10	24.58	9.7	9.3	21.0
Cedar Lake-Southeast	SN-10	14	416057	5891427	5-Aug-10	24.42	7.9	7.9	23.0

Table 5.2.7-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h)	Water Depth (m)		Water Temperature (ºC)
		Zone	Easting	Northing			Start	End	
Cormorant Lake	GN-01	14	373359	6015127	16-Sep-08	20.85	10.7	11.9	14.7
Cormorant Lake	GN-02	14	373015	6017479	16-Sep-08	22.00	10.2	10.1	14.4
Cormorant Lake	GN-03	14	374306	6018714	16-Sep-08	23.08	9.4	14.4	14.4
Cormorant Lake	GN-04	14	388010	6012539	26-Aug-08	23.00	5.1	7.9	19.1
Cormorant Lake	GN-05	14	390632	6013096	17-Sep-08	23.50	3.5	7.2	13.9
Cormorant Lake	GN-06	14	392862	6010526	18-Sep-08	19.50	8.7	8.5	14.5
Cormorant Lake	GN-09	14	381662	6009897	26-Aug-08	24.50	10.5	13.2	19.2
Cormorant Lake	GN-11	14	385983	6006500	27-Aug-08	20.67	14.8	15.7	18.3
Cormorant Lake	GN-12	14	393048	6011154	18-Sep-08	20.75	7.0	3.0	14.4
Cormorant Lake	GN-14	14	378351	6008658	29-Aug-08	24.75	15.1	11.9	18.4
Cormorant Lake	GN-15	14	369144	6010688	29-Aug-08	25.50	2.7	16.2	18.3
Cormorant Lake	GN-17	14	385578	6012874	26-Aug-08	23.67	8.6	10.8	19.0
Cormorant Lake	GN-18	14	378530	6011171	26-Aug-08	24.67	13.4	13.6	19.3
Cormorant Lake	GN-19	14	393348	6009209	19-Sep-08	23.00	5.5	7.6	14.4
Cormorant Lake	GN-20	14	391798	6008261	19-Sep-08	21.50	7.4	5.1	13.9
Cormorant Lake	GN-22	14	383812	6009990	27-Aug-08	20.00	4.9	7.3	19.7
Cormorant Lake	GN-24	14	379731	6010956	27-Aug-08	19.75	11.6	13.4	18.6
Cormorant Lake	GN-26	14	390270	6006911	27-Aug-08	19.92	7.6	7.3	17.6
Cormorant Lake	GN-33	14	380585	6018288	17-Sep-08	19.53	5.5	5.5	13.9
Cormorant Lake	GN-34	14	389351	6014536	17-Sep-08	20.33	4.3	7.5	14.1
Cormorant Lake	SN-06	14	392862	6010526	18-Sep-08	19.50	8.7	8.5	14.5
Cormorant Lake	SN-12	14	393048	6011154	18-Sep-08	20.75	7.0	3.0	14.4
Cormorant Lake	SN-20	14	391798	6008261	19-Sep-08	21.50	7.4	5.1	13.9
Cormorant Lake	SN-22	14	383812	6009990	27-Aug-08	20.00	4.9	7.3	19.7
Cormorant Lake	SN-24	14	379731	6010956	27-Aug-08	19.75	11.6	13.4	18.6

Table 5.2.7-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h)	Water Depth (m)		Water Temperature (ºC)
		Zone	Easting	Northing			Start	End	
Cormorant Lake	GN-01	14	373160	6014695	17-Aug-09	15.92	2.7	11.9	16.9
Cormorant Lake	GN-02	14	372747	6017416	17-Aug-09	16.02	3.4	10.7	16.8
Cormorant Lake	GN-05	14	389979	6013846	22-Aug-09	18.17	4.9	7.6	16.5
Cormorant Lake	GN-07	14	383450	6003367	21-Aug-09	17.03	3.1	5.8	17.0
Cormorant Lake	GN-08	14	384652	6010792	19-Aug-09	18.17	6.7	9.1	17.0
Cormorant Lake	GN-09	14	381704	6010060	21-Aug-09	17.40	13.1	14.3	17.0
Cormorant Lake	GN-11	14	385132	6007321	20-Aug-09	17.05	3.7	12.2	16.8
Cormorant Lake	GN-13	14	379334	6008537	18-Aug-09	17.50	4.3	12.8	17.0
Cormorant Lake	GN-14	14	377935	6009140	18-Aug-09	17.25	9.8	12.5	17.0
Cormorant Lake	GN-15	14	368965	6010577	17-Aug-09	15.97	4.9	10.7	16.7
Cormorant Lake	GN-16	14	388228	6011088	20-Aug-09	17.08	7.6	16.8	16.5
Cormorant Lake	GN-17	14	384452	6012953	19-Aug-09	18.17	11.3	12.8	17.0
Cormorant Lake	GN-22	14	384235	6009916	20-Aug-09	16.97	7.6	11.3	17.0
Cormorant Lake	GN-23	14	380571	6010017	18-Aug-09	17.33	14.3	14.3	17.0
Cormorant Lake	GN-24	14	380001	6010766	21-Aug-09	17.02	11.3	11.3	18.0
Cormorant Lake	GN-25	14	380395	6006622	22-Aug-09	18.33	2.7	10.7	16.4
Cormorant Lake	GN-29	14	386432	6015001	22-Aug-09	18.33	3.7	6.4	16.5
Cormorant Lake	GN-30	14	378355	6013792	19-Aug-09	17.57	3.7	4.6	17.0
Cormorant Lake	SN-02	14	372747	6017416	17-Aug-09	16.02	3.4	3.4	16.8
Cormorant Lake	SN-07	14	383450	6003367	21-Aug-09	17.03	3.1	3.1	17.0
Cormorant Lake	SN-08	14	384652	6010792	19-Aug-09	18.17	6.7	6.7	17.0
Cormorant Lake	SN-11	14	385132	6007321	20-Aug-09	17.05	3.7	3.7	16.8
Cormorant Lake	SN-23	14	380571	6010017	18-Aug-09	17.33	14.3	14.3	17.0
Cormorant Lake	SN-25	14	380395	6006622	22-Aug-09	18.33	2.7	2.7	16.4

Table 5.2.7-1. continued.

Location	Site	UTM Coordinates			Set Date	Set Duration (h)	Water Depth (m)		Water Temperature (ºC)
		Zone	Easting	Northing			Start	End	
Cormorant Lake	GN-02	14	372017	6018009	21-Aug-10	21.60	3.7	6.7	18.0
Cormorant Lake	GN-05	14	390153	6012858	21-Aug-10	24.12	5.5	4.0	18.0
Cormorant Lake	GN-08	14	384531	6010791	17-Aug-10	17.55	11.9	11.6	18.0
Cormorant Lake	GN-09	14	381379	6009354	18-Aug-10	21.75	12.8	12.8	18.0
Cormorant Lake	GN-11	14	385101	6006950	18-Aug-10	21.55	13.4	12.8	17.9
Cormorant Lake	GN-13	14	379388	6008326	19-Aug-10	21.90	4.0	13.4	17.9
Cormorant Lake	GN-14	14	377771	6008309	19-Aug-10	22.50	6.1	13.4	17.9
Cormorant Lake	GN-15	14	369147	6010262	20-Aug-10	24.73	15.2	4.3	18.0
Cormorant Lake	GN-16	14	388234	6011052	22-Aug-10	22.42	6.1	6.1	18.0
Cormorant Lake	GN-21	14	387000	6007531	17-Aug-10	17.92	13.7	13.7	18.0
Cormorant Lake	GN-22	14	384260	6009725	17-Aug-10	17.92	12.2	7.6	18.0
Cormorant Lake	GN-24	14	380063	6010606	18-Aug-10	22.65	13.7	11.6	18.0
Cormorant Lake	GN-26	14	389351	6006697	22-Aug-10	21.50	11.6	15.9	17.9
Cormorant Lake	GN-27	14	376013	6008480	20-Aug-10	23.58	9.8	10.7	18.0
Cormorant Lake	GN-28	14	380713	6012937	22-Aug-10	22.35	14.6	12.2	17.9
Cormorant Lake	GN-31	14	370580	6008950	20-Aug-10	24.00	5.5	4.0	17.9
Cormorant Lake	GN-32	14	376484	6016649	21-Aug-10	21.95	2.4	7.0	18.0
Cormorant Lake	SN-05	14	390153	6012858	21-Aug-10	24.12	5.5	4.0	18.0
Cormorant Lake	SN-09	14	381379	6009354	18-Aug-10	21.75	12.8	12.8	18.0
Cormorant Lake	SN-21	14	387000	6007531	17-Aug-10	17.92	13.7	13.7	18.0
Cormorant Lake	SN-31	14	370580	6008950	20-Aug-10	24.00	5.5	4.0	17.9

Table 5.2.7-2. Fish species list compiled from standard gang index and small mesh index gillnetting conducted in Saskatchewan River Region waterbodies, 2008-2010.

Family	Species	Scientific Name	ID Code	Captured in Study Area		
				2008	2009	2010
Hiodontidae	Goldeye	*Hiodon alosoides*	GOLD			+
Cyprinidae	Lake Chub	*Couesius plumbeus*	LKCH		+	
	Emerald Shiner	*Notropis atherinoides*	EMSH	+	+	+
	Spottail Shiner	*Notropis hudsonius*	SPSH	+	+	+
	Fathead Minnow	*Pimephales promelas*	FTMN		+	
Catostomidae	Longnose Sucker	*Catostomus catostomus*	LNSC	+	+	+
	White Sucker	*Catostomus commersoni*	WHSC	+	+	+
	Shorthead Redhorse	*Moxostoma macrolepidotum*	SHRD		+	+
Esocidae	Northern Pike	*Esox lucius*	NRPK	+	+	+
Salmonidae	Cisco	*Coregonus artedi*	CISC	+	+	+
	Lake Whitefish	*Coregonus clupeaformis*	LKWH	+	+	+
Percopsidae	Troutperch	*Percopsis omiscomaycus*	TRPR	+	+	+
Gadidae	Burbot	*Lota lota*	BURB	+	+	+
Cottidae	Slimy Sculpin	*Cottus cognatus*	SLSC	+	+	+
Percidae	Yellow Perch	*Perca flavescens*	YLPR	+	+	+
	Logperch	*Percina caprodes*	LGPR	+	+	+
	Sauger	*Sander canadensis*	SAUG	+	+	+
	Walleye	*Sander vitreus*	WALL	+	+	+

Table 5.2.7-3. Standard gang index gillnet relative abundance summaries from Saskatchewan River Region waterbodies, 2008-2010 (and overall).

Species	Saskatchewan R		South Moose L		Cedar L-SE						Cormorant L							
	2010		2009		2009		2010		Overall		2008		2009		2010		Overall	
	n	RA (%)	n	RA (%)	n	RA (%)	n	RA (%)	n	RA (%)	n	RA (%)	n	RA (%)	n	RA (%)	n	RA (%)
Goldeye	9	2.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fathead Minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	4	0.97	9	1.65	17	2.05	23	2.26	40	2.16	15	1.16	7	0.73	28	2.64	50	1.51
White Sucker	56	13.59	315	57.59	232	27.99	212	20.80	444	24.03	686	52.97	473	49.17	465	43.87	1624	48.96
Shorthead Redhorse	7	1.70	1	0.18	9	1.09	1	0.10	10	0.54	-	-	-	-	-	-	-	-
Northern Pike	54	13.11	92	16.82	34	4.10	31	3.04	65	3.52	74	5.71	46	4.78	63	5.94	183	5.52
Cisco	10	2.43	65	11.88	36	4.34	395	38.76	431	23.32	81	6.25	63	6.55	82	7.74	226	6.81
Lake Whitefish	-	-	22	4.02	1	0.12	-	-	1	0.05	126	9.73	82	8.52	132	12.45	340	10.25
Troutperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Burbot	-	-	-	-	-	-	1	0.10	1	0.05	2	0.15	2	0.21	1	0.09	5	0.15
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow Perch	5	1.21	11	2.01	125	15.08	78	7.65	203	10.98	52	4.02	40	4.16	48	4.53	140	4.22
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sauger	58	14.08	1	0.18	92	11.10	127	12.46	219	11.85	52	4.02	36	3.74	24	2.26	112	3.38
Walleye	209	50.73	31	5.67	283	34.14	151	14.82	434	23.48	207	15.98	213	22.14	217	20.47	637	19.20
Total	412	100	547	100	829	100	1019	100	1848	100	1295	100	962	100	1060	100	3317	100

n = number of fish caught and % = relative abundance

Table 5.2.7-4. Standard gang index gillnet biomass summaries from Saskatchewan River Region waterbodies, 2008-2010 (and overall).

Species	Saskatchewan R.			South Moose L.			Cedar L-SE								
	2010 (#sites=11)			2009 (#sites=14)			2009 (#sites=15)			2010 (#sites=14)			Overall (#years=2)		
	n	B (g)	%	n	B (g)	%	n	B (g)	%	n	B (g)	%	n	B (g)	%
Goldeye	9	2765	0.78	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fathead Minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	4	3730	1.05	9	6970	1.36	17	18200	3.69	23	19472	4.73	40	37672	3.44
White Sucker	56	77318	21.83	315	308290	60.10	232	221610	44.89	212	135709	32.94	444	357319	32.63
Shorthead Redhorse	7	3675	1.04	1	190	0.04	9	5200	1.05	1	1100	0.27	10	6300	0.58
Northern Pike	54	69338	19.58	92	143026	27.88	34	44628	9.04	31	44520	10.81	65	89148	8.14
Cisco	10	1180	0.33	65	12305	2.40	36	7990	1.62	395	63547	15.43	431	71537	6.53
Lake Whitefish	-	-	-	22	19790	3.86	1	1270	0.26	-	-	-	1	1270	0.12
Troutperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Burbot	-	-	-	-	-	-	-	-	-	1	310	0.08	1	310	0.03
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow Perch	5	1805	0.51	11	1200	0.23	125	15300	3.10	78	11580	2.81	203	26880	2.45
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sauger	58	27049	7.64	1	310	0.06	92	18600	3.77	127	22206	5.39	219	40806	3.73
Walleye	209	167268	47.23	31	20902	4.07	283	160902	32.59	151	113507	27.55	434	463985	42.36
Total	412	354128	100	547	512983	100	829	493700	100	1019	411951	100	1848	1095227	100

n = number of fish measured (may not equal number of fish caught); B = biomass; and % = proportion of total biomass (%)

Table 5.2.7-4. continued.

Species	Cormorant L.											
	2008 (#sites=20)			2009 (#sites=18)			2010 (#sites=17)			Overall (#years=3)		
	n	B (g)	%	n	B (g)	%	n	B (g)	%	n	B (g)	%
Goldeye	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	-	-	-
Fathead Minnow	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	15	10424	1.03	7	4470	0.61	28	29240	3.78	50	44134	1.75
White Sucker	686	560085	55.11	473	365955	49.85	465	333359	43.14	1624	1259399	49.92
Shorthead Redhorse	-	-	-	-	-	-	-	-	-	-	-	-
Northern Pike	74	124500	12.25	46	83355	11.35	63	108660	14.06	183	316515	12.54
Cisco	81	16725	1.65	63	8440	1.15	82	16015	2.07	226	41180	1.63
Lake Whitefish	126	64010	6.30	82	57800	7.87	132	92195	11.93	340	214005	8.48
Troutperch	-	-	-	-	-	-	-	-	-	-	-	-
Burbot	2	2855	0.28	2	3050	0.42	1	2195	0.28	5	8100	0.32
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	-	-
Yellow Perch	52	5175	0.51	40	3960	0.54	48	2725	0.35	140	11860	0.47
Logperch	-	-	-	-	-	-	-	-	-	-	-	-
Sauger	52	7605	0.75	36	4945	0.67	24	3130	0.41	112	15680	0.62
Walleye	207	224931	22.13	213	202125	27.53	217	185130	23.96	637	612186	24.26
Total	1295	1016310	100	962	734100	100	1060	772649	100	3317	2523059	100

n = number of fish measured (may not equal number of fish caught); B = biomass; and % = proportion of total biomass (%)

Table 5.2.7-5. Small mesh index gillnet relative abundance summaries from Saskatchewan River Region waterbodies, 2008-2010 (and overall).

Species	Saskatchewan R		South Moose L		Cedar L-SE						Cormorant L							
	2010		2009		2009		2010		Overall		2008		2009		2010		Overall	
	n	RA (%)	n	RA (%)	n	RA (%)	n	RA (%)	n	RA (%)	n	RA (%)	n	RA (%)	n	RA (%)	n	RA (%)
Goldeye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-	2	0.35	-	-	2	0.13
Emerald Shiner	1	3.03	51	2.73	-	-	-	-	-	-	151	27.71	109	19.26	-	-	260	16.48
Spottail Shiner	3	9.09	239	12.81	266	31.74	91	25.14	357	29.75	124	22.75	15	2.65	174	37.26	313	19.84
Fathead Minnow	-	-	6	0.32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	-	-	-	-	-	-	1	0.28	1	0.08	-	-	-	-	-	-	-	-
White Sucker	-	-	5	0.27	4	0.48	3	0.83	7	0.58	8	1.47	11	1.94	1	0.21	20	1.27
Shorthead Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern Pike	1	3.03	8	0.43	-	-	-	-	-	-	4	0.73	1	0.18	4	0.86	9	0.57
Cisco	-	-	-	-	4	0.48	97	26.80	101	8.42	6	1.10	14	2.47	1	0.21	21	1.33
Lake Whitefish	-	-	-	-	-	-	-	-	-	-	14	2.57	3	0.53	12	2.57	29	1.84
Troutperch	-	-	3	0.16	36	4.30	15	4.14	51	4.25	6	1.10	12	2.12	3	0.64	21	1.33
Burbot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	1	0.18	1	0.18	1	0.21	3	0.19
Yellow Perch	1	3.03	1554	83.28	437	52.15	42	11.60	479	39.92	168	30.83	303	53.53	177	37.90	648	41.06
Logperch	23	69.70	-	-	46	5.49	-	-	46	3.83	13	2.39	20	3.53	16	3.43	49	3.11
Sauger	3	9.09	-	-	33	3.94	75	20.72	108	9.00	30	5.50	68	12.01	57	12.21	155	9.82
Walleye	1	3.03	-	-	12	1.43	38	10.50	50	4.17	20	3.67	7	1.24	21	4.50	48	3.04
Total	33	100	1866	100	838	100	362	100	1200	100	545	100	566	100	467	100	1578	100

n = number of fish caught and % = relative abundance

Table 5.2.7-6. Small mesh index gillnet biomass summaries from Saskatchewan River Region waterbodies, 2008-2010 (and overall).

Species	Saskatchewan R. 2010 (#sites=2)			South Moose L. 2009 (#sites=4)			Cedar L-SE 2009 (#sites=6)			Cedar L-SE 2010 (#sites=3)			Cedar L-SE Overall (#years=2)		
	n	B (g)	%	n	B (g)	%	n	B (g)	%	n	B (g)	%	n	B (g)	%
Goldeye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	51	250	0.96	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	239	1200	4.61	266	1280	8.19	91	504	4.00	357	1784	6.32
Fathead Minnow	-	-	-	6	10	0.04	-	-	-	-	-	-	-	-	-
Longnose Sucker	-	-	-	-	-	-	-	-	-	1	64	0.51	1	64	0.23
White Sucker	-	-	-	5	100	0.38	4	110	0.70	3	173	1.37	7	283	1.00
Shorthead Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern Pike	1	160	13.28	8	9935	38.19	-	-	-	-	-	-	-	-	-
Cisco	-	-	-	-	-	-	4	530	3.39	97	2755	21.85	101	3285	11.63
Lake Whitefish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Troutperch	-	-	-	3	10	0.04	36	160	1.02	15	68	0.54	51	228	0.81
Burbot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow Perch	-	-	-	1554	14510	55.78	437	5080	32.50	42	1245	9.88	479	6325	22.40
Logperch	-	-	-	-	-	-	46	280	1.79	-	-	-	46	280	0.99
Sauger	3	1045	86.72	-	-	-	33	4980	31.86	75	4920	39.03	108	9900	35.06
Walleye	-	-	-	-	-	-	12	3210	20.54	38	2878	22.83	50	6088	21.56
Total	4	1205	100	1866	26015	100	838	15630	100	362	12607	100	1200	28237	100

n = number of fish measured (may not equal number of fish caught); B = biomass; and % = proportion of total biomass (%)

Table 5.2.7-6. continued.

Species	Cormorant L.											
	2008 (#sites=5)			2009 (#sites =6)			2010 (#sites =4)			Overall (#years=3)		
	n	B (g)	%	n	B (g)	%	n	B (g)	%	n	B (g)	%
Goldeye	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	2	40	0.32	-	-	-	2	40	0.07
Emerald Shiner	151	752	3.42	109	500	4.03	-	-	-	260	1252	2.31
Spottail Shiner	124	605	2.75	15	160	1.29	174	860	4.34	313	1625	3.00
Fathead Minnow	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	-	-	-	-	-	-	-	-	-	-	-	-
White Sucker	8	55	0.25	11	300	2.42	1	30	0.15	20	385	0.71
Shorthead Redhorse	-	-	-	-	-	-	-	-	-	-	-	-
Northern Pike	4	5275	23.97	1	1600	12.91	4	4120	20.79	9	10995	20.28
Cisco	6	320	1.45	14	660	5.32	1	570	2.88	21	1550	2.86
Lake Whitefish	14	5545	25.20	3	330	2.66	12	3308	16.69	29	9183	16.94
Troutperch	6	37	0.17	12	120	0.97	3	32	0.16	21	189	0.35
Burbot	-	-	-	-	-	-	-	-	-	-	-	-
Slimy Sculpin	1	2	0.01	1	5	0.04	-	-	-	3	7	0.01
Yellow Perch	168	2640	12.00	303	4495	36.26	177	2535	12.79	648	9670	17.84
Logperch	13	80	0.36	20	135	1.09	16	75	0.38	49	290	0.53
Sauger	30	3255	14.79	68	3860	31.14	57	4525	22.84	155	11640	21.47
Walleye	20	3440	15.63	7	190	1.53	21	3760	18.98	48	7390	13.63
Total	545	22006	100	566	12395	100	466	19815	100	1578	54216	100

n = number of fish measured (may not equal number of fish caught); B = biomass; and % = proportion of total biomass (%)

Table 5.2.7-7. Mean catch-per-unit-effort (CPUE) calculated for fish species captured in standard gang index gill nets (fish/100 m/24 h) set in Saskatchewan River Region waterbodies, 2008-2010 (and overall).

Species	Saskatchewan River			South Moose Lake			Cedar Lake-SE									Cormorant Lake											
	2010 (#sites=11)			2009 (#sites=14)			2009 (#sites=15)			2010 (#sites=14)			Overall (#years=2)			2008 (#sites=20)			2009 (#sites=18)			2010 (#sites=17)			Overall (#years=3)		
	n	CPUE	SD	n	CPUE	SD	n	CPUE	SD	n	CPUE	SD	n	CPUE	SE	n	CPUE	SD	n	CPUE	SD	n	CPUE	SD	n	CPUE	SE
Goldeye	9	0.8	0.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fathead Minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	4	0.3	0.07	9	0.7	0.18	17	1.1	0.11	23	1.4	0.13	40	1.3	0.16	15	0.7	0.06	7	0.5	0.06	28	1.9	0.29	50	1.0	0.43
White Sucker	56	5.4	0.34	315	22.1	1.30	232	15.5	0.61	212	13.1	0.91	444	14.3	1.18	686	32.5	0.80	473	31.8	0.57	465	26.5	0.49	1624	30.3	1.88
Shorthead Redhorse	7	0.6	0.11	1	0.1	0.02	9	0.6	0.09	1	0.1	0.02	10	0.3	0.26	-	-	-	-	-	-	-	-	-	-	-	-
Northern Pike	54	5.1	0.54	92	6.5	0.25	34	2.3	0.09	31	2.0	0.21	65	2.1	0.17	74	3.5	0.13	46	3.2	0.11	63	3.7	0.12	183	3.5	0.15
Cisco	10	1.0	0.23	65	4.5	0.46	36	2.4	0.21	395	24.3	2.12	431	13.3	10.97	81	3.8	0.20	63	4.2	0.39	82	5.1	0.37	226	4.4	0.40
Lake Whitefish	-	-	-	22	1.6	0.163	1	0.1	0.02	-	-	-	1	0.0	0.03	126	6.1	0.20	82	5.6	0.33	132	7.7	0.43	340	6.5	0.62
Troutperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Burbot	-	-	-	-	-	-	-	-	-	1	0.1	0.02	1	0.0	0.03	2	0.1	0.02	2	0.1	0.02	1	0.1	0.02	5	0.1	0.02
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow Perch	5	0.6	0.08	11	0.8	0.06	125	8.5	0.85	78	4.8	0.40	203	6.6	1.84	52	2.5	0.14	40	2.7	0.17	48	2.7	0.37	140	2.6	0.06
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sauger	58	6.0	0.57	1	0.1	0.02	92	6.1	0.38	127	7.8	0.52	219	6.9	0.87	52	2.6	0.16	36	2.4	0.21	24	1.4	0.10	112	2.1	0.35
Walleye	209	18.0	1.86	31	2.3	0.22	283	18.9	0.47	151	9.3	0.71	434	14.1	4.80	207	9.9	0.37	213	14.5	0.50	217	12.8	0.73	637	12.4	1.37
Total	412	37.8	2.23	547	38.4	1.64	829	55.2	1.16	1019	62.8	2.91	1848	59.0	3.76	1295	61.7	0.95	962	65.1	1.10	1060	61.9	1.60	3317	62.9	1.09

#sites = number of sites sampled; #years = number of years sampled; n = number of fish caught

CPUE = mean catch per unit effort per site (2008, 2009 and 2010) and per year (overall)

SD = standard deviation; SE = standard error

Table 5.2.7-8. Mean biomass-per-unit-effort (BPUE) calculated for fish species captured in standard gang index gill nets (g/100 m/24 h) set in Saskatchewan River Region waterbodies, 2008-2010 (and overall).

Species	Saskatchewan River			South Moose Lake			Cedar Lake-SE								
	2010 (#sites=11)			2009 (#sites=14)			2009 (#sites=15)			2010 (#sites=14)			Overall (#years=2)		
	n	BPUE	SD	n	BPUE	SD	n	BPUE	SD	n	BPUE	SD	n	BPUE	SE
Goldeye	9	249	55	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fathead Minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	4	305	68	9	510	136	17	1177	129	23	1207	148	40	1192	15
White Sucker	56	7340	451	315	21670	1442	232	14732	581	212	8440	562	444	11586	3146
Shorthead Redhorse	7	352	49	1	14	4	9	333	60	1	68	18	10	200	132
Northern Pike	54	6635	770	92	9908	615	34	2978	112	31	2803	263	65	2890	88
Cisco	10	116	27	65	846	79	36	527	56	395	3912	382	431	2220	1693
Lake Whitefish	-	-	-	22	1402	139	1	81	21	-	-	-	1	40	40
Troutperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Burbot	-	-	-	-	-	-	-	-	-	1	19	5	1	10	10
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow Perch	5	216	41	11	83	8	125	1029	87	78	710	73	203	869	159
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sauger	58	2733	265	1	23	6	92	1230	76	127	1364	95	219	1297	67
Walleye	209	14332	1586	31	1510	125	283	10745	315	151	6947	640	434	8846	1899
Total	412	32278	1977	547	35965	1791	829	32831	609	1019	25470	1062	1848	29150	3681

#sites = number of sites sampled; #years = number of years sampled; n = number of fish caught
BPUE = mean biomass per unit effort per site (2008, 2009 and 2010) and per year (overall)
SD = standard deviation; SE = standard error

Table 5.2.7-8. continued.

Species	Cormorant Lake											
	2008 (#sites=20)			2009 (#sites=18)			2010 (#sites=17)			Overall (#years=3)		
	n	BPUE	SD	n	BPUE	SD	n	BPUE	SD	n	BPUE	SE
Goldeye	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	-	-	-	-	-	-	-	-	-
Fathead Minnow	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	15	519	53	7	304	39	28	1952	315	50	925	517
White Sucker	686	26530	634	473	24650	389	465	18819	393	1624	23333	2321
Shorthead Redhorse	-	-	-	-	-	-	-	-	-	-	-	-
Northern Pike	74	5993	233	46	5758	255	63	6336	204	183	6029	168
Cisco	81	809	52	63	573	48	82	955	57	226	779	111
Lake Whitefish	126	3117	109	82	4017	276	132	5413	350	340	4182	668
Troutperch	-	-	-	-	-	-	-	-	-	-	-	-
Burbot	2	145	32	2	202	33	1	151	37	5	166	18
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	-	-
Yellow Perch	52	253	14	40	265	18	48	155	15	140	224	35
Logperch	-	-	-	-	-	-	-	-	-	-	-	-
Sauger	52	376	24	36	331	31	24	185	11	112	297	58
Walleye	207	10815	461	213	13784	485	217	10922	636	637	11840	972
Total	1295	48556	779	962	49883	785	1060	44888	1175	3317	47776	1494

#sites = number of sites sampled; #years = number of years sampled; n = number of fish caught
BPUE = mean biomass per unit effort per site (2008, 2009 and 2010) and per year (overall)
SD = standard deviation; SE = standard error

Table 5.2.7-9. Mean catch-per-unit-effort (CPUE) calculated for fish species captured in small mesh index gill nets (fish/30 m/24 h) set in Saskatchewan River Region waterbodies, 2008-2010 (and overall).

Species	Saskatchewan River			South Moose Lake			Cedar Lake-SE									Cormorant Lake											
	2010 (#sites=2)			2009 (#sites=4)			2009 (#sites=6)			2010 (#sites=3)			Overall (#years=2)			2008 (#sites=5)			2009 (#sites=6)			2010 (#sites=4)			Overall (#years=3)		
	n	CPUE	SD	n	CPUE	SD	n	CPUE	SD	n	CPUE	SD	n	CPUE	SE	n	CPUE	SD	n	CPUE	SD	n	CPUE	SD	n	CPUE	SE
Goldeye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.5	0.19	-	-	-	2	0.2	0.16
Emerald Shiner	1	0.8	0.57	51	14.7	6.63	-	-	-	-	-	-	-	-	-	151	43.2	18.85	109	24.2	6.96	-	-	-	260	22.5	12.49
Spottail Shiner	3	2.4	1.69	239	69.0	16.96	266	49.2	9.57	91	29.3	5.68	357	39.3	9.98	124	70.2	15.53	15	3.5	0.66	174	48.7	7.47	313	40.8	19.66
Fathead Minnow	-	-	-	6	1.8	0.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	-	-	-	-	-	-	-	-	-	1	0.3	0.19	1	0.2	0.17	-	-	-	-	-	-	-	-	-	-	-	-
White Sucker	-	-	-	5	1.5	0.73	4	0.8	0.23	3	0.9	0.54	7	0.8	0.09	8	4.2	1.19	11	2.4	0.71	1	0.3	0.14	20	2.3	1.14
Shorthead Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern Pike	1	0.8	0.57	8	2.3	0.24	-	-	-	-	-	-	-	-	-	4	1.6	0.34	1	0.3	0.10	4	1.0	0.21	9	0.9	0.38
Cisco	-	-	-	-	-	-	4	0.7	0.15	97	31.3	10.71	101	16.0	15.30	6	3.7	1.39	14	3.2	1.32	1	0.3	0.13	21	2.4	1.08
Lake Whitefish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	5.1	0.72	3	0.7	0.19	12	3.2	0.71	29	3.0	1.27
Troutperch	-	-	-	3	0.9	0.44	36	6.6	1.60	15	4.9	2.06	51	5.7	0.86	6	3.7	1.39	12	2.8	0.80	3	0.8	0.24	21	2.4	0.87
Burbot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2	0.11	1	0.3	0.10	1	0.3	0.13	3	0.2	0.00
Yellow Perch	1	0.8	0.57	1554	445.3	82.58	437	80.7	14.93	42	13.2	4.23	479	47.0	33.78	168	104.8	26.07	303	70.1	6.78	177	48.1	3.86	648	74.3	16.49
Logperch	23	18.3	12.94	-	-	-	46	8.4	3.43	-	-	-	46	4.2	4.20	13	12.5	5.58	20	4.7	1.92	16	4.0	1.23	49	7.1	2.72
Sauger	3	2.4	1.69	-	-	-	33	6.2	1.56	75	24.3	4.18	108	15.2	9.06	30	19.9	4.41	68	15.4	3.18	57	18.0	6.16	155	17.7	1.31
Walleye	1	0.8	0.57	-	-	-	12	2.3	0.92	38	12.4	6.03	50	7.3	5.05	20	8.1	1.46	7	1.6	0.53	21	5.8	1.25	48	5.2	1.92
Total	33	26.3	18.57	1866	535.3	91.24	838	154.8	21.79	362	116.5	21.89	1200	135.7	19.15	545	277.1	39.13	566	129.6	10.63	467	130.3	7.52	1578	179.0	49.04

#sites = number of sites sampled; #years = number of years sampled; n = number of fish caught

CPUE = mean catch per unit effort per site (2008, 2009 and 2010) and per year (overall)

SD = standard deviation; SE = standard error

Table 5.2.7-10. Mean biomass-per-unit-effort (BPUE) calculated for fish species captured in small mesh index gill nets (g/30 m/24 h) set in Saskatchewan River Region waterbodies, 2008-2010 (and overall).

Species	Saskatchewan R.			South Moose L.			Cedar L-SE								
	2010 (#sites=2)			2009 (#sites=4)			2009 (#sites=6)			2010 (#sites=3)			Overall (#years=2)		
	n	BPUE	SD	n	BPUE	SD	n	BPUE	SD	n	BPUE	SD	n	BPUE	SE
Goldeye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald Shiner	-	-	-	51	72	32	-	-	-	-	-	-	-	-	-
Spottail Shiner	-	-	-	239	346	83	266	237	48	91	162	32	357	200	38
Fathead Minnow	-	-	-	6	3	1	-	-	-	-	-	-	-	-	-
Longnose Sucker	-	-	-	-	-	-	-	-	-	1	21	12	1	10	10
White Sucker	-	-	-	5	29	14	4	20	5	3	53	31	7	37	17
Shorthead Redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern Pike	1	127	90	8	2820	228	-	-	-	-	-	-	-	-	-
Cisco	-	-	-	-	-	-	4	100	39	97	898	231	101	499	399
Lake Whitefish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Troutperch	-	-	-	3	3	1	36	29	7	15	22	8	51	26	4
Burbot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slimy Sculpin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow Perch	-	-	-	1554	4156	814	437	939	174	42	396	78	479	667	271
Logperch	-	-	-	-	-	-	46	51	21	-	-	-	46	26	26
Sauger	3	832	588	-	-	-	33	933	264	75	1592	239	108	1263	329
Walleye	-	-	-	-	-	-	12	605	247	38	938	318	50	772	167
Total	4	959	678	1866	7430	829	838	2915	491	362	4082	707	1200	3498	584

#sites = number of sites sampled; #years = number of years sampled; n = number of fish caught
BPUE = mean biomass per unit effort per site (2008, 2009 and 2010) and per year (overall)
SD = standard deviation; SE = standard error

Table 5.2.7-10. continued.

Species	Cormorant L. 2008 (#sites=5) n	BPUE	SD	2009 (#sites=6) n	BPUE	SD	2010 (#sites=4) n	BPUE	SD	Overall (#sites=3) n	BPUE	SE
Goldeye	-	-	-	-	-	-	-	-	-	-	-	-
Lake Chub	-	-	-	2	9	4	-	-	-	2	3	3
Emerald Shiner	151	213	95	109	111	30	-	-	-	260	108	62
Spottail Shiner	124	349	76	15	38	8	174	241	38	313	210	91
Fathead Minnow	-	-	-	-	-	-	-	-	-	-	-	-
Longnose Sucker	-	-	-	-	-	-	-	-	-	-	-	-
White Sucker	8	36	12	11	66	17	1	8	4	20	37	17
Shorthead Redhorse	-	-	-	-	-	-	-	-	-	-	-	-
Northern Pike	4	1977	455	1	400	163	4	1063	206	9	1147	457
Cisco	6	172	59	14	152	62	1	142	71	21	155	9
Lake Whitefish	14	2370	466	3	85	28	12	863	212	29	1106	671
Troutperch	6	29	12	12	28	7	3	8	3	21	21	7
Burbot	-	-	-	-	-	-	-	-	-	-	-	-
Slimy Sculpin	1	1	0	1	1	1	-	-	-	2	1	0
Yellow Perch	168	1900	668	303	1031	118	177	718	87	648	1216	353
Logperch	13	77	34	20	32	13	16	19	5	49	42	18
Sauger	30	2069	451	68	868	184	57	1410	447	155	1449	347
Walleye	20	2181	767	7	45	11	21	1064	163	48	1097	617
Total	545	11373	1706	566	2866	282	466	5536	504	1577	6592	2512

#sites = number of sites sampled; #years = number of years sampled; n = number of fish caught
BPUE = mean biomass per unit effort per site (2008, 2009 and 2010) and per year (overall)
SD = standard deviation; SE = standard error

Table 5.2.7-11. Summary of mean fork length (mm), weight (g), and condition factor (K) calculated for Northern Pike captured in standard gang and small mesh index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

Mesh (in)	Saskatchewan River			South Moose Lake			Cedar Lake-SE					
	2010			2009			2009			2010		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
Fork Length(mm)												
2	18	487	118	34	555	108	10	471	105	6	463	149
3	22	531	49	34	562	66	14	551	37	17	545	69
3.75	7	623	76	15	637	79	5	504	31	3	581	39
4.25	2	645	78	5	678	140	3	621	31	3	648	63
5	2	628	322	2	740	226	2	725	47	2	647	139
Total	51	536	107	90	582	102	34	537	90	31	549	102
Weight (g)												
SM	1	160	-	8	1242	-	0	-	-	0	-	-
2	18	899	750	34	1377	1232	10	942	499	6	983	645
3	22	1037	324	35	1284	561	14	1308	254	17	1351	595
3.75	7	1986	731	15	1937	675	5	1030	226	3	1400	150
4.25	2	1923	569	5	2592	1877	3	1900	226	3	2220	688
5	5	2522	1961	3	3085	2203	2	3020	368	2	2395	1633
Total	55	1264	941	100	1530	1097	34	1313	607	31	1436	740
Condition Factor (K)												
2	18	0.66	0.07	34	0.71	0.05	10	0.83	0.23	6	0.82	0.06
3	22	0.68	0.08	34	0.70	0.05	14	0.77	0.07	17	0.79	0.08
3.75	7	0.79	0.05	15	0.73	0.05	5	0.79	0.07	3	0.72	0.07
4.25	2	0.71	0.04	5	0.75	0.04	3	0.80	0.04	3	0.80	0.02
5	2	0.78	0.07	2	0.82	0.07	2	0.79	0.06	2	0.81	0.08
Total	51	0.69	0.08	90	0.71	0.05	34	0.80	0.13	31	0.79	0.07

n = number of fish caught; SD = standard deviation (could not be calculated for species and/or mesh sizes where only bulk weights were recorded; SE = standard error

Table 5.2.7-11. continued.

Mesh (in)	Cormorant Lake								
	2008			2009			2010		
	n	Mean	SD	n	Mean	SD	n	Mean	SD
Fork Length (mm)									
2	7	641	71	7	591	68	16	623	90
3	6	570	51	19	600	114	28	563	65
3.75	5	626	34	9	612	60	9	622	58
4.25	2	653	53	8	623	17	8	671	66
5	1	720	-	1	810	-	2	671	22
Total	21	622	64	44	610	89	63	604	80
Weight (g)									
SM	4	1319	-	1	1600	-	4	1030	261
2	24	1317	-	9	1759	900	16	1938	946
3	20	1420	-	19	1780	1076	28	1330	634
3.75	16	1875	-	9	1680	492	9	1794	529
4.25	10	2359	-	8	1760	109	8	2427	664
5	4	2733	-	1	4500	-	2	2425	205
Total	78	1663	-	47	1808	895	67	1683	795
Condition Factor (K)									
2	7	0.72	0.09	7	0.77	0.07	16	0.74	0.07
3	6	0.74	0.07	19	0.75	0.09	28	0.71	0.08
3.75	5	0.69	0.06	9	0.71	0.05	9	0.73	0.07
4.25	2	0.73	0.04	8	0.73	0.07	8	0.79	0.04
5	1	0.76	-	1	0.85	-	2	0.81	0.01
Total	21	0.72	0.07	44	0.75	0.08	63	0.73	0.08

n = number of fish caught; SD = standard deviation (could not be calculated for species and/or mesh sizes where only bulk weights were recorded; SE = standard error

Table 5.2.7-12. Summary of mean fork length (mm), weight (g), and condition factor (K) calculated for Walleye captured in standard gang and small mesh index gill nets set in the Saskatchewan River Region waterbodies, 2008-2010.

Mesh (in)	Saskatchewan River			South Moose Lake			Cedar Lake-SE					
	2010			2009			2009			2010		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
Fork Length (mm)												
2	22	363	74	3	402	10	88	268	60	29	328	67
3	72	394	36	16	322	91	103	365	34	57	372	45
3.75	63	414	24	9	421	40	64	387	30	38	404	37
4.25	34	432	23	3	431	83	27	409	40	22	431	37
5	6	484	53	0	-	-	1	557	-	5	462	118
Total	197	406	45	31	369	87	283	345	4	151	383	62
Weight (g)												
SM	0	-	-	0	-	-	1	3210	-	38	76	234
2	24	579	359	3	749	27	88	267	212	29	469	296
3	79	719	205	16	468	303	103	609	165	57	655	287
3.75	66	834	157	9	886	244	64	748	185	38	837	233
4.25	34	978	142	3	1070	582	27	912	286	22	1055	266
5	6	1384	479	0	-	-	1	2200	-	5	1514	1064
Total	209	800	264	31	771	473	284	578	347	189	616	456
Condition Factor (K)												
2	22	1.12	0.10	3	1.15	0.09	88	1.16	0.22	29	1.14	0.14
3	72	1.14	0.12	16	1.10	0.14	103	1.23	0.13	57	1.20	0.15
3.75	63	1.17	0.07	9	1.17	0.14	64	1.26	0.09	38	1.25	0.13
4.25	34	1.21	0.09	3	1.24	0.12	27	1.30	0.09	22	1.30	0.12
5	6	1.19	0.09	0	-	-	1	1.27	-	5	1.42	0.21
Total	197	1.16	0.10	31	1.14	0.14	283	1.22	0.16	151	1.22	0.15

n = number of fish caught; SD = standard deviation (could not be calculated for species and/or mesh sizes where only bulk weights were recorded; SE = standard error

Table 5.2.7-12. continued.

Mesh (in)	Cormorant Lake								
	2008			2009			2010		
	n	Mean	SD	n	Mean	SD	n	Mean	SD
Fork Length (mm)									
2	57	354	100	59	310	98	87	332	68
3	43	448	61	46	394	97	57	407	51
3.75	38	457	40	45	461	72	30	467	51
4.25	39	502	40	45	491	70	34	511	70
5	30	532	63	18	508	66	9	524	103
Total	207	446	93	213	415	112	217	406	95
Weight (g)									
SM	20	172	-	7	27	11	21	179	30
2	57	571	66	59	403	49	87	425	43
3	43	1023	65	46	777	77	57	741	42
3.75	38	1054	49	45	1128	67	30	1144	79
4.25	39	1418	59	45	1414	86	34	1620	119
5	30	1768	105	18	1570	157	9	1831	278
Total	227	1006	-	220	920	657	238	794	660
Condition Factor (K)									
2	57	1.00	0.12	59	1.02	0.19	87	0.98	0.08
3	43	1.07	0.09	46	1.06	0.11	57	1.05	0.07
3.75	38	1.08	0.07	45	1.09	0.10	30	1.08	0.09
4.25	39	1.11	0.14	45	1.13	0.09	34	1.14	0.10
5	30	1.15	0.13	18	1.16	0.12	9	1.15	0.08
Total	207	1.07	0.12	213	1.08	0.14	217	1.04	0.10

n = number of fish caught; SD = standard deviation (could not be calculated for species and/or mesh sizes where only bulk weights were recorded; SE = standard error

Table 5.2.7-13. Year-class frequency distributions (%) for Northern Pike captured in standard gang index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

Year-Class	Saskatchewan R		South Moose L		Cedar L-SE				Cormorant L					
	2010		2009		2009		2010		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
2009	1	1.85	-	-	-	-	-	-	-	-	-	-	-	-
2008	5	9.26	2	2.22	-	-	2	6.45	-	-	-	-	1	1.61
2007	7	12.96	1	1.11	1	2.94	-	-	-	-	-	-	3	4.84
2006	10	18.52	6	6.67	5	14.71	8	25.81	-	-	2	4.35	10	16.13
2005	18	33.33	38	42.22	6	17.65	10	32.26	3	14.29	5	10.87	12	19.35
2004	6	11.11	17	18.89	14	41.18	4	12.90	3	14.29	12	26.09	13	20.97
2003	4	7.41	10	11.11	6	17.65	4	12.90	4	19.05	11	23.91	9	14.52
2002	2	3.70	9	10.00	1	2.94	2	6.45	3	14.29	4	8.70	3	4.84
2001	1	1.85	3	3.33	-	-	1	3.23	2	9.52	1	2.17	2	3.23
2000	-	-	2	2.22	1	2.94	-	-	-	-	1	2.17	1	1.61
1999	-	-	2	2.22	-	-	-	-	2	9.52	2	4.35	3	4.84
1998	-	-	-	-	-	-	-	-	2	9.52	1	-	5	8.06
1997	-	-	-	-	-	-	-	-	-	-	4	8.70	-	-
1996	-	-	-	-	-	-	-	-	-	-	2	4.35	-	-
1995	-	-	-	-	-	-	-	-	2	9.52	1	2.17	-	-
Total	54	100	90	100	34	100	31	100	21	100	46	100	62	100

n = number of fish aged; % = relative abundance

Table 5.2.7-14. Year-class frequency distributions (%) for Walleye captured in standard gang index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

Year-Class	Saskatchewan R		South Moose L		Cedar L-SE				Cormorant L					
	2010		2009		2009		2010		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2008	4	1.91	1	3.45	2	0.71	3	2.03	-	-	1	0.48	5	2.36
2007	1	0.48	4	13.79	4	1.43	2	1.35	-	-	14	6.73	43	20.28
2006	15	7.18	8	27.59	34	12.14	9	6.08	9	4.37	12	5.77	15	7.08
2005	41	19.62	6	20.69	31	11.07	26	17.57	17	8.25	35	16.83	65	30.66
2004	11	5.26	-	-	8	2.86	4	2.70	2	0.97	3	1.44	6	2.83
2003	73	34.93	5	17.24	112	40.00	45	30.41	9	4.37	14	6.73	15	7.08
2002	27	12.92	2	6.90	38	13.57	28	18.92	9	4.37	7	3.37	7	3.30
2001	17	8.13	3	10.34	47	16.79	21	14.19	54	26.21	59	28.37	13	6.13
2000	4	1.91	-	-	-	-	6	4.05	16	7.77	11	5.29	8	3.77
1999	-	-	-	-	-	-	-	-	22	10.68	11	5.29	4	1.89
1998	3	1.44	-	-	2	0.71	2	1.35	5	2.43	2	0.96	-	-
1997	7	3.35	-	-	-	-	-	-	14	6.80	9	4.33	5	2.36
1996	-	-	-	-	2	0.71	2	1.35	38	18.45	27	12.98	24	11.32
1995	3	1.44	-	-	-	-	-	-	4	1.94	-	-	-	-
1994	2	0.96	-	-	-	-	-	-	5	2.43	2	0.96	2	0.94
1993	1	0.48	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	1	0.48	-	-
1987	-	-	-	-	-	-	-	-	1	0.49	-	-	-	-
1983	-	-	-	-	-	-	-	-	1	0.49	-	-	-	-
Total	209	100	29	100	280	100	148	100	206	100	208	100	212	100

n = number of fish aged; % = relative abundance

Table 5.2.7-15. Age frequency distributions (%) for Northern Pike captured in standard gang index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

Age	Saskatchewan R		South Moose L		Cedar L-SE				Cormorant L					
	2010		2009		2009		2010		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
1	1	1.85	2	2.22	-	-	-	-	-	-	-	-	-	-
2	5	9.26	1	1.11	1	2.94	2	6.45	-	-	-	-	1	1.61
3	7	12.96	6	6.67	5	14.71	-	-	3	14.29	2	4.35	3	4.84
4	10	18.52	38	42.22	6	17.65	8	25.81	3	14.29	5	10.87	10	16.13
5	18	33.33	17	18.89	14	41.18	10	32.26	4	19.05	12	26.09	12	19.35
6	6	11.11	10	11.11	6	17.65	4	12.90	3	14.29	11	23.91	13	20.97
7	4	7.41	9	10.00	1	2.94	4	12.90	2	9.52	4	8.70	9	14.52
8	2	3.70	3	3.33	-	-	2	6.45	-	-	1	2.17	3	4.84
9	1	1.85	2	2.22	1	2.94	1	3.23	2	9.52	1	2.17	2	3.23
10	-	-	2	2.22	-	-	-	-	2	9.52	2	4.35	1	1.61
11	-	-	-	-	-	-	-	-	-	-	1	-	3	4.84
12	-	-	-	-	-	-	-	-	-	-	4	8.70	5	8.06
13	-	-	-	-	-	-	-	-	2	9.52	2	4.35	-	-
14	-	-	-	-	-	-	-	-	-	-	1	2.17	-	-
Total	54	100	90	100	34	100	31	100	21	100	46	100	62	100

n = number of fish aged; % = relative abundance

Table 5.2.7-16. Age frequency distributions (%) for Walleye captured in standard gang index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

Age	Saskatchewan R		South Moose L		Cedar L-SE				Cormorant L					
	2010		2009		2009		2010		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
1	-	-	1	3.45	2	0.71	-	-	-	-	1	0.48	-	-
2	4	1.91	4	13.79	4	1.43	3	2.03	9	4.37	14	6.73	5	2.36
3	1	0.48	8	27.59	34	12.14	2	1.35	17	8.25	12	5.77	43	20.28
4	15	7.18	6	20.69	31	11.07	9	6.08	2	0.97	35	16.83	15	7.08
5	41	19.62	-	-	8	2.86	26	17.57	9	4.37	3	1.44	65	30.66
6	11	5.26	5	17.24	112	40.00	4	2.70	9	4.37	14	6.73	6	2.83
7	73	34.93	2	6.90	38	13.57	45	30.41	54	26.21	7	3.37	15	7.08
8	27	12.92	3	10.34	47	16.79	28	18.92	16	7.77	59	28.37	7	3.30
9	17	8.13	-	-	-	-	21	14.19	22	10.68	11	5.29	13	6.13
10	4	1.91	-	-	-	-	6	4.05	5	2.43	11	5.29	8	3.77
11	-	-	-	-	2	0.71	-	-	14	6.80	2	0.96	4	1.89
12	3	1.44	-	-	-	-	2	1.35	38	18.45	9	4.33	-	-
13	7	3.35	-	-	2	0.71	-	-	4	1.94	27	12.98	5	2.36
14	-	-	-	-	-	-	2	1.35	5	2.43	-	-	24	11.32
15	3	1.44	-	-	-	-	-	-	-	-	2	0.96	-	-
16	2	0.96	-	-	-	-	-	-	-	-	-	-	2	0.94
17	1	0.48	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	1	0.48	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	1	0.49	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	1	0.49	-	-	-	-
Total	209	100	29	100	280	100	148	100	206	100	208	100	212	100

n = number of fish aged; % = relative abundance

Table 5.2.7-17. Mean fork length- (mm), weight- (g) and condition factor- (K)-at-age for Northern Pike captured in standard gang index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

Age	Saskatchewan River										South Moose Lake									
	2010										2009									
	Year-Class	FL (mm)			W (g)			K			Year-Class	FL (mm)			W (g)			K		
		n	mean	SD	n	mean	SD	n	mean	SD		n	mean	SD	n	mean	SD	n	mean	SD
1	2009	2	282	3	2	153	11	2	0.68	0.03	2008	2	398	4	2	430	28	2	0.69	0.02
2	2008	5	392	27	5	401	80	5	0.66	0.05	2007	1	415	-	1	500	-	1	0.70	-
3	2007	7	474	57	7	749	303	7	0.67	0.06	2006	6	501	28	6	897	168	6	0.71	0.03
4	2006	9	526	44	10	1005	312	9	0.68	0.06	2005	38	559	54	38	1288	461	38	0.71	0.06
5	2005	17	534	46	18	1152	421	17	0.70	0.09	2004	17	585	57	17	1448	488	17	0.70	0.04
6	2004	5	608	61	6	1933	1051	5	0.67	0.12	2003	10	601	56	10	1571	356	10	0.72	0.06
7	2003	4	691	119	4	2846	1623	4	0.80	0.07	2002	9	665	156	9	2435	1673	9	0.72	0.05
8	2002	2	685	78	2	2375	1082	2	0.71	0.09	2001	2	622	65	3	1435	517	2	0.68	0.01
9	2001	1	804	-	1	3430	-	1	0.66	-	2000	2	816	291	2	4789	4142	2	0.77	0.07
10	2000	-	-	-	-	-	-	-	-	-	1999	2	615	50	2	1680	28	2	0.74	0.19
11	1999	-	-	-	-	-	-	-	-	-	1998	-	-	-	-	-	-	-	-	-
12	1998	-	-	-	-	-	-	-	-	-	1997	-	-	-	-	-	-	-	-	-
13	1997	-	-	-	-	-	-	-	-	-	1996	-	-	-	-	-	-	-	-	-
14	1996	-	-	-	-	-	-	-	-	-	1995	-	-	-	-	-	-	-	-	-

n = number of fish; SD = standard deviation

Table 5.2.7-17. continued.

Age	Cedar Lake-SE 2009 Year-Class	FL (mm) n	FL (mm) mean	FL (mm) SD	W (g) n	W (g) mean	W (g) SD	K n	K mean	K SD	2010 Year-Class	FL (mm) n	FL (mm) mean	FL (mm) SD	W (g) n	W (g) mean	W (g) SD	K n	K mean	K SD
1	2008	-	-	-	-	-	-	-	-	-	2009	-	-	-	-	-	-	-	-	-
2	2007	1	306	-	1	200	-	1	0.70	-	2008	2	303	151	2	305	347	2	0.80	0.00
3	2006	5	444	65	5	682	265	5	0.75	0.06	2007	-	-	-	-	-	-	-	-	-
4	2005	6	510	37	6	1130	303	6	0.83	0.07	2006	8	495	44	8	951	232	8	0.78	0.08
5	2004	14	565	61	14	1467	342	14	0.82	0.19	2005	10	559	52	10	1380	384	10	0.78	0.06
6	2003	6	562	66	6	1473	640	6	0.80	0.06	2004	4	577	27	4	1604	243	4	0.83	0.07
7	2002	1	633	-	1	1580	-	1	0.62	-	2003	4	606	41	4	1635	337	4	0.73	0.06
8	2001	-	-	-	-	-	-	-	-	-	2002	2	713	46	2	3275	389	2	0.91	0.06
9	2000	1	758	-	1	3280	-	1	0.75	-	2001	1	720	-	1	3000	-	1	0.80	-
10	1999	-	-	-	-	-	-	-	-	-	2000	-	-	-	-	-	-	-	-	-
11	1998	-	-	-	-	-	-	-	-	-	1999	-	-	-	-	-	-	-	-	-
12	1997	-	-	-	-	-	-	-	-	-	1998	-	-	-	-	-	-	-	-	-
13	1996	-	-	-	-	-	-	-	-	-	1997	-	-	-	-	-	-	-	-	-
14	1995	-	-	-	-	-	-	-	-	-	1996	-	-	-	-	-	-	-	-	-

n = number of fish; SD = standard deviation

Table 5.2.7-17. continued.

Cormorant Lake — 2008

Age	Year-Class	FL (mm)			W (g)			K		
		n	Mean	SD	n	Mean	SD	n	Mean	SD
1	2007	-	-	-	-	-	-	-	-	-
2	2006	-	-	-	-	-	-	-	-	-
3	2005	3	564	31.4	3	1308	248.5	3	0.72	0.05
4	2004	3	578	75.2	3	1447	623.5	3	0.72	0.02
5	2003	4	607	54.5	4	1601	331.7	4	0.72	0.11
6	2002	3	632	30.0	3	1958	171.6	3	0.77	0.07
7	2001	2	677	60.8	2	2278	781.4	2	0.72	0.06
8	2000	-	-	-	-	-	-	-	-	-
9	1999	2	653	52.3	2	2065	360.6	2	0.74	0.05
10	1998	2	623	10.6	2	1503	208.6	2	0.63	0.12
11	1997	-	-	-	-	-	-	-	-	-
12	1996	-	-	-	-	-	-	-	-	-
13	1995	2	703	116.7	2	2665	1428.4	2	0.73	0.05
14	1994	-	-	-	-	-	-	-	-	-

Cormorant Lake — 2009

Age	Year-Class	FL (mm)			W (g)			K		
		n	Mean	SD	n	Mean	SD	n	Mean	SD
1	2008	-	-	-	-	-	-	-	-	-
2	2007	-	-	-	-	-	-	-	-	-
3	2006	2	494	36.8	2	855	148.5	2	0.71	0.04
4	2005	4	577	55.7	5	1366	612.7	4	0.78	0.09
5	2004	13	566	56.7	13	1371	363.6	13	0.74	0.06
6	2003	11	603	65.7	11	1687	490.2	11	0.75	0.09
7	2002	4	637	48.3	4	1863	443.7	4	0.72	0.05
8	2001	1	604	-	1	1550	-	1	0.70	-
9	2000	1	688	-	1	2100	-	1	0.64	-
10	1999	2	641	32.5	2	1880	381.8	2	0.71	0.04
11	1998	1	570	-	1	1570	-	1	0.85	-
12	1997	3	650	50.5	4	2713	957.3	3	0.84	0.11
13	1996	2	849	72.1	2	4125	954.6	2	0.67	0.01
14	1995	1	810	-	1	4500	-	1	0.85	-

Cormorant Lake — 2010

Age	Year-Class	FL (mm)			W (g)			K		
		n	Mean	SD	n	Mean	SD	n	Mean	SD
1	2009	-	-	-	-	-	-	-	-	-
2	2008	1	482	-	1	785	-	1	0.70	-
3	2007	3	481	10.0	3	780	54.1	3	0.70	0.02
4	2006	11	533	27.4	11	1047	207.4	11	0.69	0.08
5	2005	12	577	35.4	12	1388	307.6	12	0.71	0.04
6	2004	13	657	77.6	13	2310	858.2	13	0.78	0.06
7	2003	11	592	58.7	11	1597	550.2	11	0.74	0.08
8	2002	3	556	22.8	3	1405	70.0	3	0.82	0.07
9	2001	2	565	77.8	2	1293	788.4	2	0.67	0.16
10	2000	1	710	-	1	2675	-	1	0.75	-
11	1999	3	693	16.6	3	2517	159.5	3	0.76	0.01
12	1998	5	705	86.3	5	2636	1130.4	5	0.72	0.10
13	1997	-	-	-	-	-	-	-	-	-
14	1996	-	-	-	-	-	-	-	-	-

n = number of fish; SD = standard deviation

Table 5.2.7-18. Mean fork length- (mm), weight- (g) and condition factor- (K)-at-age for Walleye captured in standard gang index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

Age	Saskatchewan River										South Moose Lake									
	2010										2009									
	Year-Class	FL (mm)			W (g)			K			Year-Class	FL (mm)			W (g)			K		
		n	mean	SD	n	mean	SD	n	mean	SD		n	mean	SD	n	mean	SD	n	mean	SD
0	2010	-	-	-	-	-	-	-	-	-	2009	-	-	-	-	-	-	-	-	-
1	2009	-	-	-	-	-	-	-	-	-	2008	1	215	-	1	80	-	1	0.80	-
2	2008	3	236	12	4	146	27	3	1.03	0.03	2007	4	244	109	4	246	355	4	1.02	0.11
3	2007	1	275	-	1	220	-	1	1.06	-	2006	8	357	25	8	537	85	8	1.18	0.10
4	2006	14	344	30	15	447	122	14	1.12	0.10	2005	6	407	18	6	768	121	6	1.13	0.06
5	2005	38	386	22	41	653	118	38	1.13	0.07	2004	-	-	-	-	-	-	-	-	-
6	2004	11	395	38	11	755	229	11	1.19	0.09	2003	5	439	42	5	994	239	5	1.17	0.17
7	2003	66	415	23	73	837	158	66	1.16	0.10	2002	2	395	7	2	765	50	2	1.24	0.01
8	2002	27	425	29	27	899	185	27	1.15	0.06	2001	3	454	57	3	1220	400	3	1.29	0.10
9	2001	17	430	22	17	980	150	17	1.23	0.12	2000	-	-	-	-	-	-	-	-	-
10	2000	4	411	32	4	879	163	4	1.26	0.09	1999	-	-	-	-	-	-	-	-	-
11	1999	-	-	-	-	-	-	-	-	-	1998	-	-	-	-	-	-	-	-	-
12	1998	3	485	70	3	1430	732	3	1.19	0.11	1997	-	-	-	-	-	-	-	-	-
13	1997	7	472	39	7	1227	236	7	1.16	0.08	1996	-	-	-	-	-	-	-	-	-
14	1996	-	-	-	-	-	-	-	-	-	1995	-	-	-	-	-	-	-	-	-
15	1995	3	450	11	3	1128	122	3	1.24	0.06	1994	-	-	-	-	-	-	-	-	-
16	1994	2	417	13	2	900	99	2	1.25	0.25	1993	-	-	-	-	-	-	-	-	-
17	1993	1	454	-	1	1070	-	1	1.14	-	1992	-	-	-	-	-	-	-	-	-

n = number of fish; SD = standard deviation.

Table 5.2.7-18. continued.

Age	Cedar Lake-SE 2009 Year-Class	FL (mm) n	FL (mm) mean	FL (mm) SD	W (g) n	W (g) mean	W (g) SD	K n	K mean	K SD	2010 Year-Class	FL (mm) n	FL (mm) mean	FL (mm) SD	W (g) n	W (g) mean	W (g) SD	K n	K mean	K SD
0	2009	-	-	-	-	-	-	-	-	-	2010	-	-	-	-	-	-	-	-	-
1	2008	2	166	4	2	55	21	2	1.23	0.55	2009	-	-	-	-	-	-	-	-	-
2	2007	4	211	10	4	113	21	4	1.19	0.07	2008	3	222	23	3	118	28	3	1.07	0.16
3	2006	34	232	23	34	146	60	34	1.08	0.12	2007	2	252	16	2	175	35	2	1.10	0.01
4	2005	31	269	32	31	245	81	31	1.23	0.31	2006	9	293	29	9	291	85	9	1.12	0.08
5	2004	8	346	40	8	473	182	8	1.12	0.19	2005	26	342	22	26	466	117	26	1.15	0.11
6	2003	112	370	30	112	641	158	112	1.24	0.12	2004	4	374	31	4	678	173	4	1.28	0.10
7	2002	38	384	32	38	712	177	38	1.23	0.08	2003	45	399	37	45	802	237	45	1.23	0.14
8	2001	47	395	33	47	808	218	47	1.28	0.09	2002	28	405	39	28	861	257	28	1.26	0.14
9	2000	-	-	-	-	-	-	-	-	-	2001	21	406	46	21	915	303	21	1.34	0.20
10	1999	-	-	-	-	-	-	-	-	-	2000	6	415	60	6	939	387	6	1.22	0.21
11	1998	2	456	64	2	1300	495	2	1.35	0.05	1999	-	-	-	-	-	-	-	-	-
12	1997	-	-	-	-	-	-	-	-	-	1998	2	442	74	2	1195	629	2	1.31	0.07
13	1996	2	533	35	2	1935	375	2	1.27	0.00	1997	-	-	-	-	-	-	-	-	-
14	1995	-	-	-	-	-	-	-	-	-	1996	2	590	91	2	2528	1163	2	1.19	0.02

n = number of fish; SD = standard deviation

Table 5.2.7-18. continued.

Age	Cormorant Lake																													
	2008										2009										2010									
	Year-Class	FL (mm)			W (g)			K			Year-Class	FL (mm)			W (g)			K			Year-Class	FL (mm)			W (g)			K		
		n	Mean	SD	n	Mean	SD	n	Mean	SD		n	Mean	SD	n	Mean	SD	n	Mean	SD		n	Mean	SD	n	Mean	SD	n	Mean	SD
0	2008	-	-	-	-	-	-	-	-	-	2009	-	-	-	-	-	-	-	-	-	2010	2	129	10.61	2	23	3.54	2	1.06	0.10
1	2007	1	200	-	1	80	-	1	1.00	-	2008	3	129	46.23	3	37	46.19	3	1.13	0.32	2009	1	184	-	1	60	-	1	0.96	-
2	2006	9	267	15.90	9	186	22.75	9	0.98	0.09	2007	16	212	27.20	16	103	34.35	16	1.00	0.19	2008	6	245	12.19	6	137	27.33	6	0.93	0.16
3	2005	20	287	21.27	20	233	44.08	20	0.98	0.10	2006	13	256	53.79	13	182	79.04	13	0.98	0.19	2007	49	292	23.77	49	249	88.38	49	0.97	0.06
4	2004	2	326	33.94	2	343	95.46	2	0.98	0.03	2005	35	323	56.47	35	365	140.80	35	1.04	0.19	2006	19	340	22.38	19	388	75.49	19	0.98	0.05
5	2003	11	368	61.79	11	553	230.44	11	1.03	0.08	2004	3	359	19.22	3	543	142.95	3	1.15	0.12	2005	66	384	31.98	66	587	148.87	66	1.01	0.06
6	2002	9	422	66.44	9	834	316.30	9	1.02	0.13	2003	14	410	62.11	14	786	296.20	14	1.06	0.09	2004	6	397	22.56	6	699	152.89	6	1.10	0.06
7	2001	56	450	52.09	56	1023	333.32	56	1.07	0.09	2002	7	467	31.21	7	1106	243.37	7	1.07	0.07	2003	15	462	24.03	15	1075	176.00	15	1.09	0.08
8	2000	16	487	47.40	16	1167	218.21	16	1.03	0.20	2001	59	465	56.70	59	1163	357.65	59	1.10	0.12	2002	7	483	39.38	7	1254	255.14	7	1.11	0.08
9	1999	22	482	85.23	22	1301	555.73	22	1.06	0.12	2000	11	479	37.76	11	1214	235.00	11	1.10	0.09	2001	13	501	36.25	13	1465	315.71	13	1.15	0.05
10	1998	5	459	50.79	5	1117	343.63	5	1.13	0.10	1999	11	478	81.26	11	1359	588.70	11	1.13	0.15	2000	8	518	38.85	8	1551	408.06	8	1.09	0.07
11	1997	14	475	34.28	14	1279	311.51	14	1.17	0.11	1998	2	531	35.36	2	1715	374.77	2	1.14	0.02	1999	4	477	67.82	4	1391	730.08	4	1.21	0.14
12	1996	38	507	50.22	38	1519	520.80	38	1.12	0.10	1997	9	490	87.87	9	1389	660.12	9	1.07	0.12	1998	-	-	-	-	-	-	-	-	-
13	1995	4	550	48.24	4	1896	421.02	4	1.13	0.08	1996	27	515	62.03	27	1601	667.05	27	1.12	0.09	1997	5	593	43.69	5	2513	663.42	5	1.18	0.08
14	1994	5	520	54.66	5	1686	644.51	5	1.16	0.11	1995	-	-	-	-	-	-	-	-	-	1996	24	528	62.01	24	1729	728.49	24	1.12	0.11
15	1993	-	-	-	-	-	-	-	-	-	1994	2	492	65.05	2	1185	346.48	2	0.99	0.10	1995	-	-	-	-	-	-	-	-	-
16	1992	-	-	-	-	-	-	-	-	-	1993	-	-	-	-	-	-	-	-	-	1994	2	492	25.46	2	1438	236.88	2	1.20	0.01
17	1991	-	-	-	-	-	-	-	-	-	1992	-	-	-	-	-	-	-	-	-	1993	-	-	-	-	-	-	-	-	-
18	1990	-	-	-	-	-	-	-	-	-	1991	1	688	-	1	3720	-	1	1.14	-	1992	-	-	-	-	-	-	-	-	-
19	1989	-	-	-	-	-	-	-	-	-	1990	-	-	-	-	-	-	-	-	-	1991	-	-	-	-	-	-	-	-	-
20	1988	-	-	-	-	-	-	-	-	-	1989	-	-	-	-	-	-	-	-	-	1990	-	-	-	-	-	-	-	-	-
21	1987	1	645	-	1	2920	-	1	1.09	-	1988	-	-	-	-	-	-	-	-	-	1989	-	-	-	-	-	-	-	-	-
22	1986	-	-	-	-	-	-	-	-	-	1987	-	-	-	-	-	-	-	-	-	1988	-	-	-	-	-	-	-	-	-
23	1985	-	-	-	-	-	-	-	-	-	1986	-	-	-	-	-	-	-	-	-	1987	-	-	-	-	-	-	-	-	-
24	1984	-	-	-	-	-		-	-	-	1985	-	-	-	-	-	-	-	-	-	1986	-	-	-	-	-	-	-	-	-
25	1983	1	685	-	1	2820	-	1	0.88	-	1984	-	-	-	-	-	-	-	-	-	1985	-	-	-	-	-	-	-	-	-

n = number of fish; SD = standard deviation

Table 5.2.7-19. Deformities, erosions, lesions, and tumours (DELTS) on select fish species captured in standard gang index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

Species	Deformities		Erosions		Lesions		Tumours		Total		
	n	%	n	%	n	%	n	%	$n_{Inspect}$	n_{DELTs}	$\%_{DELTs}$
Saskatchewan River											
White Sucker	-	-	-	-	-	-	-	-	56	-	-
Northern Pike	-	-	-	-	-	-	-	-	54	-	-
Walleye	-	-	-	-	-	-	-	-	209	-	-
Total	-	-	-	-	-	-	-	-	319	-	-
South Moose Lake											
White Sucker	-	-	-	-	5	8.77	-	-	57	5	8.77
Northern Pike	-	-	-	-	-	-	-	-	92	-	-
Lake Whitefish	-	-	-	-	-	-	-	-	22	-	-
Walleye	-	-	-	-	-	-	-	-	31	-	-
Total	-	-	-	-	-	-	-	-	202	5	8.77
Cedar Lake-SE											
White Sucker	-	-	-	-	-	-	-	-	270	-	-
Northern Pike	-	-	-	-	-	-	-	-	65	-	-
Lake Whitefish	-	-	-	-	-	-	-	-	1	-	-
Sauger	-	-	-	-	-	-	-	-	24	-	-
Walleye	-	-	-	-	-	-	1	0.23	434	1	0.23
Total	-	-	--	-	-	-	1	0.23	794	1	0.23
Cormorant Lake											
White Sucker	-	-	-	-	-	-	-	-	742	-	-
Northern Pike	-	-	-	-	-	-	-	-	163	-	-
Lake Whitefish	-	-	-	-	-	-	-	-	282	-	-
Walleye	-	-	-	-	-	-	-	-	637	-	-
Total	-	-	-	-	-	-	-	-	1824	-	-

n = number of inspected fish with DELTs;
$n_{Inspect}$ = total number of fish inspected for DELTs;
n_{DELTs} = total number of fish with DELTs;
% = percentage of inspected fish with DELTs ($n/n_{Inspect}\times100$);
$\%_{DELTs}$ = total percentage of inspected fish with DELTs ($n_{DELTs}/n_{Inspect}\times100$)

Table 5.2.7-20. Saskatchewan River Region IBI values.

Metric	Non standardized values						
	Sask	Moose	Cedar SE		Cormorant		
	2010	2009	2009	2010	2008	2009	2010
Number of species	12	13	12	11	13	15	13
Number of sensitive species	3	3	3	2	2	2	3
Proportion of tolerant individuals	13.5	13.9	15.2	17.3	38.6	32.1	13.9
Number of Insectivore species	9	8	9	6	9	11	8
Hill's Evenness Index	5.35	3.45	6.47	6.16	7.25	7.07	3.45
Insectivore biomass	2.7	9.2	7.3	19.0	9.2	10.4	9.2
Omnivore biomass	22.8	58.5	47.1	36.6	55.0	49.6	58.5
Piscivore biomass	74.5	32.3	45.6	44.4	35.8	40.0	32.3
Proportion lithophilic spawners	0.83	0.19	0.46	0.81	0.69	0.65	0.19
CPUE	37.8	38.4	55.2	62.8	61.7	65.1	61.9
% individuals with DELTS	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	IBI Scores						
Number of species	6.0	6.5	6.0	5.5	6.5	7.5	6.5
Number of sensitive species	3.6	3.6	3.6	2.4	2.4	2.4	3.6
Proportion of tolerant individuals	7.7	7.6	7.4	7.1	3.4	4.5	7.6
Number of Insectivore species	6.8	6.0	6.8	4.5	6.8	8.3	6.0
Hill's Effective Species Richness Index	4.7	3.0	5.6	5.4	6.3	6.1	3.0
Insectivore biomass	0.5	1.7	1.3	3.4	1.7	1.9	1.7
Omnivore biomass	6.6	1.2	2.9	4.5	1.8	2.6	1.2
Piscivore biomass	7.5	3.2	4.6	4.4	3.6	4.0	3.2
Proportion simple lithophilic spawners	8.3	1.9	4.6	8.1	6.9	6.5	1.9
CPUE	3.8	3.8	5.5	6.3	6.2	6.5	6.2
% individuals with DELTS	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Total IBI	60.3	43.5	53.3	56.6	50.4	55.3	45.9

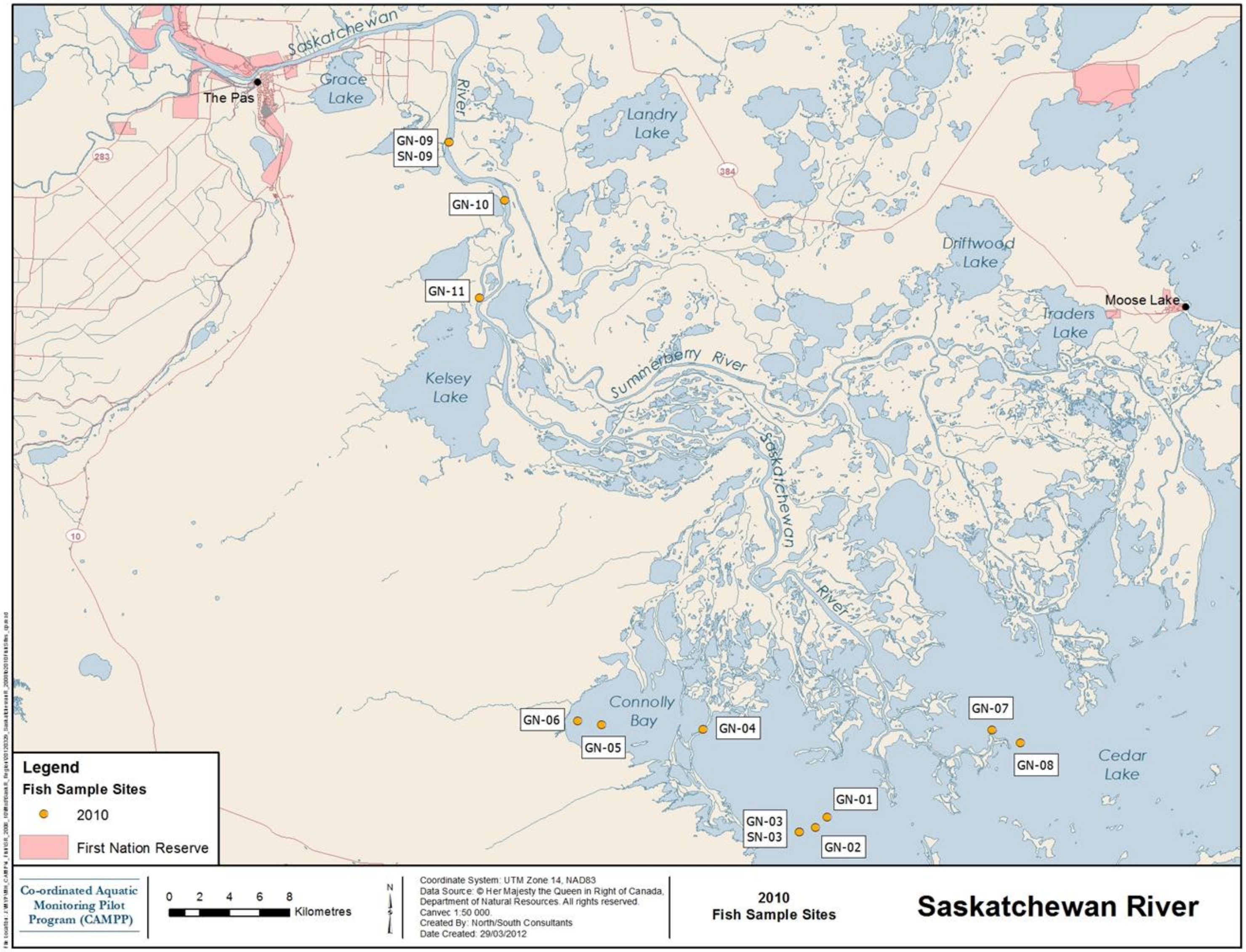


Figure 5.2.7-1. Map depicting standard gang and small mesh index gillnet sites sampled in the Saskatchewan River, 2010.

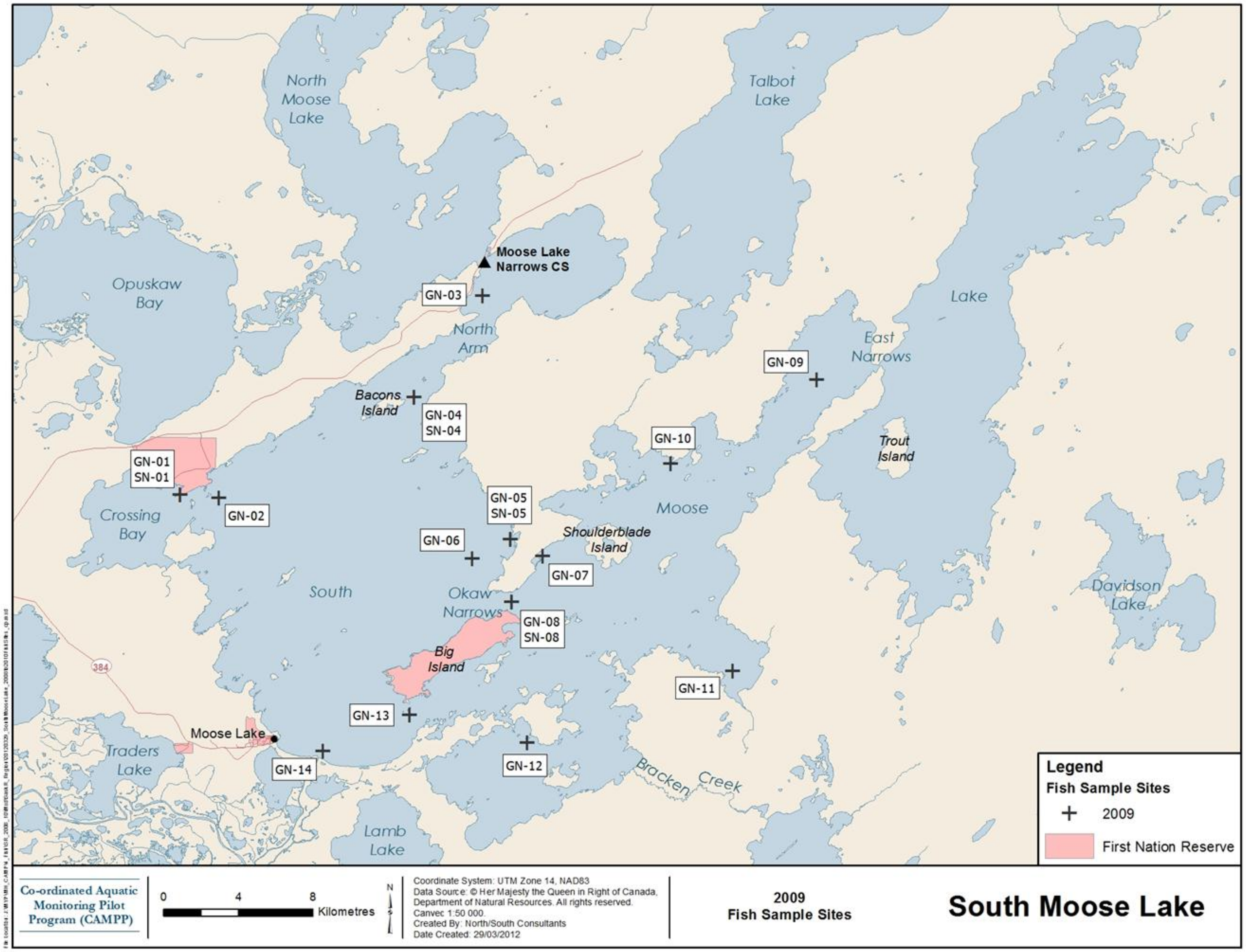


Figure 5.2.7-2. Map depicting standard gang and small mesh index gillnet sites sampled in South Moose Lake, 2009.

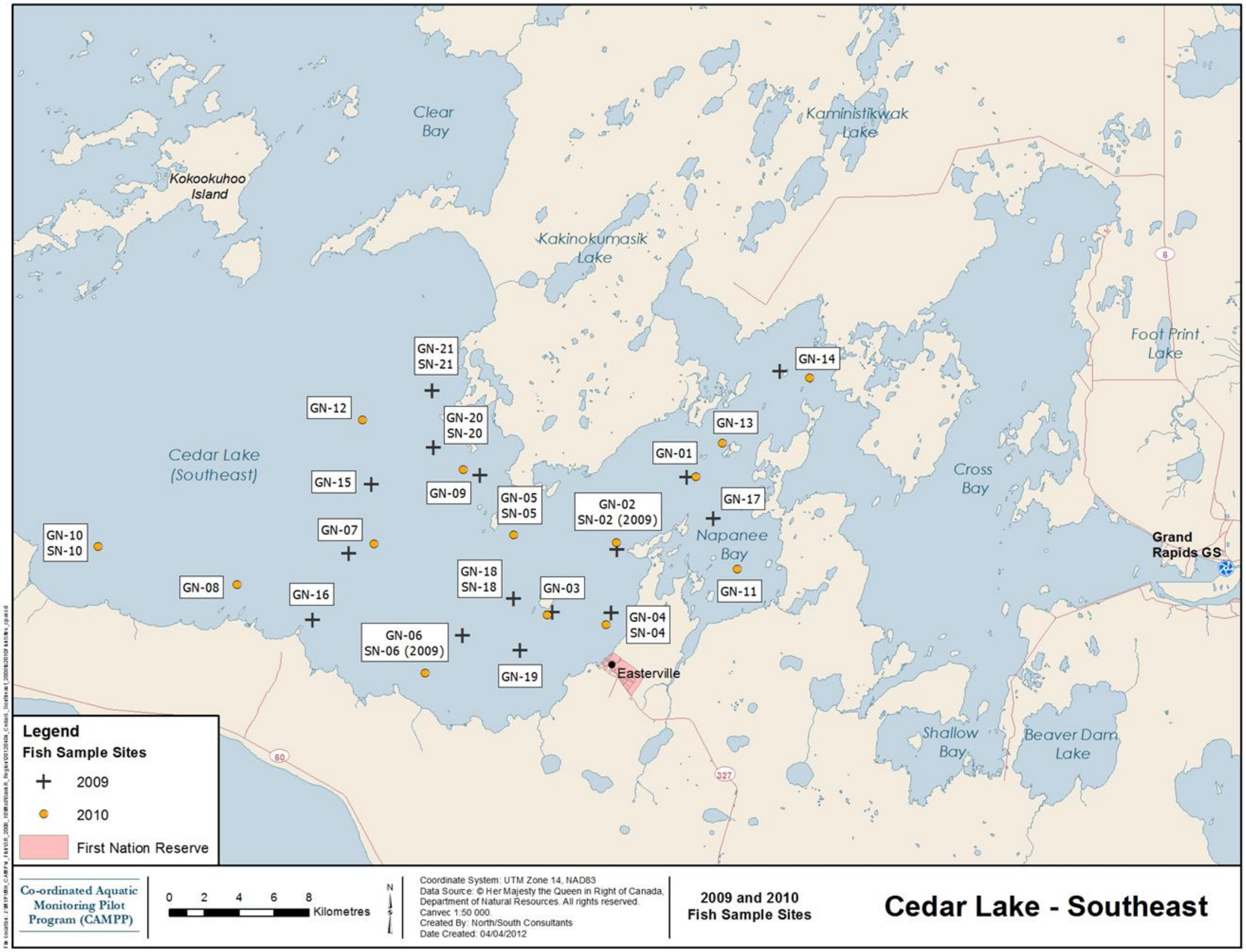


Figure 5.2.7-3. Map depicting standard gang and small mesh index gillnet sites sampled in Cedar Lake-SE, 2009-2010.

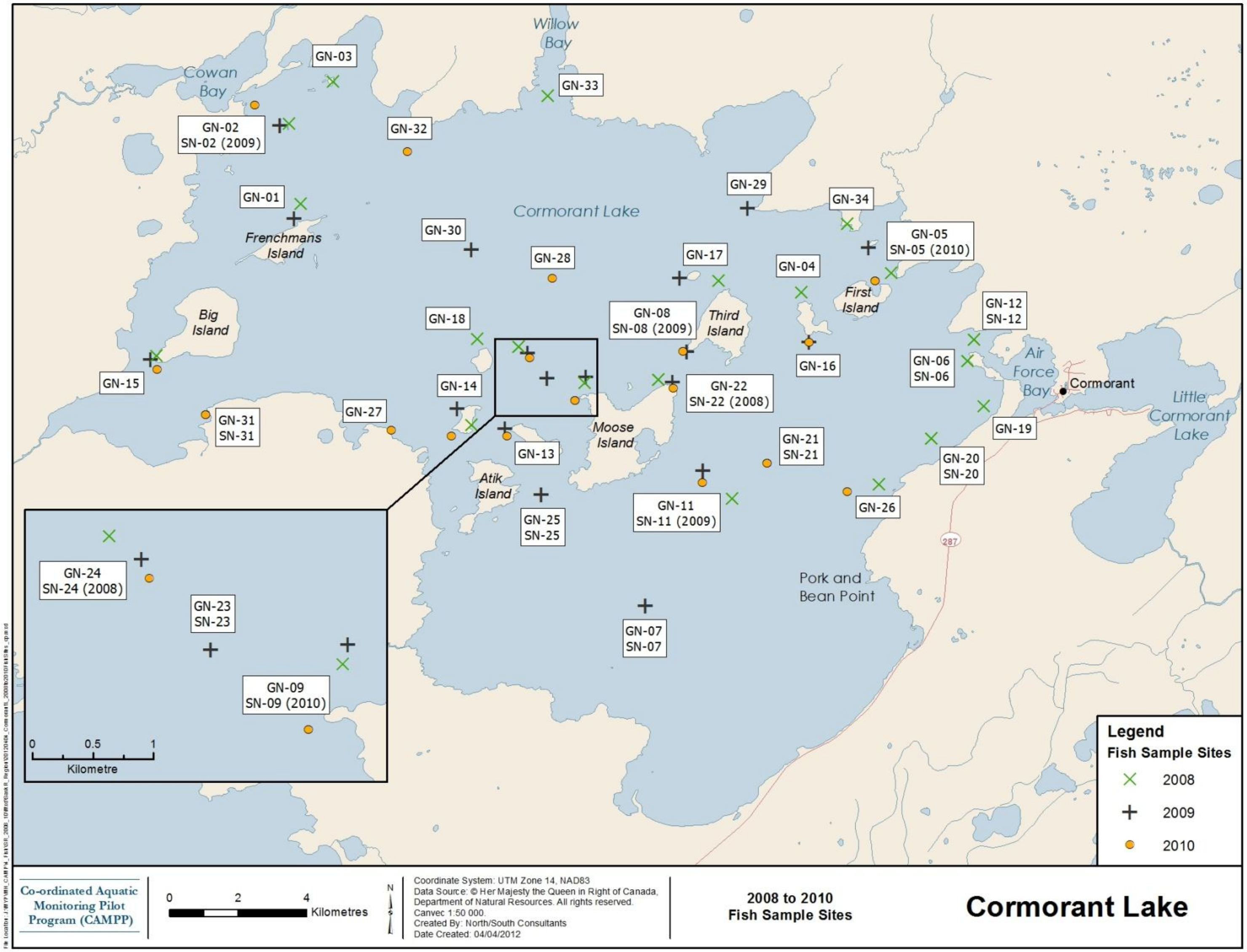


Figure 5.2.7-4. Map depicting standard gang and small mesh index gillnet sites sampled in Cormorant Lake, 2008-2010.

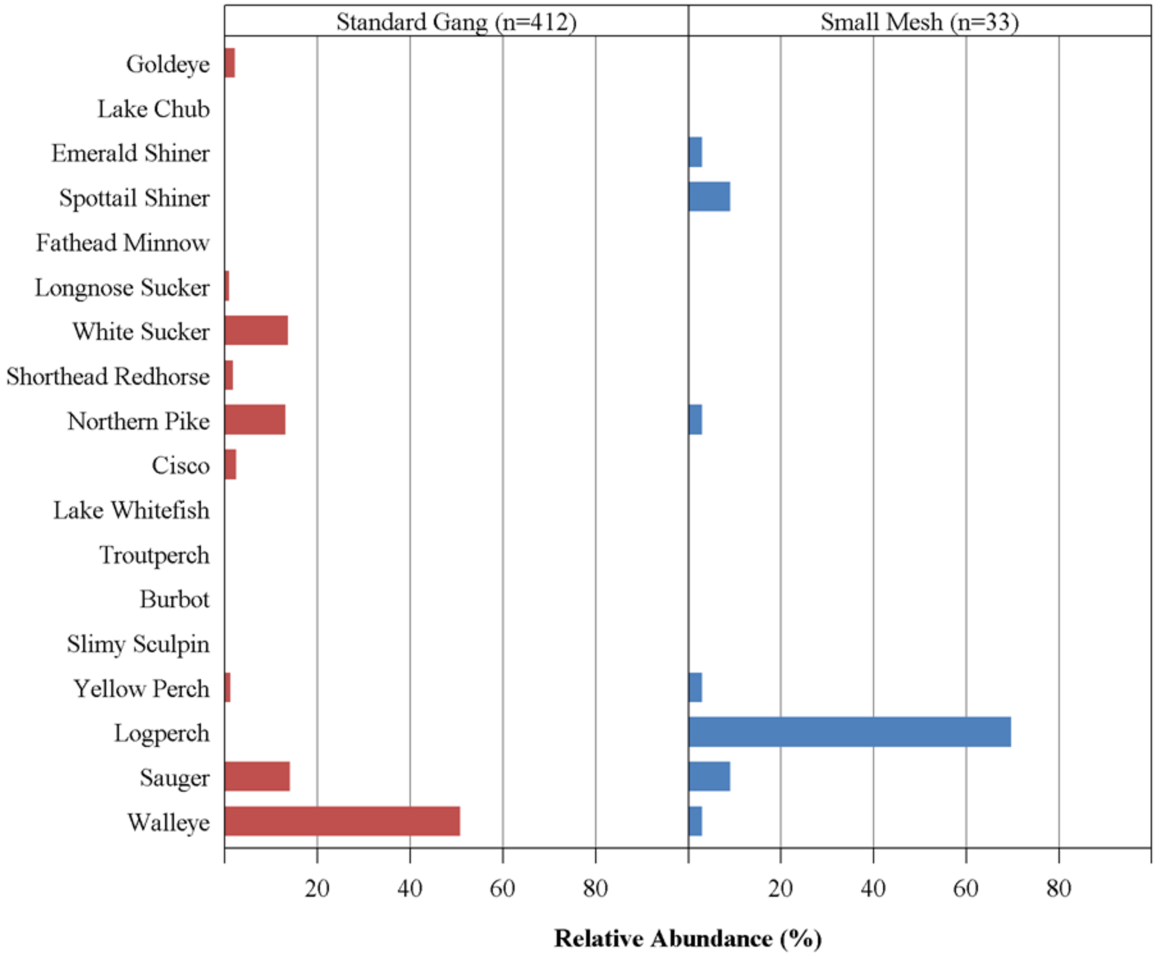


Figure 5.2.7-5. Relative abundance (%) distribution for fish species captured in (A) standard gang and (B) small mesh index gill nets set in the Saskatchewan River, 2010.

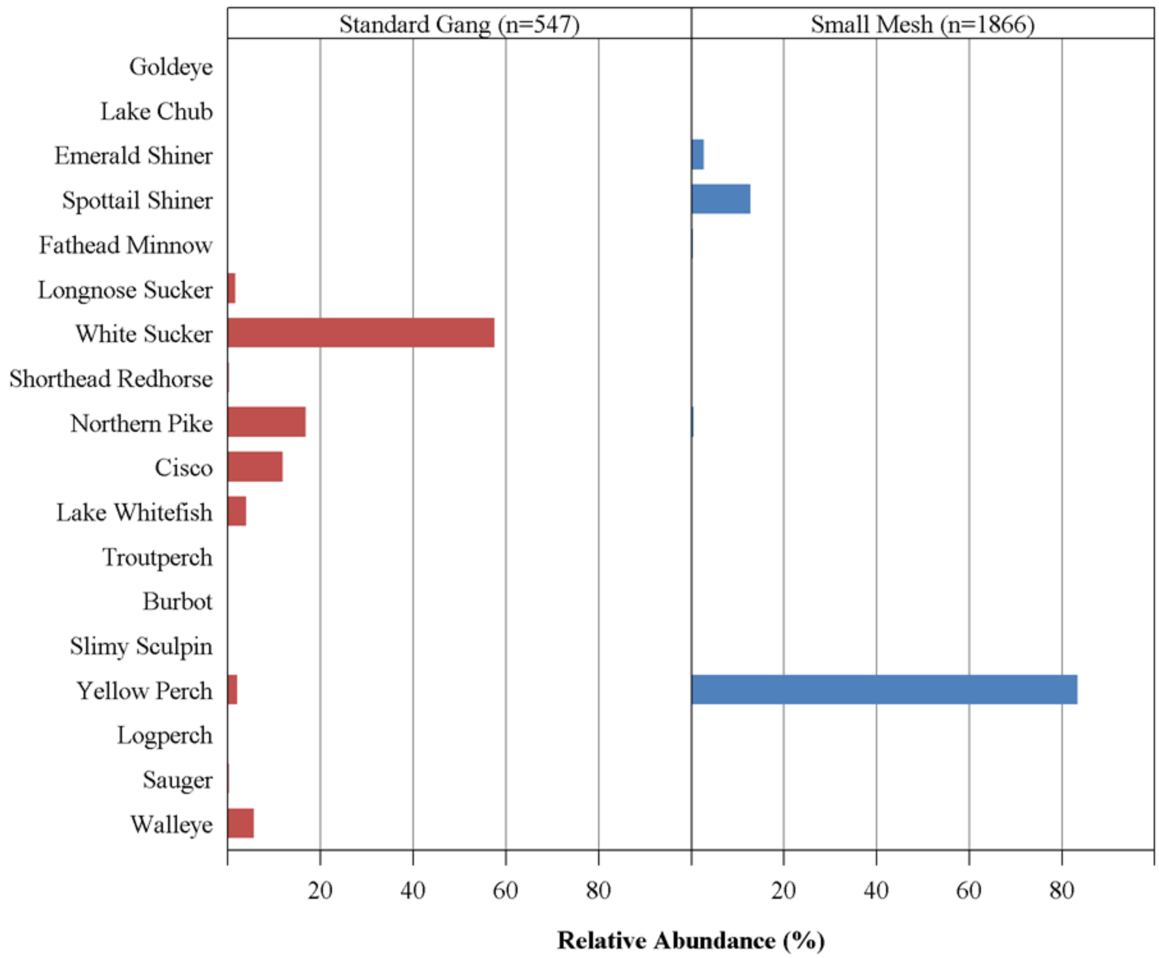


Figure 5.2.7-6. Relative abundance (%) distribution for fish species captured in (A) standard gang and (B) small mesh index gill nets set in South Moose Lake, 2009.

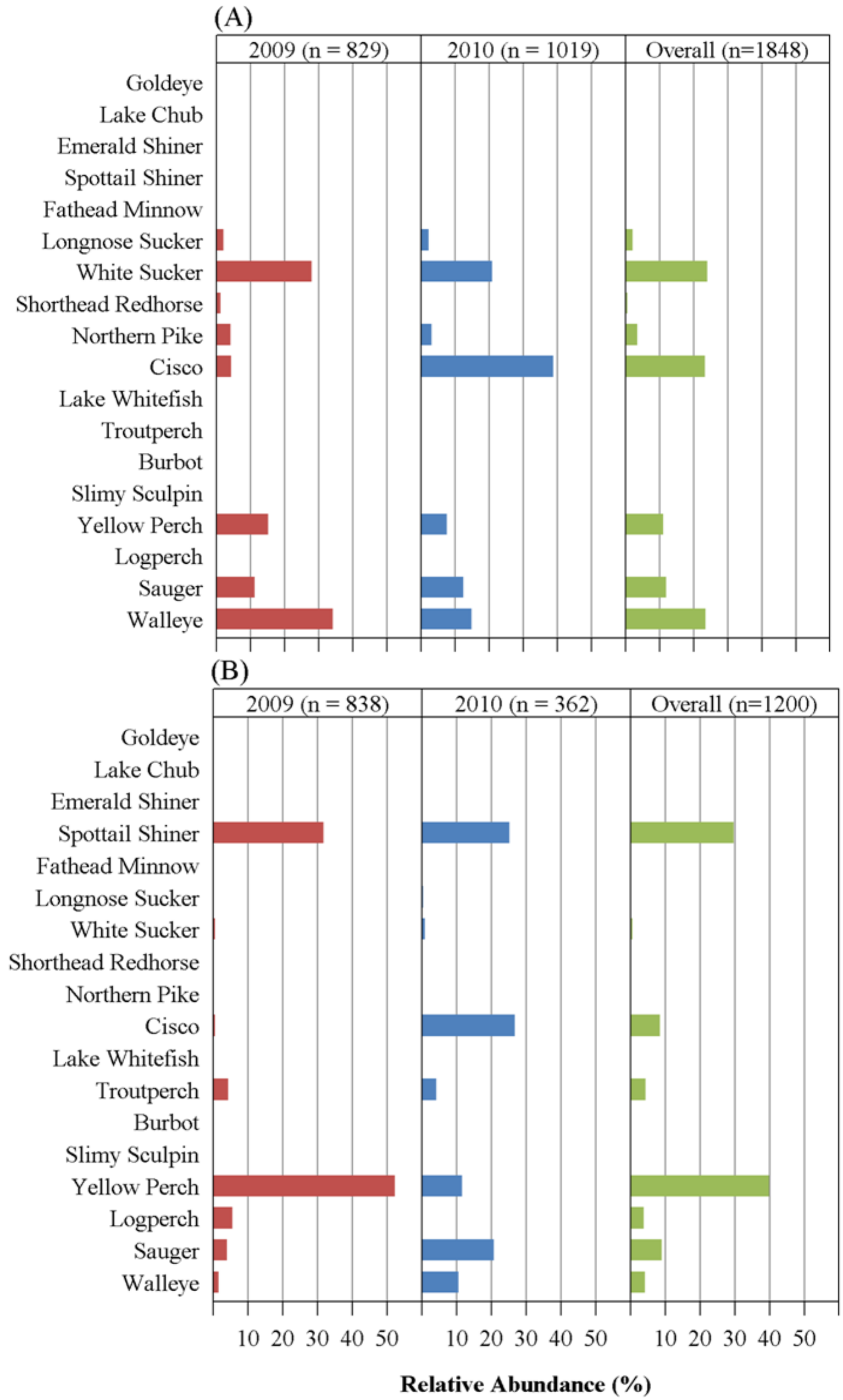


Figure 5.2.7-7. Relative abundance (%) distribution for fish species captured in (A) standard gang and (B) small mesh index gill nets set in Cedar Lake-SE, 2009-2010 (and overall).

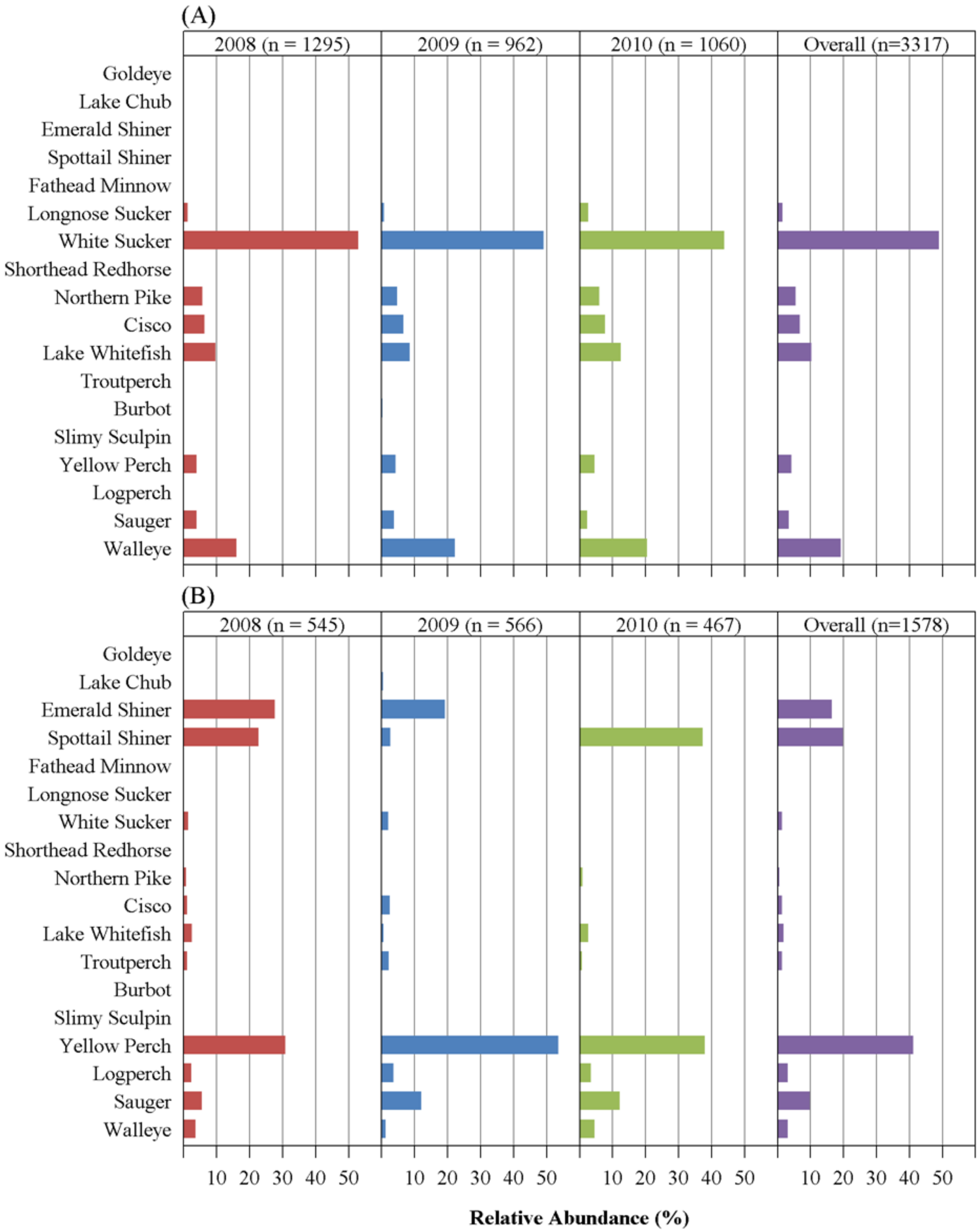


Figure 5.2.7-8. Relative abundance (%) distribution for fish species captured in (A) standard gang and (B) small mesh index gill nets set in Cormorant Lake from 2008-2010 (and overall).

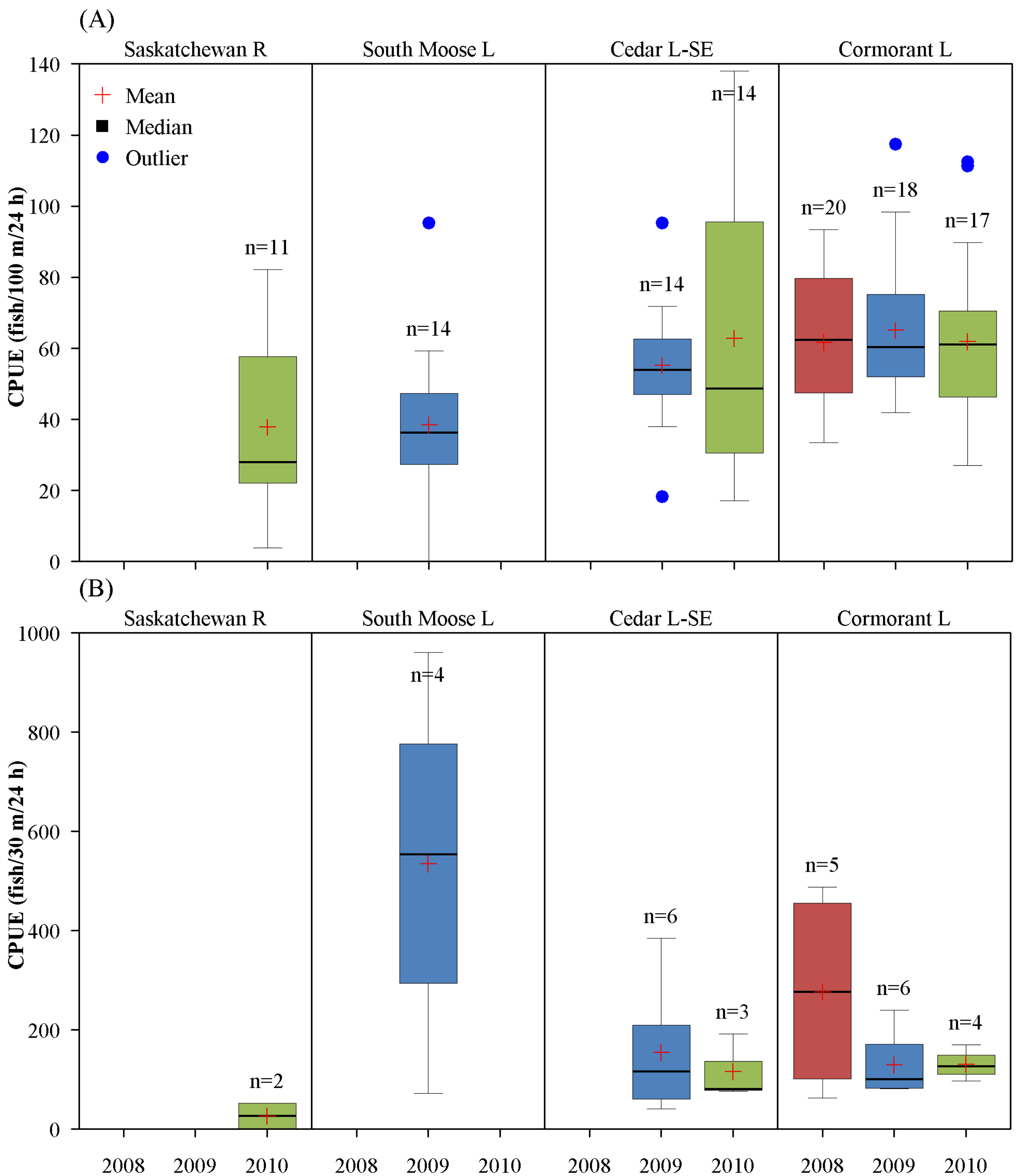


Figure 5.2.7-9. Mean and median (range) total CPUE per site calculated for fish captured in (A) standard gang and (B) small mesh index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

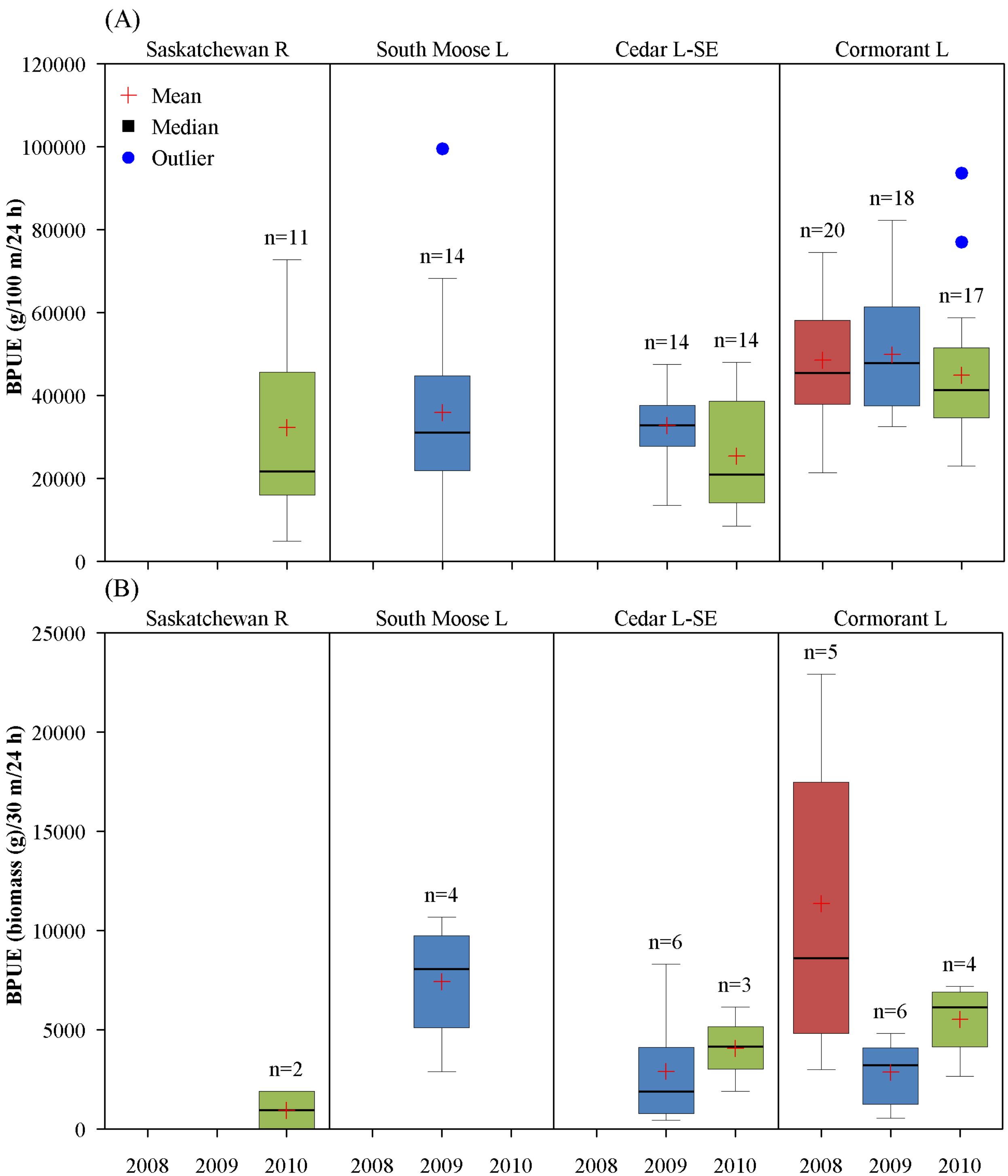


Figure 5.2.7-10. Mean and median (range) total BPUE per site calculated for fish captured in (A) standard gang and (B) small mesh index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

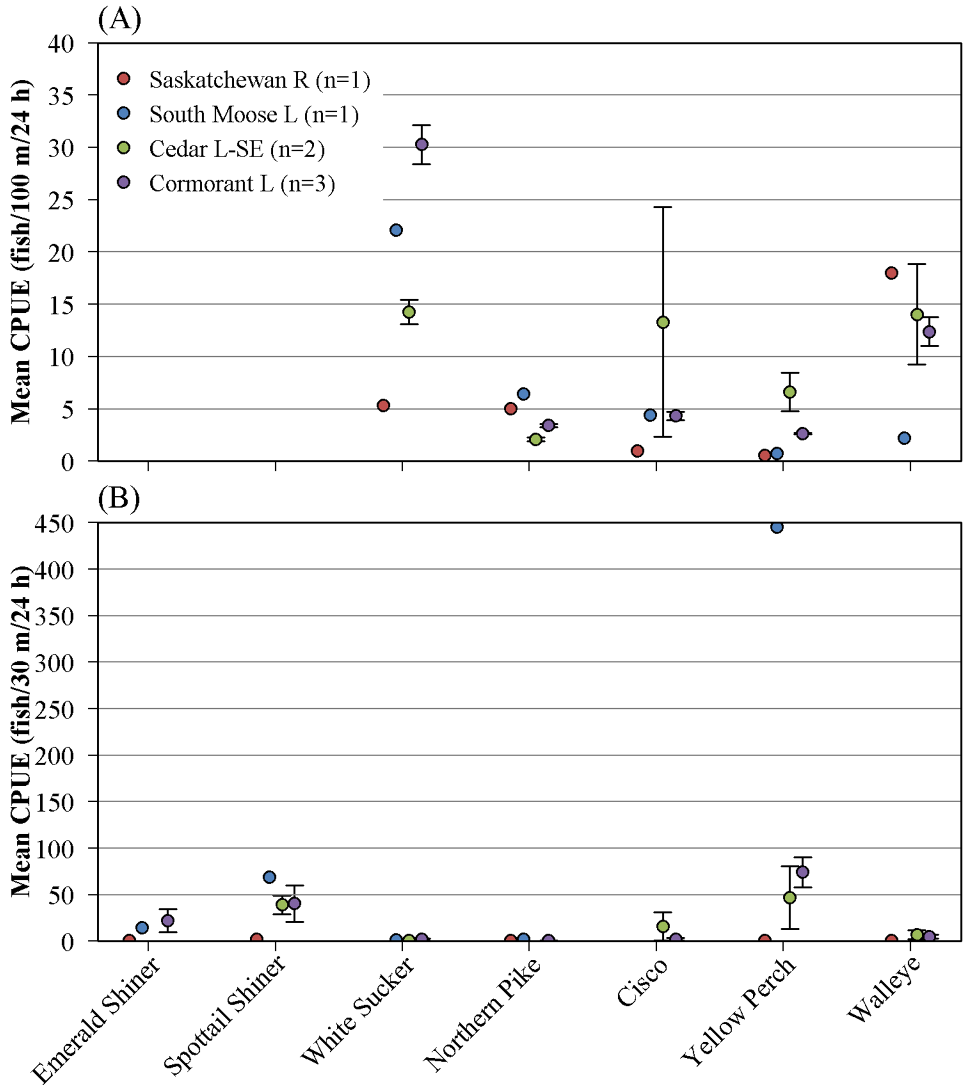


Figure 5.2.7-11. Mean (SE) CPUE for select species captured in (A) standard gang and (B) small mesh index gill nets set in Saskatchewan River Region waterbodies, from 2008-2010.

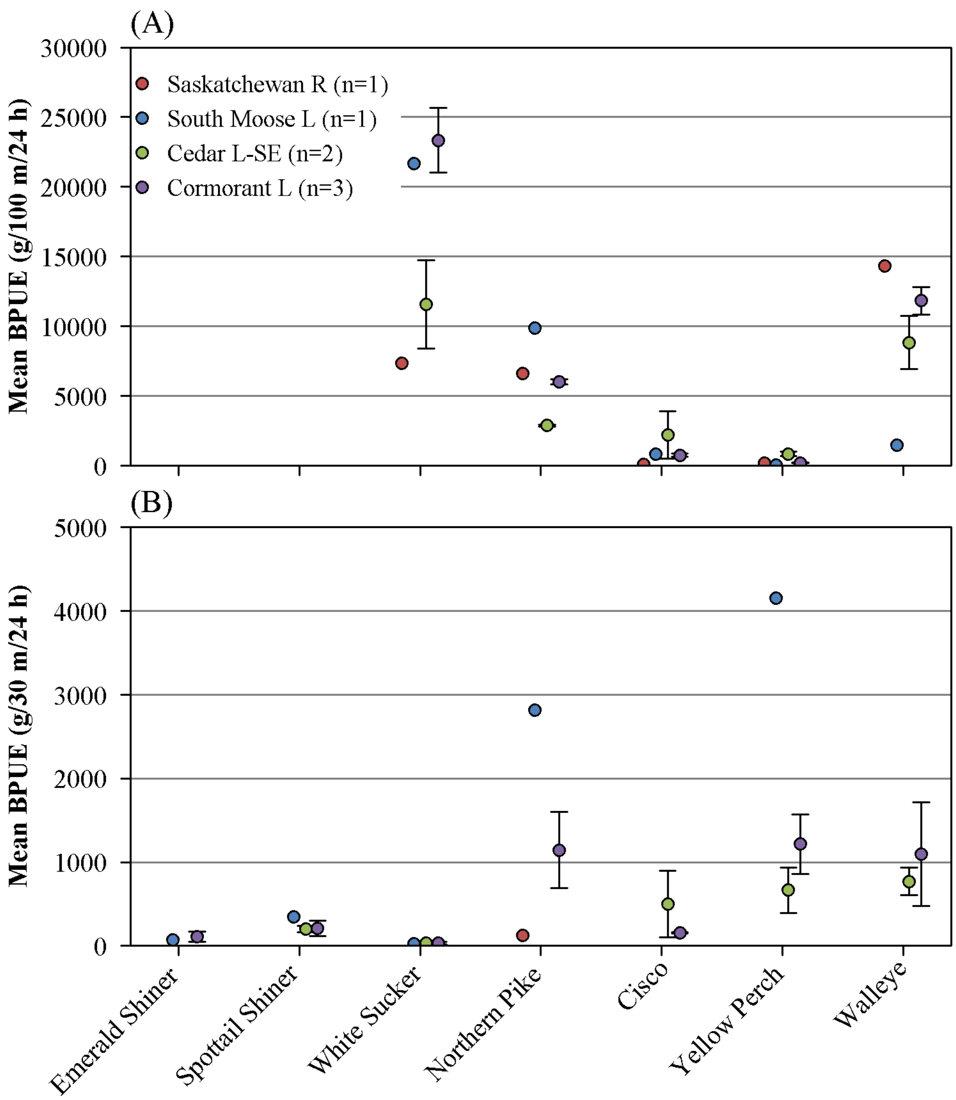


Figure 5.2.7-12. Mean BPUE (SE) for select species captured in (A) standard gang and (B) small mesh index gill nets set in Saskatchewan River Region waterbodies, from 2008-2010.

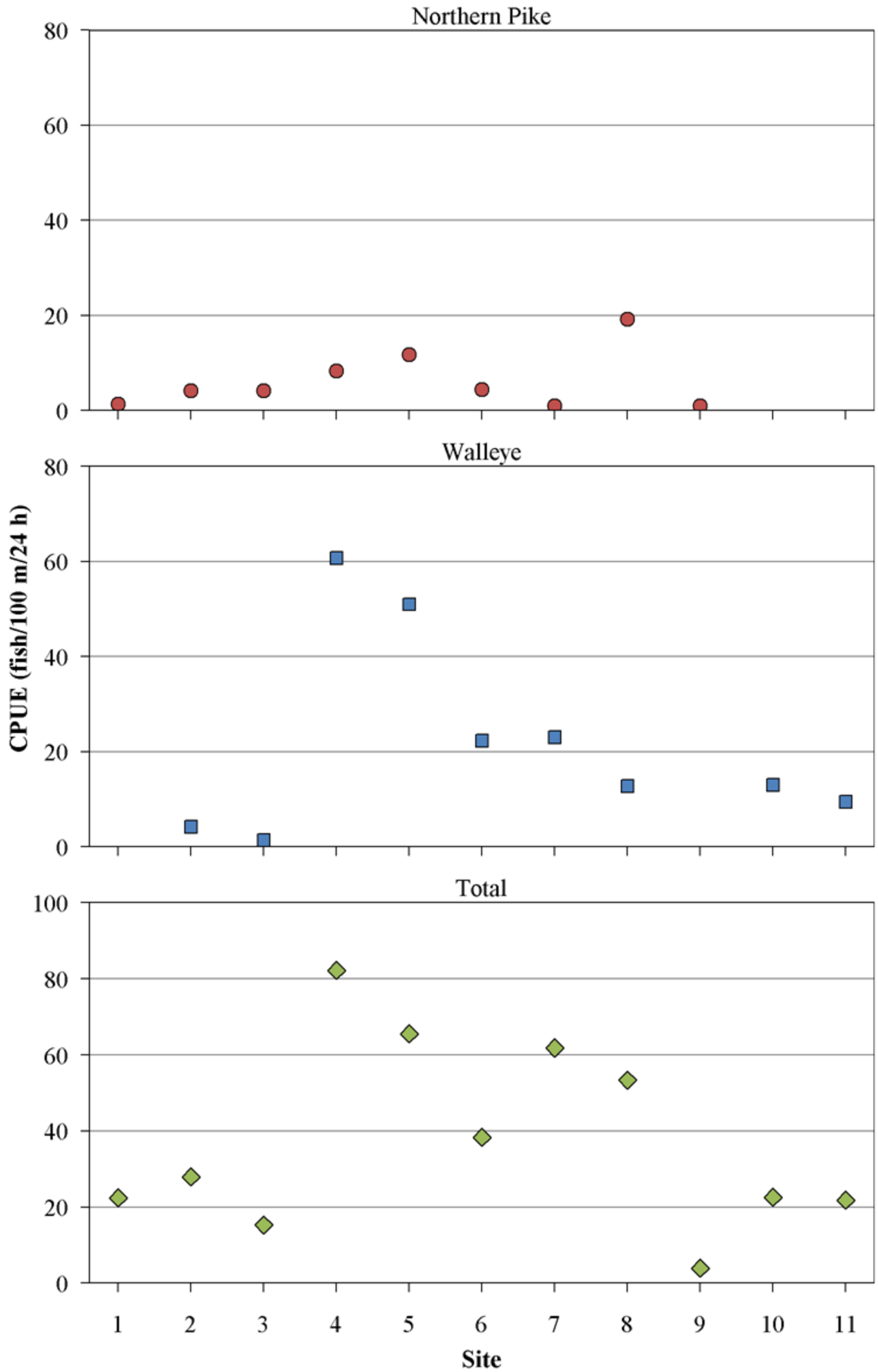


Figure 5.2.7-13. Mean CPUE (SE) by site for Northern Pike, Walleye and all species combined (Total) captured in standard gang index gill nets set in the Saskatchewan River in 2010.

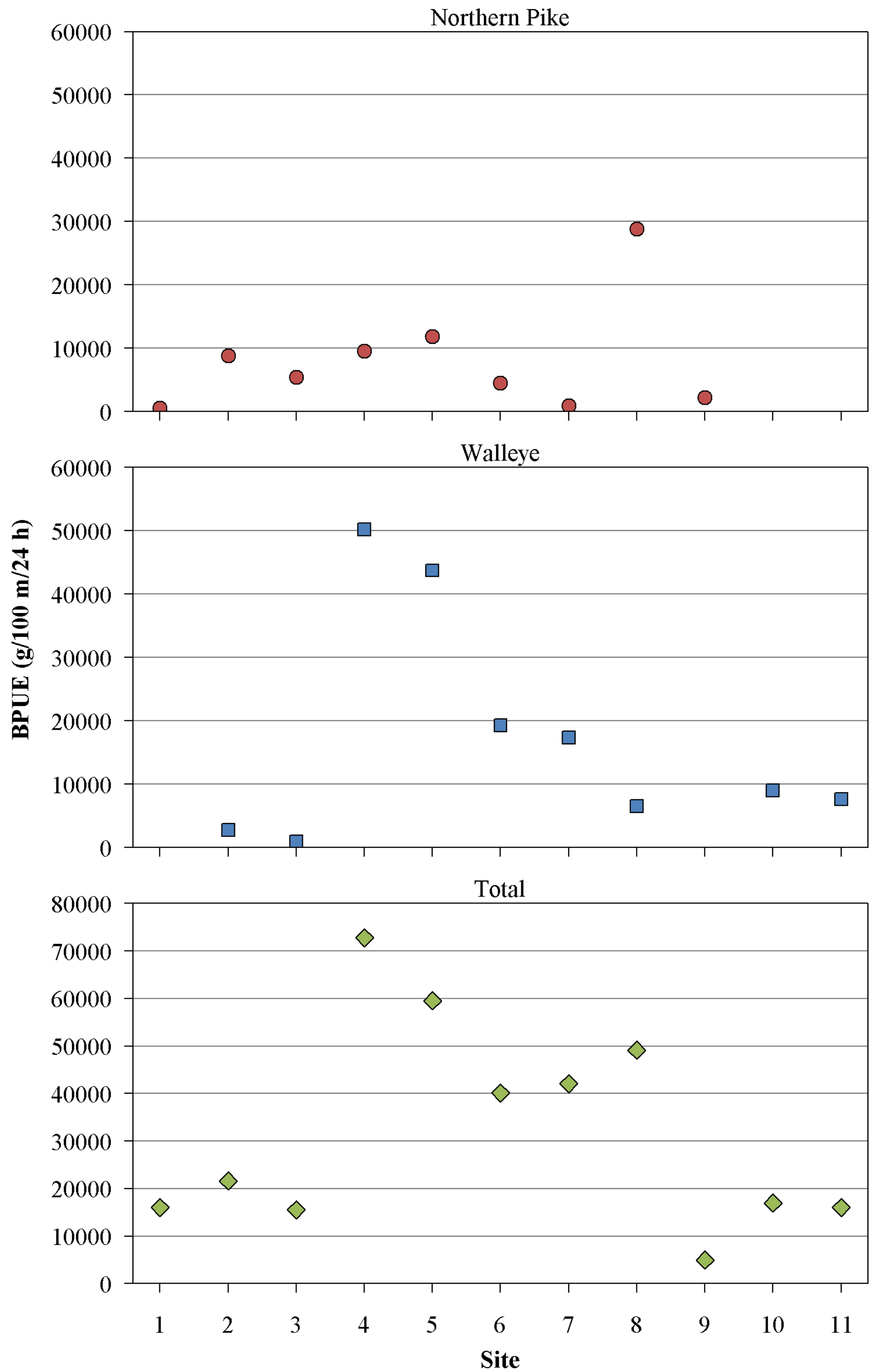


Figure 5.2.7-14. Mean BPUE (SE) by site for Northern Pike, Walleye and all species combined (Total) captured in standard gang index gill nets set on the Saskatchewan River in 2010.

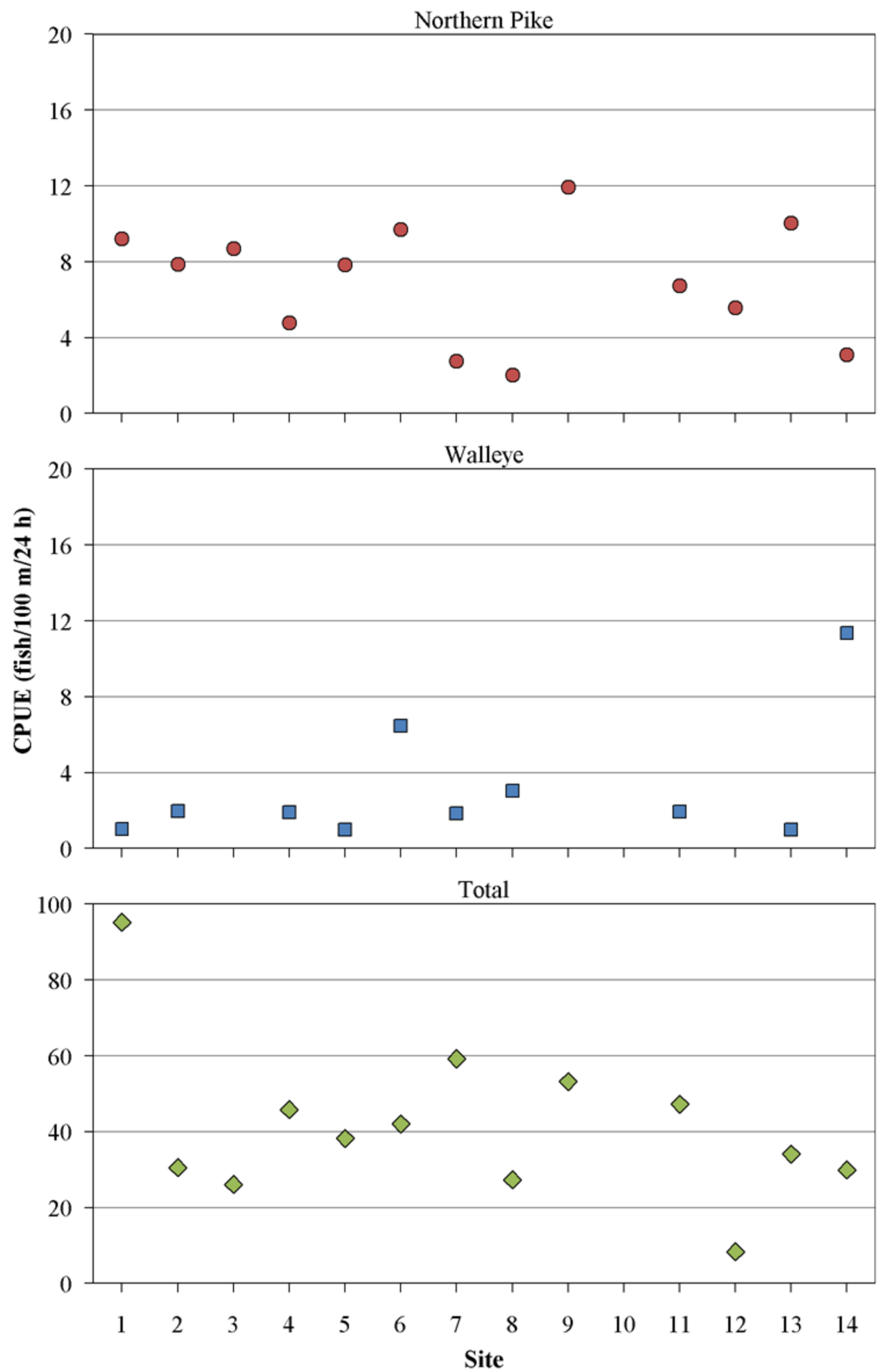


Figure 5.2.7-15. Mean CPUE (SE) by site for Northern Pike, Walleye and all species combined (Total) captured in standard gang index gill nets set on South Moose Lake in 2009.

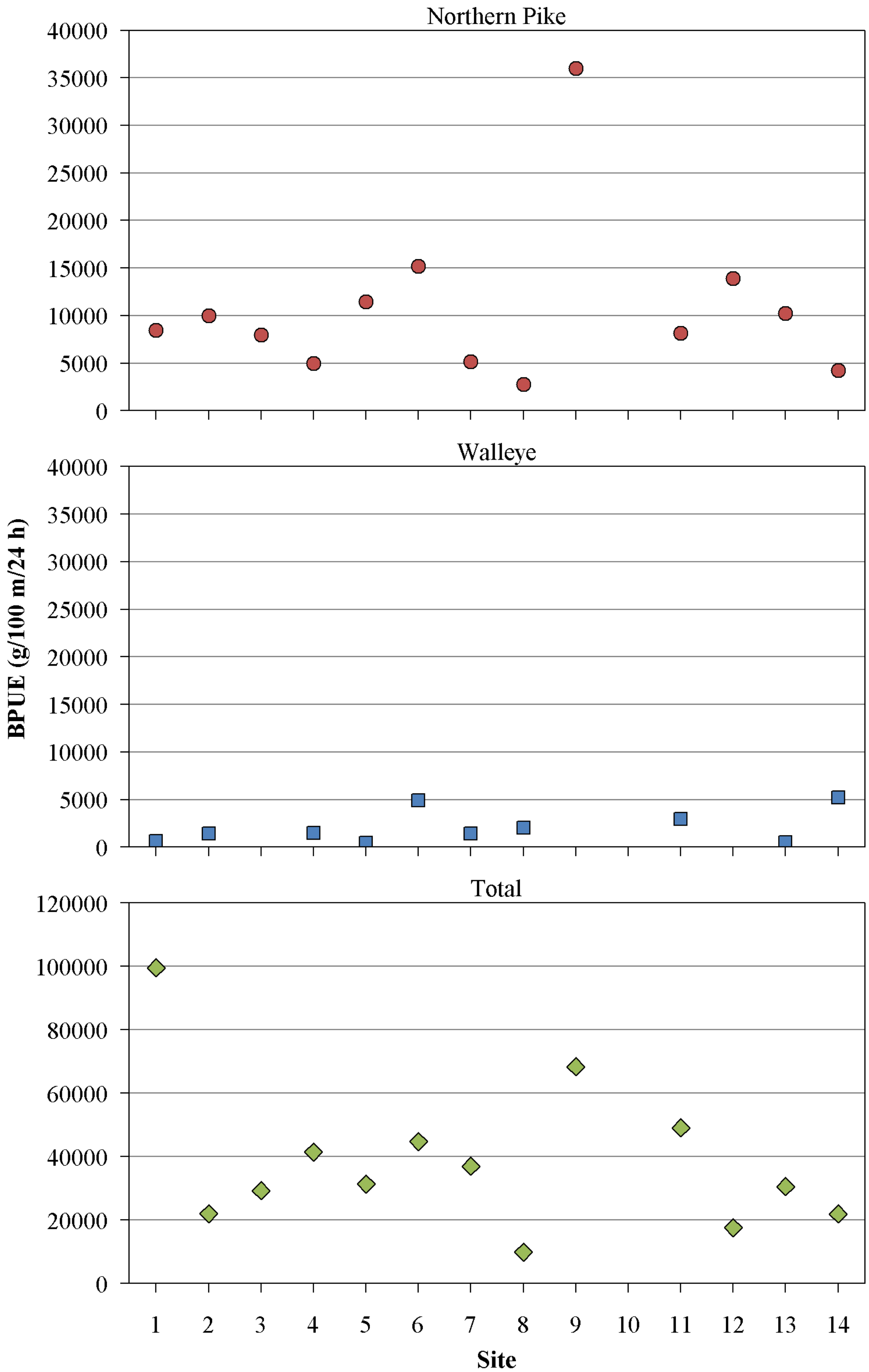


Figure 5.2.7-16. Mean BPUE (SE) by site for Northern Pike, Walleye and all species combined (Total) captured in standard gang index gill nets set on South Moose Lake in 2009.

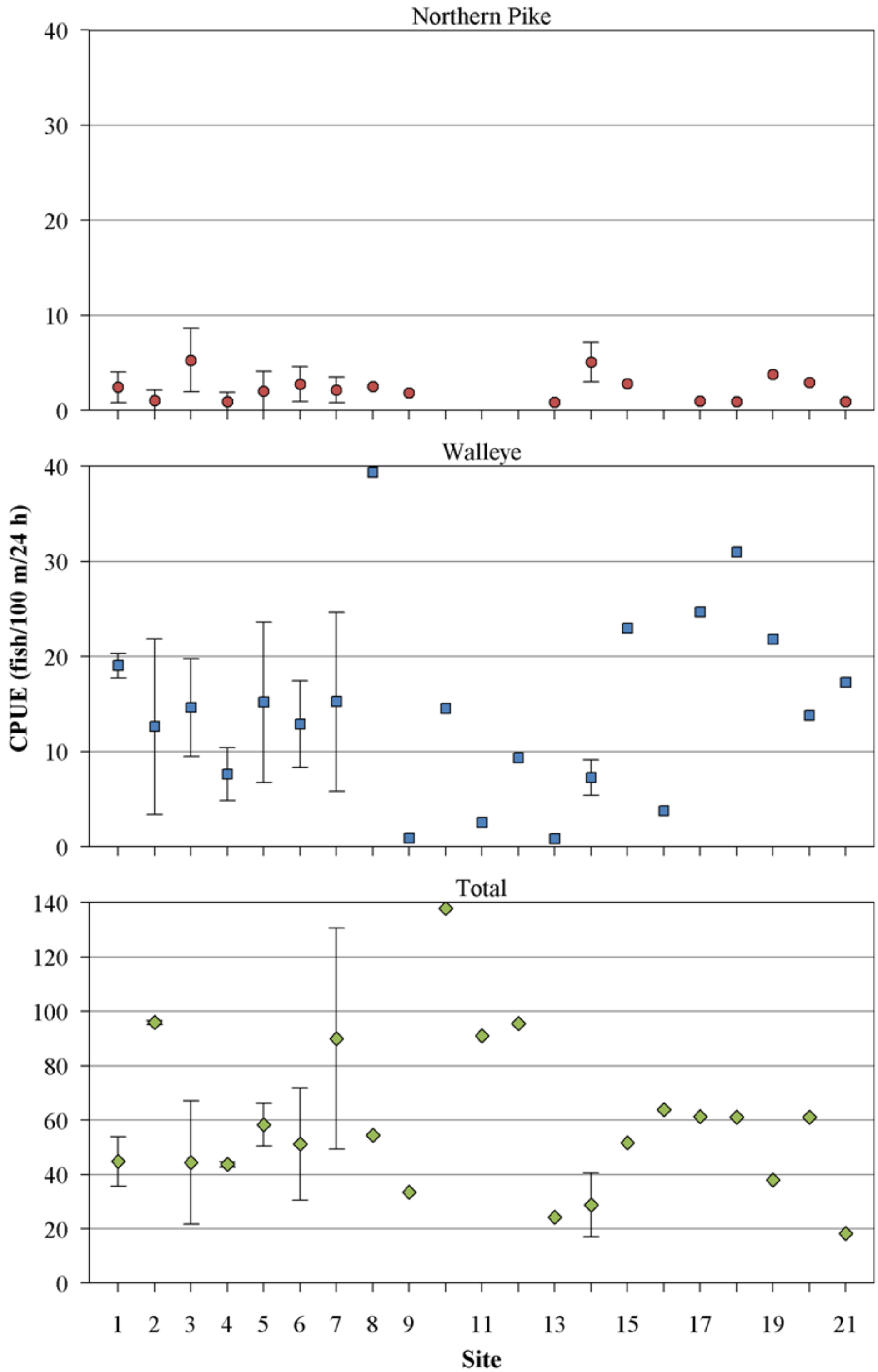


Figure 5.2.7-17. Mean CPUE (SE) by site for Northern Pike, Walleye and all species combined (Total) captured in standard gang index gill nets set on Cedar Lake-SE from 2009-2010.

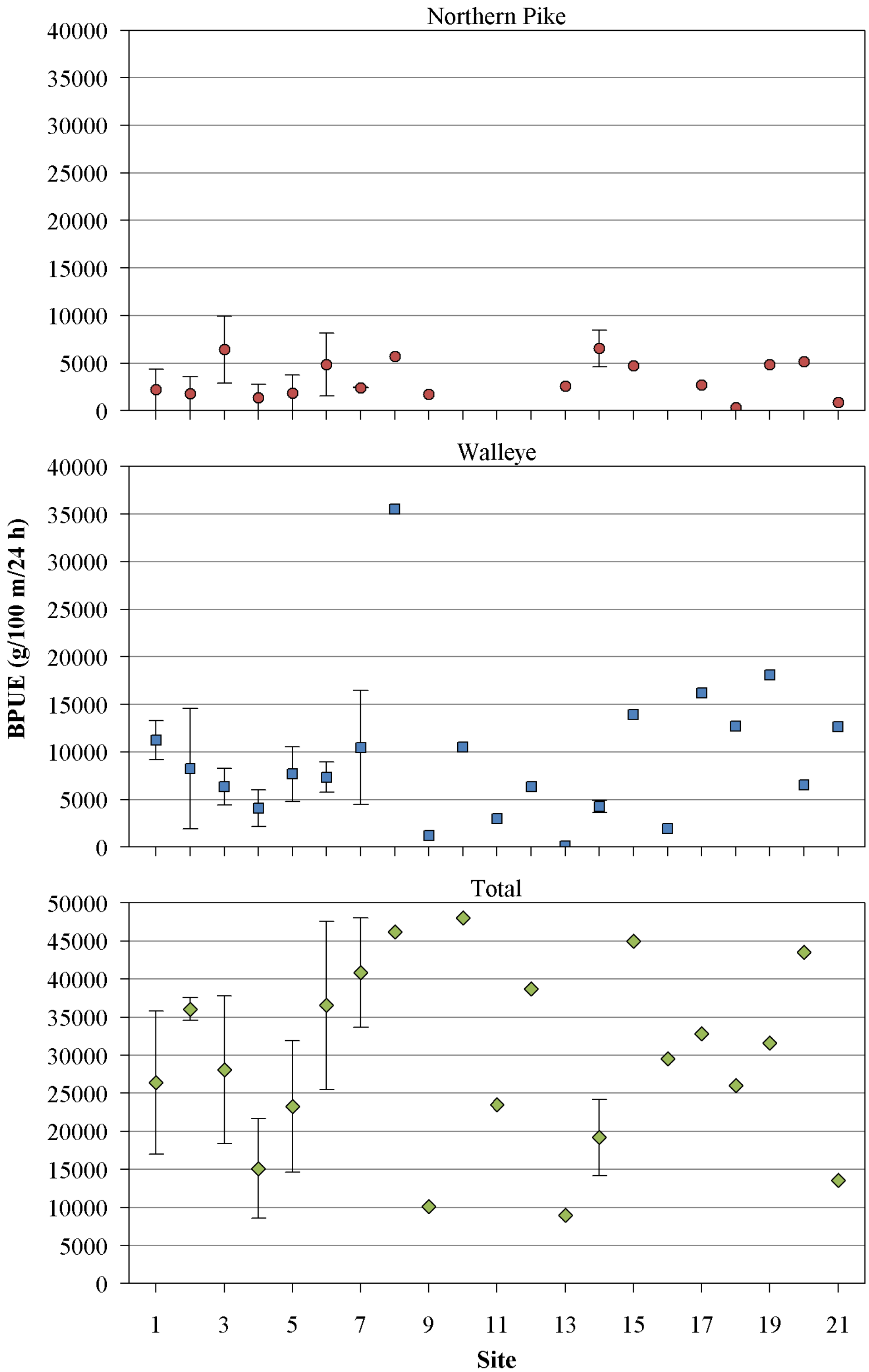


Figure 5.2.7-18. Mean BPUE (SE) by site for Northern Pike, Walleye and all species combined (Total) captured in standard gang index gill nets set on Cedar Lake-SE from 2009-2010.

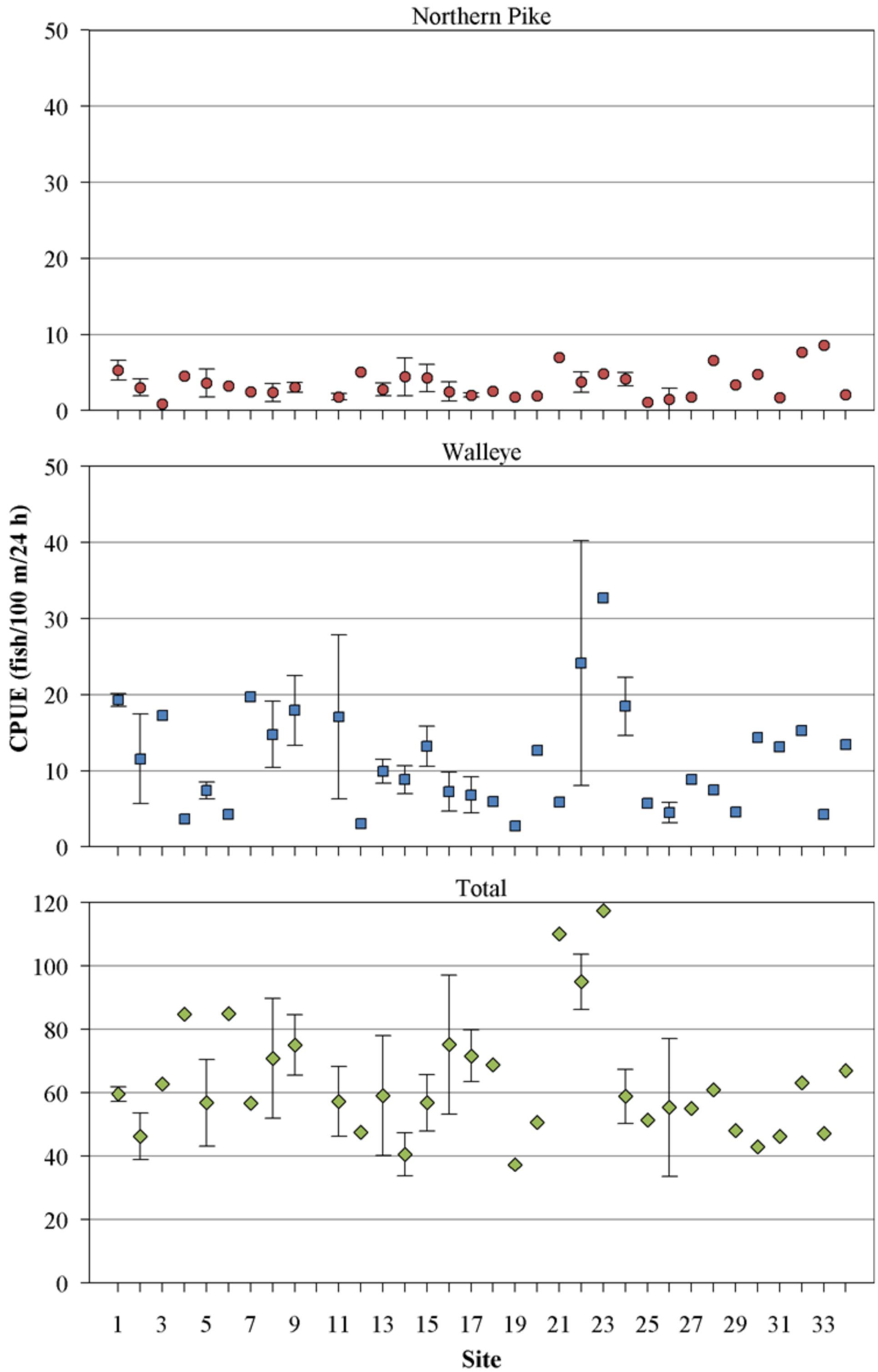


Figure 5.2.7-19. Mean CPUE (SE) by site for Northern Pike, Walleye and all species combined (Total) captured in standard gang index gill nets set on Cormorant Lake from 2008-2010.

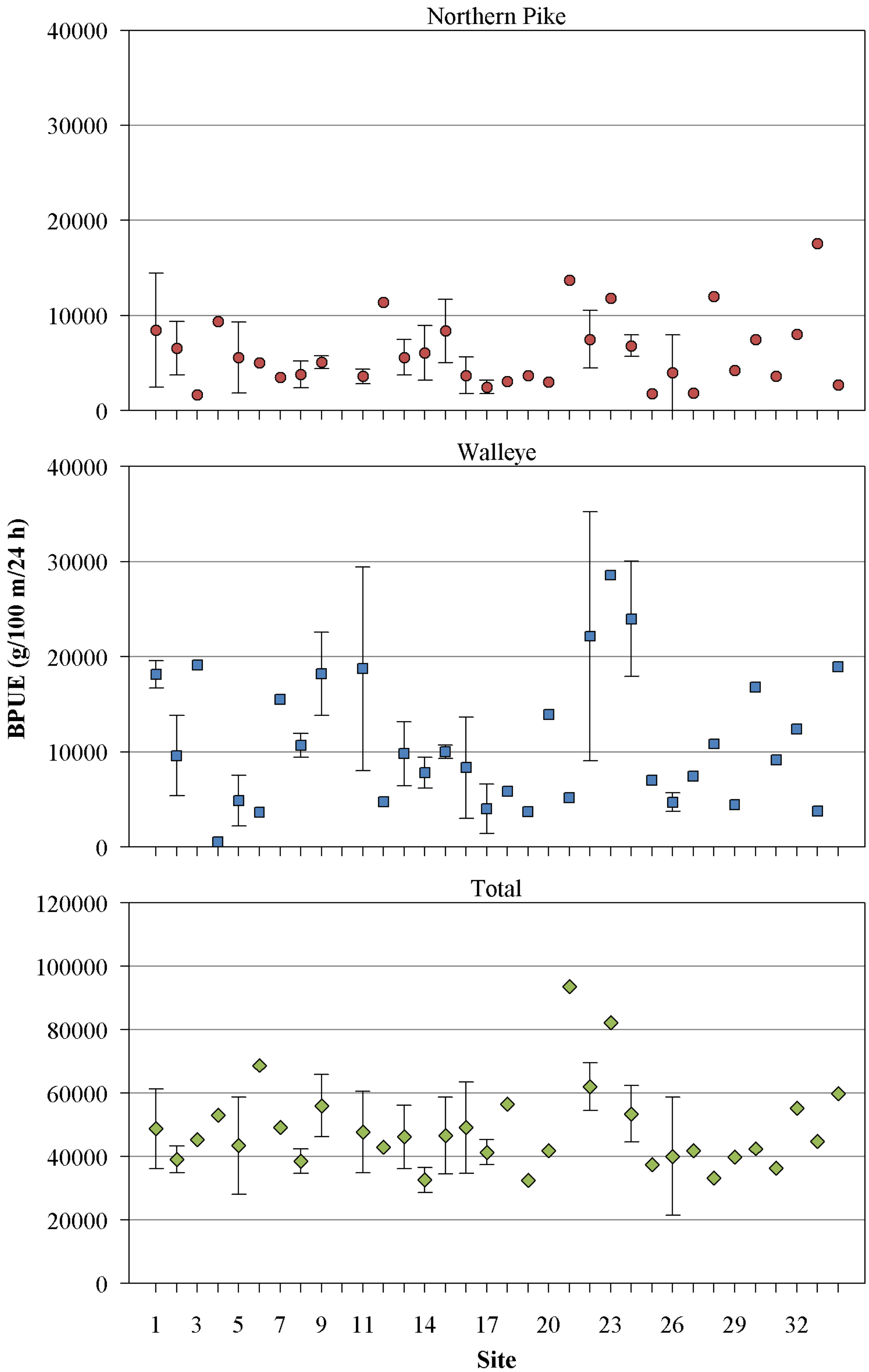


Figure 5.2.7-20. Mean BPUE (SE) by site for Northern Pike, Walleye and all species combined (Total) captured in standard gang index gill nets set on Cormorant Lake from 2008-2010.

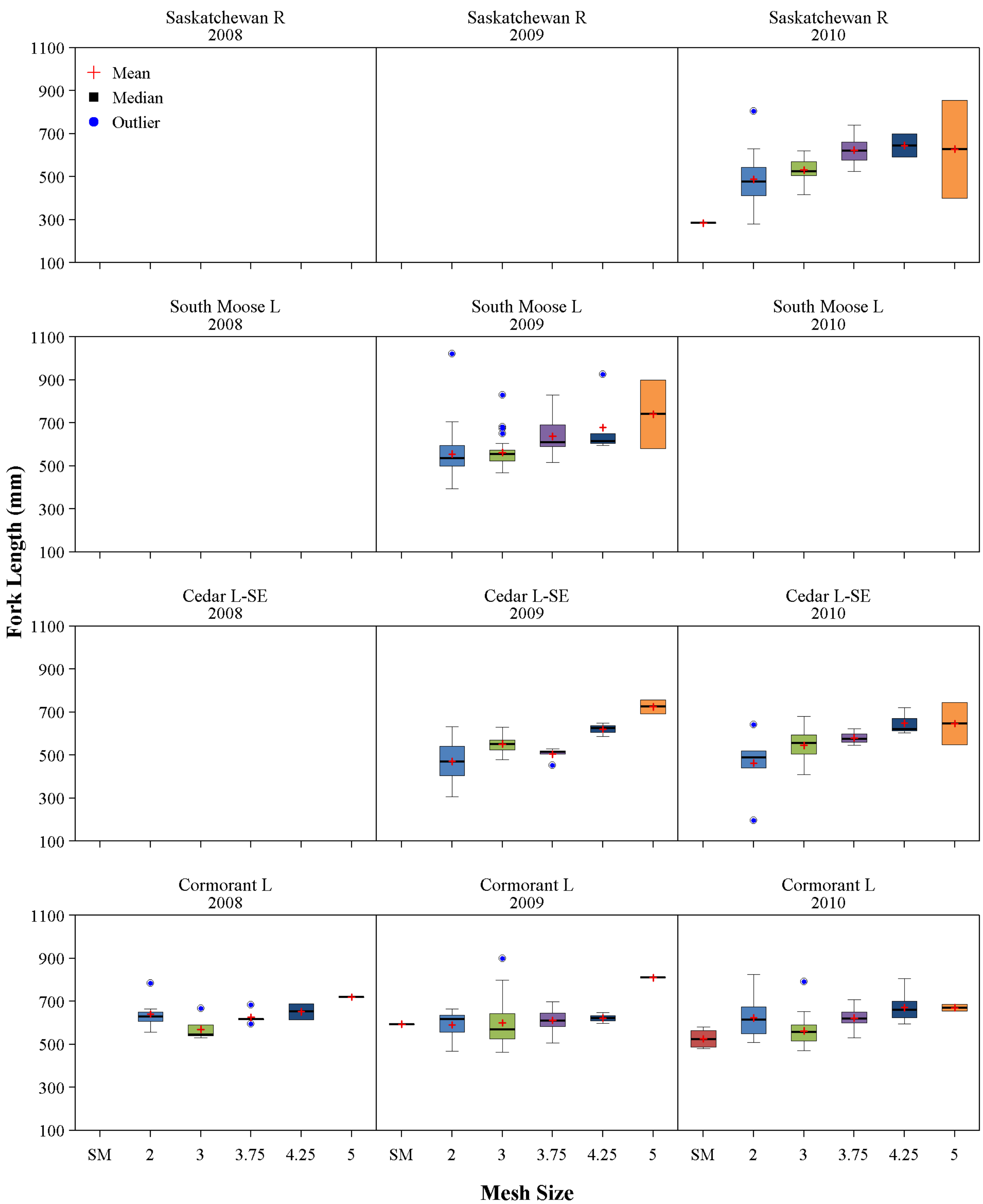


Figure 5.2.7-21. Mean and median (range) fork length (mm) per mesh size calculated for Northern Pike captured in standard gang and small mesh index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

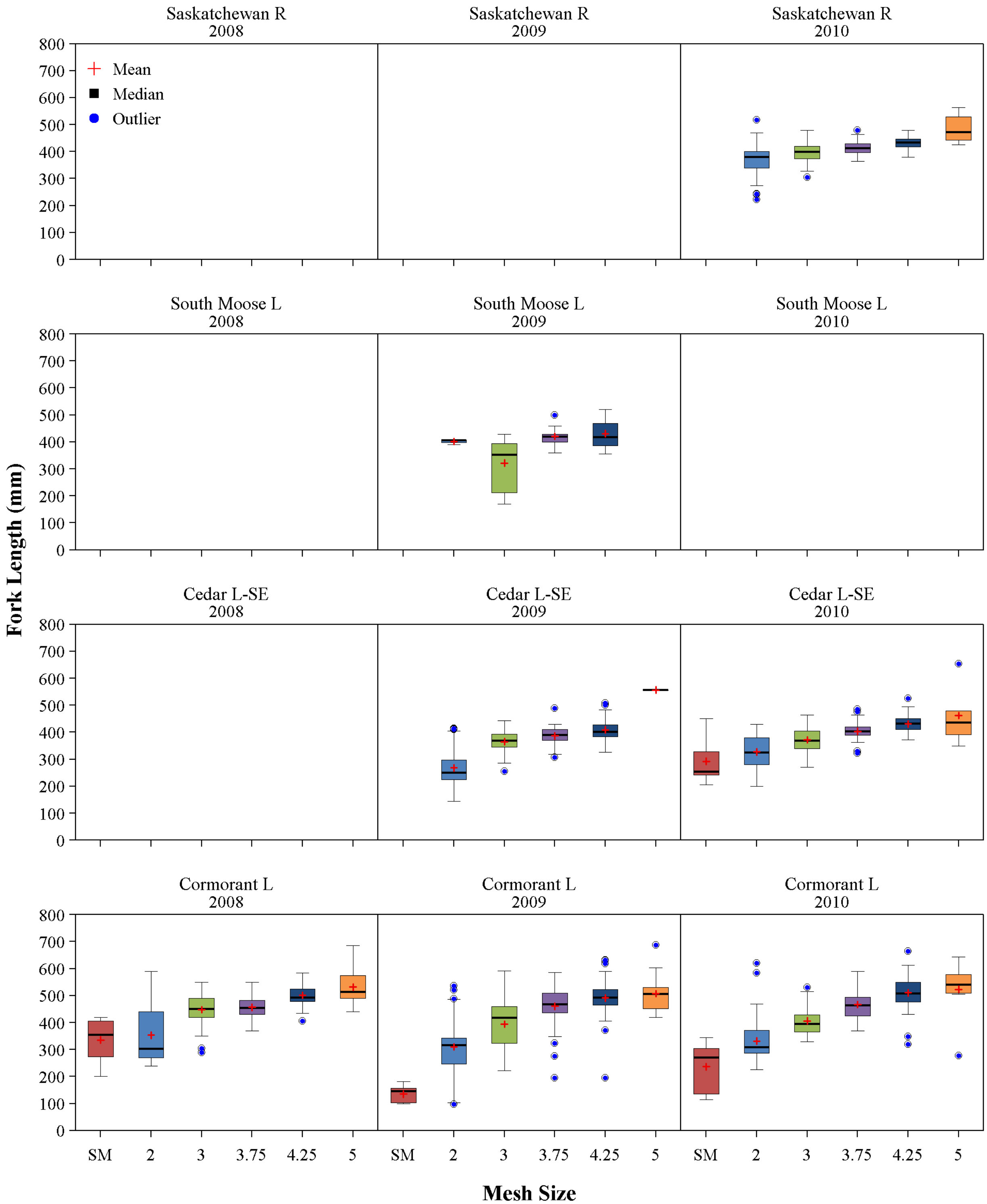


Figure 5.2.7-22. Mean and median (range) fork length (mm) per mesh size calculated for Walleye captured in standard gang and small mesh index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

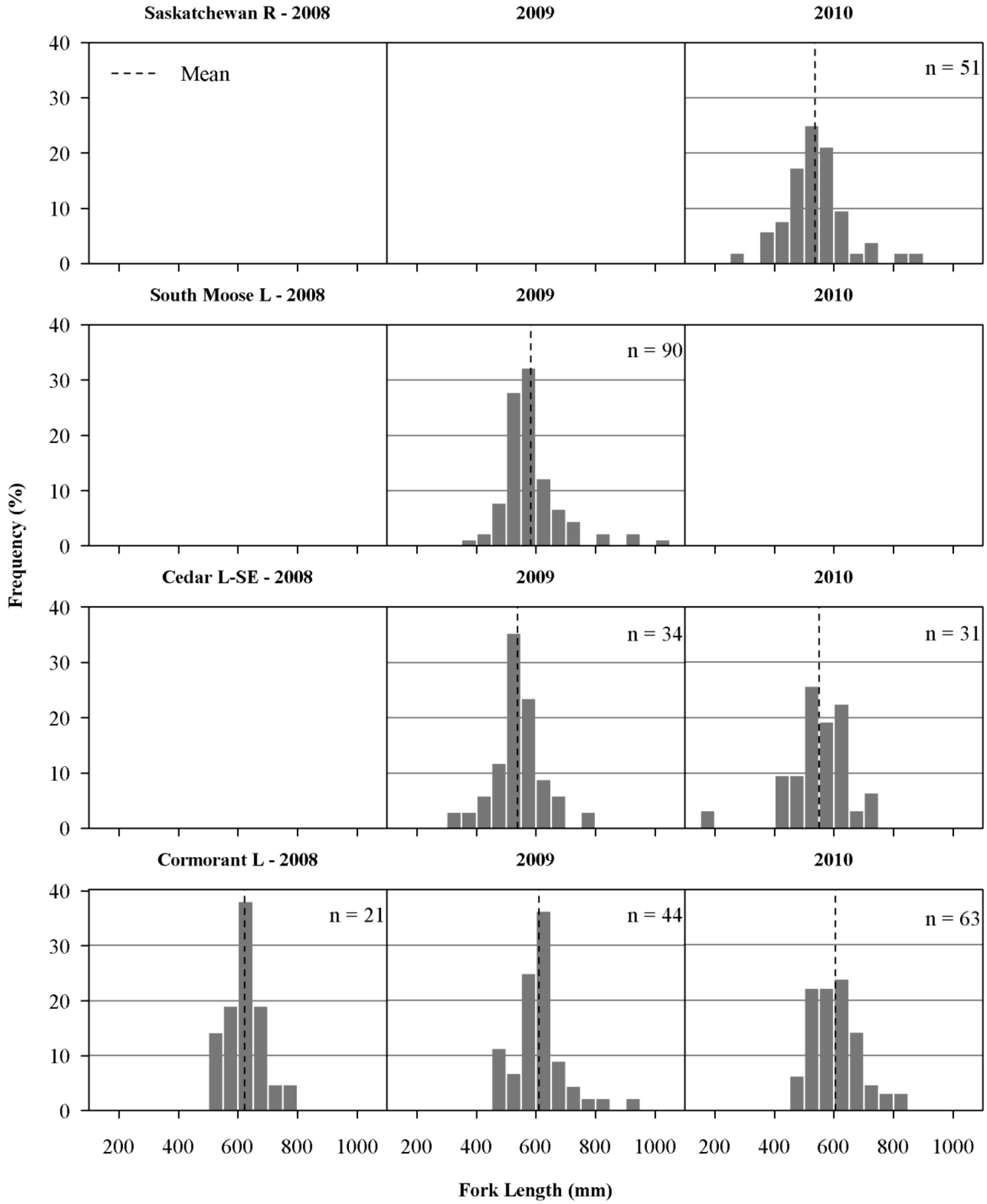


Figure 5.2.7-23. Fork length frequency histograms for Northern Pike captured in Saskatchewan River Region waterbodies, 2008-2010.

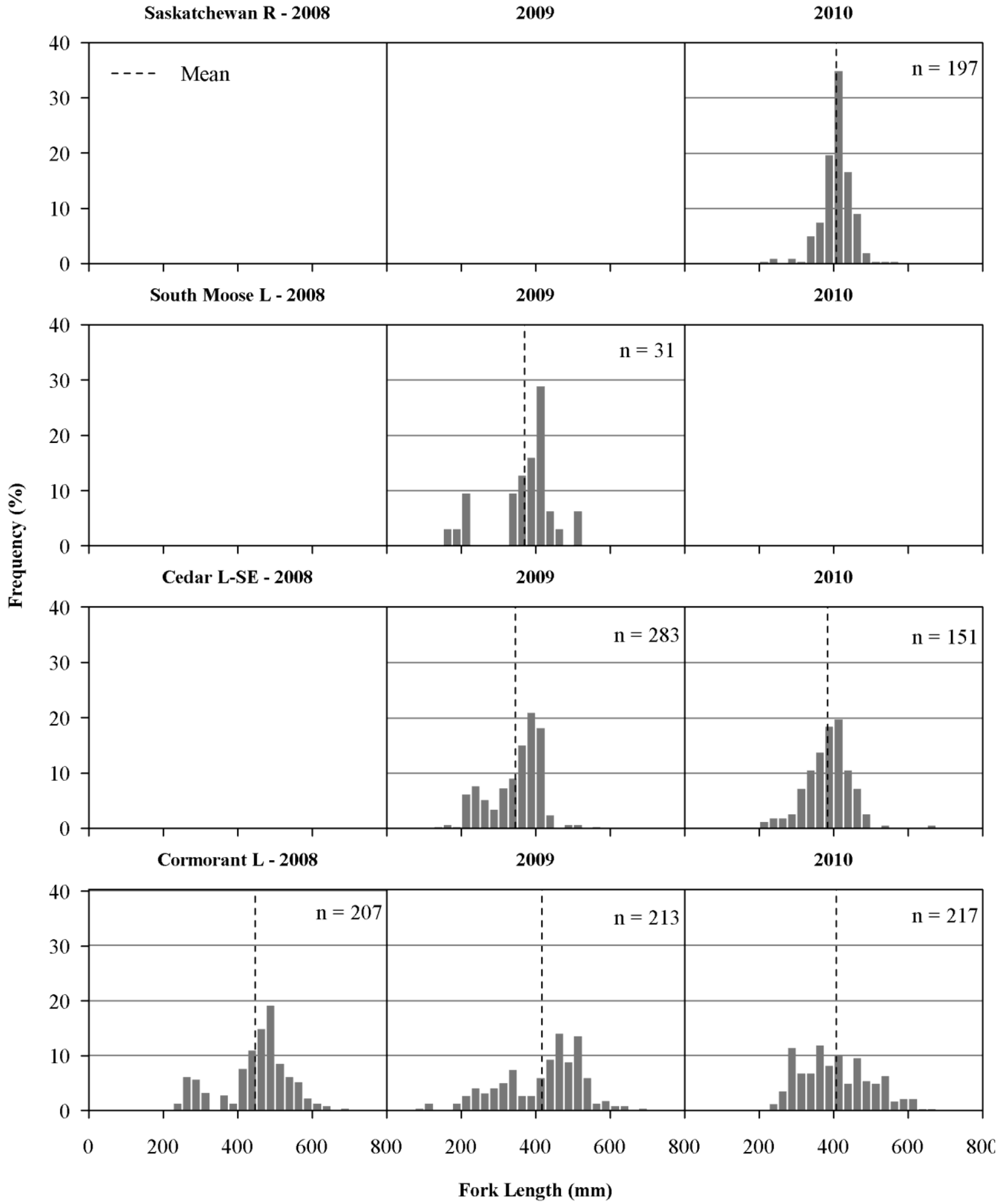


Figure 5.2.7-24. Fork length frequency histograms for Walleye captured in Saskatchewan River Region waterbodies, 2008-2010.

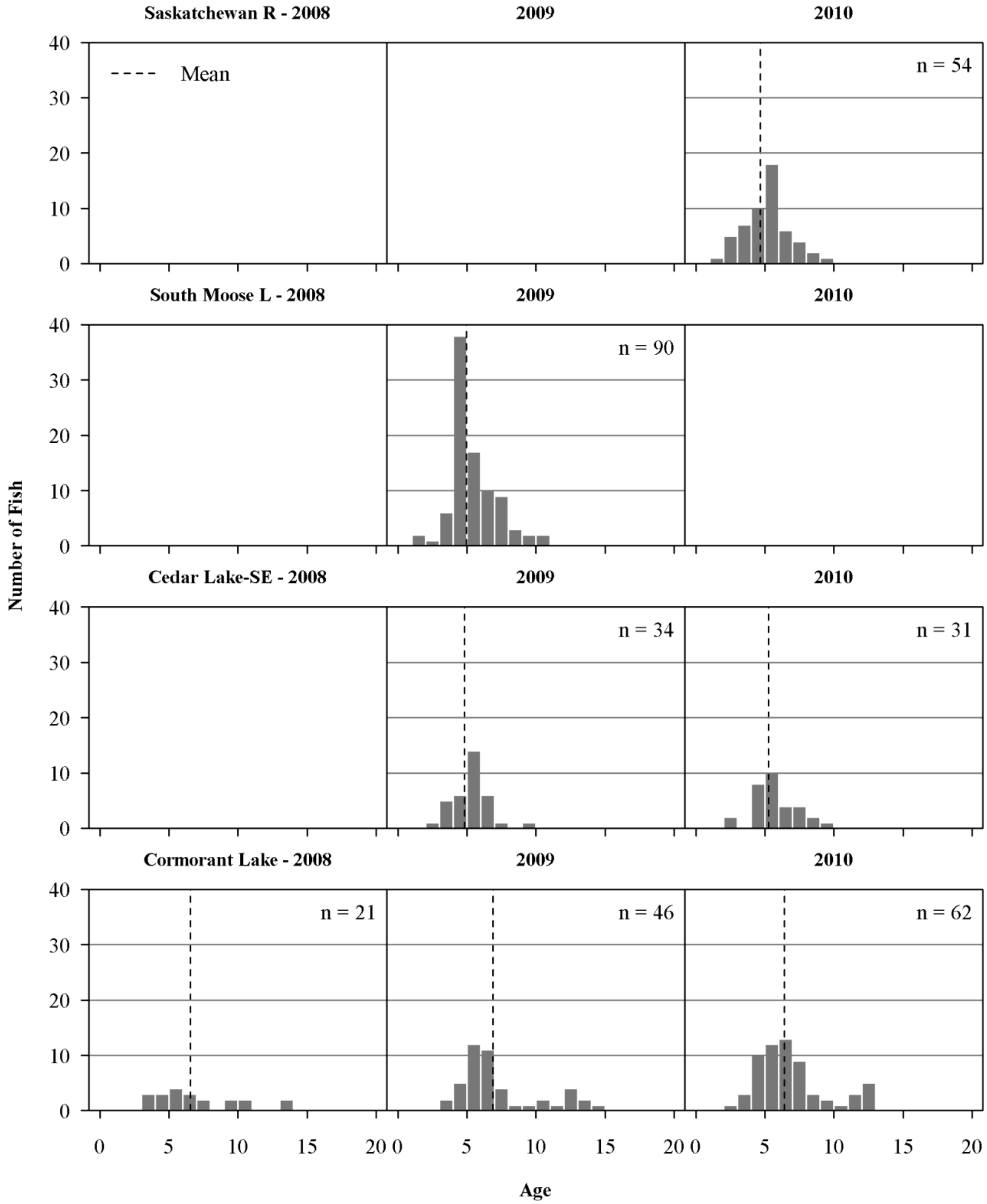


Figure 5.2.7-25. Catch-at-age plots for Northern Pike captured in standard gang index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

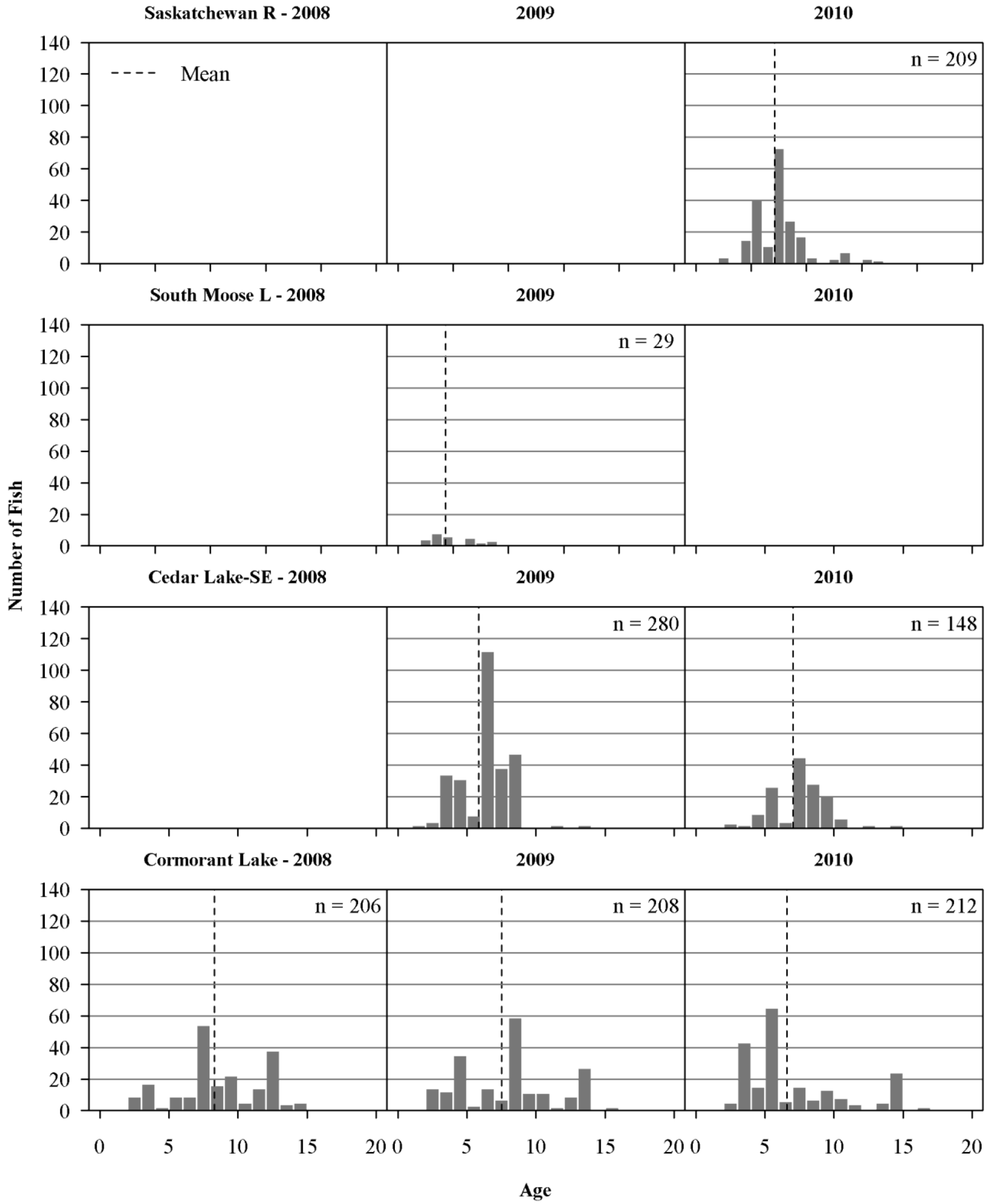


Figure 5.2.7-26. Catch-at-age plots for Walleye captured in standard gang index gill nets set in Saskatchewan River Region waterbodies, 2008-2010.

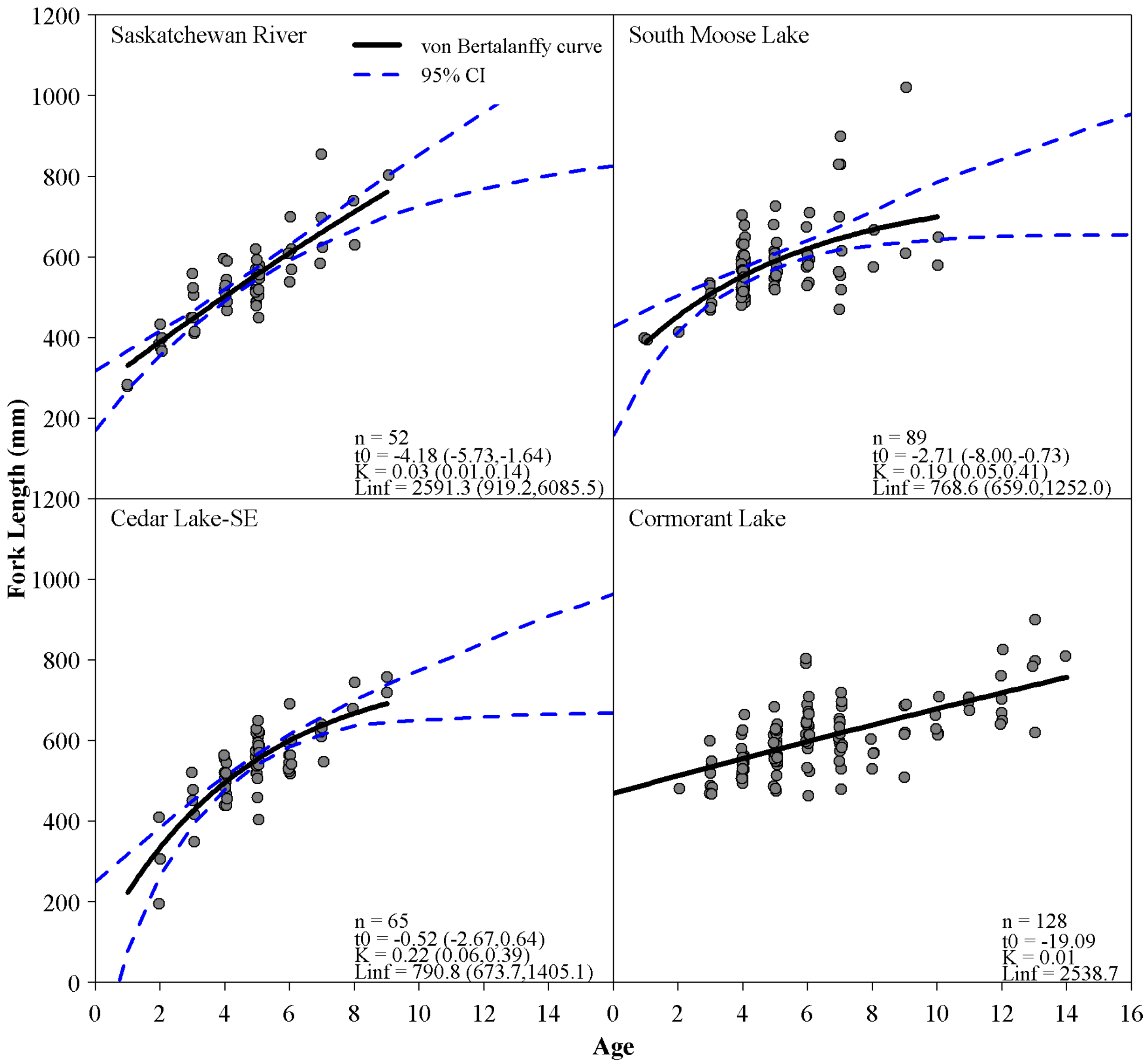


Figure 5.2.7-27. Fitted typical von Bertalanffy growth models for Northern Pike captured in standard gang gill nets set in Saskatchewan River Region waterbodies, 2008-2010. Estimated von Bertalanffy growth model parameters (asymptotic length Linf, growth coefficient K, and age when the average length was zero t0) are shown. Note: Confidence intervals could not be calculated for Cormorant Lake

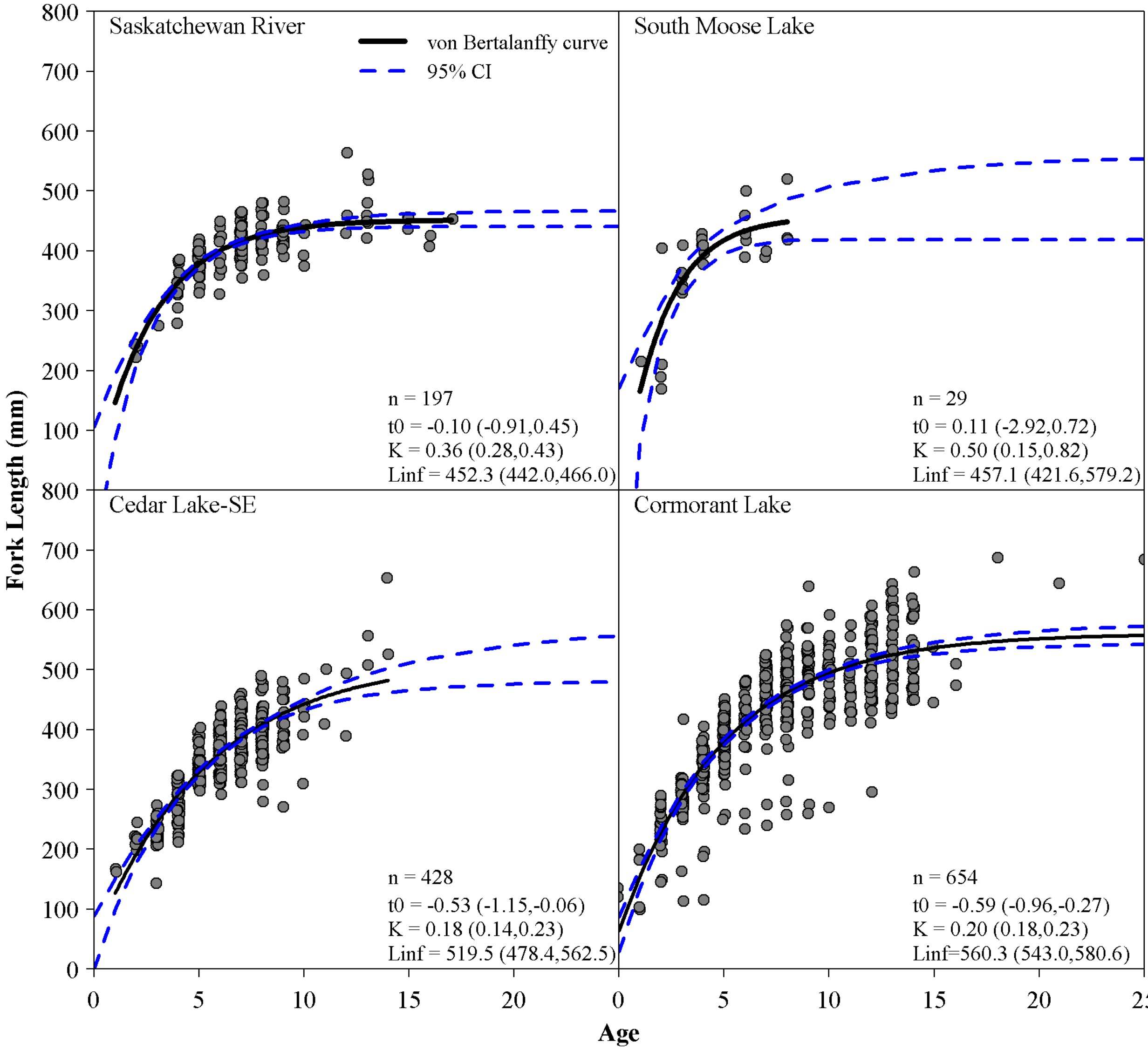


Figure 5.2.7-28. Fitted typical von Bertalanffy growth models for Walleye captured in standard gang index gill nets set in Saskatchewan River Region waterbodies, 2008-2010. Estimated von Bertalanffy growth model parameters (asymptotic length Linf, growth coefficient K, and age when the average length was zero t0) are shown.

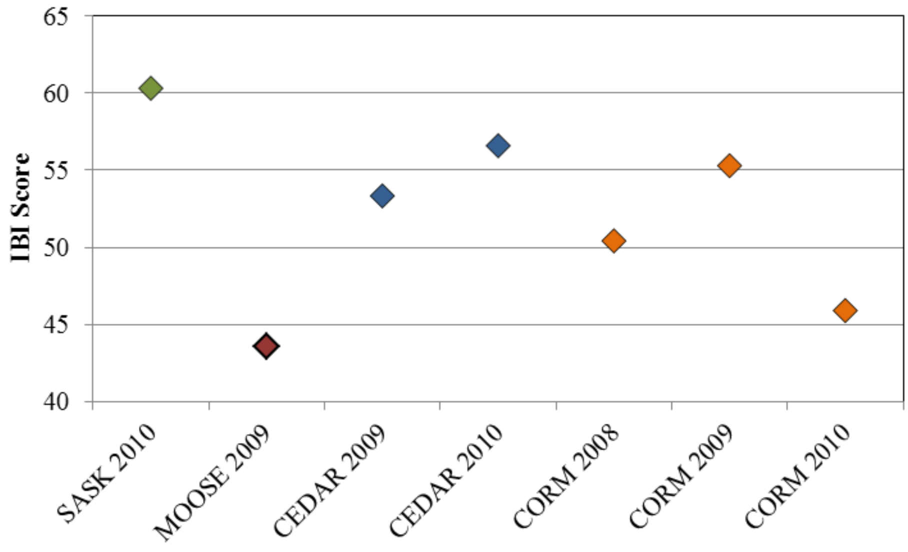


Figure 5.2.7-29. Scatter plot of yearly IBI scores for Saskatchewan River Region waterbodies, 2008-2010.

5.2.8 Fish Mercury

The following provides an overview of the results of fish mercury monitoring conducted in the Saskatchewan River Region under CAMPP. Waterbodies sampled in 2010 included the Saskatchewan River east of The Pas (which actually only included fish collected from sampling sites in Cedar Lake [West] near the outlet of the Saskatchewan River; sites GN-01 to GN-08 in Figure 5.2.8-1; see Section 5.2.7.1 for further notes on Saskatchewan River sampling in 2010), Cedar Lake (Southeast; Figure 5.2.8-2), and an off-system waterbody, Cormorant Lake (Figure 5.2.8-3). Details of sampling locations, times, and methodology are provided in Appendix 1.

5.2.8.1 Species comparisons

A total of 296 fish collected from the Saskatchewan River Region were analyzed for mercury. For most waterbodies, the target sample size of fish was met (Table 5.2.8.-1). However, no Lake Whitefish were captured from the Saskatchewan River or Cedar Lake, and no 1-year old Yellow Perch were caught from the Saskatchewan River (Table 5.2.8-1). This included the eight "Saskatchewan River" sites that are actually located within the west basin of Cedar Lake (Figure 5.2.8.-1). The mean ages of Yellow Perch from Cedar and Cormorant lakes were 1.6 and 1.8 years and mean lengths were 106 and 109 mm, respectively.

Mercury concentration and fish length were significantly positively correlated for all large-bodied species sampled from the three waterbodies (Table 5.2.8-1), indicating that length-standardization of concentrations was necessary for comparative purposes. In contrast, Yellow Perch showed either no significant relationship between the two metrics (Cormorant Lake) or if the relationship was significant, mercury concentration was negatively correlated with fish length (Cedar Lake; see Figure 6.6-1).

Length-standardized concentrations were generally within approximately 10% of arithmetic concentrations, except for Northern Pike from Cormorant Lake, for which the arithmetic concentration was approximately one third higher than the concentration calculated for fish of standard length (Table 5.2.8-1). This difference was mainly due to the relatively large average size of the Pike analyzed for mercury, which were 59 mm longer than the standard length of 550 mm (Table 5.2.8-2).

Mean arithmetic mercury concentrations of Northern Pike from the Saskatchewan River and Cedar Lake were similar to those of Walleye in the respective waterbodies, whereas mercury concentrations in these two piscivores were significantly different in Cormorant Lake (Table 1). In fact, concentrations in all four species sampled from Cormorant Lake were significantly different from each other with Pike having the highest and Yellow Perch having the lowest concentrations. Mercury concentrations in piscivorous species such as Pike and Walleye are typically substantially higher than in benthivorous species such as Whitefish and juvenile Perch, as has been previously shown in Manitoba waterbodies (Bodaly et al. 2007; Jansen and Strange 2007b; Bodaly et al. 1987; Green 1986).

5.2.8.2 Comparison to consumption guidelines

Mean length-standardized mercury concentrations of all fish species collected in the Saskatchewan River Region were substantially below 0.5 parts per million (ppm), the Health Canada standard for commercial marketing of freshwater fish in Canada (Health Canada 2007a,b) and the Manitoba aquatic life tissue residue guideline for human consumers (Manitoba Water Stewardship [MWS] 2011). Furthermore, only length-standardized concentrations in Northern Pike from the Saskatchewan River and Cormorant Lake clearly exceeded 0.2 ppm mercury (Table 5.2.8-1; Figure 5.2.8-5), a level commonly accepted as a safe consumption limit for people eating large quantities of fish domestically (see section 4.8.2.3).

Based on individual concentrations, approximately half of all Northern Pike and 30% of Walleye exceeded the 0.2 ppm guideline (Figure 5.2.8-4). Approximately 25% of the Northern Pike and 2% of the Walleye had mercury concentrations that also exceeded the 0.5 ppm Health Canada standard and the Manitoba aquatic life tissue residue guideline for human consumers (MWS 2011). In addition, mercury concentrations of most fish collected from the Saskatchewan River Region were substantially higher than the Canadian Council for Ministers of the Environment (CCME) and Manitoba tissue residue guidelines of 0.033 ppm methylmercury for the protection of wildlife consumers of aquatic biota (CCME 1999; updated to 2013; MWS 2011); the exceptions were nine Lake Whitefish from Cormorant Lake and 36 out of 50 Yellow Perch collected from Cedar and Cormorant lakes. While CAMPP monitors for total mercury rather than methylmercury in fish muscle, the vast majority of mercury in fish muscle is in the form of methylmercury (see section 4.8.2.3) and comparison to these guidelines is conservative.

5.2.8.3 Spatial comparisons

All three fish species sampled from Cedar Lake (Southeast) had significantly lower mercury concentrations than their conspecifics from either the Saskatchewan River (i.e., Cedar Lake west) or the off-system lake, Cormorant Lake (Figure 5.2.8-5). At just slightly above 0.1 ppm, Northern Pike and Walleye collected from the southeastern portion of Cedar Lake had length-standardized concentrations that are among the lowest recorded from any Manitoba waterbody in the past 20 years (Jansen 2010a,b; Jansen 2009; Jansen and Strange 2009, 2007a,b; Bodaly et al. 2007). Walleye and Pike from Cormorant Lake had higher mercury concentrations than their conspecifics from the Saskatchewan River (i.e., Cedar Lake West), but these differences were not statistically significant (Figure 5.2.8-5).

Table 5.2.8-1. Arithmetic mean (± standard error, SE) and length-standardized (95% confidence limit, CL) mercury concentrations (ppm) in Lake Whitefish, Northern Pike, Walleye, and Yellow Perch captured in the Saskatchewan River Region in 2010.

Waterbody	Species	n	Arithmetic	SE	Standard	95% CL
Saskatchewan R	Northern Pike	36	0.230	0.025	0.227	0.197 - 0.262
	Walleye	36	0.202	0.019	0.180	0.157 - 0.205
	Lake Whitefish	0	-	-	-	-
	Yellow Perch	0	-	-	-	-
Cedar L SE	Northern Pike	31	0.116[b]	0.011	0.105	0.090 - 0.121
	Walleye	36	0.106[b]	0.010	0.107	0.095 - 0.120
	Lake Whitefish	0	-	-	-	-
	Yellow Perch	25	0.016[a]	0.001	0.016	0.014 - 0.017
Cormorant L	Northern Pike	36	0.407[d]	0.029	0.304	0.256 - 0.360
	Walleye	36	0.224[c]	0.019	0.202	0.185 - 0.221
	Lake Whitefish	35	0.058[b]	0.007	0.047	0.041 - 0.055
	Yellow Perch	25	0.033[a]	0.001	-*	0.030 - 0.036

* The relationship between mercury concentration and fish length was not significant; the CL is for the arithmetic mean.

Note: Different superscripts represent significant differences between species within a waterbody. For significant differences between standardized means (i.e., within species between waterbodies) see Figure 5.2.8-5.

Table 5.2.8-2. Mean (± standard error, SE) fork length, round weight, condition (K), and age of fish species sampled for mercury from the Saskatchewan River Region in 2010.

Waterbody	Species	n	Length (mm)	Weight (g)	K	Age (years)
Saskatchewan R	Northern Pike	36	517.6 ± 20.6	1147.2 ± 168.8	0.68 ± 0.01	4.5 ± 0.3
	Walleye	36	399.9 ± 7.8	774.3 ± 40.4	1.16 ± 0.02	7.6 ± 0.6
	Lake Whitefish	0	-	-	-	-
	Yellow Perch	0	-	-	-	-
Cedar L SE	Northern Pike	31	549.2 ± 18.4	1436.1 ± 133.0	0.79 ± 0.01	5.3 ± 0.3
	Walleye [a]	36	377.3 ± 15.6	798.8 ± 107.7	1.20 ± 0.02	7.0 ± 0.4
	Lake Whitefish	0	-	-	-	-
	Yellow Perch	25	106.3 ± 4.0	19.5 ± 2.1	1.44 ± 0.03	1.6 ± 0.1
Cormorant L	Northern Pike [b]	36	608.5 ± 11.0	1776.3 ± 115.8	0.75 ± 0.01	6.5 ± 0.4
	Walleye [c]	36	415.3 ± 16.7	925.7 ± 116.3	1.05 ± 0.02	6.1 ± 0.5
	Lake Whitefish [b]	35	360.8 ± 12.0	690.9 ± 63.2	1.29 ± 0.02	11.5 ± 1.0
	Yellow Perch [d]	25	108.8 ± 2.4	16.7 ± 1.1	1.26 ± 0.02	1.8 ± 0.2

[a] n = 32 for age; [b] n = 34 for age; [c] n = 35 for age; [d] n = 12 for age.

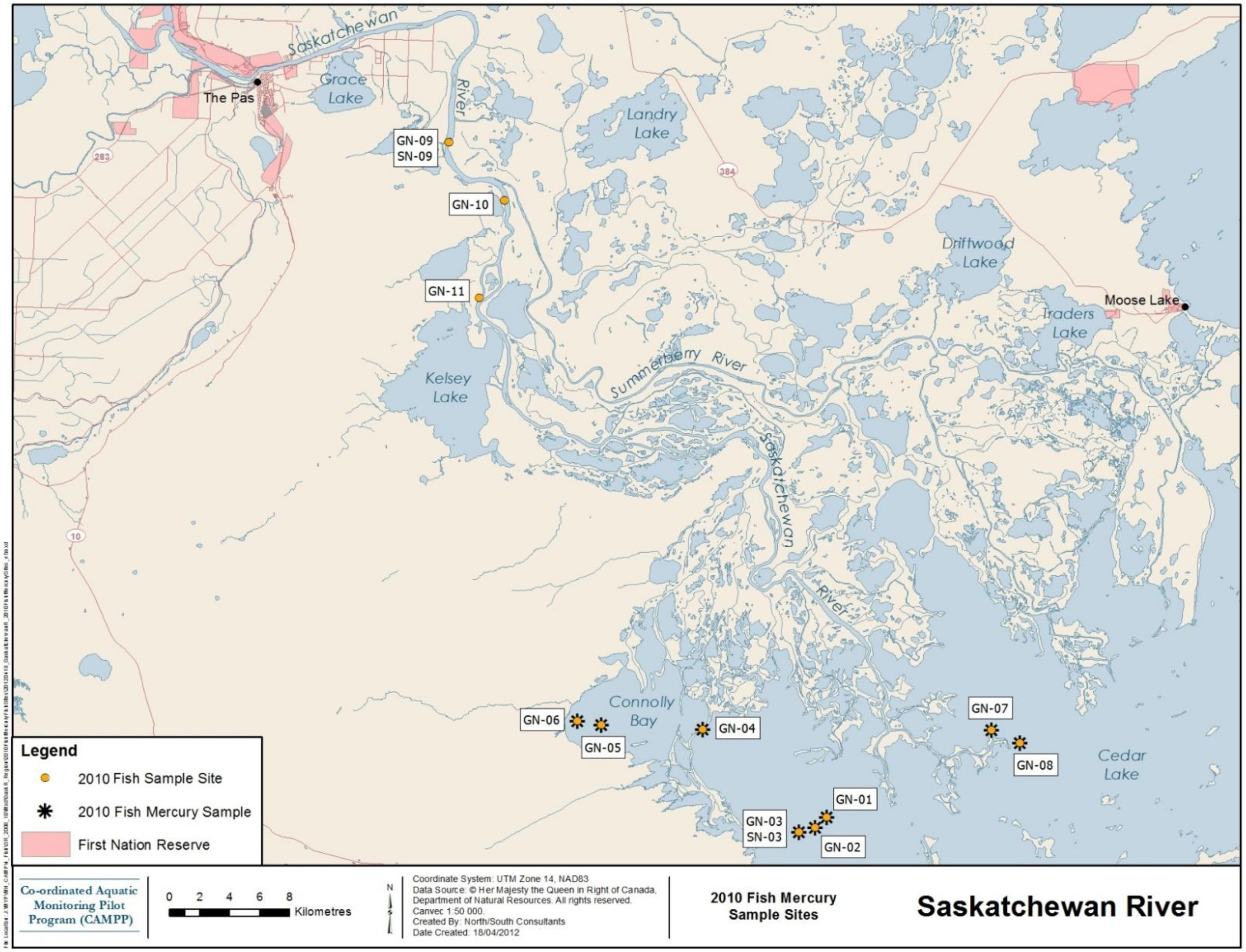


Figure 5.2.8-1. Fish sampling sites in the Saskatchewan River, indicating those sites where fish were collected for mercury analysis.

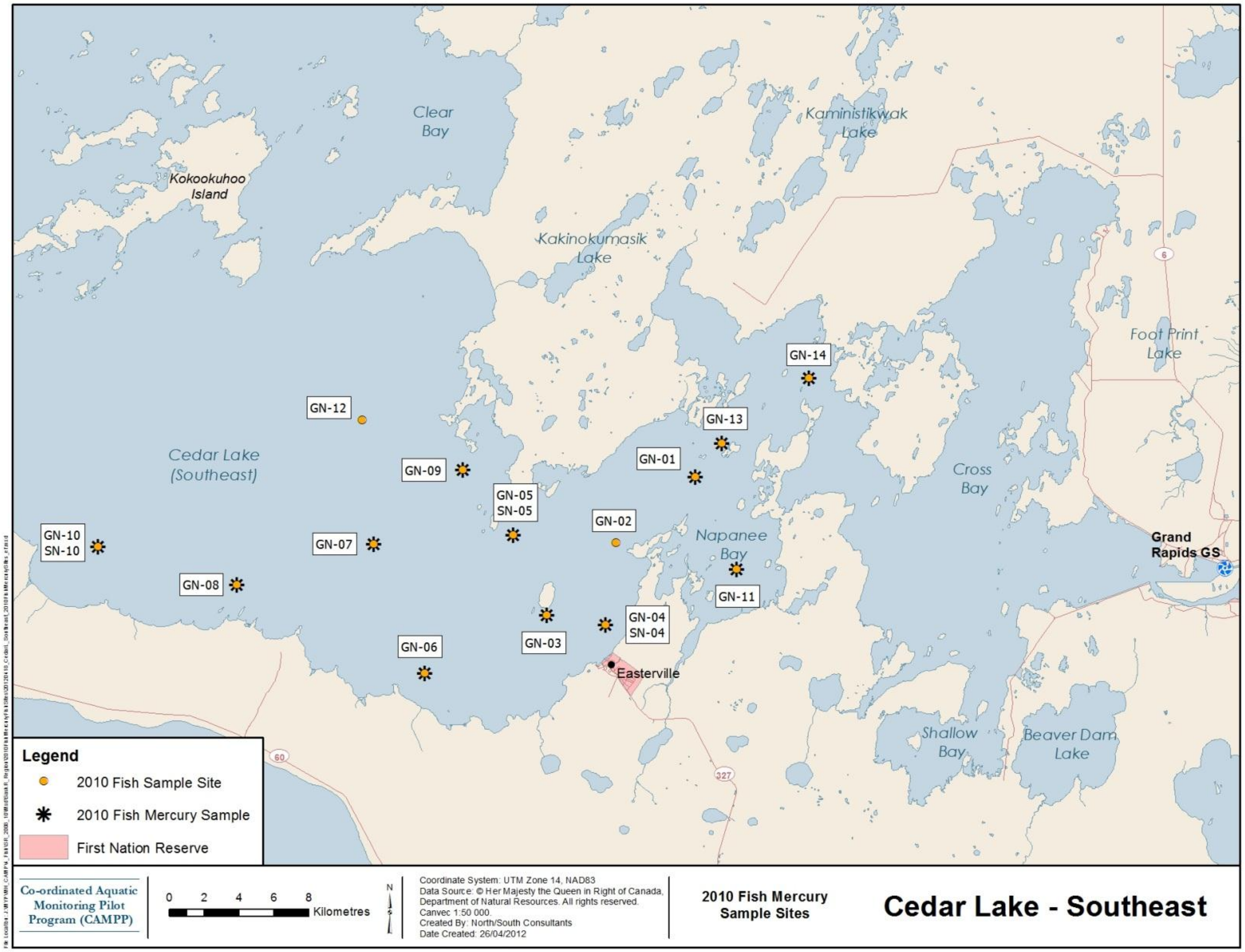


Figure 5.2.8-2. Fish sampling sites in Cedar Lake-Southeast, indicating those sites where fish were collected for mercury analysis.

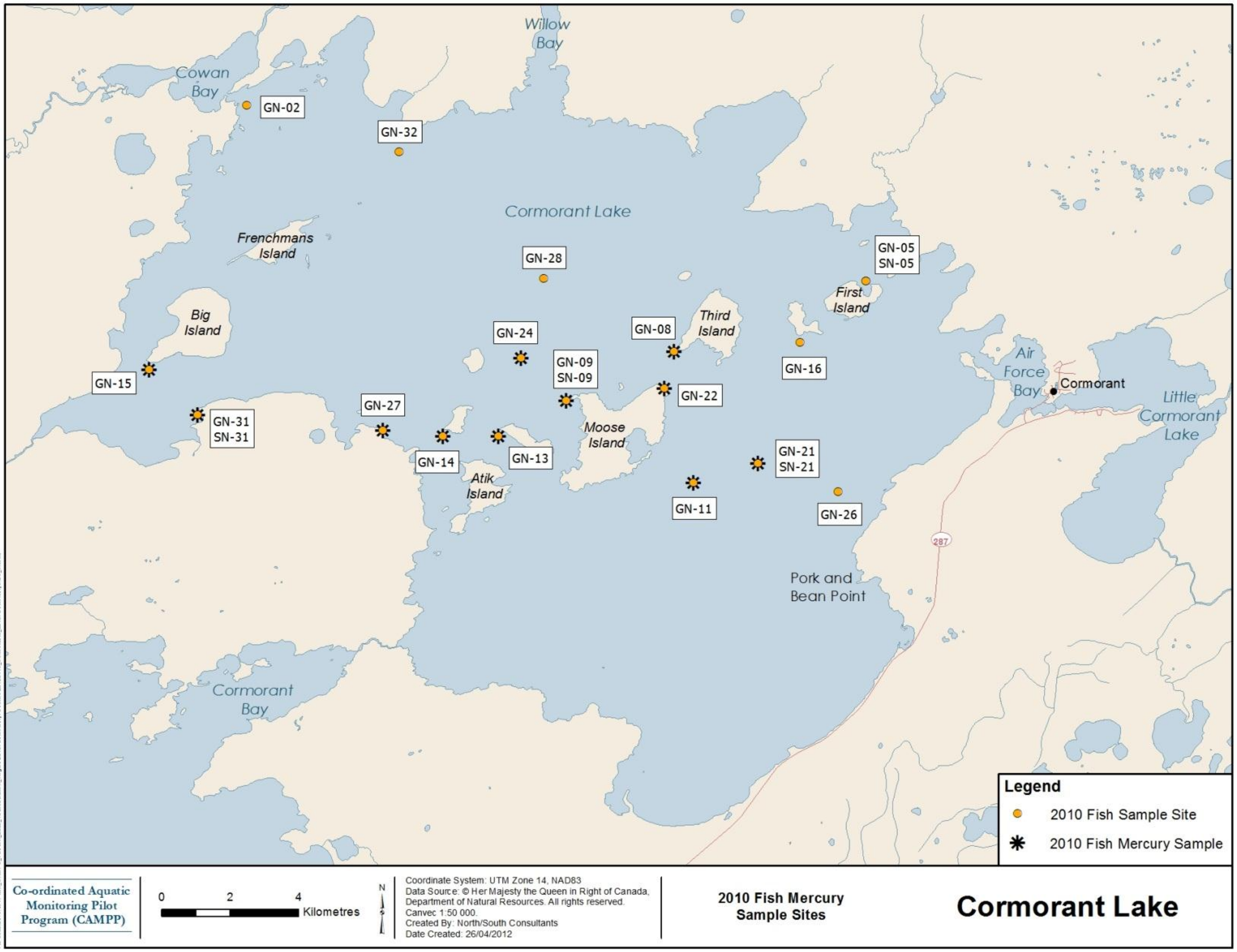


Figure 5.2.8-3. Fish sampling sites in Cormorant Lake, indicating those sites where fish were collected for mercury analysis.

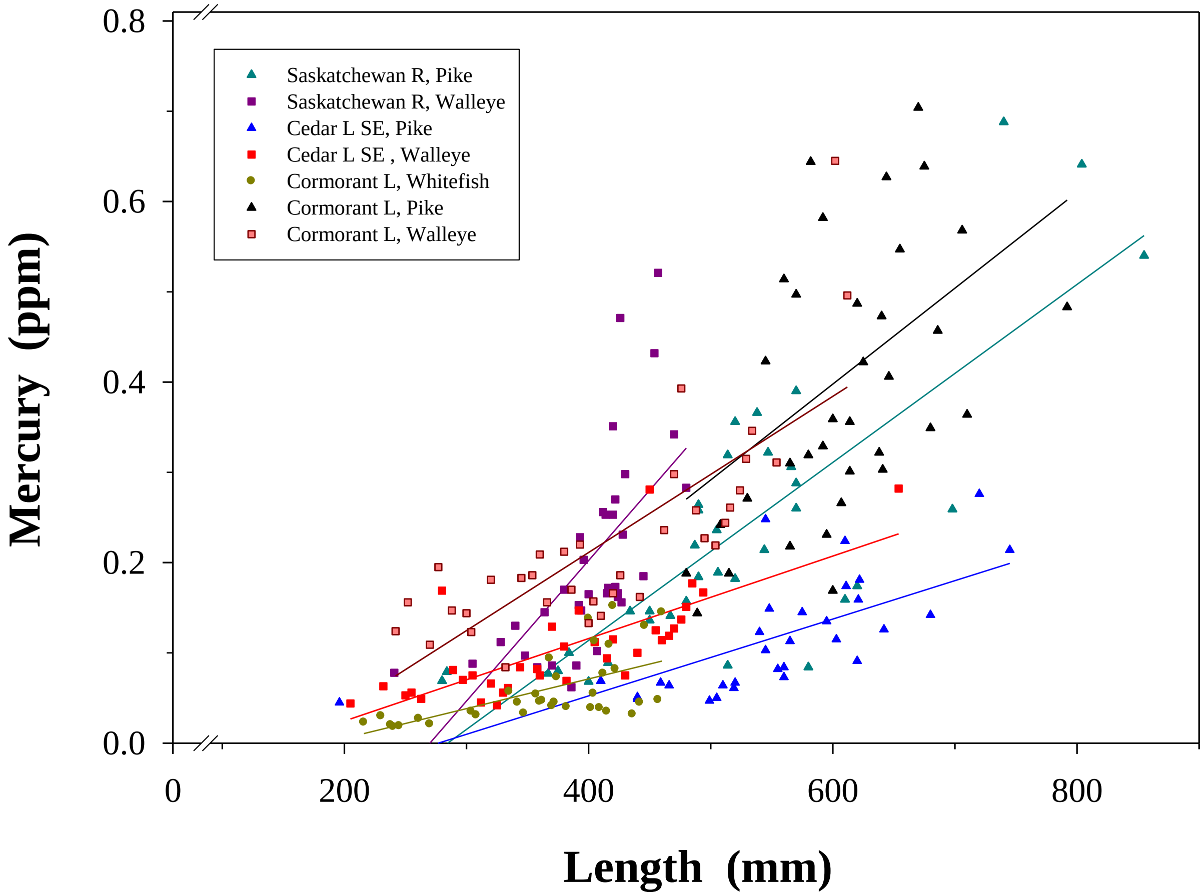


Figure 5.2.8-4. Relationship between muscle mercury concentration and fork length for Lake Whitefish, Northern Pike, and Walleye captured in the Saskatchewan River Region in 2010. Significant linear regression lines are shown.

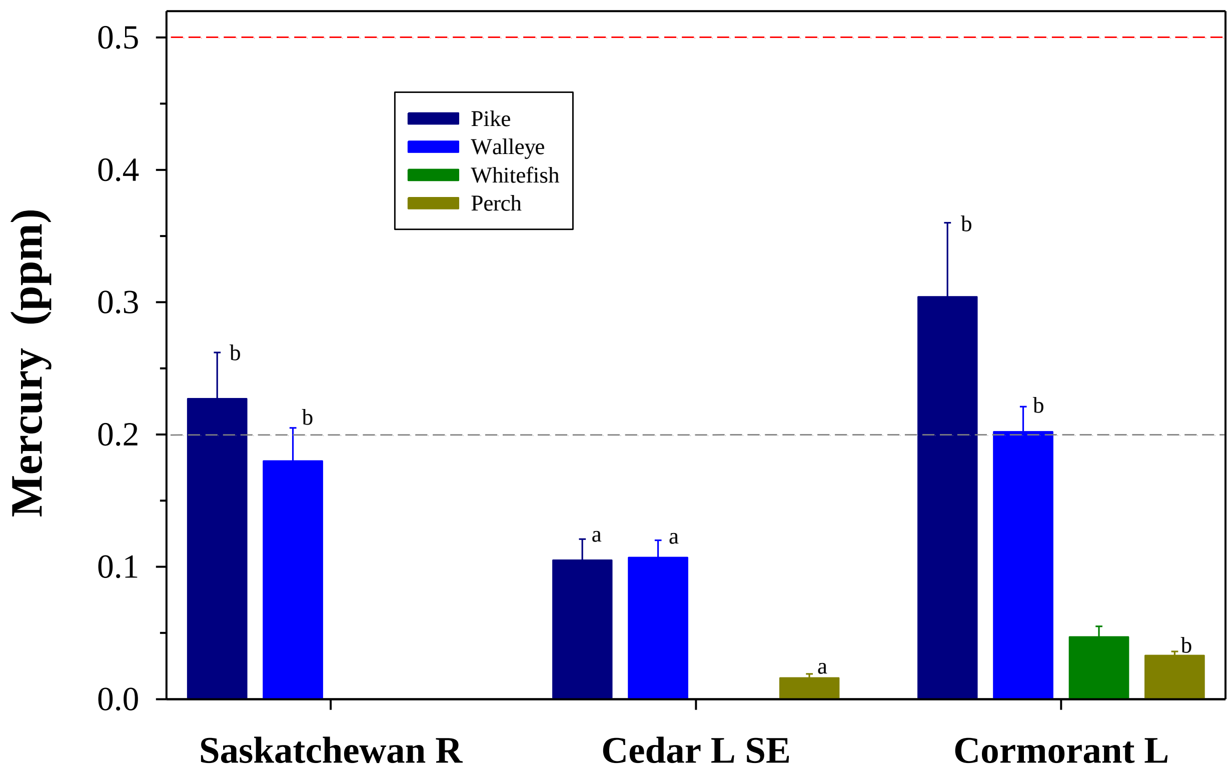


Figure 5.2.8-5. Length-standardized mean (+95% CL) muscle mercury concentrations of Northern Pike, Walleye, and Lake Whitefish, and arithmetic mean (+95% CL) concentrations of Yellow Perch from the Saskatchewan River Region in 2010. Means with different superscripts indicate a significant difference between waterbodies within species. Stippled lines indicate the 0.5 ppm standard and the 0.2 ppm guideline for human consumption.