LOWER WINNIPEG RIVER BASIN DISCUSSION SHEET SERIES
Sheet #4

Water Quality and Nutrient Loading

May 2021

Introduction

The lower Winnipeg River basin (LWRB) is located in the northwest section of the entire Winnipeg River basin (WRB), which spans parts of western Ontario and small parts of Manitoba and northern Minnesota, United States. The Discussion Sheet Series highlights research on ecological and socio-economic aspects of the basin to encourage discussion with experts, government departments, Indigenous groups, and stakeholders. The Discussion Sheet Series is based on available data collected in 2018 and 2019. Sheet 4 of 11 summarizes water quality and nutrient loading in the LWRB.

Water Quality

Four sites in the LWRB were assessed for selected water quality variables from 2000 onward (Figure 1): Eaglenest Lake (Coordinated Aquatic Monitoring Program [CAMP], 2018[1]; "off-system" site upstream of Manitoba Hydro regulation), Pointe du Bois (Environment and Climate Change Canada [ECCC], 2018b), Lac du Bonnet (CAMP, 2018), and Pine Falls Forebay (Water Quality Management Section, Manitoba Sustainable Development [MSD], 2018).

The lower Winnipeg River is isothermic, meaning temperatures are consistent through the water column (CAMP, 2017). Temperatures have been recorded at 23°C in the near-bottom environment, which may influence habitat suitability for aquatic organisms for reproductive success, growth, and survival (Hasnain et al., 2010). Dissolved oxygen (DO) is also an important indicator of the river's ability to support aquatic life: the river is well oxygenated during all seasons with a mean DO concentration of approximately 10 mg/L across all four sites, above the Canadian Council of Ministers of the Environment (CCME, 2008) guidelines of 5.0 to 9.5 mg/L for warm- to cold-water biota.

[1] The Coordinated Aquatic Monitoring Program (CAMP) was developed by the Government of Manitoba and Manitoba Hydro to monitor the health and integrity of aquatic ecosystems that are potentially influenced by hydroelectric generating stations (CAMP, 2017).

Surface water and some near-bottom samples were analyzed for turbidity, specific conductance, pH, alkalinity, hardness, total organic carbon, mercury, and fecal coliforms. None were highlighted as a concern based on provincial guidelines, and most were within guidelines for the protection of aquatic life (PAL) with few exceedances. The lower Winnipeg River has low turbidity and variable conductivity and is considered slightly alkaline and soft based on calcium carbonate, with total organic carbon within the expected range for central Canada (CCME, 2008).

Total nitrogen (TN), total Kjeldahl nitrogen, nitrate, and nitrite concentrations in the lower Winnipeg River did not exceed guidelines (Manitoba Water Stewardship [MWS], 2011). Mean total phosphorus (TP) concentrations appear to increase downstream toward Pine Falls Forebay; however, there is a large range/variability in concentrations in Pointe du Bois and Pine Falls Forebays (Figure 1). MWS (2011) indicates that TP should not exceed 25 µg/L in any pond, lake, or reservoir, or in a tributary where it connects to such sources. The percentage of samples that exceeded TP guidelines were 41% in Eaglenest Lake, 85.3% in Pointe du Bois Forebay, 57% in Lac du Bonnet, and 81% in Pine Falls Forebay (Figure 2).

Metals exceeding MWS PAL guidelines (2011) included aluminum, iron, and copper. Among all sites, the majority of samples were exceeding PAL guidelines for aluminum (PAL: 100 µg/L; MWS, 2011), with the highest concentrations in Pine Falls, at 100% exceedance of guidelines (Figure 3). Iron concentrations also increased downstream, with fewer samples exceeding guidelines (PAL: 300 µg/L; MWS, 2011) in Eaglenest Lake, Pointe du Bois Forebay and Lac du Bonnet, but nearly 50% of samples exceeded guidelines in the Pine Falls Forebay (Figure 3). Copper concentrations were well within guidelines (PAL: 4.53 µg/L; MWS, 2011) in the Pointe du Bois Forebay, but a few samples exceeded guidelines in Eaglenest Lake and Lac du Bonnet. However, 58% of samples from Pine Falls Forebay were exceeding guidelines and were highly variable between 2007 and 2017 (Figure 4).

The potential impact of metal exceedances on aquatic life is unknown, as is a major source contributor(s). There is no current data or information that explains these exceedances—whether it is influenced by human activity or naturally occurring. It could be attributed to surface water runoff, mining activity, soil chemistry/quality, river geology, or erosion.

Nutrient Loading

The Winnipeg River is the second largest contributor in absolute terms of nutrients to Lake Winnipeg (Bourne et al., 2002; Environment Canada & MWS, 2011). Despite low concentrations of nutrients in the river's surface water, the river accounts for approximately 25% of total nitrogen (TN) and 15% of total phosphorus (TP) loads to the lake (Environment Canada & MWS, 2011). Annual nutrient loading and exports increase downstream between Pointe du Bois and Pine Falls in the LWRB, and the reach between the two sites produces nearly three to four times higher nutrient exports than at each site (Table 1).

Table 1. Average annual load and export of TP and TN into Lake Winnipeg recorded at Pointe du Bois and Pine Falls[2]

LWRB site	Watershed area (ha)	Average annual nutrient load (tonnes/year)		Average annual nutrient export (kg/ha/year)	
		TP	TN	TP	TN
Pointe du Bois (2000–2017)	12,600,000	948	17,394	0.08	1.38
Pine Falls (2001–2016)	13,600,000	1,212	22,583 (2014–2016)	0.09	1.66 (2014–2016)
Nutrient load/ export between sites	1,000,000	265	4,716 (2014–2016)*	0.27	4.72 (2014–2016)*

* Net change of TN loads/exports between sites was calculated only using 2014 to 2016 data from both sites.
Source: Table was adapted from Environment Canada & MWS, 2011.

It is estimated that the reach between Pointe du Bois and Pine Falls contributes approximately 3% of the entire TP load to the lake, based on mean annual TP loads to Lake Winnipeg of 7,830 tonnes (1994–2001) (McCullough et al., 2012) and the average annual phosphorus load by the reach of 265 tonnes (Table 1). There is likely a source of nutrients in this reach; however, the source is unknown. It is possible the increased nutrient loads originate from the surrounding watershed, streams, tributaries, cabin development, erosion, and human activity (see Sheet 11: Maps).

The *State of Lake Winnipeg 1999 to 2007* report found that 97% and 79% of variation in TN and TP loading to Lake Winnipeg from the Winnipeg River was attributed to flows in the Winnipeg River, where only 50% of variability in TP load in the Red River was attributed to flow (Environment Canada & MWS, 2011), indicating that the volume of water exported from the Winnipeg River has a significant impact on total nutrient export downstream.[3] The median climate projection from an ensemble of simulations suggests an increase of mean annual precipitation and runoff into the Winnipeg River basin of 6.9% and 3.3% for the 2050s time period, respectively. While there is still uncertainty in climate projection variables, such as runoff (Manitoba Hydro, 2020), this could have impacts on nutrient loading downstream (see Sheet 1: Climate and Climate Change).

[2] Nutrient loads and exports from 2001 to 2016 in Pointe du Bois using water quality data from ECCC and Lake Winnipeg Basin Initiative and hydrometric data from Manitoba Hydro, and from Pine Falls using water quality data from the Water Quality Management Section of MSD and ECCC hydrometric data (2018). Watershed area (ha) was accessed from Environment Canada & MWS (2011).

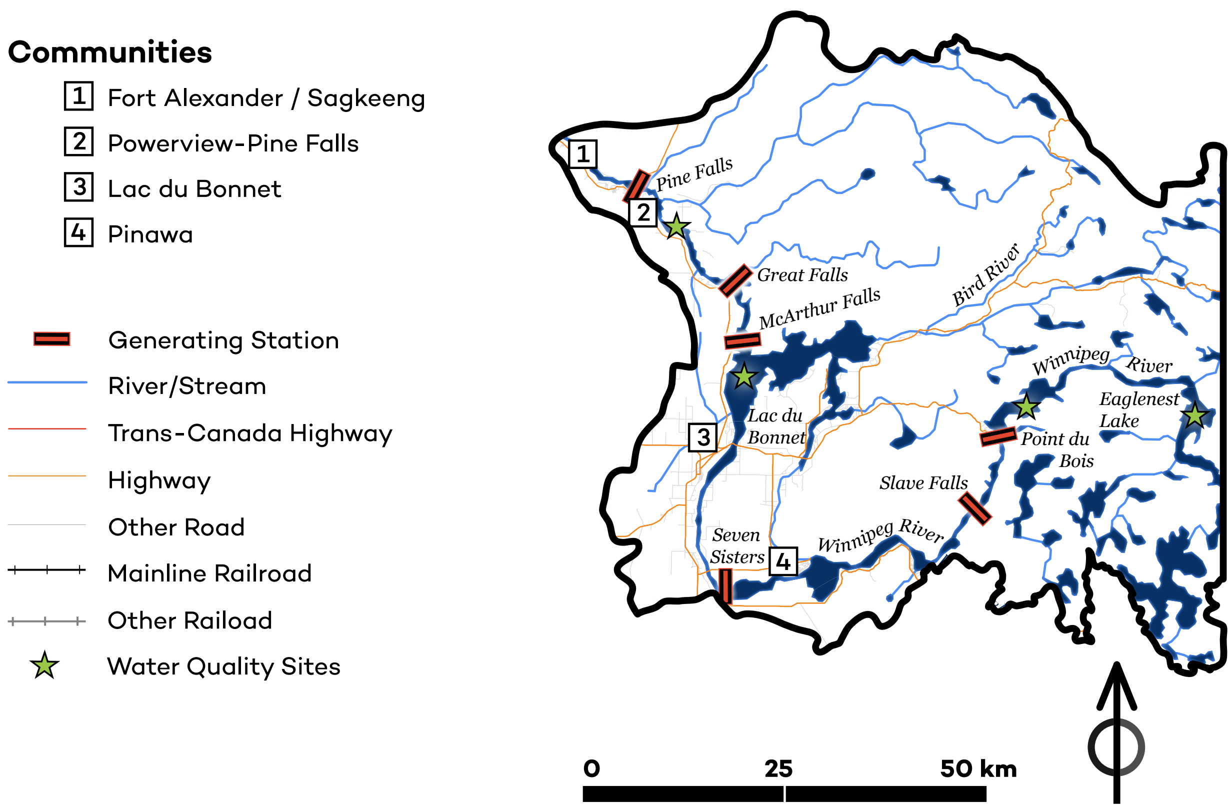
[3] For more information on river hydrology, refer to Sheet 3: Hydrology.

Data Limitations and Gaps

Water quality analyses and comparisons are limited by the reliability of the datasets, together and separately. Four sites on the lower Winnipeg River are monitored by three various organizations using different analytical methods and sampling periods. In addition, analytical methods have also changed over time, indicating that accuracy in water quality recordings may have changed, limiting the confidence for data comparison.

Future and continued monitoring of water quality in the LWRB may require an understanding of the cause or source of water quality conditions, such as nutrient loading or parameters exceeding guidelines that may impact aquatic biota and human health. It is suggested that water quality monitoring organizations communicate and collaborate with each other to ensure proper data comparison for decision making and future research and analyses.

Figure 1. Map of the LWRB highlighting water quality sampling sites



Source: Government of Manitoba, n.d.

Figure 2. Mean TP (µg/L) (± SD) recorded in Eaglenest Lake (2010 to 2017, N=12; CAMP, 2018), Pointe du Bois Forebay (2000 to 2017, N=222; ECCC, 2018b), Lac du Bonnet (2008 to 2017, N=33; CAMP, 2018), and Pine Falls Forebay (2001 to 2017, N=287; Water Quality Management Section MSD, 2018). Dotted line represents pond/land/reservoir guidelines (Manitoba Water Stewardship, 2011).

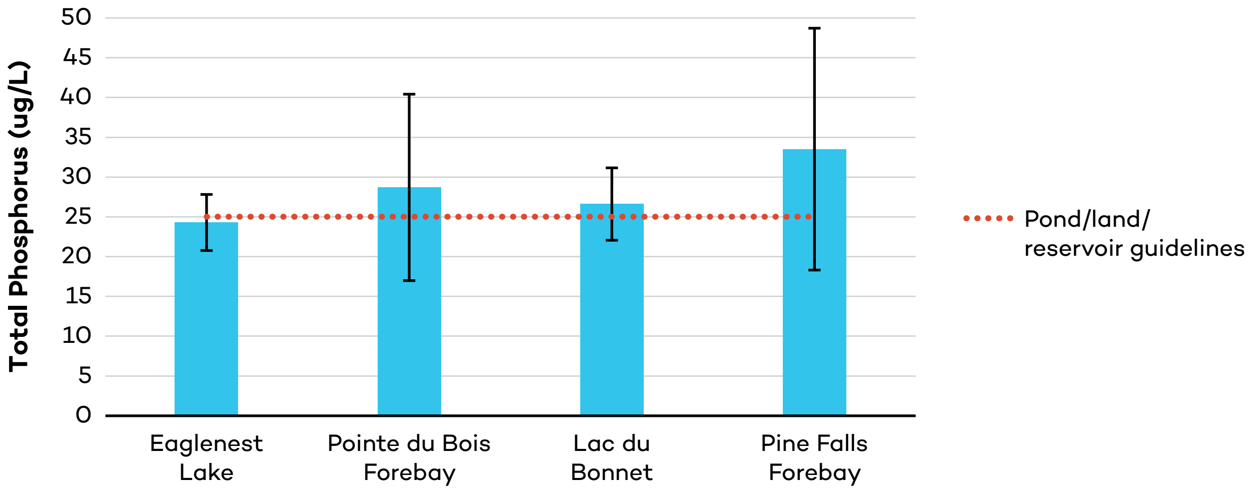


Figure 3. Mean total aluminum and total iron (µg/L) (± SD) in Eaglenest Lake (2010-2017, N=11; CAMP, 2018), Pointe du Bois Forebay (2000 to 2017, N=110; ECCC, 2018b), Lac du Bonnet (2008 to 2017, N=37; CAMP, 2018), and Pine Falls Forebay (2007 to 2017, N=129, , Water Quality Management Section MSD; 2018). Dotted line represents PAL guidelines (Manitoba Water Stewardship, 2011)

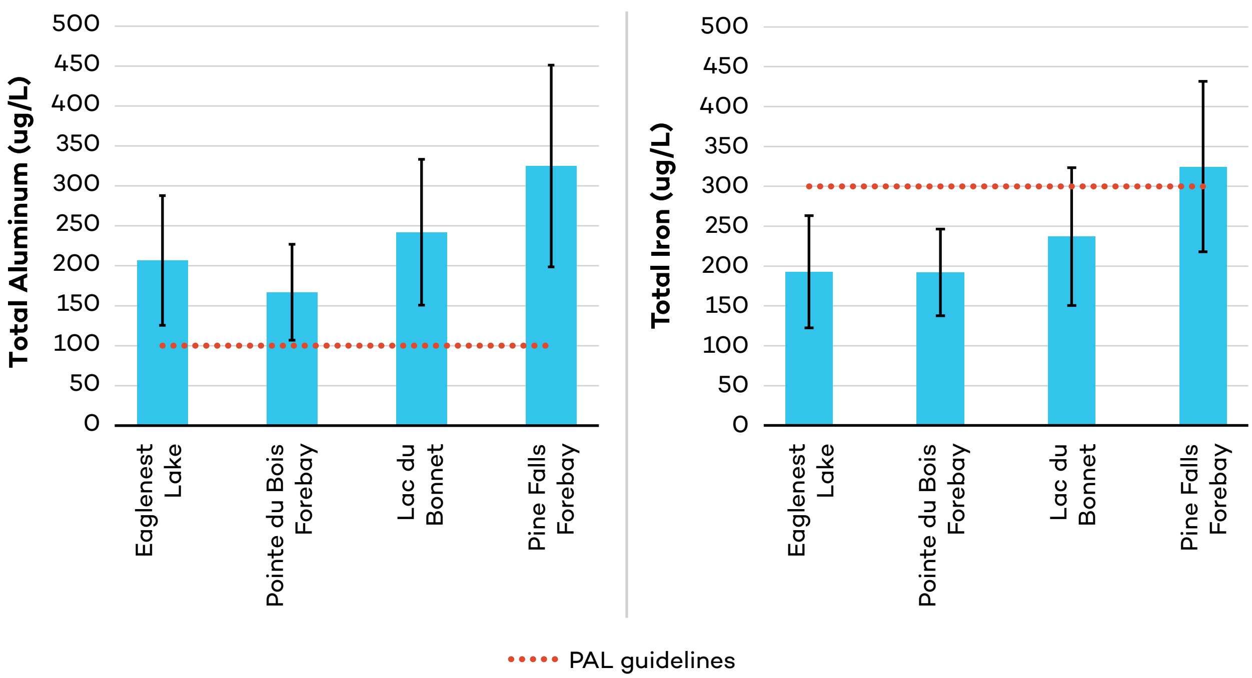
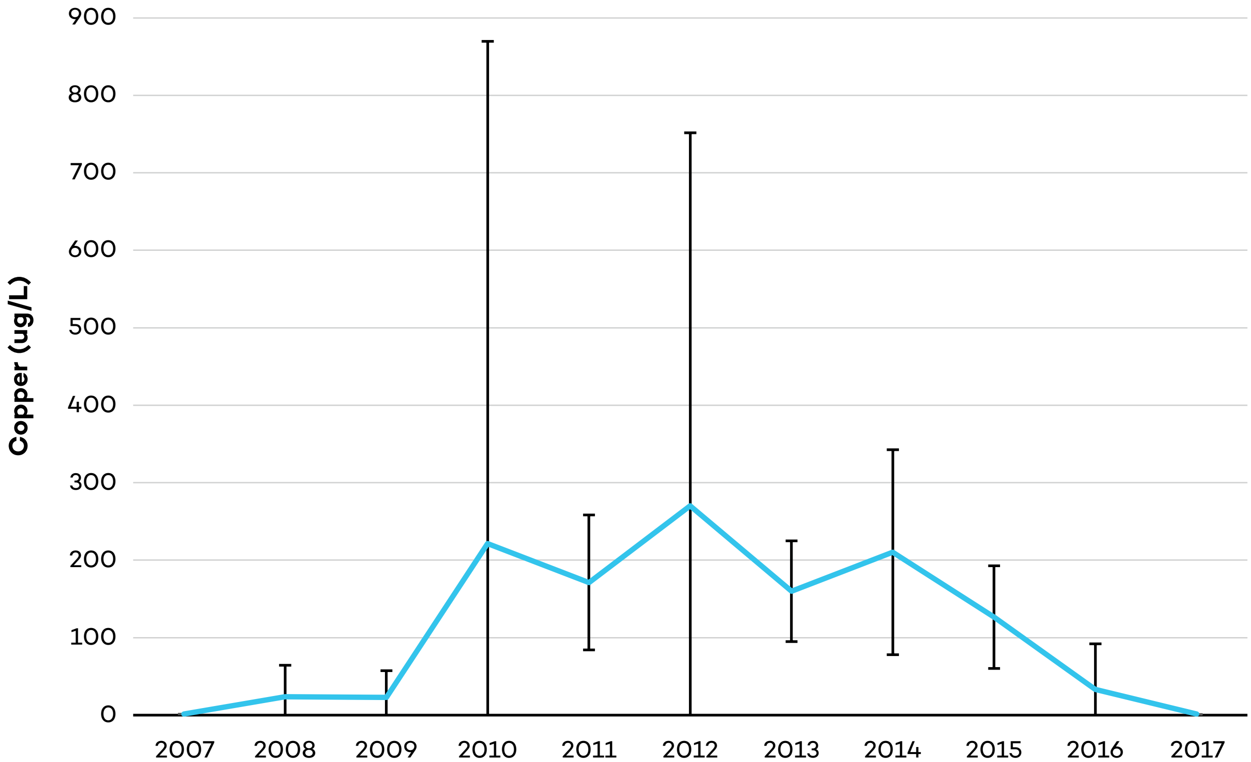


Figure 4. Trend of mean copper concentration (µg/L) (± SD) in Pine Falls Forebay (N=129)



Source: Water Quality Management Section, MSD, 2018.

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