

LWF

**LAKE
WINNIPEG
FOUNDATION**



Deadhorse Creek, Photo: Paula Kent

WINNIPEG
RIVER SYSTEM

2021 regional report

LAKE WINNIPEG
community-based monitoring network

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Lake Winnipeg Community-Based Monitoring Network: Overview

The Lake Winnipeg Community-Based Monitoring Network (LWCBMN), coordinated by the Lake Winnipeg Foundation (LWF), mobilizes citizens and watershed partners to collect water samples across Manitoba in order to measure phosphorus concentration. Phosphorus is the nutrient responsible for blue-green algae blooms on Lake Winnipeg. Phosphorus comes from diverse sources across the watershed, including municipal wastewater and agricultural runoff.

Different sub-watersheds contribute different proportions of Lake Winnipeg’s total phosphorus load. With the help of a strong network of watershed partners and citizen scientists, this long-term monitoring program is identifying phosphorus hotspots – localized areas that contribute higher amounts of phosphorus to waterways than other areas. Targeting actions to reduce phosphorus loading in hotspots will reduce the amount of phosphorus entering Manitoba’s lakes and rivers, and improve the health of Lake Winnipeg.

Snow melts, floods and heavy rainfall events are responsible for most of the phosphorus that is flushed from the land and carried into our waterways. LWCBMN samples frequently throughout the season, and particularly during the spring melt, to ensure we capture phosphorus runoff during these high-water events.

Most LWCBMN sampling is conducted at stations where water flow is continuously monitored by the [Water Survey of Canada](#) (WSC). By tracking flow online using the WSC’s real-time data, the network can notify partners and citizen scientists across the watershed to ensure frequent sampling during peak flows.

Sites with flow data can be coupled with LWCBMN data to calculate **phosphorus loads**. We need several samples throughout the season, corresponding to changes in flow, to accurately calculate these loads. Phosphorus loads can subsequently be used to calculate **phosphorus export**, based on the area of the watershed.

Phosphorus load is the total amount of phosphorus flowing past a sample site over a given period of time, expressed as tonnes per year.

Phosphorus export is the amount of phosphorus exported by each hectare of land in a year, expressed as kg/ha/y.

Sample Collection & Site Map

Water samples are collected using a weighted sampling device that collects source water directly into a 500 mL Nalgene polyethylene bottle. The sampling device is lowered into the water just before it hits the bottom, the bottle is filled, then brought back to the surface. It is rinsed three times prior to sample collection. Next, a 60 mL Nalgene polyethylene bottle containing 1 mL 4N H₂SO₄ is filled with whole water from the collection bottle.

In 2021, 919 unfiltered water samples were collected and analyzed from 93 sites. Of these 93 LWCBMN sampling sites, 73 are located near flow-metered WSC stations, four are located near non-flow-metered WSC stations, one is located near a USGS station, and fifteen are not located near any stations.

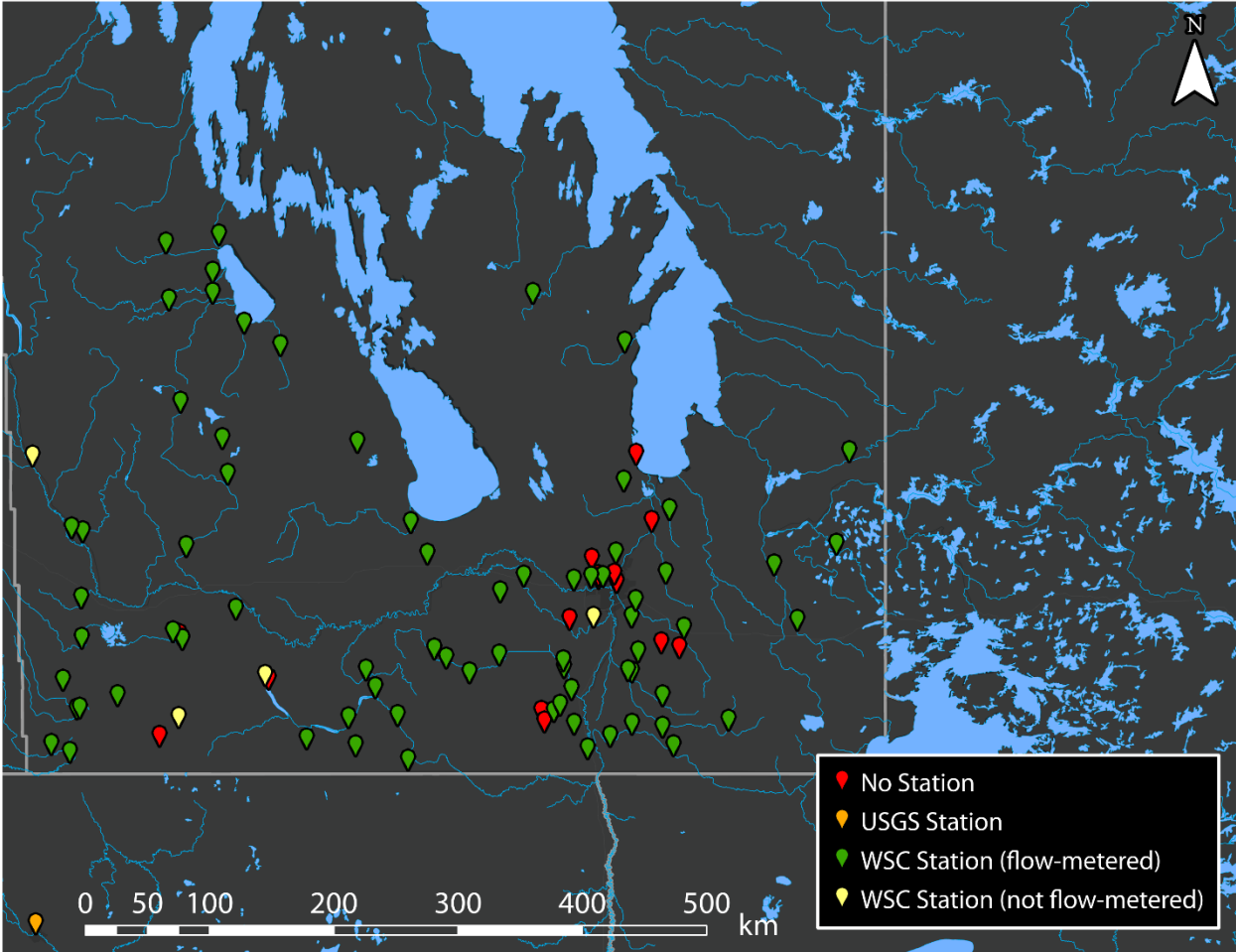


Figure 1: Map of LWCBMN sampling sites in 2021. Locations shown provided at least one sample. Colours indicate nearby station type.

Laboratory & Data Analysis

LWCBMN water samples are analysed for total phosphorus concentration. The analysis of a sample for total phosphorus (TP) is a two-step procedure involving first the chemical digestion/conversion of all P forms to orthophosphate (PO_4^{3-}) followed by the analysis of the concentration of PO_4^{3-} . The digestion procedure is patterned after USGS [Water-Resources Investigations Report 03-4174](#). The concentration of PO_4^{3-} in the sample was determined following [Murphy & Riley \(1962\)](#). The result of this analytical method is determination of unfiltered total phosphorus in mg/L.

Laboratory analysis on LWCBMN water samples was conducted in partnership with Dr. Nora Casson at her laboratory at the University of Winnipeg. Quality assurance of laboratory methods for the determination of total phosphorus was completed on samples sent from [Proficiency Testing Canada](#). Proficiency testing allows us to assess the quality of our results as compared to the results of other laboratories across the country. We received excellent passing grades of 92/100 in November 2023 and 94/100 in May 2024, further highlighting the consistency and accuracy of our laboratory methods.

Our laboratory results provide a record of the phosphorus concentrations for every day that water samples were collected, but we are equally interested in reporting the actual load of phosphorus each year in each watershed that we sample. To create this record, we multiply concentrations by the volume of water that flowed past the station every day, using flow data from Water Survey of Canada (WSC) stations.

WSC's real-time flow data subsequently undergoes additional quality assurance and quality control processes and is later published as historical flow data. Historical data is released by WSC as the official version of the data, with additional notes about unique site characteristics or considerations affecting data quality (e.g., the COVID-19 pandemic reduced field visits in 2020). Our 2020 data analysis used historical flow data.

For each station, gaps between concentration observations are filled by linear interpolation to create a continuous daily record. For the WSC flow record before or after the first or last water sample collected, we estimate the missing daily mean concentrations to be equal to the first or last measured concentration, respectively. These measured and estimated daily concentrations are then multiplied by daily flow to create a record of daily phosphorus loads.

Larger watersheds generate greater river flow and typically larger phosphorus loads. Comparing the intensity of phosphorus sources, especially among watersheds of varying sizes, is possible through the calculation of average load exported from each unit area of the watershed. Hence, we also report phosphorus export, which is simply the annual load divided by the watershed area that contributed to this load.

The export per unit area is indicative of the relative intensity of the sources generating phosphorus export, even among watersheds of different sizes. This is why we display maps of phosphorus export (and not load) in this report. Hotspots identified in these reports export several times more phosphorus per hectare than non-hotspot watersheds. Identifying hotspots can help government agencies to focus phosphorus reduction programs efficiently throughout the province.

LWCBMN By the Numbers - 2021

Table 1: Summary of 2021 LWCBMN sampling activity by region.

Region	Number of sites	Number of samples	Site with highest regional total phosphorus (TP) export (kg/ha/y)	Mean % of spring* water load	Mean % of spring* TP load
Assiniboine West	8	89	Little Saskatchewan River near Minnedosa - 0.037	40.81	42.41
Central Assiniboine	2	29	Cypress River near Bruxelles - 0.020	47.43	27.94
City of Winnipeg	6	35	Omand's Creek near Empress Street - 0.017	67.14	60.82
East Interlake	5	46	Grassmere Creek Drain near Middlechurch - 0.0073	77.41	79.81
Inter-Mountain	7	95	Ochre River near Ochre River - 0.062	47.06	37.13
Northeast Red	1	12	Devils Creek near Libau - 0.027	85.59	90.23
Pembina Valley	12	111	Kronsgart Drain near Sewell - 0.055	43.30	39.49
Redboine	11	150	La Salle River at Elie - 0.035	58.92	62.39
Souris	10	62	Pipestone Creek near Pipestone - 0.0046	43.07	40.61
Seine Rat Roseau	14	179	Manning Canal near Île-des-Chênes- 0.063	64.33	64.51
Whitemud	3	37	Whitemud River near Westbourne - 0.0072	66.49	58.92
Winnipeg River	4	66	Whiteshell River at outlet of Jessica Lake - 0.026	38.71	39.89

*LWCBMN defines "Spring" as March 1 to May 31, inclusive.

Raw data (phosphorus concentration and water flow) from LWCBMN's 2020 field season is available online at LakeWinnipegDataStream.ca, an open access hub for sharing water data.

Winnipeg River System

The Winnipeg River is the largest contributor of water (49% of annual water load) and the second largest contributor of phosphorus (15% of annual phosphorus load) to Lake Winnipeg (State of Lake Winnipeg Report, 2011). The Winnipeg River drains an area largely covered by boreal forest and Canadian Shield lakes. Within the Winnipeg River system there is extensive cottage development, as well as many hydro-electric generating stations.

In partnership with LWCBMN, volunteers collected samples at 4 sites in the Winnipeg River system, all of which were at actively monitored WSC flow meters.

Characteristics of the 2021 Field Season

2021 was a very dry year in southern Manitoba¹. As well, from March to May 2021, a historically important season for phosphorus export, most of southern Manitoba experienced severely to extremely dry conditions².

The mean peak discharge data across all LWCBMN sites with analyzed water samples was June 27, 2021 (with a standard deviation of 70.40 days). In 2021, an average of 54.60% of stream discharge occurred in spring (March 1 - May 31) across LWCBMN sites (with a standard deviation of 24.53%).

As a result of the extreme drought in 2021, there are no phosphorus exports above 0.5 (kg / ha / year) in any site in any region monitoring by LWCBMN in 2021^[KF1].

¹ <https://www.gov.mb.ca/sd/pubs/water/drought/2021/drought-conditions-report-october-2021.pdf>

² https://www.gov.mb.ca/sd/pubs/water/drought/2021/drought_conditions_report_may_2021.pdf

Manitoba Watershed District Map

Manitoba’s watershed districts are crucial partners contributing to the success of LWCBMN. In addition to assisting with sample collection, each district brings valuable community connections and a wealth of regional expertise to the network, helping us contextualize and better understand the data.

In 2021, 10 watershed districts participated in LWCBMN activities: Assiniboine West, Central Assiniboine, East Interlake; Inter-Mountain; Northeast Red, Pembina Valley, Redboine, Souris River, Seine Rat Roseau, and Whitemud.

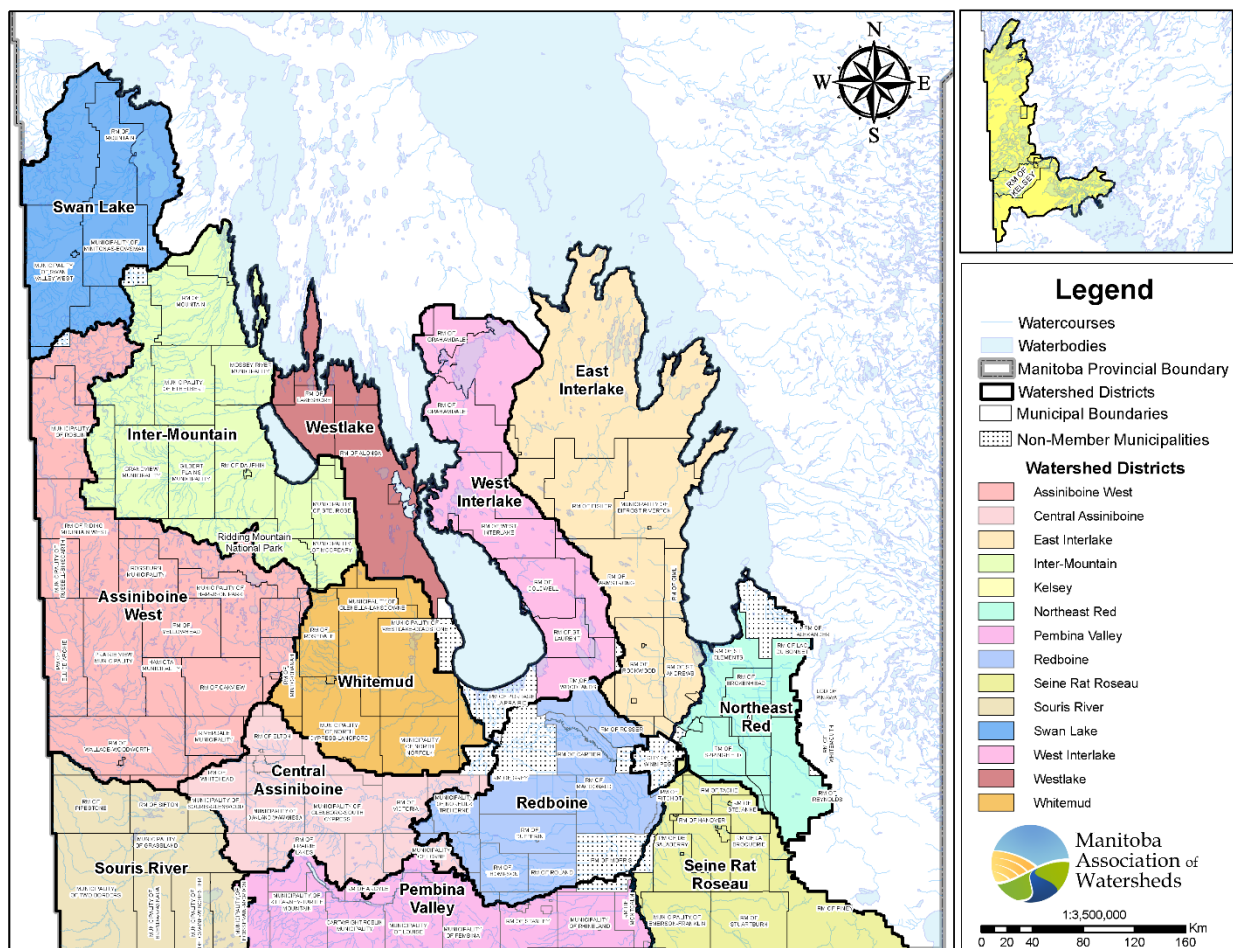


Figure 2: Manitoba Watershed District Boundaries. There are 14 total watershed districts. Map provided by Manitoba Association of Watersheds (updated July 2022).

2021 Results – Winnipeg River System Summary

Table 2: Summary of 2021 LWCBMN results in the Winnipeg River System. Letters correspond to drainage areas in Figure 3. Data shown represents sites with sampling efforts adequate enough to calculate loads/exports. ¹See footnote for explanation of acronyms/abbreviations.

	Site Name	WSC Station	GDA (km ²)	IDA (km ²)	Gross/Incr.	TP load (tonnes/y)	TP export (kg/ha/y)
A	Bird River outlet of Bird Lake	05PJ001	1040.13	NA	gross	1.67	0.016
B	Whitemouth River near Whitemouth	05PH003	3739.61	NA	gross	4.63	0.012
C	Whiteshell River at outlet of Jessica Lake	05PG001	904.12	NA	gross	2.36	0.026

To compare 2021 results to other years of data, please see LWCBMN regional reports online at <https://lakewinnipegfoundation.org/lwcbmn-regional-reports>

¹ WSC = Water Survey of Canada.
 GDA = gross drainage area (i.e., the total watershed area).
 IDA = incremental drainage area (i.e., the total watershed area minus the total watershed area of any contained upstream sites with data adequate for load/export calculation).
 Gross/Incr. = whether or not the adjacent TP load/export listed is from the gross or incremental (“Incr.”) drainage area of a site.

2021 Results – Hotspot Map

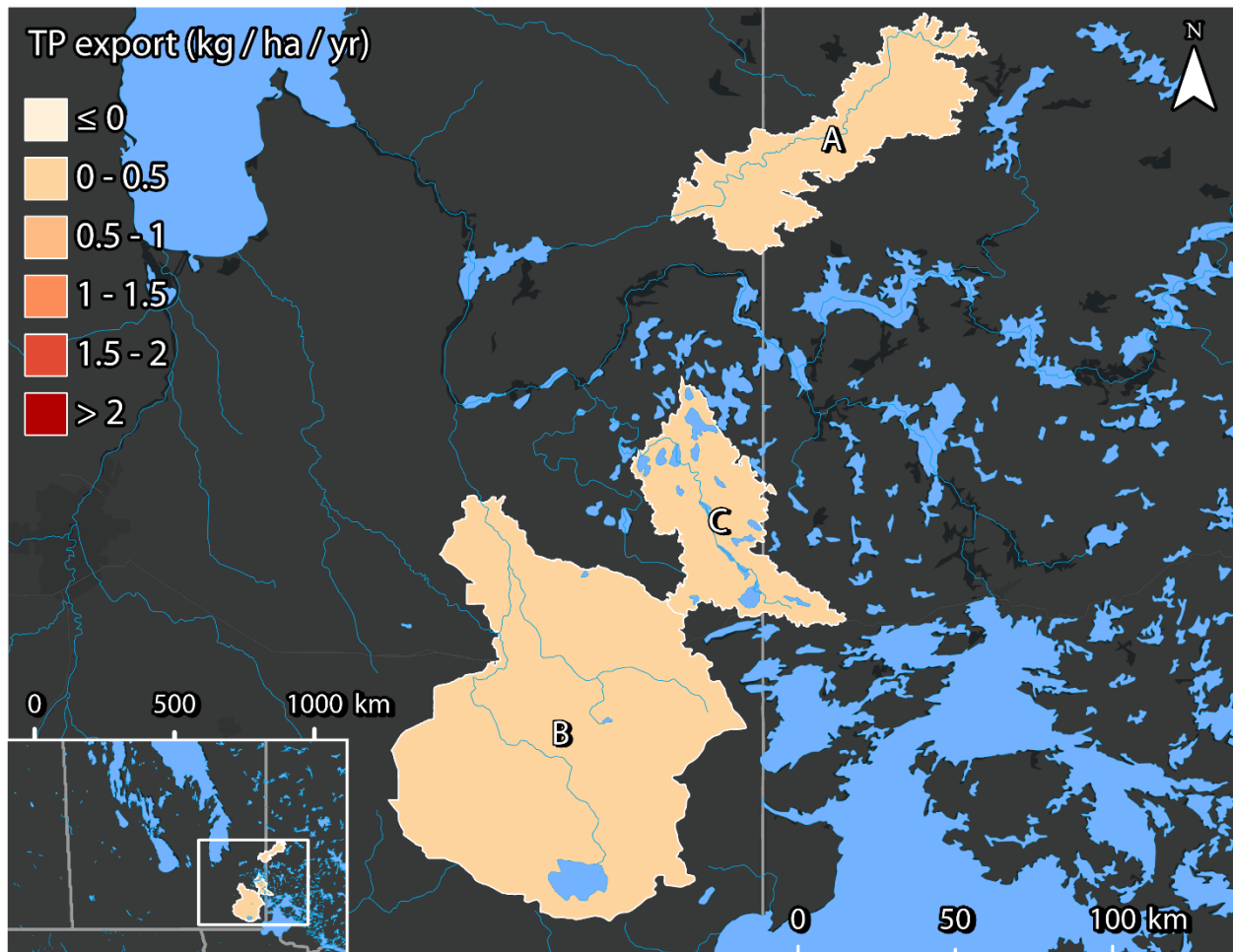


Figure 3: 2021 LWCBMN TP Export Hotspots in the Winnipeg River System. Letters correspond to sites listed in Table 2.

2021 Results – Individual Sites

Bird River outlet of Bird Lake

The Bird River flows west out of Bird Lake and discharges into Lac du Bonnet. This sampling site is located at Water Survey of Canada station 05PJ001. The sampling effort provided adequate coverage to calculate TP loads and exports.

Table 3: Indices of discharge and phosphorus from the gross drainage area of Bird River outlet of Bird Lake (05PJ001) in 2021.

Gross drainage area:	1040.13 km ²
Peak discharge:	7.62 m ³ s ⁻¹ (2021-06-11)
Peak TP concentration:	0.053 mg/L (2021-05-09)
% of water load in spring:	46.95%
% of TP load in spring:	50.96%
Water load:	0.063 km ³ y ⁻¹
TP load:	1.67 tonnes P y ⁻¹
Water export:	61.04 mm y ⁻¹
TP export:	0.016 kg P ha ⁻¹ y ⁻¹

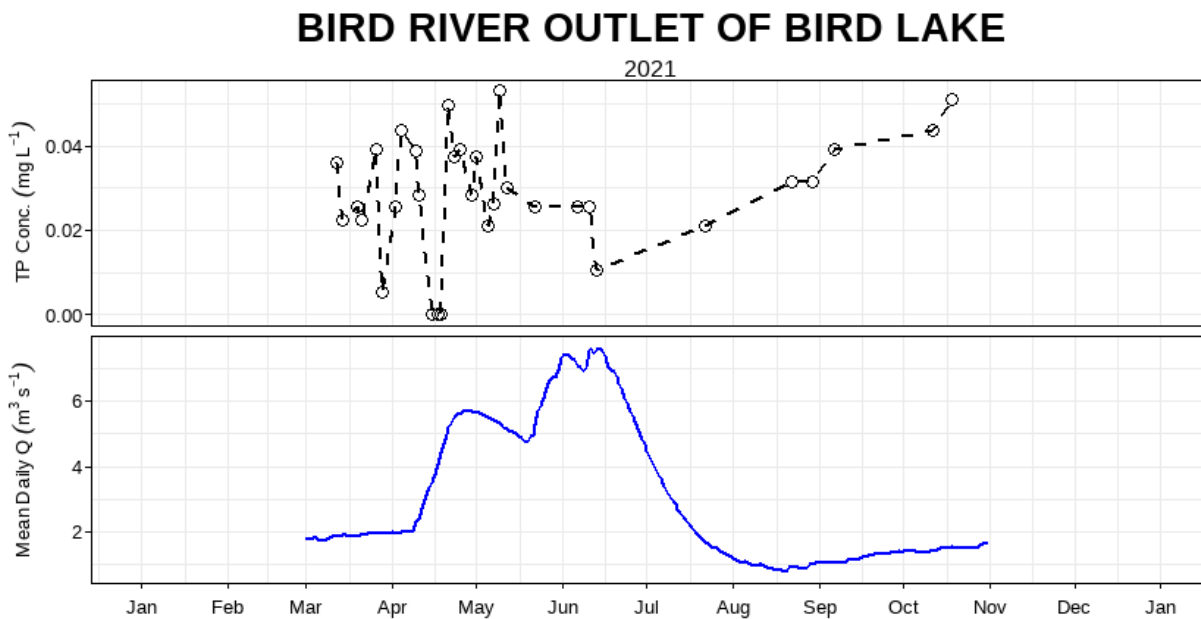


Figure 4: Mean daily discharge (m³ s⁻¹) and total phosphorus concentration (mg L⁻¹) over the 2021 sampling season at Bird River outlet of Bird Lake (05PJ001).

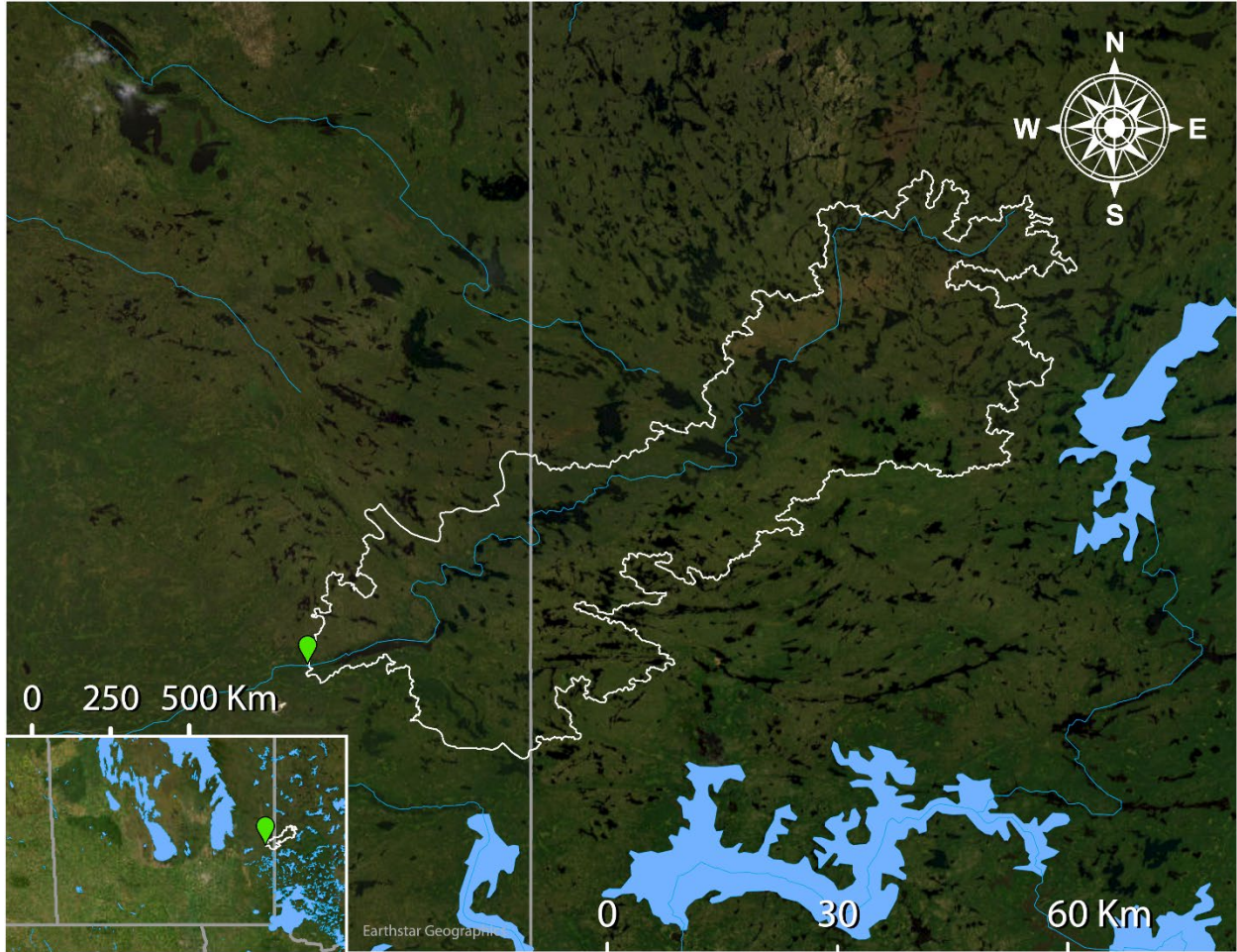


Figure 5: WSC station 05PJ001 (green) and drainage area polygon (white - source: WSC). LWCBMN samples directly at the WSC station.

Whiteshell River at outlet of Jessica Lake

The Whiteshell River is located in Whiteshell Provincial Park, near the Ontario border. It is one of the major rivers in the park, connecting many lakes, and eventually flows into the Winnipeg River. This sampling site is located at Water Survey of Canada flow meter 05PG001. The sampling effort provided adequate coverage to calculate TP loads and exports.

Table 4: Indices of discharge and phosphorus from the gross drainage area of Whiteshell River at outlet of Jessica Lake (05PG001) in 2021.

Gross drainage area:	904.12 km ²
Peak discharge:	2.64 m ³ s ⁻¹ (2021-12-25)
Peak TP concentration:	0.12 mg/L (2021-10-03)
% of water load in spring:	15.80%
% of TP load in spring:	12.08%
Water load:	0.023 km ³ y ⁻¹
TP load:	2.36 tonnes P y ⁻¹
Water export:	25.87 mm y ⁻¹
TP export:	0.026 kg P ha ⁻¹ y ⁻¹

WHITESHELL RIVER AT OUTLET OF JESSICA LAKE

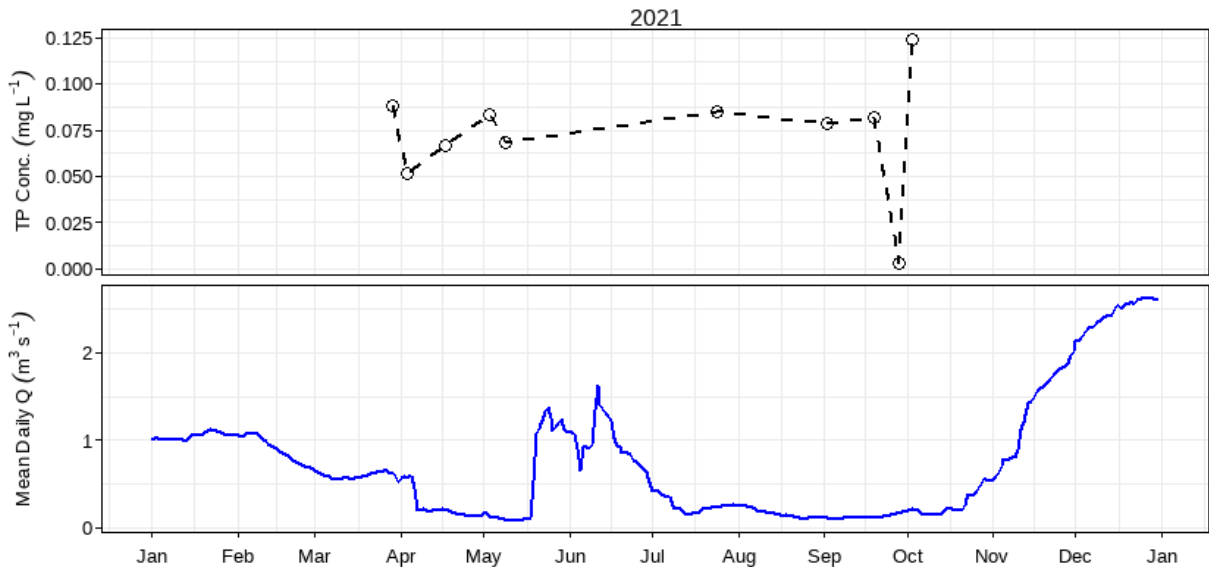


Figure 6: Mean daily discharge (m³ s⁻¹) and total phosphorus concentration (mg L⁻¹) over the 2021 sampling season at Whiteshell River at outlet of Jessica Lake (05PG001).

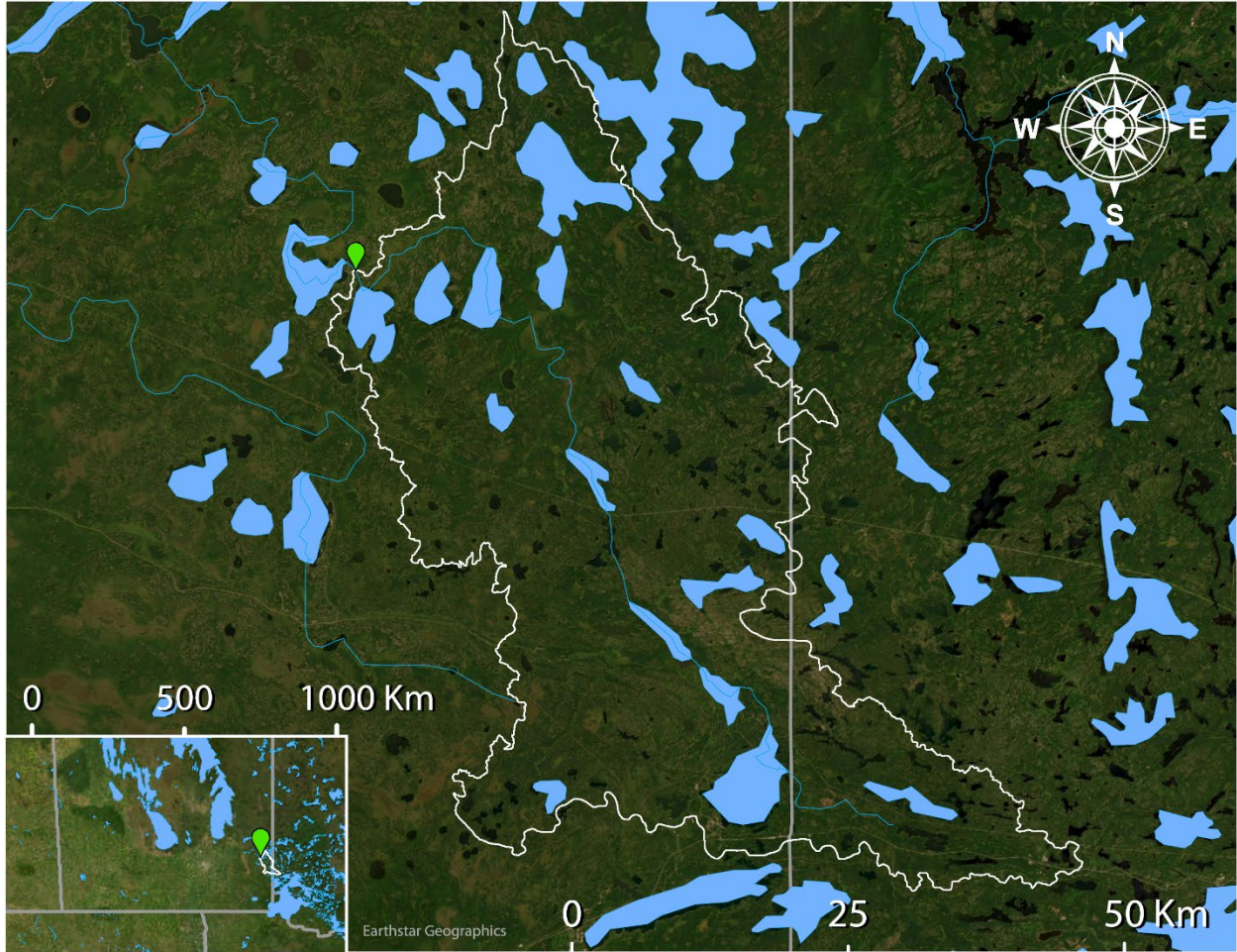


Figure 7: WSC station 05PG001 (green) and drainage area polygon (white – source: WSC). LWCBMN samples directly at the WSC station.

Whitemouth River near Whitemouth

The Whitemouth River originates from Whitemouth Lake in southeastern Manitoba. It flows through sandy land deposits from Lake Agassiz, agricultural lands and the Canadian Shield to empty into the Winnipeg River near the Seven Sisters Falls Generating Station. This sampling site is located at Water Survey of Canada station 05PH003. The sampling effort provided excellent coverage to calculate TP loads and exports.

Table 5: Indices of discharge and phosphorus from the gross drainage area of Whitemouth River near Whitemouth (05PH003) in 2021.

Gross drainage area:	3739.61 km ²
Peak discharge:	19.1 m ³ s ⁻¹ (2021-05-24)
Peak TP concentration:	0.10 mg/L (2021-03-20)
% of water load in spring:	54.70%
% of TP load in spring:	51.04%
Water load:	0.065 km ³ y ⁻¹
TP load:	4.63 tonnes P y ⁻¹
Water export:	17.36 mm y ⁻¹
TP export:	0.012 kg P ha ⁻¹ y ⁻¹

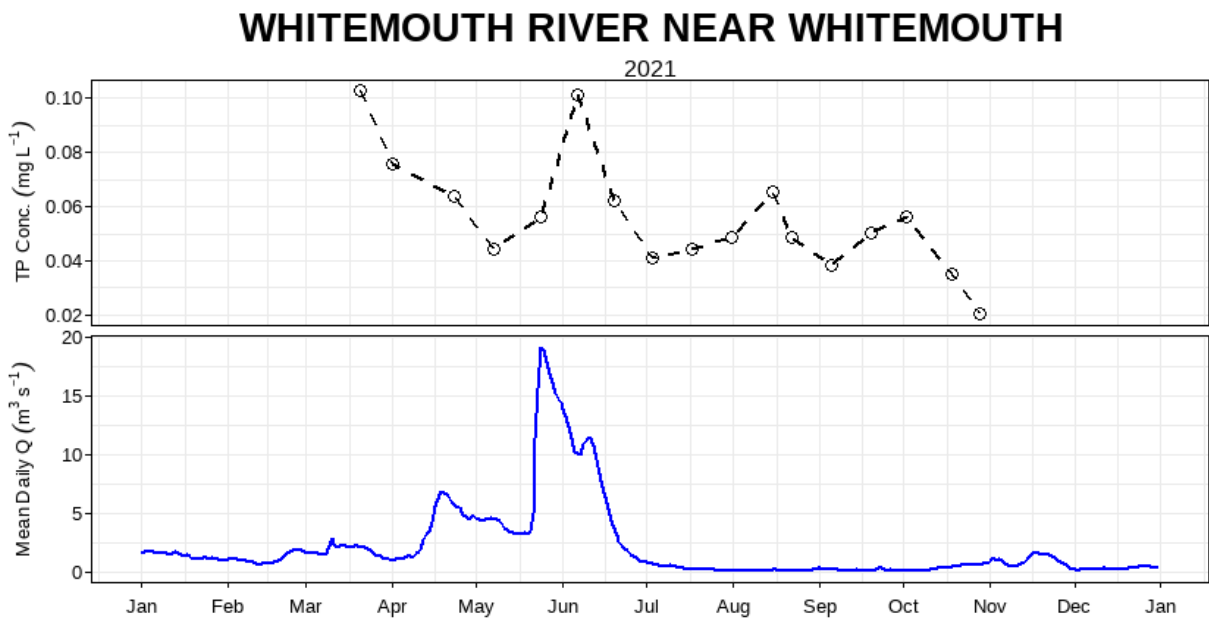


Figure 8: Mean daily discharge (m³ s⁻¹) and total phosphorus concentration (mg L⁻¹) over the 2021 sampling season at Whitemouth River near Whitemouth (05PH003).

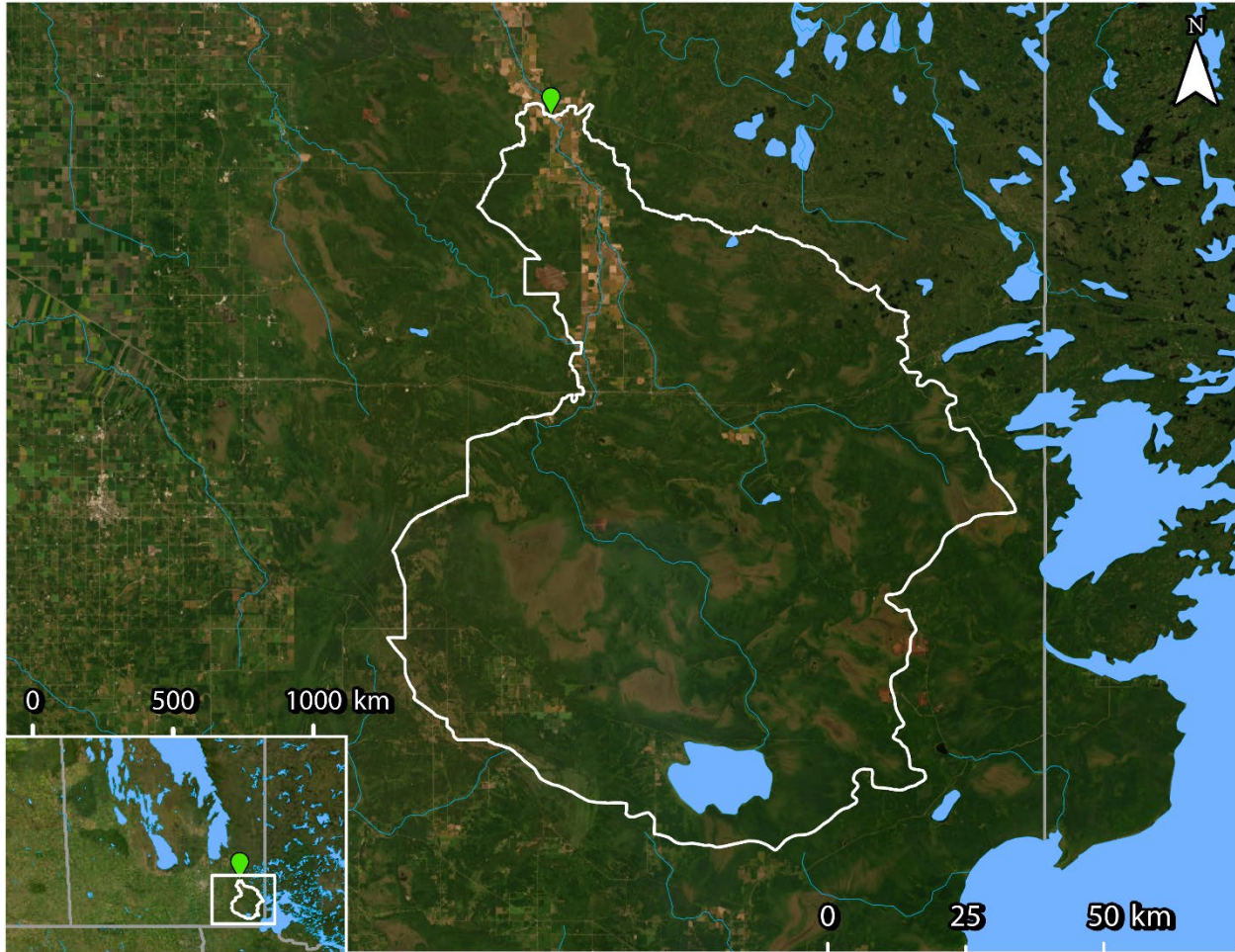


Figure 9: WSC station 05PH003 (green), and drainage area polygon (white - source: WSC). LWCBMN samples directly at the WSC station.

Birch River near Prawda

The Birch River is located north of Prawda, Man. situated along the Trans-Canada Highway. The sampling site is located at Water Survey of Canada station 05PH007. The sampling effort provided adequate coverage to calculate TP loads and exports. Because of the lack of samples between April and October, we are unable to accurately calculate loads and exports.

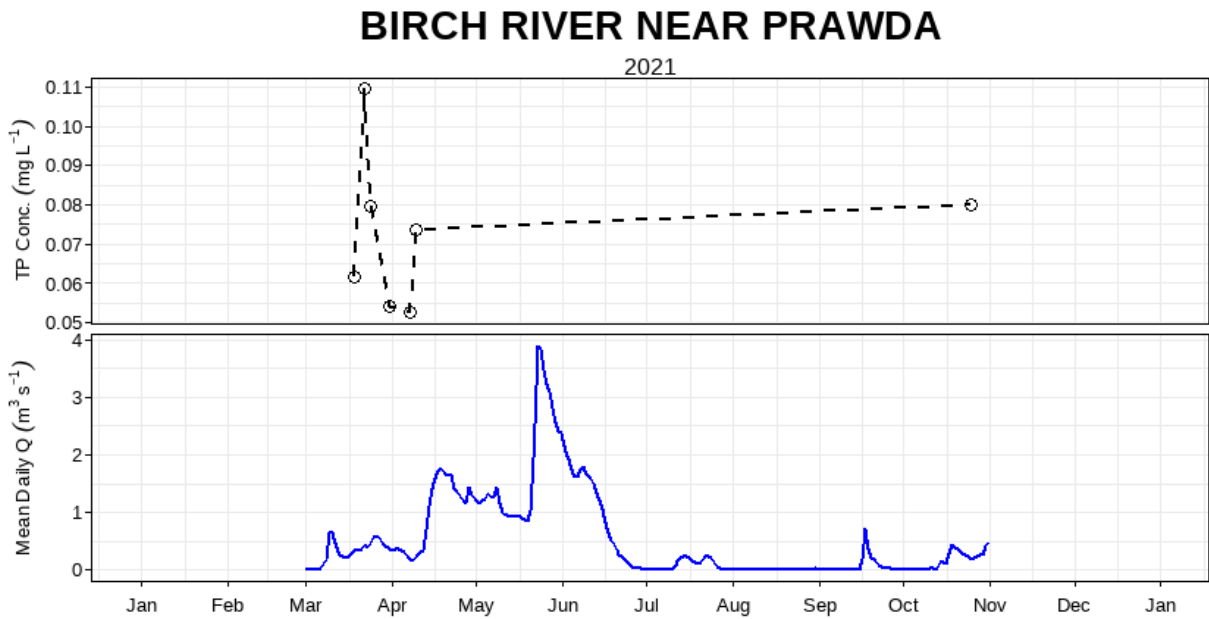


Figure 10: Mean daily discharge (m³ s⁻¹) and total phosphorus concentration (mg L⁻¹) over the 2021 sampling season at Birch River near Prawda (05PH007).

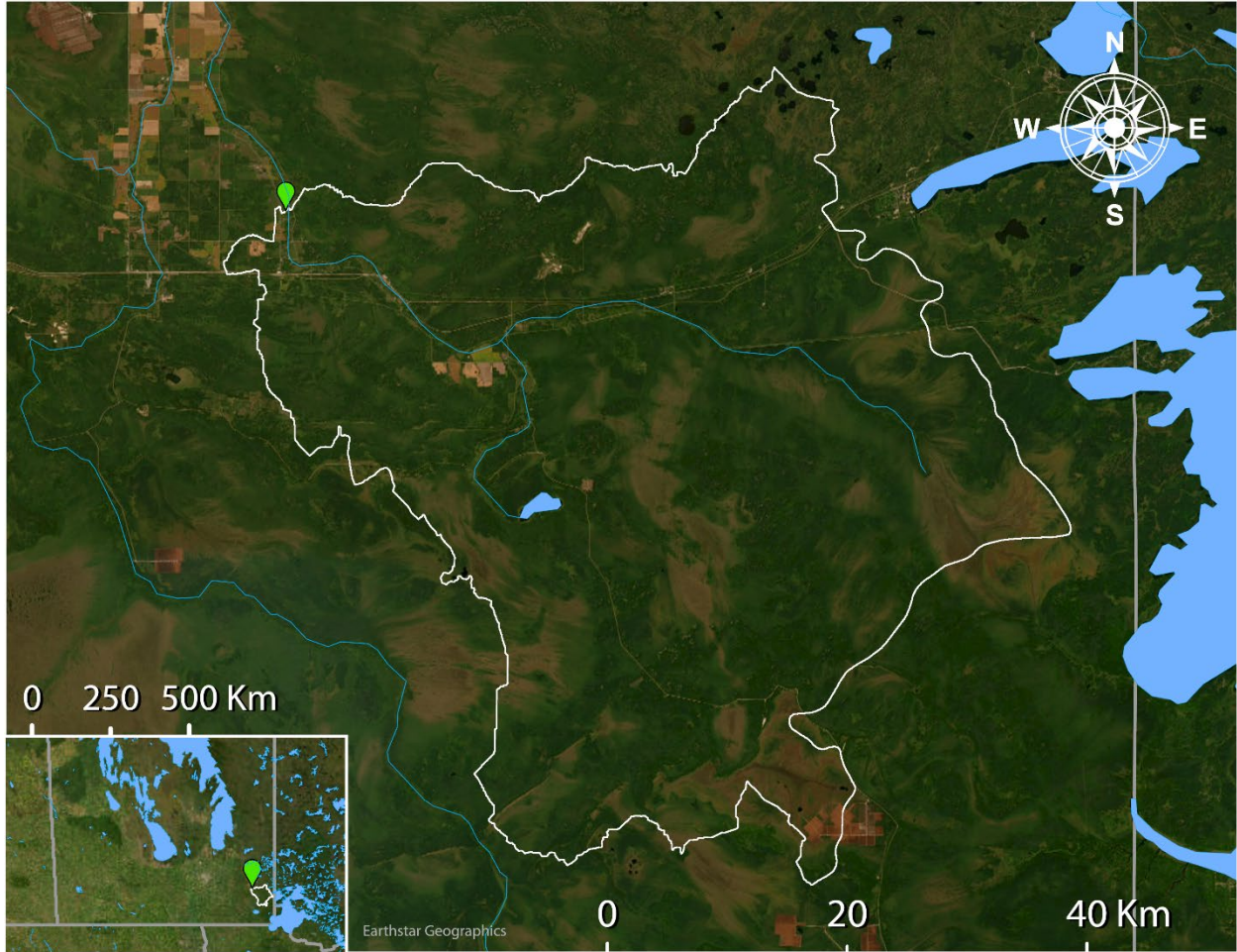


Figure 11: WSC station 05PH007 (green) and drainage area polygon (white – source: WSC). LWCBMN samples directly at the WSC station.

Map Sources

Drainage area polygons

Primarily, and whenever possible, drainage area polygons were taken from the Water Survey of Canada's (WSC) National Hydrometric Network Basin Polygons. Released on July 15, 2022, this prerelease version of the dataset contains drainage area polygons for over 7300 of the 7896 active and discontinued WSC stations. According to WSC, this dataset will continue to be updated as new polygons are added. For our analysis, we used drainage areas from this dataset.

Link: <https://catalogue.ec.gc.ca/geonetwork/srv/eng/catalog.search#/metadata/0c121878-ac23-46f5-95df-eb9960753375>

Secondarily, when no WSC drainage area polygons were available, or when it was necessary to enable accurate incremental calculations, we used drainage area polygons from the Total Gross Drainage Areas of the Agriculture and Agri-Food Canada (AAFC)'s Watersheds Project – 2013

Link: <https://open.canada.ca/data/en/dataset/67c8352d-d362-43dc-9255-21e2b0cf466c>

Due to the required use of drainage area polygons from two different datasets, some polygons may slightly overlap. Hotspot maps, as a result, have a few instances where a drainage area is visually cut off. However, most of these instances are very minor, and we display all watersheds in their full extent on each sampling site's individual section.

Map layers

Satellite imagery used in all maps is from the World Imagery map layer (Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community). World Imagery provides one meter or better satellite and aerial imagery in many parts of the world and lower resolution satellite imagery worldwide.

Lake and river map data used in all maps is from North America Environmental Atlas (Lakes, Rivers). The North American Environmental Atlas – Lakes & Rivers datasets display area hydrographic features (Lakes: major lakes and reservoirs; Rivers: major rivers, streams, and canals) of North America at a reference spatial scale of 1:1,000,000. Credits: Commission for Environmental Cooperation (CEC). 2023. "North American Atlas – Lakes and Rivers". Natural Resources Canada (NRCan), Instituto Nacional de Estadística y Geografía (INEGI), Comisión Nacional del Agua (CONAGUA), U.S. Geological Survey (USGS). Ed. 3.0, Vector digital data [1:1,000,000].

The **Lake Winnipeg Community-Based Monitoring Network** (LWCBMN) is a collaborative, long-term phosphorus monitoring program designed to identify localized phosphorus hotspots where action is required to improve Lake Winnipeg water quality. LWCBMN mobilizes citizen volunteers and watershed partners to collect water samples across Manitoba, generating robust water-quality data that is useful to community practitioners, academic researchers, government scientists and policy-makers alike. Focusing research, resources and action in phosphorus hotspots is necessary to reduce phosphorus loading to Lake Winnipeg.

LWCBMN is delivered in partnership with Manitoba's watershed districts, LWF's science advisors, volunteer citizen scientists and Dr. Nora Casson's laboratory at the University of Winnipeg. Thank you to all who make this network possible!

The **Lake Winnipeg Foundation** (LWF) advocates for change and coordinates action to improve the health of Lake Winnipeg. Combining the commitment of our grassroots membership and the expertise of our science advisors, LWF is nationally recognized for our unique capacity to link science and action. Our goal is to ensure policy and practices informed by evidence are implemented and enforced.

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Foundation



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