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Data Sources and Methods for the Phosphorus and Nitrogen Levels in Lake Winnipeg Indicator

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1 Introduction

The Phosphorus and Nitrogen Levels in Lake Winnipeg indicator is part of the Canadian Environmental Sustainability Indicators (CESI) program, which provides data and information to track Canada's performance on key environmental sustainability issues.

2 Description and rationale of the Phosphorus and Nitrogen Levels in Lake Winnipeg indicator

2.1 Description

The Phosphorus and Nitrogen Levels in Lake Winnipeg indicator reports on the status of total phosphorus and total nitrogen concentrations in the north and south basins of Lake Winnipeg and its major tributaries. It rates nitrogen and phosphorus status based on whether phosphorus and nitrogen concentrations in Lake Winnipeg and the Red, Saskatchewan and Winnipeg rivers exceed Manitoba's total phosphorus guideline for the protection of aquatic life and Alberta's total nitrogen guideline for the protection of aquatic life. Exceeding a water quality guideline indicates a greater risk to the health of the Lake Winnipeg ecosystem posed by phosphorus and nitrogen.

Water quality in the lake is considered green when ambient water quality samples are at or below water quality guidelines. Where phosphorus and nitrogen levels exceed water quality guidelines, phosphorus and nitrogen are classified as red. For the tributaries, water quality at a monitoring station is considered green when ambient water quality exceeds the phosphorus or nitrogen guideline in less than 10% of the samples considered; red indicates exceedances in greater than 50% of samples; while yellow applies when 10-49% of the samples exceed the phosphorus or nitrogen guideline.

2.2 Rationale

Phosphorus and nitrogen are essential plant nutrients; however, when concentrations in the environment are too high or too low they can have harmful impacts on the ecosystem. The water in Lake Winnipeg is naturally mesotrophic with moderate nutrient concentrations and plant growth. A century of agricultural development on the Prairies has increased nitrogen and phosphorus concentrations in the lake to the point where algal growth is approximately 500% greater than it was prior to European settlement. Continuing to track phosphorus and nitrogen concentrations allows governments and citizens to remain aware of an important aspect of the environmental condition of Lake Winnipeg.

3 Data

3.1 Data source

Total phosphorus and total nitrogen data for Lake Winnipeg are collected by Manitoba Conservation and Water Stewardship. Data for the Red, Winnipeg and Saskatchewan rivers are collected by the Water Quality and Monitoring Division of Environment Canada.

3.2 Spatial coverage

Data for this indicator cover the north and south basins of Lake Winnipeg along with the Narrows that connect the two basins. Also included are data from three of Environment Canada's water quality monitoring stations on the Red, Winnipeg and Saskatchewan rivers.

Table 1. Tributary water quality monitoring stations used for this indicator

Station Code	Station Name	Longitude	Latitude
MA05KH0001	Saskatchewan River above Carrot River	-101.34194	53.84167
MA05OC0001	Red River at Emerson, Manitoba	-97.21083	49.00806
MA05PF0022	Winnipeg River at Pointe du Bois	-95.5566116	50.30083

3.3 Temporal coverage

The phosphorus and nitrogen status for 2010 for Lake Winnipeg is reported. The status for the tributaries covers 2008-2010.

3.4 Data completeness

Data used in this indicator are collected from May to October 2010 on Lake Winnipeg, and all months of each year from 2008 to 2010 for the tributary stations. Data for 1999 to 2009 for the lake and 1999 to 2007 for the tributaries are also provided in section 4 to supplement the indicator.

3.5 Data timeliness

The Phosphorus and Nitrogen Levels in Lake Winnipeg indicator was calculated using the most recent water quality data available for each basin and the three tributary stations.

4 Methods

For Lake Winnipeg, seasonally weighted total phosphorus and total nitrogen concentrations from May to October in each basin were compared to Manitoba's phosphorus guideline for the protection of aquatic life for lakes of 0.025 mg P/L¹, and to Alberta's surface water quality guideline for total nitrogen of 1 mg N/L.² Seasonally weighted average phosphorus and nitrogen concentrations are used to account for year-to-year variability in sample collection.

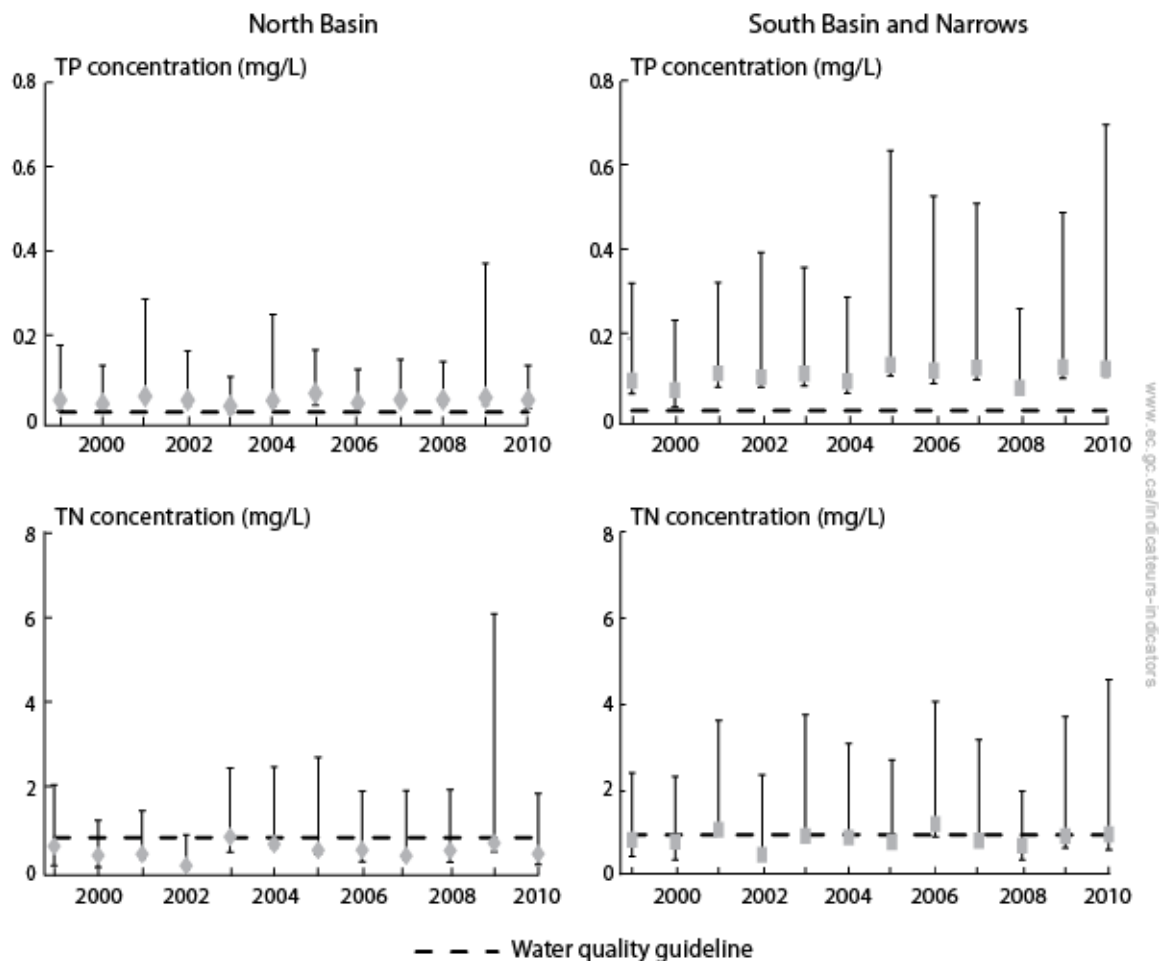
For Lake Winnipeg, the status of phosphorus and nitrogen levels was categorized into two categories: green and red. These categories were determined using the 2010 annual, seasonally weighted, average total nitrogen and total phosphorus concentrations (Figure 1), and comparing the result to the appropriate guideline. Note that even where the average values were generally below the guideline, the maximum recorded values may still be above.

¹ Manitoba Water Stewardship (2011) Manitoba Water Quality Standards, Objectives and Guidelines. Retrieved on 3 January, 2013. Available from:

http://www.gov.mb.ca/waterstewardship/water_quality/quality/website_notice_mwqsog_2011.html.

² Alberta Environment (1999) Surface water quality guidelines for use in Alberta. Retrieved on 3 January, 2013. Available from: <http://environment.alberta.ca/01322.html>.

Figure 1. Annual weighted, seasonal averages for total phosphorus (TP) and nitrogen concentrations (TN) for Lake Winnipeg, Canada, 1999 to 2010



Note: Error bars show the annual minimum and maximum concentrations.

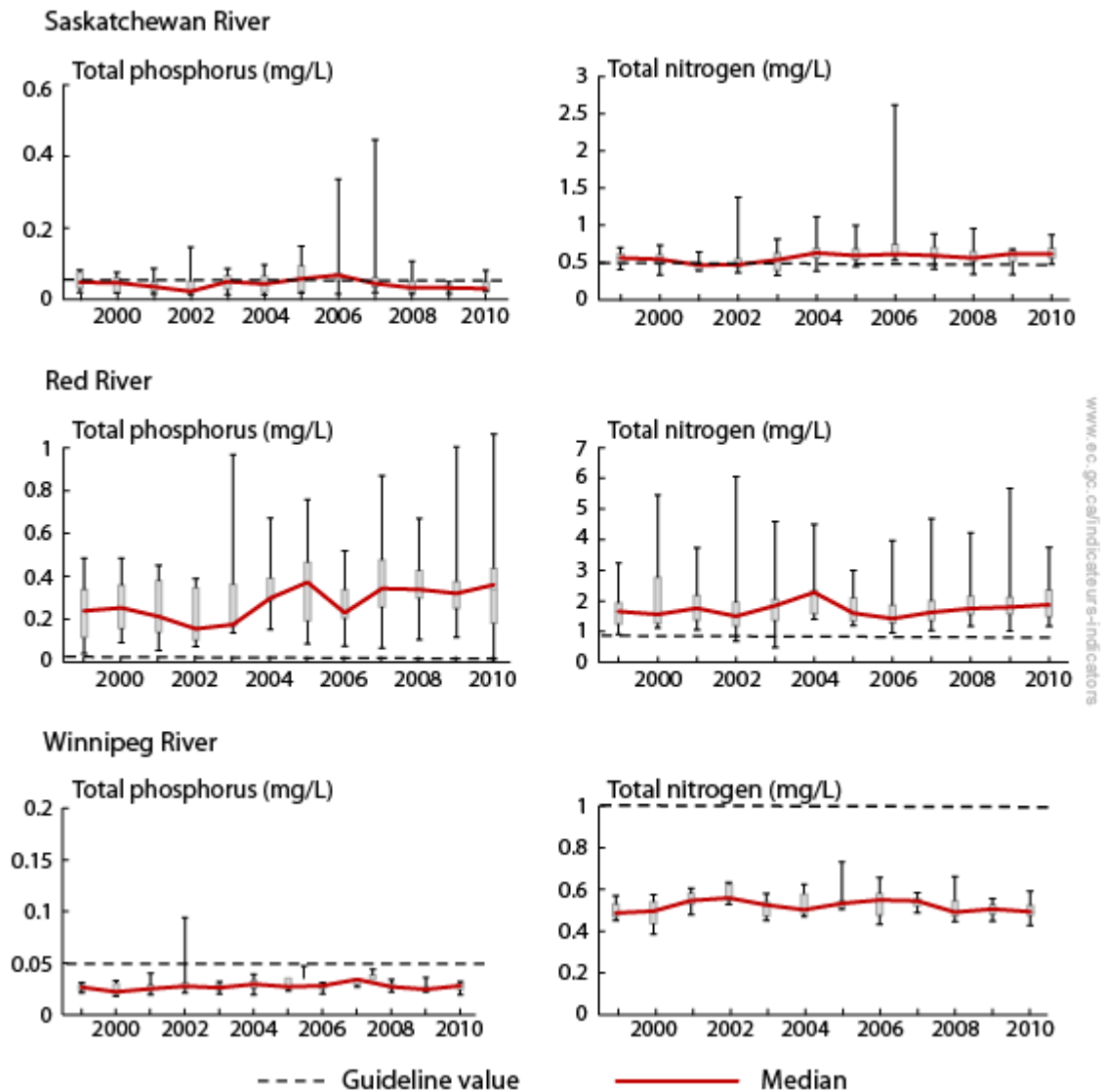
For the Red, Saskatchewan and Winnipeg rivers, the phosphorus and nitrogen status of the water quality monitoring stations was determined by comparing total phosphorus and nitrogen concentrations to Manitoba's river total phosphorus guideline of 0.05 mg P/L³ and Alberta's total nitrogen guideline of 1 mg N/L.⁴ For the rivers, the number of times the phosphorus and

³ Manitoba Water Stewardship (2011) Manitoba Water Quality Standards, Objectives and Guidelines. Retrieved on 3 January, 2013. Available from: http://www.gov.mb.ca/waterstewardship/water_quality/quality/website_notice_mwqsog_2011.html.

⁴ Alberta Environment (1999) Surface water quality guidelines for use in Alberta. Retrieved on 3 January, 2013. Available from: <http://environment.alberta.ca/01322.html>.

nitrogen concentrations were greater than the guideline between 2008-2011 were summed, and divided by the total number of samples collected over the same period (Figure 2). The nutrient status of each station was determined based on the percentage of samples greater than the guideline. Stations with fewer than 10% of samples greater than the guideline have green water quality based on phosphorus or nitrogen concentration, and stations with greater than 50% of samples exceeding the guideline are considered to have red water quality with respect to phosphorus or nitrogen. Stations with 10 to 50% exceeding the guideline are given a yellow rating, because phosphorus or nitrogen may be a problem. In rivers, total phosphorus or nitrogen concentrations will often exceed the guideline during flooding, most commonly when snow melts in the spring. The 10% cut-off allows for one sample per year to exceed the guideline; thus, a green designation means total phosphorus and nitrogen concentrations are minimally affected by human development. If greater than 50% of the samples exceed the water quality guideline, median total phosphorus or total nitrogen concentrations are likely well above the water quality guideline and water quality is impaired.

Figure 2. Annual total phosphorus and nitrogen boxplots for the Red, Winnipeg and Saskatchewan rivers, Canada, 1999 to 2010



5 Caveats and limitations

The Phosphorus and Nitrogen Levels in Lake Winnipeg indicator reflects the state of water quality in the Lake Winnipeg basin based on phosphorus and nitrogen concentrations and does not show the effect of spills or other transient events unless these are frequent or long-lasting.

The calculation of the indicators for the major tributaries and the lake are slightly different. This discrepancy exists because total phosphorus concentrations in rivers are influenced by suspended particles in the water, which may increase during high-flow events. Allowing for some natural exceedances associated with high-flow events is important. The size of Lake Winnipeg buffers it from the immediate impacts. The ratings for Lake Winnipeg and its tributaries are nonetheless comparable, with red indicating the highest level of impairment by phosphorus or nitrogen in both cases.

6 References and further reading

6.1 References

Alberta Environment (1999) Surface water quality guidelines for use in Alberta. Retrieved on 3 January, 2013. Available from: <http://environment.alberta.ca/01322.html>.

Environment Canada and Manitoba Water Stewardship (2011) State of Lake Winnipeg: 1999 to 2007. Retrieved on 3 January, 2013. Available from: http://www.gov.mb.ca/conservation/waterstewardship/water_quality/state_lk_winnipeg_report/index.html.

Manitoba Water Stewardship (2011) Manitoba Water Quality Standards, Objectives and Guidelines. Retrieved on 3 January, 2013. Available from: http://www.gov.mb.ca/waterstewardship/water_quality/quality/website_notice_mwqsog_2011.html.

6.2 Further reading

Lake Winnipeg. Available from: <http://www.manitoba.ca/lakewinnipeg>.

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Additional information can be obtained at:

Environment Canada

Inquiry Centre

10 Wellington Street, 23rd Floor

Gatineau, QC K1A 0H3

Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800

Fax: 819-994-1412

TTY: 819-994-0736

Email: Enviroinfo@ec.gc.ca