Citizen Science for Recreational Water Quality in Saskatchewan

Results from pilot program 2018

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Water quality for recreational water use in Saskatchewan

Project Summary

The goal of this project was to initiate a citizen science program to monitor recreational lake water quality in Saskatchewan. Citizen science initiatives are based on nonprofessional volunteers that are trained to collect relevant data and samples and contribute to prioritization and mitigation of water quality concerns. Our work in 2017 demonstrated that water quality measurements as collected by citizen scientists are reliable, and in 2018, we expanded the program to monitor six different lakes (Loch Leven, Kenosee, Kipabiskau, Little Manitou, Jackfish, and Murray lakes) on a monthly basis.

Methods

CS Sampling

In May, 2018, volunteers at each of the six sites were mailed a sampling kit that contained equipment to sample water depth (weighted line), temperature and pH (Tri-meter), water clarity (secchi disk and measuring tape), and water chemistry (sample bottles to fill with water). Instructions were included in the kit, as were links to online videos (https://kerrifinlay.wixsite.com/kerri/citizenscience), and data recording sheets. Volunteers were instructed to sample once per month, from June to September.

Sample Analyses

Water samples were mailed to the Saskatchewan Disease Control Laboratory (now Roy Romanow Provincial Laboratory) for analyses of water chemistry including salinity (total dissolved solids, TDS) nutrients (total nitrogen and total phosphorus), carbon (dissolved organic carbon), and algal biomass (chlorophyll a).

Results and Discussion

The following pages present an overview of the results of the water quality data obtained in 2018. Several of the water quality measurements are related to lake trophic status, specifically total nitrogen, total phosphorus, secchi disk depth, and chlorophyll a. (Carlson Trophic State Index, Carlson 1977). The trophic state index of a lake describes the biological condition of the waterbody, and has implications for water use and potential use for fisheries and recreation. The following table outlines the values of the measurements that are used to determine trophic state index.

Table 1. Trophic State Index (TSI) parameter values. Reproduced from Secchi Dip-In (secchidipin.org). Values include chlorophyll a (Chl), secchi disk depth (SD), and total phosphorus (TP). Colours have been used to identify major trophic states and are used in Tables 2-4.

A list of possible changes that might be expected in a lake as the amount of algae changes along the trophic state gradient.

TSI	Chl(µg/L)	SD(m)	TP (µg/L)	Attributes	Water Supply	Fisheries & Recreation
< 30	< 0.95	> 8	< 6	**Oligotrophy:**Clear water, oxygen throughout the year in the hypolimnion.	Water may be suitable for an unfiltered water supply.	Salmonid fisheries dominate.
30 – 40	0.95 – 2.6	8 – 4	6 – 12	Hypolimnia of shallower lakes may become anoxic.		Salmonid fisheries in deep lakes only.
40 – 50	2.6 – 7.3	4 – 2	12 – 24	**Mesotrophy:**Water moderately clear; increasing probability of hypolimnetic anoxia during summer.	Iron, manganese, taste, and odor problems worsen. Raw water turbidity requires filtration.	Hypolimnetic anoxia results in loss of salmonids. Walleye may predominate.
50 – 60	7.3 – 20	2 – 1	24 – 48	**Eutrophy:**Anoxic hypolimnia, macrophyte problems possible.		Warm-water fisheries only. Bass may dominate.
60 – 70	20 – 56	0.5 – 1	48 – 96	Blue-green algae dominate, algal scums and macrophyte problems.	Episodes of severe taste and odor possible.	Nuisance macrophytes, algal scums, and low transparency discourage swimming and boating.
70 – 80	56 – 155	0.25 – 0.5	96 – 192	**Hypereutrophy:**(light-limited productivity). Dense algae and macrophytes.		
> 80	> 155	< 0.25	192 – 384	Algal scums, few macrophytes		Rough fish dominate; summer fish kills possible.

Secchi disk transparency

Based on the secchi disk transparencies, most studied lakes are qualified as mesotrophic or eutrophic in 2018 (Table 2). Murray, Kipabiskau, and Kenosee lakes were mesotrophic on average, but Kipabiskau was eutrophic in August, when the secchi disk transparency was reduced to 0.81m. Kenosee's water clarity was highest in June, when SD reached 5 m and was classified as oligotrophic.

Table 2. Secchi disk transparency average, minimum, and maximum from June -September 2018. The months in which the minimum and maximum SD were recorded are indicated in parentheses.

Lake	**Average SD (m)**	**Minimum SD (m)**	**Maximum SD (m)**
Loch Leven	1.30	0.46 (July)	2.6 (June)
Jackfish	1.83	1.53 (July)	2.07 (July)
Murray	2.36	2 (August)	2.59 (June)
Kipabiskau	2.34	0.81 (August)	3.43 (June)
Kenosee	2.46	1.47 (September)	5 (June)
Little Manitou	1.86	1.42 (September)	2.43 (June)

Total Phosphorus

In contrast to the secchi disk transparency values, total phosphorus indicates that the lakes were eutrophic to hypereutrophic in 2018, with the exception of Jackfish lake in June (mesotrophic). The lowest phosphorus values were observed in June in all lakes, while the highest values ranged from July to September.

Table 3. Total phosphorus (TP) concentrations in Citizen Science monitored lakes in 2018. The months in which the minimum and maximum SD were recorded are indicated in parentheses.

Lake	**Average TP (ug/L)**	**Minimum TP (ug/L)**	**Maximum TP (ug/L)**
Loch Leven	107.5	30 (June)	180 (July)
Jackfish	26.7	20 (June)	30 (August)
Murray	45	30 (June)	70 (August)
Kipabiskau	102.5	30 (June)	150 (September)
Kenosee	45	30 (June)	50 (July-Sept)
Little Manitou	335	280 (June)	400 (September)

Chlorophyll a

The average chlorophyll a values agreed more with the total phosphorus in terms of identifying trophic state index in 2018, as all lakes were either eutrophic or hypereutrophic in 2018 (Table 4).

Table 4. Chlorophyll a (Chl) concentrations in Citizen Science monitored lakes in 2018. The months in which the minimum and maximum SD were recorded are indicated in parentheses.

Lake	**Average Chl (ug/L)**	**Minimum Chl (ug/L)**	**Maximum Chl (ug/L)**
Loch Leven	68.7	6.27 (June)	140.5 (July)
Jackfish	9.42	7.46 (July)	11.4 (July)
Murray	9.28	6.27 (September)	12.9 (June)
Kipabiskau	78.29	2.26 (June)	274.8 (August)
Kenosee	9.37	1.47 (June)	26.34 (September)
Little Manitou	11.68	4.76 (June)	26.82 (July)

Total Dissolved Solids

Total dissolved solids (TDS), or salinity, refers to the mineral quantities in water. TDS includes common salts such as sodium chloride, calcium, magnesium, sulphates and bicarbonates. While all have slightly different effects on animal metabolism, none are particularly worse than any other. While the lakes studied here are not primarily used for animal or livestock watering, with the exception of Little Manitou, all lakes had acceptable levels of TDS for livestock use.

Table 5. Total dissolved solids (TDS, mg/L) concentrations in Citizen Science monitored lakes in 2018.

Lake	**Average TDS (mg/L)**	**Minimum TDS (mg/L)**	**Maximum TDS (mg/L)**
Loch Leven	175	152	218
Jackfish	1544	1527	1564
Murray	955	926	982
Kipabiskau	629	585	652
Kenosee	1834	1803	1915
Little Manitou	51622	47371	54656

pH

Lake pH was fairly stable across all lakes and seasons in 2018, with a minimum observed pH of 8.65 in Kipabiskau in June, and a maximum of 9.63 in Kipabiskau in August. pH is of interest as it relates to the carbon sink or source status of lakes (Finlay et al 2015). We have found that lake with pH > 8.6 are typically considered to be carbon sinks; that is, they are pulling in carbon dioxide from the atmosphere, and potentially storing carbon in the lake sediments. These results suggest that most of these monitored lakes are consistently carbon sinks. The one exception to this conclusion is Little Manitou. Because Little Manitou has an extremely high salt content, it will also have very high carbon concentrations and therefore will likely remain a source of CO_2 to the atmosphere, despite the high pH values observed in 2018.

Table 6. pH in Citizen Science monitored lakes in 2018.

Lake	**Average pH**	**Minimum pH**	**Maximum pH**
Loch Leven	9.36	8.86	9.57
Jackfish	9.0	8.9	9.1
Murray	8.85	8.8	8.9
Kipabiskau	9.0	8.65	9.63
Kenosee	8.89	8.8	8.97
Little Manitou	8.75	8.56	9.1

Summary and Future Recommendations

The results obtained from the 2018 CS monitoring program indicated that all lakes experienced eutrophy or hypereutophy at some times, usually later in the summer. High nutrient loading and chlorophyll a concentrations can often be associated with declining water quality, including reduced fish populations, algal scums, and large weedy plant growth. While this can be cause for concern, this state is common for prairie lakes which receive considerable nutrients from the surrounding soils, both through natural levels of soil nutrients, and through agricultural amendments of fertilizers (Leavitt et al 2006). The total dissolved solids and pH values were variable among study lakes, but are again representative of hard-water aquatic ecosystems in the northern Great Plains.

Overall, the data collected here are most useful as baseline data. While observations of elevated lake trophic status may indicate the need for improved lake management, it is difficult to determine whether the current state of water quality is the result of recent anthropogenic factors, or whether the lakes were historically of comparable water quality. Instead, we recommend that the lakes continue to be monitored in the future. By following water quality parameters over time, it will be possible to detect major changes in lake trophic status, TDS, and pH, and identify potential mitigation opportunities.

We recommend that future expansion of Citizen Science transition to a more user-centered approach to data collection, specifically that we streamline our CS sampling into the Water Rangers (waterrangers.ca) program. One issue we identified with the 2018 program was the length of time required to receive and disseminate data to volunteers. Water was collected, shipped to Regina, analysed at the provincial lab, and data were forwarded to the Water Security Agency, who then forwarded the data to the University of Regina. Ultimately it took several months from sample collection to data compilation and the volunteers were left with few details of the water quality of the lake. The Water Rangers program instead includes an interactive website and smart phone app, which allows volunteers to enter their data directly, and observe the data trends over time. They can furthermore compare their lakes to other lakes across the province and country. We believe that the integration into this program will provide more immediate feedback to the volunteers and local citizens which will allow for greater citizen engagement and agency in the management of their lakes.

Resources

Finlay, K., R.J. Vogt, M.J. Bogard, B. Wissel, B. Tutolo, G. Simpson, P.R. Leavitt. 2015. Decrease in CO2 efflux from northern hardwater lakes with increasing atmospheric warming. Nature. Doi:10.1038/nature14172.

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Parameter summaries from:
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