Lake Stewardship Water Quality Guide

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INTRODUCTION

Water quality monitoring is an important component of lake stewardship activities. It provides a scientific basis for understanding lake characteristics and how activities around the lake may impact water quality, and can determine whether changes in water quality have occured over time. This manual outlines the water quality parameters measured as part of the Saskatchewan Watershed Authority's *Lake Stewardship Program*, explains why those parameters are measured, and the importance to understanding the health of lakes.

There are three general types of questions that lake stewardship groups and the public tend to ask about lakes:

1. Lake Health – Is it safe to swim in? Are the fish being protected?
2. Changes in Water Quality – Is the quality of water getting better, worse or staying about the same?
3. Water Quality Factors – What are the important factors affecting water quality, and what are realistic expectations of water quality based on the natural condition of the lake?

To help address these questions, one of the tools the Saskatchewan Watershed Authority uses is a Water Quality Index (WQI) which provides an assessment of overall water quality. Advantages to using an index include the integration of many water quality parameters into one score representing waterbody health and it's changes over time, and the presentation of complex information in an easily relatable format.

WATER QUALITY INDEX

The *Lake Stewardship Program* uses sixteen parameters in its Water Quality Index (WQI) to summarize overall lake water quality. These include key nutrients, metals, dissolved ions, pesticides and general water quality parameters. The objectives used in the Water Quality Index are based on Saskatchewan's Surface Water Quality Objectives, the Canadian Environmental Quality Guidelines and target values established by the Saskatchewan Watershed Authority to protect lake health (Table 1).

The WQI incorporates three elements: *scope* – the number of variables that do not meet the water quality objectives; *frequency* – the number of times that variables do not meet the objectives; and *amplitude* – the amount by which the objectives are not being met. From these elements, the WQI produces a score between 0 and 100.

The following descriptive categories are used to further explain the WQI results:

Excellent: (WQI value 95-100) – Water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels. These index values can only be obtained if all measurements are within objectives virtually all of the time.

Good: (WQI value 80-94) – Water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.

Fair: (WQI value 60-79) – Water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.

Marginal: (WQI value 45-59) – Water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.

Poor: (WQI value 0-44) – Water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels.

Table 1 – Objectives for the Water Quality Index

Parameter	Objective
Nutrients	
Total Phosphorus (mg/L)	0.1 [2]
Total Ammonia (µg/L)	19* [1]
NO_3-N (mg/L)	2.9 [2]
Metals	
Mercury - Inorganic (µg/L)	0.026 [1]
Aluminum (mg/L)	0.1 [1]
Chromium (µg/L)	1 [1]
Arsenic (µg/L)	5 [1]
Major Ions	
Chloride (mg/L)	100 [1]
Sodium (mg/L)	100 [2]
Sulphate (mg/L)	1000 [4]
Herbicides	
MCPA (µg/L)	0.025 [4]
2'4-D (µg/L)	4 [1]
Microbiological Water Quality	
E. coli Bacteria (units/100mL)	200 [1]
General Parameters	
Dissolved Oxygen (mg/L)	5.5 [1]
pH (units)	6.5-9.0 [3]
Chlorophyll *a* (µg/L)	50 [2]

*Value calculated based on pH and temperature.

[1] Saskatchewan's Surface Water Quality Objectives, Interim Edition, 2006.

[2] Saskatchewan Watershed Authority target value.

[3] Canadian Council of Ministers of the Environment (2006) Canadian Water Quality Guidelines for the Protection of Aquatic Life.

[4] Canadian Council of Ministers of the Environment (2005) Canadian Water Quality Guidelines for the Protection of Agricultural Uses.

PARAMETERS USED IN THE WATER QUALITY INDEX

Nutrients

Nutrients are essential for the growth and survival of all organisms. The amount of nutrients in a system influence how much life it can support. In aquatic systems nutrients can come from a variety of sources. In some lakes nutrients can increase as a result of human activities. Increased nutrients can potentially lead to a variety of problems. As a result, some key nutrients are monitored as part of the *Lake Stewardship Program*.

Total Phosphorus – In freshwater lakes, phosphorus is the nutrient most often associated with increased plant and algal growth. Increased plant and algal growth can impact recreational activities and the aesthetic value of the lake.

Ammonia – Ammonia is a form of nitrogen that can be toxic to aquatic organisms.

Nitrate – Nitrate and nitrite are also forms of nitrogen. Similar to ammonia, nitrate can be toxic to aquatic organisms.

Metals

The concentration of metals in lakes is dependent on geology, chemistry and human activity in the watershed. The metals included in the WQI are important because they have potential to be toxic to fish and other aquatic organisms. The four metals considered in the WQI are mercury, aluminum, chromium and arsenic. The objectives used for each of these metals reflect the freshwater concentrations that are considered safe for the protection of aquatic life.

Major Ions

Ions are charged particles dissolved in water. Many metals and minerals are also present in ionic form, but the major ions used in the WQI are salts -- chloride, sodium and sulphate. Processes like erosion, runoff, evaporation and human activity can contribute to dissolved ions in the water.

Herbicides

Herbicides are chemicals applied to kill or inhibit the growth of nuisance plants. Some herbicides are potentially toxic to aquatic life. The potential for contamination in aquatic systems increases with the persistence of the herbicide in the environment. The two herbicides considered in the WQI are MCPA (2-methyl-4-chlorophenoxy-acetic acid) and 2,4-D (2,4-Dichlorophenoxyacetic acid).

Microbiological Parameter

All surface water contains a variety of bacterial species. While most species are generally considered benign to human health, *E. coli* (*Escherichia coli*) is a concern for people contacting lake water through recreational activities. High *E. coli* counts can indicate contamination from livestock, wildlife and/or sewage systems.

General Parameters

Dissolved Oxygen – Dissolved oxygen is essential to most aquatic life. When dissolved oxygen becomes too low, some aquatic organisms (including fish) can become stressed, and at very low levels or prolonged periods of oxygen stress they may die. Dissolved oxygen levels can decrease as a result of increased lake productivity in winter when decomposition consumes oxygen faster than it can be replaced. Dissolved oxygen also influences many chemical processes within lakes.

pH – pH is an important water quality parameter that affects chemical and biological reactions within lakes. Extremes in pH or rapid changes in pH can impact aquatic life. Saskatchewan lakes demonstrate a variety of pH levels from basic to acidic.

Chlorophyll *a* – Chlorophyll *a* is the primary pigment that plants and algae use to convert sunlight into energy for growth. Chlorophyll *a* is measured to determine the amount of algae in the water.

ADDITIONAL PARAMETERS

During laboratory analysis of the samples collected by Saskatchewan Watershed Authority and the lake stewardship groups, a number of additional parameters are reported. Not all these parameters measured are included in the Water Quality Index, but can help us better understand water quality. Additional parameters not included in the WQI are discussed below.

Nutrients and Organics

Dissolved Organic Carbon (DOC) – In general, organic carbon compounds are a result of decomposition of organic matter. DOC is an important source of energy in lakes.

Total Kjeldahl Nitrogen – Another measure of the amount of nitrogen in water.

Ortho-Phosphate – The form of phosphorous most readily available to plants and algae in water.

Ions

Conductivity – Conductivity is a measurement of the concentration of dissolved ions in water. It is used as a measure of salinity.

Total Dissolved Solids (TDS) – Total dissolved solids is the sum of the major ions dissolved in the water and is also used as a measure of salinity.

Total Suspended Solids (TSS) – Suspended solids is a measure of undissolved and unsettled particles in the water. They reduce water clarity and may interfere with gill function in aquatic organisms. Total suspended solids can be divided into volatile and fixed suspended solids.

Alkalinity – Total alkalinity is a measure of the acid-neutralizing capacity of the water. Bicarbonate and carbonate are two sources of alkalinity.

Total Hardness – Hardness is a measurement of certain ions in the water, primarily calcium and magnesium. Hard water is not usually a health concern, but can affect the suitability of water for some purposes due to the crusty deposits that build up on water pipes.

Potassium – Potassium is one of the major ions measured for basic water chemistry.

Microbiological Parameters

Total Coliform Bacteria – Coliform bacteria are present in the environment as well as the digestive tract of animals. While some coliform bacteria can be harmful (i.e. strains of *E. coli such as E. coli 0157:H7*), most are not problematic in recreational waters. Their abundance is used to indicate conditions that may indicate the presence of harmful pathogens.

Metals

Metals not used in the WQI include: barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, soluble silicon, silver, strontium, titanium, zinc and zirconium.

Herbicides

Herbicides not used in the WQI include: 2,4,5-T, 2'4'5-TP (Silvex), bromoxynil (Buctril), dicamba (Banvel), diclofop-methyl (HoeGrass), Picloram (Tordon).

Miscellaneous Parameters

Biochemical Oxygen Demand – Biochemical oxygen demand measures the rate of uptake of oxygen by micro-organisms in a sample of water.

Chemical Oxygen Demand (COD) – Chemical oxygen demand measures the rate of chemical consumption of oxygen in a water sample.

Field Data

Turbidity – Turbidity is a measure of water clarity.

Secchi Disk Transparency – Secchi depth is a measure of water transparency.

Dissolved Oxygen/Temperature/Conductivity Profile – Dissolved oxygen, temperature, and conductivity measurements are taken at different depths to provide information about lake stratification (layering) and how mixed a lake is.

Weather Observations – The weather observations recorded in the field are: air temperature, percent cloud cover, wind speed and snow/ice thickness and/or wave height.

For more information about Saskatchewan Watershed Authority's *Lake Stewardship Program* or the topics discussed in this *Lake Stewardship Program* Manual, please contact the Saskatchewan Watershed Authority.

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