A RiverWatch Program Report for 2011

A comparison of the *Vernier* and *Sonde* water quality probes

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"Helping Ourselves to a Healthy Environment"

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Introduction

On August 31, 2011, during a visit to Golden Lake, the BRWP RiverWatch team (Jessica Danard, BRWP RiverWatch coordinator, and Sarah Anderson, Carleton University, Department of Geography and Environmental Studies) and Jack Blair (Golden Lake steward) measured some basic water quality parameters with both the Sonde water quality instrument (supplied by Dr. Murray Richardson, Carleton University, DGES) and the Vernier water quality probes owned by the Bonnechere River Watershed Project. The purpose was to see how comparable the results were, in order to decide how to use equipment in future projects.

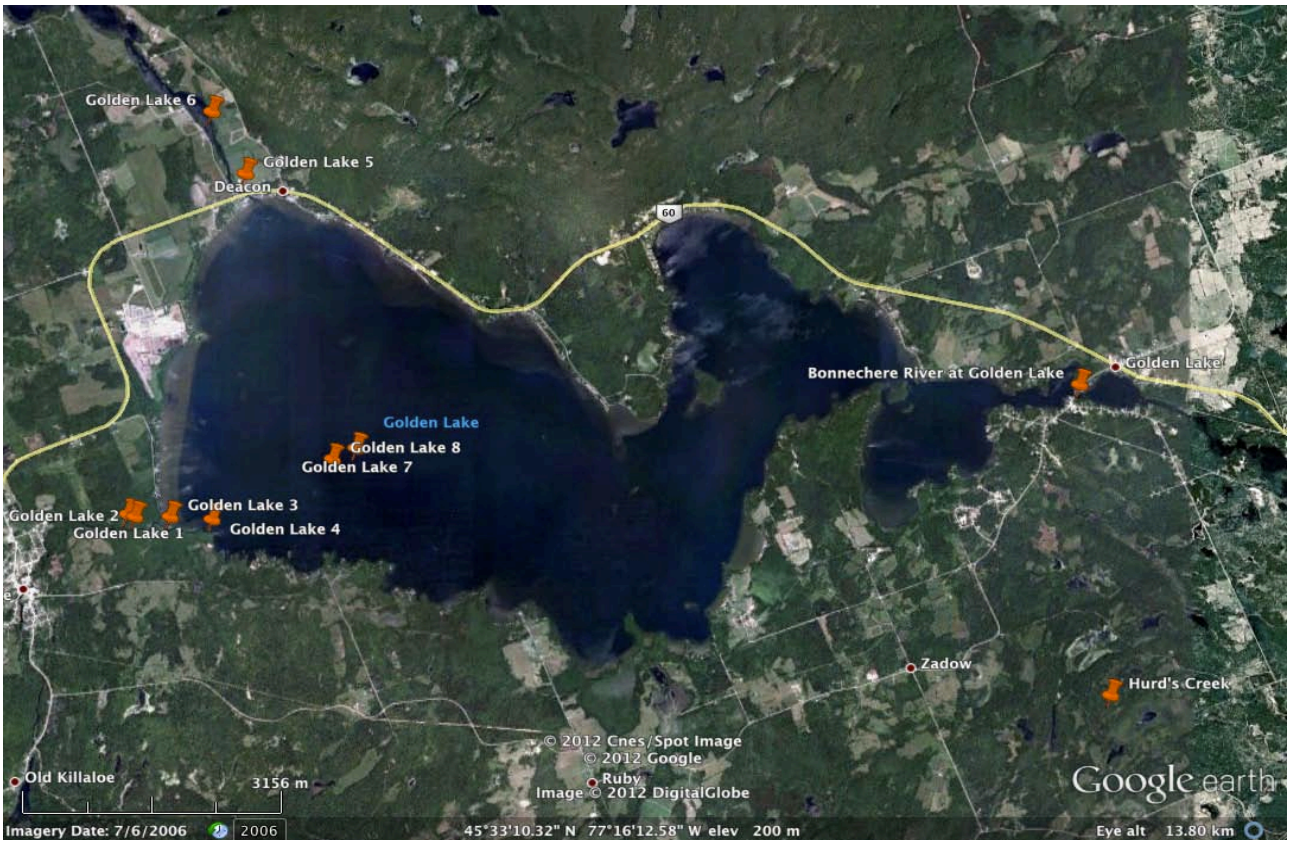
The Sonde is a handheld instrument (http://www.globalw.com/products/w_23xd.html) that can measure up to 13 different parameters including water temperature, pH, dissolved oxygen (DO), three ions (Cl^-, NO_3^-, and Ca^{2+}), chlorophyll and water depth It can be calibrated automatically simply at the touch of a button for more highly reliable data. What is a complicated calibration process for other meters, such as the Vernier is made easy using standard solutions, particularly for each of the five main parameters pH, conductivity, turbidity, DO, and depth. It costs about $15,000.

The Vernier can handle up to four probes at a time. Most probes requires calibration with each use, and should not be turned off between calibration and use. Maintaining battery life can be a challenge with the Vernier. The BRWP Vernier cost about $3,500.

Methods

The BRWP coordinator did the Vernier calibration for this comparison.

All sites were surface water, away from the shore; see the lake map for locations.



Satellite image of Golden Lake showing BRWP water chemistry measurement points (GL 1-4) during the 2011 summer season.

Results and Discussion

Temperature

	Temp (ºC)		
Site	**Vernier**	**Sonde**	Difference
GL1	20.6	20.10	0.50
GL2	20.1	19.96	0.14
GL3	21.3	19.89 (24 cm)	1.41
GL4	21.8	20.63	1.17

Measurements between probes differed by 0.81ºC on average. The Sonde was consistently lower than the Vernier. The depth of the Vernier probe was not recorded but was generally very near the surface. The depth of the Sonde was only measured at GL3 and, at 24 cm, was probably deeper than the Vernier

probe was held. The difference in water depth would have contributed to the consistently lower reading for the Sonde compared to the Vernier.

The differences between probes does not appear to be biologically significant given the range of optimal temperatures tabled below for a variety of aquatic organisms (source: Vernier manual).

Table 1: Optimal Temperature Ranges

Organism	Temperature Range (°C)
Trout	5 – 20
Smallmouth bass	5 – 28
Caddisfly larvae	10 – 25
Mayfly larvae	10 – 25
Stonefly larvae	10 – 25
Water boatmen	10 – 25
Carp	10 – 25
Mosquito	10 – 25
Catfish	20 – 25

Specific Conductance

Specific conductance is an indirect measure of total dissolved solids in freshwater including soluble salts that yield ions such as sodium, calcium, magnesium, bicarbonate, sulfate or chloride. Total dissolved solids affect the ability of water to conduct an electrical current, or its specific conductance.

	SpC (µS/cm)		
Site	**Vernier**	**Sonde**	Difference
GL1	200	257	57
GL2	192	258	66
GL3	196	257	61
GL4	183	235	52

Measurements between probes differed by 59 µS/cm on average. The Vernier was consistently lower than the Sonde. The Vernier also had greater variability among sites compared to the Sonde. Both the Sonde and the Vernier were lowest at GL4.

Typical conductivity ranges are (source: http://www.stream-team.org/Parameters/conductb.html):

Freshwater Lakes and Streams: 100 to 2000 µS
Melted Snow: 2 to 42 µS
Drinking Water: 30 to 1500 µS
Distilled Water: 0.5 to 3.0 µS

Given these ranges, the difference between the Vernier and Sonde is not likely problematic. Furthermore, most streams have a fairly constant range of conductivity under normal circumstances. Therefore, it is significant changes in conductivity that are of particular concern because they can be an indicator that a discharge or some other source of pollution has entered the water.

However, the composition of the water can be critical for aquatic organisms as well, as many organisms have very specific ranges that they can tolerate.

pH

	pH	
Site	**Vernier**	**Sonde**
GL1	7.90	7.83
GL2	4.00	7.76
GL3	9.55	7.83
GL4	-	7.85

The first pH reading by each probe was close (0.07 difference). However, as is apparent from a reading of 4, there were problems with the Vernier pH probe after that. According to information provided in the Vernier manual (tabled below), pH in the range of 6.5 to 8.2 is considered optimal for most aquatic organisms.

Effects of pH on aquatic organisms are tabled below (source: Vernier manual).

Table 1: Effects of pH Levels on Aquatic Life	
pH	**Effect**
3.0 – 3.5	Unlikely that fish can survive for more than a few hours in this range, although some plants and invertebrates can be found at pH levels this low.
3.5 – 4.0	Known to be lethal to salmonids.
4.0 – 4.5	All fish, most frogs, insects absent.
4.5 – 5.0	Mayfly and many other insects absent. Most fish eggs will not hatch.
5.0 – 5.5	Bottom-dwelling bacteria (decomposers) begin to die. Leaf litter and detritus begin to accumulate, locking up essential nutrients and interrupting chemical cycling. Plankton begin to disappear. Snails and clams absent. Mats of fungi begin to replace bacteria in the substrate.
	Metals (aluminum, lead) normally trapped in sediments are released into the acidified water in forms toxic to aquatic life.
6.0 – 6.5	Freshwater shrimp absent. Unlikely to be directly harmful to fish unless free carbon dioxide is high (in excess of 100 mg/L)
6.5 – 8.2	Optimal for most organisms.
8.2 – 9.0	Unlikely to be directly harmful to fish, but indirect effects occur at this level due to chemical changes in the water.
9.0 – 10.5	Likely to be harmful to salmonids and perch if present for long periods.
10.5 – 11.0	Rapidly lethal to salmonids. Prolonged exposure is lethal to carp, perch.
11.0 – 11.5	Rapidly lethal to all species of fish.

Dissolved Oxygen

	DO (mg/L)		
Site	**Vernier**	**Sonde**	**Difference**
GL1	7.8	7.90	0.10
GL2	7.1	7.60	0.50
GL3	7.3	7.93	0.63
GL4	5.3	8.47	3.17

Excluding GL4, measurements between probes differed by 0.41 mg/L on average. The Vernier was consistently lower (errs on the side of being conservative as an indicator) and more variable among sites than the Sonde. The divergence in measurements at GL4 suggests that the Vernier DO probe needed to be re-calibrated or serviced.

The differences between probes does not appear to be biologically significant given the range of minimal requirements tabled below for a variety of aquatic organisms (source: Vernier manual).

Table 1: Minimum DO Requirements

Organism	Minimum dissolved oxygen (mg/L)
Trout	6.5
Smallmouth bass	6.5
Caddisfly larvae	4.0
Mayfly larvae	4.0
Catfish	2.5
Carp	2.0
Mosquito larvae	1.0

Conclusion

The Vernier probes must be calibrated more often and the calibration monitored more carefully than for the Sonde. The probes need to be handled with care and monitored closely for service or replacement.

The BRWP RiverWatch coordinator has found that the Vernier battery does not hold a charge well and needed to be plugged in almost constantly which constrained its use in the field. At the time of the comparison with the Sonde, battery functioning suggested that it needed to be replaced and that may

have affected probe operation during the lake visit. Because of this, additional work to evaluate the performance of the Vernier is warranted.

In using the specific conductance probe, it is necessary to first choose at what range to measure. For BRW lakes, most measurements should be done using the low range setting (0-200).

The Vernier pH probe needs to be serviced or replaced.

Given natural ranges and biological tolerances, it would appear that the Vernier probes can be used as part of a program to measure water quality, and especially to monitor trends in particular locations. Where something is flagged in the monitoring, other instrumentation such as the Sonde could then be used. It also seems clear that not everyone is comfortable calibrating and using instrumentation such as the Vernier or the Sonde, but especially the Vernier, and the need for technical personnel must also be considered as well.