

Monitoring the Health of the Bras d'Or Lake Biosphere: Estuarine Water Quality

By Dr. Bruce Hatcher

There are three water quality monitoring programs operating in the Bras d'Or estuary.

Monitoring the quality of the water in the Bras d'Or estuary gives us an indication of its' health. We can estimate the amount of plant and animal production, and predict the suitability of the habitat for organisms ranging from bacteria to sea turtles. Similar to our reliance on our body temperature and blood chemistry in assessing our own health, the physical, chemical and biological attributes of water integrate important ecological process over long periods and large areas that would be impossible to measure at all times and locations. Water quality monitoring is the primary mode of assessing lake and estuarine health world-wide. Because all the waters of the large watershed that defines the boundary of the Biosphere flow into the estuary, the quality of water is also an indicator of the health of the entire Biosphere.

The value of monitoring as a predictor of aquatic health is a function of the variables and quantities of water that are measured, the accuracy of the measurements, the duration of sampling and the number of locations at which they are measured. How well are we sampling the immense volume (33 km³) of water in the Bras d'Or estuary, which is about three thousand times larger than the North Sydney water supply (Pottle Lake). The estuary's waters are mixed across almost 1,300 km² over periods of days to years. It is safe to say that one sample a year from the middle of the big Lake is not going to do the job!



Irish Cove (Crosby)

Fast Facts about the Bras d'Or Estuary:

- *Ocean water can enter the Bras d'Or estuary through three channels.*
- *The largest exchange of ocean water occurs through the Great Bras d'Or Channel.*
- *The Little Bras d'Or Gut and the man-made St. Peters Canal provide minimal amounts of ocean water by comparison.*
- *The water of the Bras d'Or estuary is approximately 62% salt water.*

1. Canadian Shellfish Sanitation Program

Currently, there are three water quality monitoring programs operating in the Bras d'Or estuary. The longest-running is the Canadian Shellfish Sanitation Program. The CSSP is based on a 1948 USA-Canada public health treaty designed to assure the safety of edible shellfish traded across the border. The program is managed by Environment and Climate Change Canada (EC3), in partnership with Fisheries & Oceans Canada (DFO) and the Canadian Food Inspection Agency (CFIA). The focus of monitoring is a measurement of the quantity of bacteria from the guts of mammals (faecal coliforms) in samples of surface waters in areas of the Lake where there is the possibility of shellfish harvesting.



Shellfish safety

Most of the CSSP samples are collected in shallow water near the outflows of rivers, streams and sewers and some are collected in barachois ponds. If the bacteria count is above a threshold value, the area(s) where the contaminated samples were collected are closed to shellfish harvesting. The quality control on sample collection and analysis is very high. Sampling is extensive, typically about 330 locations sampled over a total area of more than 550 km² along the shore of the estuary. Water sampling has been subcontracted to local contractors

including the Unama'ki Institute of Natural Resources (UINR) and Bras d'Or Institute of Cape Breton University (BDI). Sampling is typically done as many as five times per year during the summer and autumn, and was quite consistent from 1970 until 2006 (with a significant increase in the area sampled from 1995 onwards). After that time sample frequency became less regular, and some years were missed altogether. Sampling is now conducted entirely by commercial subcontractors.

A 30 year record of water quality

The Canadian Shellfish Sanitation Program (CSSP) is the longest and most wide-spread water quality record we have for the estuary, even though it measures only two variables during the summer months: surface water temperature and a relative concentration index (standardized counts) of one bacterium (*E. coli*) washed from the watershed into the nearshore waters of the Lake. Thus, it serves as an indicative proxy for inputs (e.g. sewage, nutrients and sediment) from the watershed to the estuary, and is also sensitive to natural inputs from non-human animals (e.g. beavers, birds). Finally, the CSSP provides a 30+ year record of surface water temperature (and also salinity for some sites). The extensive

data set is a matter of public record, and the 1981 to 2017 results are available in raw form at:

<http://data.ec.gc.ca/data/sites/areainterest/cssp-canadian-shellfish-sanitation-program/>

Some of the AZMP data are a matter of public record, and those from seven of the original sites may be obtained at:

<http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/azmp-pmza/hydro/station/multiple-eng.asp>

Data from the AZMP transect sample sites are not available online, but

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periodic publications summarize the aggregate results (most recently in DFO, 2016). The results from the two new sites in the Bras d'Or estuary are not yet available on line. Two interesting results from this relatively short time series are that the depth at which wa-ter in the Whycocomagh Basin becomes permanently anoxic (zero dissolved oxygen concentration) varies by as much as 5m during the year, and the Spring phytoplankton bloom typically occurs

Shellfish closures over time

Published analyses of CSSP data up to 2005 may be found in MacArthur *et.al.* 2003; UINR 2007.

One of the many useful results of this long time series of monitoring is that the area of the estuary **closed to shellfish harvesting has remained remarkably constant at approximately 5% of the total area** sampled since 1995. Most closures follow periods of intense precipitation.



The ultimate results (*i.e.* maps of areas closed to shellfish harvesting) are available in near real time at:

[https://interw01.dfompo.gc.ca/Geocortex/Essentials/Viewer/Index.html?viewer=CSSP_Public_En_Site.](https://interw01.dfompo.gc.ca/Geocortex/Essentials/Viewer/Index.html?viewer=CSSP_Public_En_Site)

Sketch by Barb Lock

2. Atlantic Zone Monitoring Program

The second regular monitoring of water quality in the estuary is part of the Atlantic Zone Monitoring Program (AZMP). Initiated by the Bedford Institute of Oceanography (BIO) in 1998, the AZMP works with partners to collect water samples and make measurements at 164 fixed stations from DFO research vessels as well as vessels of opportunity along 14 near-shore to off-shore transects located throughout Atlantic Canada. The Louisbourg and Cabot Strait transects are the closest to the Bras d'Or Lake. The frequency of sampling varies considerably among locations, from as rarely as once, to as often as 325 times per year. A comprehensive set of analyses (eleven variables) are per-formed on water samples collected at several depths through the water column from surface to seabed. All of the samples are analyzed at the BIO, and the quality control is excellent. In addition to water samples, a plankton net is towed, and a vertical profiling instrument is lowered through the water column, logging thirteen variables eight times per second as it descends.



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AZMP sample sites in the Bras d'Or Lake

In 2010 the BDI, Eskasoni Fish and Wildlife Commission (EFWC) and the UINR partnered with the DFO to establish two permanent AZMP sample sites in the Bras d'Or estuary. The first site is in the centre of the great lake at a depth of 257 m, and the other is in the centre of the Whycocomagh Basin (at the extreme western end of Whycocomagh Bay) at a depth of 48m. The frequency of sampling the Bras d'Or sites is at least eight times per year, depending on weather and ice conditions. High resolution optical profiles are also made at these sites for the purpose of calibrating sensors on Earth-observing satellites that can be used to estimate plankton and sediment distributions in the entire Lake. DFO terminated funding for the two Bras d'Or estuary stations in 2018, but the BDI staff continued the sampling on a volunteer basis. Funding was restored for a year in 2019, but the program no longer has stable, long term funding. The results from the two new sites in the Bras d'Or estuary are not yet available on line.

“the program no longer has stable, long term funding”

Spring algal blooms and low oxygen areas

Two interesting results from this relatively short time series are that the depth at which water in the Whycocomagh Basin becomes permanently anoxic (zero dissolved oxygen concentration) varies by as much as 5m during the year, and the Spring phytoplankton bloom typically occurs almost one month later in the Bras d'Or estuary than it does in the waters of the Cabot Strait.

Nutrient Rich Barrachois Ponds

During a seven year period from 2011 to 2017, Bras d'Or Institute staff applied the AZMP sampling protocol to about one hundred sites throughout the Lake which were being sampled as part of the CSSP sub-contract. This arrangement was terminated by EC3 in 2018, but the data allows for correlations to be drawn between these two programs. One consistent result of this comparison to date is that the abundance of dissolved plant nutrients and phytoplankton is almost always higher in waters near shore than in those at the centre of the great Lake, and the highest levels of all can be found in some of the barrachois ponds.



3. Bras d'Or Watch

The third water quality monitoring program is part of the developing *Bras d'Or Watch* citizen science project coordinated by the Bras d'Or Lake Biosphere Reserve Association (BLBRA). Teams of local volunteers at six locations around the estuary measure a small set of physical, chemical and biological variables in shallow waters and along the shoreline. Volunteers are also asked to be vigilant in watching for introduced species such as the European green crab. Bras d'Or Watch was initiated in 2015, and the plan is to have local communities take ownership of their sample sites and data over the long term. Such community based monitoring programs have a great potential to inform and engage society on the relationship between water quality and Biosphere health.



Bras d'Or Watch 2018 at Whycomomagh

“Such community-based monitoring programs have a great potential to inform and engage society.”

CAMP and CABIN

There are a few other research and citizen science projects going on at any given time that measure a diversity of water quality variables in the Bras d'Or estuary. The DFO Coastal Aquatic Monitoring Program (CAMP) includes water quality assessments, and has been implemented by the UINR at several sites on the Bras d'Or coast. The UINR also undertakes the Canadian Aquatic Biomonitoring Network (CABIN) protocols at several sites in rivers upstream of the Lake, thereby providing a measure of the quality of freshwater entering the estuary from its watershed.



Beach seine sampling at Ben Eoin

The Past informs the Present

There were years in the past during which intense programs of water sampling were undertaken by the DFO from a dedicated research vessel (e.g. Strain and Yeats, 2002) There have been three hydrodynamic models of water circulation in the estuary constructed and calibrated since 1993. There were periods of several years when station sampling and measurements were repeated. These are all important sources of information, but are only of value in the context of monitoring water quality and ecosystem health if the data are well recorded and the data sets described, archived and analyzed. One remarkable example of this is the Cape Breton Development Corporation (DEVCO) aquaculture dataset collected under the leadership of Roy Drinnan. Twenty seven sites that were deemed to be suitable for shellfish cultivation were sampled from monthly 1971 to 1975. The hand written raw data sheets have been transcribed to digital spread sheets by the staff at the Bras d'Or Institute (BDI), providing a valuable benchmark of water quality and associated biological indicators from almost half a century ago. From these data we have determined that surface water temperatures, ice cover, nutrient concentrations and plankton abundances were all measurably higher than they are now.



Photo: Bras d'Or Stewardship Society

Other pathways of transport

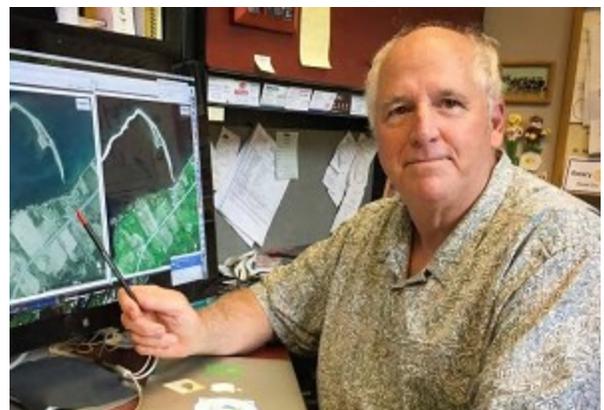


Photo: Bras d'Or Institute

Monitoring water quality in the Bras d'Or Lake can provide an integrated measure of the environmental quality of the entire Biosphere because the watershed is intimately connected to the estuary by the downward flow of rain and snowmelt water over the land surface, in streams and rivers, and through underground water transport. However, different pathways of transport change the water in different ways. For example, increases in the amount of impervious surface (e.g. roofs, pavements, landscape mats, etc.) as a result of human development in the watershed has impacts on many aspects of the ecosystem. As a result, it is necessary to monitor surface and groundwater in the watershed before it enters the Lake, but that is another article.

About The Author

Bruce Hatcher is the current chair of the board of directors of the Bras d'Or Lake Biosphere Reserve Association, the Director of the Bras d'Or Institute and occupies the Chair in Marine Ecosystem Research at Cape Breton University. For more information about the Association and about Bras d'Or Watch please visit our web-site (<https://blbra.ca/>)



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Kidston Island February 2019; photo by B. Hatcher

Bras d'Or Lake Biosphere Reserve Association
Towards a more sustainable future

<https://blbra.ca/>

