CANADA-USA AGREEMENT ON EUTROPHICATION CONTROL AND PROTECTION OF LAKE CHAMPLAIN

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On August 26, 2002 in Quebec City, an agreement was signed between Vermont (USA) and Québec (Canada) regarding phosphorus reduction in the Missisquoi Bay (Lake Champlain) watershed. Missisquoi Bay is a large shallow basin of Lake Champlain in the lake's northeast corner [1]. Vermont and Québec roughly equally share the bay's 77.5 km^2 surface area as well as its 3100 km^2 watershed (58% in Vermont, 42% in Québec). Land use for the overall watershed is 62% forested, 25% agricultural, and 5% urban. The major agricultural activities are dairy and production of corn and hay as cattle feed. Major tributaries to the bay include the Missisquoi, Pike and Rock Rivers, the combined discharge of which yields a mean water residence time of 40 days. Water exchange with the main lake is low due to a high sill near the bay's mouth that is made higher by causeways for two bridges. The bay has a maximum depth of just 4m and thus is subject to wind mixing and sediment re-suspension, as well as prolific weed growth where light is able to penetrate to the bay bottom. Winter phytoplankton communities consist of diatoms, green algae and cryptophytes, but bloom forming cyanobacteria, especially microcystin-producing Microcysis, dominate in summer. The Bay was described as mesotrophic in the 1970s [2], but since monitoring began in 1992 has had values for chlorophyll a, TP and Secchi depth that classify it as eutrophic. Location, morphology and quality status of Missisquoi Bay are presented in Figure and Table1.

Figure and Table 1. Map of Champlain Lake and Relevant parameters of Missisquoi Bay

Source: LCBP Atlas [7]

Physical parameter	Value
Average Depth (m) Max Depth (m)	2,8 4
Surface Area (km^2)	77,5
Water Volume (x10^{6}m^3)	131,6
Watershed Surf. Area CP (km^2)	1 200
Input water	gw + trib.+ ro.
Quality parameter	**Value**
TP (µg/l) QC w = 20 ug/L	43-86 (wc) 1500 ppm (s)
Chl a Biomass (µg/l) QCw = 8	7-70
Transparency (m) QCw = 1.5m	0,8-1,0
pH Dissolved Oxygen (%)	7,0-9,5 85
HM (Pb, Zn, Cd)	> MEL (+ Hg)

TP = Total Phosphorous; HM = heavy metals;
MEL = Minimal effect level;
QC = Quality Criteria;
gw = groundwater; ro= runoff; wc = water column; s = sediments; CP= Canadian portion.

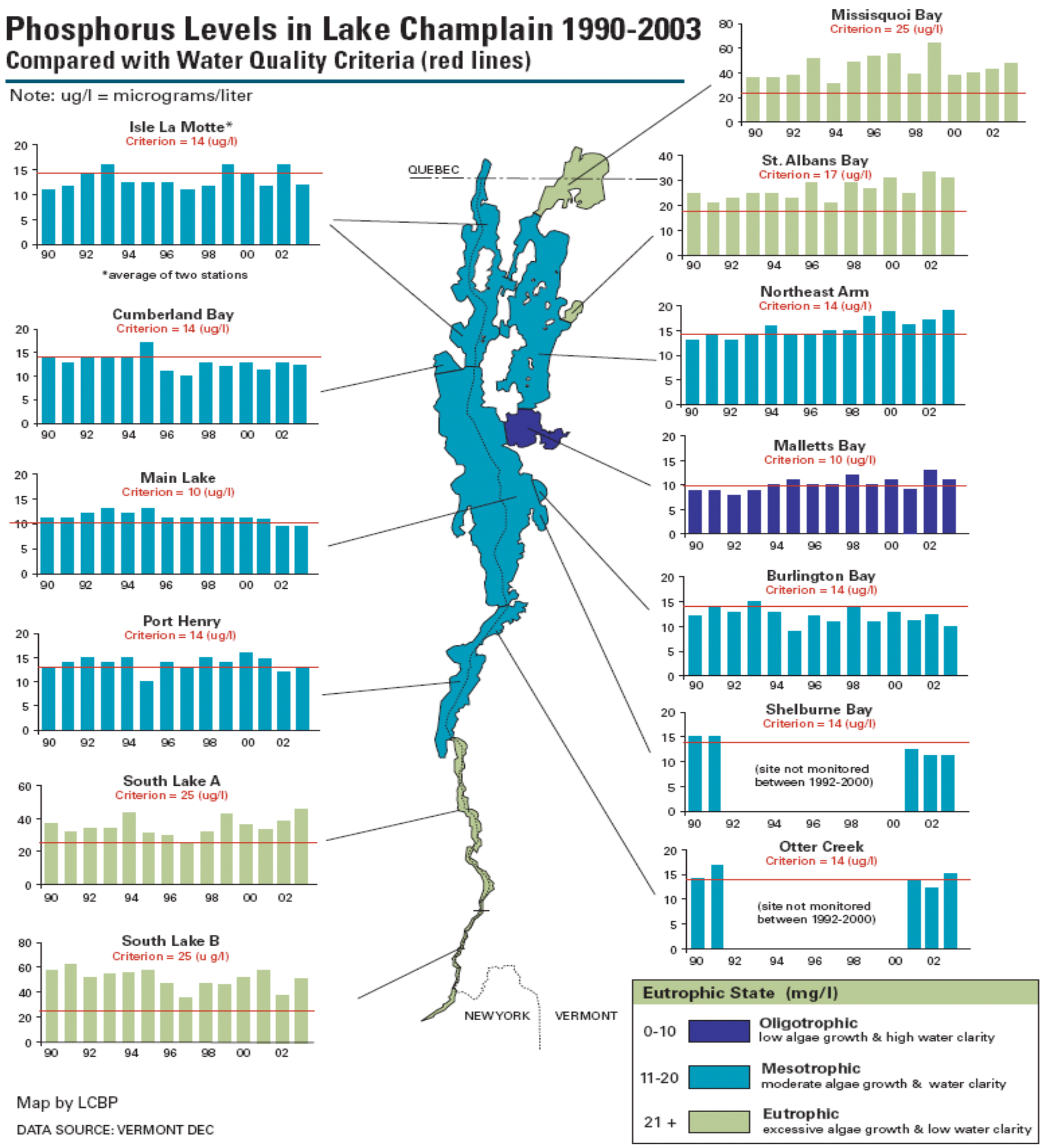
Missisquoi Bay is an important vacation area for the region. Fishing is popular year around, and resorts with boating and swimming operate in summer. Water quality is important not just for recreation and tourism, but also for water used to irrigate crops and for drinking (the municipalities of Bedford and St Armand in Philipsburgh sector, Quebec's souther Estrie region, have drinking water intakes in the bay). Lake Champlain as a whole is very important to both countries historically. It has been the site of battles in the French-British-Indian War, U.S. Revolutionary War, and War of 1812. In fact, historians believe that the Revolutionary War would have been lost if the Battle of Lake Champlain hadn't delayed British penetration into the colonies and given the colonies time for preparations. Lake Champlain also was the major commercial shipping lane between the North-Easter U.S. and Canada before transport by rail was possible. Canals were built at both ends of the lake to facilitate this trade, the Champlain Canal connecting the Lake with the Hudson River, and the Chambly Canal allowing passage around a falls on the Richelieu River, the lake's natural outflow and a tributary of the St. Lawrence River. From either canal, boaters can reach the Atlantic Ocean and the Great Lakes. Consequently, although commercial traffic is currently low, many recreational vessels ply the waters.

The water quality of Missisquoi Bay began to deteriorate in the late 18^{th} to early 19^{th} century has a result of extensive land clearing (up to 80% of the watershed), agriculture, and commercial ship traffic. However, the bay was still relatively attractive recreationally and useful as a water source until 15-20 years ago, when numerous symptoms of eutrophication became apparent, including increased nutrient concentrations, augmented aquatic vegetation growth, appearance of (toxic) cyanobacterial blooms and changes in sediment distribution that largely eliminated fish (especially walleye) spawning habitat. As a result of these changes, drinking water is trucked into several towns, beaches have closed for significant amounts of time most summers, and both tourism and property values have declined. For example, Figure 2 shows levels of excess nutrient (TP) in various Champlain Lake segments; Missisquoi Bay has the highest levels.

A potential cause of the degradation of Champlain Lake water quality is increased nutrient and sediment loading from rivers and runoff. The bay receives very little sewage or industrial effluent. Atmospheric deposition also is a likely source of excess nitrogen, but TP rather than TN is used as an indicator of nutrient pollution in this region. Missisquoi Bay and the Northeast Arm of Lake Champlain are both listed as impaired waters (for swimming, recreation, water supply) in Vermont, with the pollutants of concern listed as phosphorus and mercury. Based on water quality monitoring data collected by the Lake Champlain Basin Program, the phosphorus concentrations over the past five years (1999-2003) have averaged 0.045 mg/l in Missisquoi Bay and 0.018 mg/l in the Northeast Arm. For comparison, the water quality criteria for phosphorus endorsed by the governments of Vermont, Quebec and New York are 0.025 mg/l for Missisquoi Bay and 0.014 mg/l for the Northeast Arm. The Missisquoi Bay watershed was determined to be the largest contributor of phosphorus to Lake Champlain as a whole, compared with the combined tributary inputs to other lake segments. It is estimated that over 90% of the phosphorus load to Missisquoi Bay comes from nonpoint sources. About 25% of the watershed is used for agriculture, yet 79% of the nonpoint source phosphorus originates from agricultural areas. The amount of phosphorus (and nitrogen) flowing into the bay from its tributaries and present in sediment at the bottom of the bay contributes to the excessive growth of blue green algae [3,5,6]. The situation was serious enough to have prompted the Regional Health and Social Services Board in Quebec to ban swimming at the region's public beaches in summer 2001, 2002, 2003 and 2004 and to recommend that any activities or practices that involved direct contact with the water cease. The Vermont Department of Health has also issued warnings to avoid swimming in the bay at times during recent years. Moreover, aquatic vascular plants form dense beds that significantly limit recreational water activities in the bay (swimming, boating, windsurfing, etc).

The negative impacts listed were countered a one positive effect, however; they mobilized nearby communities to band together in discussing the causes of the problems and actions for remediation. This was not without some tensions between Canada and USA, in particular an argument over whether one of the bridges in Vermont should be removed. This slowed early trans-boundary negotiations, but was resolved when an independent consulting company indicated that water exchange between the bay and Northeast Arm would not be sufficiently augmented to justify the expense.

Figure 2. Phosphorus levels in Lake Champlain associated with eutrophication. Missisquoi Bay is designated eutrophic. Note that the scale is different for this bay. Source: LCBP – Vermont DEC [7]



The agreement states that Vermont will have 60% of the responsibility for reducing phosphorus loads to the Bay, and Quebec will assume 40% of the responsibility. Accordingly, the target phosphorus load for Vermont will be 58.3 metric tons per year (m^3/yr), and the target load for Quebec will be 38.9 m^3/yr. The target loads set by the agreement were based on the June 2000 report of the Quebec-Vermont Missisquoi Bay Phosphorus Reduction Task Force, and a subsequent addendum dated October 2001. The signing of this agreement fulfills a highest priority action of the Lake Champlain Management Plan, ***Opportunities for Action***, which is being implemented by the Lake Champlain Basin Program and its partners. The Missisquoi Bay agreement is also incorporated into the Lake Champlain Phosphorus Total Maximum Daily Load (TMDL) plan which establishes maximum allowable phosphorus loads from each sub-watershed in Vermont and New York. According to the TMDL plan, a range of actions will be necessary in the Vermont portion of the Missisquoi Bay watershed in order to achieve the target phosphorus loads [4].

The actions to implement Phosphorous reduction include 1) wastewater treatment plant upgrades, 2) best management practices on farms to reduce nutrient runoff, 3) stabilization of stream banks and stream channels, and 4) better storm-water management and erosion control on developed land and roadways. Quebec was able to proceed more quickly with mandatory regulations and outright no contact/closed beaches policies while in VT all actions are strictly voluntary and consequently slow.

An interesting advantage of the situation for Lake Champlain is the early association of researchers studying the water quality problem from each side of the Lake, and involved in some joint efforts. Certain official associations between the two countries already existed at the time the problem was recognized (International Joint Commission, Lake Champlain Management Conference, Lake Champlain Research Consortium), and these were exploited to bring about the agreement. Many research projects were conducted jointly and included research on phytoplankton, mapping of inlet influence on nutrient distribution in the lake, metabolism and spatial distribution of other trophic levels, exotic species, fish community, pollutants, sediment studies, and stable isotope food chain studies.

References:

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