Unama'ki Institute of Natural Resources

Eskasoni • Membertou • Potlotek • Wagmatcook • We'koqma'q

Unama'ki *Cape Breton* First Nations

State of the Bras d'Or Lakes

Marine Environmental Water Quality

Background Report

2007-03-01

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Wela'lioq

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Abstract

The Bras d'Or Lakes (Pitu'pa'q), situated in the heart of Cape Breton Island, are a unique semi-enclosed estuarine system of bays, inlets, and deep basins that makes up approximately 18% of the total shoreline length of Nova Scotia. Variations in salinity, tidal range, flushing times and population distribution are found within different regions of the Lakes. These differences make the Bras d'Or Lakes especially vulnerable to human pressures.

Marine water quality of the Bras d'Or Lakes was determined through examination of three subtopics: bacteriological water quality, chemical water and sediment quality and sedimentation. The integrated Driving Force-Pressure-State-Impact-Response approach currently used by the European Environmental Agency is applied to marine environmental water quality under each subtopic.

The Bras d'Or Lakes are still relatively pristine. Bacterial contamination from sewage is the primary source of pollution. Six of the eleven sub-watersheds have shown degrading water quality in recent years. They are East Bay, St. Peter's Inlet, West Bay, McKinnon's Harbour, Whycocomagh Bay and Middle and Baddeck River (combined because of the small area). Chemical water and sediment quality is very good with the exception of low to very low levels of dissolved oxygen in Whycocomagh Bay that results in anoxic sediments and water at low depths. PCB and PAH concentrations are low in all areas of the Bras d'Or Lakes, as are heavy metal concentrations in biota and sediments. Higher levels of zinc were found in Denys Basin and higher levels of lead were found just off Eskasoni. Sedimentation is difficult to measure, however, Denys Basin and Whycocomagh Bay are likely more susceptible because both contain rivers that drain into them and low flushing times.

A list of nine conclusions and recommendations were suggested. Among the list were recommendations for a long-term monitoring strategy for oceanographic and marine environmental parameters so that changes to marine environmental quality can be evaluated.

Nikana'tuek

Pitu'paq etek mikawe'k Unama'kik, wejitasiksɨpnl keknue'kl a'qati-awni'skekl tewi'tn, piskupa'ql aq temikl quspeml, ta'n mawa'tumk kisitoq suel 18% pemamkiaq etek Mi'kma'kik. Nemitumkl pilu'tekl wiskipoql, jikwapann, te'wamkikl aq milamuksultijik mimajultijik wikultijik ta'n pasɨk tami maqamikewl Pitu'paq. Wla pilu'tekl koqoe'l kisa'tu'tij Pitu'paq waqije'ktn.

Wejikjijitumk ta'n telamu'k samqwan Pitu'paq ankaptasiksɨkl ne'siskl kisi-sku'tatasikl: ta'n te'sijik ksnukwaqne'k juji'jk samqwaniktuk, kaqayo'qwapu aq ta'n tettuji essiamkapua'q samqwan aq te'sik essiamk lampo'q. "***Integrated Driving Force-Pressure- State-Impact Response Approach***" ta'n ewe'wmitij Qame'kewey Wsitqamuewey Mtmo'taqney elp ewekasik tett enkatmumk telamu'k samqwan te's kisi-wesku'tatasikl.

Pitu'paq me' ne'kaw kelu'lk. Na'sɨk mi'janapu ta'n elitk samqwaniktuk winamkwa'toq samqwan aq kisa'laji ksnukwaqne'k juji'jk kisisultinew. Tan' newtiskaq jel ne'wt tesɨkl wejkwamkukl, asukom
te'sɨkl atel poqji-ewalamu'k samqwan. Teluisultikl Tewitnu'jk (East
Bay), Apaqtukowuatek (St. Peter's Bay), Walnamkiaq (West Bay), Amasipukuek (McKinnon's Harbour), We'kopa'q (Whycocomagh Bay) Waqmitkuk aq Apatakwitk (Middle & Baddeck River), (toqa'tumkl mɨta apje'jkl). Kaqayo'qwapu aq tettuji essiamkapua'q samqwan kelu'lkl pasɨk tekle'jk wiaqtek kamlamuti We'ko pa'q na wejiaq mu kamlamutinuk essiamk aq samqwan pakwek. PCB aq PAH tekle'jk msɨt tami Pitu'paq, aq elp qasawo'q tekle'jk te'sik mimajik na'tel aq essiamkek. Pukwelk *zinc* we'jitasik Kuanu'skek (Deny's Basin) aq pukwelk sqalu'skw we'jitasik kikjuk Eskisoqnik (Eskasoni). Essiamk metue'k nikatmumk, na'sɨk Kuanu'skek aq We'kopa'q kesiajiwa'qije'jkl mɨta kitk ala'tu'titl sipu'l piskwitkl aq pawiaql tewamkikl.

Kisi-wi'kasikl wla pesqunakek te'sitkl kisite'tasikl aq ta'n telutasiksɨpnl wla wi'katikniktuk. Telutasik nuta'q pekijijiko'tasiktn apaqtukewe'l aq samqwane'l wsitqamue'l kwlaman sa'se'waskik koqoey wjit ta'n telamu'k samqwaney wsitqamu kisi- pekaji ankaptɨten.

Foreword

Kwe,

Water quality has many definitions. As humans, we tend to think of water quality in terms of what is "good" for humans, not what is good for fish, birds, or invertebrates. Bacterial water quality is measured in counts of fecal bacteria that will cause illness *to a human* when an oyster contaminated with fecal coliform bacteria is consumed, not in terms of the effect on the oyster itself. Other ways to examine marine water quality that are more applicable to determining its status is through the examination of chemical contaminants, changes in habitat or accumulation of sediments. Sedimentation is difficult to measure and evaluate but traditional knowledge tells us that there is loss of healthy near shore environments, specifically losses of eel grass beds, oyster, and elver habitat. Changes in marine water and sediments are evident. We have created an imbalance.

There are numerous opinions on how "good" the water is in the Bras d'Or Lakes, but no single place or report which gives a definitive picture of water quality, however we choose to define it. An initiative was undertaken by First Nations in Unama'ki (Cape Breton) to build capacity within First Nations on the topic of water quality and to use this knowledge to determine the current state of marine water quality for the Bras d'Or Lakes using the best data available. Our report, *Marine Environmental Quality of the Bras d'Or Lakes*, is that: a report produced using data and information collected by Environment Canada, the Bedford Institute of Oceanography, the Unama'ki Institute of Natural Resources, and the Eskasoni Fish and Wildlife Commission Inc. Data and anecdotal information include scientific papers and reports, technical publications, and Mi'kmaq traditional knowledge.

This report has been in progress since 2004 and has passed through many hands since its inception. The topic of marine water quality has been difficult to develop. The best available data was made available through the Bacteriological Water Quality reports produced by Environment Canada between 1999-2003. The newer reports 2003-2006 were not produced at the time of composition in 2004-2005 or when revising the report again in 2006-2007. Long term monitoring for bacteriological water quality is completed in most areas, but not for others. Data is collected in areas that are monitored every three years on a rotational basis, and is specific to address the public health concerns for safe shellfish consumption. Chemical water and sediment quality snapshots were taken in the mid 1990s and again briefly in 2004-2005. There is similar snapshot information on sedimentation for selected areas in the Bras d'Or Lakes. Through examination of the reports and data currently in circulation, we found that ***there is no consistent or long-term monitoring for chemical water quality and sedimentation and bacterial water quality monitored for the entire shoreline of the Bras d'Or Lakes has not been completed.***

Our report was completed as a background report from which a shorter, less technical version will be produced. The shorter version will be used as an educational tool for the general public, information for land and municipal planners and to become the baseline for future management of water quality in the Bras d'Or Lakes. By having this information readily available, we will have a reference point for water quality in the Bras d'Or Lakes and be able to evaluate future changes.

This background report was composed within a format that is currently used by other nations. It is our "experiment" for which other reports, on other topics, may be developed. We included as much information as possible, and some of our connections are speculative as there is no research conducted in our area to support some cause and effect relationships but were known to cause detrimental effects elsewhere. These are our thoughts and synthesis. We hope that you find this report a valuable tool and give serious thought to the recommendations we have proposed.

We are fortunate that the Lakes are still in very good shape and its residents are in a willing position to prevent further degradation. Let's work together to keep it that way.

We'lali'oq,

Charlie Dennis
Executive Director

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Introduction

The Bras d'Or Lakes, situated in the centre of Cape Breton Island, are surrounded by rolling hills and forests that protect them from wind, making them an international destination for sailboats, yachts, and ideal for canoeing, kayaking, and swimming. Cultural diversity is strong in Cape Breton and we see it at its best along the shores of the Bras d'Or Lakes.

Mi'kmaq are the indigenous people of Cape Breton Island, and their territory extended throughout what is presently known as the Atlantic provinces, Quebec, and the northeastern portion of Maine. This area, known as Mi'kma'ki, was divided into seven political districts that, because of European contact and upset in governing structure, do not reflect current provincial boundaries. However, the district of Unama'ki is presently known as Cape Breton Island. There are five First Nation communities located in Unama'ki, four of which are located directly on the shores of the Bras d'Or Lakes. Membertou First Nation is located within the city limits of Sydney, Cape Breton, but jointly shares and owns a piece of land in the western portion of the Bras d'Or Lakes known as Malikewe'jk (Malagawatch). Each of Unama'ki's Mi'kmaq communities has their own unique relationship with the waters they live alongside.

The Bras d'Or Lakes, or Pitu'paq in Mi'kmaw, have always been sacred to the Mi'kmaq. They provide resources such as oysters, lobster, eel, gaspereau, herring, cod, flounder, smelt, salmon, and mackerel. They were used as the primary transportation route between hunting and fishing grounds and for spiritual gatherings in all seasons. Unama'ki remained relatively uninhabited by Europeans until the late 1600s/early 1700s (Native Council of Nova Scotia 1997). Today, there is still a strong presence of Mi'kmaq culture, along with Scottish and English, found along the Bras d'Or Lakes.

Like many things, the current Bras d'Or Lakes watershed is a product of the history that precedes it. Fortunately for the Bras d'Or Lakes, this history has been relatively favourable to maintaining good water quality. Communities surrounding the Bras d'Or Lakes are small and rural; the largest community, Eskasoni First Nation, has a population of 3,800. There are no sources of industrial pollution that would significantly alter the water quality of the Bras d'Or Lakes or the organisms found there, unlike neighbouring Sydney Harbour. But that doesn't mean the Bras d'Or Lakes are pristine, or that our current activities will prevent further degradation.

In this report, we will discuss the current marine environmental quality of the Bras d'Or Lakes. The Bras d'Or Lakes have been graphically divided into their sub-watershed areas based on the topography of the Island (Figure 1). The Bras d'Or Lakes and their sub-watershed levels will be the focus of our efforts to describe the current marine environmental water quality.

Marine environmental quality is measured in many different ways. For the purpose of this report, it will be discussed under three subtopics:

I. Bacteriological water quality
II. Chemical water, sediment and biological quality
III. Sedimentation

This document looks at these separately and will go beyond a simple description to determine the current water quality of the Bras d'Or Lakes by using the integrated

Driving Force-Pressure-State-Impact-Response approach currently used by the European Environmental Agency (EEA; OECD 2003). The use of a framework such as this is advantageous in communications with the general public because it highlights cause-effect relationships, helps people to see that issues are interconnected, it is easy to understand, easily adjusted to include more details, and indicates how problems can be mitigated. Using this framework, we intend to provide information for subtopics I to III under the headings of:

- **Driving Force** (activities that result in pressure);
- **Pressure** (human pressure on the environment);
- **State** (condition of the environment and changes);
- **Impact** (changes to the environment); and
- **Response** (action taken by society to prevent and/or to change negative impacts).

For the most part, bacteriological data is the only data available to discuss water quality in many of the receiving waters of each sub-watershed in the Bras d'Or Lakes. In these instances, chemical water quality and/or sedimentation subtopics may not be included. These subtopics will only be included in sub-watershed sections where there is recent data of sufficient quality.

Bacteriological Water Quality

> *"Cases of bacterial contamination have been clearly documented to indicate the need for management measures. Present problems occur primarily around population centers due to inefficient public or private sewage systems."*
> (Wilson 1981, p.3).

Although a number of remediation efforts have been made in the nearly 25 ensuing years, this statement remains true today. Before we begin our discussion, it is worthwhile to briefly discuss the linkages between shellfish, bacteriological water quality, and shellfish closures. In general, water quality is measured by the type and amount of dissolved and suspended substances in the water column and the effect this has on the users of that water (Bjarnason et al. 1998). In most cases, the users of the water refers to human users and rarely the effects on other organisms using the water.

For this section, we are only concerned with the microbiological contaminants. Of these, bacteria are the only form that are regularly monitored. When determining human health risks associated with a given body of water, the most common indicator used is coliform bacteria.

The coliform bacteria group consists of several genera of bacteria belonging to the family Enterobacteriaceae. These are mostly harmless and live in soil, water, and the digestive system of animals. A specific category of this group is the fecal coliform bacteria, the most common member being *Escherichia coli* (*E. coli*). These organisms may be separated from the total coliform group by their ability to grow at elevated temperatures and are associated only with the fecal material of warm-blooded animals.

The presence of fecal coliform bacteria in aquatic environments indicates that the water, at the time the sample was collected, was contaminated with the fecal material of man or other warm-blooded animals. Fecal coliforms themselves are not usually considered pathogenic. However, if large numbers are found in samples, they may

indicate the presence of other pathogenic organisms. Some waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis and hepatitis. These are typically present in such small amounts that it is impractical to monitor them directly. The bacteriological standard is one of the criteria used to judge suitability for harvesting shellfish, drinking, and recreational uses. The standards require that the "most probable number" (MPN) of fecal coliform in water not exceed a median or geometric mean of 14 colonies per 100 mL of water and that no more than 10% of samples exceed 43 fecal coliforms per 100 mL to be approved for shellfish harvesting. The standard for drinking water requires there to be no fecal coliforms.

Sources of bacteriological contamination include municipal sewage discharge, poorly operating septic systems, direct sewage discharge from boats and shorefront residences, industrial waste, land wash from agriculture and urban areas, wildlife and domestic animals, and marine mammals (Bjarnason et al. 1998). When contaminants from any of these sources enter the Lakes, they mix with the surrounding water and could be ingested by the organisms that live there. It doesn't take much sewage to have an effect on a shellfish growing area. In fact, "fecal coliforms discharged from a single human in one day … if uniformly distributed in 10 feet of water, could raise counts in one acre of water above the shellfish [harvesting] limit." (Bjarnason et al. 1998, p.23).

Shellfish, being filter feeders, are a crucial part of the marine ecosystem and have the ability to filter massive amounts of water. A mussel, for example, can filter up to 300 times its weight in an hour (Bjarnason et al. 1998); an oyster can filter 3.9 L of water per hour at temperatures of 25^{o}C (Shumway 1996). Through the simple act of respiration and feeding, shellfish are able to remove chemical, biological, and naturally occurring toxins from their environment and store them in their body tissues. Many of these toxins are not harmful to the shellfish themselves but can cause serious illness if eaten by humans or other organisms. Due to the high volume of water shellfish are able to filter in a short time, as well as their ability to store toxins, they are excellent indicator organisms for water quality. For this reason, bacteriological water quality of the Bras d'Or Lakes has been traditionally measured with respect to shellfish and shellfish closures.

Through its Shellfish Water Quality Protection Program, Environment Canada is responsible for monitoring bacterial water quality and sanitary conditions within shellfish growing areas. The primary objective is to protect the public from the consumption of contaminated shellfish by ensuring that bivalve shellfish are harvested from waters of acceptable sanitary quality. Water quality surveys are used to determine whether shellfish growing areas should be approved, conditionally approved, or closed. Shoreline surveys are conducted to determine the potential sources of pollution. Water quality and sanitary conditions in areas approved for harvest must meet very stringent criteria.

Growing areas may be designated as approved for the cultivation, harvest, and direct consumption of bivalve shellfish if the area is not contaminated with fecal material, pathogenic micro-organisms, deleterious substances, or unacceptable levels of marine biotoxins to the extent that consumption of the shellfish might be hazardous. In terms of specific bacterial water quality criteria, the Canadian Shellfish Sanitation Program (CSSP) standard for approved growing areas requires a median fecal coliform level not exceeding 14/100 ml, and no more than 10% of the samples may exceed 43/100 ml. These measurements are used to categorize samples as "met approved criteria" or those that "exceeded bacterial limits," and are used to support existing classifications or to

determine whether closures are necessary. Evidence of significant, potential bacterial pollution sources, such as sewage treatment outfalls, lift stations, direct sewage discharges, septic tank seepage, marinas, and commercial wharfs is sufficient to exclude portions of growing area waters from the approved category. Permanent closures are established in these instances.

Water quality information collected by Environment Canada and its partners can be useful in identifying areas of elevated bacterial concentrations within the classified portions of the Lakes. Since the limits and criteria for areas classified approved for shellfish harvesting are very stringent, a precautionary approach is taken when recommending areas for closures. It is important to consider that, although closed areas do not meet approved status in terms of direct shellfish harvest, they should not be considered as necessarily "polluted" for the purpose of other recreational or commercial uses. Health Canada does not recommended swimming in areas where fecal bacteria levels are, or exceed, 200/100 ml. This value is much higher than the one required for shellfish closures to be implemented, therefore, areas closed to shellfish harvesting do not necessarily translate into closures for swimming.

Shellfish water quality and shoreline sanitary survey information can each play a part in gauging the overall environmental state of the Bras d'Or Lakes. Maintaining and improving shellfish growing habitats promotes sustainable residential and aquaculture development as well as enhancing local tourism and recreational opportunities. Future conservation and remediation initiatives will need to be evaluated on a case-by-case basis to ensure efforts and funds invested will produce sustainable environmental and economic benefits for all stakeholders.

The Canadian Shellfish Sanitation Program is currently the only program in which there is long-term monitoring of areas to determine water quality. It is the only source of data pertaining to bacteriological water quality in the Bras d'Or Lakes.

Chemical Water, Sediment and Biological Quality

Chemical pollution finds many ways to enter into the marine environment. Surface run-off from agricultural land supplies pesticides and nutrients that can poison or over-fertilize the water; surface run-off via storm sewers and lift stations can add a wide variety of pollutants such as heavy metals (chromium, mercury, and zinc, for example), hydrocarbons, lead (formerly added to gasoline products), residues from household and industrial cleaners, pesticides, herbicides and fertilizers, viruses and other pathogens, dumped materials, including mining spoils, automobiles, and general refuse such as industrial cooling water (Barnes and Hughes 1988; Duxbury and Duxbury 1991). Contaminants can also enter the marine environment through the air. Airborne chemicals and dust carried by the wind (also referred to as aeolian inputs) contribute to marine contamination. Even chlorine that is first added to municipal drinking water then later added to treat bacteria in sewage effluent may form a complex with organic compounds in the water potentially producing toxic chlorinated organic compounds to the marine environment. Many toxins do not remain in the water column, but are absorbed on the suspended particles of organic matter that are naturally found there. The matter clumps into aggregates, termed flocs, which, when they become large enough, settle to the bottom to be incorporated into the sediment. Toxin concentrations are greater in

sediments than in overlying waters because of their ability to bind with organic matter (Duxbury and Duxbury 1991). As chemicals are dissolved in water or bound to sediments, they eventually find their way into the biological life of the ecosystem.

Various studies conducted in the Bras d'Or Lakes between the 1960s and 1980s measured dissolved oxygen, primary and secondary production, chemical parameters, such as concentration of nutrients and other organic and inorganic elements. However, differences in current analytical methodologies and those used in the past, make comparisons and trend analyses over time difficult. To determine the chemical concentrations in water, sediments and biota requires the use of specific analytical tests and methods to detect a range of elements or compounds, and the expertise to interpret data. Tests are expensive to conduct and, as a result, have been used to provide a snapshot of the situation rather than used as routine analysis. In the past decade, there has been increased attention to environmental quality of marine ecosystems. As a result, studies to determine MEQ parameters were initiated by Eskasoni Fish & Wildlife Commission and the Bedford Institute of Oceanography in the mid-1990s and implemented through collaborative efforts between these organizations.

The most recent information compiled on this topic can be found in the *Proceedings of the Nova Scotia Institute of Science Volume 42, Part 1 (2002)* for studies completed between 1995-1997. This comprehensive publication is the primary source of data used in this section of the report and the information it contains should be considered the baseline of information for future monitoring. Earlier studies were patchy and the methodologies used were not considered as reliable as the technologies employed today.

Sedimentation

Sedimentation is the deposition of sand, silt, and clay material that is eroded from land by wave action (simply referred to as erosion), discharge from rivers, run-off from the land, deposited directly by glaciers, or through aeolian inputs (i.e., via the wind). Sedimentation effects are especially noticeable in areas where there are reduced water movements such as in estuaries, inlets, and basins. (Barnes and Hughes 1988).

As sedimentation is a land-derived problem, the composition of the land itself determines whether it is susceptible to erosion, potentially creating an opportunity for sedimentation to occur. The shoreline and seabed of the Bras d'Or Lakes are primarily comprised of Windsor Group rocks (gypsum, anhydrite, sandstone, limestone, and shale) that are particularly soft and thus easily subjected to erosion. Human activities that result in increased sedimentation can be any that remove natural vegetation. Particularly damaging are clear cutting and the clearing of land along river banks and the shoreline of the Lakes. However, any large-scale removal of vegetation within the watershed can be damaging. Water that is normally trapped within the root systems of trees and other plants and released slowly over time, quickly runs off denuded land. Usually, modest brooks become raging torrents of brown water destined for the Lakes where most of the silt burden settles to the bottom.

The Bras d'Or Lakes are known for their calm seas; however, steep and choppy seas can develop quickly, generated by strong winds. The tidal range in the Bras d'Or Lakes is low (4 to 6 cm; Petrie and Bugden 2002) but water levels can be raised by 0.5 m above the highest predicted tide due to storm surges associated with low pressure events.

Sea level gauges deployed just outside the Bras d'Or Lakes indicate a rise in sea level at about 36.7 cm/century (Shaw et al. 2006), however, we may see an increase in sea level amplified in the Bras d'Or Lakes compared to the outer coast. Approximately 77% of the coastline consists of non-rock or unconsolidated sediment with shore elevations <15 m, making it particularly vulnerable to erosion and flooding as sea levels continue to rise (Taylor and Shaw 2002). Total sea level rise from 1990 to 2100 AD will amount to about 75 cm (Shaw et al. 2006).

No studies in particular have been conducted to specifically estimate the rate of erosion and loss of habitat experienced in the Bras d'Or Lakes, although results from other studies have provided useful information to estimate the rate of sedimentation. There is currently one study in progress that addresses sea-level rise and its effect on the Lakes and will examine shoreline erosion (J. Shaw pers. comm. 2005). Traditional knowledge on erosion and sedimentation is critical for estimating whether sedimentation has increased in certain areas and to determine if there has been loss of traditional oyster habitat in the Bras d'Or Lakes as a result.

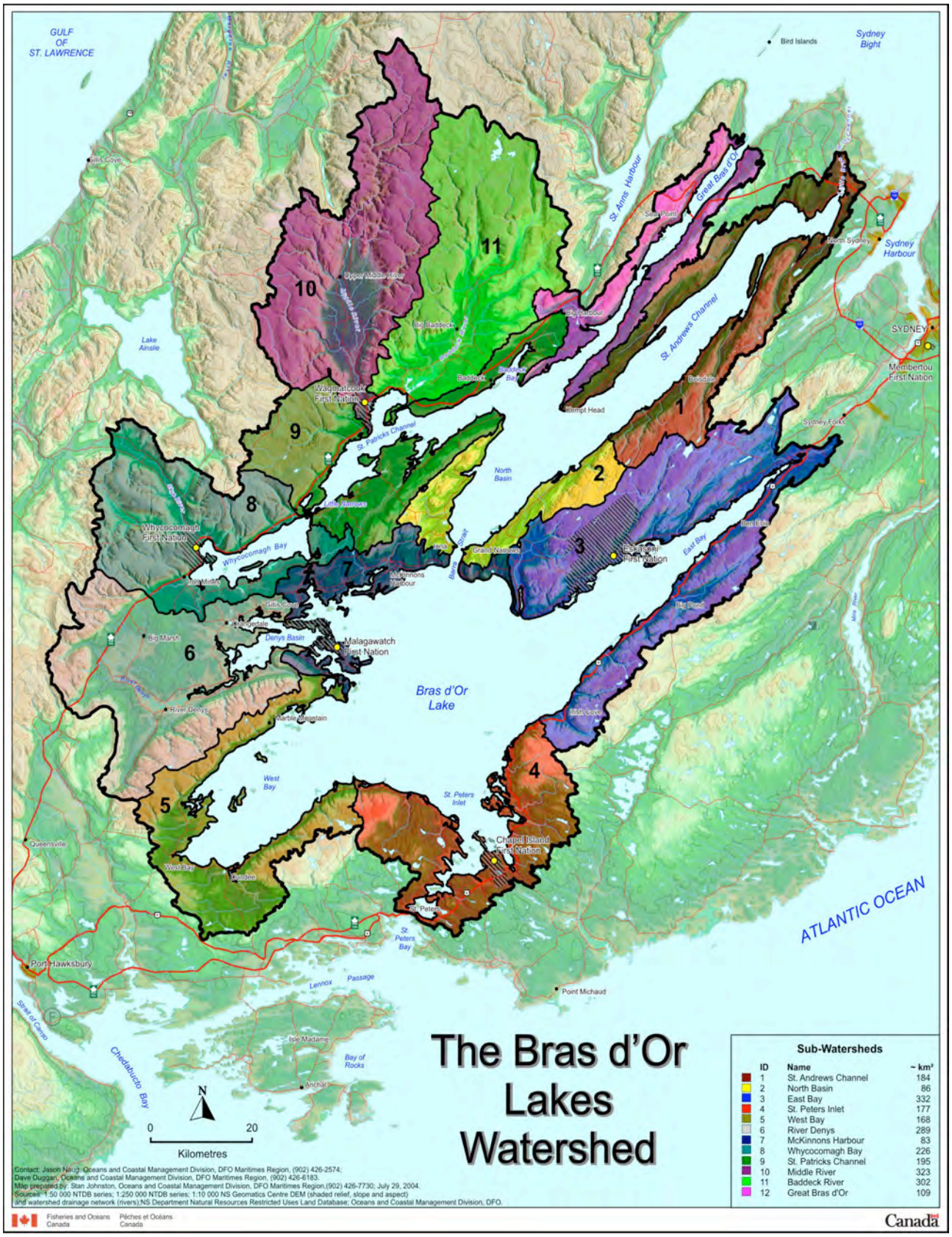


Figure 1. The Bras d'Or Lakes and its sub-watersheds.

The Bras d'Or Lakes

The Bras d'Or Lakes are Canada's only inland sea; an estuary that covers an area of 1080 km^2, approximately 1/3 of the island, with an estimated volume of 32 billion m^3, and shoreline perimeter of 1000 km (Petrie and Bugden 2002). The Lakes sit in the centre of Unama'ki (Cape Breton Island) and has earned the Mi'kmaq name "Pitu'paq", meaning "to which all things flow."

The Lakes are a unique body of water that arose when salt water flooding of freshwater basins and depressions left by glaciers occurred. The Bras d'Or Lakes had been evolving for the past 15,000 years (not long, according to geological time) when the last ice sheets retreated from the area, and were only flooded by the ocean about 4,000 to 5,000 years ago (Shaw et al. 2002). While many still refer to the Bras d'Or Lakes as an inland "sea," the Bras d'Or Lakes is more accurately described as an estuary (Petrie and Raymond 2002). An estuary is an area of marine water that is diluted by freshwater input. The Bras d'Or Lakes is connected to the ocean via three, albeit narrow, openings; two in the northern portion (Little Bras d'Or at the head of St. Andrew's Channel and the Great Bras d'Or Channel), and one in the southern area (St. Peter's Canal). Salt water within the Bras d'Or Lakes is diluted with freshwater that is derived from numerous rivers and brooks flowing from the land. Four rivers contribute the majority of the freshwater to the Bras d'Or Lakes with half of the rivers located in St. Patrick's Channel (Baddeck and Middle Rivers), and the other two found in semi-enclosed basins of Denys Basin (River Denys) and Whycocomagh Bay (Skye River).

As a result of fresh-water dilution, the salinity in the Bras d'Or Lakes is much lower than the Atlantic Ocean. Average salinity ranges between 21-22 parts per thousand (ppt), compared to 32 –35 ppt in the Atlantic Ocean, but can vary. For example, salinity is higher (28 ppt) near the entrances to the Bras d'Or Lakes and lower in the coves, inlets, and basins (sometimes as low as 18 ppt) where there is more freshwater input and less exchange with the main body of the Lakes.

Average depth is 30 m but varies throughout the Lakes. Depth in St. Andrew's Channel, for example, exceeds 280 m while small bays and coves have average depths of 10 m or less. Tidal range diminishes rapidly from the Great Bras d'Or channel inward, with tidal ranges found between 16 cm near the entrance to 4 cm at Iona (Gurbutt et al. 1993; Petrie and Bugden 2002). Barometric pressure has more effect on tidal ranges in the Bras d'Or Lakes than gravitational pull. As a result, there is essentially no inter-tidal zone compared to inter-tidal areas found along the coast. Winter temperatures fall to 0^o C (Petrie and Bugden 2002) and below, and ice cover is common in the coves, inlets, and bays but the central portion of the Bras d'Or Lakes, and the Barra Strait, are usually open. The winter of 2005-2006 was an unusual year where little ice formed on the Bras d'Or Lakes. In Crane Cove, Eskasoni, for example, the cove was covered with ice on February 19, 2006 and lasted only 3 weeks, when normally it would form in early January and last until at least the end of March. Summer temperatures exceed 16^o C in July and surface and sub-surface temperatures are even higher (>20^o C) in shallow coves such as Gillis Cove in River Denys Basin. The bottom of the Bras d'Or Lakes is primarily comprised of silt with smaller proportions of sand, gravel, and boulders (Tremblay 2002).

Like many inland bodies of water, land-based activities pose a significant threat to the quality of water, especially to one "in which all things flow". Fortunately, for the Bras d'Or Lakes, the population surrounding this inland body of water is generally rural and dominated by only three communities with populations greater than 1,000 (Eskasoni First Nation, Baddeck, and St. Peter's and its closely surrounding communities) with few industries.

1. Bacteriological Water Quality

Driving Force

There are several drivers that contribute to sewage contamination and shellfish closures in the Bras d'Or Lakes but, for the most part, they can be traced back to humans. While the population of Cape Breton decreased over the past decade, there are several areas where the population continued to increase. First Nations' populations in particular have been growing. The five First Nation communities that surround the Bras d'Or Lakes are located in five of the six sub-watershed areas in which there were increased findings of poor water quality in the observed number of sample stations. Chapel Island First Nation in St. Peter's Inlet, Eskasoni in East Bay, Malagawatch in McKinnon's Harbour, We'koqma'q in Whycocomagh Bay, and Wagmatcook in Middle and Baddeck Rivers sub-watersheds have likely contributed to declines in water quality but are not the sole contributors. Rural areas experience an increase in population during the summer months as residents move into their summer homes and cottages. Also some former summer residents are now retiring and taking up permanent residence in their cottages and/or second homes.

The Bras d'Or Lakes have always been a hotspot for boating and other recreational activities. In the summer months, people from all over flock to the shores of the Bras d'Or Lakes to enjoy its many benefits. Many have summer cottages, others take advantage of RV or camp sites, others decide to make use of the many different types of overnight accommodations, and still others make day trips to enjoy their favourite swimming or fishing hole. During this time of year, you will see many boaters taking advantage of this unique and increasingly popular boating destination. During the winter, cross country skiing, snowmobiling, and four-wheeling are common when the Bras d'Or Lakes are frozen.

Industry development is limited in the Bras d'Or Lakes to gypsum mining by Little Narrows Gypsum (Little Narrows; St. Patrick's Channel sub-watershed area), Georgia-Pacific's Melford Mine (River Denys sub-watershed area), marble mining by MacLeod Resources (River Denys sub-watershed), and tourism. Fishing in the Bras d'Or Lakes is slowly declining and limited to a small lobster fishery. The Bras d'Or Lakes are part of two different classifications of lobster fishing areas. The larger lake is lobster fishing area (LFA) 28, while the northern portion–the North Basin, Great Bras d'Or and St. Andrew's Channels are part of LFA 27 that extends beyond the Bras d'Or Lakes to adjacent Sydney Bight in the Atlantic Ocean. Other fisheries have since closed but were restricted to the use of smaller vessels and outboard motor boats. In addition to the lobster fishery, a small First Nations' food fishery exists for various species, such as eel,

mackerel, oyster, and lobster. Agriculture, either commercially or as a hobby, occurs in all areas of Cape Breton but is limited to areas where adequate soil is available. Farm animals are found in many rural areas along the Bras d'Or Lakes.

Even in the absence of humans, there is nothing to say that the waters of the Bras d'Or Lakes would be without biological contaminants. Animals, both wild and domestic, contribute significant amounts of sewage to the Lakes ecosystem. Domestic ducks, for example, have almost three times more fecal coliforms in their feces than humans and over 21 times the amount of fecal streptococci. Ducks and geese were identified as direct sources of pollution in East Bay, Denys Basin, and St. Patrick's Channel. Similarly, large beaver populations have been known to contribute significant amounts of fecal coliform bacteria to the Lakes environment. There are no data available that measure the effects of natural wildlife populations on the eutrophication of the Bras d'Or Lakes, but it is believed that large flocks of birds such as migrating geese could cause water quality to decline enough to warrant a closure to shellfish harvesting. A Microbial Source Tracking (MST) pilot study is planned for 2006 in River Denys to determine whether humans or farm animals are the main source of fecal coliform contamination. MST uses genetics to distinguish between the human and farm animal sources of fecal coliform bacteria but cannot identify fecal coliform from wildlife such as moose or beaver (S. Barrington, pers. comm. Email: March 21, 2006).

Pressure

Sewage disposal is a global, on-going problem and the Bras d'Or Lakes are not exempt. There are six communities around the Bras d'Or Lakes with a central sewage collection facility, four of which are either First Nations or service First Nation communities, and two are popular tourist destinations. They are:

- Eskasoni First Nation (East Bay Sub-Watershed)
- Chapel Island First Nation (St. Peter's Inlet Sub-Watershed)
- Wagmatcook First Nation (Middle and Baddeck Rivers Sub-Watersheds)
- Whycocomagh (Whycocomagh Bay Sub-Watershed; also services We'koqma'q First Nation)
- St. Peter's (St. Peter's Inlet Sub-Watershed); and
- Baddeck (St. Patrick's Channel Sub-Watershed).

Sewage collection systems vary from community to community but many of these systems, with the exception of Chapel Island and Baddeck, have received upgrades in the mid- to late- 1990s. The town of Baddeck upgraded its facility in 2003, while Chapel Island has made no improvements since 1985. Two of the largest communities, Eskasoni and Baddeck, are both serviced by sequential batch reactors with ultraviolet disinfection and are currently functioning under capacity. We'koqma'q is connected to the town of Whycocomagh, but maintains five lift stations in its community, all of which reported having problems with overflow. Although the treatment plant in Whycocomagh is generally capable of handing its sewage load, there are times when its maximum capacity is reached or even exceeded. Both Wagmatcook and Chapel Island use older, lagoon-based systems with chlorination and are currently at, or exceeding, capacity and in dire need of repair and modification to address the many problems within the systems. Chapel Island sewage treatment lagoon is not located on the shore of the Bras d'Or Lakes but discharges into a low-flowing brook twice a year when stream water levels are higher.

For further information on individual community central sewage treatment systems, refer to individual sub-watershed sections of this report.

At some point, all treated sewage from these communities ends up in the Bras d'Or Lakes either directly through submerged pipes or indirectly through discharge into rivers such as the Middle River (Wagmatcook) or Skye River (Whycocomagh). The only exception is the town of St. Peter's which discharges its sewage into the adjacent Atlantic Ocean. Fortunately, only two of the six systems found along the Bras d'Or Lakes are at or exceeding maximum capacity, however, there have been problems reported with lift stations overflowing and untreated sewage leaching into the Bras d'Or Lakes.

The remaining methods of sewage disposal include septic systems, chemical toilet systems, composting toilet systems, outhouses, and direct sewage outflow pipes (straight pipes). In some communities, not all homes are connected to the central sewage collection facility but rely on septic tanks. For example, there are 11 homes serviced through septic tanks in Eskasoni, and We'koqma'q has 39 units on septic systems. Throughout the remaining rural communities, septic tanks are the primary means of sewage disposal. Malagawatch in McKinnon's Harbour sub-watershed, primarily used as a summer camping area, is the only First Nation community that still uses outhouses as the primary means for waste disposal.

In addition to collecting water samples to determine whether areas meet water quality criteria for bacteriological limits, Environment Canada works with Unama'ki Institute of Natural Resources and the Eskasoni Fish & Wildlife Commission Inc. through the Sanitary Shoreline Survey to identify sources of pollution that affect, or potentially could affect, the water quality of the Bras d'Or Lakes. The survey results give a very good idea of the number and distribution of direct and potential sources of pollution. From the data compiled from surveys undertaken during 2001 to 2003, 4% of the sources identified were direct sources of pollution, while approximately 61% were identified as potential sources (Fig. 2). The majority of direct sources of pollution found along the shores of the Bras d'Or Lakes were found in St. Patrick's Channel (Fig. 3).

Of the 4% direct source pollution, pipes are the primary direct source of pollution identified in the Bras d'Or Lakes (54%), followed by non-point sources, i.e., those not specifically set to one location such as wildlife on land or in the water (19.5%), lift stations (12.6%), agriculture (9.2%), and septic tanks (3.4%; Table 1). Non-pollution sources, also called non-sources, listed in Table 1, are reference points for locating sources of pollution. They do not have an impact on the marine water but have been included because they are found along the shoreline of the Bras d'Or Lakes.

It is not known exactly how many cottages are present around the Lakes but the Cape Breton Regional Municipality has identified 1,033 seasonal, residential units on the northeastern part of the Lakes. One estimate doubles this number for a total of 2,000 seasonal cottages bordering the Lakes. A major concern regarding these cottages is that many have been reported to have old, inadequate, or malfunctioning septic tanks. Still others are reported to have no sewage treatment at all. There are currently 783 septic tanks identified as either having a direct impact on water quality (3; Table 1) or have the potential to affect water quality (780; Table 1) in those areas sampled through the Canadian Shellfish Sanitation Program.

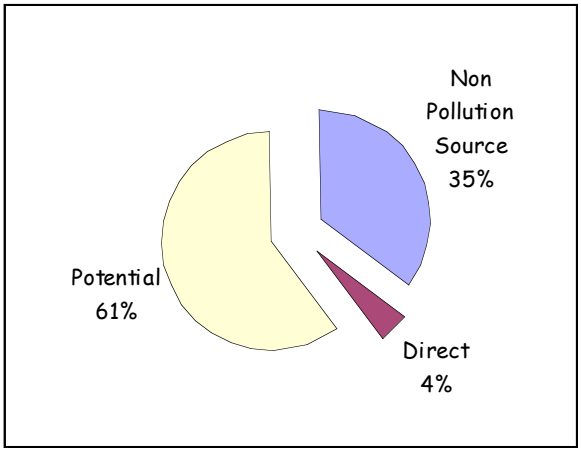


Figure 2. Sources of pollution identified in the Bras d'Or Lakes Sanitary Shoreline Survey, 2000-2002.

The majority of vessel traffic in the Bras d'Or Lakes enters through two of three openings. Boat traffic is only recorded at the most southern entrance in St. Peter's, and between the North Basin and the Bras d'Or Lakes at Barra Strait Bridge in Grand Narrows/Iona. Parks Canada at the St. Peter's Canal estimates 625 boats annually enter via the canal, a slow increase from 250 in the early 1980s. Approximately 80 % of vessels entering here are pleasure crafts and about 12% serve commercial functions such as fishing, tugs, barges, etc. (Malcolm 2003).

Barra Strait Bridge estimates for boat traffic are similar. Since Barra Strait Bridge started recording boat traffic in 1991, numbers have consistently ranged between 1,700-2,000 and saw a peak in 2002, reporting 2,100. It is estimated that only 2% of this activity is commercial (fisherman, tugs, and barges), 8% is estimated to be government vessels (Coast Guard, Navy), and the remaining 90% is recreational. A large portion of this traffic is thought to be the 30 local boats in the area and a high volume of boats travelling back and forth, so they are counted more than once. Other boating activity in the Lakes may be related to the First Nations' food fishery, recreational/sport fishing, and tour boats. Large boats, such as cruise ships and gypsum carriers, are limited to certain areas such, as St. Patrick's Channel and the Great Bras d'Or Channel, since the Barra Strait Bridge and St. Peter's Canal can only accommodate much smaller vessels.

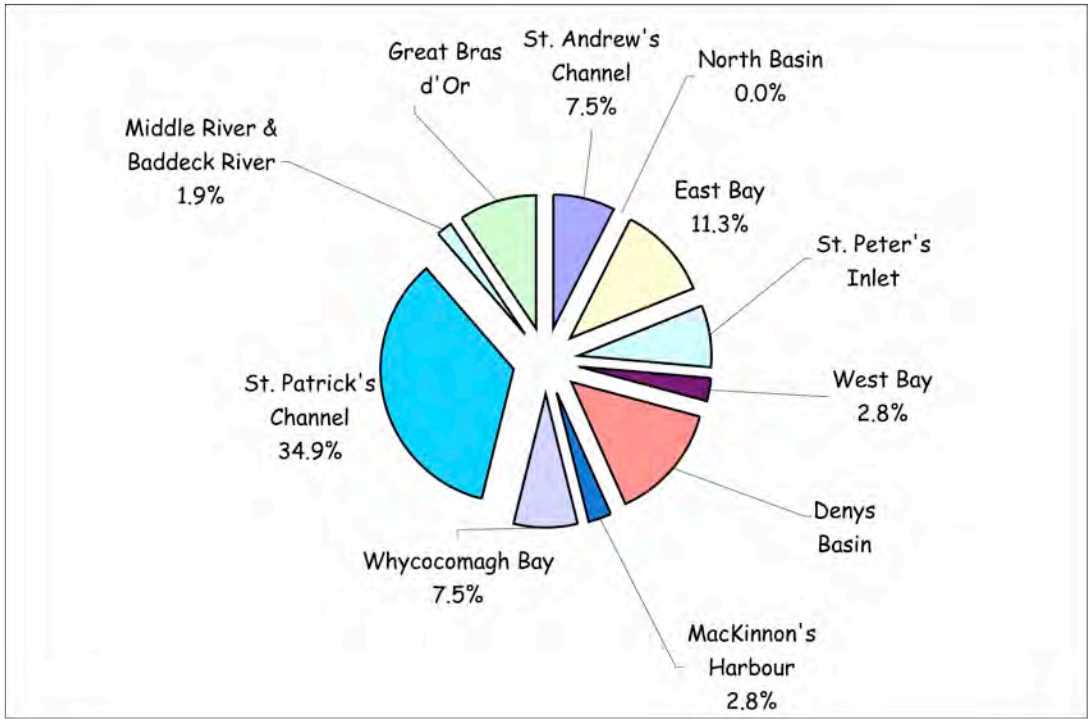


Figure 3. Locations of direct sources of pollution affecting marine water quality identified through the Sanitary Shoreline Survey between 2001-2003. Data summarized from Re-Evaluation Reports Nova Scotia Shellfish Growing Area 7 (Bras d'Or Lakes), Volumes 3-4. N=104.

There are more than a dozen provincial parks and park reserves scattered around the Lakes with many more parks for RVs and camping. Outhouses, septic tanks, and "Johnny on the spot" methods for containing and disposing waste are used but vary from park to park. The largest camping facilities can be found in East Bay (Ben Eoin Campground) and KOA in Middle River/Baddeck River sub-watershed area. Ben Eoin services its trailers weekly using a waste disposal truck, and stores sewage in a holding tank until an external waste disposal company removes it every second week. The KOA Campground, however, relies on two lagoons and a chlorinator for waste storage and treatment. High levels of fecal coliform bacteria (4600 mpn/100 ml) were found at the mouth of the pipe entering Baddeck River (Craig et al. 2001). The other remaining large camping area likely to affect the Bras d'Or Lakes is Chapel Island. Chapel Island, in St. Peter's Inlet sub-watershed, hosts an annual religious mission that draws thousands to the area for up to one month prior to the event. Camping takes place on both the mainland side in trailers and RVs, and on the island with camps. Camps rely on outhouses for sewage disposal. These outhouses are identified as a direct source of pollution, but the area surrounding the island and shoreline remain approved for shellfish harvesting. Other recreational activities on this side of the Lakes include skiing, sliding, and snowboarding at Ski Ben Eoin (East Bay).

Farming activities around the Bras d'Or Lakes are limited to a few small to medium-sized farms sparsely located in virtually all sub-watershed areas. In the Bras d'Or Lakes, agricultural activities are found in St. Andrew's Channel, St. Patrick's Channel, Skye River, Middle River and Baddeck River, East Bay, and West Bay sub-watersheds and are potential sources of pollution (Table 1). Agriculture accounts for 9.2% of direct bacteriological pollution, the majority of it occurring in the River Denys sub-watershed and less so in McKinnon's Harbour (Table 1).

Table 1 Sanitary shoreline survey data 2000–2002 compiled from Craig et al. 2001. Craig et al. 2002,and MacArthur et al. 2003.

	St. Andrew's Channel	North Basin	East Bay	St. Peter's Inlet	West Bay	Denys Basin	McKinnon's Harbour	Whycocomagh Bay	St. Patrick's Channel	Middle River & Baddeck River	Great Bras d'Or	TOTAL	
Sub-Watershed(s)	1	2	3	4	5	6	7	8	9	10& 11	12		%
Status of Sources													
Non Pollution Source	59	104	221	21	65	268	100	8	15	3	18	882	35.2
Direct	8	0	12	8	3	15	3	8	37	2	10	106	4.2
Potential	98	66	230	178	144	119	104	180	209	67	121	1516	60.5
Direct Sources													
Water Sample	1					1		4				6	6.9
Outhouse				1					1		1	3	3.4
Pipe			1		1	5		3	28	1	8	47	54.0
Septic Tank			2						1			3	3.4
Lift Station			5	6								11	12.6
Water Course												0	0.0
Wharf												0	0.0
Treatment Plant			1	1					1	1		4	4.6
Agriculture						7	1					8	9.2
Non-Point (source that is not set to one location)	7		2		2	1	2	1	2			17	19.5
Non-Source												0	0.0
Leaching (leaching type source)									1			1	1.1
Other (miscellaneous, surface drainage)						1			3		1	5	5.7
Potential Sources													
Water Sample	5		12	21	1	1	4	5				49	3.5
Outhouse	17	3	37	7	16	30	35	13	17	7	6	188	13.5
Pipe	10	23	34	1	12	43	28	43	75	6	24	299	21.5
Septic Tank	49	25	129	137	113	35	33	98	91	39	31	780	56.2
Lift Station	2							3				5	0.4
Water Course	7			2							4	13	0.9
Wharf	2	1	5	6	4			1	5	1	2	27	1.9
Treatment Plant	0								1	6		7	0.5
Agriculture	2		3		1	2						8	0.6
Non-Point (source that is not set to one location)	2	3	4	1	2	2	3	3	7	3	4	34	2.4
Non-Source		1		1	2	1		2	2	1		10	0.7
Leaching (leaching type source)		2	4		1		1		7	3	3	21	1.5
Other (miscellaneous, surface drainage, marina)	1		2	2	3	6		11	4	1	5	35	2.5

State

In general, the water quality in the Bras d'Or Lakes is very good. Historically, water quality sampling has focused on shellfish growing areas. The area classified for this activity comprises about 50% (560 km^2) of the Lakes' area. Of this, about 3% is closed and 46% open.

Figure 4. Current (2005) shellfish classification of the Bras d'Or Lakes, Cape Breton, Nova Scotia.

The largest collection of shellfish closures are found in the receiving waters of the St. Patrick's Channel sub-watershed area (Table 2; Figure 5). The area with the least amount of shellfish closures is found in the receiving waters of the Great Bras d'Or sub-watershed (Table 2; Figure 5).

Over the past 30 years, there has been an increase in the area of water designated as closed, but there has also been a significant increase in the overall amount of areas sampled (Fig. 6). Since 1995, the areas sampled under the Canadian Shellfish Sanitation Program had more than doubled in size. This is partly due to increased concern in water quality in the Bras d'Or Lakes, and because of the assistance provided by Eskasoni Fish & Wildlife Commission Inc. in completing the sampling runs necessary to collect water samples to meet national shellfish program classification criteria.

Since sampling began in the mid-1950s and up to the mid-1990s, there was a steady increase in the area of closures in the Bras d'Or Lakes. Over the past decade however, there was a slower, but steady increase until 2000 and a slight drop in closed areas after 2001. Some portions of the closed area around St. Peter's was re-classified as "approved," and other portions of River Denys Basin was re-classified as "conditional." Since 2002, there has been a slight increase in areas designated as closed, and there has been no change in classification status or area sampled between 2003 and 2005 (Fig. 6).

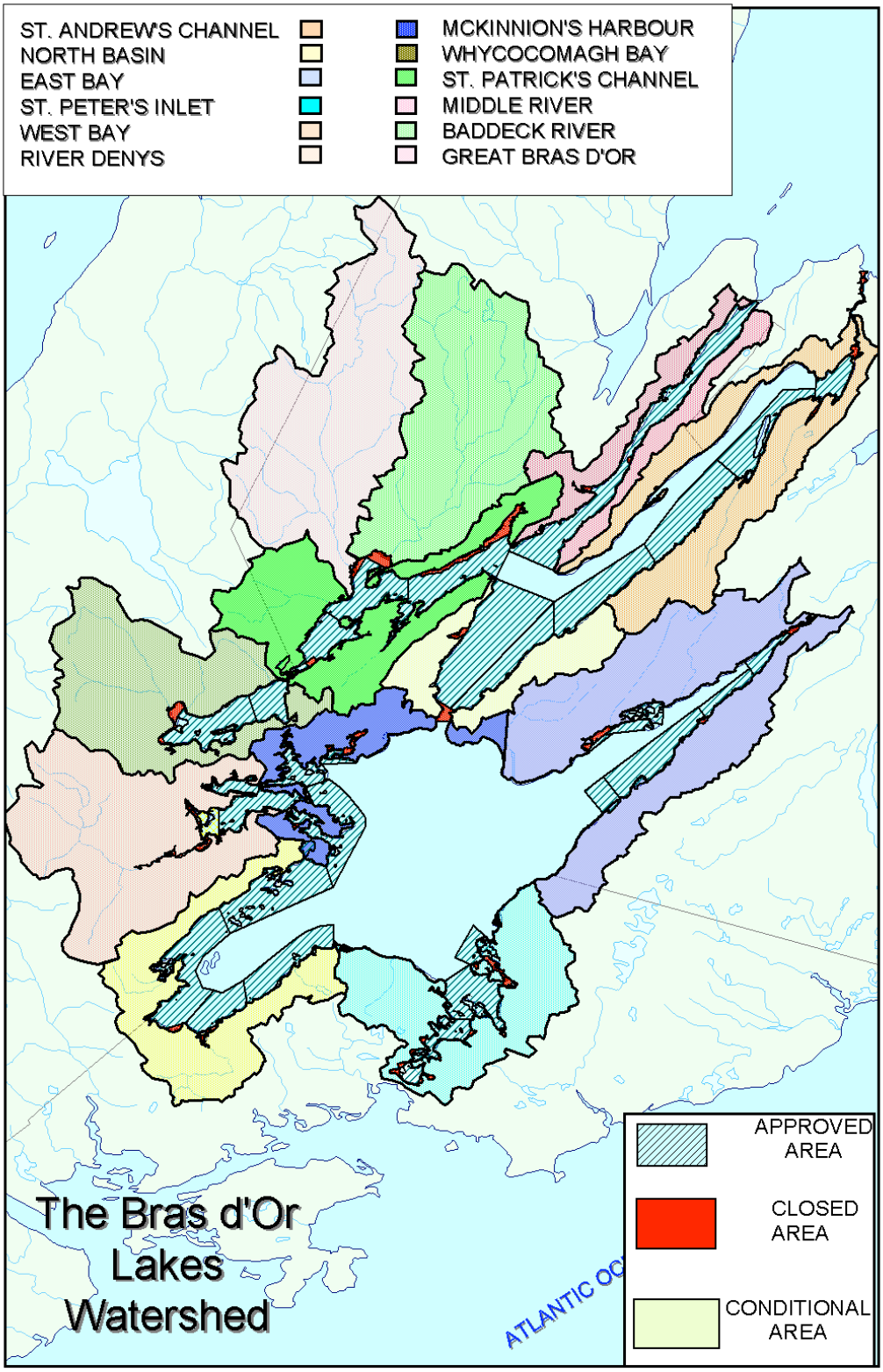


Figure 5. Shellfish classification areas in the Bras d'Or Lakes.

Table 2. Number of sample stations, closed area, marine area, shoreline length, sewage treatment facility, wharves and industry and commercial use data in sub-watershed designations.
■ Indicates presence in sub-watershed.

Sub-Watershed(s) (2005 data)	St. Andrew's Channel 1	North Basin 2	East Bay 3	St. Peter's Inlet 4	West Bay 5	River Denys 6	McKinnon's Harbour 7	Whycocomagh Bay 8	St. Patrick's Channel 9	Middle River & Baddeck River 10& 11	Great Bras d'Or 12	Total
Total Marine Area (Km^2)	127.0	95.1	130.7	90.0	147.4	36.9	144.0	33.5	63.8	6.6	56.6	
Total Area of Approved Classification (Km^2)	67.62	84.08	7.69	37.32	98.06	30.88	36.75	30.72	53.65	3.61	48.96	499.34
Total Area of Closed Classification (Km^2)	2.42	1.97	2.75	3.89	1.52	2.28	1.92	2.52	5.71	2.99	0.62	28.59
Total Area of Conditional Classification (Km^2)	0.00	0.00	0.00	0.00	0.00	3.74	0.00	0.26	0.00	0.00	0.00	4.00
Shoreline Length (km)	92.7	36.6	77.9	69.5	51.4	38.3	75.7	35.1	48.0	32.5	66.8	624.5
Sewage Treatment Plant/Lift Stations			■	■				■	■	■		
Marinas And/or Large Wharves Present	■	■		■	■		■		■			
Industry Use						■			■			
Tourism	■	■	■	■	■	■	■	■	■	■	■	
Commercial Transportation Use	■	■		■					■		■	
1998-1999 Sample Stations												
Met Approved Criteria	35	27	37	32	34	18	22	31	45	9	24	314
Exceeded Bacterial Limits	1	1	4	7	0	8	8	2	3	0	3	37
Total Sample Stations	36	28	41	39	34	26	30	33	48	9	27	351
2000-2002 Sample Stations												
Met Approved Criteria	35	27	39	32	33	20	28	30	45	8	37	336
Exceeded Bacterial Limits	1	1	6	11	1	10	9	3	3	1	3	61
Total Sample Stations	36	28	45	43	34	30	37	33	48	9	40	397
Comparisons of sample station data between evaluation periods, not including new stations added in 2000-2002												
Stations that formerly met approved criteria now exceed bacterial limits	0	0	2	5	1	0	1	1	0	1	0	11
Sub-sectors to which above applies NS-7-			040-005	all	020-015		020-013	010-008		010-006		
Stations that exceeded bacterial limits now meet approved criteria	0	0	0	2	0	0	0	0	0	0	0	4
Sub-sectors to which above applies NS-7-				030-005		020-012						
New Stations added that exceeded bacterial limits	0	0	0	1	0	2	0	0	0	0	0	17
New Stations added that met approved criteria	0	0	4	3	0	2	7	0	0	0	13	29
OVERALL STATUS (N=No change; D=Degrading; I=Improving)	N	N	D	D	D	N	D	D	N	D	N	

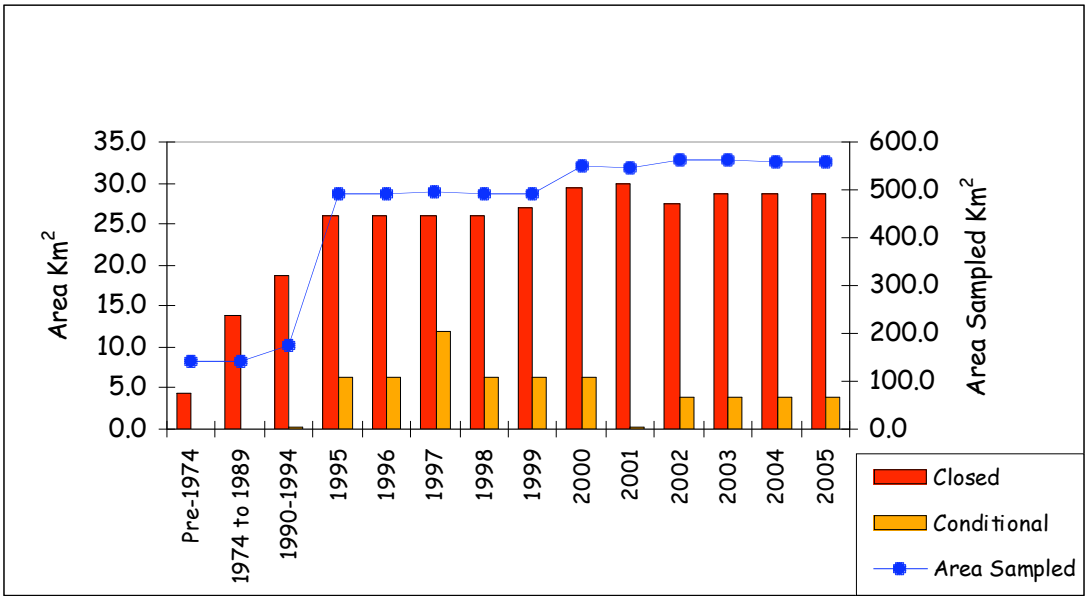


Figure 6. Historical trend in closed and conditionally classified areas and total area sampled in the Bras d'Or Lakes. Data provided by Environment Canada.

The situation looks similar when area of closures expressed in percent of total Lakes area is used to analyze changes in water quality over time as determined through the shellfish sanitation program (Fig. 7). There has been little change in the percentage of closures over the past decade, both in terms of closed area/Lakes area and closed area/area sampled. The large decrease in percent of closed area per area sampled between the early 1990s and 1995 was due to an increase in total area sampled throughout the Bras d'Or Lakes, thereby reducing the percent of area closed (Fig. 7).

Another way to examine water quality is through the use of water quality data at individual sampling stations in each of the sub-sectors. The use of station data may be a better way to examine changes and to compare areas as closures can be implemented on the basis of potential contamination rather than poor water quality. For example, closures are automatically imposed in areas where wharves or marinas are established (125 m radius around marina) as a precautionary measure to protect human health even though water quality is acceptable for shellfish harvesting. Another case can also apply. In some instances, closure size may not be increased if a sample station formerly below bacterial limits was determined to exceed those limits because the sample station was already located within existing closure boundaries. Therefore, changes in water quality may not be as obvious when comparing closure sizes unless sample station data is compared between evaluation years.

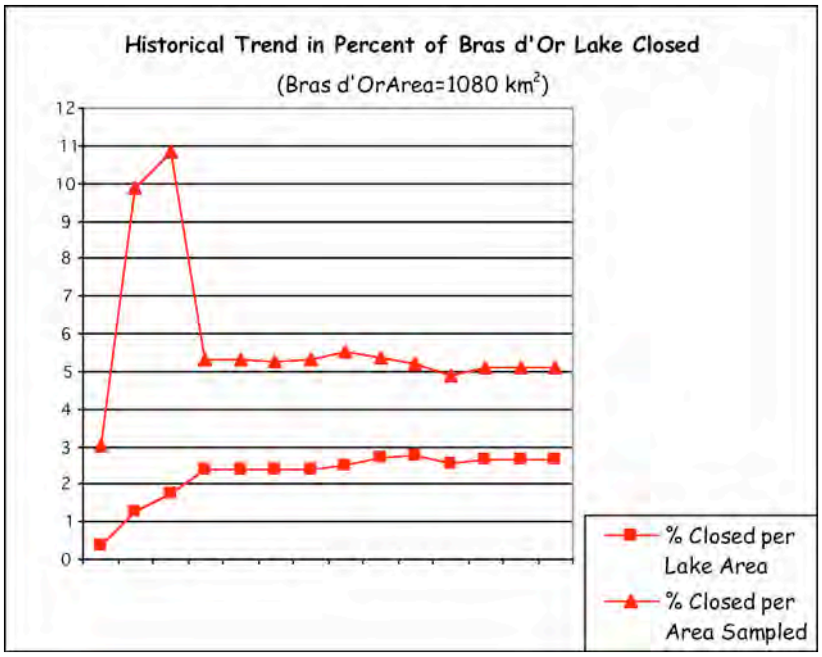


Figure 7. Historical trend of closed areas in the Bras d'Or Lakes expressed as percent closed per area sampled and percent closed per total area of the Bras d'Or Lakes.

Environment Canada uses a quantitative evaluation of the categories "met approved criteria" and "exceeded bacterial limits" when determining classification status. For the most part, Environment Canada re-visits these sites but may also increase the number and location of sample stations in certain areas that are of concern to "fine-tune" their evaluations. It is important to note that, in some instances, some of the increases in samples that exceeded bacterial limits may be a result of more intensive sampling in areas with known poor water quality and, therefore, not necessarily reflective of changes in overall water quality. Further "digging" is required in these instances and will be explained in the analysis when required.

Since 2001, a total of 397 stations were monitored throughout the Bras d'Or Lakes. Roughly one hundred or so of these stations are sampled annually. Shellfish growing areas are sampled and evaluated at least every three years on a rotational basis as per CSSP criteria. There are 9 to 48 stations found within each marine sub-watershed area, depending on the size of the sub-sectors found within the region and proximity to larger communities, especially those with sewage treatment plant facilities or because of other sanitary conditions (Table 2). Therefore, the placement of sample stations are not random but are rather strategically located in order to gauge overall bacterial water quality within the study area with an emphasis on monitoring locations where potential bacterial sources have been observed. As a result, there may be biases created toward areas that should or would show changes in poor water quality due to bacterial pollution. Overall, 16% of the sample stations had water quality that exceeded bacterial limits (i.e., 'poor' meaning water quality exceeding bacterial limits for the purpose of direct shellfish harvesting) and warranted closures between 2000-2002 (Fig. 8). When comparing water quality at

stations between evaluation periods of 1998-1999 and 2000-2002, there has been an increase of about 5% in stations that exhibited poor water quality (Figure 8). However, it should be emphasized that this increase is partly due to increases in sampling stations in River Denys where there are existing closures due to presence of poor water quality. A total of 61 stations were found to exceed bacterial limits in the Bras d'Or Lakes (Fig. 10)

The greatest change in number and percent of stations that exceeded bacterial limits, or had poor water quality, were found in Denys Basin (Figs. 9 and 11). The area experienced an increase of 18 sample stations in order to obtain additional data during dry and wet periods to determine if conditions would allow shellfish harvesting under specific environmental conditions. Many of these new stations were established in areas that were already experiencing poor water quality (Craig et al. 2001). Despite changes due to the addition of sample stations, the southern portion of Denys Basin (South Denys Basin) experienced a reduction in number of sample stations that met approved criteria year-round. This also indicates degrading water quality. Specifically, six stations did not meet approved criteria when compared to 1998-1999 evaluation years (Table 2) in addition to those already showing poor water quality. Detailed examination of the data by the authors did indicate that some of these closed stations do meet CSSP harvesting criteria under specific environmental conditions.

In 2001, sampling commenced in a new growing area sub-sector in Great Bras d'Or West (NS-7-010-002; receiving waters of the Great Bras d'Or sub-watershed) that had not been previously studied and now includes 13 new sample stations, all of which met approved criteria. East Bay sub-watershed also experienced an increase in sample stations. One station was added in the Head of East Bay (sub-sector 040-004) but no change in samples that exceeded limits was observed. In Eskasoni (sub-sector 040-005), two stations were added, both of which were stations shown to exceed bacterial limits, but this area also experienced a reduction in stations that previously met approved criteria. Other areas that experienced either an increase in stations with poor water quality, or a reduction in the number of stations that met approved criteria, include McKinnon's Harbour, St.Peter's Inlet, Whycocomagh Bay, Middle River and Baddeck River, and West Bay. The sub-watershed areas of St. Patrick's Channel and North Basin did not show any change in water quality between the evaluation periods of 1998-1999 and 2000-2002.

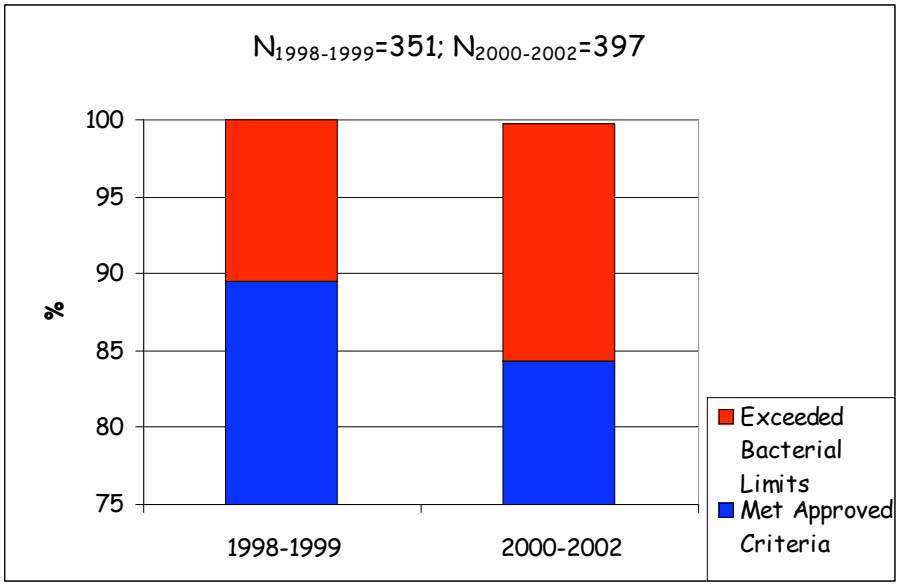


Figure 8. Water quality at sample stations in the Bras d'Or Lakes 1998-2002.

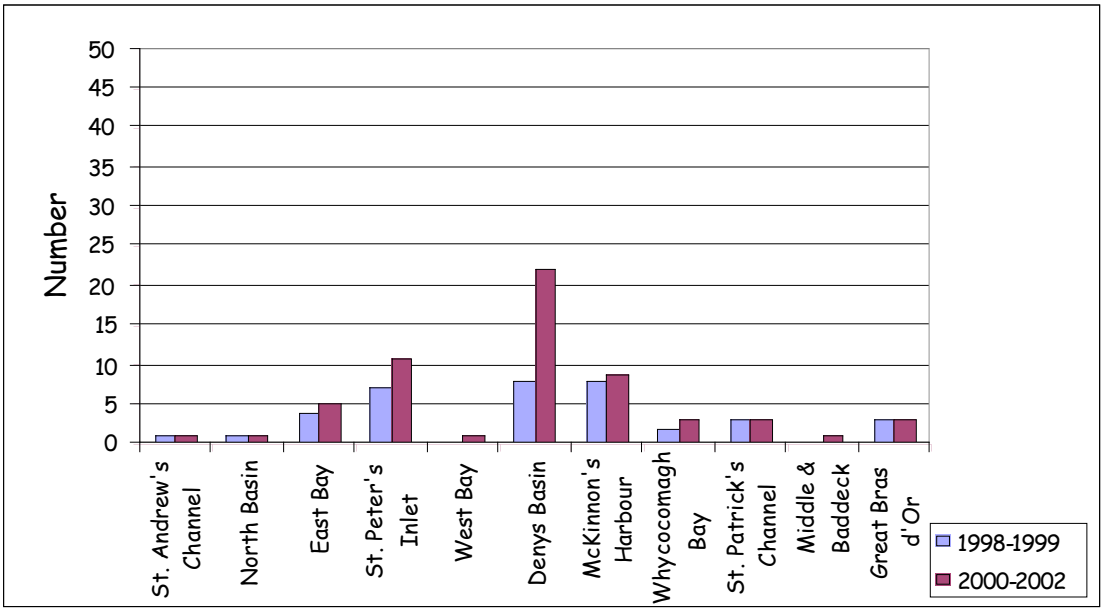


Figure 9. Number of stations with 'poor' water quality (exceeded bacterial limits) in each of the sub-watershed areas in the Bras d'Or Lakes for evaluation periods of 1998-1999 and 2000-2002.

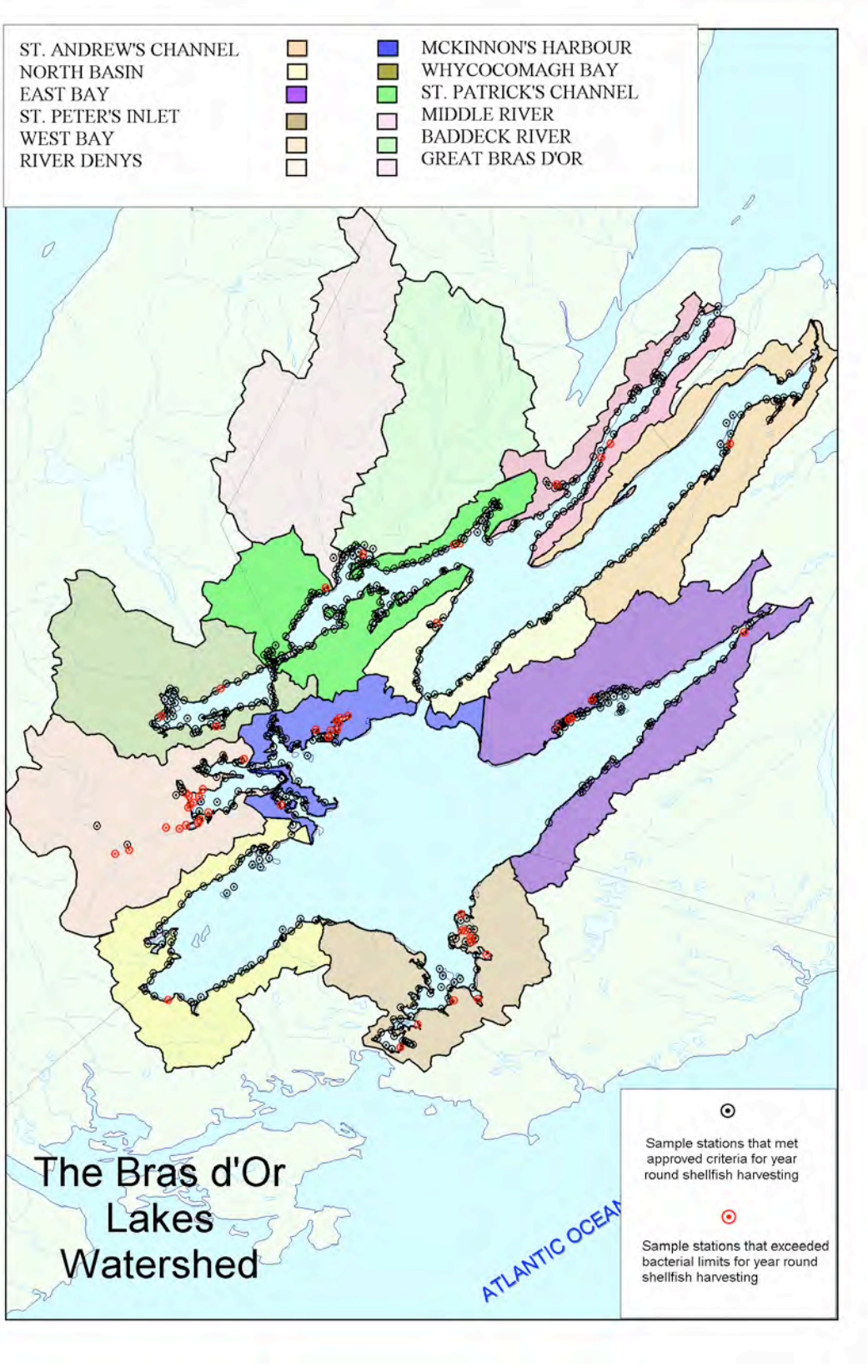


Figure 10. Stations sampled during the 2000-2002 Canadian Shellfish Sanitation Program.

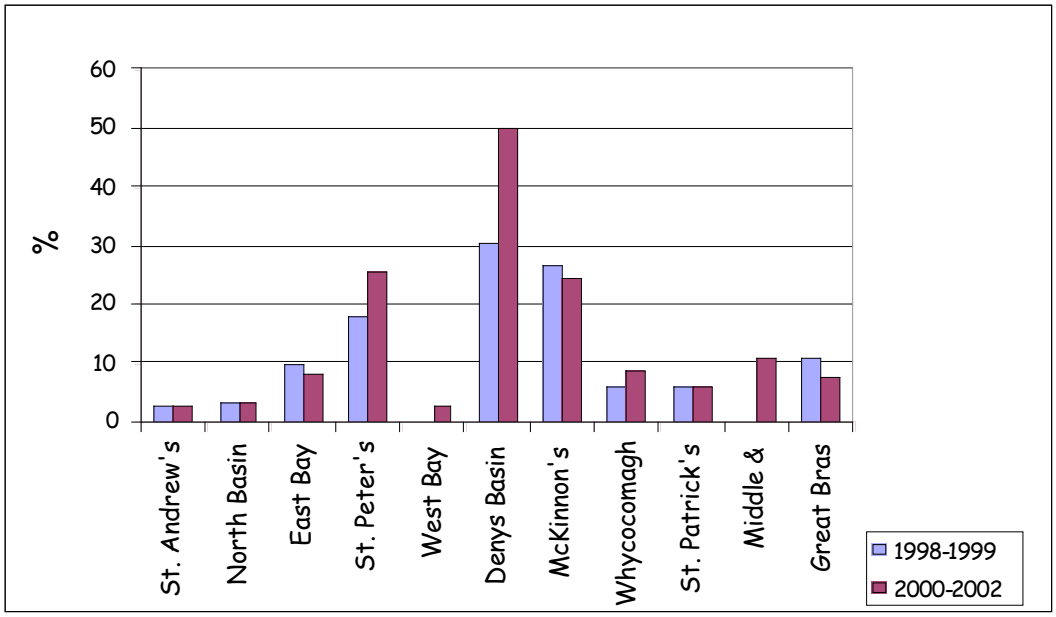


Figure 11. Percent of stations with 'poor' water quality in the receiving waters of the sub-watersheds in the Bras d'Or Lakes for evaluation periods of 1999-2000 and 2001-2003.

As a result of differences between the number of stations sampled between evaluation periods, there may be cases in which new stations added in some sub-sectors are biased, as station placement is not random. Also, stations may be removed while others are added. To solve this problem, changes in loss of sample stations between 1998-1999 and 2000-2002 were determined by comparing data for stations that were sampled during the previous evaluation period. A total of 11 stations in the Bras d'Or Lakes showed an increase in fecal coliform levels that resulted in the stations exceeding bacterial limits where formerly they had been classed as approved (Table 2). These stations were found in East Bay, St. Peter's Inlet, West Bay, McKinnon's Harbour, Whycocomagh Bay, and Baddeck River (Fig. 12) and indicate areas in which recent (within three years) degradation of bacterial water quality occurred.

On a positive note, four sample stations that previously exceeded bacterial limits now meet approved criteria. These stations were found in St. Peter's Inlet and River Denys (Fig. 13; Table 2).

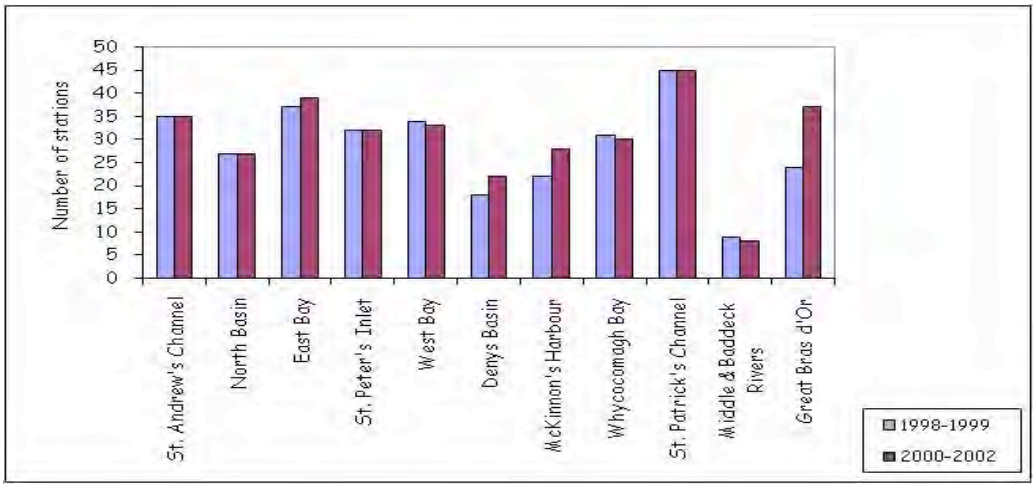


Figure 12. Number of stations that met approved water quality in each of the receiving waters for the Bras d'Or Lakes sub-watersheds for evaluation periods of 1998-1999 and 2000-2002.

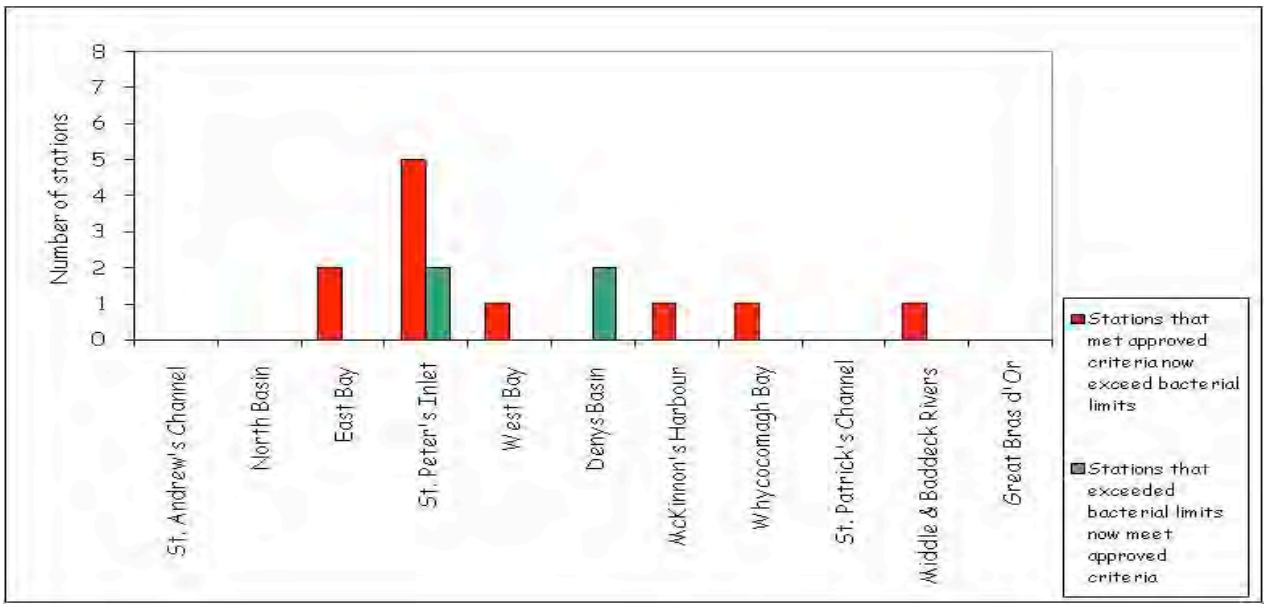


Figure 13. Changes in water quality of sample stations between 1998-1999 and 2000-2002. New stations added between evaluation periods were not included in the analysis.

The use of both shellfish closures and sample station data allows us to examine the state of the Bras d'Or Lakes more closely. As mentioned previously, shellfish closures do not entirely translate into poor water quality or are areas of "contamination". The national shellfish program requires areas within a minimum of 300 m of industrial, municipal, and sewage treatment plant outfall discharges, and the areas within a 125 m radius around marinas, to be automatically closed regardless of observed water quality conditions. 11% of shellfish closures have good water quality. Good in this sense is defined as having all the sample stations within the closure meet approved criteria. This applies to the marinas and closures around Little Narrows Gypsum, the Barra Strait, and four coves in St. Peter's where lift stations are present. These closures are permanent but show good water quality. 41% of current closures show poor water quality but are permanent because of the nature of their closures and, in this case, because they are directly adjacent to sewage outfall or lift stations. The remaining 48% of shellfish closures in the Bras d'Or Lakes, a total of approximately 14 km^2, are closed to shellfish harvest because of poor water quality and may re-open if conditions improve (Fig. 14).

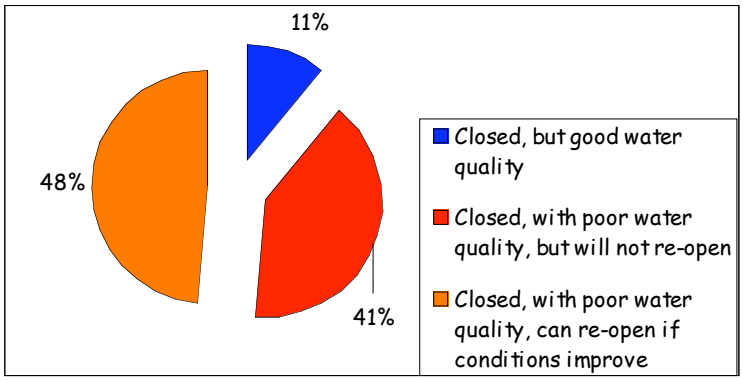


Figure 14. Percent of total area closed that has good water quality, poor water quality and not likely to re-open, and poor water quality but may re-open if conditions improve.

In summary, we are fortunate that bacterial water quality, as measured by shellfish closures in the Bras d'Or Lakes, is still very good and the area of shellfish closures has changed very little over the past 10 years. Using Environment Canada's criteria for bacteriological contamination, the number of sample stations with poor water quality in the Bras d'Or Lakes (i.e., exceeded bacterial limits) was determined to be 61 at the last published evaluation period (between sampling years 2000 to 2002). However, over a very short time (approximately three years), there has been an increase in the percentage and number of sample stations in which water quality has degraded, as indicated by the increase in sample stations that exceeded bacterial limits. Some of these changes were a result of additions of sample stations in areas where poor water quality was suspected, which would partially explain increases in the number of sample stations with poor water quality, or the addition of a new sub-sector required for classification.

Comparisons made without including data from new sample stations between evaluation periods, also indicate and possibly more reliably so, changes occurring between evaluation periods. These changes were a result of decrease in bacteriological water quality in the areas of East Bay, St. Peter's Inlet, West Bay, McKinnon's Harbour, Whycocomagh Bay, Middle River and Baddeck River (Fig. 13). Surprisingly, River Denys showed an improvement in bacteriological water quality (Fig. 11; Table 2) when otherwise appearing to be one of the areas that experienced the most reduction in water quality (Figs. 10 and 11). Slight improvements were evident in St. Peter's Inlet, but all sub-sectors of the area showed reduction in bacteriological water quality (Fig. 13). Further information on locations of sample station and sub-sectors where changes were observed is found in the corresponding sub-watershed sections.

Impact

The most obvious impact of poor water quality in terms of bacteriological limits is loss of water available to shellfish harvesting. There are currently 49 areas closed to shellfish harvesting in the Bras d'Or Lakes totalling 28.6 km^2. Another 4.0 km^2 are conditionally approved for shellfish harvesting (Table 2). The largest single closure is found alongside the community of Baddeck (St. Patrick's Channel; Table 2). However, when examining the total area of closures compared to the area of marine water for individual sub-watersheds, 45% of Middle River and Baddeck River sub-watersheds (combined because they cannot be effectively divided) were closed to shellfish harvesting with only one sample station that exceeded bacterial limits (Fig. 15; Table 2).

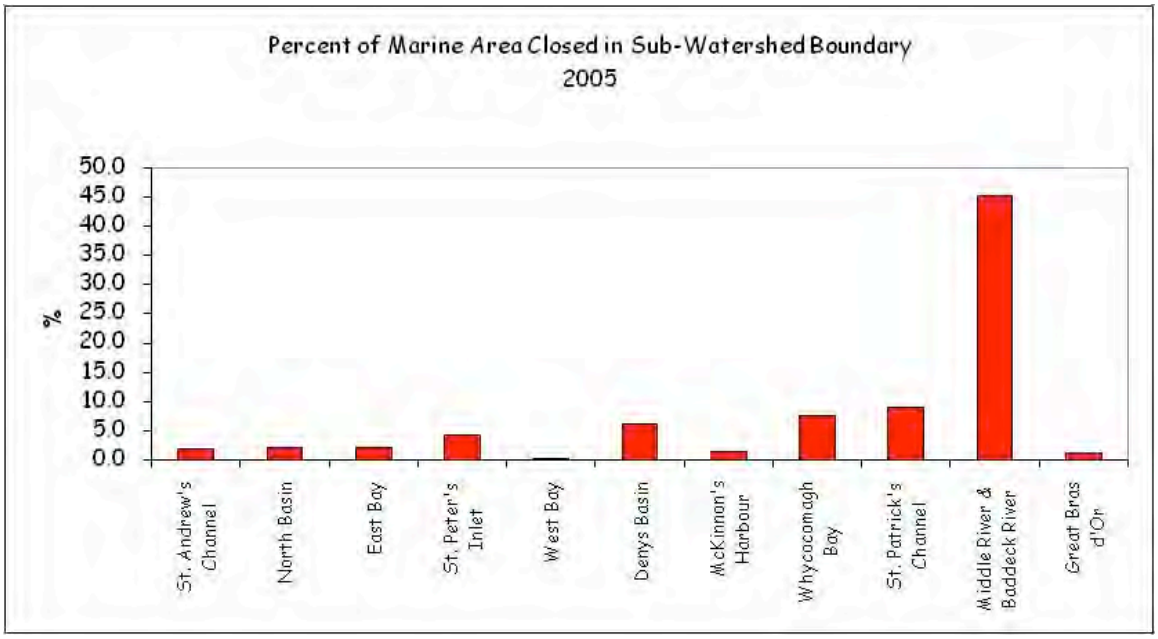


Figure 15. Percentage of marine sub-watershed area closed to shellfish harvesting in 2005.

Both St. Patrick's Channel and Whycocomagh Bay, with three stations exceeding bacterial limits, had slightly greater percentage of their areas closed within their

respective sub-watershed areas than Denys Basin (Fig. 15). In contrast, Denys Basin and St. Peter's Inlet regions had less than 10% of their area classified as closed but the highest number of sample stations with poor water quality (Table 2) and the greatest percentage of stations with 'poor' water quality (Fig. 11).

It is important to repeat that not all closures are implemented as a result of poor water quality. For example, areas may be automatically closed to shellfish harvesting if there is potential for contamination, bacterial or chemical. There are several closures in the Bras d'Or Lakes to which this applies. The area adjacent to the marina in Dundee, West Bay (closure measures 0.73 km^2) accounts for almost half of the total closed area within the marine sub-watershed but has good water quality (McArthur et al. 2002). The closure around Grand Narrow's Bridge (North Basin, East Bay, and McKinnon's Harbour sub-watersheds) had good water quality that met criteria for an approved classification (McArthur et al. 2003), but it remains closed because it is the throughway to the Bras d'Or Lakes for vessels. Also, a large wharf at Iona and a marina at Grand Narrows are located here. The closure around Little Narrow Gypsum also had water quality that met approved criteria. These areas will never re-open to shellfish harvesting or be available to oyster leaseholders. Water quality is acceptable and meets approved criteria in all these areas. Baddeck Bay, the single largest closure in the Bras d'Or Lakes, has only two sample stations with poor water quality, and the majority of the closure has acceptable water quality. Two marinas and a large wharf are located in Baddeck.

The impact of a closure implementation does not necessarily mean that oysters cannot be harvested at all. There are permits in place that allow the transfer, or relay, of oysters from closed shellfish areas to private leases where they continue to filter and quickly excrete the bacteria and, as a result, become safe for consumption. The restrictions are in place to protect the average harvester who exploits public beds (those areas that are approved for shellfish harvesting but are not leased to individuals) and those who exercise their Aboriginal and Treaty Rights. The current limit for relay licenses has been suspended at 13 and new fishers cannot enter the relay fishery to date (A. McIsaac, pers. comm. 2006).

While closed areas translate into restrictions on shellfish harvesting, bacteriological and nutrient input via sewage does provide the small benefit of increasing the natural production of the ecosystem. The oyster itself is not harmed by increases in sewage and actually benefits from increases in nutrients to the area. The Bras d'Or Lakes are an area of low productivity with low levels of nutrient input (Strain and Yeats 2002). Additional nutrient inputs from sewage (nitrogen and phosphorous) promote the growth of phytoplankton, the basis of the food web and the primary source of food for oysters. Fecal coliform bacteria are not discriminated by the oyster and become a food source as well. Within acceptable temperature ranges, oyster growth is only limited by the amount of food in the water and is accelerated in areas where there are additional inputs of nutrients as indicated by the presence of fecal coliform bacteria. However, probable non-biological inputs from sewage effluent such as cleaning solvents, pharmaceuticals, etc., offset the "fertilizer" advantages, but there is no other information on water quality in areas affected by sewage inputs (besides fecal coliform levels) to support this.

From another viewpoint, the implementation of shellfish closures may provide protection for oysters in the Bras d'Or Lakes. These oysters are essentially protected and, of course, well fed because of increase in food production due to sewage inputs. Healthy

oysters spawn readily and have a greater chance at producing viable ova. Also, as growth is accelerated, oysters become larger, faster. Oysters are one of the few species that can change their sex. Smaller oysters tend to be males while larger oysters are almost always females. The potential to use closed shellfish areas as oyster reserves has not yet been utilized and may be something to be considered especially in light of the oyster disease, MSX that has made its way into Bras d'Or Lakes' oysters.

Bacterial contamination in the Bras d'Or Lakes can affect recreational activities. Beach closures to swimming occurred in Wagmatcook and Eskasoni in 2000.

Response

The Bras d'Or Lakes are situated in the centre of Cape Breton Island, Nova Scotia. Aboriginal diversity, location, and connection to the Atlantic Ocean make an interesting soup of governments that regulate the waters and surrounding land of this unique body of water. The provincial government of Nova Scotia governs the shoreline of the Bras d'Or Lakes, including the shorelines of First Nation communities. Jurisdictions on land are provincial, while federal laws apply to First Nations. Considered a marine coastal area, the waters of the Lakes and the activities affecting them are subject to federal regulations, with the exception of aquaculture, which comes under provincial jurisdiction. There are four counties under municipal jurisdictions that also border the Bras d'Or Lakes – Cape Breton, Victoria, Richmond, and Inverness. First Nation communities of Chapel Island, Eskasoni, Membertou, Wagmatcook, and We'koqma'q have their own elected governments, while Malagawatch First Nation is owned by all Unama'ki Bands and does not have a government in place.

The land surrounding the Bras d'Or Lakes is largely rural. Although larger rural communities, such as Baddeck and Eskasoni, may have sewage treatment facilities, the primary means for sewage disposal is through septic tanks, pipes, or outhouses. In fact, outflow pipes make up 43.7% of the direct source of bacterial contamination in the Bras d'Or Lakes (Table 1). Not all pipes, however, carry sewage. Some may dispose of "grey water" depending on how their systems were designed, but are still considered direct sources of pollution. These sources of pollution are likely from older systems before environmental regulations regarding on-site sewage disposal came into effect in 1975.

There are many federal and provincial acts that regulate wastewater. Federal acts include:

- Canadian Environmental Protection Act (1999, c.33)
- Canada Marine Act (1998, c. 10)
- Canada Water Act (R.S. 1985, c.C-11)
- Coastal Fisheries Protection Act (R.S. 1985, c. C-33)
- Department of Fisheries and Oceans Act (R.S. 1985, c. F-15)
- Disposal at Sea Regulations (SOR/2001-275)
- Fisheries Act (R.S. 1985, c. F-14)
- Health Act

Further information and links to these acts can be found at:

http://atlantic-web1.ns.ec.gc.ca/ecoaction/default.asp?lang=En&n=43D592CB-1

Federal programs like Environment Canada's Sanitary Shoreline Surveys, conducted as part of the Canadian Shellfish Sanitation Program (CSSP), provide valuable, quantitative information on the types and location of direct and potential sources of pollution. Slight manipulation of the data is necessary to get a quantitative picture of what pollution sources contributed to bacteriological contamination. The application of this program to freshwater and the Bras d'Or Lakes watershed would be useful.

First Nations Land Management Act (1999, c. 24) is a framework agreement that allows First Nations to establish a land management regime. The community can enter into individual agreements with the Minister responsible to adopt a "land code" and the forces of law that allow the First Nation to exercise the powers, rights, and privileges of an owner in relation to that land, and to manage the natural resources of that land (for full description, the Act is available at http://laws.justice.gc.ca/en/F-11.8/text.html). First Nations' laws developed for environmental protection require the First Nation to enter into an agreement with the Minister and the Minister of the Environment, and any environmental protection standards developed by First Nations must be at least equivalent to those under the province of which the First Nation is located. There are 36 First Nations that have entered into individual agreements with the Minister. None of the communities listed were from Nova Scotia.

Provincial regulations include the Environment Act (1994-1995, ch.1, section1) that was proclaimed in 1995 and amalgamated a number of previous statutes into one Act. Pursuant to the Act are a number of regulations, including the Onsite Sewage Disposal System regulations. These regulations include construction standards, the need to have the systems pre-approved before installation, separation distances from watercourses and water supplies, minimum lot sizes, disposal bed composition, and qualification standards for installing systems (S. Carter pers. comm. 2006). Further information on the application process and links to the On-Site Sewage Disposal Regulations (Environment Act, Statutes of Nova Scotia, 1994-1995, Chapter 1) can be found at: http://www.gov.ns.ca/snsmr/paal/el/paal178.asp.

This initiative was likely a direct response from Nova Scotia Department of Health (NSDOH) to the Nova Scotia Department of Municipal Affairs (NSDMA) report in 1978 that addressed concerns regarding underlying geology, lot sizes, distance between disposal systems, and poor design and maintenance that were found during the province-wide study (Bjarnason et al. 1998).

In 1997, the provincial Department of Environment and Labour established a "Qualified Person" program where individuals were trained to assess lots, design, and select on-site sewage disposal systems. Once a training course is completed, the qualified individual is able, on behalf of the client, to select the best type of system for a lot based on soil conditions, lot conditions, system usage, and regulatory requirements. The Department regularly audits the submissions from qualified persons for compliance with the regulations and any issued approvals (S. Carter pers. comm. 2006). Two levels of qualified persons (QP) are trained. Individuals at the QP1 level are qualified to assess, design, and select on-site systems while QP2 individuals are qualified to select pre-designed systems from the On-Site Sewage Disposal Systems Guidelines. The program was fully implemented in 2000 and currently, there are enough individuals trained to handle the quantity of on-site applications in the province. In 2005, the province granted

QPs a letter of acknowledgement/approval without a formal review of a selected number of their on-site sewage applications and, as a result, decreased waiting time for applications to be processed. The province continues with routine auditing to maintain quality assurance and quality control designed to protect the client.

The Nova Scotia Department of Environment and Labour is in the process of developing a provincial sewage management strategy through the Water Resources Protection Act (Bill no. 32, chapter 10 of the Acts of 2000). The discussion paper could not be accessed through the website at the time of writing.

Environment Canada, through CBCL Limited, prepared the *Atlantic Canada Standards and Guidelines Manual for the Collection, Treatment, and Disposal of Sanitary Sewage*. The full document is found at:
http://www. gov.ns.ca/enla/water/docs/AtlCanStdGuideSewage.pdf

The guide provides useful information on the approval requirements and processes required for sewage treatment plants. Ultimately, the type of treatment facility depends on the receiving waters assessment, which is mandatory for systems with a proposed capacity of 50,000 US gal/day or greater (roughly 200,000 L/day). Effluent requirements for fecal coliform levels are based on point of discharge. Maximum average monthly means of fecal coliforms for discharge to freshwater lakes and low flow streams is 200/100 ml; rivers and estuaries, 1000/100 ml; and open coastline, 5000/100 ml. It would be interesting to view the Receiving Waters Assessments or to determine which discharge parameters were used when sewage treatment plants that proposed to discharge into the Bras d'Or Lakes were designed. This information resides with the community or agency that commissioned the assessment but is not publicly distributed.

A Canada-wide Strategy for the management of municipal wastewater effluents is being developed under the aegis of the Canadian Council of Ministers of the Environment (CCME). The anticipated completion date for the strategy is spring, 2007. It is Environment Canada's intention to develop a regulation for municipal wastewater effluent under the Fisheries Act. This regulation will establish national performance standards that will apply to all wastewater system across Canada, including those on federal and Aboriginal lands. It is anticipated that site-specific standards for effluent quality (based on the national performance standards) will be established by each jurisdiction through site-specific risk assessments.

For more than 25 years, concerns about the future of the Bras d'Or Lakes watershed have grown steadily. Since 1990, we have seen the formation of nine groups that directly address a portion of resource or sewage management in the Bras d'Or Lakes. It's not surprising that one of the first organizations to bring awareness to government organizations and the public on the state of the Bras d'Or Lakes was an Aboriginal organization, the Eskasoni Fish & Wildlife Commission Inc. (EFWC, founded in 1991). Maintaining the Unama'ki Mi'kmaq culture depends on many of the resources provided by the Bras d'Or Lakes. EFWC was instrumental in the expansion of sampling areas in the Canadian Shellfish Sanitation Program and continues to provide in-kind support in the form of wages and related sampling costs to the program. EFWC was also instrumental in assisting other communities in developing their groups and is an active participant on many committees. Since then, the Unama'ki Institute of Natural Resources (UINR, founded in 1998) has taken over the resource protection mandate, but EFWC

continues to be involved as technical support for many of the projects and programs under UINR's leadership.

UINR is a society represented by the five Mi'kmaq bands (Potlotek, Wagmatcook, Membertou, Eskasoni, and We'koqma'q) in Cape Breton (Unama'ki Mi'kmaq District), specifically formed to address concerns regarding natural resources and their sustainability, especially in the Bras d'Or Lakes. UINR works collaboratively with other scientific and management departments within Fisheries and Oceans, Environment Canada, Parks Canada, and Department of Natural Resources as well as community groups, schools, and universities. UINR has also been given the mandate by multi-governmental departments to become the lead organization in developing a management plan for the Bras d'Or Lakes watershed. This includes extensive collaboration with municipal, provincial, and federal government departments, as well as partnerships with community groups and private enterprise. UINR has created the Collaborative Environmental Planning Initiative (CEPI) which seeks to enhance cross-cultural understanding, develop parallel policies and regulations, create sustainable solutions to identified environmental problems, and provide innovative collaborative models with the overall goal of enhancing community health.

As part of this work, UINR has participated in the Pitu'paq Partnership, a successful and nationally unique collaboration of all municipal and First Nation leaders on Cape Breton Island, formed to address sewage issues, and is the lead organization in CEPI which seeks to create, in conjunction with stakeholders, an environmental management plan. The Ten Commitments for this partnership can be found in Appendix 1.

Other non-native organizations and their accomplishments include:

- Bras d'Or Lakes Preservation Foundation (founded 1993)

Involved in protection of private lands in Cape Breton

- Bras d'Or Lakes Stewardship Society (founded 1997)

Formed to address the sewage problem in Baddeck Bay and conservation, protection, and restoration of the Bras d'Or Lakes in general. They have successfully lobbied for a state-of-the-art sewage treatment plant that has been in operation since 2003.

- Stewards of the River Denys Watershed Association (founded 1999)

Formed to address drinking water protection and improvement, fish habitat restoration, public education, and reduction in sedimentation.

- NS Sustainable Community Initiative, Bras d'Or Lakes Field Team (SCI; founded 2001)

Coordination of government activities in the Bras d'Or Lakes and engaging communities.

- Nova Scotia Oyster Growers Association (founded 2001)

Seeks to achieve a sustainable oyster industry in the Bras d'Or Lakes through protection of oyster resources and water quality.

A complete description of each of the community groups operating on the Bras d'Or Lakes, their approaches, capabilities, resources, and visions can be found in Appendix 2.

Sewage is a local concern and the means to address the problem begin at the grassroots. While many of the sources of pollution are land based, significant potential exists for direct contamination from marine traffic during the spring to fall months. There have been instances where the release of sewage from boats into small coves was enough to have the area closed to shellfish harvesting. Some initiatives to address the problem of sewage dumping by boats were undertaken between 1998 and 2000. In 1998, the Bras d'Or Stewardship Society partnered with the Department of Environment and Labour, the local municipalities, and the Nova Scotia Youth Conservation Corps to sponsor a Green Craft initiative to educate boaters on the effects of boating sewage and alternatives to discharging. In 1999, a pump-out station for boats was installed at the Grand Narrows Marina and in 2000, another pump-out station was installed at St. Peter's Marina.

Public education and installation of pump-out stations for vessels were the initial steps necessary to set the stage for further action. In July 2001, the Bras d'Or Stewardship Society approached the Nova Scotia Sustainable Communities Initiative's Bras d'Or Lakes' field team to explore the possibility of obtaining a non-discharge designation for the Bras d'Or Lakes. In 2002, the Pitu'paq Partnership took the lead role in preparing an application to have the Bras d'Or Lakes designated as a non-discharge zone under the Canadian Shipping Act. The application met all targets and reached the Gazette 1 stage in the fall of 2004. At the date this report was completed, the Pitu'paq Partnership's proposal had been accepted and was in the final regulatory stages before being added to the Canadian Shipping Act Schedule. Currently, it is moving toward Gazette II, at which point the non-discharge designation will become law. A four-year implementation strategy with various components is in progress. This strategy will include an education and outreach program implemented over the first three years (year 1 completed in 2005), and it will also ensure that two to four additional pump-out facilities are in place prior to enforcement. By the fourth year, it is expected that there should be full compliance with Pleasure and Non-Pleasure Craft Sewage Pollution Prevention Regulations.

From 1994 to 2003, communities around the Bras d'Or Lakes have invested over $9,000,000 in infrastructure for sewage treatment. Although these communities are rural communities, it does provide a clear indication of the growing concern surrounding the issue of sewage contamination in the Bras d'Or Lakes. Among First Nations, for example, there have been attempts in Chapel Island to connect as many houses as possible to the central system. In 1997, a new sub-division on Backlands Road as well as the new school were connected to the central system and, in 1999, homes along Mountain Road were connected. Training for the plant's operations is kept current. The primary plant operator has received system-specific training from Indian and Northern Affairs Canada (INAC), as well as Level 1 training (not certification) from Atlantic Canada Water Works Association. A backup operator is also in place and has received on-the-job training from the primary operator.

Chapel Island has also responded to concerns around the St. Anne's Mission by providing port-a-potties on the mainland during the Mission, as well as constructing three 2,728 L concrete holding tanks for campers. Facilities on the island, however, remain poor and there are reports that campers feel the three holding tanks are poorly located and should be spread out rather than grouped in one area. There are also many trailers on the mainland side of Chapel Island. These are serviced with a vacuum truck for waste

removal and educational awareness brochures on the ill-effects of dumping sewage directly into the Bras d'Or Lakes are provided. The Unama'ki Institute of Natural Resource Officers, Department of Environment, Fisheries and Oceans and Department of Natural Resources conduct joint patrols of the area during the St. Anne's Mission weekend. Chapel Island First Nation is in the process of developing the mainland side as a camping/trailer park with sewer hook-up, electricity, and running water. The trailer park will be completed before the Annual Mission in 2006.

The most significant response to poor water quality taken by the community of Eskasoni occurred in 1998 when the new sewage treatment plant was completed. The new system replaced the overtaxed oxidation ditch and lagoon system that existed prior to 1998. Over the years, a number of repairs have been made to pipes and manholes and, in 1995, 620 m of new pipes were installed. The operator of this facility has received training by the design and engineering firm for this plant and by the Public Works and Government Services Canada. A backup operator, who has over 30 years experience, is also employed.

In We'koqma'q, an agreement was signed in 1995 between the Municipality of Inverness and the Department of INAC to have wastewater from the First Nation Community of We'koqma'q treated by the off-reserve municipal treatment facility in Whycocomagh. Repairs to the collection system were made from 1995 to 1998 to address concerns around major infiltration areas and, in 2002-2003, an estimated $780,000 was spent on the extension of sewer and water lines ($127,125 contributed by the First Nation of We'koqma'q). Over the years, the Band has also decommissioned upwards of 75 on-site septic systems and connected the homes to the central collection system.

In Wagmatcook, a number of mitigation projects have taken place and more are being planned in an effort to improve marine water quality. The most significant response taken by the Band is the proposed upgrades to the South End Lagoon. This upgrade will increase the system's capacity as well as improving its functioning capabilities.

The First Nation community of Malagawatch is in an unique management situation. There is no one governing body in place that protects the land or surrounding waters from degradation. A survey was completed as part of a summer student employment program through the Union of Nova Scotia Indians in 2002, with recommendations such as implementation of composting toilets, a recycling program to help reduce the litter and garbage collection problems, and a no dumping policy. To date, none of these recommendations have been put into action.

Over the past number of years, improvements have been made to sewage collection facilities in non-First Nations communities. In particular, both St. Peter's and Baddeck have upgraded their sewage treatment systems. Beginning in 1998, the town of St. Peter's carried out a series of improvements to the sewage collection and treatment system. In 2001, following sampling conducted during 1999 and 2000 to determine the effectiveness of these improvements, the conditional area was upgraded to approved status. One of the existing five closures was also removed. The marine pump-out station located in St. Peter's was installed in 2000 and is connected to the central system, and in 2002, $1.2 million was spent to upgrade the existing treatment plant. St. Peter's releases treated effluent into the adjacent Atlantic Ocean so unless repairs are made to the lift stations that are found to be affecting the Bras d'Or Lakes, it is unlikely that improvements will directly benefit the Lakes.

Baddeck recently invested in a new facility that began operating in May 2003. The new treatment plant is a state-of-the-art sequence batch reactor (SBR) with ultraviolet treatment to sterilize the effluent. The system consists of one equalization tank, four batch reactors, and two sludge digesters. The sludge is treated on-site by way of a two-stage aerated digester and then de-watered by a centrifuge. The water is then fed back to stage one of the process and the remaining sludge is taken to a landfill site. The treatment plant currently services approximately 500 households and businesses plus the marine pump out stations, which are active during the summer boating season. Not all houses in Baddeck are hooked up to the new treatment plant, specifically a number of houses with malfunctioning septic systems on the Shore Road. The capacity of the new system is one million gallons and is operating under capacity at 250 thousand gallons. This is the most advanced treatment plant located on the Bras d'Or Lakes.

II. Chemical Water Quality

The micro-environments of the Bras d'Or Lakes show differences in their nutrient, chemical, and oxygen concentrations because of their physical geographies. Many of them are separated from the main part of the Lakes by sills and narrow channels, while others like barachois ponds, may be completely cut off from the Lakes by sandbars and other barriers that permit only an occasional exchange of water. As a result, circulation is restricted in these environments and negative environmental effects are evident in a shorter period of time. For example, Whycocomagh Bay has the longest flushing time, estimated at 2 years (Petrie and Bugden 2002).

The longer flushing times result in problems such as eutrophication (a process whereby a body of water becomes over-enriched in organic and mineral nutrients so that algae, bacteria, and other micro organisms flourish and deplete the oxygen content of the water). Noticeable effects of eutrophication are hydrogen sulphide production (rotten egg smell), and fish kills noticed by adjacent communities even though they do not affect the Lakes as a whole. This often has the effect of increasing community concern about the water quality in the Bras d'Or Lakes even though the problem is very localized.

Organic compounds and heavy metals (in water, sediment, and biota), productivity, and oxygen will be addressed in this section.

Driving Force

Chemical water quality is primarily affected by local industrial activities, but other sources that may contribute to pollution are leakage from landfill sites and dumps, and illegal or unauthorized dumping of wastes in the watershed area and marine waters of the Bras d'Or Lakes. Chemicals from fertilizers and animal wastes are known to contribute phosphorous and nitrates to the watershed through run-off during precipitation events. Fin-fish aquaculture is an additional source of concentrated waste products and unconsumed food, much of which is comprised of oils and animal by-products. The use of antibiotics and pesticides is common in fin-fish aquaculture and has the potential to affect other marine organisms.

One of the most popular attractions of Cape Breton Island are the Bras d'Or Lakes with their scenic routes, world-renowned golf courses, and camping areas. The Bras d'Or Lakes can be viewed from many areas of Cape Breton and especially from the many roads and highways along the shoreline. Route 4, between Port Hawkesbury and Sydney, is located so close to the shoreline in some areas that spray from the Lakes often results in icy conditions in the winter. Other major highways include Route 216 between East Bay and Grand Narrows, Route 223 between Iona and Northside Whycocomagh Bay through Little Narrows, and Route 205 through Baddeck. The TransCanada Highway (Route 105) traverses Cape Breton, connecting mainland Nova Scotia with the ferry departure point for Newfoundland and Labrador at North Sydney. Highway 105 circles round Whycocomagh and Nyanza Bays before passing Baddeck. Thereafter, the highway leaves the Lakes' shores before returning to them when it crosses the Great Bras d'Or Channel by way of Seal Island Bridge. The bridge gives access to Boularderie Island which is traversed before the highway crosses Little Bras d'Or Channel enroute to North Sydney. Road salt accumulation, oil and gas spills, as well as other chemicals found in cars and trucks, could very easily come in contact with the Bras d'Or Lakes.

Dumping has been reported in the Bras d'Or Lakes. A barge was sunk in the Lakes north of Grand Narrows, and using side scan sonar two shipwrecks were found in Barra Strait. Other shipwrecks have been reported in Whycocomagh Bay and there may be others.

Pressure

There are a few produce farms located in the Bras d'Or Lakes watershed and current information on the type of agriculture taking place is limited. These produce farms are restricted to lands around the Skye, Middle and Baddeck Rivers, all of which are major contributors of freshwater to the Bras d'Or Lakes. The opportunities for expanding agriculture are limited by a lack of quality soil, since most of the arable soil within the watershed is already used for farming and the remainder is inside forestry reserves (UMA 1989).

Mining also takes place within the watershed. Two gypsum mines are found in Unama'ki: Little Narrows (Little Narrows Gypsum) and Melford (Georgia-Pacific). They both use an open-pit method of extraction and ship raw product to other places for refinement. Melford Mine is found in an area where there are numerous small streams that feed into River Denys. A small-scale marble mine (MacLeod Resources Ltd.) is also in operation in River Denys. Diamond wire saws are used to extract large blocks of stone at a size of 4.8 m^3 (Connolly 2002). MacLeod Resources Ltd. received a loan for expansion of its facility to process and finish its own product (Nova Scotia Business Inc. 2004).

One hospital is located on the shores of the Bras d'Or Lakes at Baddeck with effluent treated through the municipal sewage system. Wastes, medications, potent cleaners, and other substances may possibly be dissolved in the effluent and current treatment of sewage does not include neutralization or removal of such chemical products. First Nations also have clinics in each of their communities with varying degrees of medical services offered. Biomedical wastes are disposed of separately, however, antiseptics, medications, and industrial strength cleaners may enter the Lakes.

First Nations in general have experienced problems with dumping of discarded household items (including appliances such as fridges and stoves), automobile and oil-based waste products in the watershed area. It is unknown whether other First Nations have areas that are used for dumping and whether these sites exist in other rural non-First Nation communities.

There are numerous golf courses in Unama'ki. They are a concern because of the chemicals (herbicides, pesticides, and fertilizers) that are used to maintain the greens. Two golf courses are located along the Bras d'Or Lakes – Dundee Resort and Golf Course and Bell Bay Golf Club in Baddeck. Dundee Resort and Golf Course in Dundee, West Bay has been in operation since 1977 and expanded to an 18-hole course in 1981. A larger golf course, Bell Bay Golf Club, was established in Baddeck in 1997-1998. Aerial photos show that the course is not directly located on the shore. Baddeck Bay is visible from the mounds/hills rather than directly from the course. Trees separate the greens from the course and Route 205. Baddeck Forks Golf Club, Baddeck Forks, has been in operation since 1973. While it is not visible from the Lakes, it is situated along the Baddeck River which empties into the Lakes.

State

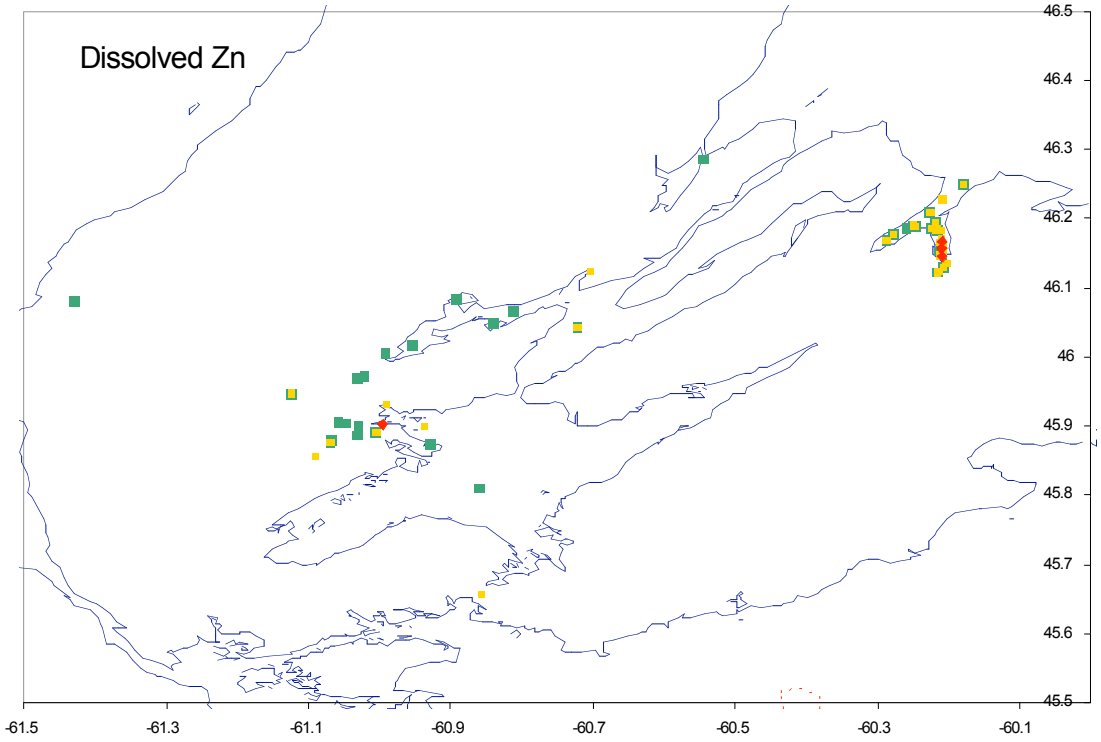
Organic Compounds and Heavy Metals

Generally, organic contamination, (PCBs, PAHs) and heavy metal concentrations (copper, zinc, lead, and cadmium–Cu, Zn, Pb and Cd respectively) in sediments, water, and biota are below the federal sediment and water quality guidelines for the protection of aquatic life. These concentrations are lower compared to other areas, such as Halifax and Sydney Harbours, despite lower salinities found in the Bras d'Or Lakes. Higher concentrations of metals are generally higher in lower saline environments (Strain and Yeats 2002).

The main flux of heavy metals flowing into the Bras d'Or Lakes is through the Great Bras d'Or Channel from Sydney Bight. Dissolved metal concentrations are also low in the rivers that drain into the Bras d'Or Lakes compared to other rivers in New Brunswick and Nova Scotia. However, in 1995, Cape Breton rivers were found to have higher concentrations of cadmium, copper, lead, and zinc than other rivers sampled in Nova Scotia and New Brunswick (Dalziel et al. 1998). There is a concern with zinc concentrations found in the water in south River Denys Basin from samples obtained in 2003 (Figure 16), as it is easily accumulated in oysters even in the absence of local elevated levels (Strain and Yeats 2002). Dissolved zinc was found in levels greater than the probable effects level (PEL -probably would cause biological effects) established in international marine water quality guidelines for this element, and thus are probably harmful (as indicated by the color red). Potentially harmful levels of arsenic, cadmium,

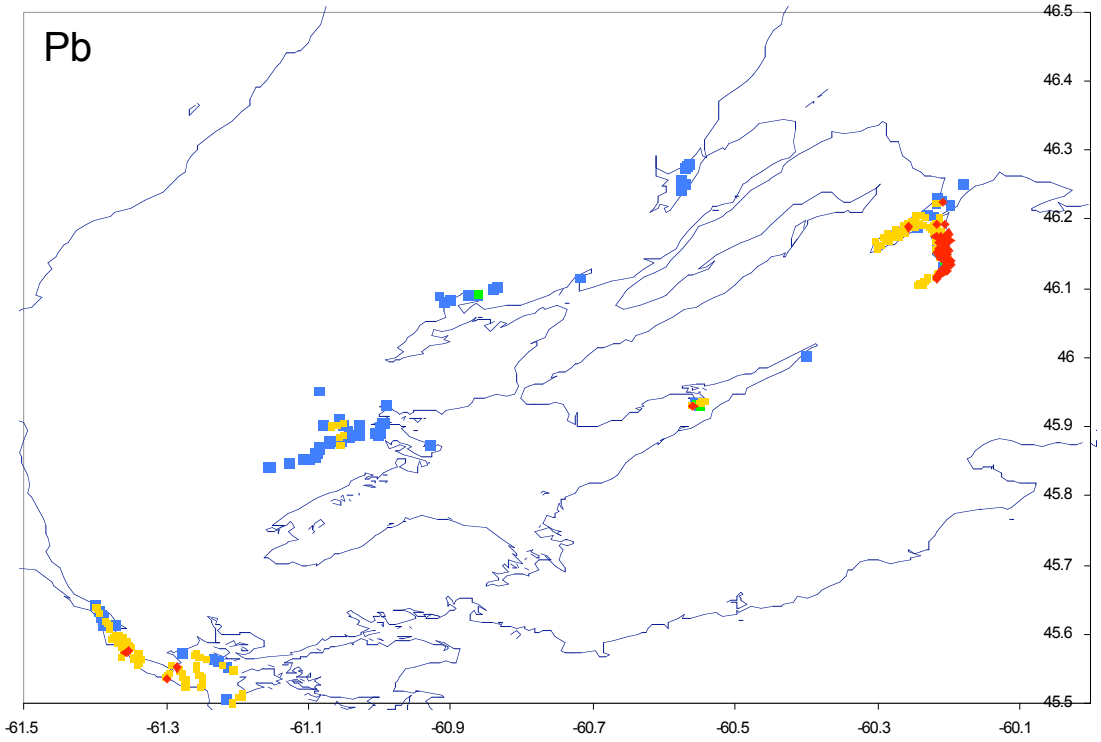
copper, and lead were also found in Denys Basin (Bedford Institute of Oceanography Containment Data Base, Yeats pers. comm. 2005). See Appendix 4.

Elevated lead in sediments were found in East Bay (near Eskasoni) in one sample collected in 2003 and classified as probably harmful (Figure 17; red). Copper and zinc were found outside Eskasoni at levels that are possibly harmful (Bedford Institute of Oceanography Containment Data Base, Yeats pers. comm. 2005). Cadmium, arsenic, chromium, copper, mercury, PCBs, and PAHs in sediments were found to be at background (natural) levels or slightly higher, but not harmful for most regions sampled. Mercury, cadmium, lead and arsenic were detected in fish and oyster samples in 2002-2004 but were below guidelines established under the Canadian Food Inspection Agency (Denny and Berubé 2003; UINR 2005). No samples were taken in the southern portion of the Bras d'Or Lakes during the MEQ survey in 2003-2004. For further information on the levels of arsenic, cadmium, chromium, copper, mercury, PCBs, and PAHs and distribution of samples taken during the 2003-2004 survey, refer to Appendix 4.



Blue	background levels (natural)
Green	greater than background and less than threshold effects level (TEL; contaminated but not harmful)
Yellow	greater than background and TEL but less than probable effects level (PEL; possibly harmful)
Red	greater than PEL (probably harmful)

Figure 16. Levels of dissolved zinc found during the marine environmental quality (MEQ) survey conducted by the Bedford Institute of Oceanography and the Eskasoni Fish & Wildlife Commission Inc. in 2003-2004. Map and data presentation provided by Dr. Phil Yeats, Bedford Institute of Oceanography.



Blue	background levels (natural)
Green	greater than background and less than threshold effects level (TEL; contaminated but not harmful)
Yellow	greater than background and TEL but less than probable effects level (PEL; possibly harmful)
Red	greater than PEL (probably harmful)

Figure 17. Levels of lead found in marine sediments during marine environmental quality (MEQ) survey conducted by the Bedford Institute of Oceanography and the Eskasoni Fish & Wildlife Commission Inc. in 2003-2004. Map and data presentation provided by Dr. Phil Yeats, Bedford Institute of Oceanography.

Productivity

The nutrient inputs to the Bras d'Or Lakes has been described as low and can only support a relatively low level of natural productivity (Strain and Yeats 2002). Nitrogen and phosphorous are essential elements for phytoplankton production. Nitrogen and phosphorous inputs are derived primarily from coastal exchange with Sydney Bight and from vertical mixing with deep waters in the channels. Other external sources of nitrogen and phosphorous are from rivers, sewage, aquaculture, or agriculture but are more localized and have little affect on the production of the Bras d'Or Lakes as a whole. The nitrogen to phosphorous ratio required for phytoplankton production (the Redfield ratio) is 16:1; Bras d'Or Lakes ratios have been found in the range of 5.4:1, 4.6:1 and 2.7:1 (spring, summer and fall respectively), which suggests that nitrogen is the limiting

nutrient in the lakes (Strain and Yeats 2002). Nitrogen: phosphorous ratios for Sydney Bight increased to their highest levels (to 10) in February in studies completed in 1995-1997, which is considered low for coastal areas. Chlorophyll *a* concentrations are also found to be low throughout the Lakes, but the measurements made may have occurred after spring bloom had taken place in 1996. Nitrate, ammonia, and dissolved oxygen measurements are consistent with Atlantic coastal inlets for Nova Scotia (Strain and Yeats 2002).

Potentially toxic phytoplankton has been found in the Bras d'Or Lakes although no reports of outbreaks from shellfish poisoning–such as diarrhetic shellfish poisoning (DSP), amnesic shellfish poisoning (ASP), or paralytic shellfish poisoning (PSP)–have occurred to date. Algal species that cause DSP, ASP, and PSP naturally occur in the environment at low levels, but increases in temperature, light, and nutrients can result in an algal bloom. Toxins produced by the phytoplankton are not normally harmful to the shellfish that ingest them, but since the toxins accumulate in their tissues, they can be toxic to the humans who consume them. Thirty-seven species of phytoplankton have been identified in 12 sample sites located in the areas of Chapel Island, Eskasoni, We'koqma'q, Wagmatcook, and Malagawatch First Nations, and the oyster seed collection area of Gillis Cove in River Denys Basin. The species identified have been classified into one of three categories: potentially toxic (species that produce toxins), harmful (linked to fish or shellfish kills and harmful to marine animals and birds), and other species (identified but not known to cause harm) (McIsaac et al. 2003). Eight species were identified as potentially toxic, six species as harmful, and 23 as other. Twelve species have not been identified but are believed to be neither harmful nor potentially toxic. All sampling sites had at least four of the potentially toxic algae identified in the Bras d'Or Lakes, although in differing quantities. A list of species identified is found in Appendix 5.

Oxygen

Dissolved oxygen concentrations are generally within acceptable limits based on sediment and water quality guidelines for the protection of animal life. However, lower concentrations of dissolved oxygen have been measured in Whycocomagh Bay and in some barachois ponds compared with the rest of the Bras d'Or Lakes. Elevated iron and manganese levels have also been found in these areas but are a result of reduction-oxidation reactions that take place during eutrophication rather than as a result of environmental contamination. Denys Basin was not affected by low oxygen levels. There is limited information on water quality in barachois ponds but we can expect these areas in particular to suffer from eutrophication, especially where there is established summer residency and direct input from sewage outflow or seepage, and little exchange of water with the main body of the Lakes.

In summary, the chemical quality of the water, sediments and biota of the Bras d'Or Lakes is very good with respect to heavy metal and organic compound contamination, but naturally poor in nutrients, and presumably primary productivity, despite increases in nutrients from sewage pollution. Parts of Whycocomagh Bay and other low flushing areas such as Denys Basin, Dena's Pond, Baddeck Bay and St. Peter's Channel and numerous barachois ponds located around the Lakes are more likely to

experience nutrient enrichment and suffer high bacterial contamination leading to eutrophication.

Impact

There is little impact on the chemical quality of the water in the Bras d'Or Lakes primarily due to low industrial and aquaculture activities, and small population size. "The Lakes as a whole should be relatively unaffected by new inputs of nutrients from human activities and are at low risk for eutrophication." (Strain and Yeats 2002, p. 61).
Many metals, such as zinc, are required in trace amounts for biological processes, but when found at higher levels have the effect of poisoning organisms, including humans. Other metals, such as cadmium, lead and mercury, are especially toxic (Government of British Columbia 2005).

Finfish aquaculture in the Bras d'Or Lakes was popular in the 1990s with fish cage systems established in Seal Island, Whycocomagh Bay, Dena's Pond, and St. Peter's Inlet but are no longer in operation as of 2003-2004. Environmental impact of finfish aquaculture on water quality is no longer a concern as a result of closure of all finfish sites, however, long-term or residual effects of anti-fouling chemicals and/or antibiotics from feed may still be a concern in these areas.

Increases in phosphorous in a localized environment can, under the right conditions, cause large increases in the production of algae, blue-green algae (cyanobacteria), and bacterial production. Combined with a lack or limited exchange between the air and other oxygen-rich waters, the area can become eutrophic and oxygen depleted. Other effects are reduction in light transmission as a result of overproduction of algae, increase in detritus (dead organic matter) settling in the sediment, strong hydrogen sulfide odours, and mass mortalities of fish and invertebrates, making the water unsuitable for recreation, aquaculture, or fishing (Brönmark and Hansson 1998). Amaguadees Pond in Eskasoni suffered from eutrophication in the late 1990s/early 2000 and resulted in a temporary relocation of families who lived in the immediate area to hotels in Sydney because of the odour. Fish kills were observed in the aquaculture operation in Whycocomagh Bay in the late 1990s as a result of anoxic conditions brought about by local eutrophication.

Response

As chemical water quality is still very good in the Bras d'Or Lakes, there have been no additional local management initiatives by community groups. Many of the responses discussed in bacteriological water quality apply to this section as well. Since 1999, on behalf of Environment Canada, Eskasoni Fish and Wildlife Commission Inc. has mapped potential fecal coliform bacteria pollution sources all around the Bras d'Or Lakes, barachois ponds, and connecting bodies of water. There is no long-term monitoring in place for heavy metals, oxygen, pH, potentially toxic phytoplankton, or organics for these areas by federal, provincial, or First Nations' governments.

In 2003, UINR, in partnership with Environment Canada, initiated an environmental awareness program to educate the public about some of the issues that threaten the Bras d'Or Lakes. Posters and brochures were developed as the means to convey information on protecting the Bras d'Or Lakes from invasive species, etc. Another project conducted through UINR targeted the youth of Eskasoni (Grades 4 to 12). The project focused on providing information on the source of Eskasoni's drinking

water supply, activities that impact the quality of water (forestry, pollution, dumping, recreational activities, etc.), and how to protect it (UINR 2004). As well, a poster contest provided the youth with another opportunity to participate. The contest helped to demonstrate the importance of protecting water sources as part of the overall goal of maintaining water quality. A general approach to protecting drinking water was given to the youth of Chapel Island, Wagmatcook, We'koqma'q, and Membertou First Nations.

III. Sedimentation

There is a limited amount of information available on the rate of sedimentation for the Bras d'Or Lakes.

Driving Force

Sedimentation causes are derived from the land surrounding the Bras d'Or Lakes. The shores of the Bras d'Or Lakes are easily subjected to erosion because of Cape Breton's geology. Northern Cape Breton Island is dominated by a highland block of ancient metamorphic and granite rocks. The Cape Breton Highlands are situated on the highest part of the tilted plain and have been subjected to the greatest degree of erosion. The boundaries of the Highlands are, in places, depositional and faulted. Erosion has preferentially exploited the softer material and exposed a steep scarp slope at its margins. Faulting has defined the straight sides of the Highlands on the east and west, influencing the angular drainage patterns of many rivers and streams. The two main fault directions are north-northeast and west-northwest, with the former predominating. The perimeter of the Bras d'Or Lakes is lined with residential developments and cottages. Some houses are located on the shoreline. Some landscapes are extended to the water with little vegetation such as trees and grass to act as traps to prevent excessive sedimentation.

Clear-cutting in forests along the rivers may be a problem in some First Nation communities and a contributing factor in non-First Nation lands prior to April 2000 when provincial legislation came into effect. Clear-cutting around streams and rivers on First Nation communities also occurs. Naturally high elevations in some areas, such as Eskasoni, We'koqma'q, and Wagmatcook, make expansion of residential developments away from the shoreline difficult.

Land developments and building of roads and highways contribute to excessive or unnatural sedimentation accumulations. Sub-division developments are occurring in River Denys, off Whycocomagh Bay, and in First Nation and non-First Nation communities. The majority of the provincial roads are situated along the perimeter of the Bras d'Or Lakes, and often very close to the water.

Gypsum mining operations are found in Melford (near Whycocomagh on the TransCanada Highway) and Little Narrows (Route 228). Areas with high potential for future gypsum mining are Dundee (Richmond County, West Bay sub-watershed), and Middle River (Victoria County, Middle River sub-watershed) (Adams 1993).

Pressure

The demand for land with water views or direct water access is high and so are the property values. Property owners are free to remove naturally-occurring vegetation from their properties' edge, except along streams and lakes that are protected by the provincial government.

Forestry is the prominent industry in Cape Breton. Stora-Enso leases the majority of Crown Lands that are harvested for softwood. The majority of the harvesting lands are found in the Cape Breton Highlands, which includes a portion of the Bras d'Or Lakes watershed. Occasional unregulated harvesting by individuals also occurs on First Nation lands.

Canada's largest workable gypsum and anhydrite deposits are located in Nova Scotia (Adams 1993). 81% of raw product is shipped to the United States via bulk carriers. Two gypsum and anhydrite mines are found in Cape Breton, both of which use open-pit mines to obtain a high-quality and low-cost material (Panagapko 2003). Little Narrows Gypsum produces 1.2 million tons annually that is shipped in lots of 12,000 to 40,000 tonnes (Sysco 2003). The gypsum is transferred via conveyor belt from the mine site to bulk ore carriers, which arrive from the United States and as far away as South America and Europe. These large ships enter the Lakes via the Great Bras d'Or Channel, making between 30 and 100 trips a year (Adams 1993).

With the exhaustion of mineral deposits at the Sugar Camp Mine near Port Hastings, Georgia-Pacific has transferred its gypsum extraction operations to a new mine at Melford. The life of this new mine will be 20 years with estimated reserves of 35 million tonnes.

State

General sedimentation rates are estimated at 5 cm per century for St. Patrick's Channel but can vary by area. There are some areas, like due south of Baddeck, where there has been no sedimentation at all (J. Shaw pers. comm. 2005). A bathymetric (bottom topography) survey conducted by Natural Resources Canada using interferometric side scan and multibeam sonar technologies was completed in 2004. This survey delineated the circuitous channels of ancient riverbeds now buried beneath layers of sediment in Denys Basin and St. Patrick's Channel (Shaw et al. 2005, p. 6). Furthermore, evidence was found of the existence of bioherms (carbonate rock formations in the form of a reef, often made up of fossilized remains of coral, algae, molluscs, and other sedentary marine organisms) that were buried some 3,500 years ago. The bioherms are probably oyster shell beds that could not keep up with the sedimentation and, as a result, are now buried under the mud. (Shaw et al. 2005) Height of the bioherms is estimated to be 4 m and approximately 3500 years old (Shaw et al. 2005, p. 6). Based on the height of the bioherms, the rate of sedimentation could be estimated to be 11 cm per century, more than twice the rate estimated for St. Patrick's Channel.

After rainfall, there are many areas where muddy water forms a band around the perimeter of the shoreline, especially in the area of residential developments. The width of the band varies depending upon severity of land run-off, rainfall, and wind conditions at the time. There has been no formal documentation of these "siltation events" either by aerial photography or survey of traditional ecological knowledge (TEK).

With knowledge of known causes of siltation and physical oceanographic processes, we can conclude that significant sedimentation must be occurring in areas that receive substantial freshwater input and that are poorly flushed. Particularly susceptible are Denys Basin, Whycocomagh Bay, and the numerous barachois ponds found around the Bras d'Or Lakes, where significant sedimentation may be occurring from river outflow and run-off from land development.

There is information available on the location of historic Mi'kmaq oyster fishing areas. Oyster populations in the Bras d'Or Lakes are decreasing but it was assumed that they were fished out, or until more recently, infected with the oyster disease MSX (multinucleated sphere X) or SSO (seaside organism disease). It is quite possible that there are areas that are unable to provide suitable habitat for settlement or, as oysters are sedentary organisms, were smothered by excess sediment (or silt) in the water. Naturally occurring oyster beds are a reflection of the bottom type available for oyster settlement and can thus be used to gauge general increases in sedimentation. There is no current information on whether these areas are still suitable for oysters to settle.

It appears that there are insufficient data to discuss the current overall state of Bras d'Or Lakes with regards to sedimentation.

Impact

Sedimentation negatively affects water quality and ecosystems in many ways. It can suffocate organisms and bottom-dwelling communities of invertebrates, especially organisms with limited, or no mobility, such as molluscs. Silt clogs the delicate filtering mechanisms in molluscs and reduces their ability to feed themselves and to act as natural filters of the water (Barnes and Hughes 1988). It destroys habitat by replacing the area with a layer of fine sediments and prohibits the area from reestablishment with organisms and communities that have specific habitat requirements. For example, clean surfaces are necessary for oysters to settle and hard-bottom conditions are optimum for producing a "choice" oyster. Transformation of habitat caused by sedimentation leads to changes in community assemblages, as one or more species dies out to be replaced by others better suited to the new conditions.

Loss of oyster habitat is becoming an increasing problem, especially in areas of low tidal action. Two particularly susceptible areas are River Denys Basin and Whycocomagh Bay. Both receive waters from major rivers and are characterized by low flushing. Not only can oysters be affected, but other fish species depend on near-shore environments to carry out some part of their lifecycle. Bras d'Or Lakes' herring (*Clupea harengus harengus*), for example, have one of the shallowest recorded spawning areas on the Atlantic coast (Crawford et al. 1982). These shallow areas are found in coves and inlets that are likely to be directly affected by sedimentation, and in some case, sewage. Unstable sediment, i.e. newly deposited and not anchored by vegetation such as eel grass, can become re-suspended under turbulent wave action and prevent light from being transmitted through the water column. Limited light has the effect of reducing primary production in the area. Atlantic herring spring-spawning populations in the Bras d'Or Lakes have been declining over the past decade and no longer support a commercial fishery (Denny et al. 1998). Numerous spawning areas were documented in the Lakes prior to 1996 but are reduced to smaller numbers with smaller spawning biomass. It is undetermined whether environmental changes such as loss of habitat, or human pressure,

such as the commercial fishery, have caused a decline in the spring-spawning population of Atlantic herring. Simultaneous pressure from both sources has likely contributed to its decline.

The areas that can be affected by sedimentation are important areas of primary production of marine flora. The Bras d'Or Lakes have a range of shoreline flora but the dominant species is eelgrass (*Zostera marina*). Eel grass is characteristic of warmer, sheltered waters and grows in silt and mud, consistent with conditions found in the Bras d'Or Lakes (Tremblay 2002).

Chemical contaminants and toxins can be bound up in bottom sediment when they are adsorbed by deposited silt particles. Probable Effect Level (probably would cause biological effects) concentrations of zinc are found in River Denys Basin water.

Response

Nova Scotia Department of Natural Resources' (DNR) regulations protect stream and rivers from excessive sedimentation during forestry operations by requiring the establishment of riparian buffer zones known as Special Management Zones (SMZ). These extend 20 m on each side of a channel that is greater than 50 cm in width. StoraEnso, operating under its own Environmental Management System, exceeds the minimum requirements under provincial legislation and the Nova Forest Alliance Best Management Practices (StoraEnso 2004). It is the responsibility of the landowner to implement proper erosion control measures to protect the aquatic environment from sedimentation (Department of Natural Resources 2005).

We'koqma'q has asked residents not to cut trees in their community and is following the honour system of enforcement. It is hoped that this curtailing of logging will prevent excessive water runoff with the ultimate goal of eliminating excessive sedimentation in Whycocomagh Bay.

In August 2005, UINR, Environment Canada, and the Bedford Institute of Oceanography installed a hydrometric flow gauge station in Denys River to collect data on water flow and level of river water discharge into the South Denys Basin.

Conclusion & Recommendations

The bacterial water quality of the Bras d'Or Lakes is considered very good with just 2.6% of the total marine area closed to shellfish harvesting. There has been an increase in sampling effort by Environment Canada and its partners over the past decade to include approximately 50% of the Bras d'Or Lakes. Currently, close to half of the marine waters are sampled through the Canadian Shellfish Sanitation Program (Fig. 4) and show a small, approximately 0.5 %, increase in overall area of shellfish closures between 1995 to 2005 (Fig. 7). Considering the total length of shoreline in the Bras d'Or Lakes (about 1,000 km; Table 2), only 60 sample sites had water quality that exceeds bacterial limits to permit the harvest of shellfish. Approximately 1/3 of these sites found in River Denys (Table 2) were included to gather more data for re-evaluation and re-classification of the closure in Denys Basin. Nevertheless, water quality is degrading in the Bras d'Or Lakes. Examination of sample station data between 1998–1999 and 2000–

2002 showed a loss of 11 stations to poor water quality (i.e., considered to have exceeded bacterial limits) in approximately 3 years (Table 2).

Chemical water quality, as determined through measurements of heavy metals and organics, is still very good in the Bras d'Or Lakes with only a single sample from Eskasoni showing probably harmful levels of lead in sediments (Fig. 17). Productivity is naturally low in the Bras d'Or Lakes but may be higher in some areas such as Whycocomagh Bay, River Denys, McKinnon's Harbour, and the barachois ponds where there is an increase in nutrient input via sewage, although there is no sampling or data to support this. Dissolved oxygen in water and sediments are within acceptable limits for the protection of aquatic life in most areas, with the exception of Whycocomagh Bay where anoxic water and sediments have been found and may be permanent. Information on rates of sedimentation is limited except for areas of St. Patrick's Channel and River Denys. Given the potential negative impacts of sedimentation on aquatic life in the Bras d'Or Lakes, the lack of information on current rates and areas affected is a big concern.

Over the past decade, the concern for water quality in the Bras d'Or Lakes has been growing. Many individuals assume that the areas of "red" on the Bras d'Or Lakes' map that indicate closed to shellfish harvesting are areas of extreme pollution and contamination. This assumption is not entirely accurate. There are many areas that are closed because bacterial levels are high enough to be of concern when harvesting oysters. However, there are many other areas that closures are implemented as a precautionary measure to protect human health because of local sanitation concerns and are, therefore, precautionary. These areas are Grand Narrows/Iona, Dundee, Little Narrows Gypsum, and MacDougall Pond. Some areas, despite any improvements in water quality, will never re-open. Specifically, these are Baddeck Bay, Eskasoni, Nyanza Bay, four small coves in St. Peter's Inlet, Whycocomagh, and Little Bras d'Or.

Recreational activities such as swimming are not affected. You can swim just about anywhere in the Bras d'Or Lakes except where there are sewage treatment plants that discharge effluent into the Lakes.

Our efforts to improve bacterial water quality must be realistic. Currently, 11% of shellfish closures have water quality that is acceptable for shellfish harvesting but are closed because of the presence of wharves, marinas, or industry and are precautionary. They will likely never re-open in the future unless the facilities are removed. Approximately 40% of current closures have poor water quality but will never re-open because of the presence of lift stations and sewage treatment plants. The remaining closures (48%) have poor water quality because of poor local sanitary conditions, such as inadequately maintained septic tanks, direct discharge into water courses, outhouses, farming, wildlife, and where there is fertilizing using manure.

Current management of bacterial water quality is implemented to protect human health. But what about ecosystem health? Moderate amounts of fecal coliform bacteria do not harm the ecosystem, or oysters, instead contributing dissolved nutrients that promote oyster growth and increasing production in near-shore environments through phytoplankton growth. In the Bras d'Or Lakes, where nutrient levels are naturally low and nitrogen is the limiting nutrient, sewage may not be a bad thing all the time (Strain and Yeats 2002). Excessive amounts cause problems when combined with a physical environment that accumulates fecal matter such as Whycocomagh Bay, Dena's Pond, and McKinnon's Harbour, and around the barachois ponds such as Amaguadees Pond in

Eskasoni. Also harmful are cleaning agents, laundry detergents, body washes, shampoos, fabric softeners, and pharmaceuticals, to name a few, that can alter the pH of marine water or combine with other additives to form toxic compounds. The impact of the physical and chemical components of sewage effluent in the Bras d'Or Lakes is currently unknown.

The Nova Scotia Department of Environment and Labour trains individuals to assess and select septic systems based on geology and distances from water courses and water supplies. Judging by the location of some of the new homes on the Bras d'Or Lakes, this cannot possibly apply to marine environments. But we must also realize that the marine environment of the Bras d'Or Lakes is not an oceanic environment. It is relatively self-contained, with slower flushing rates, lower salinities, limited tidal action with essentially no inter-tidal zone, higher summer temperatures, ice cover in the winter, and low natural productivity. The uniqueness of Bras d'Or Lakes is reason alone to implement Bras d'Or Lakes-based management to reduce levels of fecal coliform bacterial contamination, especially in areas that have low flushing action.

In conclusion, the use of shellfish closures as indicators of water quality only provides one measure of water quality assessment. This measure only reflects the amount of fecal bacteria entering the Lakes. Other issues that affect the Lakes' health, such as sedimentation, heavy metals, organic compound contamination, oxygen, and pH are not recorded directly by these means and affect the quality of water for the organisms living in the Bras d'Or Lakes rather than around it.

Based on our findings, we have summarized a list of conclusions and developed recommendations to address them.

Conclusion		**Recommendation**
1	There are septic systems in the Bras d'Or Lakes watershed that are old, undersized and prone to malfunction. Properly designed and maintained septic systems are an effective means of sewage treatment. There are regulations in place for new home construction.	Support the establishment of programs to upgrade, maintain and replace malfunctioning septic systems.
2	The weak link in some community sewage systems is lift stations that carry sewage from lower elevations to the central sewer lines.	Support First Nations and municipalities in obtaining the necessary infrastructure funding to properly maintain and operate their sewage management systems.

3	There are still straight pipes discharging sewage or grey water into the Lakes.	Support the establishment of programs to replace all straight pipes with proper septic systems.
4	Pesticides, herbicides, chemical fertilizers and manure can enter the Lakes in run-off water after heavy rainfall.	Ensure environmental management plans are implemented for farms, golf courses and other sources of contaminants. Environmentally-friendly substitutes for toxic chemicals should be used.
5	The Bras d'Or Lakes have been declared a non-discharge zone for untreated boat sewage and chemicals. There are six pump-out stations available.	Some parts of the Lakes are a long distance from these facilities and can't accommodate larger vessels. Support community groups to establish additional pump-out stations on the Bras d'Or Lakes
6	The concentrations of organic compounds and heavy metals in sediments and the dissolved state are very low, mostly at background levels. Higher levels of zinc were found in the vicinity of Denys Basin and concentrations of lead were measured in sediments off Eskasoni.	Further focused testing and monitoring should be conducted.
7	Nutrients essential for phytoplankton production, which is the base for all marine life in the Lakes, are not abundant.	A long-term monitoring program should be carried out to learn more about the nutrient dynamics in the Lakes.
8	The Nova Scotia provincial government has legislation to protect fresh water. There is limited legislative protection for marine coastal areas.	Governments should strengthen legislation for marine coastal areas.
9	Studies to examine the levels of nutrients, marine environmental quality and habitats have been completed using different methods. This makes comparisons difficult.	A monitoring strategy using consistent methods should be developed so that changes can be evaluated and compared.

Sub-Watershed: St Andrew's Channel

St. Andrew's Channel is located on the northeastern corner of the Bras d'Or Lakes. The Channel connects to the Atlantic Ocean via the Bras d'Or Lakes' smallest channel, the Little Bras d'Or (8 km long and only 100 m at the widest point, with an average depth of only 5 m). St. Andrew's Channel is one of the two areas (the other is the North Basin) in which there are deep (>200 m) and isolated basins (Petrie and Raymond 2002).

The area is rural with a combination of permanent and summer homes found along 92.7 km of shoreline. The largest community found in this sub-watershed is Bras d'Or. The sub-watershed area is shared by Victoria and Cape Breton Counties.

1. Bacteriological Water Quality

Driving Force

Many tourists are drawn to the Little Bras d'Or region of the Lakes. This area is part of a scenic drive although the majority of the shores of St. Andrews Channel are more quiet and remote, especially the northern shore of Boularderie Island. Rural communities such as Boisdale have camp grounds, and bed & breakfast accommodations. Rental cottages, picnic parks, and campgrounds can be found along the southern shore of the Channel. Recreational swimming along these shores is popular.

Many of the homes situated close to the shore are a mixture of temporary summer residences and permanent dwellings. Both types of homes appear to have few or no trees, brush, or shrubs between the lots and shore.

Little Bras d'Or is a base for commercial fishing activities in this area. Numerous wharves are found just at the head of the channel. A marina (no pump-out station) is also found here.

There are few industries in St. Andrew's Channel. A sheep farm and Scotsburn Dairy Farm are the two main farms found here. Several hobby farms with grazing animals were found throughout this region. The only rail transportation route between Sydney and mainland Nova Scotia operates through here.

Pressure

Population in Bras d'Or is relatively small with about 400 residents. 30% of the homes in the area were identified to have inadequate on-site septic systems for various reasons such as poor soil conditions, improper installation, or amount of land available for installation (McArthur et al. 2003).

There are nine direct sources of pollution located in this sub-watershed, all found in the Little Bras d'Or area. The direct sources identified were all non-point. One water sample with high fecal coliform levels (110 MPN/100 ml) was taken from an area in which a water course drains into the basin closed to shellfish harvesting. This suggests

the source drains from a higher elevation through the water course and is not found directly on the shores.

Potential sources of pollution are septic tanks, outhouses, and pipes scattered among the rural areas of this Channel (Table 3).

State

In the sub-sector of St. Andrew's Channel/Long Island in Barrachois Harbour, 2% of the sampled area is closed to shellfish harvesting due to poor water quality (Fig. 18). A slight increase in the area closed to shell fishing occurred between 1998 and 1999; however, no further change has been observed since then (Fig 19). The one station identified with poor water quality was found north of Barrachois Harbour (sub-sector 020-009; MacArthur et al. 2003). This change is not evident when comparing water quality at sample stations between evaluation years (1998-99 and 2001-2002) (Table 4).

The sub-sectors of Boisdale (020-008) and Long Island (020-009) were added in 1999.

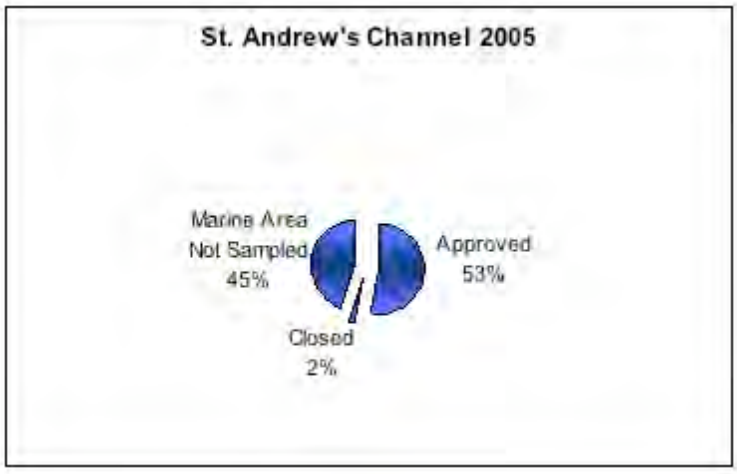


Figure 18. Current shellfish classifications in the receiving waters of St. Andrew's Channel sub-watershed.

Table 3. Potential and direct sources of pollution found during the Sanitary Shoreline Survey. Data compiled using MacArthur et al. 2003.

		SUB-WATERSHED: ST. ANDREW'S CHANNEL					
	Sub-Sectors	Little Bras d'Or NS-07-020-001	St. Andrew's Channel/Boisdale NS-07-020-008	St. Andrew's Channel/Long Island NS-07-020-009	Great Bras d'Or Shunacadie NS-07-020-007	TOTAL	%
STAUS OF SOURCES	Non Pollution Source	3	34	2	20	**59**	**35.8%**
	Direct	9	0	0	0	**9**	**5.5%**
	Potential	28	38	13	18	**97**	**58.8%**
	Total	**40**	**72**	**15**	**38**	**165**	
DIRECT	Water Sample	1				**1**	**11.1%**
	Outhouse					**0**	
	Pipe					**0**	
	Septic Tank					**0**	
	Lift Station					**0**	
	Water Course					**0**	
	Wharf					**0**	
	Treatment Plant					**0**	
	Agriculture					**0**	
	Non-Point (source that is not set to one location)	7				**7**	**77.8%**
	Non-Source	1				**1**	**11.1%**
	Leaching (leaching type source)					**0**	
	Other (miscellaneous, surface drainage)					**0**	
POTENTIAL	Water Sample	5				**5**	**5.2%**
	Outhouse	2	8	2	5	**17**	**17.5%**
	Pipe	2	5		3	**10**	**10.3%**
	Septic Tank	9	23	8	9	**49**	**50.5%**
	Lift Station	2				**2**	**2.1%**
	Water Course	4		3		**7**	**7.2%**
	Wharf	2				**2**	**2.1%**
	Treatment Plant					**0**	**0.0%**
	Agriculture	2				**2**	**2.1%**
	Non-Point (source that is not set to one location)		1		1	**2**	**2.1%**
	Non-Source					**0**	**0.0%**
	Leaching (leaching type source)					**0**	**0.0%**
	Other (miscellaneous, surface drainage, marina)		1			**1**	**1.0%**

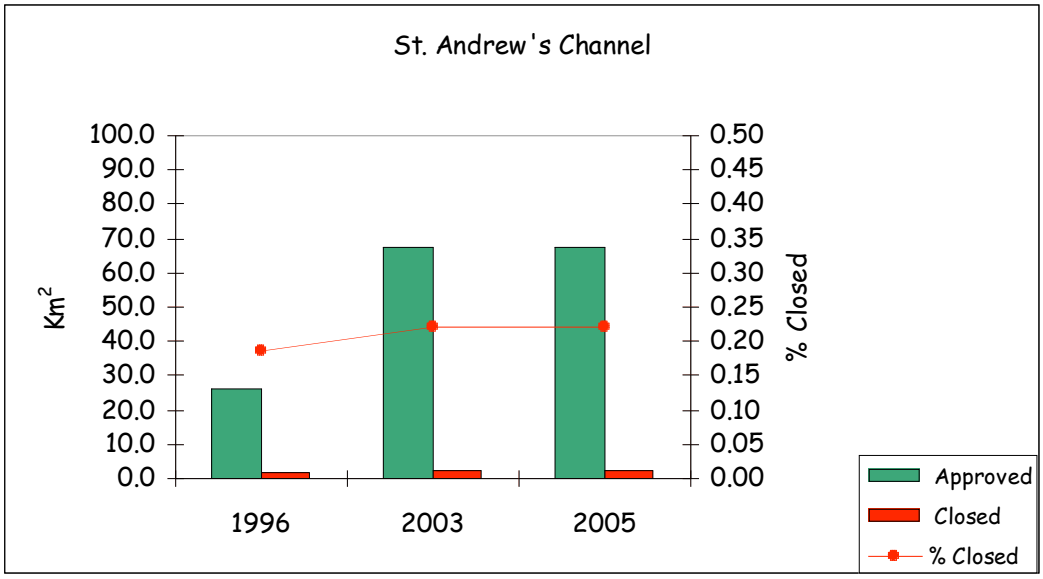


Figure 19. Changes in shellfish closures in receiving waters of St. Andrew's Channel sub-watershed between 1996 and 2005. Percent closed was standarized using the Bras d'Or Lakes area of 1,080 km^2.

Table 4. Water quality at sample stations within each sub-sector found within St. Andrew's Channel sub-watershed area.

	SUB-WATERSHED: ST. ANDREW'S CHANNEL					
Year	**Bacteriological Water Quality Sampling Stations**	**Little Bras d'Or NS-07-020-001**	**St. Andrew's Channel/Boisdale NS-07-020-008**	**St. Andrew's Channel/Long Island NS-07-020-009**	**Great Bras d'Or Shunacadie NS-07-020-007**	**TOTAL**
1998-1999	Approved	11	9	12	3	35
	Exceeded Levels	0	0	1	0	1
	Total	11	9	13	3	36
2000-2002	Approved	11	9	12	3	35
	Exceeded Levels	0	0	1	0	1
	Total	11	9	13	3	36

Impact

There are currently 2.42 km^2 of the Bras d'Or Lakes in this sub-watershed area closed to shellfish harvesting. The is in Little Bras d'Or with almost no possibility of ever being opened due to the presence of wharves and other pollution sources such as marine garbage dumping and the free connection to the coastline and Sydney Harbour.

Response

A Canada-wide Strategy for the management of municipal wastewater effluent is being developed under the aegis of the Canadian Council of Ministers of the Environment (CCME). The anticipated completion date for the strategy is spring, 2007. It is Environment Canada's intention to develop a regulation for municipal wastewater effluent under the Fisheries Act. This regulation will establish national performance standards that will apply to all wastewater systems across Canada, including those on federal and Aboriginal lands. It is anticipated that site-specific standards for effluent quality (building on the national performance standards) will be established by each jurisdiction, through site-specific risk assessments.

In recent years, UINR, partnered with Environment Canada and Nova Scotia Youth Conservation Corps, initiated an environmental awareness program to educate the public on some of the issues that threaten the Bras d'Or Lakes. In one project, posters and brochures were developed to convey information on protecting the Bras d'Or Lakes, and to provide information on invasive species, etc. In another project, university students were hired to research the problem of sewage released from boats in the Bras d'Or Lakes, and to provide the boating communities with information on legislation designating the Bras d'Or Lakes a non-discharge zone for boating sewage.

No other responses relating to this sub-watershed have been identified.

Sub-Watershed: North Basin

North Basin sub-watershed is located north of Grand Narrows/ Iona and includes the northern portion of the Barra Strait. The Barra Strait separates the North Basin from the Bras d'Or Lakes and controls the exchange of water (Petrie and Bugden 2002). Other than St. Andrew's Channel, the North Basin is the only area in which a deep (>200 m) and isolated basin is found (Petrie and Raymond 2002). Like most areas of the Bras d'Or Lakes, the population in the surrounding area is small and rural. The sub-watershed area is shared between Victoria and Cape Breton Counties. 36.6 km of shoreline are found within this sub-watershed.

1. Bacteriological Water Quality

Driving Force

North Basin is dominated by small rural communities. Iona lies on both the North Basin and McKinnon's Harbour sub-watersheds and is likely the largest rural community in this region. North Basin is the only connection to the Bras d'Or Lakes. Seasonal visitors frequent this area, arriving by both land and water. It is common to see yachts, sailboats, and other pleasure craft in this area on a summer day. A marina with a pump-out station located at Grand Narrows (McKinnon's Harbour sub-watershed), is a popular destination for many local boats and visiting vessels. North Basin side of Iona has a deep water wharf and is frequently used. This wharf is a popular base for recreational mackerel fishers in the summer and fall months. Maskell's Harbour is also a popular area for overnight anchorage for pleasure craft. Road traffic crossing the Barra Strait Bridge is routinely interrupted during the summer by the lift bridge that allows the passage of sailboats and other vessels through the channel. Iona is home to the Highland Village, a re-creation of a pioneer settlement. There are also two hotels and two bed and breakfast accommodations in the immediate area.

Pressure

North Basin is in the centre of Cape Breton and found north of the Barra Strait which connects the two main sections of the lakes. Boating traffic must pass this area to get to and from the inner sub-watersheds. A wharf owned by Central Cape Breton Community Ventures is located in this sub-watershed and may be considered a pressure due to the nature of its use. The marina is equipped with a sewage pump-out facility although reports of usage are very small given the high traffic of boats each season. In addition to being a destination for many boats from mainland Nova Scotia and the United States, the Bras d'Or Lakes are often used as a sheltered shortcut by many boats destined for the Gulf of St. Lawrence, St. Pierre and Miquelon, and South Western Newfoundland. Local watercrafts also travel between the north and south regions of the Lakes. All this boat traffic must pass through the North Basin. With the possible exception of the Great Bras d'Or Channel, this is the most traveled area of the Bras d'Or Lakes.

There were no direct sources of pollution identified in this area. However, potential sources of pollution were septic tanks (37.9%) and pipes (34.8%; Table 5). The only area closed to shellfish harvesting because of intermittent poor water quality was Maskell's Harbour.

State

Within the North Basin, 2 % of the area is closed to shellfish harvesting due to poor water quality. A large percentage of the area is sampled by Environment Canada (Fig. 20).

Figure 20. Current shellfish classifications within the receiving waters of the North Basin sub-watershed.

There was an increase in shellfish closures between 1996 and 1998, but the number of closures has remained unchanged since 1998 (Fig. 21). The increase was due to a closure implemented in Maskell's Harbour (sub-sector 020-005) where intermittent discharge of sewage from pleasure boats was enough to degrade water quality and warrant closure (Craig et al. 1999). This is one of the two harbours in the Bras d'Or Lakes where sewage from pleasure crafts was noted to have changed water quality. There were no changes in water quality for sample stations in North Basin between evaluation periods (Table 6).

Table 5. Direct and potential sources of pollution identified in the North Basin sub-watershed area. The data compiled using Craig et al. 2001.

	Sub-Sectors	SUB-WATERSHED: NORTH BASIN Great Bras d'Or Grand Narrows NS-07-020-005	Great Bras d'Or Christmas Island NS-07-020-006	Great Bras d'Or Shunacadie NS-07-020-007	TOTAL	%
STAUS OF SOURCES	Non Pollution Source	21	57	26	**104**	**61.2%**
	Direct	0	0	0	**0**	**0.0%**
	Potential	29	30	7	**66**	**38.8%**
	Total	**50**	**87**	**33**	**170**	
DIRECT	Water Sample				**0**	
	Outhouse				**0**	
	Pipe				**0**	
	Septic Tank				**0**	
	Lift Station					
	Water Course					
	Wharf					
	Treatment Plant				**0**	
	Agriculture					
	Non-Point (source that is not set to one location)				**0**	
	Non-Source					
	Leaching (leaching type source)				**0**	
	Other (miscellaneous, surface drainage)				0	
POTENTIAL	Water Sample				**0**	
	Outhouse		3	4	**3**	**4.5%**
	Pipe	15	8	1	**23**	**34.8%**
	Septic Tank	12	13		**25**	**37.9%**
	Lift Station				**0**	
	Water Course				**0**	
	Wharf	1			**1**	**1.5%**
	Treatment Plant				**0**	
	Agriculture				**0**	
	Non-Point (source that is not set to one location)		3	1	**3**	**4.5%**
	Non-Source	1			**1**	**1.5**
	Leaching (leaching type source)		2		**2**	**3.0%**
	Other (miscellaneous, surface drainage, marina)			1	**1**	**1.5%**

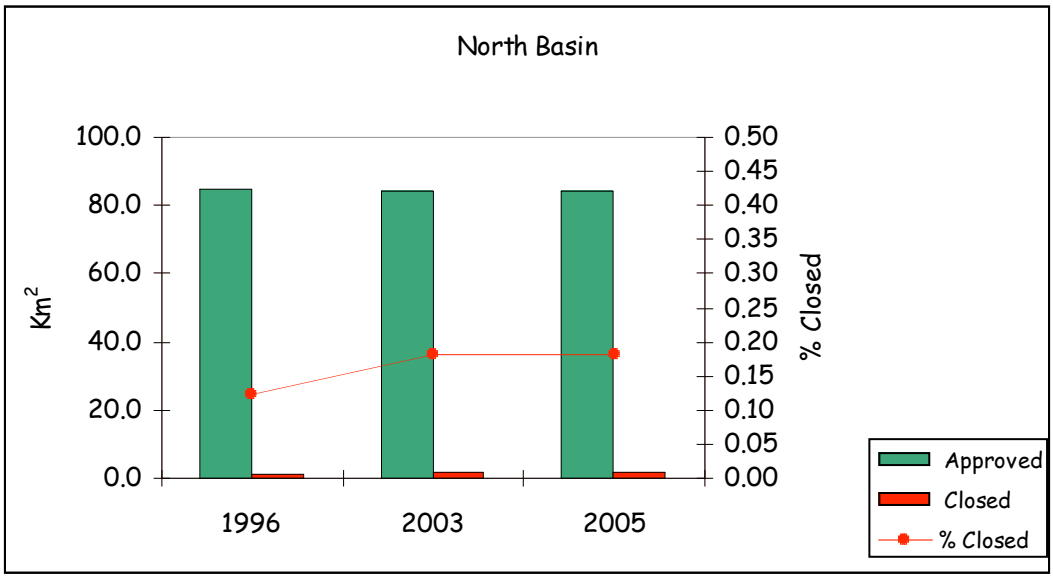


Figure 21. Changes in area of shellfish closures in the North Basin. Percent closed was standarized using the Lake area of 1080 km^2.

Table 6. Water quality at sample stations within each sub-sector of the North Basin sub-watershed for evaluation periods of 1998-1999 and 2001-2002.

SUB-WATERSHED: NORTH BASIN

Year	Bacteriological Water Quality Sampling Stations	Great Bras d'Or Grand Narrows NS-07-020-005	Great Bras d'Or Christmas Island NS-07-020-006	Great Bras d'Or Shunacadie NS-07-020-007	TOTAL
1998-1999	Approved	8	10	9	27
	Exceeded Levels	1	0	0	1
	Total	9	10	9	28
2000-2002	Approved	8	10	9	27
	Exceeded Levels	1	0	0	1
	Total	9	10	9	28

Impact

There are currently 1.97 km^2 of marine area closed to shellfish harvesting. Approximately 1/3 of this closure is due to poor water quality in Maskell's Harbour. The remaining closure was implemented due to the presence of potential contamination sources such as the government wharf in Iona, Grand Narrows Marina, railway track and bridge that runs across the Barra Strait. This latter closure is permanent and the area will never re-open to shellfish harvesting. Poor water quality in Maskell's Harbour is intermittent but the harbour may be re-opened if conditions improve.

Response

The Bras d'Or Lakes are unique and the environmental protection they require should be defined by all people who interact with them. Organizations set up to help raise awareness and stress the importance of this natural resource are the Unama'ki Institute of Natural Resources, Eskasoni Fish & Wildlife Commission, and Bras d'Or Lakes Stewardship Society. These groups have many different approaches for sustaining the beauty and pristine conditions we all would like to see for the Lakes. Some of their projects are named and explained in other sections of this report.

All but one of the closures in North Basin are precautionary (that is, due to the close vicinity of wharves, bridges, etc.). That closure is due to pollution that, in the majority of cases can be traced to boat traffic. Hence, the implementation of "non-discharge area" legislation should eliminate this source of contamination.

A Canada-wide Strategy for the management of municipal wastewater effluents is being developed under the aegis of the Canadian Council of Ministers of the Environment (CCME). The anticipated completion date for the strategy is spring, 2007. It is Environment Canada's intention to develop a regulation for municipal wastewater effluent under the Fisheries Act. This regulation will establish national performance standards that will apply to all wastewater systems across Canada, including those on federal and Aboriginal lands. It is anticipated that site-specific standards for effluent quality (building on the national performance standards) will be established by each jurisdiction, through site specific risk assessments.

II. Chemical Water Quality

Driving Force

Chemical water quality is primarily affected by local industrial activities but other sources that may contribute to pollution are leakage from landfill sites and dumps, and illegal or unauthorized dumping of wastes in the watershed area. Chemicals from fertilizers are known to contribute phosphorus and nitrates to the watershed through run-off during precipitation events.

Pressure

There are a few produce farms located in the Bras d'Or Lakes watershed and current information on the type of agriculture taking place is limited. These produce

farms are restricted to lands around the Skye, Middle and Baddeck Rivers, all of which are major contributors of freshwater to the Bras d'Or Lakes. The opportunities for expanding agriculture are limited by the lack of quality soil. Most of the arable soil within the watershed is already used for farming and the remainder is inside forestry reserves (UMA 1989).

Most communities surrounding this sub-watershed are small and rural with no clinics or hospitals. The homes in the Iona and Washabuck area are mainly permanent. The construction of the bridge may have contributed to concentrations of chemicals in the North Basin. Because zinc is one of the most commonly used metals in the industrial world, natural waters are particularly prone to contamination. The railway crossing adjacent to the sub-watershed makes this area particularly vulnerable to chemical spills.

State

Organic Compounds and Heavy Metals

According to Strain and Yeats (2002), organic contamination (PCBs, PAHs) and heavy metal concentrations (copper, zinc, lead and cadmium; Cu, Zn, Pb and Cd respectively) in sediments, water, and biota are below the federal sediment and water quality guidelines for the protection of aquatic life. These concentrations are lower compared to other areas, such as Halifax and Sydney Harbours, despite lower salinities found in the Bras d'Or Lakes. Concentrations of metals are generally higher in lower saline environments.

The main flux of heavy metals flowing into the Bras d'Or Lakes is through the Great Bras d'Or Channel from Sydney Bight. Sampling conducted in 1995 indicated that, with the exception of cadmium (Cd), copper (Cu), lead (Pb) and zinc (Zn), Cape Breton rivers that drain into the Bras d'Or Lakes had lower heavy metal concentrations than rivers sampled in New Brunswick and in other regions of Nova Scotia (Dalziel et al.1998). There is a concern with zinc concentrations found in water samples from North Basin in 2003 (Figure 16), as zinc is easily accumulated in oysters even in the absence of local elevated levels (Strain and Yeats 2002). Dissolved zinc was found in levels greater than the background but less than probable effects level (PEL -probably would cause biological effects) established in international marine water quality guidelines for this element, and thus are potentially harmful (as indicated by the color yellow) (Fig. 16).

Productivity

Nitrate levels in the Bras d'Or Lakes south of Barra Strait are lower than the levels in both St. Andrew's Channel and the North Basin, north of Barra Strait. The North Basin and Barra Strait are effective barriers to nitrate supply from Sydney Bight or from the deep reservoir in St. Andrew's Channel. These concentration differences, combined with estimates of vertical mixing, suggest that the flux of nitrate into the surface layer is 5-10 times greater in the North Basin than in the Bras d'Or Lakes. The higher availability of nitrogen in the North Basin probably makes the total biological production there significantly higher than the Barra Strait (Strain and Yeats 2002, pg. 50).

Oxygen

In general, North Basin sub-watershed is not affected by low oxygen levels. Dissolved oxygen concentrations are within acceptable limits in sediment and water quality guidelines for the protection of animal life. However, concentrations of dissolved oxygen have been found lower from spring to fall as a result of organic decomposition (Strain and Yeats, pg. 52). Metal concentration varies in these regions but is well below the federal sediment and water quality guidelines for the protection of aquatic life. But there appeared to be a higher concentration of dissolved zinc in this area compared to the rest of the Lakes (Appendix 3).

Overall, the quality of the water is very good with respect to heavy metal and organic compound contamination. A concern in this area is Maskell's Harbour. Being shallow and enclosed, the possibility of eutrophication exists resulting in oxygen depletion due to nutrient enrichment from boat sewage.

Impact

There is no impact on the chemical quality of the water in this sub-watershed area primarily because of a lack of industrial and aquaculture activities, and small population size. "The Lakes as a whole should be relatively unaffected by new inputs of nutrients from human activities and are at low risk for eutrophication" (Strain and Yeats 2002, p. 61). Trace amounts of many metals, such as zinc, are required for metabolic processes. However, these same elements at higher concentrations can poison organisms, including humans, and are especially toxic to aquatic micro-organisms. They also bio-accumulate in the food chain (Government of British Columbia 2005).

Response

As chemical water quality is still very good in the Bras d'Or Lakes, there are no additional local management initiatives. There is no long-term monitoring for heavy metals, oxygen, pH, potentially toxic phytoplankton, or organics for these areas by federal, provincial, or First Nations' governments.

In 2003, UINR, in partnership with Environment Canada, initiated an environmental awareness program to educate the public in some of the issues that threaten the Bras d'Or Lakes. Posters and brochures were developed as the means to convey information on protecting the Bras d'Or Lakes, and on different topics such as invasive species, etc. Another project conducted through UINR targeted the youth of Eskasoni (Grades 4 to 12). The project centered on providing information on the source of Eskasoni's drinking water supply, activities that impact the quality of water (forestry, pollution, dumping, recreational activities, etc.), and how to protect it (UINR 2004). A poster contest provided youth with another opportunity to participate by helping to raise community awareness of the importance of maintaining water quality through the protection of water sources. A general approach to protecting water was also presented to the youth of Chapel Island, Wagmatcook, We'koqma'q, and Membertou First Nations.

Sub-Watershed: East Bay

The East Bay sub-watershed is the most populated sub-watershed area in Unama'ki. Located along Route 4 and only a 30-minute drive from the largest city on the Island, the area is popular among those who wish to make this area a permanent home, or for summer fun. Eskasoni is the largest First Nation community in Atlantic Canada. The sub-watershed area lies within Cape Breton County. 77.9 km of shoreline is found in this sub-watershed.

1. Bacteriological Water Quality

Driving Force

The most recent statistics[1] show that the population of Eskasoni is increasing. Over a ten-year period from 1991 to 2001, Eskasoni saw an increase of 535 individuals bringing its total population to 2,741. In the same 10-year period, 265 new dwellings were constructed. In the previous 10-year period from 1981 to 1991, 195 new homes were built. The current number of private dwellings in Eskasoni is 753. It is important to note that, although the total land area of Eskasoni is 35.77 km^2, the majority of the homes lie within a half kilometre of the shoreline. Steeply elevated terrain located on the northern portion of the community restricts residency and sub-division development.

An increase in the number of people and housing can have negative effects on the Lake's ecosystem. The expansion of the community will put greater stress on sewage systems, which in turn can create greater stress on the marine environment. More houses means greater water usage as well. This additional water will be added to the sewage system, thereby placing more stress on the treatment facility.

There are more than a dozen provincial parks and park reserves scattered around the Lakes with many more parks for RVs and camping. Three camping areas can be found in East Bay. Ben Eoin Campground is the largest camping area on the eastern side of Cape Breton Island. The Lakes are also promoted as a destination for boating enthusiasts from around the world.

Pressure

Wastewater from the community of Eskasoni is treated by means of a two-cell sequential batch reactor (SBR) with aerobic digestion and ultraviolet disinfection. The outfall from the treatment plant is submerged approximately 100 m off the north coast of East Bay. The wastewater treatment plant was constructed in 1998 and is operating at a

[1]Statistics Canada 1996 and 2001 Community Profiles available on the worldwide web at http://www12.statcan.ca/english/profil01/PlaceSearchForm1.cfm.

flow rate of approximately 1,363,800 L/day, well under its designed capacity of 5,682,500 L/day. Higher flow rates occur during wet periods due to infiltration of surface water. In addition to the SBR, there is also a single cell facultative lagoon used for emergency overflow purposes. Downstream from the plant are known swimming and shellfish harvesting areas.

The collection system operates with the assistance of eight lift stations that are cleaned on a monthly basis, five of which are considered to be directly affecting water quality (Table 7). Only one of these lift stations is equipped with holding facilities in case of overflow. All lift stations are both fenced and secured with the exception of lift station #2, which is not fenced, and lift station #6, which is neither fenced nor secured. See Appendix 6 for location of lift stations. There is no backup power supply for the lift stations, but with the exception of lift station #1, all are equipped with red-light alarm systems in case of failure/malfunction. Sludge from aerated sludge digestion is pumped and trucked to a disposal site on the reserve. This area is reported to be not secure with residential properties within approximately 300 m. There have also been reports of occasional odour from the plant, and of sewage backups and basements flooding due to line blockages from vandalism at manholes. For the location of the lift stations and the wastewater collection system, see Appendix 6.

Indian and Northern Affairs Canada (INAC) test the effluent quality of the lagoon twice per year. In June 2001, the sample exceeded applicable guidelines for suspended solids, BOD, and fecal coliform bacteria. A sample collected by the operator later in the fall of that year was within the guidelines for all parameters. Effluent is also tested weekly for pH and dissolved oxygen by the operator.

In addition to households connected to the treatment plant, there are 11 homes with on-site septic systems (Table 7). Mainly because of age, many of these systems have been reported as having problems with sewage seeping from the ground every spring. A malfunctioning on-site septic system was reported as responsible for an algae bloom in Amaguadees Pond, Eskasoni in 2001.

No formal emergency plan currently exists, but the community does have some equipment on hand in the event problems occur. The community owns and operates a vacuum truck that can be used in the case of an emergency and as well, confined space entry equipment and personal safety equipment are available on-site. A 2001 site visit to the sewage treatment plant by MGI Limited revealed a lack of emergency spare parts for the system, no operation and maintenance manuals available, and inadequate ventilation in the plant, although there were no chemicals stored on site (MGI 2002b).

The other sub-sector in which there was one sample station that exceeded bacterial limits was the head of East Bay (Table 8). One pipe and a non-point source (such as wildlife) were identified as direct sources of pollution for this sub-sector (Table 9).

The campground in this sub-watershed area is found in Ben Eoin (sub-sector NS-7-040-002; Big Pond) and is perhaps the largest one found along the shores of the Bras d'Or Lakes. The campground offers daily sewage pumping services and deposits the waste into a holding tank. Once full, the tank is pumped out and removed from the premises. No outhouses are found in the campground. The marine side around the park remains open to shellfish harvesting and swimming but the inside waters (MacDougall's Pond) is closed to shellfish harvesting. The area in general was identified as a direct

source of pollution via its septic system and local sanitary sources (MacArthur et al. 2003). Many individuals set up their trailers and RVs in Castle Bay on the sand bar that separates Amagudees Pond from the waters of East Bay. These trailers are all equipped with holding tanks for sewage and are serviced every two days for a small fee. The other popular camping area is at the PowWow grounds along Indian Brook. Camping only occurs for a couple of days per week in the weeks leading to the PowWow (typically at the end of June) and waste from the holding tanks is emptied into manholes.

State

Poor water quality was reported in the waters of and adjacent to Eskasoni (Shellfish Growing Area sub-sector NS-7-040-005), and the Head of East Bay (NS-7-040-004). Levels of bacteriological contamination (fecal coliform) were as high as 1700 MPN/100mL in some areas of Eskasoni, which is common for an area in which treated effluent is discharged. The area has been sampled since the 1970s and last evaluated in 2002. Currently, 2% of the marine waters with the sub-watershed area are closed to shellfish harvesting (Fig. 22). Overall, water quality in Eskasoni has worsened and as a result, the percentage of closed area increased by 50% between 2000 and 2001 (Fig. 23). This is also evident when sample stations were analyzed.

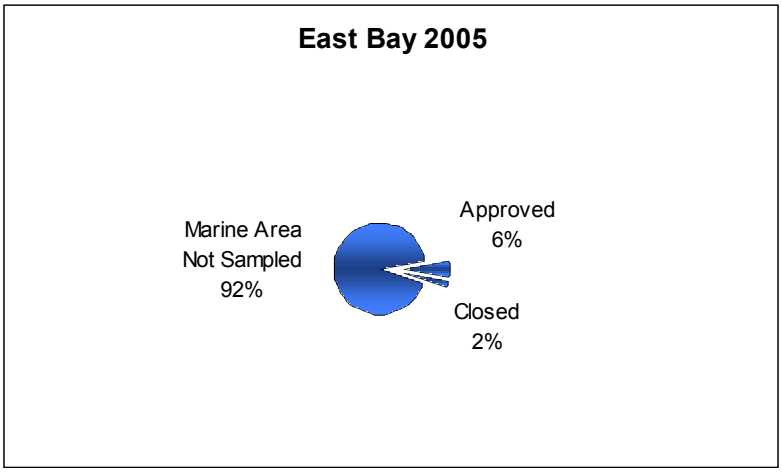


Figure 22. Percentage of marine waters of the East Bay sub-watershed area sampled and classified through the Canadian Shellfish Sanitation Program in 2005.

Table 7. Direct and potential source of pollution found during the Sanitary Shoreline Survey (data compiled from MacArthur et al. 2003).

SUB-WATERSHED: EAST BAY									
	Sub-Sectors	**Irish Cove/MacPherson's Pond NS-7-040-001**	**East Bay/Big Pond NS-7-040-002**	**East Bay/Ben Eoin NS-7-040-003**	**East Bay (Head) NS-7-040-004**	**Eskasoni NS-7-040-005**	**TOTAL**	**%**
STAUS OF SOURCES	Non Pollution Source	34	63	28	94	2	**221**	**47.8%**
	Direct	0	2	1	2	6	**11**	**2.4%**
	Potential	40	61	53	42	34	**230**	**49.8%**
	Total	**74**	**126**	**82**	**138**	**42**	**462**	
DIRECT	Water Sample						**0**	
	Outhouse						**0**	
	Pipe				1		**1**	
	Septic Tank		2				**2**	**18.2%**
	Lift Station					5	**5**	**45.5%**
	Water Course						**0**	
	Wharf						**0**	
	Treatment Plant					1	**1**	**9.1%**
	Agriculture						**0**	
	Non-Point (source that is not set to one location)			1	1		**2**	**18.2%**
	Non-Source						**0**	
	Leaching (leaching type source)						**0**	
	Other (miscellaneous, surface drainage)						**0**	
POTENTIAL	Water Sample	1	1		3	7	**12**	**5.2%**
	Outhouse	5	16	7	4	5	**37**	**16.1%**
	Pipe	4	9	3	13	5	**34**	**14.8%**
	Septic Tank	27	32	42	17	11	**129**	**56.1%**
	Lift Station						**0**	**0.0%**
	Water Course						**0**	**0.0%**
	Wharf	1			2	2	**5**	**2.2%**
	Treatment Plant						**0**	**0.0%**
	Agriculture	2				1	**3**	**1.3%**
	Non-Point (source that is not set to one location)		1	1	2		**4**	**1.7%**
	Non-Source						**0**	**0.0%**
	Leaching (leaching type source)		2		1	1	**4**	**1.7%**
	Other (miscellaneous, surface drainage, marina)					2	**2**	**0.9%**

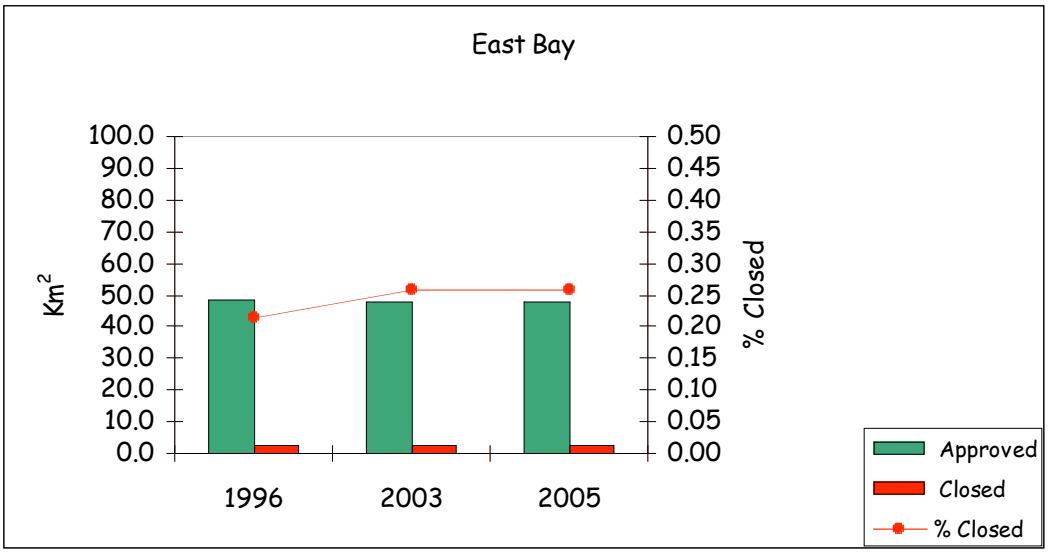


Figure 23. Changes in approved and closed classifications in East Bay (NS-7-040-005). The percent closed/km^2 has been standardized using the area of the Bras d'Or Lakes (1080 km^2).

Table 8. Sample stations in each sub-sector found in the marine waters of East Bay sub-watershed area.

SUB-WATERSHED: EAST BAY

Year	Bacteriological Water Quality at Sampling Stations	Irish Cove/McPherson's Pond NS-7-040-001	East Bay/Big Pond NS-7-040-002	East Bay/Ben Eoin NS-7-040-003	East Bay (Head) NS-7-040-004	Eskasoni NS-7-040-005	TOTAL
1998-1999	Approved	5	8	4	4	16	37
	Exceeded Levels	0	0	0	1	3	4
	Total	5	8	4	5	19	41
2000-2002	Approved	5	8	4	5	17	39
	Exceeded Levels	0	0	0	1	5	6
	Total	5	8	4	6	21	44

The apparent cause for the increase in the number and percent of sample stations in East Bay (Table 7-8) is due to the increase in the number of sample stations that exceeded bacterial limits in the Eskasoni sub-sector (Table 8). Five of the six stations found to exceed bacterial limits were found in the area of Eskasoni First Nation. The remaining station, station 12, was found to have marginal water quality (MacArthur et al. 2003). The station is located in an area of summer cottages that belong to Eskasoni residents, near Goat Island. Other sample stations in other sub-sectors have shown no change between approved or exceeding bacterial limits between these years.

Impact

Concerns regarding fecal coliform densities in the waters adjacent to Eskasoni have caused two areas to be closed to shellfish harvesting. These closures were last evaluated in 2002. The largest of these closed areas is 1.494 km^2 extending along the shoreline of the community (Figure 24). This closure has been in place since the 1970s and was expanded in 2001. There is also a small closure (0.033km^2) in Crane Cove, which was implemented sometime in 1990 as a precautionary closure because of the presence of a problematic lift station in the area (Craig et al. 1999). Overflow from rain overwhelms the system causing the excess to be drained into Crane Cove. Poor water quality is found here. For further information on Eskasoni's sewage treatment facility, refer to Appendix 6.

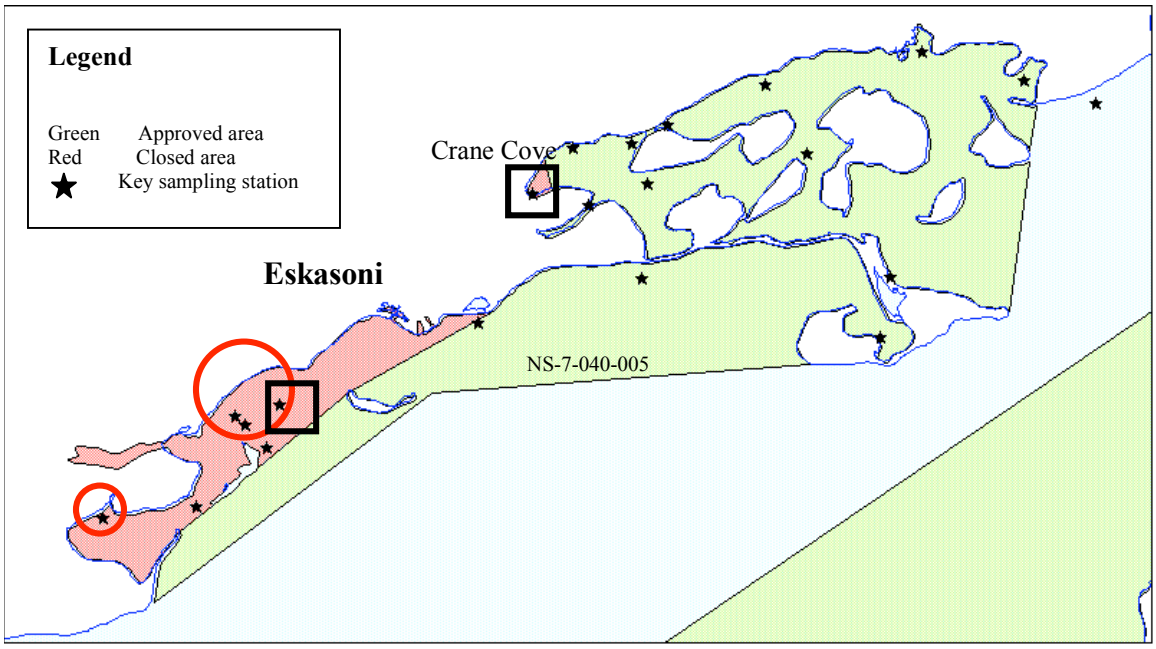


Figure 24. Eskasoni First Nation (Shellfish Growing Area Sub-sector NS-7-040-005). Red circles indicate stations with poor water quality; black squares show stations that previously met approved criteria but now exceed bacterial limits (also poor water quality).

There have been a number of substantiated and anecdotal reports of algae blooms occurring around the Lakes, many at popular swimming locations. Algae blooms are often an indication of excess nutrients, such as phosphorous and nitrogen that are found in waste products. However, the only beach on the Bras d'Or Lakes that is regularly sampled and tested for fecal coliform bacteria is the supervised beach in the Baddeck area. Reports of illness and high fecal coliform densities in the East Bay, Big Pond, and Ben Eoin area resulted in temporary summer closures to popular swimming beaches during 1993-1995. Beach closures also occurred in 2000 at beaches in Eskasoni.

Response

As chemical water quality is still very good in the Bras d'Or Lakes, there are no additional local management initiatives. Since 1999 Environment Canada and Eskasoni Fish & Wildlife Commission Inc. have mapped potential fecal coliform bacteria pollution sources all around the Bras d'Or Lakes, barachois ponds, and connecting bodies of water. There is no long-term monitoring in place for heavy metals, oxygen, pH, potentially toxic phytoplankton, or organics for these areas by federal, provincial or First Nations governments.

In 2003, UINR, in partnership with Environment Canada, initiated an environmental awareness program to educate the public in some of the issues that threaten the Bras d'Or Lakes. Posters and brochures were developed as the means to convey information on protecting the Bras d'Or Lakes from invasive species, etc. Another project conducted through UINR was targeted to the youth of Eskasoni (Grades 4 to 12). The project centered on providing information on the source of Eskasoni's drinking water supply, activities that impact the quality of water (forestry, pollution, dumping, recreational activities, etc.), and how to protect it (UINR 2004). A poster contest also provided the youth with another opportunity to participate in increasing community awareness for source protection and general water. A general approach to protecting water was given to the youth of Chapel Island, Wagmatcook, We'koqma'q and Membertou First Nations.

II. Chemical Water Quality

Driving Force

Chemical water quality is primarily affected through local industrial activities but other sources that may contribute pollution are leakage from landfill sites and dumps, and illegal or unauthorized dumping of wastes in the watershed area. Chemicals from fertilizers are known to contribute phosphorous and nitrates to the watershed through run-off during precipitation events.

Pressure

There is one animal farm in this sub-watershed. Two non-point sources of pollution (typically wildlife) were identified in the Sanitary Shoreline Survey for this area (Table 7).

One medical clinic is located on the shores of the Bras d'Or Lakes in Eskasoni with effluent treated through the community sewage treatment plant. Wastes, medications, potent cleaners, and other substances are likely dissolved in the effluent.

Eskasoni First Nation has experienced problems with dumping of household wastes such as fridges and stoves, automobile and oil-based waste products in and around streams, such as Indian Brook. This type of waste has been documented in the streams that supply the community with its drinking water (UINR 2005).

State

Organic Compounds and Heavy Metals

Lead in sediments has been found in East Bay near Eskasoni in one sample collected in 2003, and classified as probably harmful according to international marine water quality guidelines for this element (red; Bedford Institute of Oceanography Containment Data Base, Yeats pers. comm. 2005). Possibly harmful levels of copper and zinc were found outside of Eskasoni (yellow; Bedford Institute of Oceanography Containment Data Base, Yeats pers. comm. 2005).

Methyl mercury, lead, and arsenic have been detected in fish samples in 2002-2004 but were well below guidelines established under the Canadian Food Inspection Agency (Denny and Berubé 2003).

Productivity

Problems with algae blooms occurred in Amaguadees Pond, Eskasoni as a result of sewage input. Potentially toxic phytoplankton has been found in the area of Eskasoni, although no reports of outbreaks from shellfish poisoning–such as diarrheic shellfish poisoning (DSP), amnesic shellfish poisoning (ASP) or paralytic shellfish poisoning (PSP)–have occurred to date. Thirty-seven species of phytoplankton have been identified in 12 sample sites located in the areas of Chapel Island, Eskasoni, We'koqma'q, Wagmatcook, and Malagawatch First Nations, and the seed collection area of Gillis Cove in River Denys Basin. The species identified have been classified into one of three categories: potentially toxic (species that produce toxins), harmful (linked to fish or shellfish kills and harmful to marine animals and bird) and other species (identified but not known to cause harm) (McIsaac et al. 2003). Four of the eight species identified as potentially toxic were found in Eskasoni's Crane Cove. A list of species identified is found in Appendix 5.

Oxygen

Dissolved oxygen concentrations are within acceptable limits of sediment and water quality guidelines for the protection of animal life. There is limited information on water quality in barachois ponds but we can expect these areas in particular to suffer from eutrophication, especially where there is established summer residency and little exchange of water with the main body of the Lakes. In particular, Amaguadees Pond experiences problems with anoxic conditions caused by algal blooms.

Overall, the quality of the water is very good with respect to heavy metal and organic compound contamination, but poor in nutrients and primary productivity for the Bras d'Or Lakes. The numerous barachois ponds located around the sub-watershed area are more likely to experience either enriched nutrient content from high bacteriological

contamination, or limited and slow exchange with the main body of the Lakes, or both and, as a result, suffer the biological consequences of eutrophication.

Impact

There is little impact on the quality of the water in the Bras d'Or Lakes primarily due to low industrial and aquaculture activities and small population size. "The Lakes as a whole should be relatively unaffected by new inputs of nutrients from human activities and are at low risk for eutrophication" (Strain and Yeats 2002, p. 61).

Under the right conditions, increases in phosphorous to a localized environment, can cause large increases in algae, blue-green algae (cyanobacteria), and bacterial production. Combined with a lack or limited exchange between the air and other oxygen-rich waters, the area can become eutrophic and oxygen depleted. Other effects are reduction in light transmission as a result of overproduction of algae, increase in detritus (dead organic matter) settling in the sediment, strong hydrogen sulphide odours, and mass mortalities of fish and invertebrates, making the water unsuitable for recreation, aquaculture, or fishing (Brönmark and Hansson 1998). Amaguadees Pond in Eskasoni suffered from eutrophication in 2001 and, because of the odour, families who lived in the immediate area were temporarily re-located to hotels in Sydney.

Response

As chemical water quality is still very good in the Bras d'Or Lakes, there are no additional local management initiatives. Since 1999 Environment Canada and Eskasoni Fish & Wildlife Commission Inc. have mapped potential fecal coliform bacteria pollution sources all around the Bras d'Or Lakes, barachois ponds, and connecting bodies of water. There is no long-term monitoring in place for heavy metals, oxygen, pH, potentially toxic phytoplankton, or organics for these areas by federal, provincial, or First Nations' governments.

In 2003, UINR, in partnership with Environment Canada, initiated an environmental awareness program to educate the public in some of the issues that threaten the Bras d'Or Lakes. Posters and brochures were developed as the means to convey information on protecting the Bras d'Or Lakes from invasive species, etc. Another project conducted through UINR was targeted to the youth of Eskasoni (Grades 4 to 12). The project centered on providing information on the source of Eskasoni's drinking water supply, activities that impact the quality of water (forestry, pollution, dumping, recreational activities, etc.), and how to protect it (UINR 2004). A poster contest also provided youth with the opportunity to increase community awareness about source protection and general water quality. A general approach to protecting water was given to the youth of Chapel Island, Wagmatcook, We'koqma'q, and Membertou First Nations.

Sub-Watershed: St. Peter's Inlet

St. Peter's Inlet is characterized by numerous small coves, bays, and inlets. A man-made canal constructed in 1869 has made it a convenient and popular entrance to the Bras d'Or Lakes from the Atlantic Ocean and is the only southern point for vessel traffic entering and/or exiting the Bras d'Or Lakes. Small commercial vessels, fishing boats, and sailboats use this entrance. Potlotek (Chapel Island) First Nation is found in this sub-watershed area. It is the smallest of the First Nation communities in Unama'ki. Population was noted to be 310 in 1988 (Menon and Machell, 1988). St. Peter's is one of the two largest non-First Nation communities on the Bras d'Or Lakes is a popular tourist destination. This sub-watershed area lies within Richmond County boundaries. 69.5 km of shoreline is found in this sub-watershed.

1. Bacteriological Water Quality

Driving Force

Potlotek is a small First Nation community. Statistical data on the community is lacking[2]. However, some data are available indicating that like many First Nation communities, Potlotek is increasing in population. In the decade from 1991 to 2001, the population grew from 128 to 419 individuals. The growth rate on the reserve is just over 5% annually with a projected population of 1,070 by 2018 (ADI Limited 1999). Again, the population increase is reflected in an increase in housing. In fact, the number of dwellings has more than tripled from 1981 to 2001. Prior to 1981 there were 35 units built. From 1981 to 1991, 20 dwellings were constructed and, in the following decade, 65 more were built for a total of 120.

Potlotek receives a high number of seasonal visitors (upwards of 2,000) in a very short period of time. In late July, a religious Mission takes place for five days on one of the islands owned by the community (Chapel Island), but the Island is known to have occupants for the entire month leading to the Mission. It also hosts occasional campers in May during Pentecost Sunday weekend. The Island (known as "Miniku") has outhouses and portable toilets for waste disposal. Individuals dump their port-a-potties in outhouses or take them to adjacent islands for disposal. In the past, it was observed that portable toilets were dumped directly outside of cabins but this has since changed. It was also noted that some were directly disposing their RVs wastes into the Bras d'Or Lakes. Numerous motor homes and trailers can be found on the mainland side of Potlotek in June and July prior to the Mission.

[2]Data quality index showing, for the short census questionnaire (100% data), a global non-response rate higher than or equal to 5% but lower than 10%. Statistics Canada, 2001 Community Profile.

Pressure

A conclusion made in a 2002 MGI study of water and wastewater systems in Potlotek provides a good summary of pressures in the community.

> *"The community is at risk from poor quality effluent discharging to a low flow brook near the community water supply and from raw sewage overflows due to the lack of spare parts, prompt maintenance and the lack of plans for the management of failures. The four homes with private water systems are at high risk of bacterial impacts from the on-site septic systems."* (MGI Limited 2002a, pg.9)

Wastewater from the community of Potlotek is collected in a central sewage treatment facility that consists of a two-cell facultative lagoon with chlorination disinfection. The current lagoon was constructed in 1985. The lagoon outfall is not submerged and is discharged into a low-flow brook that connects Indian Lake (the community's potable water supply) with Robertson Cove in the Bras d'Or Lakes. Neither the capacity nor the retention time of the lagoon is known. Discharge occurs twice per year with disinfection taking place at the chlorination contact chamber. These discharge events are typically planned for late fall and spring when water levels in the receiving brook are highest to allow for good dilution.

The collection system operates with the aid of three lift stations that are cleaned at two-month intervals. Sewage backups have been reported at the lift stations due to power outages or pump malfunctions. There is no back-up power supply for these lift stations; however, stations #1 and #3 are equipped with red-light alarms for failure/malfunction notification. In an overflow situation, lift station #1 will overflow directly into the community water supply at Indian Lake. Lift station #2 is reported to have recurring problems with its pump causing overflows into the same low-flow brook leading to Robertson Cove. There are also five homes in the community with private septic systems. Reported malfunctions in these systems have the potential to affect the nearby Indian Lake water supply, as well as the Bras d'Or Lakes. For the location of the lift stations and the wastewater collection system, see Appendix 6.

The Department of Indian and Northern Affairs (INAC) typically tests the effluent, however, no samples have been collected since November 2000. The lagoon effluent is reported to periodically exceed the guidelines for effluent quality and it is not known if the retention time for the lagoon or the chlorination system is adequate for seasonal discharges.

Additional problems with the wastewater system, identified by MGI Limited during a 2001 site visit, include; excessive weed growth at the sewage lagoon, high vegetation and rodent problems at the chlorination chamber, no formal emergency response plan, no personal safety or confined spaces equipment on site, limited spare parts on hand for wastewater treatment and collection systems, and a lack of ventilation in chemical storage area.

During the annual St. Anne's Mission, hundreds of people use the few sanitary facilities on the Island. Earth pit privies are used on the Island while chemical toilets are provided on the mainland. Due to the low elevation on the Island and, the presumably near-surface groundwater table, the function of the pit privies would be constrained. Storm and groundwater drainage are likely to carry human wastes and other contaminants

to the surrounding Bras d'Or Lakes presenting significant potential for impact on water quality.

St. Peter's is also a popular tourist destination, receiving upwards of 17,000 visitors per year[3]. Because St. Peter's hosts one of the three entrances into the Lakes, it experiences a large number of visitors from boat traffic. Parks Canada reports approximately 625 boats passing through the St. Peter's Canal annually.

There are four anchorage areas and one marina identified in this sub-watershed area. There are currently five locations scattered throughout the Bras d'Or Lakes that offer facilities for pumping sewage from boats. In 2002, the number of pump-outs reported by marina operators was highest for St. Peter's compared with other reports–22 at the Barra Strait Marina, 7 at Cape Breton Boat Yard, 50 at the Baddeck Marina, 4 at the Dundee Marina, and 62 at Wallace MacAskill Marina in St. Peter's. St. Peter's Marina's new pumping station equipment is reported to have a life span of 15-20 years. Many people feel the number and distribution of these pump-out stations is inadequate to service the boating community of the Bras d'Or Lakes. However, others argue that the use of the current facilities does not warrant the construction of new facilities. It is important to note that the pump-out stations are limited to use by small crafts. Larger vessels are unable to dock at these locations because of inadequate water depth.

A number of camping facilities and trailer parks exist around the Lakes. Some of these facilities use package treatment systems before discharging into the Bras d'Or Lakes or waters flowing into the Lakes.

Lift stations accounted for 75% of the direct sources of pollution identified. Potential sources of pollution are septic tanks (Table 9).

State

Poor water quality is reported in the area. 4% of the marine waters within the sub-watershed area are closed to shellfish harvesting (Fig. 25).
Poor water quality is reported in two coves adjacent to the Potlotek First Nations community. Only one cove (Robertson's Cove) is adjacent to First Nations' land. Levels of bacteriological contamination (fecal coliform densities, to be more precise) were as high as 540 MPN/100mL in some areas. This area was last evaluated in 2002. Land belonging to Potlotek is divided into sub-sectors 030-004 and 030-005.

[3] Nova Scotia Tourism and Culture. "2000 Nova Scotia Traffic Flow Report" February 2002. Available at http://www.nstpc.com/docs/Traffic_Flow_Report.pdf. Figure based on total party trips minus party pass through or the sum of party stops, party visits and overnight party trips.

Table 9. Potential and direct sources of pollution found in St. Peter's Inlet sub-watershed area during the Sanitary Shoreline Survey. Data was compiled using MacArthur et al. 2003.

		SUB-WATERSHED: ST. PETER'S INLET				
	Sub-Sectors	St. Peter's Inlet/Chapel Island NS-07-030-004	St. Peter's Inlet/St. Peter's NS-07-030-005	Hay Cove/Red Islands NS-07-030-006	TOTAL	%
STAUS OF SOURCES	Non Pollution Source	5	12	4	**21**	**10.1%**
	Direct	6	2	0	**8**	**3.9%**
	Potential	50	82	46	**178**	**86.0%**
	Total	**61**	**96**	**50**	**207**	
DIRECT	Water Sample				**0**	
	Outhouse	1			**1**	**12.5%**
	Pipe				**0**	
	Septic Tank				**0**	
	Lift Station	4	2		**6**	**75.0%**
	Water Course				**0**	
	Wharf				**0**	
	Treatment Plant	1			**1**	**12.5%**
	Agriculture				**0**	
	Non-Point (source that is not set to one location)				**0**	
	Non-Source				**0**	
	Leaching (leaching type source)				**0**	
	Other (miscellaneous, surface drainage)				**0**	
POTENTIAL	Water Sample	21			**21**	**11.8%**
	Outhouse	2	3	2	**7**	**3.4%**
	Pipe		1		**1**	**0.6%**
	Septic Tank	23	70	44	**137**	**77.0%**
	Lift Station				**0**	
	Water Course	1	1		**2**	**1.1%**
	Wharf	2	4		**6**	**3.4%**
	Treatment Plant				**0**	**0.0%**
	Agriculture				**0**	
	Non-Point (source that is not set to one location)		1		**1**	**0.6%**
	Non-Source		1		**1**	**0.6%**
	Leaching (leaching type source)				**0**	
	Other (miscellaneous, surface drainage, marina)	1	1		**2**	**1.1%**

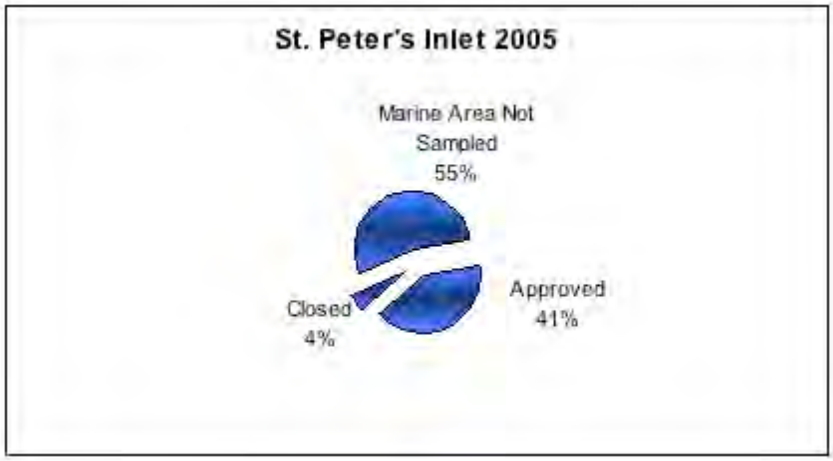


Figure 25. Percent of marine area approved, closed and not sampled in St. Peter's Inlet sub-watershed area.

A report in 2002 by MGI Limited observed an algal bloom in a low-flow brook that carries wastewater from the community sewage lagoon to the Bras d'Or Lakes. This algal bloom was reported to be backing upstream into the community's potable water supply at Indian Lake. Currently, this area has two closures that were implemented in 2003 due to degradation of water quality to "marginal" as listed in the Environment Canada Shellfish Classification report (MacArthur et al. 2003). The report recommended that this area be kept under observation.

From 1967 to the 1980s, water quality in and around St. Peter's was considered quite good and there were no closures implemented. In 1989, shellfish closures were established in two coves near Handleys Island. These coves were closed due to observed problems with a lift station and several on-site septic systems in the vicinity. In 1993, an additional closure was implemented in Carters Cove, and most of the remaining portion of the sub-sector was classified as conditional when recent water quality testing showed significantly higher bacterial counts following considerable rainfall events.

The number of sample stations that exceeded bacterial limits also increased for this area between 1998-1999 and 2000-2002 (Fig. 10). The increase in sample stations that exceeded bacterial levels occurred in Chapel Island (NS-7-030-004; Table 10) but the changes in water quality at the sample stations occurred in Soldier's Cove and MacNab's Cove. Both are rural areas with no central sewage collection. The other increase in the number of sample stations with water quality that exceeded bacterial limits occurred in the Hay Cove/Red Islands area. Station 6 had acceptable water quality in 1998-1999 but samples taken in 2002 showed it to have deteriorated. As it was already located within an existing shellfish closure, no changes in classification status were made (MacArthur et al. 2003). Five stations that met approved criteria in 1998-1999 now exceed bacterial limits (Fig. 12).

Changes in sample station data is also reflected in the increase in shellfish closures for St. Peter's Inlet (Fig. 26), however, there has only been an increase of 0.3 km^2 between 1996 and 2003 but an increase of 1 km^2 between 2003 and 2005. The

evaluation reports from Environment Canada are not yet available for 2003–2005 to determine the number and location of sample station data with poor water quality and to compare between evaluation years.

Table 10. Sample stations in each sub-sector found in the marine waters of St. Peter's Inlet sub-watershed area.

SUB-WATERSHED: ST. PETER'S INLET

Year	Bacteriological Water Quality at Sampling Stations	St. Peter's Inlet/Chapel Island NS-07-030-004	St. Peter's Inlet/St. Peter's NS-07-030-005	Hay Cove/Red Islands NS-07-030-006	TOTAL
1998-1999	Approved	12	14	6	32
	Exceeded Levels	0	2	5	7
	Total	12	16	11	39
2000-2002	Approved	10	17	5	32
	Exceeded Levels	2	3	6	11
	Total	12	20*	11	43

* No data for one station

Overall, there has been a decrease in water quality for this area (Figure 26). Recent changes (<5 years) have occurred in the rural areas of Soldier's Cove, MacNab's Cove, and Hay Cove (sub-sector 030-004) as a result of five sample stations found to exceed bacterial limits (based on data in MacArthur et al. 2003; Table 10).

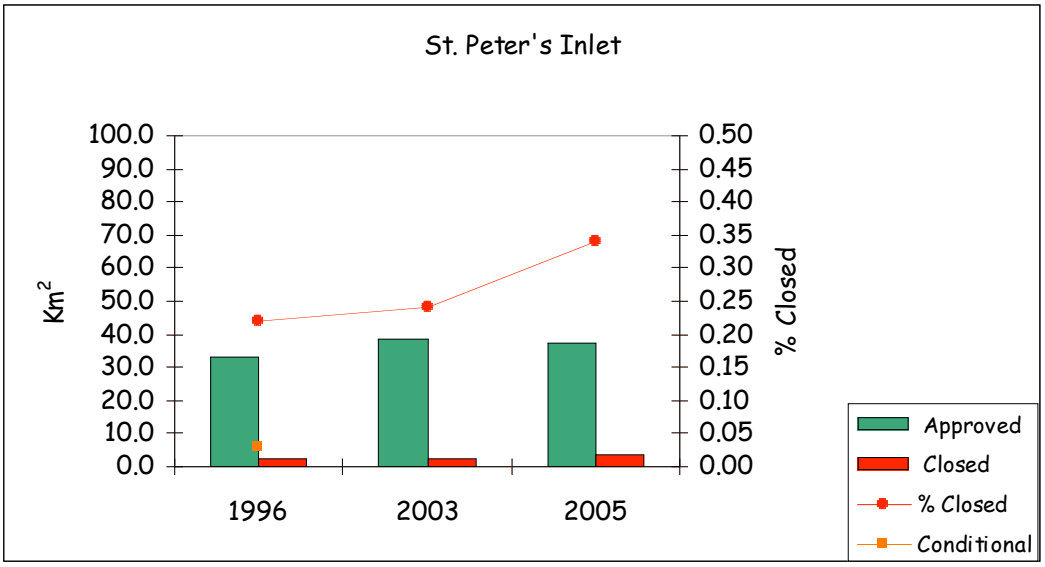


Figure 26. Changes in shellfish classification in St. Peter's Inlet between 1996 and 2005. Percent closed was standarized using the Lakes' area of 1,080 km^2.

Impact

St. Peter's Inlet had 11 closures totalling 3.68 km^2 in 2005. Within St. Peter's Inlet, there are seven coves that are closed to shellfish harvesting but only three of these have sample stations that exceeded bacterial limits in 2002, one of which includes Robertson's Cove (MacArthur et al. 2003; Figure 27-27). Two new closures were implemented after the 2002-2003 evaluation in Soldier's Cove and MacNab's Cove where poor water quality was found at two stations (Fig. 27). The remaining two closures in this sub-watershed area are also a result of poor water quality.

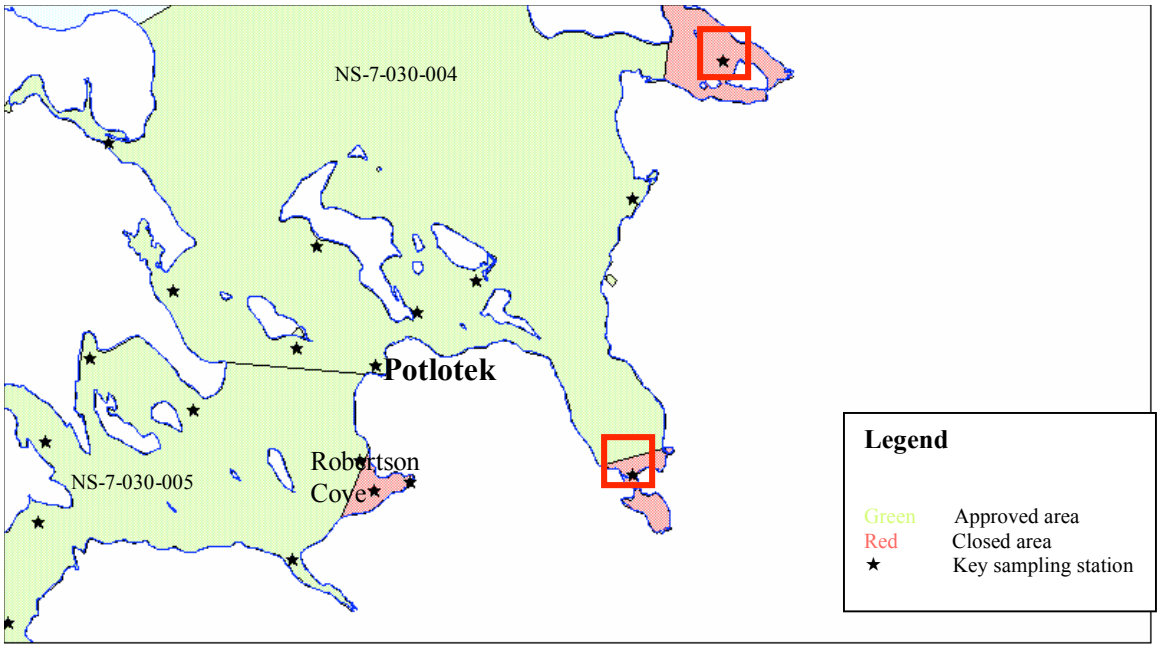


Figure 27. Chapel Island First Nation (Shellfish Growing Areas 7-030-004 and 7-030-005). Red circles indicate sample stations that have poor water quality in 1998-1999; Red squares show stations that previously met approved criteria but now exceed bacterial limits (also poor water quality); black squares indicate sample stations added that exceeded bacterial limits (also poor water quality).

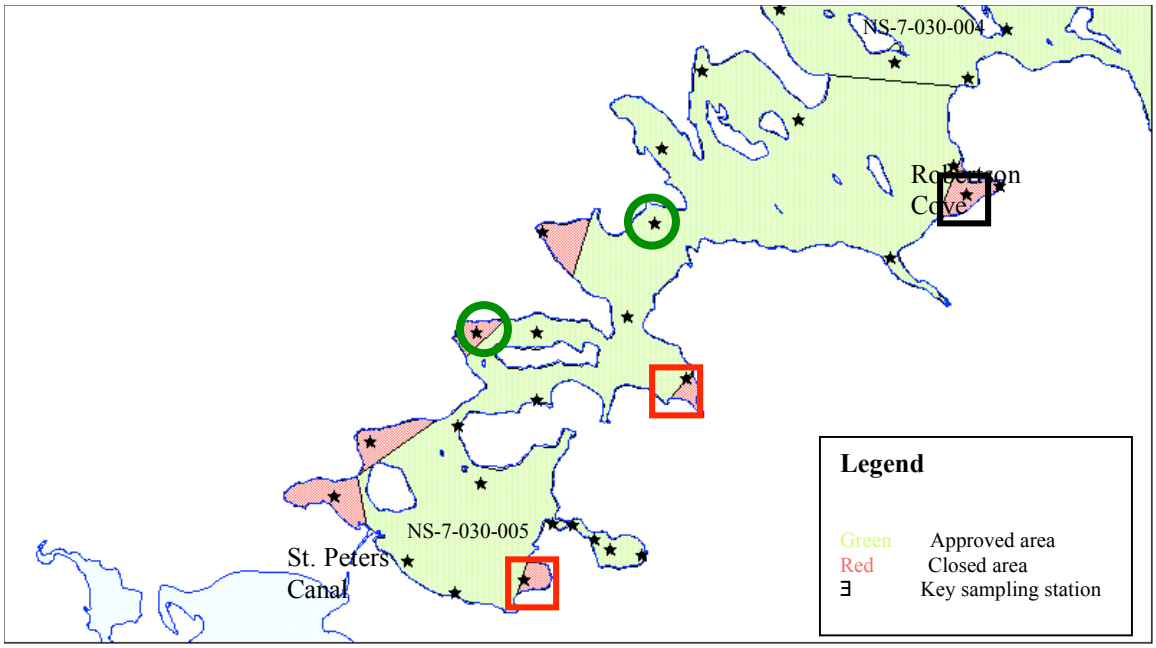


Figure 28. Closures and sample station locations in St. Peter's/St. Peter's Inlet. Red circles indicate sample stations that have poor water quality in 1998-1999; red squares show stations that previously met approved criteria but now exceed bacterial limits (also poor water quality); black squares indicate sample stations added that exceeded bacterial limits (also poor water quality). Green circles indicate stations that have exceeded bacterial limits but now meet approved criteria.

Response

Throughout the years there have been attempts to connect as many houses as possible to the central system in Potlotek. In 1997, Backlands Road and the new school were connected to the central system and, in 1999, Mountain Road was connected. Training is kept current. The primary plant operator received system specific training from INAC as well as Level 1 training (not certification) from the Atlantic Canada Water Works Association. A back-up operator is also in place and received on-the-job training from the primary operator.

Potlotek has also responded to concerns around the St. Anne's Mission by providing port-a-potties on the mainland during the Mission, as well as constructing three 2,728 L concrete holding tanks for campers. Facilities on the Island, however, remain poor and there are reports that campers feel the three holding tanks are poorly located and should be spread out rather than grouped in one area. There are also many trailers on the mainland side of Chapel Island. These are serviced with a vacuum truck for waste removal. Education awareness brochures describing the ill effects of dumping sewage directly into the Bras d'Or Lakes have been produced and distributed at the annual event. The Unama'ki Institute of Natural Resource Officers, Department of Environment, Fisheries and Oceans, and Department of Natural Resources conduct joint patrols of the area during the St. Anne's Mission weekend. Potlotek is in the process of developing the

mainland side as a camping/trailer park with sewer hook-up, electricity and running water. The trailer park will be completed before the Annual Mission in 2006.

Beginning in 1998, the Town of St. Peters carried out a series of improvements to the sewage collection and treatment system. In 2001, following sampling conducted during 1999 and 2000 to determine the effectiveness of these improvements, the conditional area was upgraded to approved status. One of the existing five closures was also removed. Three small closures were implemented in coves still affected by rainfall events. Water quality and sanitary conditions have improved within this sub sector compared with the early '90s, and the upgraded shellfish classification reflects this overall trend. (Figure 7).

The marine pump-out station located in St. Peter's was installed in 2000 and, in 2002, $1.2 million was spent to upgrade the existing treatment plant. However, as the effluent is discharged into the adjacent Atlantic Ocean rather than the Bras d'Or Lakes, improvements made to the treatment plant do not necessarily mean that there will be a positive impact on the Bras d'Or Lakes. It is unknown whether improvements were made to the lift stations that are found along the Bras d'Or Lakes.

II. Chemical Water Quality

Driving Force

Chemical water quality is primarily impacted through local industrial activities but other sources that may contribute pollution are leakage from landfill sites and dumps, and illegal or unauthorized dumping of wastes in the watershed area. Chemicals from fertilizers are known to contribute phosphorous and nitrates to the watershed through run-off during precipitation events.

Finfish aquaculture in the Bras d'Or Lakes was popular in the 1990s with fish cage systems established in St. Peter's Inlet but is no longer in operation as of 2003-2004. Concern for the environmental impact of finfish aquaculture on water quality is no longer a challenge as a result of the closure of all finfish sites, however, long-term or residual effects of anti-fouling chemicals and antibiotics from feed may still be a concern in these areas.

St. Peter's is the throughway to the Bras d'Or Lakes for small crafts, especially for those coming from southern areas.

Pressure

There are a few produce farms located in the Bras d'Or Lakes watershed and current information on the type of agriculture taking place is limited but produce farms are restricted to lands around the Skye, Middle and Baddeck Rivers, all of which are major contributors of freshwater to the Bras d'Or Lakes. Most of the arable soil within the watershed is inside forestry reserves or used for farming. The opportunities for expanding agriculture are limited by the lack of quality soil (UMA 1989).

Several medical clinics are hooked up to the central sewage collection system that ultimately empties into the waters of the Bras d'Or Lakes with effluent treated through

the municipal sewage system. Wastes, medications, potent cleaners, and other substances are likely dissolved in the effluent.

Generally, First Nations have experienced problems with dumping of household items such as fridges and stoves), automobile and oil-based waste products in the watershed area. It is undetermined whether Potlotek has these dump sites and whether they exist in other rural areas.

Estimates show that 625 vessels entering St. Peter's Canal annually.

State

Organic Compounds and Heavy Metals

Methyl mercury, lead, and arsenic have been detected in fish samples collected around Potlotek in 2002-2003 but were well below guidelines established under the Canadian Food Inspection Agency (Denny and Berubé 2003). Samples taken in 2004 by UINR from sediment, water, and traditional marine foods are being analyzed for metals and organic compounds. There is limited sampling for heavy metals and organic compounds to determine marine environmental quality around the southern portion of the Bras d'Or Lakes.

Productivity

The productivity of the Bras d'Or Lakes has been described as low, supporting a relatively low level of natural productivity (Strain and Yeats 2002). Potentially toxic phytoplankton has been found in the area of Chapel Island although no reports of outbreaks from shellfish poisoning–such as diarrhetic shellfish poisoning (DSP), amnesic shellfish poisoning (ASP) or paralytic shellfish poisoning (PSP)–have occurred to date. All sampling sites had at least four of the potentially toxic algae identified in the Bras d'Or Lakes, although in differing quantities. A list of species identified is found in Appendix 5.

Oxygen

St. Peter's Inlet sub-watershed is generally not affected by low oxygen levels. Metal concentrations vary in these regions but are well below the federal sediment and water quality guidelines for the protection of aquatic life (Appendices 3 & 4). There is limited information on water quality in barachois ponds but we can expect these areas in particular to suffer from eutrophication, especially where there is established summer residency and little exchange of water with the main body of the Lakes.

Overall, the quality of the water is very good with respect to heavy metal and organic compound contamination. The area of St. Peter's Inlet and numerous barachois ponds located around the Lakes are more likely to experience enriched nutrient content from high bacteriological contamination, limited and slow exchange with the main body of the Lakes, or both and, as a result, suffer the biological consequences of eutrophication.

Impact

There is no impact on the chemical quality of the water in this sub-watershed area primarily due to no industrial or aquaculture activities, and small population size. “The Lakes as a whole should be relatively unaffected by new inputs of nutrients from human activities and are at low risk for eutrophication” (Strain and Yeats 2002, p. 61). Many metals, found in trace amounts, such as zinc, are required for biological processes. Those metals found in greater levels have the effect of poisoning organisms (including humans), are especially toxic to aquatic micro-organisms, and bio-accumulates in the food chain (Government of British Columbia 2005).

Response

As chemical water quality is still very good in the Bras d'Or Lakes, there are no additional local management initiatives. Since 1999, Environment Canada and Eskasoni Fish & Wildlife Commission Inc. have mapped potential fecal coliform bacteria pollution sources around the Bras d'Or Lakes, barachois ponds, and connecting bodies of water. There is no long-term monitoring in place for heavy metals, oxygen, pH, potentially toxic phytoplankton, or organics for these areas by federal, provincial, or First Nations’ governments.

In 2003, UINR, in partnership with Environment Canada, initiated an environmental awareness program to educate the public in some of the issues that threaten the Bras d'Or Lakes. Posters and brochures were developed as the means to convey information on protecting the Bras d'Or Lakes from invasive species, etc. Another project conducted through UINR was targeted to the youth of Eskasoni (Grades 4 to 12). The project centered on providing information on the source of Eskasoni’s drinking water supply, activities that impact the quality of water (forestry, pollution, dumping, recreational activities, etc.), and how to protect it (UINR 2004). A poster contest provided the youth with an opportunity to increase community awareness of source protection and general water quality within the community. A general approach to protecting water was to the youth of Chapel Island, Wagmatcook, We’koqma’q, and Membertou First Nations.

Sub-Watershed: West Bay

West Bay is the widest bay in the Bras d'Or Lakes, stretching 18 km across its widest point. The majority of the sub-watershed area is within 10 km of the shoreline. 51.4 km of Bras d'Or Lakes shoreline is found within this sub-watershed area. The sub-watershed area is shared between Inverness and Richmond Counties.

1. Bacteriological Water Quality

Driving Force

Dundee Resort and Golf Club is the largest resort on the shores of the Bars d'Or Lakes. The resort offers recreational activities such as golf, water sports, swimming, tennis, in addition to fine dining and accommodations. There is also a marina located along the shore of Dundee (Dundee Marine). The rural setting of West Bay is removed from the main highways that lead into the larger towns and this may be why it is still undeveloped compared with other equally beautiful areas found around the Bras d'Or Lakes. Animal farming is found in this area.

Pressure

Very few direct sources of pollution are found here but animal farming is one identifiable source (Table 11). Fox, mink and horse farms can be found in the head of West Bay with a horse farm located in Pringle's Harbour. One outflow pipe in Pringle's Harbour was identified as a direct source of pollution but drains into a ditch rather than a stream and was not directly impacting the bacteriological quality of the water (Craig et al. 2002). Potential sources of pollution are septic systems in the area (Table 11).

Scattered throughout the Bras d'Or Lakes are five facilities for pumping sewage from boats, one of which is found in this sub-watershed. Many feel the number and distribution of these pump-out stations is inadequate to service the boating community of the Bras d'Or Lakes. However, others argue that the use of the current facilities does not warrant the construction of new facilities. The Dundee Marine pump-out station operates on an on-site system, which is reported to be slow and in need of upgrades. In comparison to other pump-out stations, Dundee reported only four pump outs in 2002, while other stations such as the Barra Strait Marina reported 22; Cape Breton Boat Yard, 7; Baddeck Marina, 50, and 62 at Wallace MacAskill Marina in St. Peter's. It is important to note that the pump-out stations are limited to use by small crafts. Larger vessels are unable to dock at these locations due to the water depth. The marina at Dundee reported that, in addition to the 30 permanent boats moored there, it received 360 to 450 transient boat visits throughout the season, 50% of which where local.

The Dundee Resort and Golf Club is renowned for its impeccably kept fairways. Fertilizers, herbicides, and pesticides are likely entering the Bras d'Or Lakes during times of heavy rainfall.

State

A large percent of the marine waters for this sub-watershed area is sampled (68%) with only 1% closed to shellfish harvesting (Fig. 29). Poor water quality is reported in this region. In particular, changes (>5 years) occurring in West Bay Head (7-020-015) are evident in the increase in number of sample stations with water quality that exceeded bacterial limits (Table 12). The increase in number of sample stations with poor water quality resulted in the implementation of a new closure between MacIntosh Point and Kuliks Point. This change is also reflected in the increase in closed area between 2000 and 2002 (Fig. 30).

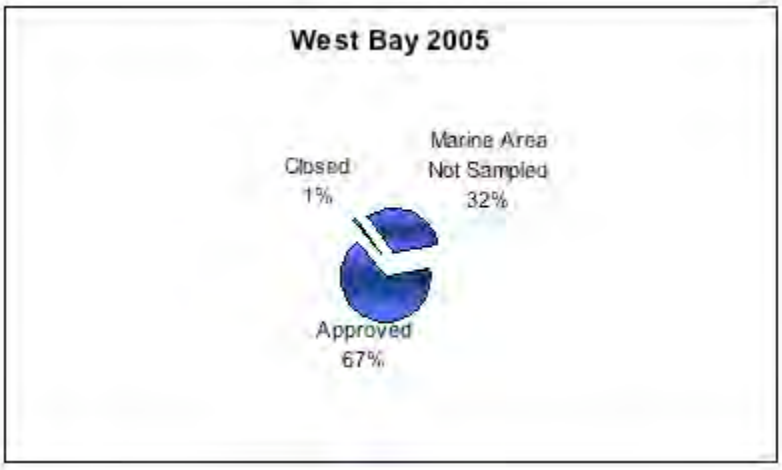


Figure 29. Percent of marine area approved, closed, and not sampled in West Bay sub-watershed area.

Table 11. Sample stations in each sub-sector found in the marine waters West Bay.

	Sub-Sectors	SUB-WATERSHED: WEST BAY McKinnon's Cove/ Marble Mountain NS-7-020-014	West Bay (Head) NS-7-020-015	West Bay/ Dundee NS-7-030-001	West Bay/ Pringle Harbour NS-7-030-002	TOTAL	%
STAUS OF SOURCES	Non Pollution Source	11	11	33	10	**65**	**30.7%**
	Direct	0	2	0	1	**3**	**1.4%**
	Potential	23	73	34	14	**144**	**67.9%**
	Total	**34**	**86**	**67**	**25**	**212**	
DIRECT	Water Sample					**0**	
	Outhouse					**0**	
	Pipe				1	**1**	**33.3%**
	Septic Tank					**0**	
	Lift Station					**0**	
	Water Course					**0**	
	Wharf					**0**	
	Treatment Plant					**0**	
	Agriculture					**0**	
	Non-Point (source that is not set to one location)		2			**2**	**66.7%**
	Non-Source					**0**	
	Leaching (leaching type source)					**0**	
	Other (miscellaneous, surface drainage)					**0**	
POTENTIAL	Water Sample			1		**1**	**0.7%**
	Outhouse	6	6	3	1	**16**	**11.1%**
	Pipe		5	5	2	**12**	**8.3%**
	Septic Tank	14	68	20	11	**113**	**78.5%**
	Lift Station					**0**	**0.0%**
	Water Course					**0**	**0.0%**
	Wharf	1	1	2		**4**	**2.8%**
	Treatment Plant					**0**	**0.0%**
	Agriculture			1		**1**	**0.7%**
	Non-Point (source that is not set to one location)		2			**2**	**1.4%**
	Non-Source	1	1			**2**	**1.4%**
	Leaching (leaching type source)			1		**1**	**0.7%**
	Other (miscellaneous, surface drainage, marina)	1	1	1		**3**	**2.1%**

Table 12. Water quality found at sample stations within each sub-sector in West Bay.

SUB-WATERSHED: WEST BAY						
Year	**Bacteriological Water Quality at Sampling Stations**	**McKinnon's Cove/ Marble Mountain NS-7-020-014**	**West Bay (Head) NS-7-020-015**	**West Bay/ Dundee NS-7-030-001**	**West Bay/ Pringle Harbour NS-7-030-002**	**TOTAL**
1998-1999	Approved	10	12	5	7	**34**
	Exceeded Levels	0	0	0	0	0
	Total	10	12	5	7	34
2000-2002	Approved	10	11	5	7	33
	Exceeded Levels	0	1	0	0	1
	Total	10	12	5	7	34

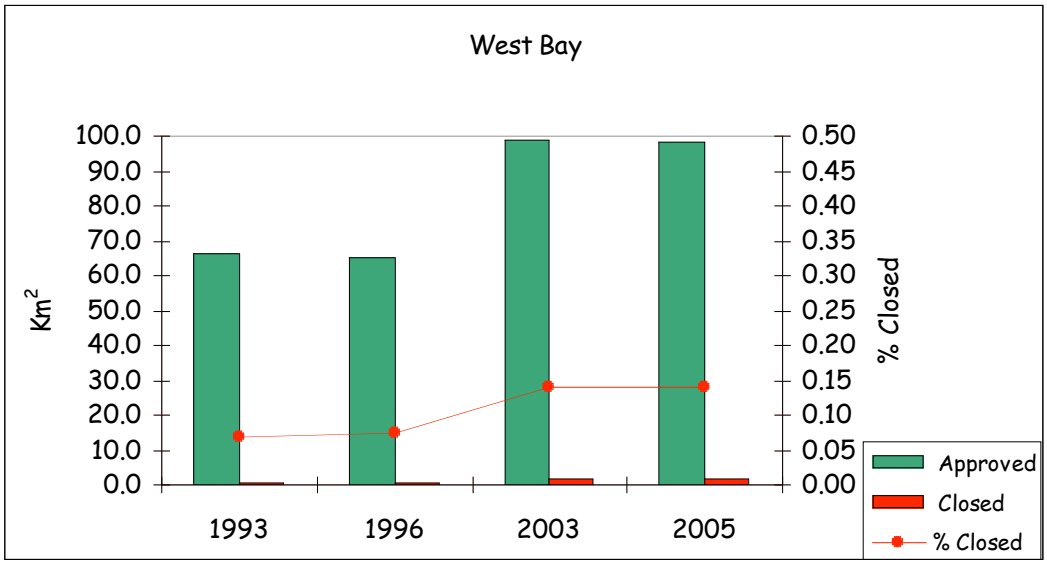


Figure 30. Changes in shellfish classification status for West Bay over time. Percent closed was standarized using the Lakes area of 1080 km^2.

Impact

Within West Bay, there are three closed areas totalling 1.51 km^2 in this watershed. Almost half of the closed area is linked to the marina in Dundee (0.73 km^2). It is the least impacted area in the entire Bras d'Or Lakes watershed.

Response

See responses in “Bras d’Or Lakes”. No additional responses were found for this area.

Sub-Watershed: River Denys

Denys Basin is a small basin (36.9 km^2) located on the western side of the Bras d'Or Lakes. It is comprised of two basins, the north and south, that are connected to the main body of the Bras d'Or Lakes through a narrow and winding channel that is approximately 7 km long (Strain and Yeats 2002). Because of the narrow and long connection, it is considered to be somewhat isolated from the main body of the Lakes. The bottom of Denys Basin is flat and the depth is considered to be shallow (average depth is 5 m) compared to other areas of the Bras d'Or Lakes.

This area is rural with widely distributed homes and farms within the watershed. Shallow depth, nutrient influx from River Denys, and warm summer and fall waters provide excellent conditions for oyster rearing. Denys Basin is considered to be the best area for spawning, growing, and harvesting oysters. In particular Gillis Cove is used for spawning oysters and collecting spat (settling oyster larvae).

A portion of Malagwatch (Malikewe'jk) First Nation is found in this sub-watershed area. Malagawatch is owned by the five First Nation communities in Unama'ki (Potlotek, We'koqma'q, Wagmatcook, Eskasoni, and Membertou). Although there are a handful of permanent residences on the reserve, it is mainly used for summer vacations, traditional harvest of marine and terrestrial resources, and spiritual retreats.
Malagawatch is in Big Harbour Island and is uniquely situated. The reserve land borders both the River Denys and McKinnon's Harbour sub-watersheds, but the majority of land is found within the McKinnon's Harbour sub-watershed.

There are 38.3 km of shoreline found in this sub-watershed and it is one of the few sub-watershed areas in which the entire area is sampled and classified. The area lies within Inverness County.

1. Bacteriological Water Quality

Driving Force

Malagawatch is a small reserve approximately 63 acres in size. There approximately 60 vacation homes or cabins on the reserve, of which approximately 30 are located along the shoreline. Statistics show that during the summer months, each cabin hosts an average of five people, and upwards of 300 people camp here through the summer season. None of the seasonal facilities have any type of sewage collection or treatment system except outhouses (Union of Nova Scotia Indians 2002). There are no provincial legislation or Mi'kmaq governance guidelines to protect this sacred land from future pollution.

Animal farming is common practice in Denys Basin.

Pressure

This area is under pressure from rural sub-division and residential developments. The high volume of visitors during summer recreation season and insufficient infrastructure to dispose of sewage and other waste products has created a potential for significant environmental harm to the community of Malagawatch. The main method of sewage disposal is outhouses, and the majority of seasonal visitors dispose about one to two gallons of sewage per day.

Approximately 54% of the direct sources of pollution are due to agricultural activities and non-point sources, such as wildlife (Table 13). The Denys Basin sub-sector contains the majority of the direct sources of pollution identified in the Sanitary Shoreline Survey (Table 13).

State

Poor water quality has been reported in this area. However, water quality for all sampling stations surrounding the community of Malagawatch returned favourable results for those that are part of the River Denys sub-watershed. It is important to note that the water surrounding this community falls under three separate Shellfish Growing Area sub-sectors, which are not necessarily sampled during the same year. Consequently, the information presented here ranges from 2000–2002. For the remainder of Denys Basin, many changes have occurred in shellfish classification status over the past five years.

The majority of Denys Basin sub-watershed area is approved and open to shellfish harvesting (Fig. 31). Only 6% is closed, but a large portion is classified as conditional, which means there are certain restrictions on harvesting after heavy rainfall events.

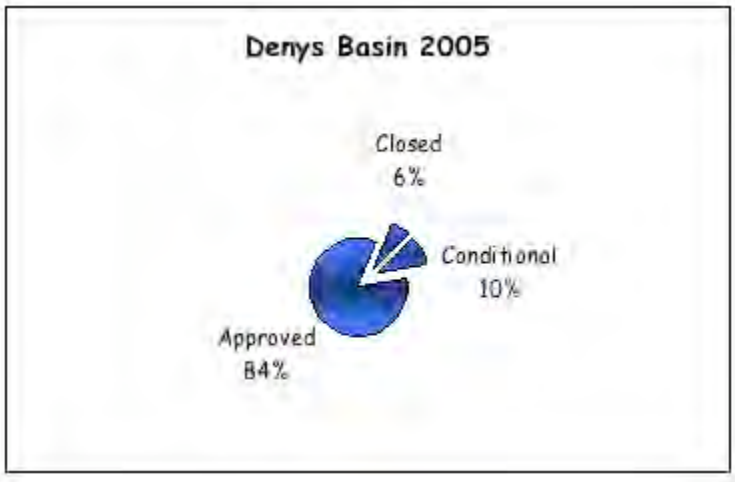


Figure 31. Percent of marine area approved, closed, and conditional in Denys Basin sub-watershed area.

Table 13. Potential and direct sources of pollution found during the Sanitary Shoreline Survey. The data was compiled using MacArthur et al. 2003 and Craig et al. 2002.

SUB-WATERSHED: RIVER DENYS

	Sub-Sectors	North Basin/ The Boom NS-07-020-011	Denys Basin NS-07-020-012	TOTAL	%
STAUS OF SOURCES	Non Pollution Source	11	257	**268**	**66.7%**
	Direct	1	14	**15**	**3.7%**
	Potential	27	92	**119**	**29.6%**
	Total	**39**	**363**	**402**	
DIRECT	Water Sample	1		**1**	**6.7%**
	Outhouse			**0**	
	Pipe		5	**5**	**33.3%**
	Septic Tank			**0**	
	Lift Station			**0**	
	Water Course			**0**	
	Wharf			**0**	
	Treatment Plant			**0**	
	Agriculture		7	**7**	**46.7%**
	Non-Point (source that is not set to one location)		1	**1**	**6.7%**
	Non-Source			**0**	
	Leaching (leaching type source)			**0**	
	Other (miscellaneous, surface drainage)		**1**	**1**	**6.7%**
POTENTIAL	Water Sample		1	**1**	**0.8%**
	Outhouse	12	18	**30**	**25.2%**
	Pipe	10	33	**43**	**36.1%**
	Septic Tank	4	31	**35**	**29.4%**
	Lift Station			**0**	
	Water Course			**0**	
	Wharf			**0**	
	Treatment Plant			**0**	
	Agriculture		2	**2**	**1.7%**
	Non-Point (source that is not set to one location)		2	**2**	**1.7%**
	Non-Source		1	**1**	**0.8%**
	Leaching (leaching type source)			**0**	
	Other (miscellaneous, surface drainage, marina)	1	5	**6**	**5.0%**

In the early 1970s, water quality was considered very good, with one small closure near the mouth of Denys River, and remained unchanged until 1993. However, between 1993 and 1997, new sampling stations were added; three new closures were implemented and increased in size. A year-long sampling survey conducted by Environment Canada and the Eskasoni Fish and Wildlife Commission in 2000 and 2001, determined that the water quality during dry conditions was acceptable to allow for a safe harvest of oysters. Dry conditions in this instance were defined as less than 12.5 mm of rainfall in any 48-hour period. As a result, closures were removed and reclassified as conditional in 2001. The change in classification does not necessarily mean that water quality improved, but rather the conditions were better understood during wet and dry weather conditions. The current classification shows six small closures and one large conditional area. The trend in water quality shows an increase between 2001 and 2005 (Fig. 32).

There was also an increase in sample stations, and those sample stations showed poor water quality (Table 14). The addition of sample stations and increase in sampling resulted in the re-classification of the area in 2001. When 2000-2002 sample station data was compared with stations that had been sampled in 1998-1999 during the normal sampling schedule, none of the samples that previously met approved criteria had degraded to exceeded bacterial limits (Table 2). In fact, there were two stations that previously exceeded bacterial limits, but now met approved criteria. The 16 stations that were added to fine tune the extent of fecal coliform contamination exceeded bacterial limits in 2000-2002. Overall, there appears to be an improvement in bacteriological water quality in this area.

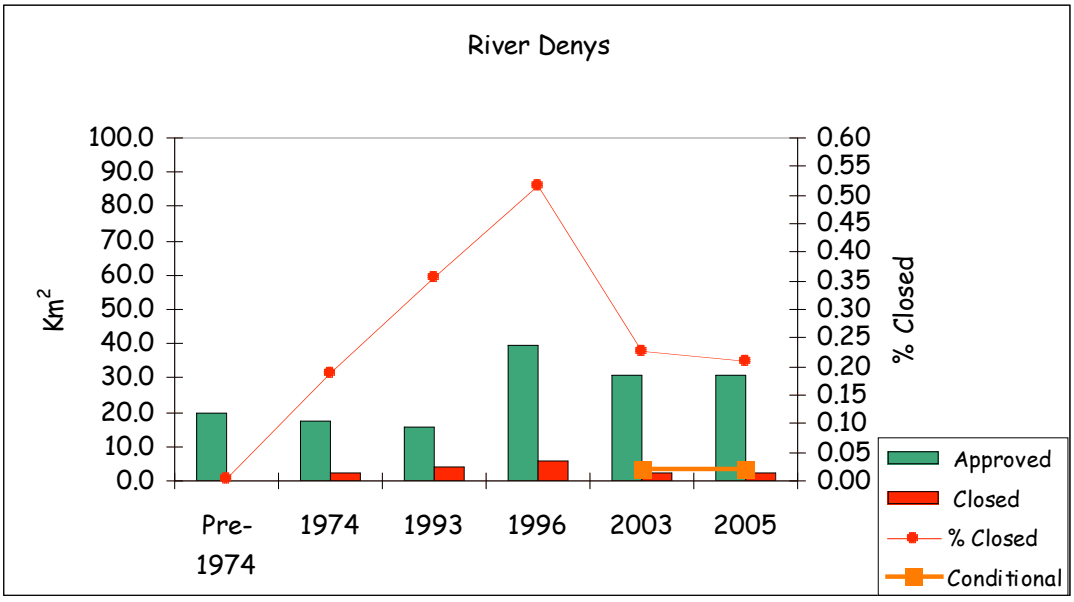


Figure 32. Changes in water quality over time in River Denys Basin (Malagawatch not included). The conditional area is expressed in km^2 and is read using the primary axis (left). Percent closed was standarized using the Lakes' area of 1,080 km^2.

Table 14. Water quality at sample stations in the Denys Basin.

SUB-WATERSHED AREA: DENYS BASIN				
Year	**Bacteriological Water Quality at Sampling Stations**	**North Basin/ The Boom NS-07-020-011**	**Denys Basin NS-07-020-012**	**TOTAL**
1998-1999	Approved	8	10	18
	Exceeded Levels	0	8	8
	Total	8	18	26
2000-2002	Approved	10	12	22
	Exceeded Levels	0	22	22
	Total	10	34	44

Impact

There are six closed areas totalling 2.27 km^2 and 3.6 km^2 of conditionally approved areas found in River Denys sub-watershed area. There are currently 23 oyster leases in Denys Basin, 4 of which are leased by First Nations (Nova Scotia Department of Aquaculture and Fisheries 2006). There are a total of 98 oyster leases in Bras d'Or Lakes, thus 23.4% of oyster leases can be found in this sub-watershed area.

The River Denys sub-watershed is the most productive oyster-growing region in the Bras d'Or Lakes. As a result, there are also economic and social impacts that occur from the closure of shellfish growing areas. The degree of these impacts is difficult to quantify due to the many indirect costs that are associated with such closures. However, Bjarnason et al. (1998) list six effects that occur due to the closure of a shellfish-growing area. They are listed as; a reduction in the total available supply of shellfish, greater competition, higher procurement costs from distant sources, intermittent operations due to inconsistency of supply, reduced local employment, and reduced profit. In addition to these economic and social impacts, the closure (or rather the contamination) of shellfish areas has an environmental impact. Due to the interconnected nature of the ecosystem and our still limited understanding of interactions within the Bras d'Or Lakes' ecosystem, we may not know or fully understand the extent of these negative impacts on the environment and the species living here. Shellfish such as mussels and oysters are filter feeders which store contaminants in their body tissue and are excellent indicator organisms. Increasing shellfish contamination is the first sign of deteriorating water quality. If left unchecked, this added stress to the ecosystem may lead to wider environmental problems.

Response

In Malagawatch, a survey was completed as part of a 2002 summer student employment program by the Union of Nova Scotia Indians and contained recommendations including implementation of composting toilets, a recycling program to reduce the litter and garbage collection problems, and a no-dumping policy. To date, none of these recommendations have been put into action.

The Stewards of the River Denys Watershed Association have been working since 1999 to address drinking and marine water protection and improvement.

II. Chemical Water Quality

Driving Force

Chemical water quality is primarily affected through local industrial activities, but other sources that may contribute pollution are leakage from landfill sites and dumps, and illegal or unauthorized dumping of wastes in the watershed area. Chemicals from fertilizers are known to contribute phosphorous and nitrates to the watershed through run-off during precipitation events.

Mining for marble and gypsum occurs in this sub-watershed.

Pressure

There are a few produce farms located in the Bras d'Or Lakes watershed and current information on the type of agriculture taking place is limited but produce farms are restricted to lands around the Skye, Middle and Baddeck Rivers, all of which are major contributors of freshwater to the Bras d'Or Lakes. Most of the arable soil within the watershed is inside forestry reserves or used for farming. The opportunities for expanding agriculture are limited by the lack of quality soil remaining (UMA 1989). There is deer farming in the rural areas of River Denys sub-watershed area.

Mining also takes place within the watershed. One of the two gypsum mines are found in the Bras d'Or Lakes watershed area is located in this sub-watershed area–the Melford Mine is owned by Georgia-Pacific. Melford Mine uses an open-pit method of extraction and ships raw product to other areas for refinement.

A small scale marble mine is in operation in Marble Mountain by MacLeod Resources Limited. Diamond wire saws are used to extract large blocks of stone at a size of 4.8 m^3 (Connolly 2002). MacLeod Resources recently received a loan for expansion of its facility to process and finish its own product (Nova Scotia Business Inc. 2004).

First Nations in general have experienced problems with dumping of household items (including appliances such as fridges and stoves), automobile and oil-based waste products in the watershed area. It is unconfirmed whether Malagawatch has areas that are used for dumping and whether these sites exist in other rural non-First Nation communities.

State

Organic Compounds and Heavy Metals

Organic contamination (PCBs, PAHs) and heavy metal concentrations (copper, zinc, lead and cadmium; Cu, Zn, Pb and Cd respectively) in sediments, water, and biota are well below the federal sediment and water quality guidelines for the protection of aquatic life (Appendix 4).

There is a concern with zinc concentrations found in the water in south River Denys Basin from samples obtained in 2003 (Table 1), as it is easily accumulated in oysters even in the absence of local elevated levels (Strain and Yeats 2002). Dissolved zinc was found in levels greater than the probable effects level (PEL -probably would cause biological effects) established in international marine water quality guidelines for this element, and thus are probably harmful (as indicated by the color red; Bedford Institute of Oceanography Containment Data Base, Yeats pers. comm. 2005). Methyl mercury, lead, and arsenic have been detected in fish samples in 2002-2003 but were well below guidelines established under the Canadian Food Inspection Agency (Denny and Berubé 2003). Samples taken in 2004 from sediment, water, and traditional marine foods by UINR are being analyzed for metals and organic compounds.

Productivity

The productivity of the Bras d'Or Lakes has been described as low and can only support a relatively low level of natural productivity (Strain and Yeats 2002). Nitrogen and phosphorous are essential elements for phytoplankton production. Chlorophyll *a* concentrations are also found to be low throughout the Lakes but the timing of measurements made may have occurred after spring bloom had taken place in 1996. However, oysters in River Denys do possess shells with a green tinge and sometimes with green bands across their shells. This would indicate a high source of Chlorophyll *a* in their diets. Nitrate, ammonia, and dissolved oxygen measurements are consistent with Atlantic coastal inlets for Nova Scotia (Strain and Yeats 2002).

Potentially toxic phytoplankton has been found in Gillis Cove although no reports of outbreaks from shellfish poisoning–such as diarrhetic shellfish poisoning (DSP), amnesic shellfish poisoning (ASP) or paralytic shellfish poisoning (PSP)–have occurred to date. All sampling sites had at least four of the potentially toxic algae identified in the Bras d'Or Lakes, although in differing quantities. A list of species identified is found in Appendix 5.

Oxygen

Dissolved oxygen concentrations are within acceptable limits in sediment and water quality guidelines for the protection of animal life. Denys Basin is not affected by low oxygen levels. Metal concentrations vary in these regions (Appendices 3 & 4) but are well below the federal sediment and water quality guidelines for the protection of aquatic life.

Overall, the quality of the water is very good with respect to heavy metal and organic compound contamination, but poorly understood in areas of nutrient content and primary productivity. The areas of Denys Basin are not as likely to experience enriched nutrient content from high bacteriological contamination and suffer the consequences of

eutrophication because of its shallow depth, despite its limited exchange with the main body of the Lakes.

Impact

There is little impact on the chemical quality of the water in the Bras d'Or Lakes primarily because few industrial and aquaculture activities, and small population size. "The Lakes as a whole should be relatively unaffected by new inputs of nutrients from human activities and are at low risk for eutrophication" (Strain and Yeats 2002, p. 61). Many metals found in trace amounts are required for biological processes, such as zinc. Those metals found in greater levels have the effect of poisoning organisms, including humans, and are especially toxic to aquatic micro-organisms. They bio-accumulate in the food chain (Government of British Columbia 2005).

Oyster aquaculture in particular could be affected if metal concentrations and organic compounds continue to increase.

Increases in phosphorous in a localized environment can, under the right conditions, cause large increases in algae, blue-green algae (cyanobacteria), and bacterial production. Combined with a lack or limited exchange between the air or other oxygen-rich waters, the area can become eutrophic and depleted. Other effects are reduction in light transmission as a result of overproduction of algae, increase in detritus (dead organic matter) settling in the sediment, strong hydrogen sulphide odours, and mass mortalities of fish and invertebrates making the water unsuitable for recreation, aquaculture or fishing (Brönmark and Hansson 1998).

Response

As chemical water quality is still very good in the Bras d'Or Lakes, there have been no additional local management initiatives. Since 1999, Environment Canada and Eskasoni Fish & Wildlife Commission Inc. have mapped potential fecal coliform bacteria pollution sources all around the Bras d'Or Lakes, barachois ponds, and connecting bodies of water. There is no long-term monitoring in place for heavy metals, oxygen, pH, potentially toxic phytoplankton, or organics for these areas by federal, provincial or First Nations' governments.

In 2003, UINR, in partnership with Environment Canada, initiated an environmental awareness program to educate the public in some of the issues that threaten the Bras d'Or Lakes. Posters and brochures were developed as the means to convey information on protecting the Bras d'Or Lakes against invasive species, etc. Another project conducted through UINR was targeted to the youth of Eskasoni (Grades 4 to 12). The project centered on providing information on the source of Eskasoni's drinking water supply, activities that impact the quality of water (forestry, pollution, dumping, recreational activities, etc.) and how to protect it (UINR 2004). A poster also provided the youth with the opportunity to increase community awareness of source protection and general water quality within the community. A general approach to protecting water was given to the youth of Potlotek, Wagmatcook, We'koqma'q and Membertou First Nations.

III. Sedimentation

Driving Force

Sedimentation causes are derived from the land surrounding the Bras d'Or Lakes. The shores of the Lakes are easily subjected to erosion because of the geology of Cape Breton Island. The perimeter of the Bras d'Or Lakes is lined with residential developments and cottages. Some houses are located, literally, along the shoreline. Lawns are extended to the shores with little vegetation, such as trees and grass, available to act as traps to prevent sedimentation from occurring.

Clear-cutting in forestry along the rivers may have been a problem in some First Nation communities and a contributing factor in non-First Nation lands prior to April 2000 when provincial legislation came into effect. Clear-cutting around streams and rivers on First Nation communities also occurs. Lack of land available in Malagawatch makes expansion of residential developments away from the shoreline difficult.

Land developments and building of roads, both highway and access roads, contribute to excessive or unnatural sedimentation accumulations. Sub-division developments are occurring in River Denys. The majority of provincial roads are situated along the perimeter of the Bras d'Or Lakes, and often very close to the water, except in areas of high elevations.

Mining also takes place within the watershed. One of the two gypsum mines found in the Bras d'Or Lakes watershed area is located here. The Melford Mine, owned by Georgia-Pacific and in operation since 2002, uses an open-pit method of extraction and ship raw product to other areas for refinement.

Pressure

The demand for land with water views or direct water access is high and so are the property values. Property owners are free to remove naturally occurring vegetation from their property edge, except along streams and Lakes that are protected by the provincial government.

Forestry is the prominent industry in Cape Breton. Stora-Enso leases the majority of Crown Lands that are harvested for softwood. The majority of the harvesting lands found in the Cape Breton Highlands, are included in the Bras d'Or Lakes watershed. Occasional harvesting also occurs on First Nations' lands by individuals with little enforcement.

The Melford Mine is located very close to the Trans-Canada Highway. Excess gypsum and mining spoil has the potential to run into the ditches and ultimately end up in a river or stream that flows into the Bras d'Or Lakes.

State

An interferometric side scan survey using multi-beam imagery to gather bathymetric (bottom topography) data was completed in 2004, and findings show that River Denys "lies under a carpet of mud" (Shaw et al. 2005, p. 6). Evidence of the existence of bioherms (carbonate rock formations in the form of a reef, often made up of fossilized remains of coral, algae, molluscs, and other sedentary marine organisms) that were buried some 3500 years ago was also found. The bioherms are probably oyster shell

beds that could not keep up with the sedimentation and, as a result, are now buried under the mud (Shaw et al. 2005). Height of the bioherms are estimated to be approximately 4 m. Based on the height of the bioherms, the rate of sedimentation is estimated to be 11 cm per century, more than twice the rate estimated for St. Patrick's Channel.

After rainfall, there are many areas where muddy water forms a band around the perimeter of the shoreline, especially in the area of residential developments. The width of the band varies depending upon rainfall and wind conditions at the time.

Information is available on the location of suitable oyster beds. Naturally occurring oyster beds are a reflection of the bottom type available for oyster settlement and can be used to gauge general increases in sedimentation. There is no current information on whether these areas are still suitable for oysters to settle.

Impact

Loss of oyster habitat is becoming an increasing problem, especially in areas of low tidal action. River Denys Basin is at risk for loss of habitat. This area has a major river draining into the Basin and, because of its isolation from the main body of the Lakes, it has low tidal and flushing action. Loss of habitat often results in loss of existing communities of organisms that are replaced by those species that are more adaptable to the newly created habitat. The loss of oysters, either by loss of habitat, clogging of filtering apparatus, or suffocation, also results in a loss of the water's natural filtering system. Probably Effect Level (probably would cause biological effects) concentrations of zinc are found in River Denys Basin water.

Atlantic herring spring-spawning populations in the Bras d'Or Lakes have been declining over the past decade and no longer support a commercial fishery (Denny et al. 1998). Numerous spawning areas were documented in the Lakes in this area prior to 1996 but are reduced to smaller numbers with smaller spawning biomass. It is undetermined whether environmental changes such as loss of habitat, or human pressure, such as the commercial fishery, have caused a decline in the spring-spawning population of Atlantic herring, but simultaneous pressure of both are likely contributors.

Response

Provincial legislation protects stream and rivers from excessive sedimentation during forestry operations by implementing riparian buffer zones known as Special Management Zones (SMZ). These extend 20 m on each side of a channel that is greater than 50 cm in width. Nova Scotia Department of Natural Resources enforces SMZ in harvesting practices. StoraEnso, operating under its own Environmental Management System, exceeds the minimum requirements under legislation and the Nova Forest Alliance Best Management Practices. (StoraEnso 2004) It is the responsibility of the landowner to implement proper erosion control measures to protect the aquatic environment from sedimentation (Department of Natural Resources 2005).

Melford Mine works in close association with ADI Limited to monitor water quality of local streams that may be affected by run-off during heavy rainfall.

In August 2005, Environment Canada and the Bedford Institute of Oceanography implemented a hydrometric flow gauge station in Denys River to collect data on water flow and level and turbidity of river water discharge into the South Denys Basin.

Sub-Watershed: McKinnon's Harbour

McKinnon's Harbour sub-watershed is located on the north western section of the Bras d'Or Lakes. It is the only section where railway tracks can be found alongside the shore and leads to the historic train station of Orangedale in the River Denys sub-watershed. Prior to the construction of the Barra Strait Bridge, it was also the location of the ferry that provided service between Iona and Grand Narrows (North Basin sub-watershed). Like St. Peter's Inlet, there are many small islands that dot the entranceway to the numerous inlets and coves found within the Harbour.

Malagawatch First Nation is found within this sub-watershed as well. It is uniquely situated and borders both the River Denys and McKinnon's Harbour sub-watersheds, but the majority of reserve land is found within the McKinnon's Harbour sub-watershed.

McKinnon's Harbour sub-watershed lies between the boundaries of Victoria and Inverness Counties. There is 75.7 km of shoreline found in this sub-watershed.

1. Bacteriological Water Quality

Driving Force

Malagawatch is a small reserve approximately 63 acres in size. There are about 60 vacation homes or cabins on the reserve, of which approximately 30 are located along the shoreline. Statistics show that during the summer months, each cabin hosts an average of five people, and upwards of 300 people camp here through the summer season. None of the seasonal facilities have any type of sewage collection or treatment system except outhouses (Union of Nova Scotia Indians 2002). There are no provincial legislation or Mi'kmaq governance guidelines to protect this sacred land from pollution.
Cattle and wild rabbits were observed in the area during shoreline surveys. The natural shape and small opening (<25 m) to McKinnon's Harbour restrict water exchange with the main body of the Bras d'Or Lakes (MacArthur et al. 2003).

Pressure

The high volume of visitors during summer recreation season and insufficient infrastructure to dispose of sewage and other waste products has created a potential for significant environmental harm to the community of Malagawatch. The main method of sewage disposal is outhouses, and the majority of seasonal visitors dispose about one to two gallons of sewage per day.

Animals (other than humans) account for all direct sources of pollution found in McKinnon's Harbour sub-watershed (Table 15). Slow flushing times between McKinnon's Harbour proper and the main body of the Lakes result in accumulation of fecal coliform bacteria, especially in the head of the Harbour. Potential sources of

pollution include outhouses (~34%) and septic tanks (~32%; Table 15). The majority of potential sources of pollution can also be found in the McKinnon's Harbour sub-sector (Table 15).

State

1% of the marine waters were closed to shellfish harvesting but a large area remains un-sampled in the deeper portions of McKinnon's Harbour (Fig. 33). Poor water quality is reported in this sub-watershed area. The majority of stations with poor water quality are located within existing shellfish closures (Table 16) and no change in the number of stations showing poor water quality was observed for McKinnon's Harbour (sub-sector 020-010). Changes in shellfish closures occurred in the past (before 2003, however, they have remained the same between 2003 and 2005 (Fig. 34). The number of sample stations with poor water quality in this small area is not surprising as McKinnon's Harbour is a long, narrow body of water with a small and restrictive opening and we would expect poor flushing of water and limited exchange with the main body of the Lakes and, consequently, accumulation of fecal coliform bacteria in the harbour.

The change in water quality occurred in Malagawatch Harbour (sub-sector 020-011; Table 16) in the area of Big Harbour Centre at sampling station 3 (Figure 35). Fecal coliform values were as high as 350 MPN/100mL when sampled in 2001. Overall, water quality is decreasing in this area.

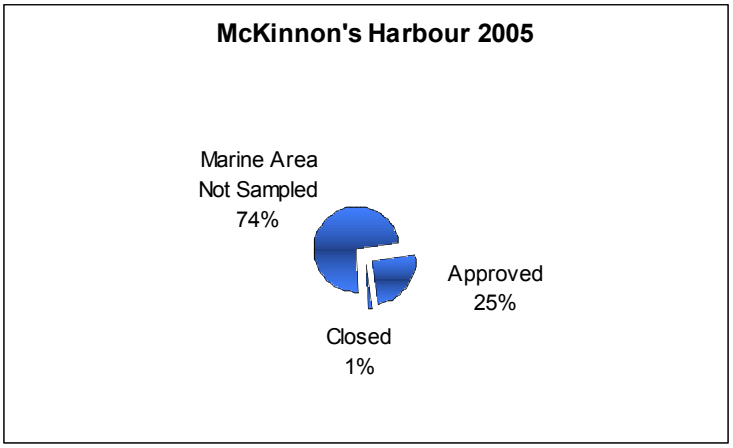


Figure 33. Percent of marine waters in the McKinnon's Harbour sub-watershed area classified, their status and area not sampled.

Table 15. Direct and potential sources of pollution identified in McKinnon's Harbour sub-watershed during the Sanitary Shoreline Survey. Data was compiled using MacArthur et al. 2003.

	SUB-WATERSHED: McKINNON'S HARBOUR Sub-Sectors	McKinnon's Harbour NS-07-020-010	Malagawatch Harbour NS-07-020-013	North Basin/ The Boom NS-07-020-11	TOTAL	%
STAUS OF SOURCES	Non Pollution Source	71	24	5	**100**	**48.3%**
	Direct	2	1	0	**3**	**1.4%**
	Potential	74	18	12	**104**	**50.2%**
	Total	**147**	**43**	**17**	**207**	
DIRECT	Water Sample				**0**	
	Outhouse				**0**	
	Pipe				**0**	
	Septic Tank				**0**	
	Lift Station				**0**	
	Water Course				**0**	
	Wharf				**0**	
	Treatment Plant				**0**	
	Agriculture	1			**1**	**33.3%**
	Non-Point (source that is not set to one location)	1	1		**2**	**66.7%**
	Non-Source				**0**	
	Leaching (leaching type source)				**0**	
	Other (miscellaneous, surface drainage)				**0**	
POTENTIAL	Water Sample	4			**4**	**3.8%**
	Outhouse	20	13	2	**35**	**33.7%**
	Pipe	24	1	3	**28**	**26.9%**
	Septic Tank	25	4	4	**33**	**31.7%**
	Lift Station				**0**	
	Water Course				**0**	
	Wharf				**0**	
	Treatment Plant				**0**	
	Agriculture				**0**	
	Non-Point (source that is not set to one location)			3	**3**	**2.9%**
	Non-Source				**0**	
	Leaching (leaching type source)	1			**1**	**1.0%**
	Other (miscellaneous, surface drainage, marina)				**0**	

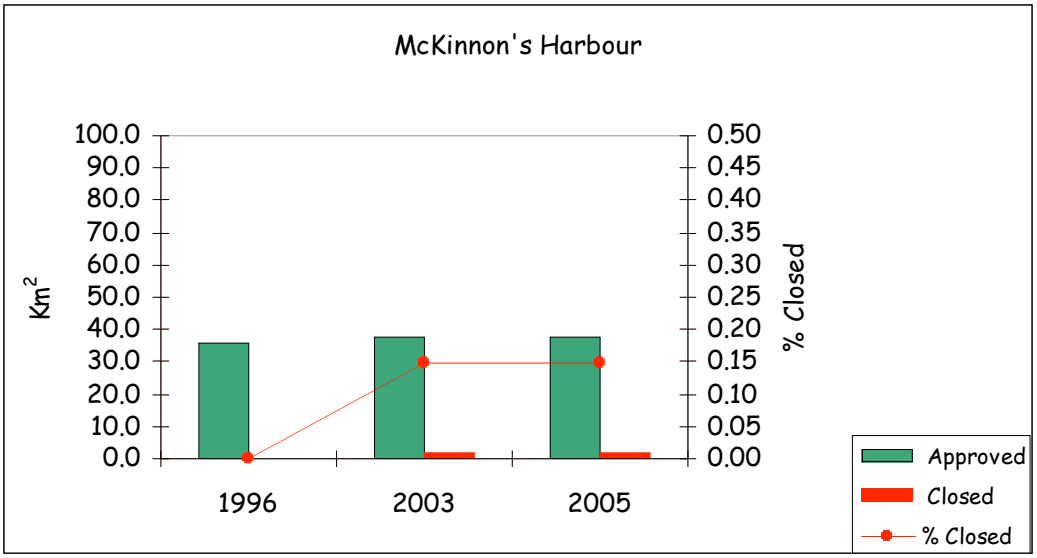


Figure 34. Changes in shellfish closures over time. Percent closed was standarized using the Lakes area of 1080 km^2.

Table 16. Water quality at sample stations in each of the sub-sectors that make up the receiving waters of the McKinnon's Harbour sub-watershed.

SUB-WATERSHED AREA: McKINNON'S HARBOUR					
Year	**Bacteriological Water Quality Sampling Stations**	**McKinnon's Harbour NS-07-020-010**	**Malagawatch Harbour NS-07-020-013**	**North Basin/ The Boom NS-07-020-11**	**TOTAL**
1998-1999	Approved	7	6	9	22
	Exceeded Levels	8	0	0	8
	Total	15	6	9	30
2000-2002	Approved	7	7	14	28
	Exceeded Levels	8	1	0	9
	Total	15	8	14	37

Impact

As a result of elevated levels of fecal coliform contamination three shellfish closures totalling 1.92 km^2 are in effect within this sub-watershed area (Figure 35).

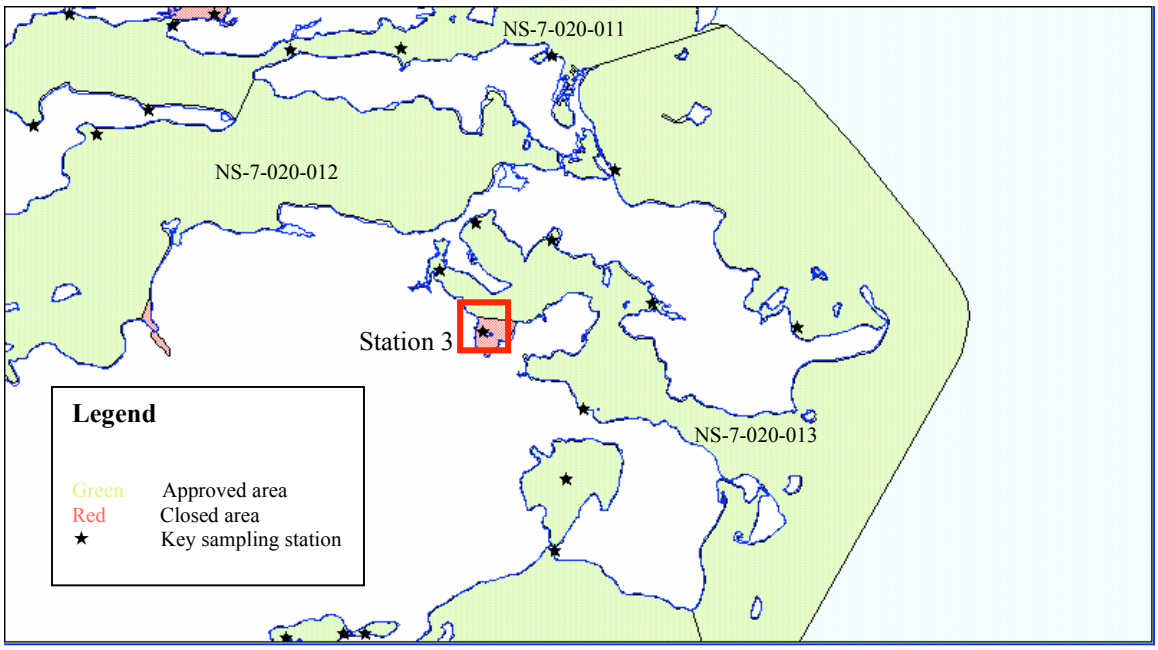


Figure 35. Shellfish Growing Areas 7-020-010, and 7-020-013). Red squares show stations that previously met approved criteria but now exceed bacterial limits (also poor water quality); black squares indicate sample stations added that exceeded bacterial limits (also poor water quality). 8 other sample stations in sub-sector 010-010 also have poor water quality but are not shown on this figure.

Response

A survey was completed in 2002 as part of a summer student employment program by the Union of Nova Scotia Indians with recommendations such as implementation of composting toilets, a recycling program to reduce litter and garbage collection problems, and a no-dumping policy. To date, none of these recommendations have been put into action.

II. Chemical Water Quality

Driving Force

Chemical water quality is primarily affected through local industrial activities, but other sources that may contribute pollution are leakage from landfill sites and dumps, and illegal or unauthorized dumping of wastes in the watershed area. Chemicals from fertilizers are known to contribute phosphorous and nitrates to the watershed through run-off during precipitation events.

Pressure

There are a few produce farms located in the Bras d'Or Lakes watershed and current information on the type of agriculture taking place is limited but produce farms are restricted to lands around the Skye, Middle and Baddeck Rivers, all of which are major contributors of freshwater to the Bras d'Or Lakes. Most of the arable soil within the watershed is inside forestry reserves or used for farming. The opportunities for expanding agriculture are limited by the lack of quality soil remaining (UMA 1989).

First Nations in general have experienced problems with dumping of household items (including appliances such as fridges and stoves), automobile and oil-based waste products in the watershed area. It is unconfirmed whether Malagawatch has areas that are used for dumping and whether these sites exist in other rural non-First Nation communities.

Railway ties and other structures used in the construction of railway systems and ferry docks are filled with chemicals that prevent the natural decomposition of wood products. While the ferry system is no longer in operation, it is unknown if all structures and materials have been removed from the shoreline and water. The railway has occasional traffic and therefore the tracks remain. It is unlikely that they ever will be removed in the event that the train service is re-established in Cape Breton.

State

Organic Compounds and Heavy Metals

Organic contamination (PCBs, PAHs) and heavy metal concentrations (copper, zinc, lead and cadmium; Cu, Zn, Pb and Cd respectively) in sediments, water, and biota are well below the federal sediment and water quality guidelines for the protection of aquatic life. These concentrations are lower in the Bras d'Or Lakes compared with other areas such as Halifax and Sydney Harbours despite lower salinities found in the Lakes (concentrations of metals are generally higher in lower saline environments) (Strain and Yeats 2002).

Methyl mercury, lead, and arsenic were detected in fish samples in 2002-2003 but were well below guidelines established under the Canadian Food Inspection Agency (Denny and Berubé 2003). Samples taken by UINR in 2004 from sediment, water, and traditional marine foods are being analyzed for metals and organic compounds.

Productivity

The productivity of the Bras d'Or Lakes has been described as low and can only support a relatively low level of natural productivity (Strain and Yeats 2002). As McKinnon's Harbour is restricted from the main body of the Lakes and has numerous areas in which nutrients from wastes seep into the water, productivity may be higher here.

Potentially toxic phytoplankton have been found in Malagawatch although no reports of outbreaks from shellfish poisoning–such as diarrhetic shellfish poisoning (DSP), amnesic shellfish poisoning (ASP) or paralytic shellfish poisoning (PSP)–have occurred to date. All sampling sites had at least four of the potentially toxic algae identified in the Bras d'Or Lakes, although in differing quantities. A list of species identified is found in Appendix 5.

Oxygen

Dissolved oxygen concentrations are within acceptable limits in sediment and water quality guidelines for the protection of animal life. However, concentrations of dissolved oxygen have been found to be lower in some barachois ponds compared with the rest of the Bras d'Or Lakes. There is limited information on water quality in barachois ponds but we can expect these areas to suffer from eutrophication, especially in areas where there is established summer residency and little exchange of water with the main body of the Lakes. The environment of McKinnon's Harbour is similar to a barachois pond and oxygen depletion may be a concern in the future.

Overall, the quality of the water is very good with respect to heavy metal and organic compound contamination.

Impact

There is little impact on the chemical quality of the water in the Bras d'Or Lakes primarily because of few industrial and aquaculture activities, and small population size. "The Lakes as a whole should be relatively unaffected by new inputs of nutrients from human activities and are at low risk for eutrophication" (Strain and Yeats 2002, p. 61). Many metals found in trace amounts are required for biological processes, such as zinc. Those metals found in greater levels have the effect of poisoning organisms including humans. They are especially toxic to aquatic micro-organisms, and bio-accumulate in the food chain (Government of British Columbia 2005).

Increases in phosphorous to a localized environment, under the right conditions, can cause large increases in algae, blue-green algae (cyanobacteria), and bacterial production. Combined with a lack or limited exchange between the air or other oxygen-rich waters, the area can become eutrophic and depleted. Other effects are; reduction in light transmission as a result of overproduction of algae, increase in detritus (dead organic matter) settling in the sediment, strong hydrogen sulphide odours, and mass mortalities of fish and invertebrates making the water unsuitable for recreation, aquaculture, or fishing (Brönmark and Hansson 1998).

Response

As chemical water quality is still very good in the Bras d'Or Lakes, there have been no additional local management initiatives. Since 1999, Environment Canada and Eskasoni Fish & Wildlife Commission Inc. have mapped potential fecal coliform bacteria pollution sources all around the Bras d'Or Lakes, barachois ponds, and connecting bodies of water. There is no long-term monitoring in place for heavy metals, oxygen, pH, potentially toxic phytoplankton, or organics for these areas by federal, provincial, or First Nations' governments.

Sub-Watershed: Whycocomagh Bay

Whycocomagh Bay is comprised of two basins that are separated by a broad, shallow area known as a sill. The western basin is narrow and steep-sided (maximum depth 48 m), while the eastern basin is wide and gently sloping (max. depth 38 m). The eastern basin is directly connected to the rest of the Lakes through Little Narrows, which itself is only about 100 m wide and 12 m deep. Whycocomagh Bay is considered to be isolated because of this restricted connection and shallow sills separating the basins (Strain and Yeats 2002). Flushing time estimated for this Bay is approximately two years, the longest flushing time of any area in the Bras d'Or Lakes (Petrie and Bugden 2002). The area has been used for aquaculture in the past, particularly for finfish aquaculture, by the We'koqma'q First Nation. Whycocomagh Bay lies within the boundaries of Inverness and Victoria Counties. There is 35.1 km of shoreline found in this watershed.

Two communities dominate the small area: the village of Whycocomagh and the We'koqma'q First Nation. Both communities are connected to the main sewage treatment facility in the Village of Whycocomagh.

1. Bacteriological Water Quality

Driving Force

Like other First Nation communities around the Bras d'Or Lakes, the population of We'koqma'q is also increasing. In the ten-year period from 1991 to 2001, the population increased by 213 persons to reach the current census of 635. This increase in population is reflected in the increase in housing in the area. Prior to 1981, only 70 dwellings had been constructed in We'koqma'q. Today, that number has more than doubled. From 1981 to 1991, 40 new dwellings were constructed and, in the period from 1991 to 2001, 55 new dwellings were constructed for a total of 165 dwellings in We'koqma'q.

Pressure

Sewage from We'koqma'q is pumped to an off-reserve treatment facility in Whycocomagh that is operated by the County of Inverness. The wastewater treatment plant was constructed in 1977 and upgraded in 1994. The plant utilizes an extended aeration lagoon and effluent is discharged into the Skye River, which drains into the Bras d'Or Lakes at Whycocomagh Bay. The plant is designed to handle up to 200,000 gallons/day and, in 1995, it was reported to be operating below capacity at the beginning of a projected 20-year life span.

The First Nation Community of We'koqma'q is responsible for the operation and maintenance of five lift stations located in the community. All lift stations are equipped

with emergency lights in case of equipment failure. However, the lift stations do not have forced air ventilation and there is no emergency plan in place in case of sewage overflows. Lift stations overflowing into open ditches and nearby water bodies has prompted a number of complaints due to foul odours.

High fecal coliform counts have been reported in the Skye River. A lift station failed on June 10, 1998 resulting in the discharge of raw sewage into the Skye River, eventually entering the Bras d'Or Lakes. In March 1999, sampling revealed fecal coliform bacteria counts of >24,000 MPN/100mL, or 12 times higher than effluent targets (ADI Limited 1999).

The shoreline survey also identified three lift stations. A lift station is part of a central collection system that pumps sewage up gradient to a treatment plant. Some systems make use of a number of these lift stations before sewage arrives at the final destination. The main component of a lift station is a mechanical pump typically connected to a local power supply. Breakdowns and malfunctions are not uncommon and, if no holding tank is installed, the raw sewage will overflow. A power outage is a good example of an incident where a lift station may fail. If there is no auxiliary power supply the station will soon overflow, typically into the Bras d'Or Lakes, or waters flowing into the Lakes.

During a 2001 site visit, the engineering consulting firm, MGI Limited, noted that access to one of the lift station's catch basins was not secure and posed a potentially fatal fall hazard. It was also noted that there were no spare parts or pumps on-site to deal with any malfunctions, and no reporting programs were in place to inform the public or authorities of system failures. The system operator is reported to have over 18 years on-the-job experience and has received training from the contractor who installed the lift stations (MGI 2002d). A secondary operator is in place and received on-the-job training from the primary operator (MGI 2002d). For the location of the lift stations and the wastewater collection system, see Appendix 6.

In addition to the sewage collection system, the Band is also responsible for 39 on-site septic systems in the community. Many of these systems are reported to malfunction annually due to septic system collapse or drainage problems.

Additional pressures in Whycocomagh Bay occur because of an underwater sill at the mouth of the Bay near Little Narrows. This sill restricts the flow of water in and out of the Bay resulting in exchange of water occurring on the surface, with little or no mixing at the deepest sections of the Bay. This creates anoxic bottom conditions. As a result of the location of the sill, the flushing time in this area has been calculated to be up to 700 days, the longest flush time calculated for any area within the Bras d'Or Lakes. This is of great concern since contaminants and pollutants will remain in this section longer than any other area of the Lakes' ecosystem.

Table 17. Potential and direct sources of pollution found in along the shoreline in Whycocomagh Bay.

	SUB-WATERSHED: WHYCOCOMAGH BAY Sub-Sectors	Little Narrows NS-07-010-007	Whycocomagh Bay NS-07-010-008	TOTAL	%
STAUS OF SOURCES	Non Pollution Source	0	8	**8**	**4.1%**
	Direct	1	8	**9**	**4.5%**
	Potential	51	129	**180**	**91.4%**
	Total	**52**	**144**	**197**	
DIRECT	Water Sample		4	**4**	**44.4%**
	Outhouse			**0**	
	Pipe	1	2	**3**	**33.3%**
	Septic Tank			**0**	
	Lift Station			**0**	
	Water Course			**0**	
	Wharf			**0**	
	Treatment Plant		1	**1**	**1.1%**
	Agriculture			**0**	
	Non-Point (source that is not set to one location)		1	**1**	**1.1%**
	Non-Source			**0**	
	Leaching (leaching type source)			**0**	
	Other (miscellaneous, surface drainage)			**0**	
POTENTIAL	Water Sample		5	**5**	**2.8%**
	Outhouse	10	3	**13**	**6.6%**
	Pipe	10	33	**43**	**23.9%**
	Septic Tank	26	72	**98**	**54.4%**
	Lift Station		3	**3**	**1.7%**
	Water Course			**0**	
	Wharf		1	**1**	**0.6%**
	Treatment Plant			**0**	
	Agriculture			**0**	
	Non-Point (source that is not set to one location)	3		**3**	
	Non-Source	2		**2**	
	Leaching (leaching type source)			**0**	
	Other (miscellaneous, surface drainage, marina)		11	**11**	**6.1%**

State

High levels of fecal coliform were reported along entire shoreline of We'koqma'q, excluding the north and east shores of Indian Island, and a number of surrounding sites within the Shellfish Growing Area Sub sector 7-010-008. Levels of bacteriological contamination (fecal coliform densities) were as high as 1,600 MPN/100mL in numerous areas. This area was last evaluated in 2003 and no classification changes were recommended by Environment Canada (Tables 17 & 18).

The area was first surveyed in 1963. Van Otterloo (1975) indicated that there was a problem with rain run-off to the Bay, resulting in elevated fecal coliform counts during rainstorms, so a new closure was recommended. The closure implemented in 1975 covered most of the Bay up to Indian Island and remained unchanged until 1990. Currently, the entire marine area of this sub-watershed is sampled with 7% of the area closed to year-round shellfish harvesting (Fig. 36).

Overall, the percentage of closed areas has increased only slightly since 1999 (1%, Fig. 37), after decreasing by almost 5% in the 1990s when the new sewage treatment plant was built.

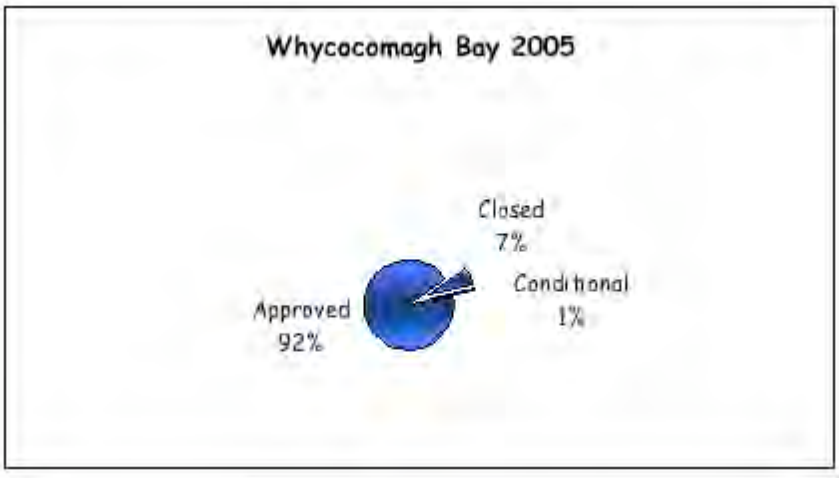


Figure 36. Percentage of area approved, closed, and conditionally classified in Whycocomagh Bay.

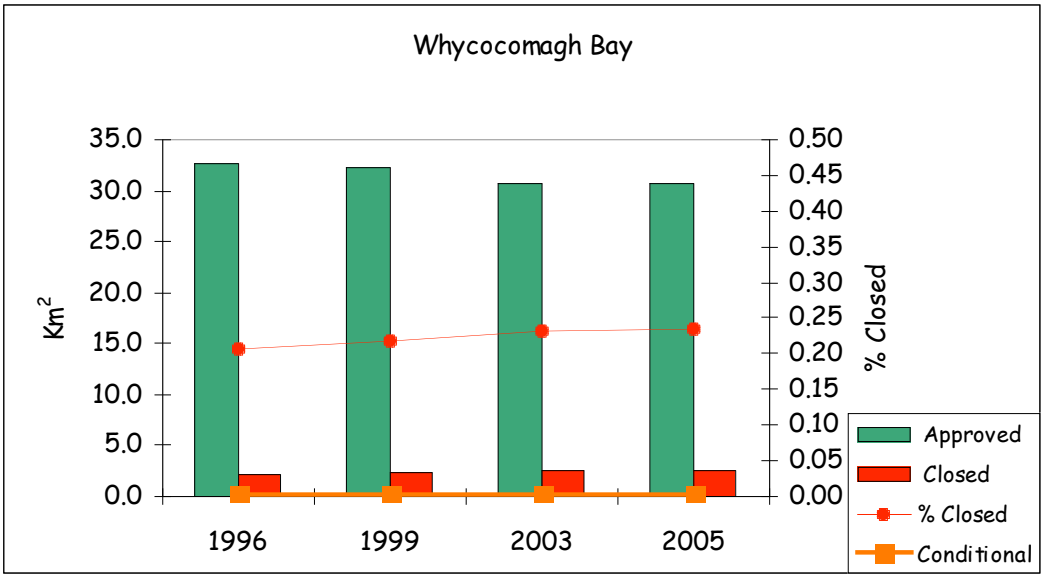


Figure 37. Graph showing changes in shellfish classification in Whycocomagh Bay over time. Percent closed was standarized using the Lakes area of 1080 km^2.

Table 18. Water quality at sample stations in Whycocomagh Bay.

SUB-WATERSHED: WHYCOCOMAGH BAY

Year	Bacteriological Water Quality at Sampling Stations	Whycocomagh Bay NS-07-010-008	Little Narrows NS-07-010-007	TOTAL
1998-1999	Approved	23	8	31
	Exceeded Levels	2	0	2
	Total	25	8	33
2000-2002	Approved	22	8	30
	Exceeded Levels	3	0	3
	Total	25	8	33

Impact

High fecal coliform densities in the waters adjacent to We'koqma'q (sub-sector 7-010-008) have resulted in one large and four smaller closures totalling 2.52 km^2 closed to shellfish harvesting (Figure 38). One conditionally approved area of 0.26 km^2 is found here. This area was last evaluated in 2002.

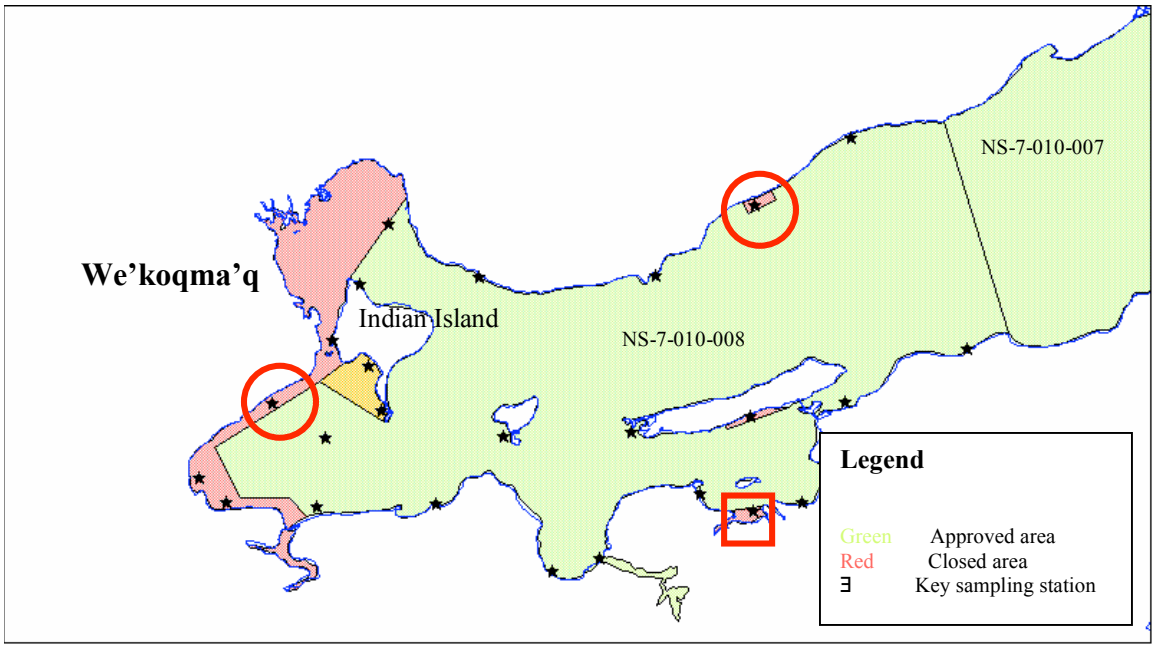


Figure 38. Shellfish Growing Area Sub sector 7-010-008 (We'koqma'q First Nation). Red circles indicated sample stations with poor water quality. Red squares show stations that previously met approved criteria but now exceed bacterial limits (also poor water quality); black squares indicate sample stations added that exceeded bacterial limits (also poor water quality).

There are also economic and social impacts that occur from the closure of shellfish growing areas. The degree of these impacts is difficult to quantify due to the many indirect costs that are associated with such closures. However, Bjarnason et al. (1998) list six effects that occur due to the closure of a shellfish growing area; a reduction in the total available supply of shellfish, greater competition, higher procurement costs from distant sources, intermittent operations due to inconsistency of supply, reduced local employment, and reduced profit. In addition to these economic and social impacts, the closure (or rather the contamination) of shellfish areas has an environmental impact. Due to the interconnected nature of the ecosystem and our still limited understanding of interactions within the Bras d'Or Lakes' ecosystem, we may not know or fully understand the extent of these negative impacts on the environment and the species living here. Shellfish, such as mussels and oysters are filter feeders which store contaminants in their tissues, and are excellent indicator organisms. Increasing shellfish contamination is the first sign of deteriorating water quality. If left unchecked, this added stress to the ecosystem may lead to wider environmental problems.

Response

In 1995, an agreement was signed between the Municipality of Inverness and the Department of Indian and Northern Affairs (INAC) to have wastewater from the First Nation Community of We'koqma'q treated by the off-reserve municipal treatment facility in Whycocomagh. Repairs to the collection system ensued from 1995 to 1998 to address concerns around major infiltration areas and, in 2002-2003, an estimated $780,000 was spent on the extension of sewer and water lines ($127,125 contributed by the First Nation of We'koqma'q). Over the years, the Band has also decommissioned upwards of 75 on-site septic systems and connected the homes to the central collection system.

II. Chemical Water Quality

Driving Force

Chemical water quality is primarily affected by local industrial activities, but other sources that may contribute pollution are leakage from landfill sites and dumps, and illegal or unauthorized dumping of wastes in the watershed area. Chemicals from fertilizers are known to contribute phosphorous and nitrates to the watershed through run-off during precipitation events.

Pressure

There are a few produce farms located in the Bras d'Or Lakes watershed and current information on the type of agriculture taking place is limited but produce farms are restricted to lands around the Skye, Middle and Baddeck Rivers, all of which are major contributors of freshwater to the Bras d'Or Lakes. Most of the arable soil within the watershed is inside forestry reserves or used for farming. The opportunities for expanding agriculture are limited by the lack of quality soil remaining (UMA 1989).

One clinic is situated on the shores of the Bras d'Or Lakes (We'koqma'q) with effluent treated through the municipal sewage system. Wastes, medications, potent cleaners, and other substances are likely dissolved in the effluent.

First Nations in general have experienced problems with dumping of household items (including appliances such as fridges and stoves), automobile and oil-based waste products in the watershed area. It is undetermined whether We'koqma'q has areas that are used for dumping and whether these sites exist in other rural non-First Nation communities.

State

Organic Compounds and Heavy Metals

Organic contamination (PCBs, PAHs) and heavy metal concentrations (copper, zinc, lead and cadmium; Cu, Zn, Pb and Cd respectively) in sediments, water, and biota are well below the federal sediment and water quality guidelines for the protection of aquatic life.

Methyl mercury, lead and arsenic have been detected in fish samples in 2002-2003 but were well below guidelines established under the Canadian Food Inspection

Agency (Denny and Berubé 2003). At the time of this report, samples taken by UINR in 2004 from sediment, water, and traditional marine foods are being analyzed for metals and organic compounds.

Productivity

The productivity of the Bras d'Or Lakes has been described as low and can only support a relatively low level of natural productivity (Strain and Yeats 2002).

Potentially toxic phytoplankton has been found in the Bras d'Or Lakes although no reports of outbreaks from shellfish poisoning–such as diarrhetic shellfish poisoning (DSP), amnesic shellfish poisoning (ASP) or paralytic shellfish poisoning (PSP)–have occurred to date. All sampling sites had at least four of the potentially toxic algae identified in the Bras d'Or Lakes, although in differing quantities. A list of species identified are found in Appendix 5.

Oxygen

Dissolved oxygen concentrations are within acceptable limits in sediment and water quality guidelines for the protection of animal life. However, concentrations of dissolved oxygen have been found to be lower in Whycocomagh Bay and in some barachois ponds compared with the rest of the Bras d'Or Lakes. Elevated iron and manganese levels have also been found in these areas but are a result of reduction-oxidation reactions that take place during eutrophication rather than as a result of environmental contamination. Sediments are permanently anoxic (P. Yeats pers. comm. 2006). Metal concentration varies in these regions (Appendices 3 & 4) but are well below the federal sediment and water quality guidelines for the protection of aquatic life. There is limited information on water quality in barachois ponds, but we can expect these areas to suffer from eutrophication, especially in areas where there is established summer residency and little exchange of water with the main body of the Lakes.

Overall, the quality of the water is very good with respect to heavy metal and organic compound contamination. Whycocomagh Bay is more likely to experience enriched nutrient content from high bacteriological contamination, limited and slow exchange with the main body of the Lakes, or both, and as a result suffer the biological consequences of eutrophication.

Impact

There is little impact on the chemical quality of the water in the Bras d'Or Lakes primarily because of few industrial and aquaculture activities, and small population size. "The Lakes as a whole should be relatively unaffected by new inputs of nutrients from human activities and are at low risk for eutrophication" (Strain and Yeats 2002, p. 61). Many metals found in trace amounts are required for biological processes, such as zinc. Those metals found in greater levels have the effect of poisoning organisms, including humans. They are especially toxic to aquatic micro-organisms, and bio-accumulate in the food chain (Government of British Columbia 2005).

Finfish aquaculture in the Bras d'Or Lakes was popular in the 1990s with fish cage systems established in Whycocomagh Bay, but as of 2000 it is no longer in operation. Concern for the environmental impact of finfish aquaculture on water quality is no longer an issue as a result of the closure of all finfish sites, however, long-term or residual

effects of anti-fouling chemicals and antibiotics from feed may still be a concern in these areas.

Increases in phosphorous to a localized environment, under the right conditions, can cause large increases in algae, blue-green algae (cyanobacteria), and bacterial production. Combined with a lack or limited exchange between the air or other oxygen rich waters, the area can become eutrophic and anoxic. Other effects are reduction in light transmission as a result of overproduction of algae, increase in detritus (dead organic matter) settling in the sediment, strong hydrogen sulphide odours, and mass mortalities of fish and invertebrates, making the water unsuitable for recreation, aquaculture, or fishing (Brönmark and Hansson 1998). Fish kills were observed in the aquaculture operation in Whycocomagh Bay in the mid-1990s as a result of eutrophic conditions.

Response

As chemical water quality is still very good in the Bras d'Or Lakes, there are no additional local management initiatives. Since 1999, Environment Canada and Eskasoni Fish & Wildlife Commission Inc. have mapped potential fecal coliform bacteria pollution sources all around the Bras d'Or Lakes, barachois ponds and connecting bodies of water. There is no long-term monitoring in place for heavy metals, oxygen, pH, potentially toxic phytoplankton, or organics for these areas by federal, provincial, or First Nations' governments.

In 2003, UINR, in partnership with Environment Canada, initiated an environmental awareness program to educate the public in some of the issues that threaten the Bras d'Or Lakes. Posters and brochures were developed as the means to convey information on protecting the Bras d'Or Lakes from invasive species, etc. Another project conducted through UINR was targeted to the youth of Eskasoni (Grades 4 to 12). The project centered on providing information on the source of Eskasoni's drinking water supply, activities that affect the quality of water (forestry, pollution, dumping, recreational activities, etc.) and how to protect it (UINR 2004). A poster contest provided the youth with the opportunity to increase community awareness of source protection and general water quality within the community. A general approach to protecting water was to the youth of Chapel Island, Wagmatcook, We'koqma'q, and Membertou First Nations.

Sub-Watershed: St. Patrick's Channel

St. Patrick's Channel is located in the northeastern portion of the Bras d'Or Lakes and is connected to Little Narrows on the south and the Great Bras d'Or Channel on the north. Baddeck is the largest community in the St. Patrick's Channel sub-watershed and the largest community located on the Bras d'Or Lakes, with a population of 982 people and many thousands more during tourism season (Statistics Canada 2001).

1. Bacteriological Water Quality

Driving Force

In addition to being the largest non-First Nation community on the Bras d'Or Lakes, Baddeck is also one of Cape Breton Island's major tourism destinations with more than 93,000 tourists visiting the community each year[4]. Baddeck hosts a large number of lodging facilities, the world-famous Alexander Graham Bell National Historic Site, Bell Bay Golf Club, and is among the most sought after locations for boating enthusiasts from around the world. In recent years, Baddeck has experienced a large number of shuttle buses arriving from the nearby City of Sydney, where passengers on luxury cruise ships disembark for day trips around the Island. Cruise ships also make the voyage through the Lakes to Baddeck, carrying hundreds of passengers to the community. These tourism activities see the population of the community swell to great numbers in the summer and fall months.

Commercial fishing is more active in the northern portion of the Bras d'Or Lakes. While there is little commercial fishing activity in general within the Bras d'Or Lakes, the majority of it occurs in the North Basin, St. Andrew's and the Great Bras d'Or Channels.

Pressure

Tourism is a growing industry and attracts hundreds of thousands of visitors each season. Unmistakably, this means greater pressure on the Lakes' environment. Every person, recreational vehicle, or boat that travels through the watershed has to dispose of their wastes somewhere and, the majority of the time, those wastes, either directly or indirectly, find their way into the Lakes. The Baddeck route sees just shy of 300,000 party trips[5] per season. There are nine anchorage areas identified in this sub-watershed, however, Baddeck is, by far, the most popular area for anchorage.

The majority of the commercial boating activity in the Lakes revolves around the Little Narrows Gypsum Mines and the small, local, fishing industry. There are typically between 30 to 100 ships ranging between 11,500 and 59,000 tons dead weight that pass

[4] Nova Scotia Tourism and Culture. "2000 Nova Scotia Traffic Flow Report" February 2002. Available at http://www.nstpc.com/docs/Traffic_Flow_Report.pdf. Figure based on total party trips minus party pass through or the sum of party stops, party visits and overnight party trips.

[5] Party trips – Represents the sum of party pass through, party stops, party visits and overnight party trips for a specific community. Nova Scotia Tourism and Culture. "2000 Nova Scotia Traffic Flow Report" February 2002. Available at http://www.nstpc.com/docs/Traffic_Flow_Report.pdf.

through the Great Bras d'Or Channel bound for the Little Narrows Gypsum Mine from May to December. The number of fishing vessels in the Lakes is somewhat less clear. Data from 1983 indicate there were approximately 31 boats located within the Lakes. An additional 22 fishing boats were located at the mouth of the Great Bras d'Or Channel and another 82 boats located at the mouth of the Little Bras d'Or Channel, with the vast majority of these vessels' activities occurring outside the Lakes (Kenchington 2001). Changes in fisheries regulations through the 1990s (discussed in Response section) caused a reduction in commercial fishing and likely a reduction in commercial vessels using the Lakes. A few licenses have since been acquired by First Nation communities, which would add to the total number of boats present in the Lakes, however, the majority of newly acquired licenses are for areas and species that are fished outside the Bras d'Or Lakes. Other boats that occasionally visit the Lakes are those of the Coast Guard, Department of Fisheries, RCMP, Navy, and various research vessels including two stationed in Eskasoni that are owned by the Eskasoni Fish and Wildlife Commission. Cruise ships are also reported to travel into the Baddeck area three or four times per year.

There are currently five locations scattered throughout the Bras d'Or Lakes that offer facilities for pumping sewage from boats. The community of Baddeck has two of the five pump-out stations. The pump-out station located at the Cape Breton Boat Yard has a manual pump and a mobile container that is then transferred to the municipal system. The second station is located at Baddeck Marine and is directly hooked to the municipal system, although it is reported to be slow and requires upgrades. In 2002, the number of pump-outs reported by marina operators was as follows: 22 at the Barra Strait Marina, 7 at Cape Breton Boat Yard, 50 at the marina in Baddeck, 4 at the Dundee Marine, and 62 at Wallace MacAskill Marina in St. Peter's. It is important to note that the pump-out stations are limited to use by small crafts. Larger vessels are unable to dock at these locations because of inadequate water depth.

A number of camping facilities and trailer parks exist around the Lakes. Some of these facilities utilize package treatment systems before discharging into the Bras d'Or Lakes or waters flowing into the Lakes. Fraser's Trailer Camp, for example, has a package plant with a 7,500 gallons per day design flow that serves 30 hook-ups. The KOA campground in Baddeck has a dumping station that feeds into a two-cell lagoon with a chlorination contact chamber. The effluent is then discharged into the Baddeck River (Baddeck River sub-watershed). More than 100 campsites at this campground have no sewage collection. The Seal Island Trailer Campground is equipped with two 5,000 gallon septic tanks and 3,000 ft of weeping tile in the disposal field. Four campgrounds are identified in the St. Patrick's Channel sub-watershed.

There are 37 direct sources of pollution identified in this sub-watershed, with all but one found in Baddeck Bay (sub-sector 010-005). Over 75% of the direct sources were identified as pipes. Potential source of pollution include pipes (~36%) and septic tanks (~43%) (Table 19).

Table 19. Direct and potential sources of pollution found along the shoreline in St. Patrick's Channel sub-watershed.

	SUB-WATERSHED: ST. PATRICK'S CHANNEL					
	Sub-Sectors	**Baddeck Bay/ St. Patrick's Channel NS-07-010-005**	**Little Narrows NS-07-010-007**	**Nyanza Bay NS-07-010-006**	**TOTAL**	**%**
STAUS OF SOURCES	Non Pollution Source	14	0	1	**15**	**5.7%**
	Direct	36	1	0	**37**	**14.2%**
	Potential	136	54	19	**209**	**80.1%**
	Total	**186**	**55**	**20**	**261**	
DIRECT	Water Sample					**0.0%**
	Outhouse	1			**1**	**2.7%**
	Pipe	27	1		**28**	**75.7%**
	Septic Tank	1			**1**	**2.7%**
	Lift Station					
	Water Course					
	Wharf					
	Treatment Plant	1			**1**	**2.7%**
	Agriculture					
	Non-Point (source that is not set to one location)	2			**2**	**5.4%**
	Non-Source					
	Leaching (leaching type source)	1			**1**	**2.7%**
	Other (miscellaneous, surface drainage)	3			**3**	**8.1%**
POTENTIAL	Water Sample				**0**	
	Outhouse	13	3	1	**17**	**8.1%**
	Pipe	50	23	2	**75**	**35.9%**
	Septic Tank	58	20	13	**91**	**43.5%**
	Lift Station				**0**	
	Water Course				**0**	
	Wharf	4		1	**5**	**2.4%**
	Treatment Plant	1			**1**	**0.5%**
	Agriculture				**0**	
	Non-Point (source that is not set to one location)	2	4	1	**7**	**3.3%**
	Non-Source		1	1	**2**	
	Leaching (leaching type source)	4	3		**7**	**3.3%**
	Other (miscellaneous, surface drainage, marina)	4			**4**	**1.9%**

State

Poor water quality has been reported in the waters surrounding Baddeck (Shellfish Growing Area Sub sector NS-7-010-005). Levels of bacteriological contamination (fecal coliform densities) were as high as 1,700 MPN/100mL in some areas.

This area was last evaluated in 2003. The area has been surveyed for shellfish classification since at least 1963 with an increase in size of the closure in 1974. Currently, 9% of the marine area is closed to shellfish harvesting (Fig. 39).

Since 1998, there have been no additional areas closed to shellfish harvesting (Fig. 40) or additional sample stations with poor water quality (Table 20). Overall, there is no change in water quality for this area.

Figure 39. Percent of area in St. Patrick's Channel sub-watershed area classified as approved or closed and remaining area not sampled by Environment Canada.

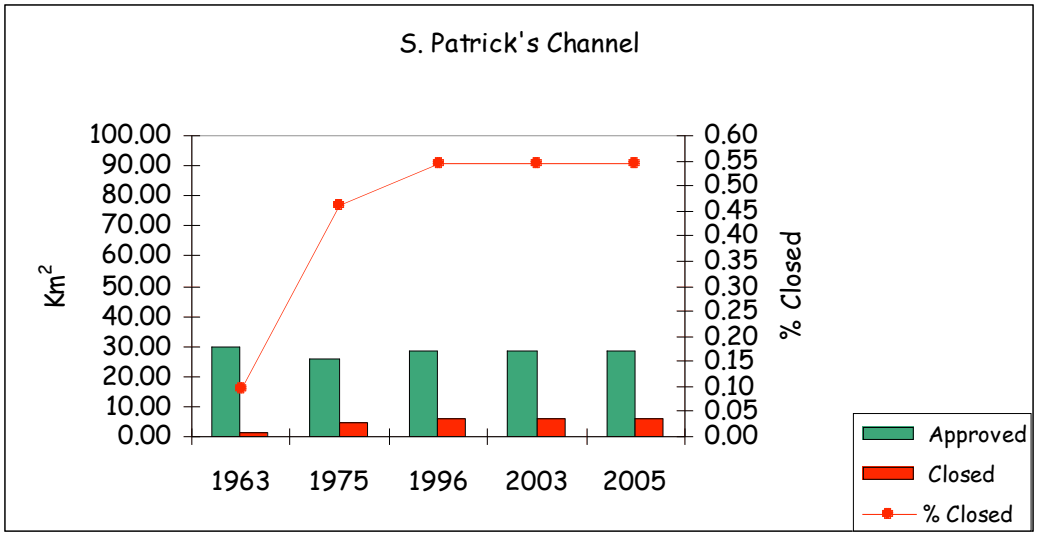


Figure 40. Changes in shellfish classifications over time for St. Patrick's Channel. Percent closed was standarized using the Lakes' area of 1,080 km^2.

Table 20. Water quality at sample stations in St. Patrick's Channel.

SUB-WATERSHED: ST. PATRICK'S CHANNEL					
Year	**Bacteriological Water Quality at Sampling Stations**	**Baddeck Bay/ St. Patrick's Channel NS-07-010-005**	**Nyanza Bay/St. Patrick's Channel NS-07-010-006**	**Little Narrows NS-07-010-007**	**TOTAL**
1998-1999	Approved	15	10	20	45
	Exceeded Levels	2	1	0	3
	Total	17	11	20	48
2000-2001	Approved	15	10	20	45
	Exceeded Levels	2	1	0	3
	Total	17	11	20	48

In 2003, a new sewage treatment plant was built for Baddeck Bay. Provided that the currently unserviced houses will be connected up to this plant, water quality should improve. As to the question of whether water quality has changed in this area, a review of some of the information provided by Environment Canada is necessary. Fecal coliform counts (raw data) in 1996 showed that water quality decreased in certain areas compared to counts from those sampling stations recorded in 1990. Overall water quality conditions have not changed significantly within this sub sector. Upgrades to the Baddeck sewage treatment plant were not completed when the 2003 survey was conducted. Baddeck is very popular for recreational boating during the tourist season and this will need to be factored into future surveys that investigate whether or not existing closures can be reduced.

Impact

As a result of elevated levels of fecal coliform contamination, one large shellfish closure (4.966 $km^{2)}$ is in effect (Figure 41). This is the largest continuous closure located on the Lakes. The area was last evaluated in 2003.

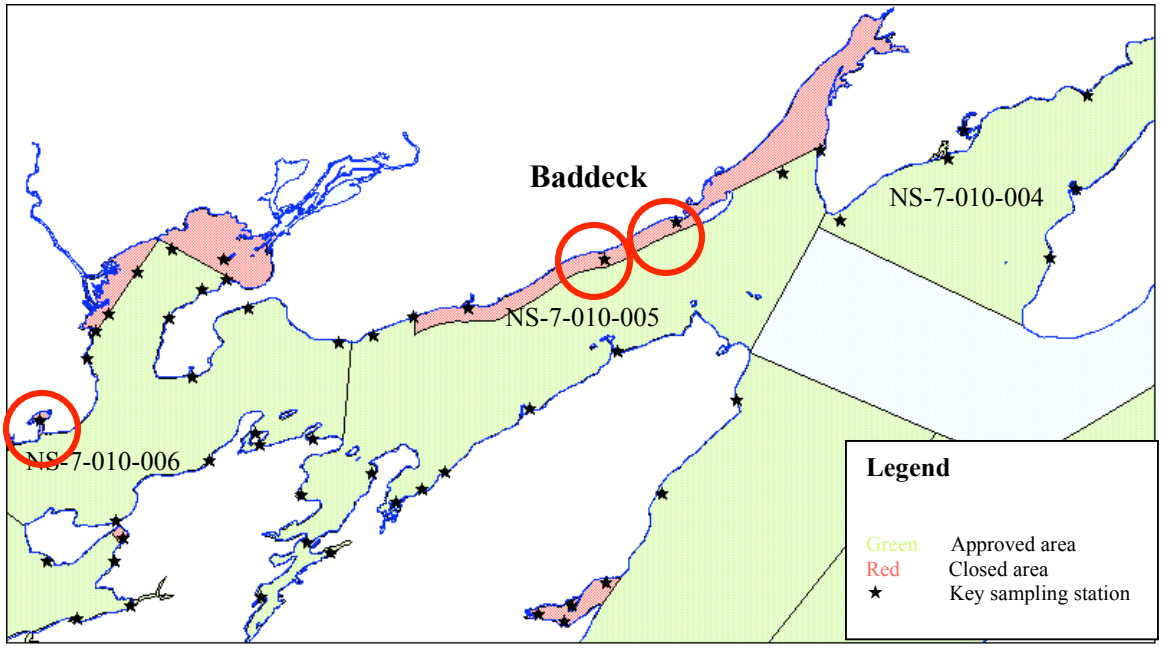


Figure 41. Shellfish Growing Area 7-010-005 (Baddeck). Red circles indicate sample stations with poor water quality. Note: Nyanza Bay is not included in this sub-watershed.

Response

High volumes of wastewater and an out-of-date sewage treatment plant prompted the community to invest in a new facility that began operating in May 2003. The new treatment plant is a state-of-the-art sequence batch reactor, or SBR, system with ultraviolet lights to treat the effluent. The system consists of one equalization tank, four batch reactors, and two sludge digesters. The sludge is treated on-site by way of a two-stage aerated digester and than dewatered by a centrifuge. The water is then fed back to stage one of the process and the remaining sludge is taken to a landfill site.

The treatment plant currently services approximately 500 households and businesses plus the marine pump-out stations, which are active during the summer boating season. Sources have noted that not all houses in Baddeck are hooked to the new treatment plant, specifically, a number of houses with malfunctioning septic systems on Shore Road. The capacity of the new system is 1,000,000 gallons and, on the day of our site visit (a rainy November 26, 2004), the plant operator said it was operating at 250,000 gallons but, during tourist season, it would double that intake value. Fecal coliform test results for the treated discharge were, at times, as low as 10 ppm, and the BODs and Suspended Solids were returning better than acceptable values of 20 ppm. This is the most advanced treatment plant located on the Bras d'Or Lakes.

Further testing is needed to determine the effects the new treatment plant is having on the water quality in the Baddeck area. As the old treatment plant was suspected to be the major cause of poor water quality, it would be surprising if the water quality did not show signs of improvement, although it may take several years to notice changes.

II. Chemical Water Quality

Driving Force

Chemical water quality is primarily affected by local industrial activities but other sources that may contribute pollution are leakage from landfill sites and dumps, and illegal or unauthorized dumping of wastes in the watershed area. Chemicals from fertilizers are known to contribute phosphorous and nitrates to the watershed through run-off during precipitation events.

Pressure

There are a few produce farms located in the Bras d'Or Lakes watershed and current information on the type of agriculture taking place is limited but produce farms are restricted to lands around the Skye, Middle and Baddeck Rivers, all of which are major contributors of freshwater to the Bras d'Or Lakes. Most of the arable soil within the watershed is inside forestry reserves or used for farming. The opportunities for expanding agriculture are limited by the lack of quality soil remaining (UMA 1989).

Mining also takes place within the watershed. One of two gypsum mines found in Unama'ki is located in Little Narrows (Little Narrows Gypsum). The mine uses an open-pit method of extraction and ships raw product to other areas for refinement. Approximately 30–100 vessels dock at Little Narrows Gypsum between May and October each year.

One hospital is located on the shores of the Bras d'Or Lakes (Victoria County Community Hospital, Baddeck) with effluent treated through the municipal sewage system. Wastes, medications, potent cleaners, and other substances are likely dissolved in the effluent.

It is undetermined whether rural non-First Nation communities have sites that are used for illegal dumping.

Baddeck is home to a newly developed, first-class golf course. Fertilizers, herbicides, and pesticides from the course are likely entering the Bras d'Or Lakes during times of heavy rainfall.

State

Organic Compounds and Heavy Metals

Organic contamination (PCBs, PAHs) and heavy metal concentrations (copper, zinc, lead and cadmium; Cu, Zn, Pb and Cd respectively) in sediments, water and biota are well below the federal sediment and water quality guidelines for the protection of aquatic life (Appendix 4).

The main source of heavy metals flowing into the Bras d'Or Lakes is through the Great Bras d'Or Channel from Sydney Bight. Metal concentrations are low in the rivers that drain into the Bras d'Or Lakes compared with rivers New Brunswick and Nova Scotia, however, in 1995, higher concentrations were found for cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn) in Cape Breton rivers than other sample rivers in Nova Scotia and New Brunswick (Dalziel et al.1998).

Productivity

The productivity of the Bras d'Or Lakes has been described as low and can only support a relatively low level of natural productivity (Strain and Yeats 2002). Nitrogen and phosphorous are essential elements for phytoplankton production. Nitrogen and phosphorous inputs are derived primarily from coastal exchange with Sydney Bight and from vertical mixing with deep waters in the Channels. Other external sources of nitrogen and phosphorous are from rivers, sewage, aquaculture or agriculture, but are more localized and have little effect on the production of the Bras d'Or Lakes as a whole. Nitrate, ammonia, and dissolved oxygen measurements are consistent with Atlantic coastal inlets for Nova Scotia (Strain and Yeats 2002).

Potentially toxic phytoplankton has been found in the Bras d'Or Lakes although no reports of outbreaks from shellfish poisoning–such as diarrhetic shellfish poisoning (DSP), amnesic shellfish poisoning (ASP) or paralytic shellfish poisoning (PSP)–have occurred to date. All sampling sites, including Cranberry Cove (outside Baddeck) had at least four of the potentially toxic algae identified in the Bras d'Or Lakes, although in differing quantities. A list of species identified is found in Appendix 5.

Oxygen

Dissolved oxygen concentrations are within acceptable limits in sediment and water quality guidelines for the protection of animal life. There is limited information on water quality in barachois ponds, but we can expect these areas in particular to suffer from eutrophication, especially where there is established summer residency and little exchange of water with the main body of the Lakes.

Overall, the quality of the water is very good with respect to heavy metal and organic compound contamination. Dena's Pond and numerous barachois ponds located around the Lakes are more likely to experience enriched nutrient content from high bacteriological contamination, limited and slow exchange with the main body of the Lakes, or both, and as a result suffer the biological consequences of eutrophication.

Impact

There is little impact on the chemical quality of the water in the Bras d'Or Lakes primarily because of few industrial and aquaculture activities, and small population size. "The Lakes as a whole should be relatively unaffected by new inputs of nutrients from human activities and are at low risk for eutrophication" (Strain and Yeats 2002, p. 61). Many metals found in trace amounts are required for biological processes, such as zinc. Those metals found in greater levels have the effect of poisoning organisms (including humans), are especially toxic to aquatic micro-organisms, and bio-accumulate in the food chain (Government of British Columbia 2005).

Finfish aquaculture in the Bras d'Or Lakes was popular in the 1990s with fish cage systems established in Dena's Pond, but it is no longer in operation. Concern for the environmental impact of finfish aquaculture on water quality is no longer a challenge as a result of the closure of all finfish sites; however, long-term or residual effects of anti-fouling chemicals and antibiotics from feed may still be a concern in these areas.

Increases in phosphorous to a localized environment, under the right conditions, can cause large increases in algae, blue-green algae (cyanobacteria), and bacterial production. Combined with a lack or limited exchange between the air or other oxygen rich waters, the area can become eutrophic and depleted. Other effects are reduction in light transmission as a result of overproduction of algae, increase in detritus (dead organic matter) settling in the sediment, strong hydrogen sulphide odours, and mass mortalities of fish and invertebrates making the water unsuitable for recreation, aquaculture, or fishing (Brönmark and Hansson 1998).

Response

As chemical water quality is still very good in the Bras d'Or Lakes, there are no additional local management initiatives. Since 1999, Environment Canada and Eskasoni Fish & Wildlife Commission Inc. have mapped potential fecal coliform bacteria pollution sources all around the Bras d'Or Lakes, barachois ponds, and connecting bodies of water. There is no long-term monitoring in place for heavy metals, oxygen, pH, potentially toxic phytoplankton, or organics for these areas by federal, provincial, or First Nations' governments.

In 2003, UINR, in partnership with Environment Canada, initiated an environmental awareness program to educate the public on some of the issues that threaten the Bras d'Or Lakes. Posters and brochures were developed as the means to convey information on protecting the Bras d'Or Lakes, providing information on invasive species, etc.

III. Sedimentation

Driving Force

Sedimentation causes are derived from the land surrounding the Bras d'Or Lakes. The shores of the Bras d'Or Lakes are easily subjected to erosion because of the geology of Cape Breton Island. The perimeter of the Bras d'Or Lakes is lined with residential developments and cottages. Some houses are located along the shoreline. Lawns are extended to the shores as well with little vegetation, such as trees, available to act as traps to prevent sedimentation from occurring.

Clear-cutting in forests along the rivers may be a problem in some First Nation communities and a contributing factor in non-First Nation lands prior to April 2000 when provincial legislation came into effect. Clear-cutting around streams and rivers on First Nation communities also occurs. Naturally high elevations in some areas, such as Eskasoni, We'koqma'q, and Wagmatcook, make expansion of residential developments away from the shoreline difficult.

Land developments and building of roads, both highway and access roads, contribute to excessive or unnatural sedimentation accumulations. Sub-division developments are occurring in River Denys, off Whycocomagh Bay, and in First Nation and larger non-First Nation communities. The majority of the provincial roads are situated along the perimeter of the Bras d'Or Lakes, and often very close to the water, except in areas of high elevations.

Gypsum mining is one of the few industries found along the shores of the Bras d'Or Lakes. 1.2 million tons are exported annually via freight carriers entering and exiting the Bras d'Or Lakes. Approximately 30 to 100 boats come into Little Narrows to receive shipments of gypsum rock.

Pressure

The demand for land with water views or direct water access is high and so are the property values. Property owners are free to remove naturally occurring vegetation from their property edge, except along streams and lakes that are protected by the provincial government.

Forestry is the prominent industry in Cape Breton. Stora-Enso leases the majority of Crown Lands that are harvested for softwood. The majority of the harvesting lands are found in the Cape Breton Highlands, which is included in the Bras d'Or Lakes watershed. Occasional harvesting also occurs on First Nation lands by individuals with little enforcements.

State

There is some information on the rate of sedimentation for this sub-watershed. A general estimate of 5 cm/century is given for St. Patrick's Channel but there are areas where there has been no sedimentation occurring, such as south of Baddeck (J. Shaw pers. comm. 2005).

After rainfall, there are many areas where muddy water forms a band around the perimeter of the shoreline, especially in the area of residential developments. The width of the band varies depending upon rainfall and wind conditions at the time.

Information is available on the location of suitable oyster beds. Naturally occurring oyster beds are a reflection of the bottom type available for oyster settlement and can thus be used to gauge general increases in sedimentation. There is no current information on whether these areas are still suitable for oysters to settle.

Impact

Loss of oyster habitat is becoming an increasing problem, especially in areas of low tidal action. Losses of habitat often result in loss of existing communities of organisms, to be replaced by those species that are more adaptable to the newly-created habitat. The loss of oysters, either by loss of habitat, clogging of filtering apparatus, or suffocation also results in a loss of the water's natural filtering system.

Atlantic herring spring-spawning populations in the Bras d'Or Lakes have been declining over the past decade and no longer support a commercial fishery (Denny et al. 1998). Numerous spawning areas were documented in the Lakes prior to 1996, including Baddeck Bay and Herring Cove, but the numbers have declined with smaller spawning biomass. It is uncertain whether environmental changes, such as loss of habitats, or human pressures, such as the commercial fishery, have caused a decline in the spring-spawning population of Atlantic herring, but simultaneous pressure of both are likely contributors.

Response

Provincial legislation protects stream and rivers from excessive sedimentation during forestry operations by implementing riparian buffer zones known as Special Management Zones (SMZ). These extend 20 m on each side of a channel that is greater than 50 cm in width. Nova Scotia Department of Natural Resources enforces SMZ in harvesting practices. StoraEnso, operating under its own Environmental Management System, exceeds the minimum requirements under provincial legislation and the Nova Forest Alliance Best Management Practices (StoraEnso 2004). It is the responsibility of the landowner to implement proper erosion control measures to protect the aquatic environment from sedimentation (Department of Natural Resources 2005).

Sub-Watersheds: Middle River & Baddeck River

The sub-watershed areas are named after the rivers that drain into Nyanza Bay. They are two of six rivers responsible for most of the freshwater input into the Bras d'Or Lakes. Because these two rivers drain into the same small bay, they could not reasonably be divided into separate sub-watershed components and will be discussed together. Of all the sub-watershed components, this has the smallest combined area of only 6.6 km^2. Wagmatcook First Nation is found here. It is the second-smallest First Nation community in Unama'ki. Wagmatcook is located approximately 20 km west of Baddeck and at the mouth of the Middle River. It is home to approximately 435 residents (Statistics Canada 2001).

1. Bacteriological Water Quality

Driving Force

Waqmatcook is a small First Nation community whose population has changed little over the past 10 years. From 1991 to 2001, the population increased by only 71 people, to reach 444 in 2001. Although population growth has been slow, the number of new homes constructed during this period accelerated, from 10 new homes built between 1981 to 1991, to 60 new homes built between 1991 to 2001. The total number of households in Wagmatcook is 130. This trend appears to be continuing and there is currently a plan to construct a new subdivision of approximately 12 houses, all of which will be connected to the newly modified south-end lagoon.

The Middle and Baddeck Rivers empty into Nyanza Bay. Activities farther up in the sub-watershed may have an impact on the water quality.

Pressure

The community of Wagmatcook has two sewage treatment systems serving the community. The older East End lagoon was built in 1971 and is a simple, single-cell lagoon that discharges into the Middle River estuary. The newer three-cell lagoon, known as the South End lagoon, was constructed in 1993/94 and discharges into the Bras d'Or Lakes at Nyanza Bay. Both the East End lagoon and the South End lagoon have significant shortcomings in regards to capacity and design (MGI 2002c).

Lack of sampling is another problem facing the community. Prior to the summer of 2004, sampling was conducted twice a year (spring and fall) by the Department of Indian and Northern Affairs (INAC). Unfortunately, the individual who held this position

left the job and there has been no replacement. As a result, there is no testing currently being carried out at either location.

East End Lagoon

The large East End lagoon services 40% of the homes on the Reserve, as well as a local school, for approximately 300 people. This is a facultative system that uses a contact chamber for chlorination treatment of the effluent before it is discharged into Middle River. This system has one notable advantage over the three-cell lagoon in that the operator is able to determine the settling time, compared to the newer three-cell lagoon, which discharges continually.

The system is now well over its original designed capacity of about 150 people. The overuse of the system has contributed to several years of test results that exceed the Guidelines for Effluent Quality at Federal Establishments for suspended solids, biological oxygen demand (BOD), and fecal coliform bacteria. However, as mentioned above, no testing program is currently in place.

A 1998 study by the engineering and consulting firm, CBCL Limited, concluded that by making upgrades–such as increasing the berm height, installing a mechanical aeration system, constructing a treatment building, and other modifications–the capacity of the lagoon could be increased to accommodate 800 people (ADI Limited, 1999). These recommendations have yet to be initiated.

South End Lagoon

The South End lagoon is a three-cell aeration system with five active aerators in the first cell and three in the second cell, with the third cell functioning as a settling pond. The system services roughly 60% of the community and is operating well below its maximum capacity. However, the functioning of the system needs improvement. The facility operator reported that the aerators are not functioning properly and lose pressure farther down the line away from the pump house. Furthermore, it was suggested that the system never functioned properly since its construction in 1993. An obvious example of this is the location of the outflow pipe, which discharges on land, never having been extended to the Lakes as originally planned.

The 1999 *Environmental Baseline Study of Six Nova Scotia First Nations* prepared by ADI Limited, suggested that the existing Sanuril Chlorination system is difficult to control and recommended retrofitting to a hypo-chlorination system. It has not been determined if this has been done. Effluent monitoring results show that the system is performing fairly well and only occasionally exceeds effluent targets (Pers. Comm.). However, all monitoring has since stopped with the departure of the person who was formally responsible for testing.

The collection system which transports wastewater to the South End lagoon is supported by two lift stations. These lift stations have been known to overflow mainly because of pump malfunctions in periods of heavy precipitation. The overflow is discharged directly into the Bras d'Or Lakes. No holding tanks are present. For the location of the lift stations and the wastewater collection system, see Appendix 6.

Improvements in the entire South End lagoon system are planned. These upgrades will increase both the capacity and the efficiency of the system.

The small community of Middle River (population 300) is one the largest communities found in this sub-watershed. As this community is not situated directly on the shores of the Bras d'Or Lakes, it is unknown how many potential sources of pollution drain into Middle River that ultimately end up in Nyanza Bay. Recreational fishing (catch and release) is popular in Middle River. It is one of the few areas that has Atlantic salmon, albeit hatchery reared.

Two sources of direct pollution were found in this area and were identified as a pipe and the treatment plant in Wagmatcook (Table 21). Potential sources of pollution found here include septic tanks (~58%) and outhouses (~10%) (Table 21).

State

All marine waters of Nyanza Bay are sampled by Environment Canada. A large proportion is closed to shellfish harvesting (Fig. 42), however, there is only one sample station showing poor water quality (Table 22). No changes in shellfish closures have been observed (Fig. 43) although there has been an increase in the number of sample stations showing poor water quality (Table 22). Overall, there has been a decrease in water quality in this area.

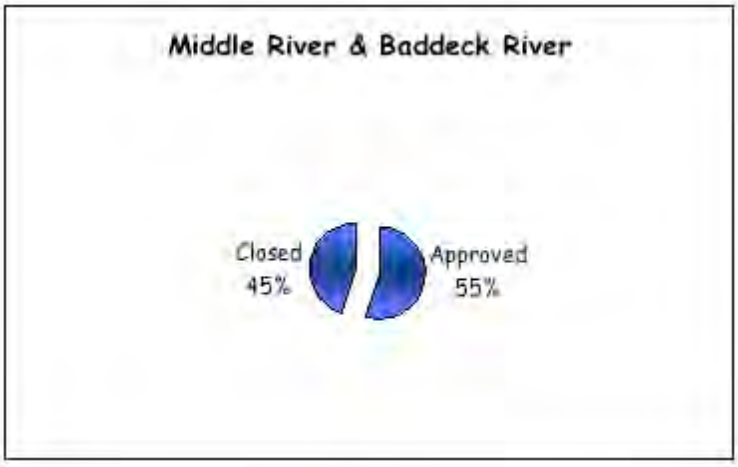


Figure 42. Percent of area of Nyanza Bay (Middle River and Baddeck River sub-watershed areas) closed and open (approved) to shellfish harvesting.

Table 21. Direct and potential sources of pollution found along the shoreline in Nyanza Bay.

SUB-WATERSHED AREA: MIDDLE & BADDECK RIVERS

	Sub-Sectors	Nyanza Bay/ St. Patrick's Channel NS-07-010-006	TOTAL	%
STAUS OF SOURCES	Non Pollution Source	3	**3**	**4.2%**
	Direct	2	**2**	**2.8%**
	Potential	67	**67**	**93.1%**
	Total	**72**	**72**	
DIRECT	Water Sample		**0**	
	Outhouse		**0**	
	Pipe	1	**1**	**50.0%**
	Septic Tank		**0**	
	Lift Station		**0**	
	Water Course		**0**	
	Wharf		**0**	
	Treatment Plant	1	**1**	**50.0%**
	Agriculture		**0**	
	Non-Point (source that is not set to one location)		**0**	
	Non-Source		**0**	
	Leaching (leaching type source)		**0**	
	Other (miscellaneous, surface drainage)		**0**	
POTENTIAL	Water Sample		**0**	
	Outhouse	7	**7**	**10.4%**
	Pipe	6	**6**	**9.0%**
	Septic Tank	39	**39**	**58.2%**
	Lift Station		**0**	**0.0%**
	Water Course		**0**	
	Wharf	1	**1**	**1.5%**
	Treatment Plant	6	**6**	**9.0%**
	Agriculture		**0**	
	Non-Point (source that is not set to one location)	3	**3**	**4.5%**
	Non-Source	1	**1**	**1.5%**
	Leaching (leaching type source)	3	**3**	**4.5%**
	Other (miscellaneous, surface drainage, marina)	1	**1**	**1.5%**

Table 22. Water quality at sample stations in Nyanza Bay.

SUBWATERSHEDS: MIDDLE AND BADDECK RIVERS			
Year	Bacteriological Water Quality Sampling at Stations	St. Patrick's Channel/Nyanza Bay NS-07-010-006	TOTAL
1998-1999	Approved	9	9
	Exceeded Levels	0	0
	Total	9	9
2000-2002	Approved	8	8
	Exceeded Levels	1	1
	Total	9	9

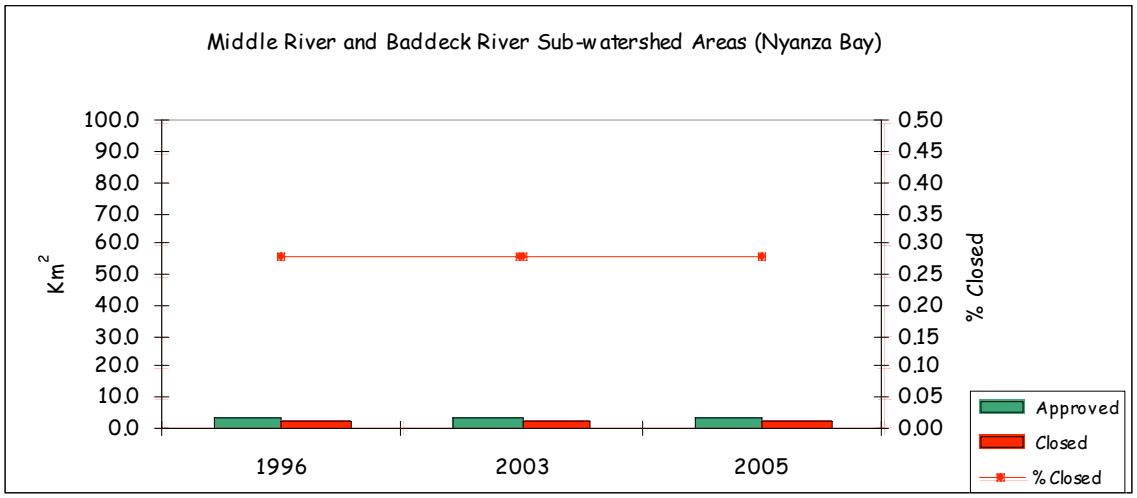


Figure 43. Changes in shellfish classification for Nyanza Bay. Percent closed was standarized using the Lakes' area of 1,080 km^2.

Impact

Due to concerns of elevated fecal coliforms, one large section totalling 2.99 km^2, of this potential aquaculture area, has been closed to shellfish harvesting (Fig. 44).

Beach closures occurred in 2000 in Wagmatcook.

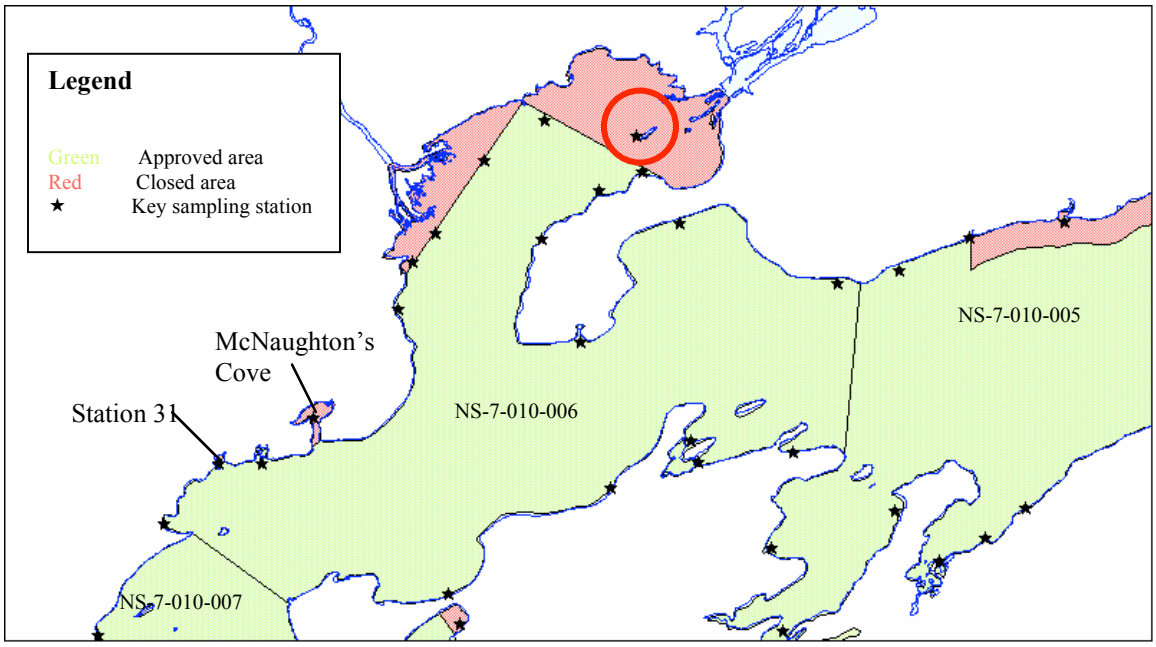


Figure 44. Shellfish Growing Area Subsector NS-7-010-006 (Wagmatcook First Nation). The red circle indicates the sample station with poor water quality. Note: Only Nyanza Bay makes up the sub-watershed areas of Middle River and Baddeck Rivers.

Response

Throughout the years, a number of mitigation projects have taken place and more are being planned in an effort to improve marine water. Included in these measures has been the participation of the plant operator in the Circuit Rider Program. This program began in October 2002 as part of the INAC's First Nations Water Management Strategy that was aimed at providing safe drinking water to First Nation communities, and protecting the environment through efficient wastewater management. The plant operator has received Level 1 certification through this program. Other initiatives have been taken by the Band to upgrade the sewage collection system, such as the repair of the lift station on Fisheries Road in 2003.

The most significant response taken by the Band is the proposed upgrades to the South End lagoon. This upgrade will increase the system's capacity as well as its functioning capabilities.

II. Chemical Water Quality

Driving Force

Chemical water quality is primarily affected by local industrial activities but other sources that may contribute pollution are leakage from landfill sites and dumps, and illegal or unauthorized dumping of wastes in the watershed area. Chemicals from fertilizers are known to contribute phosphorous and nitrates to the watershed through run-off during precipitation events. Farming takes place in the Middle River sub-watershed near the community of Middle River.

Tourism is popular in many of the rural areas. Both the Baddeck River and Middle River are popular canoeing and fishing areas.

Pressure

There are a few produce farms located in the Bras d'Or Lakes watershed and current information on the type of agriculture taking place is limited, but produce farms are found in lands around the Skye, Middle, and Baddeck Rivers, all of which are major contributors of freshwater to the Bras d'Or Lakes. Most of the arable soil within the watershed is inside forestry reserves or used for farming. The opportunities for expanding agriculture are limited by the lack of quality soil remaining (UMA 1989).

Baddeck Forks Golf Course is located near the Baddeck River. There is a possibility of fertilizers and herbicides entering the river during times of heavy rainfall. It is undetermined whether dumping occurs in this sub-watershed, however, given the fact that it is a popular recreational area, there are likely cases of dumping of garbage from camping activities.

State

Organic Compounds and Heavy Metals

Organic contamination (PCBs, PAHs) and heavy metal concentrations (copper, zinc, lead and cadmium; Cu, Zn, Pb and Cd respectively) in sediments, water, and biota are well below the federal sediment and water quality guidelines for the protection of aquatic life (Table 1 and 4). These concentrations are lower compared with other areas, such as Halifax and Sydney Harbours, despite lower salinities found in the Bras d'Or Lakes. Higher concentrations of metals are generally higher in lower saline environments (Strain and Yeats 2002).

The main source of heavy metals flowing into the Bras d'Or Lakes is through the Great Bras d'Or Channel from Sydney Bight. Metal concentrations are low in the rivers that drain into the Bras d'Or Lakes compared with rivers in New Brunswick and Nova Scotia. However in 1995, higher concentrations were found for cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn) in Cape Breton rivers than other sample rivers in Nova Scotia and New Brunswick (Dalziel et al.1998).

Methyl mercury, lead, and arsenic were detected in fish samples in 2002-2003 but were well below guidelines established under the Canadian Food Inspection Agency (Denny and Berubé 2003). At the time of this report, samples taken by UINR in 2004 from sediment, water, and traditional marine foods are being analyzed for metals and organic compounds.

Productivity

The productivity of the Bras d'Or Lakes has been described as low, supporting a relatively low level of natural productivity. (Strain and Yeats 2002) Nitrogen and phosphorous are essential elements for phytoplankton production. Nitrogen and phosphorous inputs are derived primarily from coastal exchange with Sydney Bight and from vertical mixing with deep waters in the channels. Other external sources of nitrogen and phosphorous are from rivers, sewage, aquaculture or agriculture but are more localized and have little effect on the production of the Bras d'Or Lakes as a whole. The nitrogen to phosphorous ratio required for phytoplankton production (the Redfield ratio) is 16:1; Bras d'Or Lakes' ratios have been found in the range of 5.4:1, 4.6:1, and 2.7:1 (spring, summer, and fall respectively), which suggests that nitrogen is the limiting nutrient in the Lakes (Strain and Yeats 2002). Nitrogen: phosphorous ratios for Sydney Bight increased to their highest levels in February (to 10:1) in studies completed between 1995-1997, but is considered low for coastal areas. Chlorophyll *a* concentrations are also found to be low throughout the Lakes, but the measurements made may have taken place after spring bloom had taken place in 1996. Nitrate, ammonia, and dissolved oxygen measurements are consistent with Atlantic coastal inlets for Nova Scotia (Strain and Yeats 2002).

Potentially toxic phytoplankton has been found outside Wagmatcook although no reports of outbreaks from shellfish poisoning–such as diarrhetic shellfish poisoning (DSP), amnesic shellfish poisoning (ASP) or paralytic shellfish poisoning (PSP)–have occurred to date. All sampling sites had at least four of the potentially toxic algae identified in the Bras d'Or Lakes, although in differing quantities. A list of phytoplankton species identified in the 2002 study is found in Appendix 5.

Oxygen

Dissolved oxygen concentrations are within acceptable limits for sediment and water quality guidelines for the protection of animal life.

Overall, the quality of the water is very good with respect to heavy metal and organic compound contamination.

Impact

There is little impact on the chemical quality of the water in the Bras d'Or Lakes primarily because of few industrial and aquaculture activities, and small population size. "The Lakes as a whole should be relatively unaffected by new inputs of nutrients from human activities and are at low risk for eutrophication" (Strain and Yeats 2002, p. 61). Many metals found in trace amounts such as zinc, are required for biological processes. Those metals found in greater levels have the effect of poisoning organisms, including humans, are especially toxic to aquatic micro-organisms, and bio-accumulate in the food chain (Government of British Columbia 2005).

Finfish aquaculture in the Bras d'Or Lakes was popular in the 1990s with fish cage systems established in Seal Island, Whycocomagh Bay, Dena's Pond, and St. Peter's Inlet but are no longer in operation as of 2003-2004. Concern for the environmental impact of finfish aquaculture on water quality is no longer a challenge as a result of the closure of all finfish sites, however, long-term or residual effects of anti-fouling chemicals and antibiotics from feed may still be a concern in these areas.

Increases in phosphorous to a localized environment under the right conditions, can cause large increases in algae, blue-green algae (cyanobacteria), and bacterial production. Combined with a lack or limited exchange between the air or other oxygen rich waters, the area can become eutrophic and depleted. Other effects are reduction in light transmission as a result of overproduction of algae, increase in detritus (dead organic matter) settling in the sediment, strong hydrogen sulphide odours, and mass mortalities of fish and invertebrates making the water unsuitable for recreation, aquaculture, or fishing (Brönmark and Hansson 1998).

Response

As chemical water quality is still very good in the Bras d'Or Lakes, there are no additional local management initiatives. Since 1999, Environment Canada and Eskasoni Fish & Wildlife Commission Inc. have mapped potential fecal coliform bacteria pollution sources all around the Bras d'Or Lakes, barachois ponds, and connecting bodies of water. There is no long-term monitoring in place for heavy metals, oxygen, pH, potentially toxic phytoplankton, or organics for these areas by federal, provincial, or First Nations' governments.

Sub-Watershed: Great Bras d'Or

Great Bras d'Or Channel is situated in the north western portion of the Bras d'Or Lakes and is the main channel of exchange between the Bras d'Or Lakes and Sydney Bight. It is the main entrance to the Bras d'Or Lakes for larger vessels and consequently, is less suitable for aquaculture than other areas (Craig et al. 2001). However, temperature, salinity, and flushing times are more similar to a true ocean environment than anywhere else in the Bras d'Or Lakes and make it more suitable than any other area for certain types of aquaculture, such as finfish.

Shoreline and land elevations are particularly steep on the western side of the Great Bras d'Or Channel and, as a result, the area is sparsely populated although there are cottages and homes situated along the shoreline. Small animal farms are common in this area (Craig et al. 2001).

1. Bacteriological Water Quality

Driving Force

Farms with small animals are found in this area. Finfish aquaculture was popular in Seal Island in the 1990s but is no longer in operation. Homes and cottages are common along the shoreline.

Pressure

Direct sources of pollution in this area are high, with 80% of direct sources identified as pipes (Table 23). An outhouse and run-off from a field containing chemical fertilizer and manure are other direct sources identified.

State

The majority of the marine waters in this area are sampled and classified. Only 1% of the sub-watershed area is closed to shellfish harvesting while 87% remains open (Fig. 45). Poor water quality was reported in Great Bras d'Or Centre (sub-sector 010-003), but no changes were observed in numbers of sample stations that showed poor water quality between evaluation years (Table 24). A new sub-sector was added and sampled in 2000, but no new closures were issued (Craig et al. 2001). The area closed to shellfish harvesting has not changed between 2003 and 2005 (Fig. 46). Overall, there has been a slight increase in shellfish closures in the past decade (Fig. 46) with no change in water quality in the past five years (Table 24).

Table 23. Direct and potential sources of pollution identified in the receiving waters of the Great Bras d'Or sub-watershed area.

	SUB-WATERSHED: GREAT BRAS D'OR Sub-Sectors	Great Bras d'Or Centre NS-07-010-004	Great Bras d'Or East NS-07-010-003	Great Bras d'Or West NS-07-010-002	TOTAL	%
STAUS OF SOURCES	Non Pollution Source	4	9	5	**18**	**12.1%**
	Direct	0	10	0	**10**	**6.7%**
	Potential	41	38	42	**121**	**81.2%**
	Total	**45**	**57**	**47**	**149**	
DIRECT	Water Sample					
	Outhouse		1			**10.0%**
	Pipe		8		**8**	**80.0%**
	Septic Tank					
	Lift Station					
	Water Course					
	Wharf					
	Treatment Plant					
	Agriculture					
	Non-Point (source that is not set to one location)					
	Non-Source					
	Leaching (leaching type source)					
	Other (miscellaneous, surface drainage)		1		1	**10.0%**
POTENTIAL	Water Sample				**0**	
	Outhouse	2	4	3	**6**	**5.0%**
	Pipe	3	21	6	**24**	**19.8%**
	Septic Tank	28	3	27	**31**	**25.6%**
	Lift Station				**0**	
	Water Course	4			**4**	**3.3%**
	Wharf	2			**2**	**1.7%**
	Treatment Plant					
	Agriculture					
	Non-Point (source that is not set to one location)	1	3	1	**4**	**3.3%**
	Non-Source					
	Leaching (leaching type source)		3		**3**	**2.5%**
	Other (miscellaneous, surface drainage, marina)	1	4		**5**	**4.1%**

Figure 45. Percent of the marine area of the Great Bras d'Or sub-watershed classified for shellfish harvesting and remaining area currently not sampled.

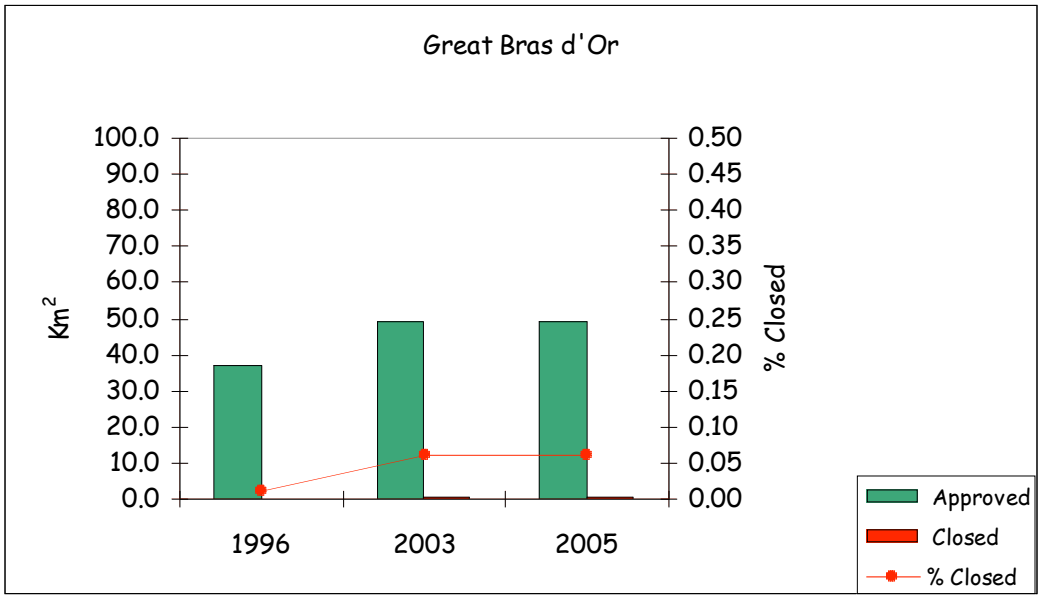


Figure 46. Shellfish closed areas in Great Bras d'Or. Percent closed was standarized using the Lakes' area of 1,080 km^2.

Table 24. Water quality at sample stations in each sub-sector of the Great Bras d'Or sub-watershed area.

SUB-WATERSHED: GREAT BRAS D'OR					
Year	Bacteriological Water Quality Sampling Stations	Great Bras d'Or Centre NS-07-010-003	Great Bras d'Or East NS-07-010-004	Great Bras d'Or West NS-07-010-002	TOTAL
1998-1999	Approved	16	8		24
	Exceeded Levels	3	0		3
	Total	19	8	0	27
2000-2002	Approved	16	8	13	37
	Exceeded Levels	3	0	0	3
	Total	19	8	13	40

Impact

Three shellfish closures totalling 0.62 km^2 are found in this sub-watershed area. Sample stations and closures that showed poor water quality are found in Big Harbour and in two unnamed coves in Boularderie.

Response

No additional responses found.

Literature Cited

Adams G.C. 1993. Gypsum and Anhydrite in Nova Scotia. Mineral Resources Branch Information Circular ME 16 Third Edition. [On-line]: http://www.gov.ns.ca/natr/meb/ic/ic16.htm. February 23, 2006.

ADI Limited. 1999. Environmental Baseline Study Of Six Nova Scotia First Nations. Prepared for: The Union of Nova Scotia Indians.

Barnes, R.S.K. and R.N. Hughes. 1988. Ch. 12. Human Exploitation and Interference. *In*: An Introduction to Marine Ecology. 2nd Edition. Cambridge: Blackwell Scientific Press. pp. 299-321.

Bjarnason, David, Nellie Roest, Melissa Marschke, Heidi Scheafer, Sharon Ho. (1998). *Taking Responsibility For Water Quality In The Bras d'Or Lakes.* Dalhousie University.

Brönmark, C. and L.A. Hansson, 1998. The Biology of Lakes and Ponds. New York: Oxford University Press. 216 pp.

Connolly, Pat. 2002. There's marble in them thar hills. The Cape Bretoner.com. Archives, 2002, vol. 10, no. 2. [On-line]: http://www. capebretoner.com/archives/02-10-02.html. August 9, 2005.

Craig, C, J.H Young, D. Walter, A.S. Menon, and C. Dennis. 1999. Re-evaluation Report, Nova Scotia Growing Area 7 (volume 1). Environment Canada Environmental Protection Branch, Manuscript Report No. EP-AR-99-3.

Craig, C, D. Walter, A.S. Menon, and C. Dennis. 2001. Re-evaluation Report, Nova Scotia Growing Area 7 (Bras D'Or Lakes, Volume 3). Environment Canada Environmental Protection Branch, Manuscript Report No. EP-AR-2001-15.

Craig, C, D. Walter, and C. Dennis. 2002. Re-evaluation Report, Nova Scotia Growing Area 7 (Bras D'Or Lakes, Volume 4). Environment Canada Environmental Protection Branch, Manuscript Report No. EP-AR-2002-018.

Crawford, R.H., D.M. Webber, and G. Boutlier. 1982. The biology of the herring from the Bras d'Or Lakes Cape Breton, Nova Scotia. Man. Tech. Rep. Ser. N.S. Dept. Fish. 82-04: iv + 66 p.

Dalziel, J.A., P.A. Yeats and P.B. Amirault. 1998. Inorganic chemical analysis of major rivers flowing into the Bay of Fundy, Scotian Shelf and the Bras d'Or Lakes. Can. Tech. Rep. Fish. Aquat. Sci. 2226.

Denny, S., Clark, K.J., M.J., Power, and R.L. Stephenson 1998. The status of the herring in the Bras d'Or Lakes in 1996-1997. Canadian Stock Assessment Secretariat Research Document 98/80: 33p.

Denny, S. and C. Berube 2003. Risk Assessment for the Consumption of Wild Fish for Five First Nation Communities in Unama'ki (Cape Breton), Nova Scotia. Final Project Report prepared for First Nations Environmental Contaminants Program Health Canada. Unama'ki Institute of Natural Resources, September 5, 2003.

Department of Natural Resources. 2005. Before you build a wharf or do other Work on the shore of your coastal waterfront property. [On-line]: **http://www.gov.ns.ca/natr/land/polocybeforeyoubuild.htm**. August 17, 2005.

Duxbury, A.C. and A. B. Duxbury. 1991. An Introduction to the World's Oceans. 3rd Edition. Dubuque: Wm. C. Brown. Publishers. 446 pp.

Government of British Columbia. 2005. Water Quality Ambient Water Quality Guidelines for Zinc Overview Report. [On-line]: **http://www.gov.bc.ca/wat/wq/Bcguidelines/zinc.html**. August 17, 2005.

Gurbutt, P.A., B. Petrie, and J.F. Jordon. 1993. The physical oceanography of the Bras d'Or Lakes: data analysis and modeling. Can. Tech. Rep. Hydrogr. Ocean Sci: 147, 61 pp.

Hipwell, William T, M.A. 2001. Taking Charge Of The Bras D'Or: Ecological Politics In The 'Land Of The Fog' Department of Geography and Environmental Studies, Carleton University. Ottawa, Ontario.

Kenchington, T. J. and E. Carruthers. 2001. Unamapaqt – A Description of the Bras d'Or Marine Environment (Version 0.2.2). Gadus Associates. Prepared for: Una'maki Environmental Committee, Union of Nova Scotia Indians. March 2001.

Malcolm, Karen, 2003. Proposed Designation of the Bras d'Or Lakes as a Non-Discharge Zone for Boating Sewage under the Canadian Shipping Act. The Pitu'paq Partnership.

MacArthur, David, C. Craig, D. Walter, and C. Dennis. 2002. Re-evaluation Report, Nova Scotia Growing Area 7 (Bras D'Or Lakes, Volume 5). Environment Canada Environmental Protection Branch, Manuscript Report No. EP-AR-2002-018.

MacArthur, David, C. Craig, D. Walter, and C. Dennis. 2003. Re-evaluation Report, Nova Scotia Growing Area 7 (Bras D'Or Lakes, Volume 5). Environment Canada Environmental Protection Branch, Manuscript Report No. EP-AR-2003-6.

McIsaac, A. S. Denny and V. Bushell. 2003. Bras d'Or Lakes Phytoplankton Monitoring Program. Final Project Report prepared for First Nations Environmental Contaminants Program Health Canada. Unama'ki Institute of Natural Resources, June 30, 2003.

Menon, A.S. and J.R. Machell. Review of Nova Scotia Shellfish Growing Area Sector 7-02 and 7-03 (Denys Basin and St. Peter's Inlet). Environment Canada Report EP-AR-89-03.

MGI Limited. 2002a. Assessment Study of Water and Wastewater Systems and Associated Water Management Practices at Chapel Island First Nation Cape Breton, NS (Site #06041) Atlantic Region.

MGI Limited. 2002b. Assessment Study of Water and Wastewater Systems and Associated Water Management Practices at Eskasoni First Nation Cape Breton, NS (Site #06044) Atlantic Region.

MGI Limited. 2002c. Assessment Study of Water and Wastewater Systems and Associated Water Management Practices at Wagmatcook First Nation Cape Breton, NS (Site #06046) Atlantic Region.

MGI Limited. 2002d. Assessment Study of Water and Wastewater Systems and Associated Water Management Practices at Whycocomagh First Nation Cape Breton, NS (Site #06065) Atlantic Region.

Native Council of Nova Scotia. 1997. Mi'kmaq Resource Guide. Second Edition. Truro: Eastern Woodland Publishing. 28 pp.

Nova Scotia Business Inc. 2004. News Release: Cape Breton Marble Quarry Expanding. [On-line]: http://www.novascotiabuisness.com/news/newsreleases.html?newsid=89&newrequest=true.

Nova Scotia Department of Aquaculture and Fisheries. 2006. Aquaculture maps. http://www.gov.ns.ca/fish/aquaculture/aquamap.shtml.

OECD. 2003. Annex II. The Pressure-State-Response (PSR) Model. In: OECD Environmental Indicators. [On-line]: **http://www. oecd.org/dataoecd/7/47/24993546.pdf.**

Papagapko, D. 2003. Gypsum and Anhydrite. [On-line]: http:www.nrcan.gc.ca/mms/cmy/content/2003/30.pdf. February 23, 2006.

Petrie, B. and G. Bugden. 2002. The physical oceanography of the Bras d'Or Lakes. *In*: Proceedings of the Nova Scotia Institute of Science: 42(1). pp. 9-36.

Petrie, B. and J. Raymond. 2002. The Oceanography of the Bras d'Or Lakes: General Introduction. *In*: Proceedings of the Nova Scotia Institute of Science: 42(1). pp. 9-36.

Pitu'paq. 2004. Bras D'Or Lakes, Fisheries Resources and Pollution Sources, Working Atlas Based On The Pitu'paq Database.

Shaw, J. D.J.W. Piper, and R.B. Taylor. 2002. The Geology of the Bras d'Or Lakes, Nova Scotia. *In*: Proceedings of the Nova Scotia Institute of Science: 42(1). pp. 127-148.

Shaw, J., P.J. Potter, D. Beaver and D.R. Parrott. 2005. Interferometric Sidescan Survey in Denys Basin, Bras d'Or Lakes, Nova Scotia, 2004. Geological Survey of Canada (Atlantic). Report prepared for the Department of Fisheries and Oceans.

Shaw, J., R.B. Taylor, E. Patton, D.P. Potter, G.S. Parkes and S. Hayward. 2006. Sensitivity of the Coasts of the Bras d'Or Lakes to Sea-Level Rise. Geological Survey of Canada (Atlantic) Open File Report 5397. Dartmouth: 99 pp. 38.

Shumway, S.E. 1996. Chap. 13: Natural environmental Factors. In: Kennedy, V.S, R.I.E. Newell, and A.F. Eble. eds. The Eastern Oyster *Crassostrea virginica*. Maryland: Maryland Sea Grant College. 733 pp.

Statistics Canada. 1996 Community Profiles Available on the Worldwide Web at http://www12.statcan.ca/english/Profil/PlaceSearchForm1.cfm last visited on January 14, 2005.

Statistics Canada. 2001 Community Profiles Available on the Worldwide Web at http://www12.statcan.ca/english/profil01/PlaceSearchForm1.cfm last visited on January 14, 2005.

StoraEnso. 2004. StoraEnso Port Hawkesbury Limited Woodlands Unit Environmental Management System Reference for Harvesting Contractors. Issued August 31, 2004.

Strain, P. and P. Yeats. 2002. The Chemical Oceanography of the Bras d'Or Lakes. *In*: Proceedings of the Nova Scotia Institute of Science: 42(1). pp. 37-64.

Sysco. 2003. Bulk Cargo (Land Use Plan and Re-Development Strategy; Appendix D). Environmental Design and Management Limited. [On-line]: http://www.Sysco.ns.ca/AppenD_1_1.htm. February 23, 2006.

Taylor, R.B. and J. Shaw. 2002. Coastal Character and Coastal Barrier Evolution. *In*: Proceedings of the Nova Scotia Institute of Science: 42(1). pp. 149-174.

Tremblay, J.M. 2002. Large Epibenthic Invertebrates in the Bras d'Or Lakes. *In*: Proceedings of the Nova Scotia Institute of Science: 42(1). pp. 101-126.

UMA. 1989. Bras d'Or Lake Watershed Integrated Resource Management Plan Study. pp. + 142.

Unama'ki Institute of Natural Resources. 2004. Source to Tap: Protecting Eskasoni First Nation's Drinking Water through Community Awareness and a Potential Hazards Survey. Report prepared for Health Canada. January 2005.

Unama'ki Institute of Natural Resources. 2005. Contaminant Levels in Traditional Fish Species and Harvesting Areas in Unama'ki (Cape Breton). Report prepared for Health Canada's National First Nations Contaminants Program and Assembly of First Nations. June 2005.

Union of Nova Scotia Indians. 2002. Malagawatch Environmental Health Baseline Study. Report prepared for First Nations Environmental Health Services, Health Canada. September 4, 2002.

Van Otterloo, H.R. 1975. Shellfish Growing Areas in Bras d'Or Lakes Cape Breton, Nova Scotia (NS-17) An Investigation of Sanitary Conditions in 1974. Environment Canada Report EPS-5-AR-75-3.

Wilson, Ruth Reid. 1981. Information Notes on the Bras d'Or Lakes. Prepared for the Bras d'Or Institute Files.

Appendix 1

The 10 Commitments of Pitupa'q

The Pitu'paq Committee is committed to addressing all three sources of sewage contamination, the malfunctioning of on-site sewage disposal systems, sewage treatment plants and boating sewage.
The Pitu'paq Committee has made the:

1. Commitment to view the sewage management issue affecting the Bras d'Or Lakes from three perspectives: Sewage treatment plants, on-site sewage disposal systems, and boating.
2. Commitment to act as a unified body to develop a plan for implementation and seek funding to support it - i.e (MOU among municipalities and First Nations).
3. Commitment to identify priority areas where on-site sewage disposal systems are malfunctioning.
4. Commitment to co-operate with the responsible regulatory agencies to perform a current audit of sewage treatment plants and provide an action plan to address any identified deficiencies.
5. Commitment to ensure treatment plant operators receive all required training.
6. Commitment to recommend to government agencies the regulatory changes they feel are required to ensure the health of the Bras d'Or Lakes with respect to sewage.
7. Commitment to ensure on-going education and awareness of the public with respect to the care and maintenance of on-site sewage disposal systems.
8. Commitment to additional public education directed at the risks associated with the dumping of raw sewage into the Bras d'Or Lakes from recreational and other marine craft.
9. Commitment to review and establish, where applicable, Deed Transfer Regulations which will provide for upgrading of on-site sewage disposal systems at the point of a property sale.
10. Commitment to create waste management districts to manage pump-out and on-going maintenance and repair of on-site sewage disposal systems with a view to stimulating private sector growth in this area while ensuring environmental protection

Appendix 2

Community Groups and Approaches

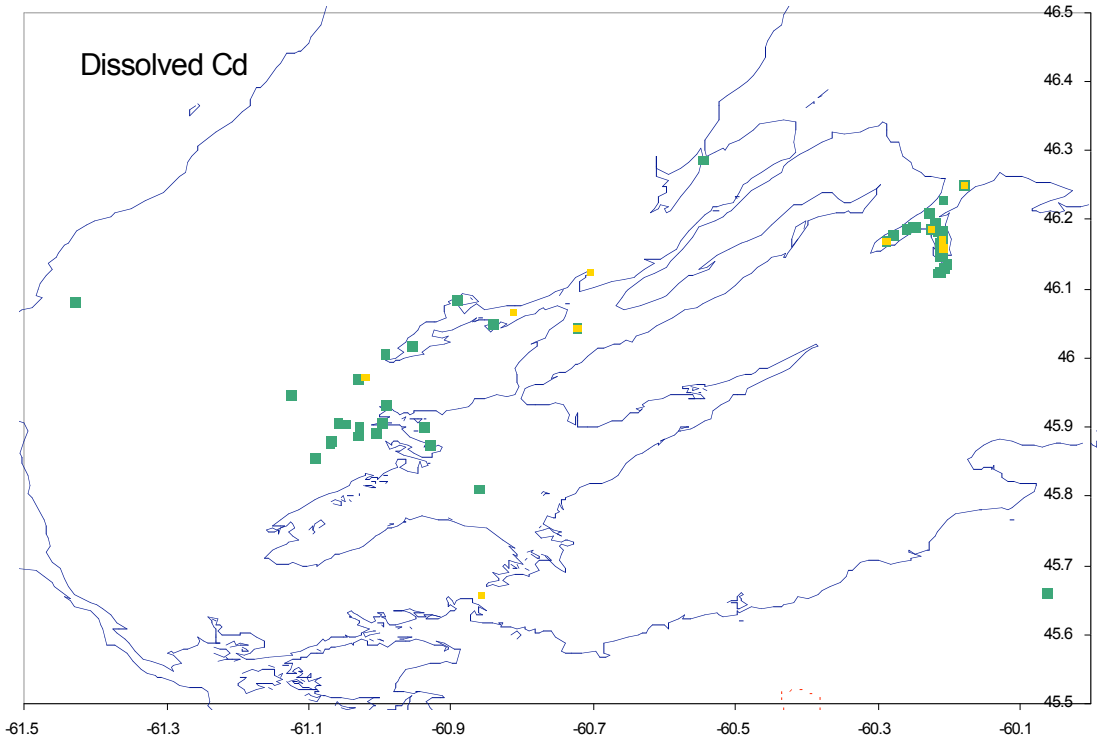
Group	Approach	Capabilities and Resources	Visions for the Bras d'Or Lakes
Eskasoni Fish & Wildlife Commission Inc.	Originally established to acquire communal licenses in response to *R. v. Denny, Paul, and Sylliboy* (1990) recognizing the Aboriginal right to fish. Implementation of a native guardian program through the Aboriginal Fisheries Strategy to assist DFO in monitoring and habitat enhancement for salmon. Since expanded to the use of traditional and western science to investigate issues impacting the Bras d'Or Lakes. Works closely with UINR.	Scientific research and technical capacity in the area of fisheries science, invertebrates, water quality, zooplankton, phytoplankton, fish aging, molecular techniques, electrofishing, stomach content analysis and data analysis. Traditional Ecological Knowledge Geographic Information Systems (Map Info) Funding obtained through projects and collaborations.	Improvement in communications between various groups working on similar issues through a central organization. A network of funding sources would be available to support the communication and the organization. Use existing and future science knowledge to develop resource management strategies based on local traditional and scientific knowledge
Bras d'Or Sustainable Communities Initiative – Bras d'Or Lakes Field Team	Secretariat role where they coordinate government activities in the Bras d'Or Lakes and engaging communities.	Coordination of efforts from various levels of government to take action on issues regarding sustainability. Members are in-kind contributions from other organizations and have access to traditional government funding through their members that are not available to the communities.	Develop, communicate and implement a shared vision of government working together to support sustainable communities.
Pitupa'q Committee	Collecting data and updating pre-existing digital maps as a means of identifying areas that are affected directly, or potentially affected, by sewage pollution. Concerted effort by Unama'ki First Nation chiefs (through UINR), mayors and wardens as a means of addressing the sewage pollution problem of the Bras d'Or Lakes.	Base mapping, geo-spatial analysis of data, development of map products, archival research, collecting water samples, creating public education materials. Funding provided by various programs such as HRDC and through in-kind contributions from UINR and EFWC.	Restore the Bras d'Or Lakes to their former pristine state and to manage these waters and surrounding lands to ensure these waters can support development in other areas such as aquaculture, fisheries and tourism.

Group	Approach	Capabilities and Resources	Visions for the Bras d'Or Lakes
Bras d'Or Partnership Committee	Supports First Nation efforts and establishing relationships between First Nations and non-native communities. Formed to establish a public education awareness program on the deteriorating state of the Bras d'Or Lakes through posters, formal workshops, newsletters, video and brochures aimed at the youth and public sector.	Technical expertise in digital photography and video and presentation programs. UINR provided secretariat and chairing roles and obtained funding from INAC to hire a coordinator to develop and implement a program.	Not presently active however plans are to re-establish this management body through UINR
Unama'ki Institute of Natural Resources	Representation from Mi'kmaw chiefs of Cape Breton (Unama'ki) that was established to become more involved management issues as it related to Cape Breton. Use of political strength and collaboration with communities and other levels of government to promote and contribute to the understanding and protection of the Bras d'Or Lakes marine system and its watershed by assisting in the development of monitoring programs, data collection and to enter into other arrangements that will enable UINR to meet their goals. Supported by EFWC Science.	Forestry engineering and planning, terrestrial research and marine research through close associations with the Eskasoni Fish & Wildlife Commission Inc. Funding is provided through projects from various governmental departments. Previously funded through Eskasoni First Nation.	Potential for First Nations to be involved in every aspect of Natural Resource Management. Coordination and cooperation between First Nations, government and community groups. Unified voice for the Bras d'Or Lakes. Better coordination without taking anything from other groups. Help government to work towards meeting the requirements of the Bras d'Or Lakes community.
Bras d'Or Stewardship Society	Promote accountable and responsible stewardship of the Bras d'Or Lakes and its watershed through promotion of conservation strategies that for protection and preservation, acquiring scientific information and ideas related to the forum and to provide a forum for educational awareness and cooperation among individuals and communities.	Creating education awareness through dissemination of newsletters and public broadcasts. Funded through membership fees and donations.	Focus on conservation, protection and restoration, which basically covers all aspects of issues. Process for the equal say for all participating.
Bras d'Or Preservation Society	Conservation organization established to obtain conservation relief and fee interests in environmentally important lands and to generate community education on the need to conserve the Bras d'Or Lakes.	Capabilities? Funded through volunteers and in-kind staff support from the Bras d'Or Lakes Interpretive Centre (Baddeck).	

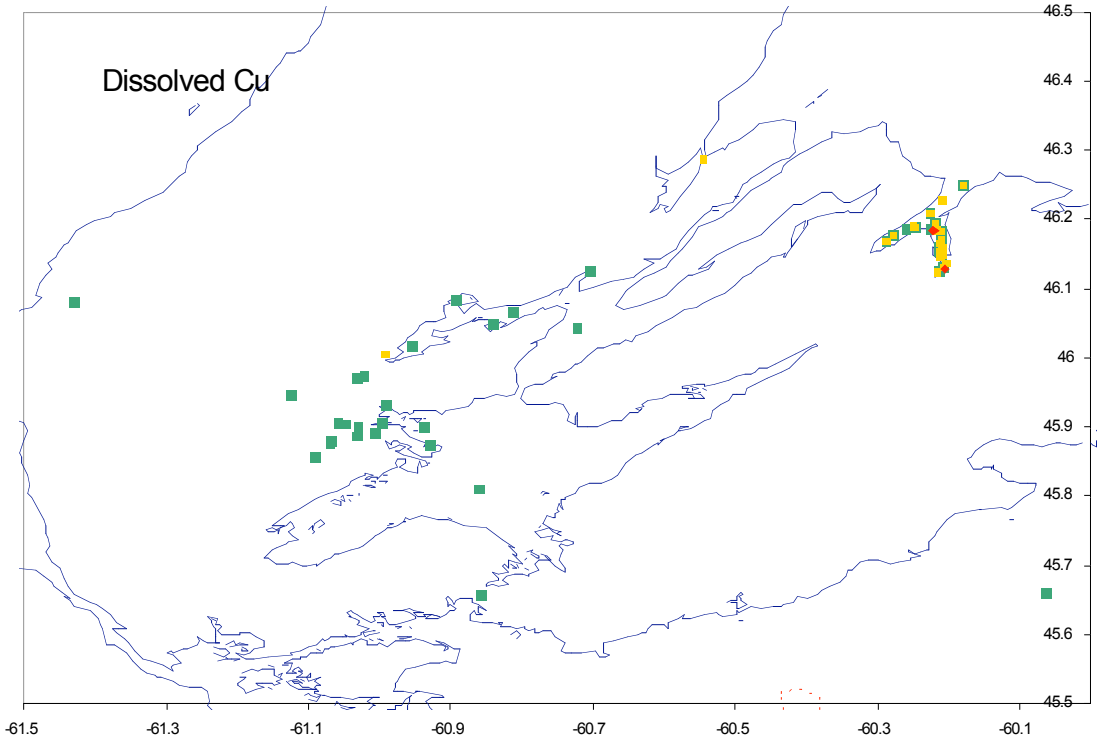
Group	Approach	Capabilities and Resources	Visions for the Bras d'Or Lakes
SIMBOL (Science for the Integrated Management of the Bras d'Or Lakes)	Joint research program between the Bedford Institute of Oceanography and UINR to conduct and foster collaborative research on the ecology of the Bras d'Or Lakes and to exchange information and expertise on the lakes and Cape Breton itself. Also involves Dalhousie University through a scholarship established by DFO for research conducted on the Bras d'Or Lakes and at UINR. Works closely with UINR and EFWC Science.	Research in all areas of oceanography, fisheries, invertebrates, mapping, marine chemistry, etc. Funded through the SIMBOL project of DFO.	From a science perspective, maintaining the quality (water quality, biodiversity, etc) of the Bras d'Or Lakes is essential. The vision is to improve upon the current state.
Nova Scotia Oyster Growers Association	Foster a sustainable oyster industry in the Bras d'Or Lakes through protection of oyster resource, water quality and the consumer of oyster products from the Bras d'Or Lakes .	Knowledge of oyster aquaculture methods and environmental issues. Funded through annual membership fees and volunteers.	Were not contacted.
Stewards of the River Denys Watershed Association	Fish habitat restoration of the River Denys Basin watershed. Education (River Ranger program) and water sampling throughout the watershed.	Funded through grants, in-kind contributions from local industry and federal summer internship programs.	Groups merged to become the Stewards of the River Denys Watershed Association. Improve water quality so that oysters can be harvested. Increasing public awareness on water quality issues. Decreasing silt accumulation Restoration of fish habitat
Denys Watershed Advisory Group	Works closely with the Stewards of the River Denys Watershed Association in improving water quality of the River Denys Basin.	Limited technical services such as water sampling, shoreline surveys, oyster surveys and in-stream restoration techniques. Supported by local volunteers and compliments the Stewards of the River Denys Watershed Association.	

Appendix 3

Dissolved heavy metal distributions and concentrations, Bras d'Or Lakes 2003.



Blue background levels (natural)
Green greater than background and less than threshold effects level (TEL; contaminated but not harmful)
Yellow greater than background and TEL but less than probable effects level (PEL; possibly harmful)
Red greater than PEL (probably harmful)


Dissolved Cu
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46.4
46.3
46.2
46.1
46
45.9
45.8
45.7
45.6
45.5
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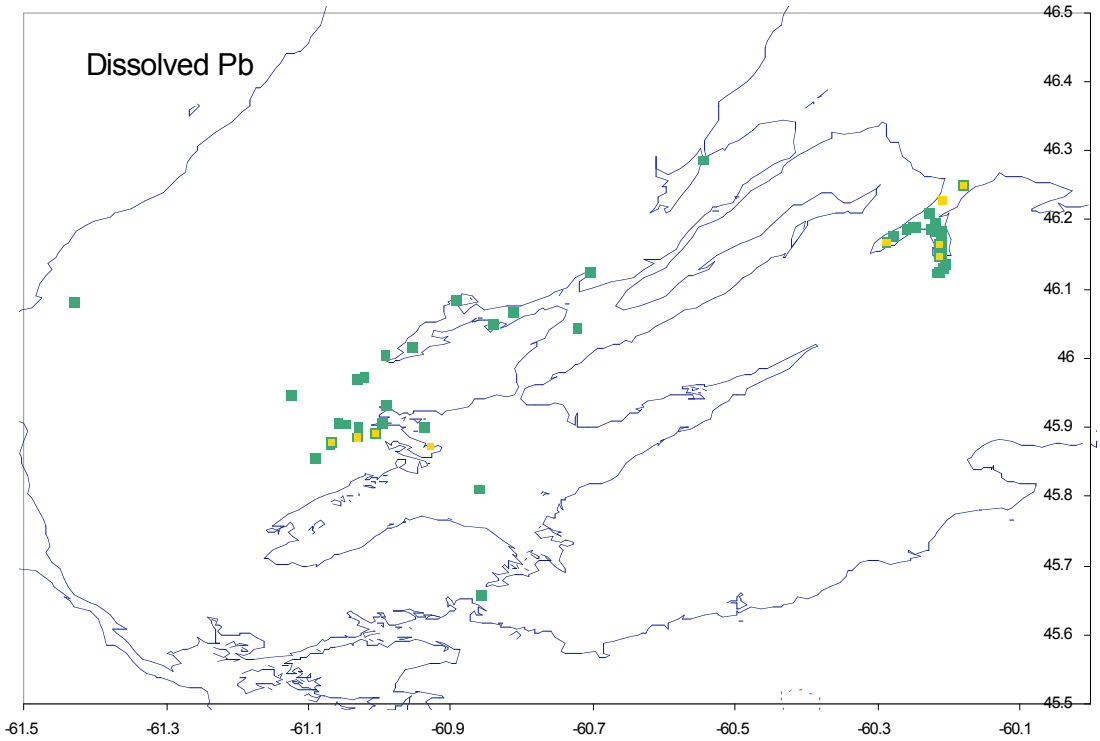
-60.9
-60.7
-60.5
-60.3
-60.1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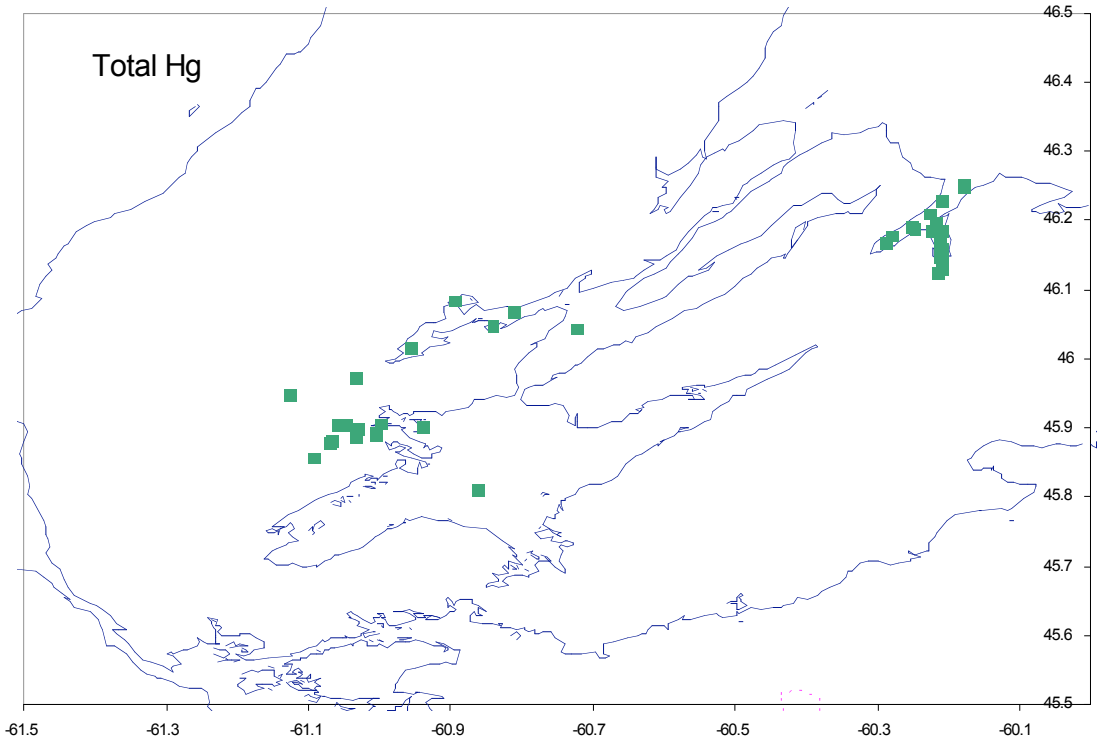
46.4
46.3
46.2
46.1
46
45.9
45.8
45.7
45.6
45.5
-61.5
-61.3
-61.1
-60.9
-60.7
-60.5
-60.3
-60.1


Total Hg
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46.4
46.3
46.2
46.1
46
45.9
45.8
45.7
45.6
45.5
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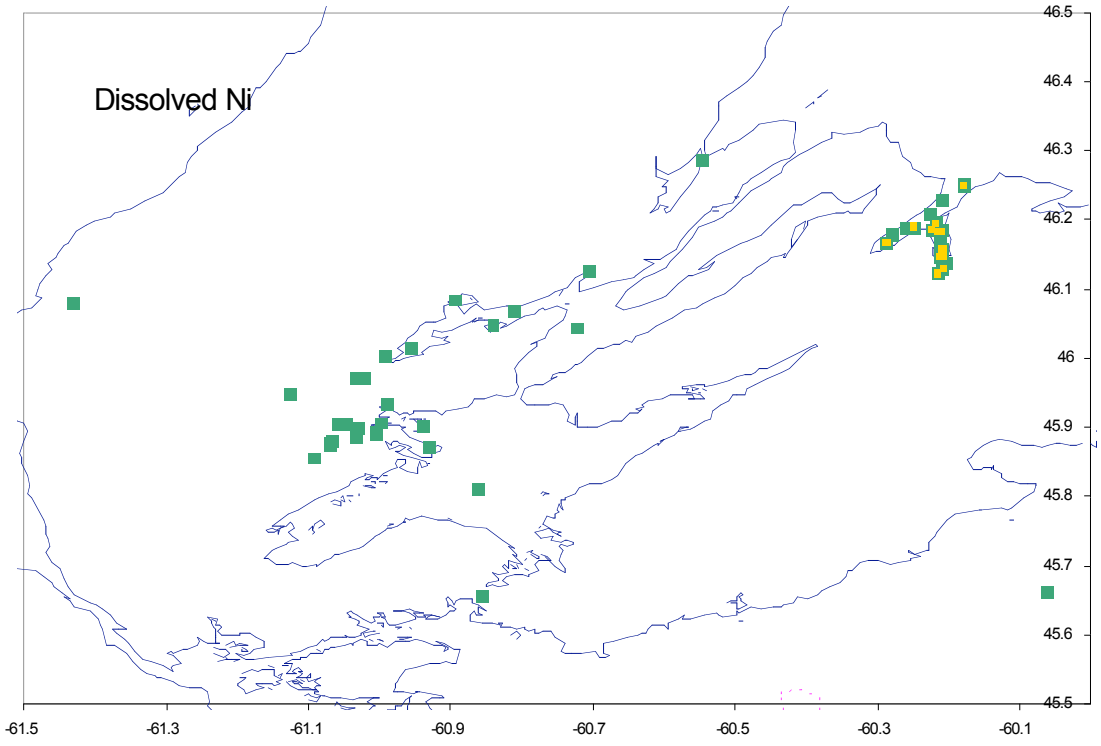
-61.3
-61.1
-60.9
-60.7
-60.5
-60.3
-60.1


Dissolved Ni
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46.3
46.2
46.1
46
45.9
45.8
45.7
45.6
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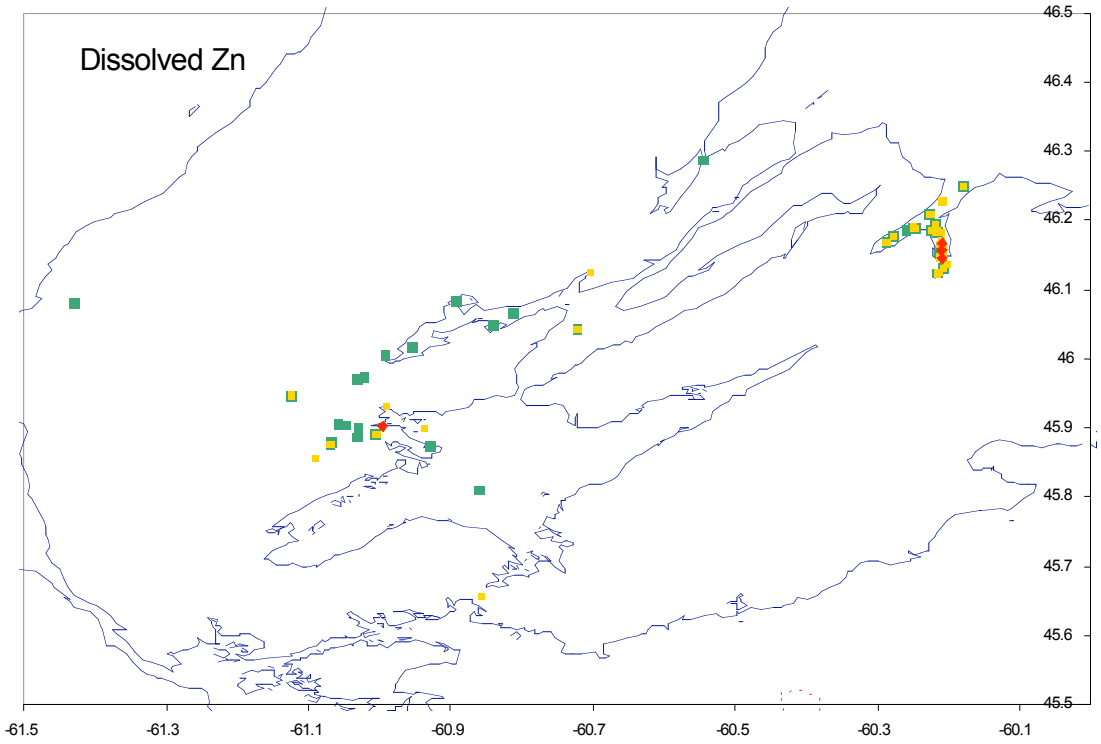
Dissolved Zn
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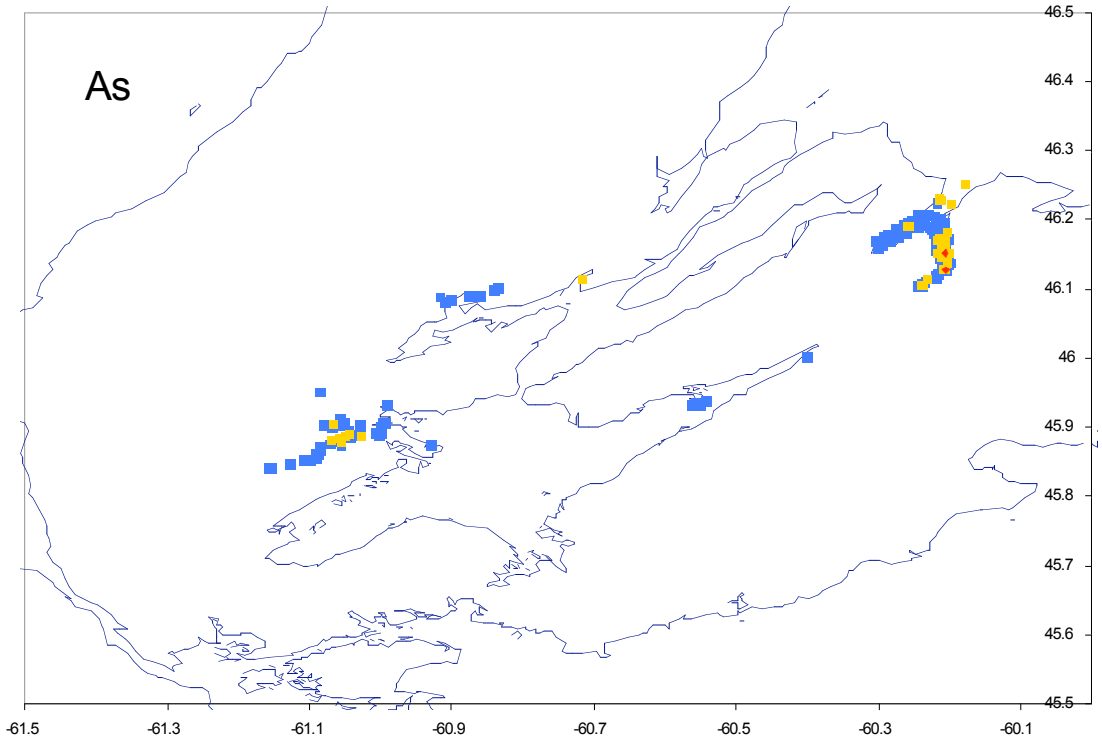
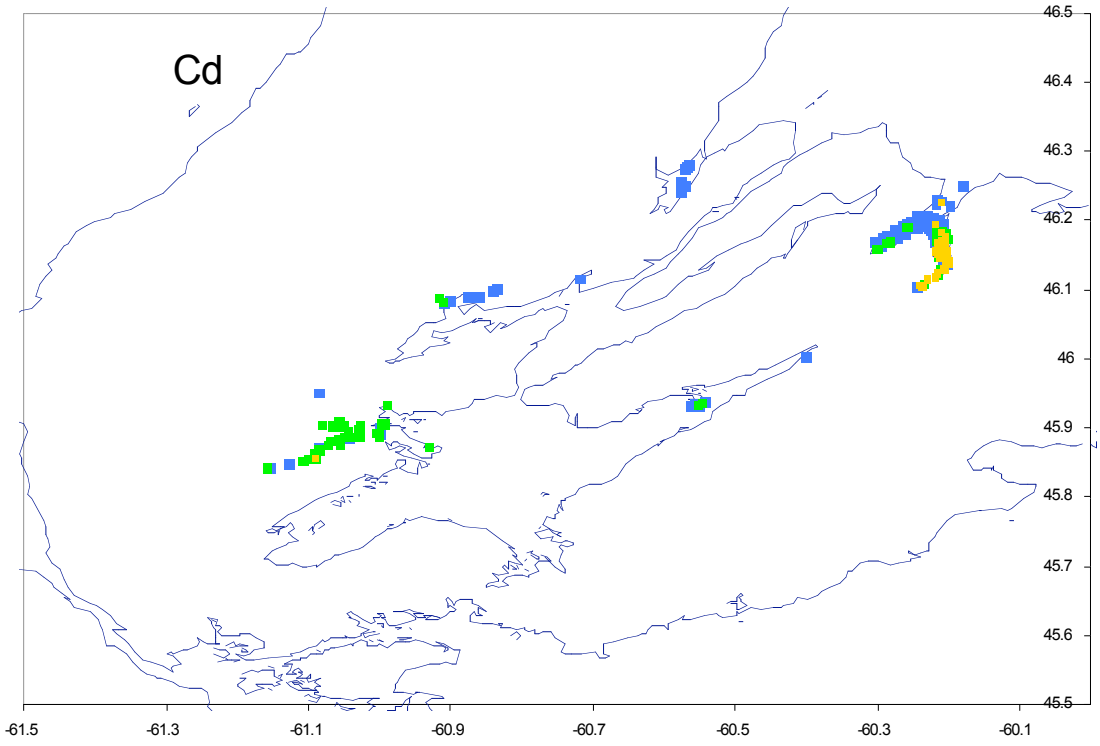
46.1
46
45.9
45.8
45.7
45.6
45.5
-61.5
-61.3
-61.1
-60.9
-60.7
-60.5
-60.3
-60.1

Appendix 4

Heavy metal distributions and concentrations in sediments, Bras d'Or Lakes 2003.



Blue background levels (natural)
Green greater than background and less than threshold effects level (TEL; contaminated but not harmful)
Yellow greater than background and TEL but less than probable effects level (PEL; possibly harmful)
Red greater than PEL (probably harmful)


Cd
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46.3
46.2
46.1
46
45.9
45.8
45.7
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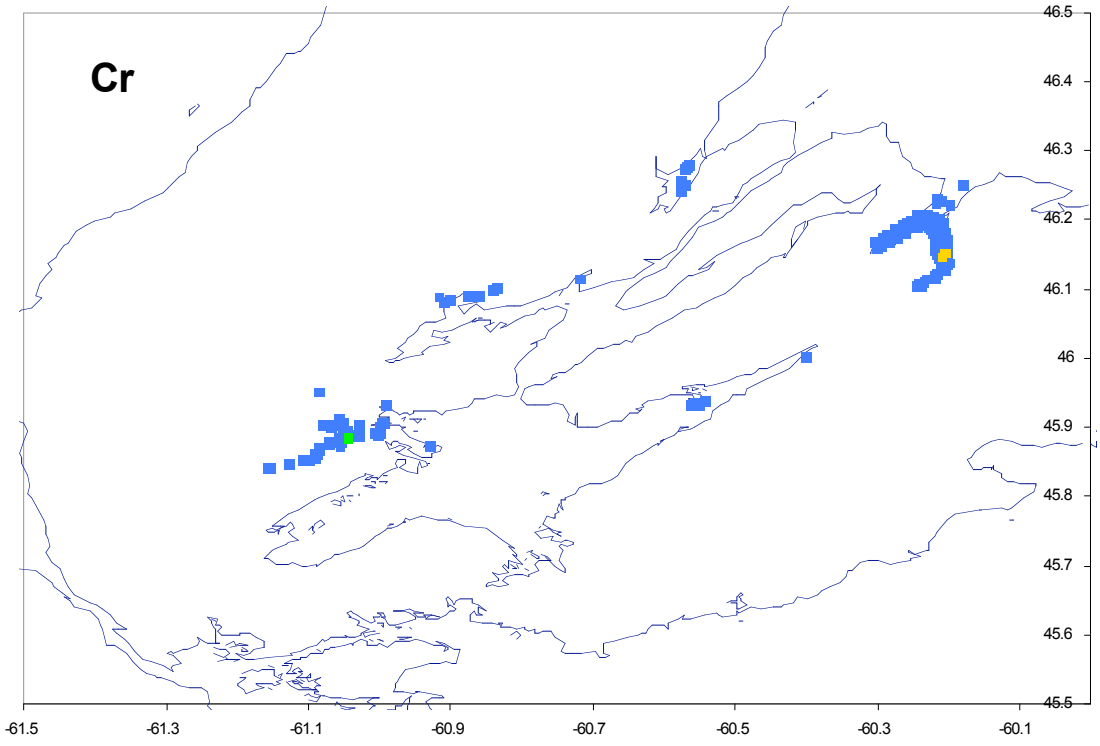
-60.7
-60.5
-60.3
-60.1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46
45.9
45.8
45.7
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-60.3
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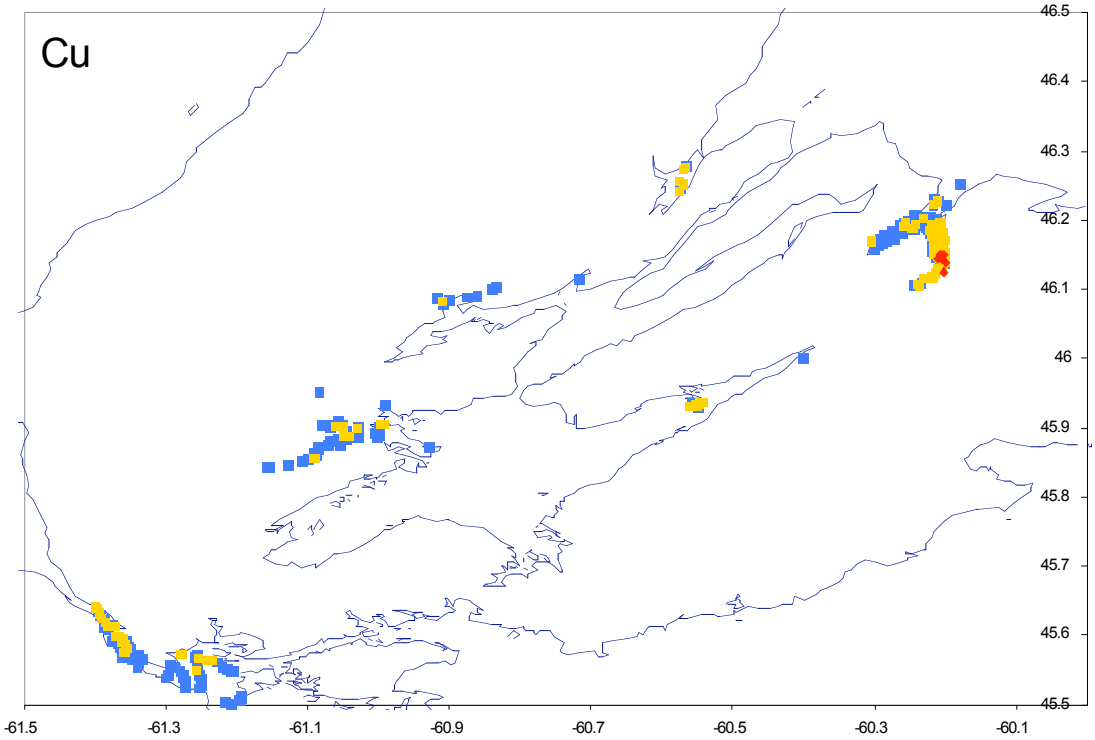
Cu
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46.4
46.3
46.2
46.1
46
45.9
45.8
45.7
45.6
45.5
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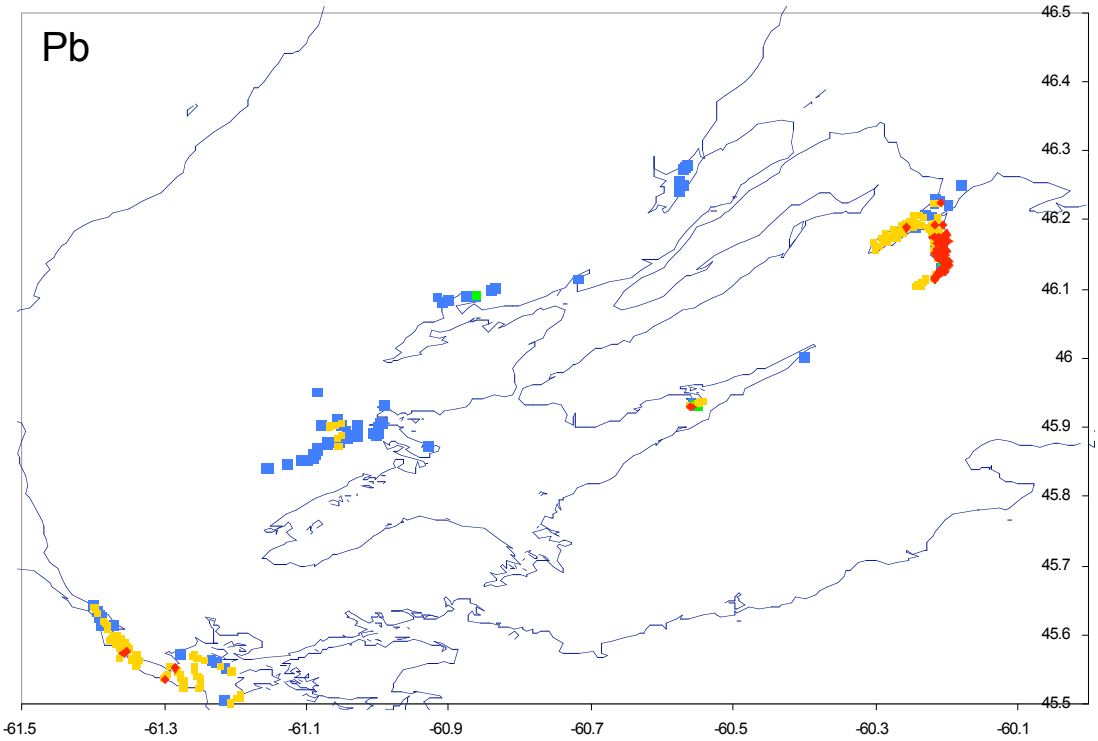
-60.9
-60.7
-60.5
-60.3
-60.1


Pb
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46.4
46.3
46.2
46.1
46
45.9
45.8
45.7
45.6
45.5
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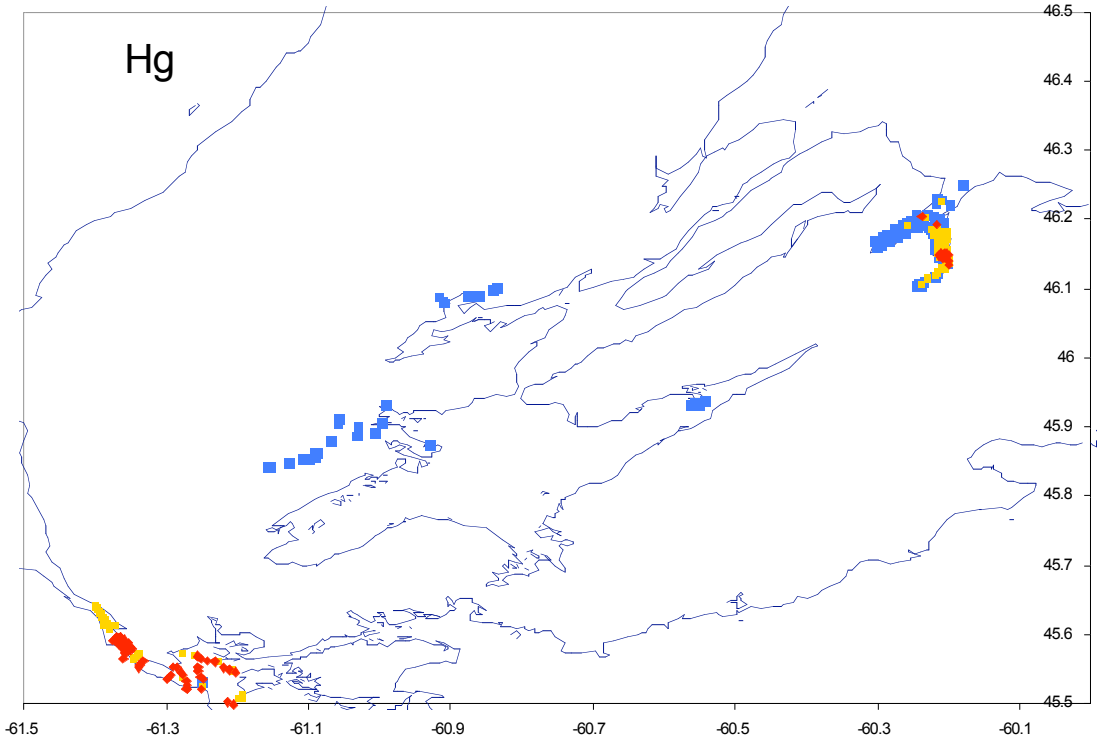
-60.9
-60.7
-60.5
-60.3
-60.1


Hg
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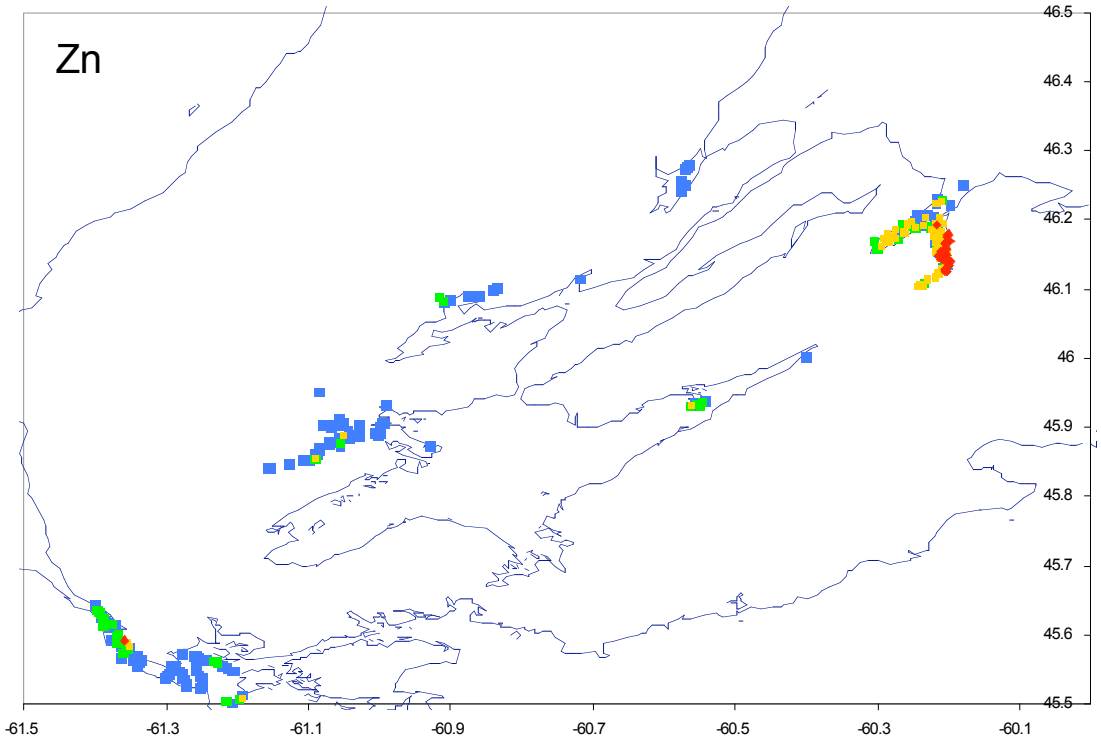
46.3
46.2
46.1
46
45.9
45.8
45.7
45.6
45.5
-61.5
-61.3
-61.1
-60.9
-60.7
-60.5
-60.3
-60.1


Zn
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46.3
46.2
46.1
46
45.9
45.8
45.7
45.6
45.5
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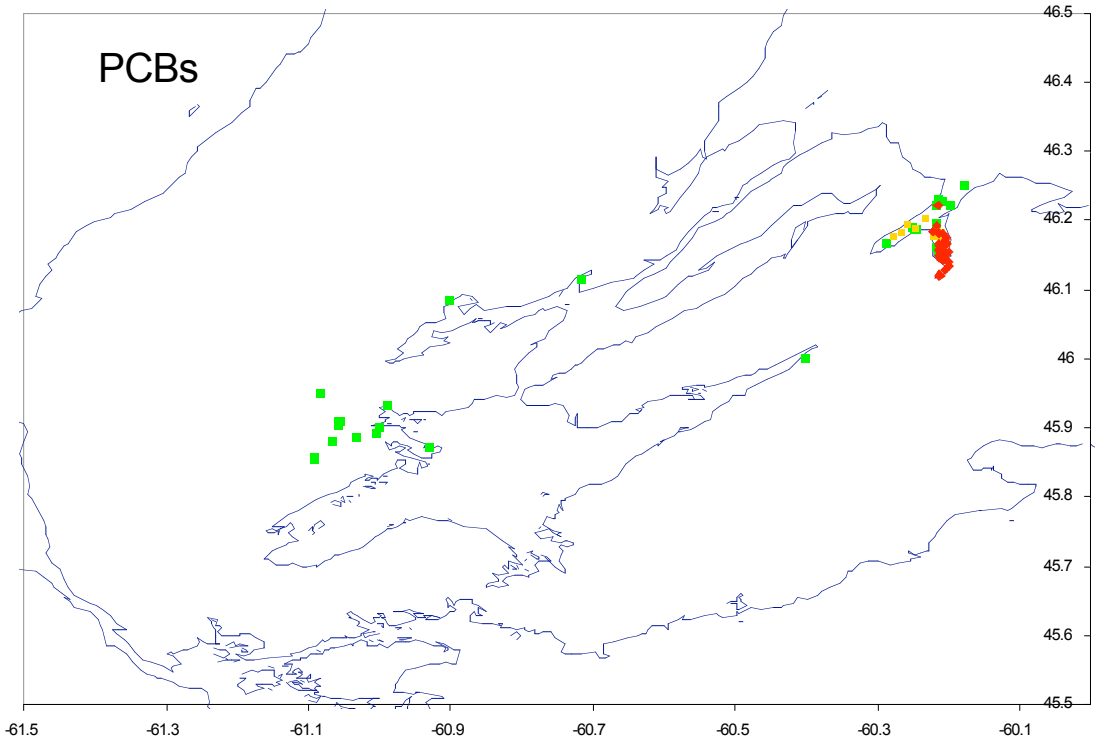
-60.9
-60.7
-60.5
-60.3
-60.1


PCBs
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46.4
46.3
46.2
46.1
46
45.9
45.8
45.7
45.6
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-60.9
-60.7
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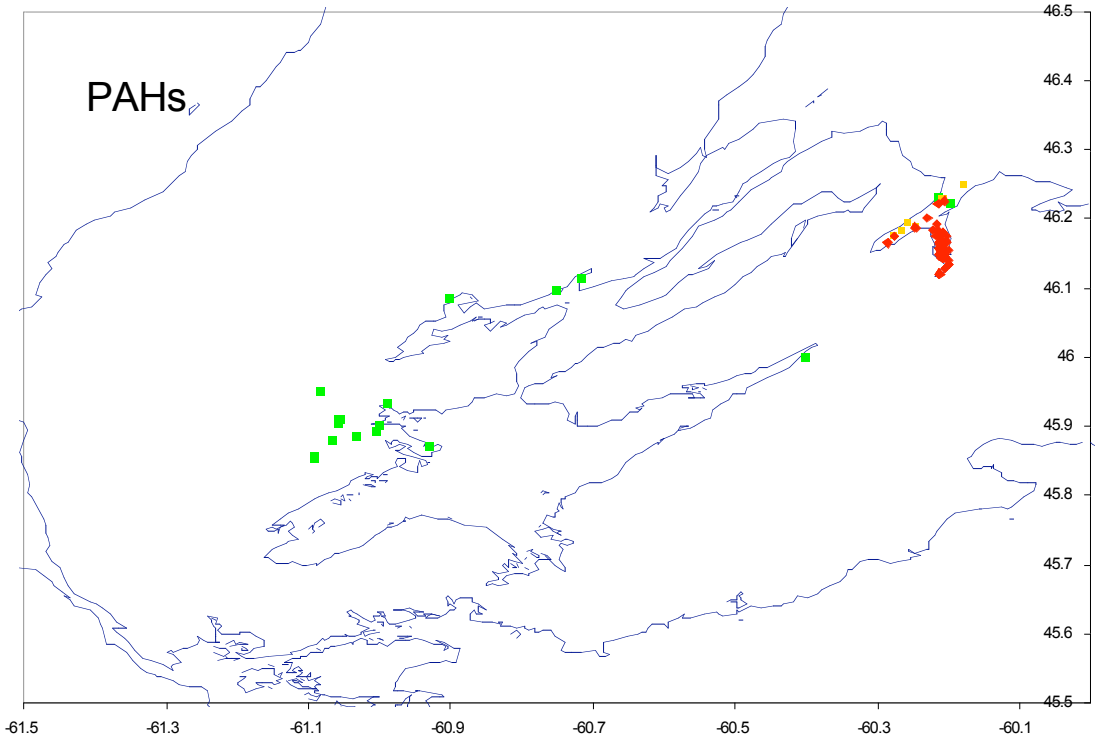
-60.3
-60.1


PAHs
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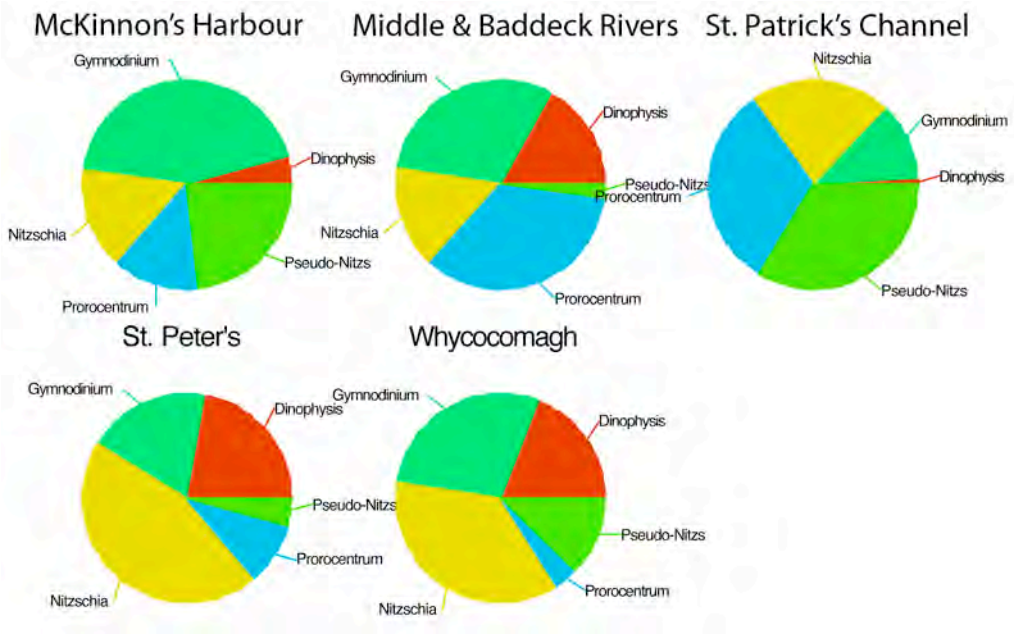
46.3
46.2
46.1
46
45.9
45.8
45.7
45.6
45.5
-61.5
-61.3
-61.1
-60.9
-60.7
-60.5
-60.3
-60.1

Appendix 5

Potentially toxic species found in the Bras d'Or Lakes during phytoplankton sampling in 2002-2003.



Mean cells per liter of potentially toxic phytoplankton species (organized by sub-watershed area) in samples from the Bras d'Or Lakes Phytoplankton Monitoring Program 2002 -2003

Appendix 6

Site Plans for four First Nation communities, showing the location of wastewater collection system and the flow process for each community.

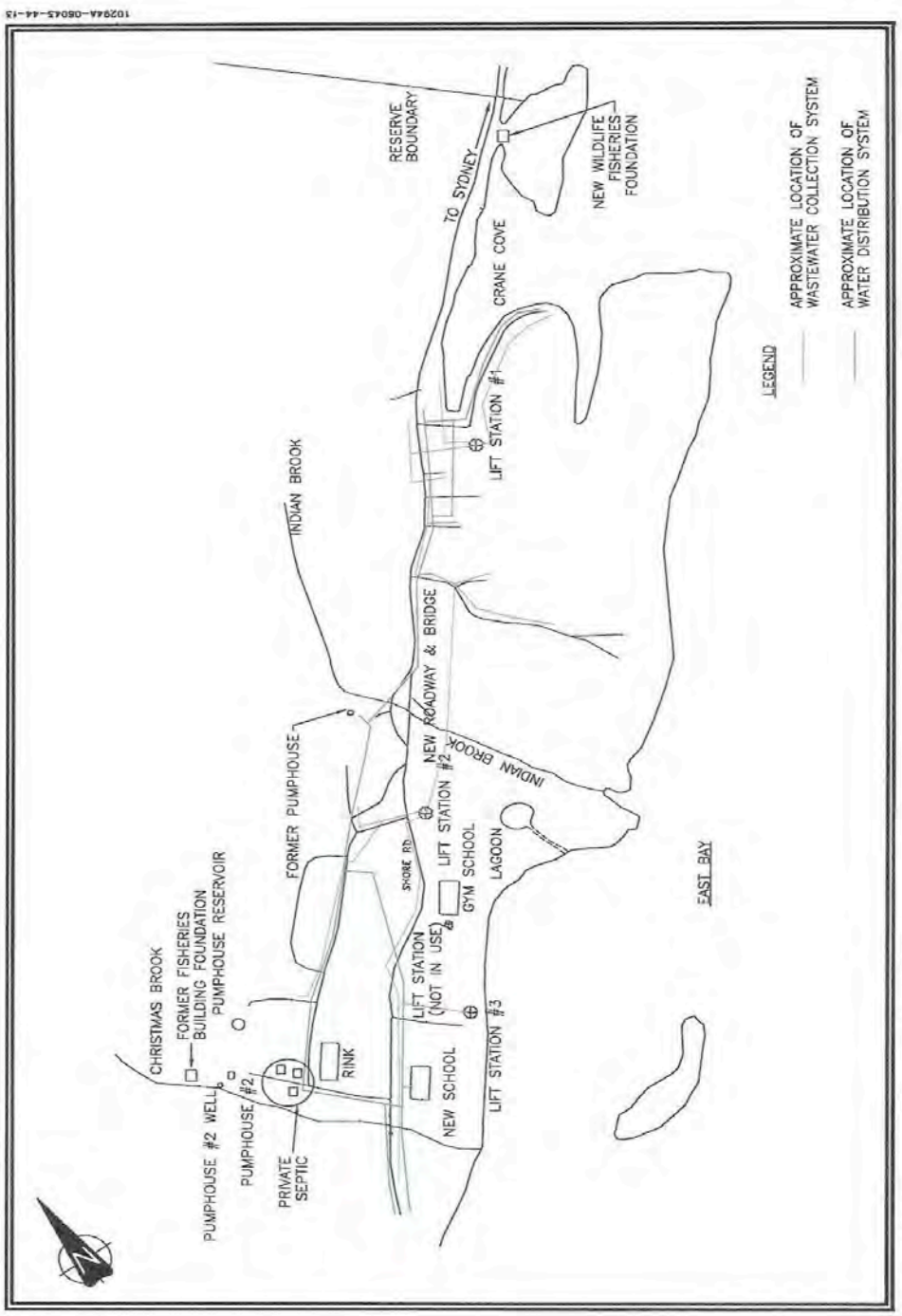


Figure 1. Eskasoni North, water and wastewater systems.

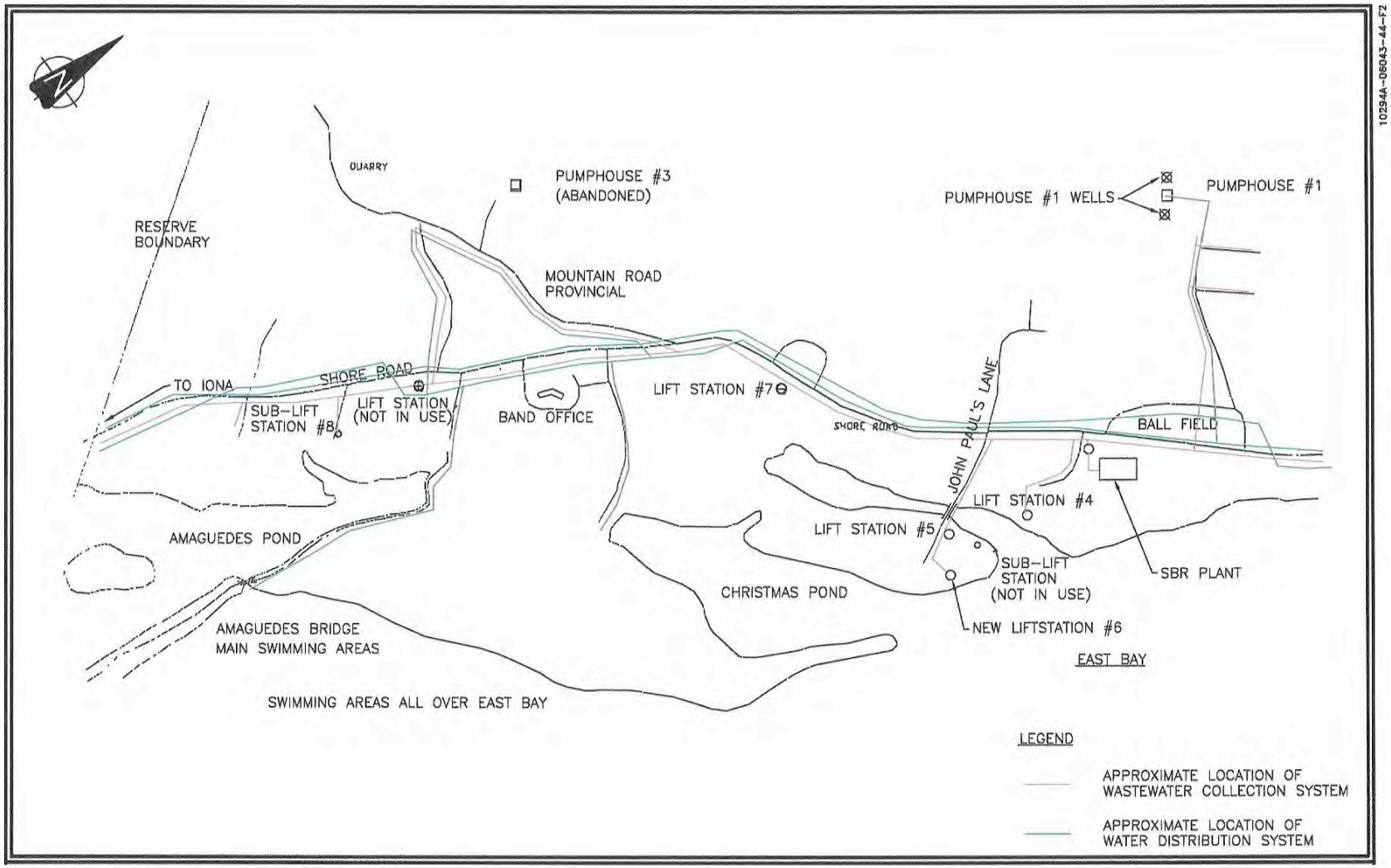


Figure 2. Eskasoni South, water and wasterwater systems

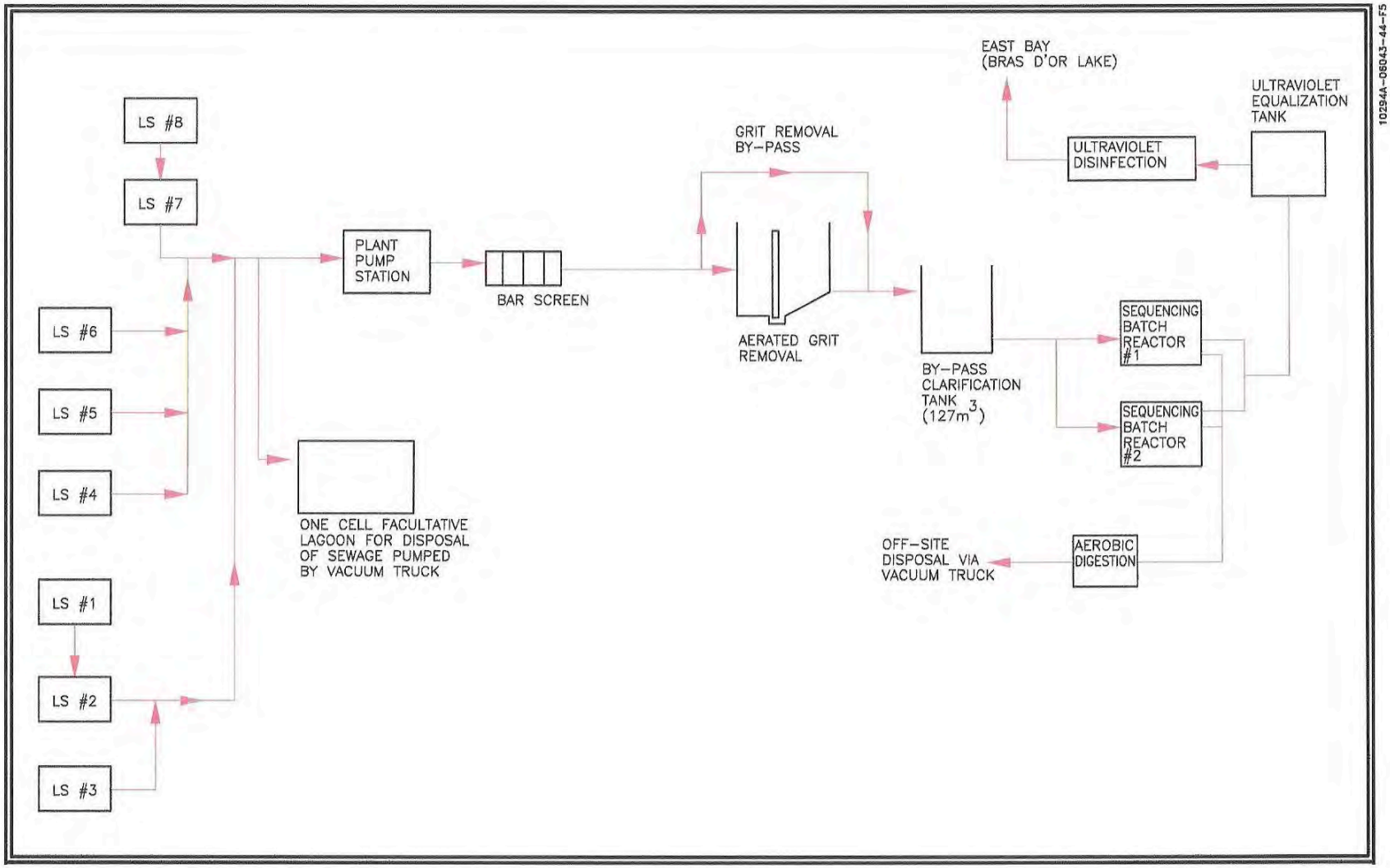


Figure 3. Eskasoni wastewater flow process.

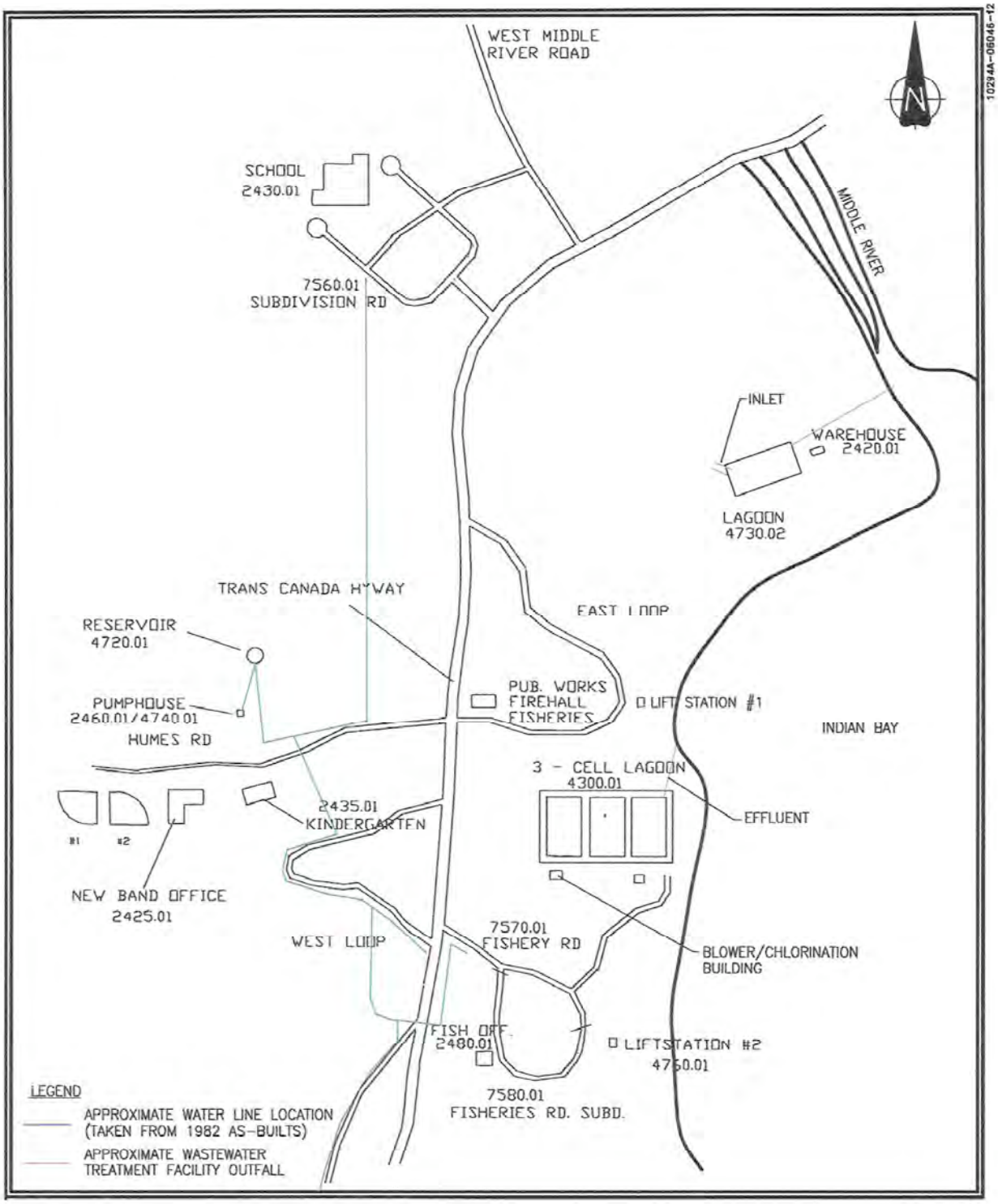


Figure 4 Whapmagoostui water and wastewater systems

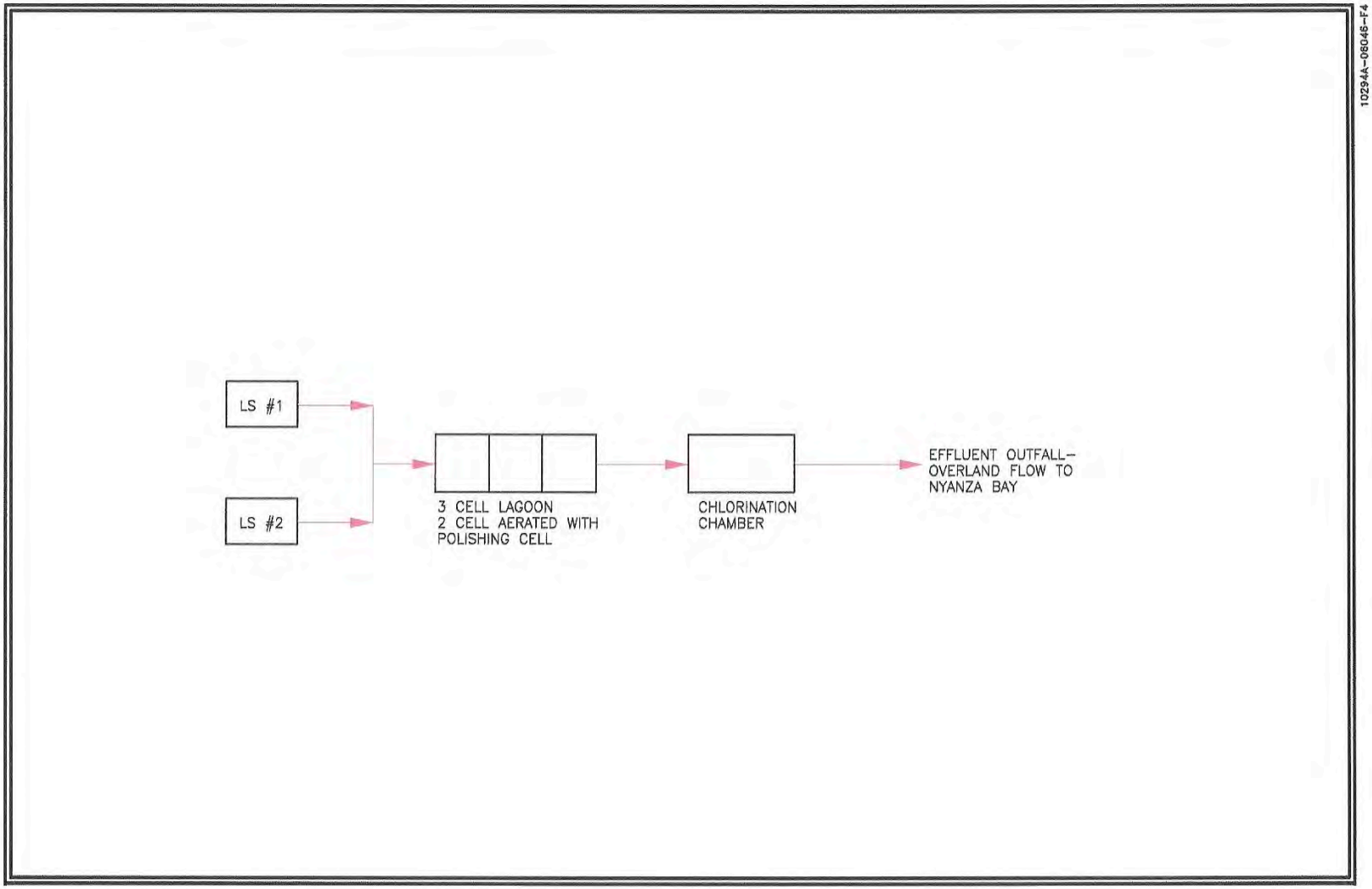


Figure 5. Wagmatcook wastewater flow process for the south end lagoon.

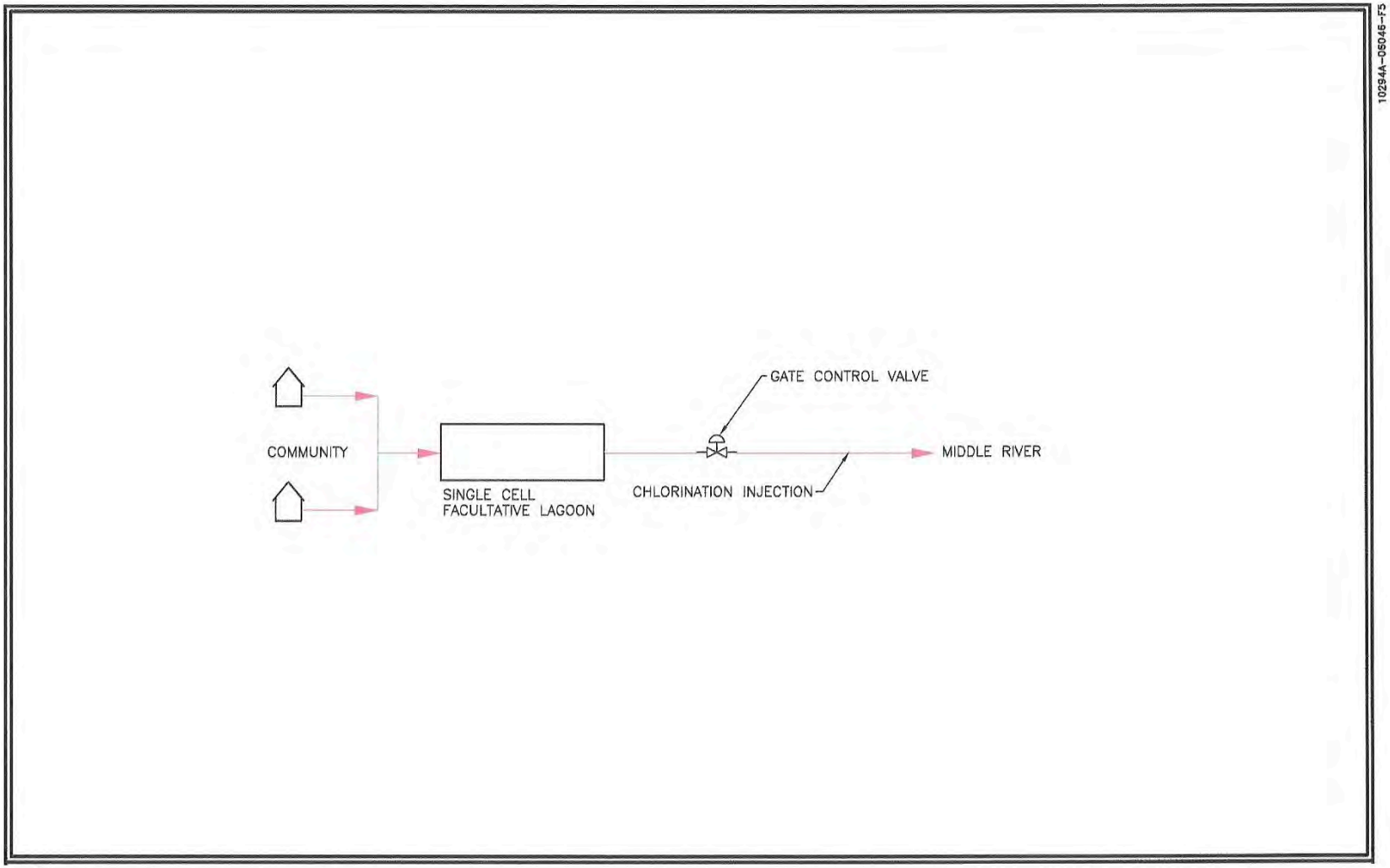


Figure 6. Wagmatcook wasterwater flow process for the

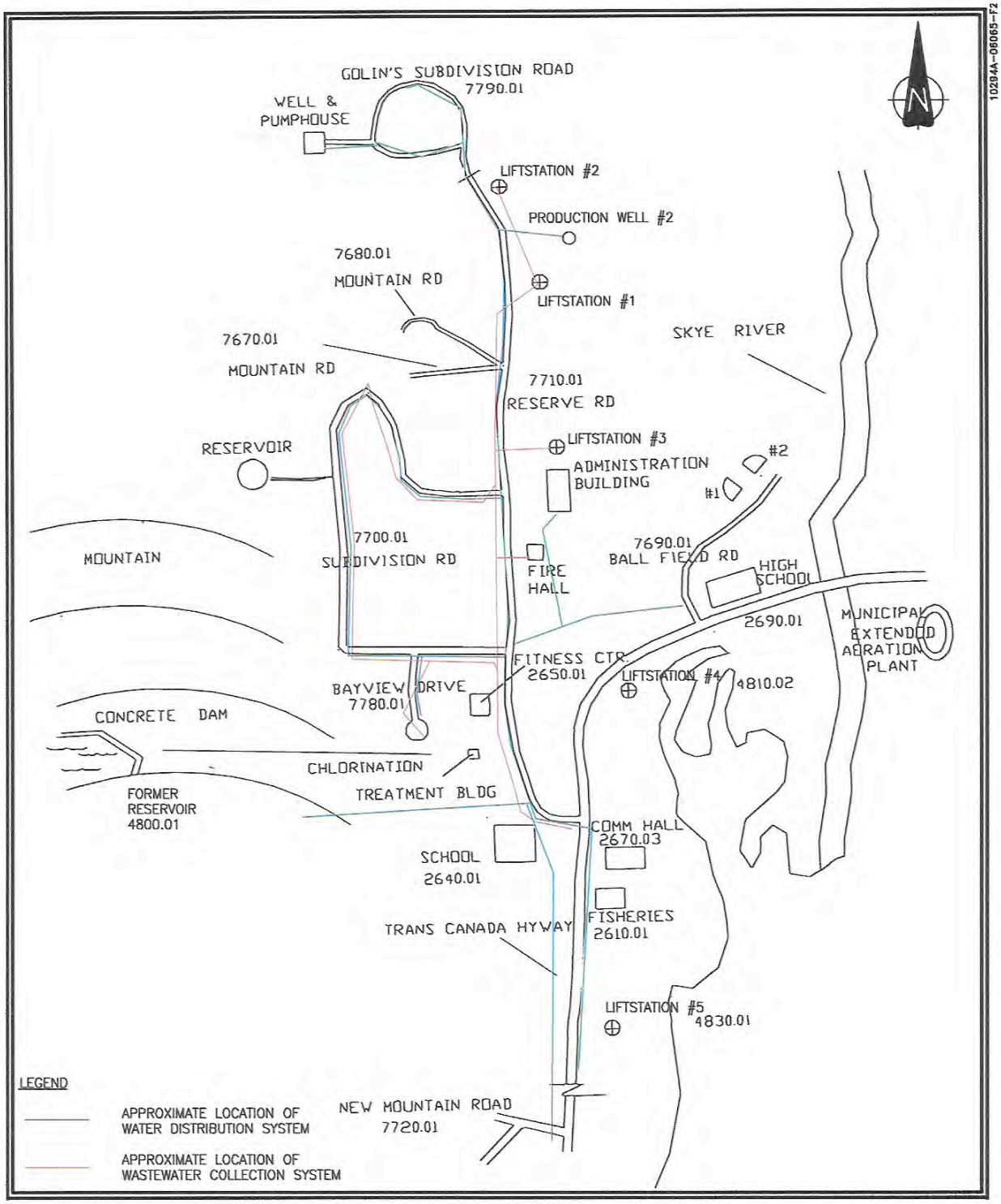


Figure 7. Waycobah water and wastewater systems.

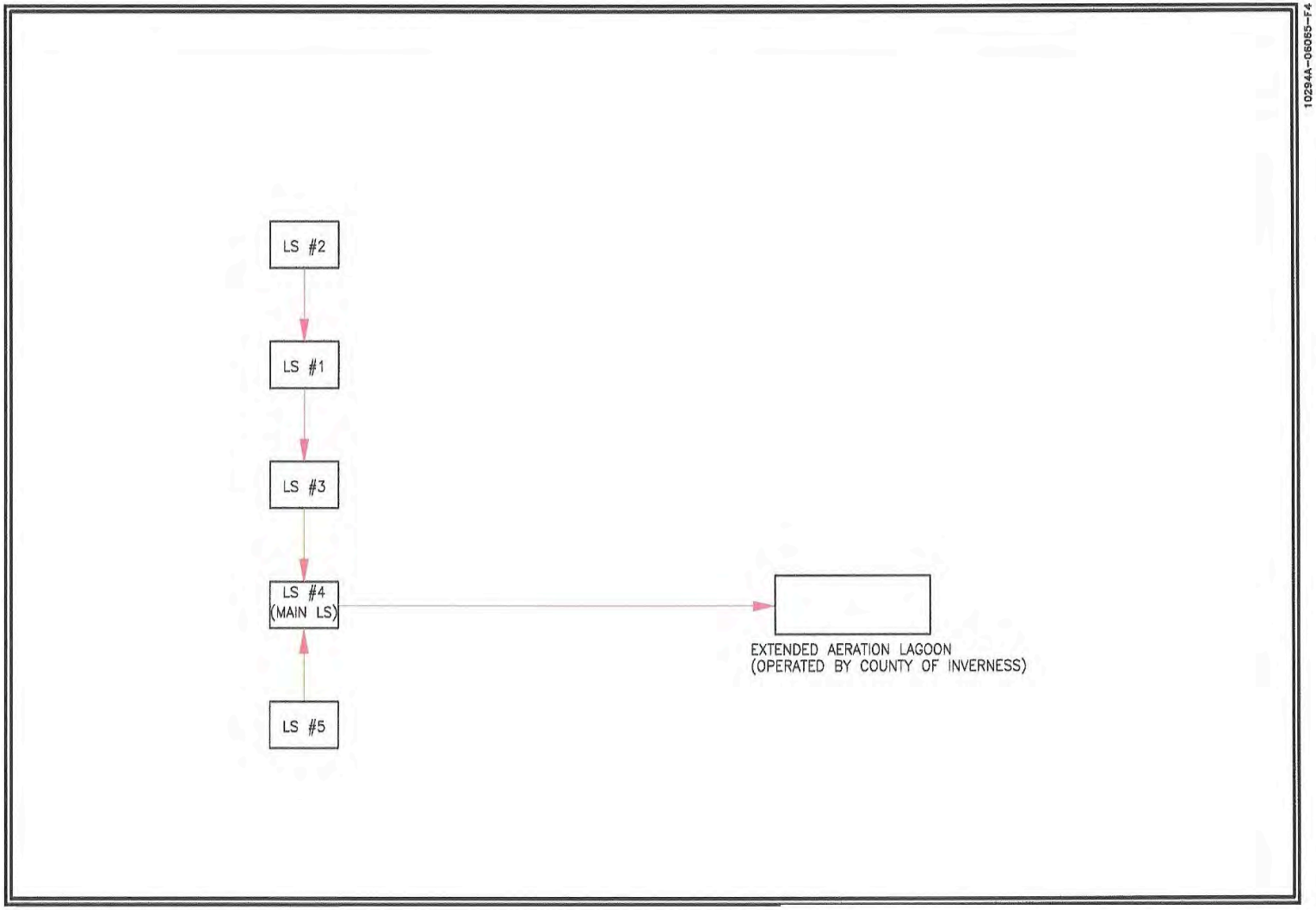


Figure 8. Waycobah wastewater flow process.

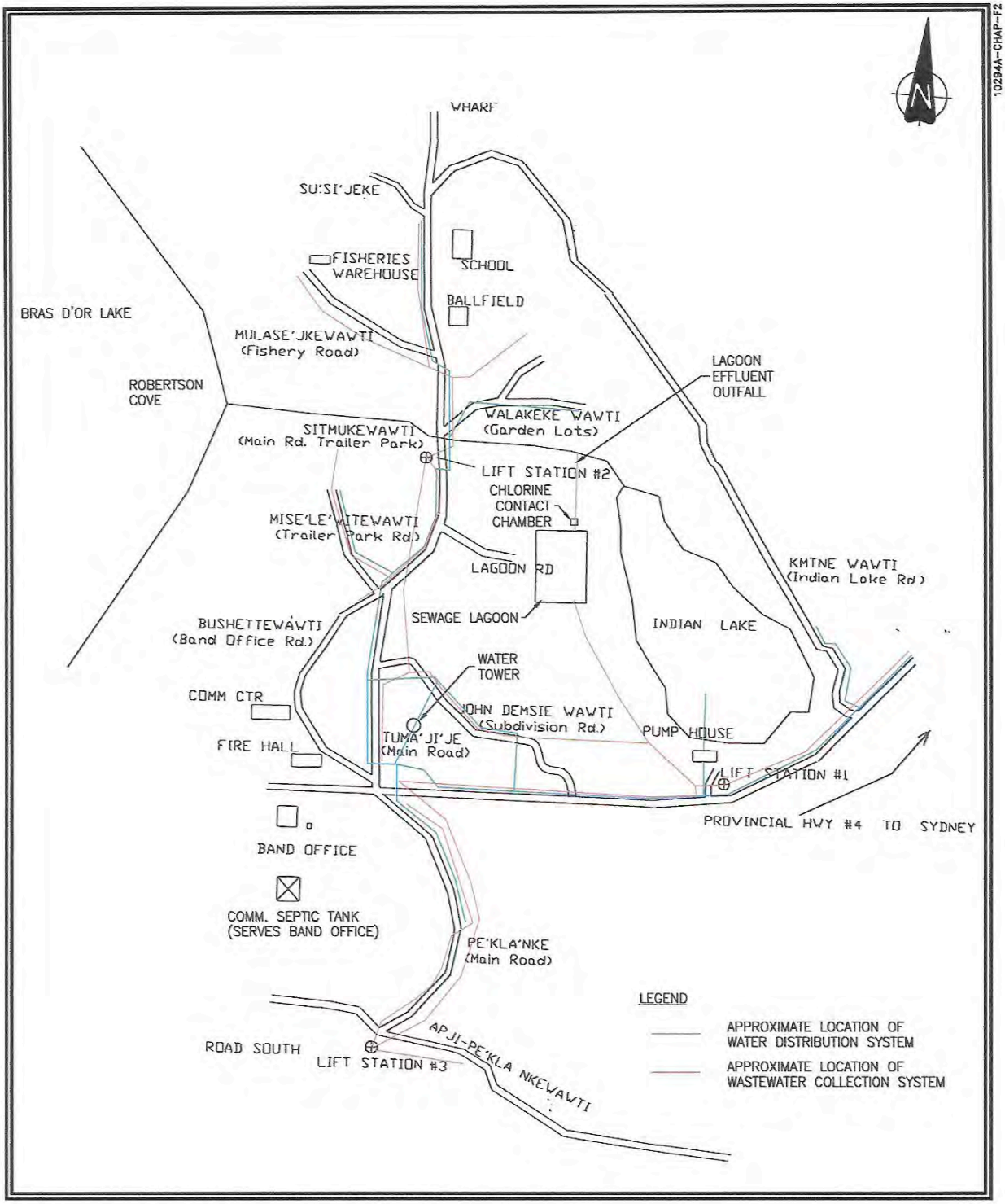


Figure 9. Chapel Island water and wastewater systems.

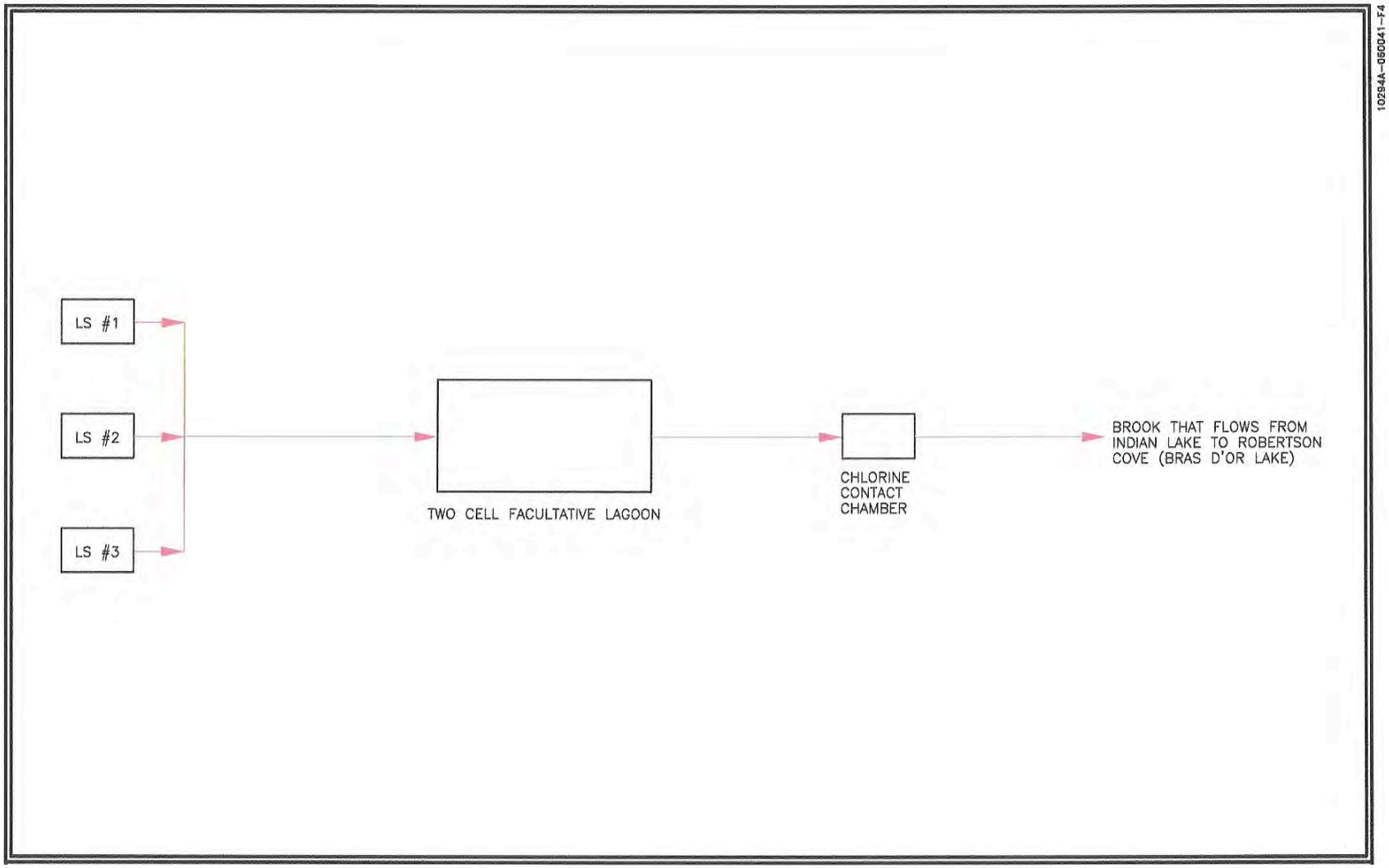


Figure 10. Chapel Island wastewater flow process.

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