Water Quality and Sewage Pollution in the Bras d'Or Lakes

The problem

A major threat to water quality in the Lakes is pollution by human sewage. Although sewage contamination has rarely been serious enough to warrant closure of beaches to swimming, it has been of real concern to the aquaculture industry and in particular, oyster growers. The basic ingredient of sewage, human fecal material, is normally harmless and merely adds nutrients that aquatic plants can utilize. However, it is that which can potentially accompany the fecal material that is of concern. Pathogens that cause serious illnesses and even death are spread through sewage contamination. Often the greatest risk in times of natural disasters such as earthquake and flood is the possibility of sewage contamination of the drinking water supply. At such times the silent killers, typhoid and cholera are an ever present danger. In the case of the Bras d'Or Lakes, the major risk is to the aquaculture industry and in particular shellfish growers. Oyster farming dominates this business, although mussels, clams, and even scallops in certain locations, are candidates for culture. These molluscs feed on phytoplankton, which they filter from the water. Their filtering system is not particularly selective and all particles within a certain size range are pulled in. If present in the water column, pathogenic organisms can be filtered out and aggregated or accumulated in the tissues of the mollusc to pose a threat to the humans that consume them.

Oysters at Eskasoni Fish and Wildlife Commission

It should be noted that not all fecal material ending up in the Lakes comes from humans. Wildlife also adds its share, albeit generally a small contribution. However, in some instances where seabirds congregate, their droppings can seriously impact a local area; ducks, geese and cormorants are prime candidates.

Migrating geese over Barra Strait

How is sewage contamination measured?

To guard against the risk of contaminated shellfish entering the marketplace, water in the vicinity of oyster beds is monitored for presence of sewage. The specific organism looked for in tests is one of a family of bacteria, the *Enterobacteriaceae*, and is called *Esherischia coli.* Since it is one of the most common components of human feces and occurs in the millions in our intestines, *E. coli* was chosen very early in the development of the technology as an "indicator". It plays a vital role in our digestive system, being responsible, along with other species of bacteria, for providing us with many necessary micronutrients, such as Vitamin K and B-complex. *E.coli* occurs in a number of forms or strains, most of which are harmless to humans; however, one strain (named 0157:H7), that lives in the intestines of healthy cattle, is a rare variety that produces large quantities of one or more related, potent toxins that cause severe damage to the lining of the intestine, resulting in serious hemorrhaging, and in very serious cases even kidney failure.

So, if generally speaking, these bacteria are harmless why test for their presence? Because these bacteria are so common, they are used as a proxy or an indicator of the presence of sewage, which can potentially carry a number of pathogens. Typhus, cholera and hepatitis are some of the diseases that can spread rapidly when water supplies become contaminated. So *E. coli* is used for detection because there are a lot more coliforms in human feces than there are pathogens and since the testing procedure involves culturing these organisms in is obviously safer to use the harmless bacteria.

E. coli bacteria - indicate presence of sewage

The actual testing for the presence of coliform bacteria is quite involved. In brief, water samples are subdivided in a number of dilutions and eye-dropper amounts of these subsamples are used to inoculate a culture medium contained in shallow dishes. The culture medium is generally agar, a product made from seaweed. These dishes are then incubated in a controlled environment for a set period of time at which point the dishes are inspected for evidence of bacterial growth. Any patch of growth is tested with a dye. Certain dyes are taken up preferentially by coliform bacteria and are used to indicate presence of the bacteria. Thereafter the testing exercise becomes mathematical and statistical. Average numbers of positive cultures are tabulated and the probable number of bacteria in the original, undiluted water sample is calculated. The level below which shellfish harvesting is allowed is an MPN (most probable number of bacteria determined by calculation) of 14 per 100 milliliters of water sample. By contrast the level at which it is determined to be unsafe for swimming is an MPN of 200 per 100 ml.

Who does the monitoring?

Environment Canada is responsible for conducting testing for presence of sewage contamination in marine waters. This task is carried out under the direction of the Canadian Shellfish Sanitation Program (CSSP) within this federal department. The program runs two surveys; one travels the shoreline to document actual and potential sources of sewage pollution, and the second carries out water sampling in areas that are, or could potentially be used for culture of shellfish.

The shoreline survey lists and maps details on such things as open sewers, malfunctioning septic systems, outhouses, lift stations (mechanism used to pump sewage uphill to a community sewer system), sewage treatment plants, wharves and farms. Pipes are also tabulated; these may come from septic tank filter fields or may be for the discharge of so-called 'gray water'. Either are considered sources of pollution. Whereas the shoreline survey is done on foot, the water sampling survey is done by boat. Specific sampling locations, or stations, are determined and water samples from these are returned to the laboratory for analysis. At present, 397 stations are monitored throughout the Lakes for bacterial contamination. The number of stations per sub-watershed ranges from 9 to 44; the number is a function of the size of sub-watershed, presence of aquaculture and number of sites with obvious signs of sewage pollution. In Cape Breton, the Bras d'Or Lakes and area are divided into northern, southern and St. Peter's and vicinity and are sampled on a three year rotational basis. Certain localities such as Denys Basin, where shellfish harvesting is a major activity and where there are sewage contamination concerns, are however, monitored on an annual basis.

Shellfish harvesting site classification.

The CSSP has three classifications to identify harvest sites; these are open, conditionally open and closed. Some areas closed to shellfishing can be reopened after certain conditions are met, but others will remain permanently closed.

Open

In these localities, water quality is considered good where an average of a number of samples is an MPN of 14/100 ml or less and that no more than 10% of the samples have an MPN of 43/100 ml or greater. Also there must be no high risk pollution sources in the area as determined by the shoreline survey. The open classification can only be given to new sites where there have been a minimum of 15 sampling runs completed; a portion of which are done following rainfall events. The results are then statistically analysed and depending on the results, the area is considered to be open, conditional or closed.

Conditional

These localities have, for the most part, good water quality. Although the water quality is suitable for the growth and harvesting of shellfish, there are certain times when it is not. Poor water quality may result from excessive river discharge after heavy rainfall. Farmyard manure can runoff into the river upstream and be carried down to bays where the freshwater is discharged into the Lakes. Most often this occurs at certain times of the year such as spring after melting of snow or ice resulting in the so-called 'spring freshet'. In localities deemed 'conditional', shellfish harvesting will be banned during certain months and can only be reopened after testing indicates good water quality and also that the shellfish themselves are not contaminated. Shellfish, such as oysters, will accumulate pollutants in their tissues when living in contaminated water but will soon rid themselves of these with the return of clean water. Oysters growing in polluted areas can be moved to clean localities to self-clean; this process is known as depuration.

Closed

When water quality testing indicates the average MPN is in excess of 14/100 ml, or when more than 10% of the samples have an MPN greater than 43/100 ml even though the average is less than 14/100 ml, then shellfish harvesting is prohibited in the area. These areas will remain closed until sampling determines it safe to reopen them. *However, certain localities will always be classified as closed since there is a permanent potential for contamination.* Areas in the vicinity of wharves, lift stations and outflows from sewage treatment plants are so classified. It is not uncommon for lift stations to overflow, such as during heavy rainfall when raw sewage would be washed down into the Lakes. Frequent boat traffic at and around wharves and the potential for discharge of pollutants, accidental or otherwise, is an ongoing threat to water quality.

State of the water quality in the Bras d'Or.

Overall the water quality of the Bras d'Or Lakes is good. About half of the Lakes' area has not been tested, but since most of this area is within the largest lake, Bras d'Or Lake and away from the shoreline, it can be safely assumed that most of the water here is of the good quality. Of the remaining half that is sampled, the majority is approved for shellfish harvesting, about 0.5% is approved conditionally and just under 3% is not approved and closed to shellfish harvesting (see Figure 3).

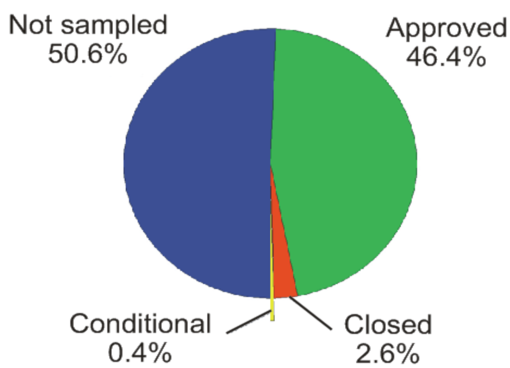


Figure 3. Shellfish classifications within the Bras d'Or Lakes

About half of the closed area could be reopened should water quality improve. However, the remainder will stay permanently closed due to potential risk of contamination, even though at the moment a considerable amount of it has good water quality (see Figure 4).

Prior to 1974 just under 0.5% of the total area of the Lakes was closed to shellfish culture and harvesting; this rose to just under 2.5% by 1995 and has changed little since. The main reason for this increase in the mid 90s was because of an almost threefold increase in the area that was sampled. Although three times the area was sampled the area that tested poor enough for closure rose only about 44%

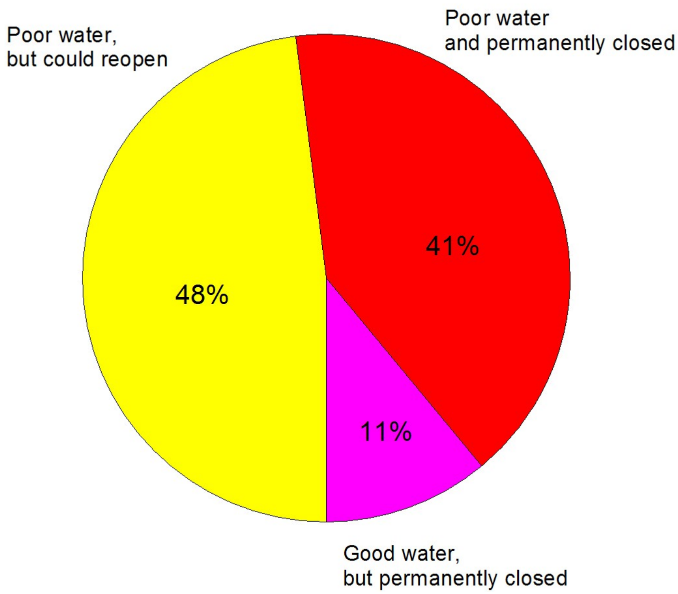


Figure 4. Categories within closed areas.

Change in closure area over time.

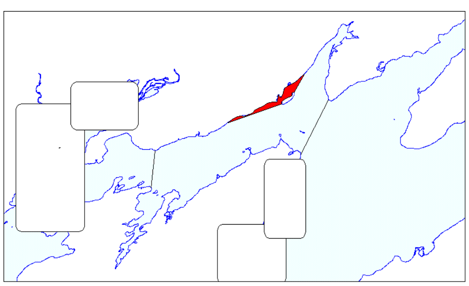


Figure 5. Baddeck pre 1975

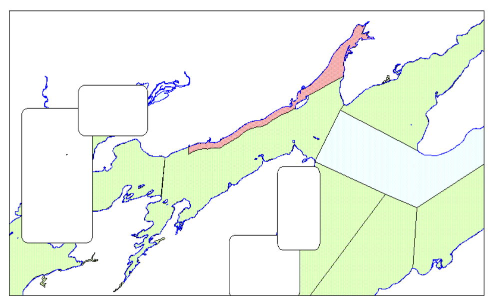


Figure 6. Baddeck 1975 - 2003

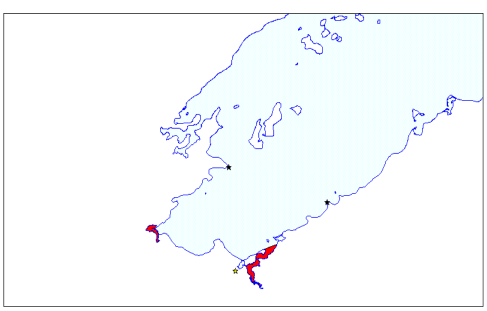


Figure 7. Head West Bay 1981-2001

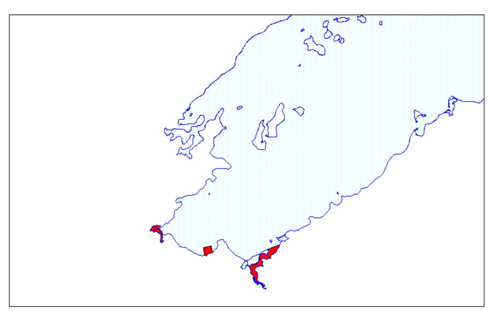


Figure 7. Head West Bay 2002

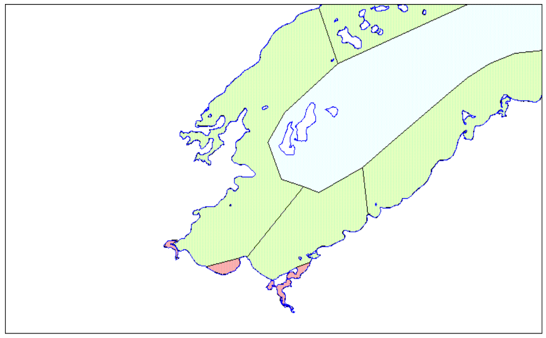


Figure 7. Head West Bay 2003

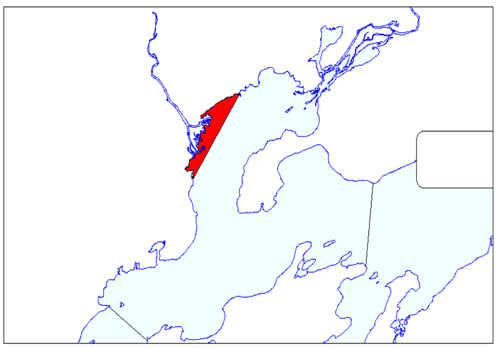


Figure 8. Nyanza Bay 1963-1974

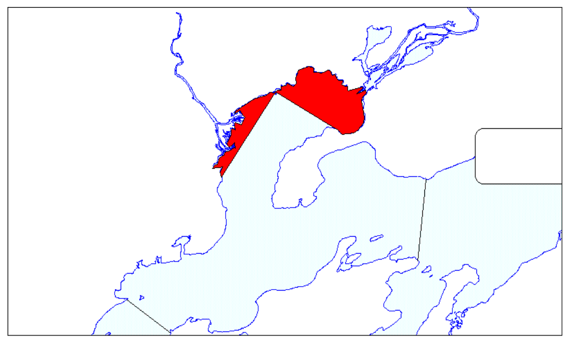


Figure 9. Nyanza Bay 1975-1990

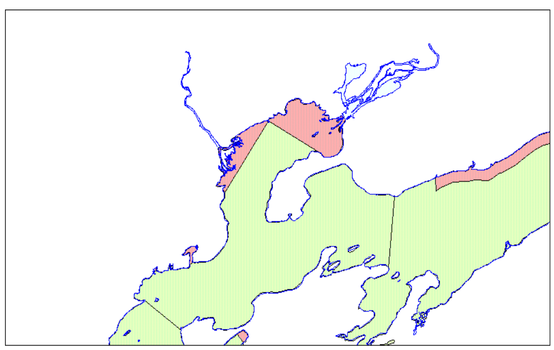
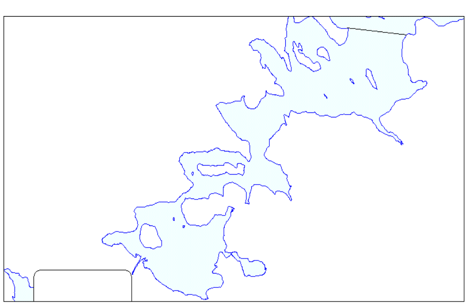


Figure 10. Nyanza Bay 1991-2003



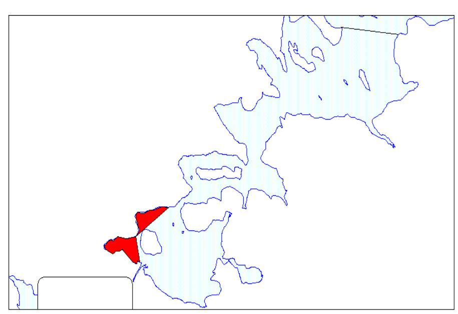


Fig. 11. St. Peter's Inlet 1967

Fig. 11. St. Peter's Inlet 1988-1992

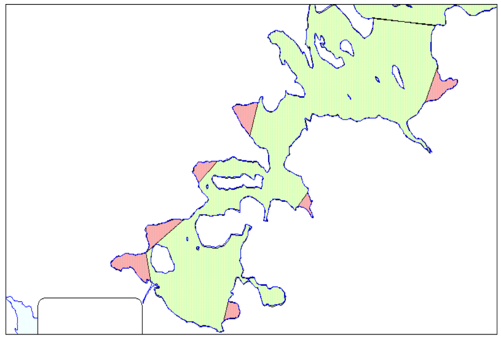
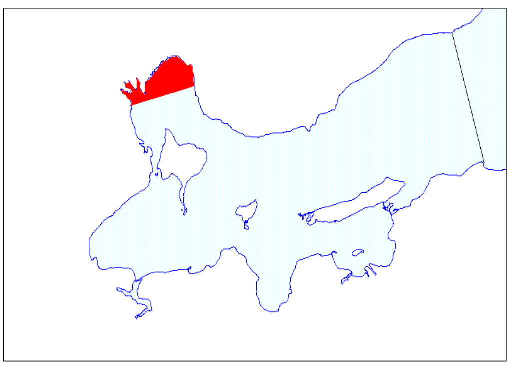


Fig. 12. St. Peter's Inlet 1992-2003



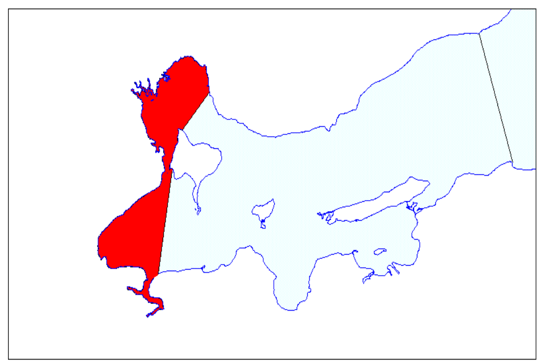
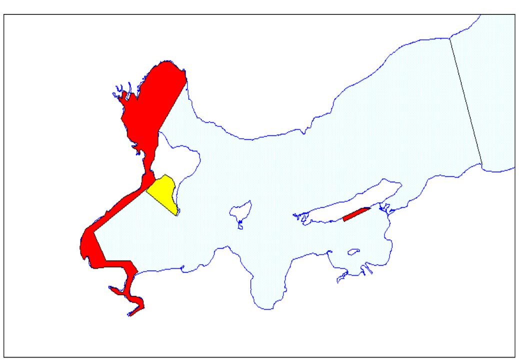


Fig. 13. Head Whycocomagh Bay 1963-1974

Fig. 14. Head Whycocomagh Bay 1975-1990



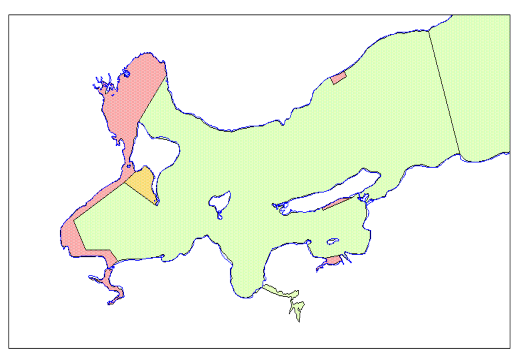


Fig. 15. Head Whycocomagh Bay 1991-2000

Fig. 16. Head Whycocomagh Bay 2001-2003

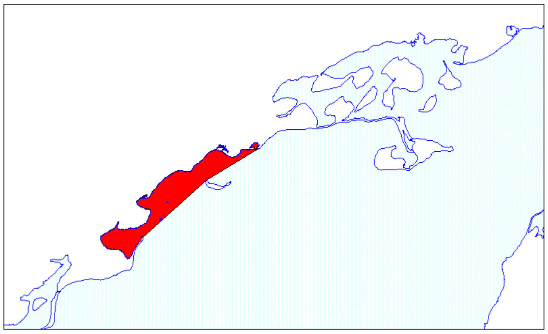


Figure 17. Eskasoni 2001

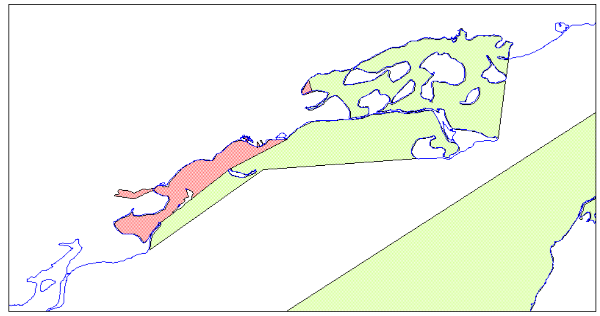


Figure 18. Eskasoni 2003

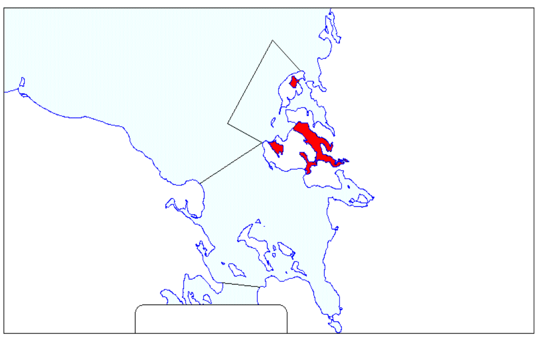


Fig. 19. Chapel Island/Red Islands 1993-1996

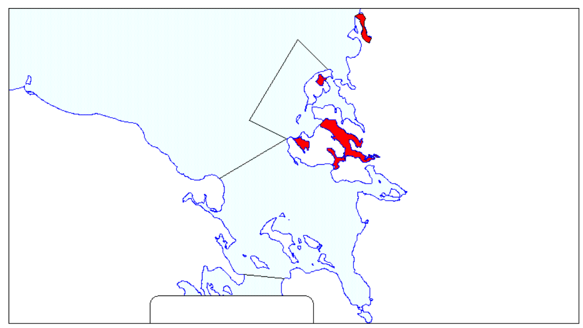


Fig. 20. Chapel Island/Red Islands 1997-2002

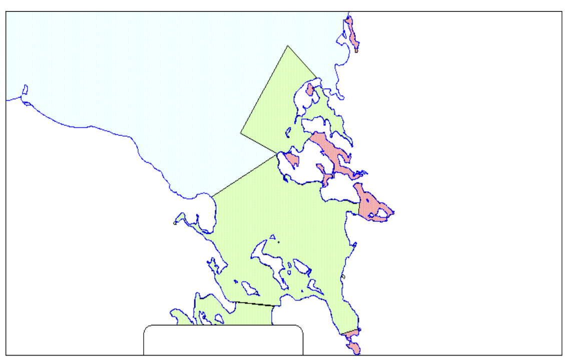


Fig. 19. Chapel Island/Red Islands 2003

Excerpted from a document prepared by Timothy Lambert for the Unama'ki Institute of Natural Resources (UINR) as part of an Environment Canada/UINR State of the Environment (SOE) report for the Bras d'Or Lakes. Figures depicting change of shellfish closure area over time prepared by Curtis Young for the SOE report.