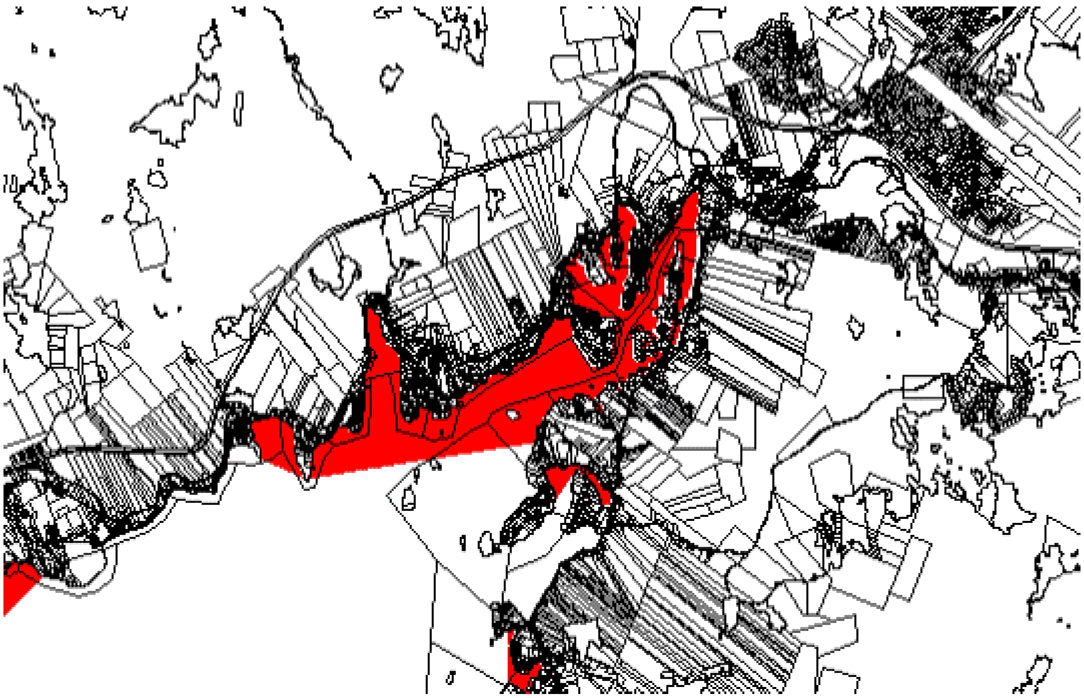
Pollution and Coastal Zone Management: A Case Study of Shellfish Bed Closures in St. Margaret's Bay, Nova Scotia



Head of St. Margaret's Bay: 2002 (map courtesy of HRM)

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Abstract

Current research attributes land-based development as the major cause of marine pollution. Shellfish, with their ability to filter large amounts of water, are considered an indicator species for declining water quality due to chemical and bacterial contamination from point and non-point source pollution.

The Head of St. Margaret's Bay has experienced an overwhelming increase in the size of its shellfish closure area in the past two years. Yet between 1995 and 2001, the closure area essentially remained unchanged. It is unknown whether this dramatic increase is the result of cumulative environmental impact and / or a significant pollution event occurring sometime in 2002.

The following report is presented as requested to the Halifax Regional Municipality (HRM) Planning Committee by students in the School for Resource and Environmental Studies, Dalhousie University as part of a joint project in collaboration with HRM, Environment Canada (EC), and the Department of Fisheries and Oceans (DFO). The report concerns the recent exponential increase in shellfish closures in the St. Margaret's Bay area. Although there is reason to believe that leaking septic tank systems in older residential developments are the likely source of increased levels of fecal coliform, there is an interest in expanding the scope of probable causes by investigating other contributing factors from both land and water use practices. Accordingly, this report will examine a variety of land and water use activities that may be linked to fecal coliform-related shellfish closures in the St. Margaret's Bay area. It will also explore a broad range of issues pertaining to coastal zones that are applicable to St. Margaret's Bay, including legislation, marine environmental quality indicators, community involvement and education, and integrated coastal zone management.

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Introduction

Most of the pollution entering the world's coastal waters originates from human activities on land (GESAMP, 2001a). The land and sea are closely linked through physical, geological, biological and atmospheric processes. As such, the effects of harmful activities on land will be felt in coastal waters. For example, sewage and chemicals are washed off the land into streams and rivers during wet weather, which in turn flow into the sea. The pollution of coastal waters around the world is largely attributed to commercial and residential development. A lack of public awareness is often a key factor at the root of this problem. For some, the direct connection between land activities and marine pollution is not readily apparent. As well, proper disposal of pollutants can be expensive and existing legislation for protecting coastal zones may not be adequate or enforced.

Shellfish, Fecal Coliform and Sewage

Good water quality is vital to the shellfish harvesting industry (Lorio and Malone, 1994; GESAMP, 2001a). Shellfish feed by straining large amounts of water through their gills. Particulate food caught on the surface of the gills is transported to the digestive tract (Massachusetts Office of Coastal Zone Management [MOCZM], 1995). Bacteria and viruses may also be ingested during the filter-feeding process, along with toxic pollutants and heavy metals. For this reason, shellfish are commonly used as an indicator organism for evaluating marine water quality, and detecting changes in aquatic ecosystem health. The accumulation of pathogens in shellfish tissues often has little effect on the animal itself. When consumed by humans, however, the consequences can be serious.

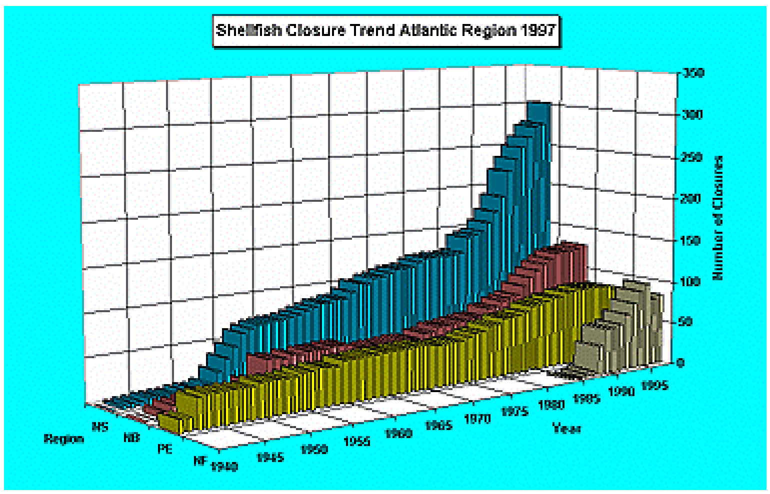
"Of all the pollutants introduced by humans, sewage has the longest history, and efforts to control it date back more than a century" (Topping, 1976, p. 304). The human population explosion has resulted in a desperate need for an acceptable way of dealing with sewage created by people and animals. It has long been recognized that feces is a major source of waterborne disease transmitted by the fecal-oral route (Kator and Rhodes, 1994). Feces contain dangerous pathogens (i.e., organisms capable of causing diseases) like *Salmonella* and *Escherichia coli* bacteria, known to cause typhoid fever, food poisoning, and cholera, and viruses linked to hepatitis-A, gastro-enteritis, and polio.

Feces also contain fecal coliform bacteria, which live in the intestines of humans and other warm-blooded animals. While not a pathogen itself, fecal coliform in water indicates the potential presence of pathogens since both are commonly found in raw sewage. In addition, both fecal coliform and the pathogens mentioned above tend to accumulate in shellfish tissues. For these reasons, fecal coliform has traditionally been used as an indicator of sewage pollution in water and shellfish (MOCZM, 1995).

Health authorities have established standards and protocols to manage the public safety hazard posed by the consumption of shellfish contaminated by pathogens. Shellfish waters are tested for fecal coliform levels, and subsequently classified on this basis (MOCZM, 1995). Harvesting is forbidden in areas contaminated with unacceptably high levels of fecal coliform, and shellfish from areas with borderline levels of fecal coliform must be cleansed or sterilized before sale (Topping, 1976).

The number of areas being closed to shellfish harvesting, due to elevated levels of fecal coliform in the water, poses a serious problem for the shellfish industry. Closures in the Atlantic Provinces have been increasing on the whole, with Nova Scotia experiencing the largest rise (Figure 1). Currently, 35% of Nova Scotia's shellfish growing areas are closed to harvesting (Canada's National Program of Action for the Protection of the Marine Environment from Land-based Activities [CNPA], 2000).

Figure 1: Trends in Shellfish Closures in the Atlantic Provinces (source: EC, 2003).



Sources of Pollution

In many parts of the world, treatment processes have been implemented to help reduce the harmful environmental effects of sewage before it enters the sea. However, sewage still reaches the sea from a number of direct (point) sources such as municipal piped outfalls, and indirect (non-point) sources such as leaky septic tanks and farm animal waste (CNPA, 2000). In Nova Scotia, "sewage treatment facilities serve approximately 24% of the population, while an additional 45% of the population is served by on-site disposal systems. As a result, some 31% of the population (almost 300,000 people) still has sewage collection systems without treatment" (CNPA, 2000, p. 87).

Recreational boaters contribute to point-source pollution by discharging raw or poorly treated sewage from their holding tanks into the water. The San Francisco Estuary Project (1995) website states, "studies have found high levels of coliform bacteria in areas with heavy concentrations of recreational boats. Studies have also shown a direct relationship between the number of boats in a sampled area and increased coliform levels in both the water column and shellfish". Amazingly, "the untreated discharge from one weekend boater puts the same amount of bacterial pollution into the water as does the treated sewage of 10,000 people" (San Francisco Estuary Project, 1995). Compared to the open ocean, the problem is more serious when dumping occurs in confined spaces such as harbours, coves, and inlets where flushing rates may not be as fast (San Francisco Estuary Project, 1995; EC, 2001). Marinas and yacht clubs are often situated in these areas, so boaters tend to congregate there to anchor, swim, and fish.

In Canada, it is illegal for vessels to discharge raw sewage into the water (EC, 2001). Along with the human health risk posed by the consumption of contaminated shellfish, swimmers, water-skiers, surfers, and others can get sick when they come into contact with water containing fecal pollution. Common symptoms include nausea, stomachache, vomiting, diarrhea, sore throat, cough, runny nose, earache, respiratory problems, skin infections, and rashes (San Francisco Estuary Project, 1995).

Sewage from non-point sources usually reaches the sea by being washed off into rivers and estuaries during wet weather. This runoff is exacerbated by coastal zone development and urbanization. When terrestrial vegetation is removed and replaced by soil-sealing infrastructure such as houses, parking lots, and roads, the soil loses its ability to absorb water (Percy, 1997; Puget Sound Shoreline Stewardship Guidebook, 2002). The threat of land runoff is heightened when steep slopes border watercourses and seas. Non-point source pollution is a major problem because it often goes undetected while causing significant damage to the marine environment. Once detected, the origin of the pollution may be difficult to trace.

Leaky septic tanks are one of the main causative agents of non-point source pollution (Hodges, 1977). Septic tanks are commonly used for disposal of wastewater in rural areas. During the cleansing process, solid materials are removed from wastewater in the septic tank. The wastewater then flows into a drain field, where it is slowly absorbed and filtered by the ground. Polluted wastewater can enter watercourses when the absorptive capacity of the soil is inadequate for proper disposal (Hodges, 1977). Yet by far the most common reason for septic tank failure is improper maintenance by homeowners. "When a system is poorly maintained and not pumped out on a regular basis, sludge (solid material) builds up inside the septic tank, then flows into the absorption field, clogging it beyond repair" (Vogel, 2002). The lifespan of a septic tank system is between 20 and 25 years, after which it needs to be replaced to prevent leaks and malfunctions (Correa, 1999).

Farm animal wastes are another key contributor to non-point source pollution. These pollutants can enter watercourses as runoff from agricultural lands (Hodges, 1977). Agricultural runoff has been positively linked to shellfish closures (EC, 2002b). This problem is particularly severe near large, overcrowded feedlots. It may come as a surprise that feces from domestic animals, dogs in particular, also play a major role in contributing to water pollution. According to Hodges (1977, p. 231), "domestic animals produce about 1 billion metric tons of fecal wastes each year". Remarkably, "a single gram of dog feces contains an average of 23 million fecal coliform bacteria" (Slagle and Meiburg, 2001). As with farm animals, domestic animal waste poses a serious problem when it is washed into streams and rivers during storms. The United States Environmental Protection Agency reports that "for watersheds of up to twenty-square miles draining to small coastal bays, two to three days of droppings from a population of about 100 dogs would contribute enough bacteria and nutrients to temporarily close a bay to swimming and shellfishing" (The Stormwater Manager's Resource Center, 2003).

There are several issues that make land-based sources of fecal contamination difficult to manage. First, it may be hard to pinpoint exactly where the sewage is coming from because there may be several sources (GESAMP, 2001a). Second, there is often a lack of awareness concerning the connection between land activities and marine sewage pollution. People may not realize that their septic tank is old or has not been maintained properly. They may not understand the extent to which dog waste contributes to water quality problems, or they may not want to deal with their dog's feces (Slagle and Meiburg, 2001). Third, septic system upgrades are expensive, so those who cannot afford it may not want to admit that their system requires maintenance. Similarly, municipalities may be unable to finance a sewage treatment plant upgrade, or the construction of one in the first place. Fourth, agriculture is a major industry upon which the livelihood of many people depends. As such, environmental matters must be dealt with in a careful, sensitive manner against potentially serious social and economic ramifications. Finally, the economic benefits derived from developing subdivisions often outweigh environmental concerns and, as such, are accompanied by a lack of foresight. Property lots may be located on soil with limited absorption capacity, or placed so close together that the carrying capacity of the land and waterways is exceeded (Hodges, 1977).

Background on St. Margaret's Bay

St. Margaret's Bay is characterized by its natural beauty. Its rugged coastline is typical of the south shore of Nova Scotia, and the forested hinterland is interrupted only as it reaches the shoreline homes (Taylor and Frobel, 1996). Despite the boulder-lined shore, there are several sandy beaches in the area, along with some saltwater marshes and intertidal mud flats (Halifax County Regional Development Agency [HCRDA], 1995-96). There is a significant amount of residential development around the Head of the Bay.

The biological resources of the area include the typical Atlantic Coast fish, such as cod, herring, and flounder (HCRDA, 1995-96). There are also bluefin tuna, porpoises, and whales in the outer reaches of the Bay. Atlantic salmon and trout can be found in the streams and brooks in the watershed. Animals in the area include beaver, moose, black bears, and deer. There are wild berries, such as cranberries and bake apples. Bird life is abundant; cormorants, great blue herons, eagles, and terns can be seen. Seaweeds in the Bay include kelp and rockweed (HCRDA, 1995-96). The ocean floor supports clams, worms, crabs, and scallops.

<u>Land and Water Uses</u>

Human activities in St. Margaret's Bay are largely based on the natural resources in the area. There have been various recreational and commercial fishing activities over the years, including a lobster and mackerel fishery, shellfish harvesting, and eel spearing

(HCRDA, 1995-96). The area is popular for tourism and recreational activities. The St. Margaret's Bay Yacht Club is a key attraction. Camping, windsurfing, diving, kayaking, boating, swimming, hiking and biking are just a sample of the many activities people enjoy.

A considerable amount of infrastructure exists in the area, mainly for residential and recreational purposes. The main road in the area winds along the coast, in some cases within meters of the shoreline (Taylor and Frobel, 1996). Wharves, piers, docks and slipways line the shore, built for private, government and commercial watercraft (HCRDA, 1995-96). Major infrastructure includes a fish plant, a municipal sewage treatment plant, and an ice plant. There are also a few aquaculture leases for oysters and mussels on the eastern side of the Bay (Nova Scotia Department of Agriculture and Fisheries, 2001).

Geomorphology of St. Margaret's Bay

St. Margaret's Bay is a large coastal inlet, 16 km long and 10 km wide (Piper and Keen, 1976). The middle of the Bay is a large flat-bottomed basin, with depths up to 90m. There is a bedrock sill at the southern mouth of the Bay at a depth of 55m (although a substantial portion of it lies at less than 20m). This sill plays a major role in the movement of ocean water into the Bay. The Bay is generally deeper on the western side, with steep cliffs being mirrored by steep underwater slopes. Its eastern and northeastern portions are generally more shallow and gradual, with underwater shoals of sediment. The floor of the Bay is underlain with bedrock, which was scoured by the glaciers as they retreated (Piper and Keen, 1976). A thick layer of glacial sediments, including gravelly sands and mud in the northeastern sections, overlies the bedrock. These glacial deposits along the coast were the main source of new sedimentation on the floor of the Bay at the time of the Piper and Keen study (1976). This is likely still the case, as wave action continuously moves the cobble, gravel and sand around. The coastline of St. Margaret's Bay is largely made up of granite, with some limestone on the eastern side.

Circulation

The ocean water in St. Margaret's Bay circulates in a counter-clockwise direction (Heath, 1973; Piper and Keen, 1976). Ocean water generally enters the Bay on the eastern side, and leaves it on the western side (Heath, 1973). This horizontal movement dominates over any vertical movement of water, and results in a well-mixed bay. Understanding this pattern of circulation is important, since it is how pollutants, debris, silt and juvenile organisms from coastal habitats are carried out to sea and cooler, nutrient rich waters enter the Bay (Duxbury and Duxbury, 1994). The tidal currents in the Bay are strong, but decrease in velocity as they reach the Head of the Bay (Piper and Keen, 1976).

A strong thermocline does occur in summer, however, with a layer of warm, relatively fresh water above and a layer of cool, highly saline water on the bottom (Heath, 1973). Both of these layers continue to move in a counter-clockwise direction. This stratification is more pronounced after heavy rainfalls when rivers discharge more freshwater (and potential pollutants) into the system. Most of the freshwater entering the Bay enters in the north and northeast portions of the Bay (Piper and Keen, 1976).

The dominant counter-clockwise movement of ocean water is the principle mechanism through which flushing of the Bay occurs (Heath, 1973). The flushing time is the amount of time it takes for water in the Bay to be completely exchanged with water from the open ocean (Duxbury and Duxbury, 1994). The overall flushing time of St. Margaret's Bay is approximately 12 days (Gregory et al., 1993). The flushing times for smaller sections of the Bay are difficult to estimate, however, because of the complexity of the coastline and micro-circulation cells this may generate (Kennish, 1998). This should be an area for further investigation. The flushing rates for individual coves, if substantially higher than for the Bay as a whole, may contribute to the local retainment of sewage pollution and therefore shellfish closures.

Table 1: Freshwater Discharge in St. Margaret's Bay (source: Gregory et al., 1993).

Month	Discharge Rate ($m^{3/}s$)	Month	Discharge Rate (m^3/s)
January	29.0	July	10.1
February	22.4	August	8.6
March	30.5	September	10.7
April	50.7	October	17.2
May	29.4	November	30.3
June	16.7	December	33.0

Canadian Shellfish Sanitation Program

The purpose of the CSSP is to ensure public health and safety by assessing shellfish harvesting areas for contamination (EC, 2003). This program is administered by three federal government agencies, each of which plays a different role. EC collects and analyses water samples, and recommends closure areas to the Shellfish Growing Area and Survey Classification Committee. DFO is responsible for enforcing these closures, along with overseeing harvesting, relaying and depuration procedures. The Canadian Food Inspection Agency (CFIA) is responsible for "the handling, processing, marketing, import and export of shellfish and liaison with foreign governments. CFIA is also responsible for the management of the marine biotoxin monitoring program" (EC, 2003).

Criteria for Determining Shellfish Closures

The monitoring conducted by EC consists of two parts: a bacteriological survey and a shoreline survey (EC, 2003). The bacteriological survey involves collecting and analysing water samples for the presence of fecal coliform. If water samples show a median fecal coliform higher than 14 MPN/100ml (where MPN is Most Probable Number), or more than 10% of the samples are above 43 MPN/100ml, the area will be closed to shellfish harvesting. The shoreline survey documents the type of land use practices around the sites being tested and records observations of potential sources of sewage. The area will be closed if it is clear from the shoreline survey that there are direct sources of fecal coliform entering the water, even if bacteriological test results on samples from a particular site are within the acceptable fecal coliform range (Young et al., 2002).

In the case of the shellfish closure in the Head of St. Margaret's Bay in 2002, the decision was based on the large number of tested sites that failed to meet the above criteria (Young et al., 2002). The larger closed area incorporates seven previous closures, along with new areas that have deteriorated beyond acceptable levels. Although one sample within the closed area did meet the criteria, it would not be prudent to harvest shellfish at this site since it is surrounded by contaminated water. For this reason it was included in the shellfish closure area (J. Young, pers. comm., May 9, 2003).

Municipal Legislation

Significant legislation exists in Nova Scotia to give municipalities the power to regulate and control a variety of activities pertaining to the environment. HRM has the power to create and enforce by-laws that it deems necessary for maintaining a healthy environment in St. Margaret's Bay and throughout the entire municipality. The following is a summary of relevant information involving land, water, and environmental quality taken from the Municipal Government Act, 1998.

Dogs

Under section 175(1i) of the Act, a council may make by-laws "requiring the owner of a dog, other than a dog that is trained to assist and is assisting a person with a disability, to remove the dog's feces from public property and from private property other than the owner's". Since it is likely that the pollution in St. Margaret's Bay is caused in part by fecal runoff from domestic dog waste, HRM could enforce municipal bylaw D-100, *Respecting the Registration and Regulation of Dogs*, more strictly to help mitigate this source of pollution (HRM, 2001).

Minimum Standards

Section 181(1a) of the Act states that "a council may make by-laws prescribing minimum standards of sanitation, plumbing, water supply, lighting, wiring, ventilation, heating, access, maintenance, appearance, construction and material for buildings, or parts thereof, occupied for residential or commercial purposes." HRM could create/enforce the minimum standards by-law more strongly with respect to sanitation, plumbing, and maintenance in areas of St. Margaret's Bay where increased development has occurred.

Municipal Planning Strategy

Proper planning and development are essential for the positive growth of St. Margaret's Bay and the entire HRM. Good planning can help to prevent environmental degradation in the future. Part VIII (ss. 190-267) of the Act addresses "Planning and Development" and is worthy of HRM's consideration. It gives the municipality the authority to establish a municipal planning strategy. This planning strategy should "establish (a) policies which address problems and opportunities concerning the development of land and the effects of the development; (b) policies to provide a framework for the environmental, social and economic development within a municipality…" (s. 213).

According to section 214(1), statements of policy may relate to matters including:

(a) the goals and objectives of the municipality for its future;

(b) the physical, economic and social environment of the municipality;

(c) the protection, use and development of lands within the municipality, including the identification, protection, use and development of lands subject to flooding, steep slopes, lands susceptible to subsidence, erosion or other geological hazards, swamps, marshes or other environmentally sensitive areas;

(d) stormwater management and erosion control…

(f) in connection with a development, retention of trees and vegetation for the purposes of landscaping, buffering, sedimentation or erosion control;

(g) studies to be carried out prior to undertaking specified developments or developments in specified areas…

(i) the provision of municipal services and facilities…

(l) the subdivision of land…

(m) the use and conservation of energy, including the height and siting of developments;

(n) measures for informing, or securing, the views of the public regarding contemplated planning policies and actions or by-laws arising from such policies…

The municipality may also establish planning and area advisory committees (ss. 200-201). Separate or joint advisory committees may be created for different parts of the municipality to deal with matters specific to the area.

<u>Community Council</u>

Under part XXII, section 521(1), HRM holds the power to establish a community council for an area. The powers and duties of a community council include making recommendations with respect to "…appropriate by-laws, regulations, controls and development standards for the community…" (s. 521[1c]) and " the adoption of policies that would allow the people of the community to participate more effectively in the governance of the community" (s. 521[1e(ii)]).

A community council can be an extremely useful tool in municipal management. Public involvement is crucial to the success of any management plan geared toward improving environmental quality. A community council could assist HRM in better understanding the values and attitudes of the people of St. Margaret's Bay, by putting forth important work and input.

Land Use By-Laws

HRM has the power to adopt and enforce land use by-laws in St. Margaret's Bay and throughout the municipality to sustain and improve environmental quality. Under section 220(4) of the Act, a land-use by-law may regulate

(a) the minimum dimensions for frontage and lot area for any class of use and size of structure;

(b) the maximum floor area of each use to be placed upon a lot, where more than one use is permitted upon a lot;

(c) the maximum area of the ground that a structure may cover;

(ca) the location of a structure on a lot…

(e) the percentage of land that may be built upon…

(g) the maximum density of dwelling units…

Moreover, where a municipal planning strategy allows, section 220(5) states that a land-use by-law may

(d) in connection with a development, regulate, or require the planting or retention of, trees and vegetation for the purposes of landscaping, buffering, sedimentation or erosion control…

(f) regulate the location of disposal sites for any waste material;

(g) in relation to a development, regulate or prohibit the altering of land levels, the excavation or filling in of land, the placement of fill or the removal of soil unless these matters are regulated by another enactment of the Province;

(h) regulate or prohibit the removal of topsoil…

(l) prescribe methods for controlling erosion and sedimentation during the construction of a development;

(m) regulate or prohibit excavation, filling in, placement of fill or reclamation of land on floodplains identified in the land-use by-law;

(n) prohibit development or certain classes of development where, in the opinion of council, the

(i) cost of providing municipal wastewater facilities, stormwater systems or water systems would be prohibitive,

(ii) provision of municipal wastewater facilities, stormwater systems or water systems would be premature…

(o) prohibit development within a specified distance of a watercourse;

(p) prohibit development on land that

(i) is subject to flooding or subsidence,

(ii) has steep slopes,

(iii) is low-lying, marshy, or unstable…

Subdivisions

Part IX (ss. 268-292) of the Act addresses "Subdivisions" and is important when considering the management and development of St. Margaret's Bay. Currently there are several subdivisions in the area, and conceivably more could be added in the future. Under section 271(5a,d), a subdivision by-law may require that prior to approval of a final plan of subdivision, the applicant shall "install [and/or] provide the water systems, wastewater facilities, stormwater systems and other services in the area of land being subdivided to the standards prescribed by the municipality". The applicant may also be required to "have a qualified professional certify to the municipality that the services have been designed and installed to the standards prescribed by the municipality" (s. 271[6]).

In St. Margaret's Bay, a subdivision called Allan Heights was built in the 1970s. As discussed, septic tank systems typically have a lifespan of 20-25 years. Thus, it is reasonable to believe that many of the septic tanks in Allan Heights may now be faulty, causing sewage to leak into the water and increasing levels of fecal coliform in the bay. HRM should require that professionals study these septic systems to determine their efficacy and safety. Any defects should be repaired immediately in order to reduce the flow of fecal waste into the bay.

Septic Systems

HRM has the authority to enforce stringent regulations regarding septic systems in St. Margaret's Bay. Enforcement is essential if fecal coliform levels in the bay are to be reduced. According to part XIII, section 333(1) of the Act, "no person shall permit the discharge into wastewater facilities or a stormwater system of a municipality or a village or into wastewater facilities or a stormwater system or building service connection connecting with the wastewater facilities or stormwater system of a municipality or a village of

(g) the contents of septic tanks, holding tanks or wastes from marine vessels or vehicles or sludge from sewage treatment plants…

(j) sewage in concentrations of suspended solids that exceed the limit specified by the council or village commission by by-law;

> (k) sewage that exerts or causes biological oxygen demand and chemical oxygen demand greater than amounts specified by the council or village commission, by by-law…

The Act also deals explicitly with private septic systems, which is extremely relevant to HRM in its management of St. Margaret's Bay. HRM has the authority to enforce proper treatment of these systems: "A municipality may, by by-law, require owners of private on-site sewage disposal systems to have the systems pumped, emptied, cleaned, checked and maintained in accordance with the standards set out in the by-law" (s. 336). Prohibitions under section 338 state that no person shall

> (a) permit stormwater, surface water, ground water, roof runoff, subsurface drainage, cooling water or industrial process waters to be discharged into a sanitary sewer…
>
> (c) discharge sewage anywhere except into a municipal sewer, private on-site sewage system or central sewage collection and treatment system;
>
> (d) permit any contents of a septic tank or cesspit to be discharged into a municipal sewer or watercourse.

According to section 339, "a person who owns, maintains or operates private wastewater facilities or who owns or occupies land on or under which there is private wastewater facilities shall maintain and operate the system in such a manner that

> (a) a danger to the public health is not created by the system;
>
> (b) sewage or effluent from the system does not appear on the surface of the ground, or in any ditch, excavation or building basement…
>
> (d) sewage or effluent from the system does not leak from any part of the system…

Any person found to be in violation of these regulations may be given seven days notice to correct the problem, after which "the engineer may cause to be done all work necessary for compliance with the notice" (s. 339[3]).

Recommendations to HRM

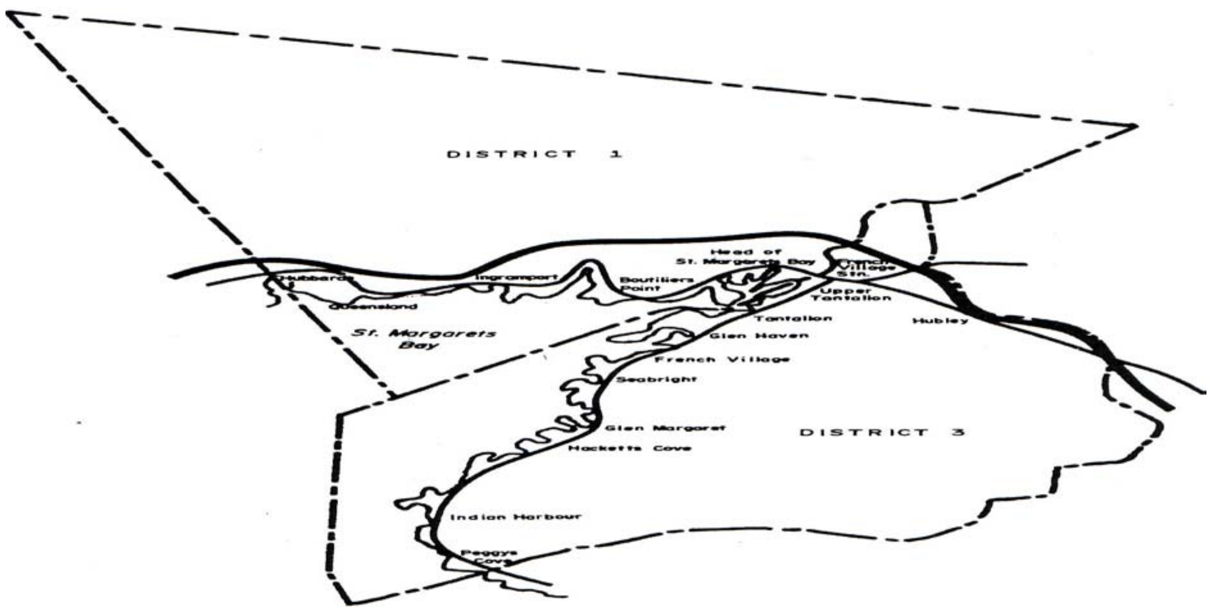
HRM has the legal authority to implement measures for decreasing and preventing environmental degradation in a variety ways. It is recommended that HRM carefully inspect current by-laws to determine if they are adequate and, more importantly, if they are being properly enforced in St. Margaret's Bay. Community councils, and planning and advisory committees can provide useful information and assistance to HRM in this regard. Overall, it appears that HRM holds ample authority to promote positive environmental change in St. Margaret's Bay.

Applied Land Use Practices in St. Margaret's Bay

In many cases, the increase in shellfish bed closures in St. Margaret's Bay can be associated with coastal zone development on land. As such, the importance of land use practices is apparent when protecting shellfish fisheries. As discussed above, urbanization and agriculture practices are two of the major sources of bacterial contamination of shellfish. In the St Margaret's Bay area, the population of Planning

District 3 has grown exponentially: 16.7% for the period from 1986 to 1991, compared to 1.5% for the period from 1981-1986 (HRM, 1995a). This population boom has been accompanied by a substantial rise in the number of new homes and subdivisions being constructed (Friends of St Margaret's Bay, 2002).

Figure 2: Planning districts 1 & 3 (source: HRM, 1995a).



While the Municipal Planning Strategy for the St. Margaret's Bay area outlines the land use intent for the planning district, it does not commit "Council to undertake any of the projects or actions contained herein" (HRM, 1995a). Therein lies a significant weakness in the strategy, particularly for land-use practices as they relate to the shellfish bed closures in the area. Granted, the planning strategy also states that, "Council cannot take any action within the scope of this strategy which would, in any manner, be inconsistent with the strategy or at variance with it" (HRM, 1995a). Yet the document fails to define the terms *inconsistent* and *variance*. This kind of ambiguity sets a dangerous precedent, for when terms are undefined they are open to interpretation.

Table 2: Zoning Designations in the St. Margaret's Bay Area (source: HRM, 1995b)

Designation	Activities Permitted	Designation	Activities Permitted
R-1 (SINGLE UNIT DWELLING) ZONE:	Single unit dwellings, day care facilities. Business uses, bed and breakfasts. Community use (open space)	R-A (RESIDENTIAL) ZONE:	Single unit dwellings, auxiliary dwelling units, day care facilities. Business uses, bed and breakfasts. Community use (open space)

R-A1 (GENERAL RESIDENTIAL) ZONE:	Single unit dwellings, auxiliary dwelling units, day care facilities. Business uses, bed and breakfasts. Community uses (open space and institutional)	R-1E (RESIDENTIAL ESTATE) ZONE:	Single unit dwellings, auxiliary dwelling units, day care facilities. Business uses, bed and breakfasts. Community use (open space). Agricultural uses (stables)
R-2 (TWO UNIT DWELLING) ZONE:	Single unit dwellings, two unit dwellings, day care facilities. Business uses, bed and breakfasts. Community use (open space)	MRR-1 (MIXED RURAL RESIDENTIAL) ZONE:	Single unit dwellings, two unit dwellings, mobile dwellings skirted, day care facilities, business uses, boat houses. Commercial uses (e.g., bed and breakfasts, convenience stores). Resource uses (agriculture, forestry, fishery support) Community use (open space and institutional)
MU-1 (MIXED USE) ZONE:	All uses *except the following*: residential (mobile home parks, multi-unit dwellings, senior citizen housing over 20 units), commercial uses (entertainment uses, campgrounds, marinas), resource uses (agricultural, extractive facilities, sawmills and industrial mills over 3,000 sq ft.), industrial uses (salvage yards, does not apply to traditional uses and service industries), Construction and demolition	MU-2 (MIXED USE) ZONE:	Same as MU-1 designation except fish processing plants are not permitted

C-1 (LOCAL BUSINESS) ZONE:	Residential uses (single unit dwellings, two unit dwellings, day care facilities <14 children. Business uses in conjunction with permitted dwellings). Commercial uses (variety and grocery stores, service shops)	C-1A (COMMUNITY COMMERCIAL) ZONE:	Commercial uses (variety and grocery stores, service shops, craft shops, antique shops). Residential uses (single unit dwellings, two unit dwellings, mobile homes skirted, day care facilities <14 children. Business uses in conjunction with permitted dwellings)
C-3 (TOURIST INDUSTRY) ZONE:	All MRR-1 (mixed rural residential uses). Tourism uses (motels, hotels, restaurants)	MR-1 (MIXED RESOURCE) ZONE:	Residential uses (single unit dwellings, two unit dwellings, mobile dwellings. Business uses in conjunction with permitted dwellings). Resource uses (agricultural uses, forestry uses, fishery uses, extractive facilities and bulk storage facilities, composting operations) Commercial uses (hunting and fishing lodges). Community uses (recreational uses, private and public parks, open space uses)
MR-2 (MIXED RESOURCE) ZONE:	Residential uses (single unit dwellings, two unit dwellings, mobile dwellings. Business uses in conjunction with permitted dwellings) Resource uses, Commercial uses (hunting and fishing lodges), Community uses (open space uses)	I-1 (GENERAL INDUSTRIAL) ZONE:	Industrial uses (manufacturing, processing, or assembly operations, forestry industries over 3000 sq ft, office or retail use connected with the aforementioned industries

I-1 (SALVAGE YARD) ZONE:	Salvage and scrap yards, service stations, and associated dwelling units	I-3 (MIXED INDUSTRIAL) ZONE:	Manufacturing, assembly, or warehousing operations within a building, transportation yards, heavy machinery sales, office or retail use, composting operations
P-3 (PROVINCIAL PARK) ZONE:	Conservation and related uses. Recreational uses, public parks. Commercial uses applicable to public park use	P-4 (CONSERVATION) ZONE:	Conservation uses (conservation, historic sites and monuments). Watershed uses (distribution, management, resource use associated with watershed management)
CD-1 (C&D MATERIALS TRANSFER STATIONS) ZONE:	Construction and demolition materials transfer stations	CD-2 (C&D MATERIALS PROCESSING FACILITIES) ZONE:	Material processing facilities, accessory dwelling units, excluding construction and demolition disposal
CD-3 (C&D MATERIALS DISPOSAL SITES) ZONE:	All CD-2 zone uses, construction and demolition disposal, accessory dwelling units	ICH (INFRASTRUCTURE CHARGE HOLDING) ZONE:	No development except for single unit dwellings and open space uses

Zoning Regulations and Watercourses

The HRM Land Use Bylaw for the St. Margaret's Bay area contains numerous sections involving setbacks from watercourses. Section 4.19(a) stipulates that a building or structure (with the exception of boathouses and buildings related to such activities) must be at least 25 feet (7.6 m) from the edge of a watercourse or body of water (HRM, 1995b). Other land uses vary in the distance they are required to be from watercourses. For example, agricultural uses must be at least 300 feet (91.5 m) from a watercourse; construction and demolition (C&D) transfer stations must be 98.4 feet (30 m) from a watercourse; and, C&D processing facilities must be 196.8 feet (60 m) from a watercourse (s. 12.6; HRM, 1995b).

Despite the good intentions of the land use bylaw, its effectiveness is confounded by the fact that a large portion of the land around the St Margaret's Bay area is elevated. Most of the structures and accompanying activities (e.g., farming) are located on slopes, which act as a catalyst for agricultural and urban runoff. A typical example of this is Mason's Point where "given the steepness of the hill in some areas, fecal coliform might be leached by land wash" (Young and Menon, 1998, p. 90). Not surprisingly, fecal coliform levels are notably higher around Mason's Point. Unfortunately, the bylaw fails to account for the influence of sloped land on runoff, thereby impeding good land use planning practice.

The bylaw is further weakened by a caveat in section 4.19(a) that states, "any existing building *within* this setback distance (25 feet or 7.6 m) shall be a permitted and conforming use". While not all existing buildings between the shore and 25-foot setback can be relocated, perhaps some could be moved to adhere to current setback regulations. HRM should inventory and classify existing structures as to their potential for relocation as well as their current impact on marine environmental pollution.

Figure 3: Sanitary Observation Stations for Potential Problem Areas Associated with Agricultural and Urban Runoff around Mason's Point, Head of St. Margaret's Bay. (source: Young and Menon, 1998).

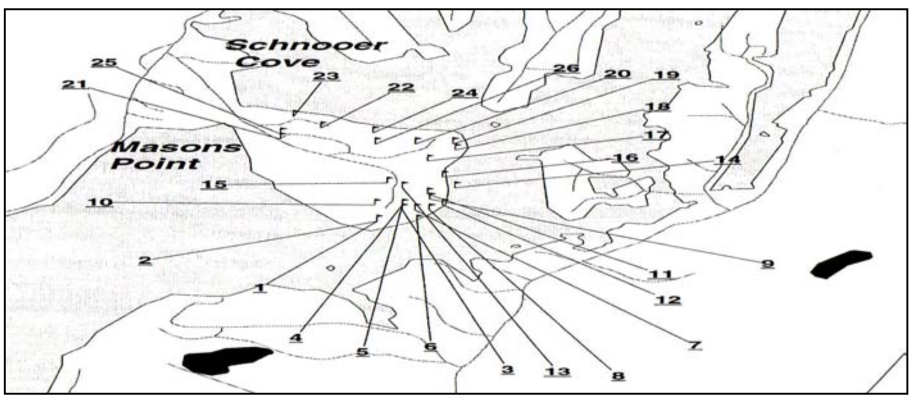


Table 3: Shoreline Sanitary Survey around Mason's Point, Head of St. Margaret's Bay (source: Young and Menon, 1998).

Survey Site	Observations
1	Abandoned house
2	House, 75 m from shore with septic tank
3	House, situated on a hill, 75 m from shore
4	House
5	House, 150 m from shore with possible septic tank
6	House, 100 m from shore with possible septic tank
8	New house 50 m from shore, a small wharf is present
9	Large log house
10	House, 250 m from shore
11	House, 40 m from shore. A well is located 140m from shore with a possible septic tank 75 m from shore

12	House, 125 m from shore
13	No buildings present
14	Two houses on a steep hill 60 m from shore
15	Two houses on a steep hill 250 m from shore
16	Two houses, one is 60 m from shore; the other is 70 m from shore. Both are located on a steep hill
17	Two houses 70 m from shore; both are located on a steep hill. Two unoccupied cottages are also present
18	Six houses in close proximity with the nearest house being 20 m from the shore. There are also two small wharves and a 2 speed-boat without a head
19	Three houses in close proximity, with the nearest being 25 m from shore.
20	Two abandoned houses
21	Two houses
22	Three houses, all located 100 m from shore
23	Thirteen cottages, most of which are 20 m from shore, although a few are within 10 m of the shore
24	Cottage, 50 m from shore
25	Five houses in close proximity
26	Two houses on the North side of the road and two houses on the South side of the road

<u>Sampling Stations in St. Margaret's Bay</u>

The following is an analysis of land use and water-based activities near selected bacteriological sampling stations in the St. Margaret's Bay area (Figure 4). It was compiled from data provided by HRM, DFO, and EC. Shellfish closures often are not the result of a single source of pollution; rather, "multiple pollution sources account for the largest area closures, followed by sewage out-falls, agricultural/hinterland drainage, boat sewage discharges, urban run-off including septic seepage and pulp mill pollution" (EC, 2002a).

Figure 4: Location of Sampling Stations in the St Margaret's Bay Area (source: EC Environmental Protection Branch, 2002a)

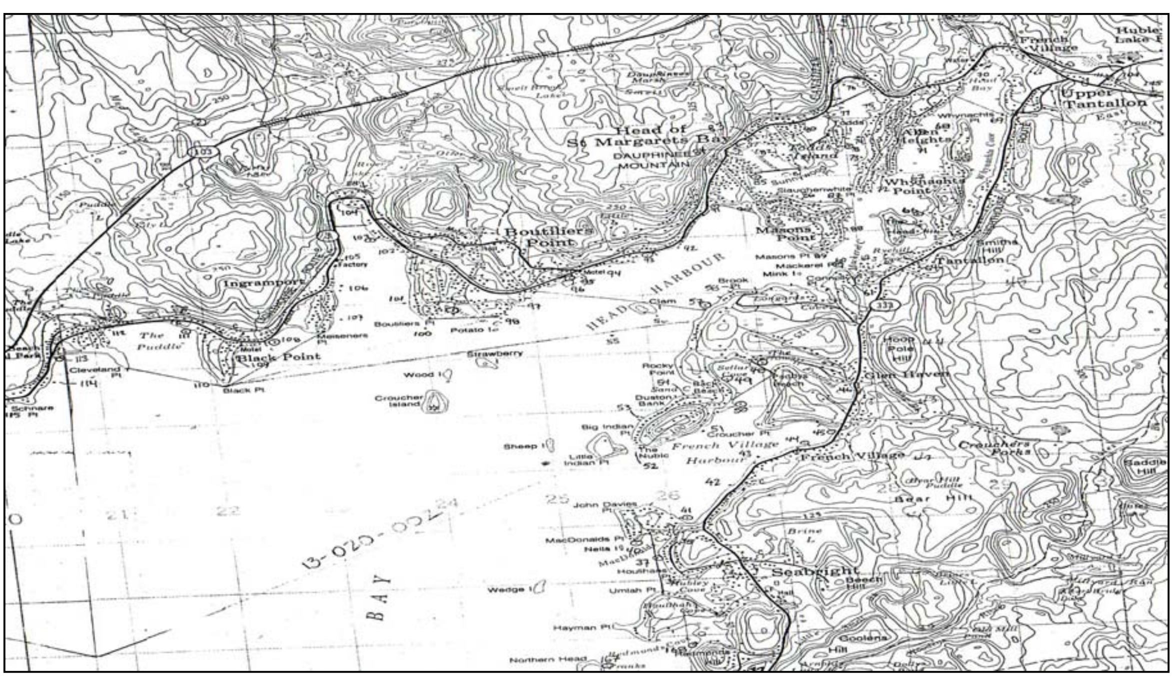


Table 4: Zone Classifications and Coastal Activities for Select Sampling Stations in St. Margaret's Bay (source: EC Environmental Protection Branch, 2002; HCRDA, 1995-6; HRM, 1995b).

Sample Station	Zone Classification	Coastal Activities
#33	R-2 and MU-2	Anchorage
#37	R-A	Aquaculture leases
#41	*MRR-1	Mooring area
#42	MU-1	Fish plant
#45	*MRR-1 and MU-1	Swimming
#48	*MRR-1	Anchorage
#49	*MRR-1	Anchorage
#53	*MRR-1	Private docks
#57	*MRR-1	Large mooring area
#66	MU-2	Intertidal mud flats
#67	*MRR-1	Boat building and fishing
#70	*MRR-1	No classification
#71	R-A	Sailing and cruising
#76	MU-2	Environmentally impacted area
#78	R-A	Private docks and mooring areas
#85	R-A	Anchorage, sailing, and private docks
#89	R-A	Recreational fishing
#93	MU-2	No classification
#95	C-3	Small marina, small craft harbour, hotel
#96	C-3	Small marina, small craft harbour, hotel
#102	*MRR-1	Private docks, diving, recreational fishing, and sailing
#103	*MRR-1	Private docks, diving, recreational fishing, and sailing
#104	MU-1	Diving, recreational fishing, and sailing
#105	I-1	Recreational fishing and sailing
#107	*MRR-1	Private docks
#108	MU-1	Swimming
#111	MU-1	Swimming and kayaking
#112	MU-1	Swimming and kayaking

*Mixed Rural Residential Area

(Note: The information for this table was taken from data collected in 1996; it may not be entirely up-to-date.)

From the above table, one can see the links between land use zoning and the accompanying water-based activities in relation to possible sources of pollution. In some areas there is a Mixed Rural Residential land classification which, when combined with the accompanying water-based coastal activity (e.g., mooring areas, marinas, private docks, and recreational fishing), increases the likelihood of fecal coliform bacteria. Existing water-based coastal activities must be taken into account when developing or modifying land-use zoning by-laws for coastal communities.

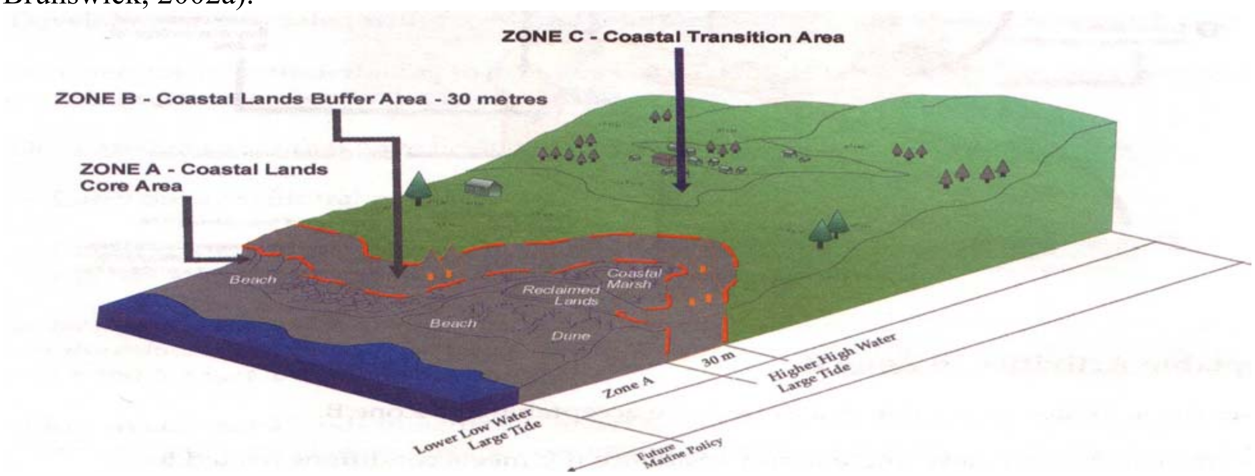
Setbacks from Watercourses

When establishing setbacks from watercourses, several factors must be considered including the variability of river breaks, the stability of the ground, the slope stability of the land, all possible mitigative measures, and any pertinent information applicable to the site (e.g., underlying geology; Government of Alberta, 2002a). A setback should be regarded as the *minimum* distance required to protect watercourses from contamination. In Alberta, the provincial guideline calls for a 45 m setback, but slope and break setback guidelines state, “local conditions could result in the setback being increased” (Government of Alberta, 2002b). Notwithstanding environmental concerns, another reason for greater setback distances arises when there is the potential for running and drinking water supplies to be contaminated (New Canaan Environmental Commission, 2002). Also, “setbacks should be deeper whenever faster runoffs are anticipated [and] the land is steep” (New Canaan Environmental Commission, 2002). HRM should incorporate this notion into its plans for St. Margaret’s Bay since these conditions are present in the area.

<u>New Brunswick</u>

HRM could look to the other two Maritime Provinces for guidance in determining appropriate setbacks from watercourses. In New Brunswick, the coastal area has been divided into three zones, with different restrictions on the types of activities permitted in each zone. New Brunswick’s Coastal Areas Protection Policy was formally introduced in 2002 and contains the following steps leading to its implementation: (a) public consultation; (b) stakeholder consultation; (c) regulatory amendments; (d) an implementation strategy; (e) training; (f) coastal regulations; and (g) implementation and on-going training (Jordan, 2003).

Figure 5: Proposed Coastal Zones in New Brunswick (source: Government of New Brunswick, 2002a).



The most significant part of New Brunswick's policy is that the proposed setback of 30 m is taken from the perimeter of the Coastal Lands Core Area (Zone A) instead of the edge of the watercourse itself. The list of proposed prohibited activities within this zone include groynes, infilling, dredging, excavation, soil disposal, beach quarrying, and the construction of causeways should a bridge be technically feasible (Jordan, 2003). Given that setbacks are established from the perimeter of sensitive ecological features (e.g., beaches, sand dunes, and coastal marshes), they are protected and able to mitigate urban and agricultural runoff (Government of New Brunswick, 2002a).

In addition to the Coastal Areas Protection Policy, New Brunswick also has a Surface Water Protection Program. Again, it consists of a series of zones extending out from the watercourse, which serve to mitigate urban and agricultural runoff. Zone A refers to the watercourse itself, Zone B refers to the 75 m setback, and Zone C designates the remainder of the watershed area (Government of New Brunswick, 2002b). The use of motorized watercrafts is one of the restricted activities in Zone A. In Zone B, trees cannot be removed within 15 m of a watercourse.

Prince Edward Island

Prince Edward Island has a similar policy for setbacks from watercourses. There are specific distances for setbacks that are taken from the perimeter of natural features rather than the coastline itself. For example, a building must be at least 30.5 m from a migrating sand dune, and the exterior of a building must be at least "22.9 meters or 60 times the annual rate of erosion, whichever is greater, to a beach, measured from the top of the bank" (Government of Prince Edward Island, 2002).

Recommendations to HRM

Ideally, the area around St. Margaret's Bay should be re-evaluated as to the suitability of the existing planning strategy and land use by-law. Ground-truthing should be carried out to obtain up-to-date information on the types of land- and water-based activities occurring on the St. Margaret's Bay coastline. Any agricultural use of land should be prohibited where there is a substantial slope bordering a watercourse As well, setbacks should be measured from the perimeter of significant coastal features rather than the edge of the watercourse.

Marine Environmental Quality Indicators

Indicators are used in a variety of disciplines, but are particularly useful for measuring environmental quality and sustainability. They provide information on current conditions, and can serve as warning signs for the future. "The main cause of biodiversity loss in the marine environment is human activity: increased coastal and urban development, growing demand for food resources and commercial product, and increased pollution" (New Zealand Environmental Reporting Programme [NZERP], 2003). It is therefore crucial that we monitor our effects on natural systems, and try to minimize negative impacts.

Eutrophication

Eutrophication is a significant and persistent problem in coastal areas. It is the process by which a body of water becomes enriched with dissolved nutrients (such as nitrogen and phosphorous) that promote the growth of aquatic plant life, especially algae (Dictionary.com, 2003; Merriam-Webster Online, 2003). As with terrestrial plants, aquatic plants take in oxygen from their surroundings during the respiration process. Thus, an increase in aquatic vegetation will reduce the amount of dissolved oxygen in the water available for fish and other marine life. *Anoxic* conditions occur when a body of water has been severely depleted of oxygen. Marine life will perish under these conditions. Eutrophication often occurs when pollution from sewage and fertilizers, which is rich in nutrients, enters the sea.

Phytoplankton are microscopic, free-floating, marine algae that serve as food for fish and other larger organisms. Essentially, they form the cornerstone of the marine food web. Eutrophication causes such algae to proliferate out of control, forming what are known as algal blooms. Some algal blooms contain toxins that can be lethal when ingested; these are called *harmful algal blooms* (HAB). HAB toxins accumulate in shellfish tissues during the filter-feeding process. Neither shellfish nor the small fish that eat them seem to be directly affected by the toxins (Northwest Fisheries Science Centre, 2003). However, larger fish, seabirds, marine mammals, and humans that eat contaminated shellfish can become severely ill and even die. Depending on the type of toxin present, humans can suffer a variety of gastrointestinal and neuro-muscular side effects including diarrhea, paralysis, and short-term amnesia.

Ecological Indicators

Past scientific studies in St. Margaret's Bay have included such things as its physical oceanography, geology, marine ecology, and the productivity of seaweeds and phytoplankton (Heath, 1973; Mann, 1972; Platt, 1975; Piper and Keen, 1976; Gregory et al., 1993; Sheibling et al., 1999). Currently, EC continues its fecal coliform sampling. Water is tested every few years at different places in the Bay. Fecal coliform, temperature and salinity are measured, and shellfish closures are assigned accordingly. In addition, St. Margaret's Bay is used as a study area by various scientific researchers and their students at Dalhousie University (Sheibling, 2002). HRM should encourage and support studies such as these, which measure and record specific scientific parameters in the Bay.

Dr. Ken Mann, a retired marine ecologist, studied the interactions between kelp, sea urchins, and lobster in St. Margaret's Bay. Sea urchins feed on the kelp beds, and lobster prey upon the urchins (K. Mann, pers. comm., April 26, 2003). As such, the kelp beds are near the bottom of the food chain and are important for the survival of other species, and the overall stability of the marine ecosystem. The quality and size of the kelp beds, like all plants, is partly dependent on the amount of sunlight they receive for photosynthesis. According to Mann, St. Margaret's Bay has the potential for eutrophication due to the pollution from sewage and fertilizers that flows into the Bay. As discussed above, eutrophication can lead to large algal blooms, which can block out the sunlight needed for photosynthesis. This has potential implications for the kelp beds of the Bay, and all species that depend on them.

The above example illustrates the complex interdependencies of typical ecosystems. We lack perfect understanding of how all the various components contribute to the productivity and stability of ecosystems. In fact, many of these components have yet to be discovered. We have much to learn about how ecosystems function, fluctuate, and evolve on a broader scale. Still, pollution from activities on land is unnatural and has affected the ecosystem of St. Margaret's Bay. It is therefore best to err on the side of caution. Only when we take action to decrease the flow of harmful substances into the Bay can we move closer to our goal of maintaining the ecological integrity of the coastal zone for present and future generations.

Other possible indicators

Various countries around the world have created environmental performance indicator programmes in an attempt to monitor and measure human activities and their effects on the environment. New Zealand has developed an impressive set of indicators, both available and proposed, for marine environmental quality (MEQ). These indicators include sedimentation, land use/eutrophication risk, chlorophyll-a index, toxic contaminants, percent of area under protection, and threatened species (NZERP, 2003). It also has sets of indicators for beach water quality, which include "time not suitable for bathing and shellfish gathering' and 'toxic and non-toxic algal blooms" (NZERP, 2003). A separate set of nine indicators has been created for assessing fish stocks. Further information on New Zealand's MEQ indicator programme is available online at <http://www.environment.govt.nz/indicators/marine/>.

Recommendations to HRM

HRM should look to other governments, both nationally and internationally, for ideas and lessons learned on MEQ. Extensive work has already been done on indicators for sustainability. For example, Canada is currently conducting "Canada's Sustainability Indicators Initiative" (The Sustainability Report, 2003). An international conference on *The Role of Indicators in Integrated Coastal Management* (http://www.udel.edu/CMS/csmp/indicators/reference.html) held in Ottawa saw the collaboration of the DFO, Government of Canada, and the Intergovernmental Oceanographic Commission (IOC) of UNESCO (with the support of the U.S. National Oceanic and Atmospheric Administration and the International Geographical Union). Its goal was to encourage scientific discussion on the development and application of indicators for sustainable coastal and ocean development. HRM could adopt existing provincial or national incentives for monitoring and measuring environmental quality. Finally, HRM should incorporate more science into their policy input process, be it done internally or sourced from other groups / agencies.

Scientific studies and monitoring programs are integral components of sustainable development and proper management. Efforts should be made to encourage these types of activities. For example, small scholarships could be provided for students to conduct research in St. Margaret's Bay and throughout the municipality. Studies that particularly need to be encouraged include:

1. The differentiation between human and animal sources of fecal coliform pollution using molecular biological methods such as PCR (polymerase chain reaction);
2. The hydrology and surface water pathways of the area;
3. The imperviousness of the area (i.e. how much of the natural surface area has been paved, which alters the amount and composition of surface runoff) (White et al., 2000).

Community groups can play a large role in monitoring various indicators. In fact, community monitoring programs are very cost-effective for government departments (Jacoby et al., 1997). HRM could engage members of the community to become environmental stewards and participate in volunteer monitoring programs for their coastal zone. There is great potential for designing and implementing a MEQ indicator programme that responds to the uniqueness of St. Margaret's Bay.

Community Involvement and Education

Rationale

It is evident that sewage pollution entering St. Margaret's Bay is not originating from a single, dominant source; rather, the sewage is from many small sources that together are causing a severe effect on the marine environment. This is typical of a *cumulative effect*: one action may not harm the environment, but several actions combined may result in a significant effect (Pinkerton, 1991; P. Duinker, pers. comm., Feb. 10, 2003). The problem is aggravated by the fact that some natural features in the area that would normally help mitigate the pollution, such as marshes and riparian zones, have been damaged or destroyed during coastal zone development.

Because the detrimental effects are cumulative and caused by the actions of many individuals, groups, businesses and agencies, any attempts at eliminating the land-based sources of pollution must involve as many members of the community as possible (Pinkerton, 1991). It is the people who live and work in the community "whose values and activities ultimately determine the treatment of the environment" (Jacoby et al., 1997, p. 205-6). Therefore, any unilateral attempts by government at rectifying the situation would be futile without community involvement. However, it is not intended that individuals be singled out and "blamed" for pollution. Rather, the problem should, and can, be addressed at the broader community level.

Education is a major component of involving the community and moving towards a solution (Cicin-Sain and Knecht, 1998). Citizens cannot act on a problem they do not know about. When the community is educated about a problem, they are often quite willing and eager to do something about it, or at least to support policy revision aimed at a solution. Education about the value of the marine environment and the effects of land-based sources of pollution should be directed at all sectors of society, and all education levels. One method of raising awareness about these issues is to have an annual "coastal stewardship" award, which highlights a particular development or project that has been implemented in an environmentally responsible manner (Cicin-Sain and Knecht, 1998, p. 241).

However, "while education is key, it must be combined with open discussion of the problems and concerns of local residents" (Pinkerton, 1991, p. 1330). People cannot simply be presented with a problem (and/or a solution) without the opportunity to ask questions about it. Open houses and meetings could be held with the purposes of educating people about proper sewage treatment, addressing their concerns, and receiving feedback from them about proposed solutions.

<u>Benefits and Drawbacks</u>

Besides the absolute need to do so, there are innumerable benefits to involving the community in addressing sewage problems (Pinkerton, 1991; Jacoby et al., 1997; Pinho, 2000). People are a valuable source of information about local causes of pollution, which often would go undetected by regulatory officials. The community may act as a sort of "watchdog" for destructive activities. Citizens also know what solutions would have the best chance of being successful in their communities. Concerned citizens often find innovative solutions and can be very resourceful at securing outside funding for projects. As well, involved citizens tend to become educators in the community (Pinho, 2000). They exert peer pressure on their friends, families and neighbours and "encourag[e] people to see that the community shares a collective responsibility for water quality and for protecting clean-water-dependent industries, like shellfish culture" (Pinho, 2000, p. 447).

More and more, communities are demanding to be involved in management decisions that affect their area (Pinkerton, 1991; Jacoby et al., 1997). While involving the community may initially appear to be cumbersome and slow the process down, it can be far more dangerous to implement decisions without consulting the community first (Shepherd and Bowler, 1997). Citizens hold a tremendous amount of power to drastically slow down or even halt a process that they are not happy with. Since to date there is no formal process for dealing with the sewage problem in St. Margaret's Bay, it would be fairly easy and certainly beneficial to involve the community from the outset in any course of action.

Case Studies

The following case studies give concrete examples of community educational activities and programs that have been successful in dealing with sewage pollution. They are not meant to be prescriptive, but simply to illustrate the kinds of things that can be done at the community level. HRM may choose to implement some of these ideas themselves in an educational program for the area, or to facilitate such activities through community groups that already exist in the area, such as the Friends of St. Margaret's Bay. In any case, all stakeholders in the area must be involved to some extent, including residents, fishers, aquaculturalists, tourism representatives, developers, environmentalists, First Nations, farmers, boaters, local businesses, and all levels of government.

Baynes Sound, Vancouver Island, BC

The Baynes Sound on Vancouver Island, British Columbia, was one of the most productive shellfish growing areas in the province. In 1994, however, 20% of its shellfish harvesting areas were closed due to fecal coliform contamination (Pinho, 2000). These closures were implemented as a result of water quality testing by EC under the CSSP program. This resulted in economic losses in the community and highlighted the issue of pollution in the Sound. In response, the Baynes Sound Stewardship Action Group (BSSAG) was formed, comprising government representatives, shellfish harvesters, and community groups.

A preliminary study of septic systems in the area was conducted, with the help of a local septic company, to determine their condition (Pinho, 2000). "The study results indicated a need for improved education, routine maintenance, and, in some cases, complete replacements of on-site septic systems in the region" (Pinho, 2000, p. 446). A local community group developed educational kits, which were distributed throughout the area by volunteers.

Residents were invited to a "septic social", which was a huge success (Pinho, 2000, p. 446). At this septic social, participants were treated to an oyster barbecue and given presentations on caring for their septic systems. A septic company also inspected a nearby septic system as a demonstration. Another creative tool used is described below:

> An interactive full-size model of a septic system was constructed for the program to further educate and involve citizens in understanding the proper functioning of septic systems. The system is made largely of a PVC pipe frame with ripstop nylon covers illustrating the general concept of a distribution box, septic tank, and distribution pipes. The model is set up at community events and parents are encouraged to "flush" their children down the play toilet and have them crawl through the distribution box, into the septic tank, and then "flow" out one of the three distribution pipes. This has become a hugely popular and fun educational tool for approaching rural residents on this unfamiliar subject (Pinho, 2000, p. 446).

Regarding pollution from farms, another local community group under BSSAG developed a program to encourage farmers to plant trees in riparian zones and construct fences to prevent their livestock from entering waterways. A key element to this program's success was not only the financial incentive that was offered, but also the fact that farmers were involved in the design and implementation of the program from the beginning. "The insight and credibility gained from involving the agricultural community in the program management was an essential component for farmer participation in this project" (Pinho, 2000, p. 446). Both a program representative and a retired member of the farming community approached individual farmers. Although more evidence needs to be gathered, preliminary testing in Baynes Sound has shown an improvement in water quality (Pinho, 2000). This demonstrates that community efforts directed at mitigating pollution from land-based activities can produce results. It would therefore be beneficial for HRM to work closely with community groups in the St. Margaret's Bay area.

<u>Sequim Bay, Washington, DC</u>

Sequim Bay is a smaller watershed in the Puget Sound watershed system in Washington, DC. It was also experiencing deteriorating water quality due to land-based sources of pollution, which affected both shellfish and salmon health (Pinkerton, 1991). Sequim Bay had similar sources of pollution to those in St. Margaret's Bay, such as "a new marina, livestock use of streams, failing septic tanks, erosion from timber felling and transport, and steady population growth…" (Pinkerton, 1991, p. 1328). The local county took the lead in addressing these problems and hired a coordinator (with external funding) to involve the public in an overall management plan for the watershed. This public involvement "created the political will and widespread local involvement necessary to get significant compliance and support for life styles which are less destructive to water quality" (Pinkerton, 1991, p. 1328). This level of compliance could not have been achieved if the county had simply imposed a plan on the community without consultation or involvement.

The way in which the coordinator approached and defined the sewage problem was a major contributor to the success of creating and implementing the plan (Pinkerton, 1991). It is therefore extremely important to have an experienced, skilled coordinator in dealing with these issues. When working with committees and the community, the coordinator always focussed on solutions instead of causes. In addition, pollution was not defined by its source, such as farms or forestry, so that no individual or group would feel blamed. Instead, pollution was defined according to its type, such as bacteria or sediments. Wording used in regulations also reflected this approach.

One of the recommendations articulated by the community was "the opportunity for voluntary compliance, before the use of enforcement" (Pinkerton, 1991, p. 1331). This is reflected in the following practice:

> If a complaint about farm practices polluting a stream is initiated by or filed with the county or Department of Ecology, the complaint is forwarded to the local farmers` voluntary association, which contacts the landowner and offers technical assistance to remedy the situation. Technical assistance can include cost sharing of improvements. A recommendation for enforcement is sent to the state only if the landowner is unwilling to cooperate (Pinkerton, 1991, p. 1331).

This technique, along with the overall planning strategy of involving the public, has worked. "On one creek in the Sequim Bay watershed, for example, the five most important cattle farmers who created 90% of the bacteria in the creek adopted best management practices to reduce or eliminate runoff from their pastures into fish streams. One year later, there is already a 10% reduction in fecal coliform levels" (Pinkerton, 1991, p. 1330).

Recommendations to HRM

HRM should initiate a public education program immediately and aim for a high level of community involvement in finding solutions. A monitoring program should also be established that allows for community participation. Accordingly, existing groups such as the Friends of St, Margaret's Bay should be involved in the education process.

Integrated Coastal Zone Management

The need for considering land and water together is gaining wide recognition, but this is not always reflected in management plans (Cicin-Sain and Knecht, 1998; CNPA, 2000; Ricketts, 2000; Chao, 2002). Today, integrated coastal zone management (ICZM) is considered to be "the most appropriate process to address current and long-term coastal management issues" (World Bank, 1993, p. 1). Cicin-Sain and Knecht (1998, p. 461) define ICZM as "a continuous and dynamic process by which decisions are made for the sustainable use, development, and protection of coastal and marine areas and resources." According to the Noordwijk Guidelines, "the purpose of ICZM is to maximize the benefits provided by the coastal zone and to minimize the conflicts and harmful effects of activities upon each other, on resources and on the environment" (Post and Lundin, 1996, p.1).

ICZM can be used in the promotion of sustainable economic development, the restoration of damaged habitats, the protection of biodiversity, or the equal allocation of resources among stakeholders (Cicin-Sain and Knecht, 1998; GESAMP, 2001b). Ultimately, it "should result in consistency of policy and legislation between different levels and sectors of government" (GESAMP, 2001b, p. 11-12). ICZM is a slow process requiring ample funds. However, creating a management plan that is effective and satisfying to all stakeholders requires considerable time, along with the use of all necessary resources.

Integration

Integration lies at the very core of ICZM. There are five major dimensions of integration: intersectoral, intergovernmental, spatial, science-management, and international (Cicin-Sain and Knecht, 1998).

1. *Intersectoral integration:* Integration within and between sectors is necessary for preventing efforts from overlapping, and keeping all relevant sectors informed of past, current, and future activities. Management plans created by different groups

and agencies should be communicated within the sector, and coordinated with a broad, large-scale coastal zone management plan.

2. *Intergovernmental integration:* Intergovernmental integration implies cooperation and coordination between all levels of government: municipal, provincial, and national. This kind of integration is necessary for dealing with jurisdictional issues. Jurisdiction over the environment and natural resources is very complicated in Canada. Governments must work together to find ways to properly manage coastal zones, where often more than one government level can exert authority.

3. *Spatial integration:* Spatial integration involves the association between the land and water areas of the coastal zone. Understanding the land-water relationship is crucial to successful and sustainable management.

4. *Science-management integration:* Science-management integration refers to the important but often weak link between science, policy-making, and management of coastal zones. Efforts should be made to translate the relevant science into appropriate policies and management plans.

5. *International integration:* International integration implies the necessary consideration and use of international laws and recommendations. For coastal zones, international bodies and regulations should be incorporated into management plans (e.g., United Nations Convention on the Law of the Sea).

Capacity

There are four major types of capacity required for the successful implementation of an ICZM program: legal and administrative, financial, technical, and human resources (Cicin-Sain and Knecht, 1998). Legal and administrative backing must be present for the ICZM process to operate in a lawful and defensible manner. Sufficient funds, and technical and human resources must be available to conduct ICZM and carry the process through to completion.

In summary, ICZM allows for a more effective engagement of stakeholders in the decision-making process. In turn, this can lead to more relevant decisions, increased compliance with regulations, decreased conflict, and less expensive enforcement. Most importantly, the contribution of all stakeholders can promote economic development that corresponds to people's values and preferences (Graham and Idechong, 1998). Planning and management, education and public involvement, monitoring, and research are all essential to the successful implementation of an ICZM plan.

It has been said that the ICZM process is not limited to one single project, rather it can consider all existing initiatives that could contribute to the development of an ICZM plan in an area (Henocque, 2003). It is recognized that it would take considerable time to initiate an ICZM strategy for St. Margaret's Bay. However, certain ICZM characteristics can be utilized to benefit the Bay and its occupants, particularly the concept of integration, as explained above.

Recommendations to HRM

Efforts can be made to increase communication between sectors and all levels of government. This is an ongoing problem that is not limited to environmental management. Additionally, ICZM theory should be considered in all management decisions related to land use practices, especially in coastal zones.

An assessment of the potential for ICZM in St. Margaret's Bay (and ideally for all of HRM) should be conducted. This will provide all managers and levels of government with a solid understanding of where HRM stands in terms of potentially creating an ICZM plan with a coordinating body. This could ultimately lead to ICZM being incorporated into all of HRM's activities, benefiting the area economically, socially, politically, and environmentally.

Conclusion

After working on this project for several months, we have come to appreciate the challenge and difficulties posed by the situation in St. Margaret's Bay. This report may be overwhelming at first; however, we hope that it will serve as a good reference and starting point for dealing with the shellfish closures and managing the coastal zone.

The incidence of fecal coliform-related shellfish closures in St. Margaret's Bay is not unique, as can be seen from other examples and case studies discussed in this report. We have tried to accumulate all available information related to fecal pollution and shellfish closures in the area, but research should continue as indicated in the recommendations list. Scientific understanding, public outreach and education, legislation, community involvement, and government integration are all essential to finding an appropriate solution.

While the St. Margaret's Bay situation may seem complex, it does not mean that there cannot be realistic, effective action to help improve it. Not everything can be sorted out at once, but some initial response should occur as soon as possible. Once HRM begins the process of initiating proper coastal zone management practices, these efforts can be expanded to other areas. In other words, once a model for coastal zone management has been created, it can be applied to the entire municipality. It will be much easier to begin this process sooner rather than later, especially considering the predictions for population increase within HRM, which will continue to exert pressure on the natural environment.

We have enjoyed working on this project, and would like to thank all who assisted us in our research. We are available to answer any questions and can be contacted through John Charles at HRM.

Summary of Recommendations to HRM

- Look to other governments, both nationally and internationally, for ideas and lessons learned on MEQ.
- Inspect current by-laws to determine if they are adequate and, more importantly, if they are being properly enforced in St. Margaret's Bay.
- Consider existing land- and water-based coastal activities when developing or modifying land-use zoning by-laws for coastal communities.
- Re-evaluate the area around St. Margaret's Bay for the suitability of the existing planning strategy and land use by-law.
- Prohibit any agricultural use of land where there is a substantial slope bordering a watercourse.
- Establish setbacks from the perimeter of significant coastal features (e.g., sand dunes, marshes) rather than the edge of the watercourse.
- Initiate a public education program immediately.
- Aim for a high level of community involvement in finding solutions.
- Involve the community in a monitoring program.
- Do more science (or campaign for it to be done by other groups/agencies).
- Engage in close collaboration with Friends of St. Margaret`s Bay and other community and environmental groups in the area.
- Increase communication between sectors and all levels of government.
- Consider ICZM theory in all management decisions.
- Conduct an assessment of the potential for ICZM in St. Margaret's Bay (and ideally for all of HRM).

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About The Authors

Shauna Barrington

Originally from Cape Breton Island NS, Shauna graduated from St. Francis Xavier University in 1996 with a B.Sc. in Biology. Her degree included courses in oceanography, environmental microbiology, environmental geology and geochemistry, and freshwater ecology. In the summer of 1996, she completed a course in Biological Oceanography at the Bermuda Biological Station for Research. This was an intensive, international program that focused on nutrient and carbon cycling in the upper levels of the ocean.

After completing her Biological Oceanography course, Shauna chose to enter the health care field, and graduated from the Queen Elizabeth II Health Sciences Centre in 1998 with a Diploma in Diagnostic Cytology. She then worked as a Cytologist in Switzerland for four years.

Currently, Shauna is working on an integrated management plan for the River Denys Watershed (located on the Bras d'Or) for her thesis at Dalhousie, in collaboration with DFO. This will involve assimilating the current scientific data for the area and identifying gaps in knowledge. The River Denys Basin is also experiencing shellfish closures due to fecal coliform in the marine environment. Shauna completed a course in Integrated Coastal Zone Management last winter.

Shannon Long

Originally from Ottawa ON, Shannon graduated from Queen's University with a BSCH in environmental and earth systems science in 2002. Shannon participated in an exchange to Australia in her third year, and has experience in environmental education, conference planning and public speaking, facilitating, physical geography, GIS, and biology. Shannon has an interdisciplinary background with a focus on natural and social science and environmental issues.

Shannon's current thesis work at Dalhousie University involves surveying residents of Palau (a small developing island state in the Pacific) to gain a better understanding of their values, preferences and attitudes regarding coastal resources and marine protected areas (MPA) in their country. This will contribute to a larger MPA management effectiveness study that has been initiated by the World Commission on Protected Areas Marine Division and the World Wildlife Fund for the United States and all its protectorates and affiliations (including Palau).

Susan Thompson

Originally from Fredericton NB, Susan graduated from Mount Allison University with a B.Sc. in biology in 2000. During her senior year, she completed a research project under the joint supervision of Dr. Irena Kaczmarska (Mount Allison) and Dr. Stephen Bates

(DFO, Moncton NB). The study related to harmful algal blooms, specifically the effects of bacteria on the sexual reproduction of the toxic diatom *Pseudo-nitzschia multiseries*.

In September 2001, Susan was hired as an assistant microbiologist for 3 months with the Fisheries Research Services (FRS) Marine Laboratory in Aberdeen, Scotland. At FRS, she participated in ongoing shellfish monitoring involving media and sample preparation, and chromogenic analysis of shellfish for *Escherichia coli*. Susan also assisted on a project involving diarrhetic shellfish toxin extraction, wrote a literature review on shellfish depuration, and began an experiment involving *E. coli* O157 in seawater.

For her thesis research at Dalhousie University, Susan is examining how forest age and management practices affect the quality and quantity of coarse woody debris (dead wood) in forest ecosystems in southwestern Nova Scotia. Her findings will be applied to research involving wildlife habitat, carbon budget modelling, and the Kyoto Protocol.

Cory Wendorf

Originally from Mississauga ON, Cory graduated from McMaster University with an honours degree (with distinction) in philosophy in 2002. While at McMaster, Cory was employed as a research assistant for the Bertrand Russell archives. Cory also holds an honours diploma in business from Sheridan College.

Prior to returning to full-time studies, Cory was employed in the purchasing/logistics field where he held numerous management positions for both regional and national-based companies.

Cory's current thesis research at Dalhousie University involves analyzing the human appropriation of net primary production (the products of photosynthesis) in terms of land-use practices, and relating the findings to concepts of biodiversity and sustainability.