REGIONAL ASSESSMENT MAGDALEN ISLANDS

Regional Assessment Magdalen Islands

Priority Intervention Zone 21

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NOTE TO READERS

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Preface

In April 1994, the governments of Canada and Quebec approved a four-year action plan to carry on the work of the St. Lawrence Action Plan.

The goal of St. Lawrence Vision 2000 (SLV 2000) is to conserve and protect the St. Lawrence River and the Saguenay River, so that people living along their shores can reclaim use of these rivers in a manner compatible with sustainable development.

The Priority Intervention Zones program — better known by its French acronym ZIP (zones d'intervention prioritaire) — is a major element of the Community Involvement component of the St. Lawrence Vision 2000 action plan.

Through the ZIP program, riverside communities are invited to play an active part in achieving the objectives aimed at restoring the St. Lawrence and Saguenay rivers.

The program enables various community partners, non-governmental organizations and citizens committees to work together to identify common priorities for the conservation and restoration of the St. Lawrence River.

We are pleased to present this assessment report on the uses, resources and main environmental problems specific to this area. It has been prepared using all the data available from the various federal departments and provincial ministries involved in SLV 2000.

We hope it will prompt a more enlightened debate based on information that is as objective as possible, and that the debate will help the different partners involved to draw up and implement an action plan for the restoration of the area in question.

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Management Perspective

The ZIP program is a federal-provincial initiative involving stakeholders and shoreline communities in implementing measures to restore the St. Lawrence River. The program has three phases: producing a regional assessment report on the state of a specific area of the St. Lawrence, consulting shoreline partners in setting priorities for action, and developing an ecological rehabilitation action plan (ERAP).

The regional assessment is a synthesis of four technical reports on the biological, physico-chemical, socio-economic and public health aspects of the study area, prepared by the federal and provincial partners of the St. Lawrence Vision 2000 action plan as part of its Community Involvement component.

The process of gathering and analysing data area by area has never before been undertaken for the entire St. Lawrence. The technical reports go a step further, assessing our knowledge of the current state of a given area based on known quality criteria.

The challenge, then, is to offer a scientific opinion based on the available information. The pitfalls are numerous: the data were collected for other purposes, the geographic and temporal coverage is less than ideal, and the chemical analysis methods are not standardized, to name but a few.

The ZIP team remains nonetheless convinced that an enlightened and thoughtful overview of each study area can be presented without further delay. This initial assessment is therefore intended to be a discussion paper that will serve as a starting point for the shoreline partners in each study area.

Perspective de gestion

Le programme des Zones d'intervention prioritaire (ZIP) relève le défi de la concertation entre les gouvernements fédéral et provincial et de l'implication communautaire des partenaires riverains, en vue de mettre en oeuvre des mesures de réhabilitation du Saint-Laurent. Ce programme comporte trois grandes étapes, soit l'élaboration d'un bilan environnemental sur l'état du Saint-Laurent à l'échelle locale, la consultation de partenaires riverains, avec l'identification de priorités d'intervention, et l'élaboration d'un plan d'action et de réhabilitation écologique (PARE).

Un bilan régional est établi à partir d'une synthèse des quatre rapports techniques portant sur les aspects biologiques, physico-chimiques, socio-économiques et sur la santé humaine du secteur étudié. Ces rapports sont préparés par les partenaires fédéraux et provinciaux du Plan d'action Saint-Laurent Vision 2000, dans le cadre du volet Implication communautaire.

La cueillette et l'analyse des données existantes à l'échelle locale constituent une première pour l'ensemble du Saint-Laurent. Les rapports techniques vont plus loin encore, en proposant un bilan des connaissances sur l'état actuel d'un secteur à partir de critères de qualité connus.

Le défi consiste donc à poser un jugement scientifique fondé sur l'information disponible. Les embûches sont nombreuses : les données ont été recueillies à d'autres fins, la couverture spatiale ou temporelle n'est pas idéale, les méthodes d'analyses chimiques ne sont pas uniformes, etc.

L'équipe de travail ZIP demeure convaincue qu'il est possible de poser, sans plus attendre, un regard éclairé et prudent sur chaque secteur. Cette première évaluation constitue un point de départ et un document de base rédigé à l'intention des partenaires riverains de chaque secteur d'étude.

Abstract

Environmentally, the Iles-de-la-Madeleine archipelago (more commonly known in English as the Magdalen Islands) is very different from other maritime areas in Quebec. The archipelago's main feature is the presence of vast stretches of sand dunes, stabilized in part by vegetation, that partially isolate the islands' lagoons and shallow ponds from the sea. These environments, sheltered from the disruptive effects of waves and ice, favour the development of intertidal marshes and eelgrass beds, and are used intensively by birds for nesting or during migration, and by many species of fish. The many small islands that surround the larger ones are also used intensively by seabirds and also by seals for breeding and resting.

Being open to the Gulf, the coastline is subject to the disruptive effects of waves and ice. Beaches are denuded of vegetation and endobenthic fauna are sparse. However, below the low-water mark, an abundance of diverse benthic fauna is found, including American lobster, Giant scallop, Snow crab and several species of groundfish such as Winter flounder, Canadian plaice and Atlantic cod.

The pelagic environment around the islands is characterized by the great diversity and abundance of zooplankton in summer. Several economically-valuable species, such as Atlantic herring and Atlantic mackerel, use this environment for spawning and feeding.

Local sources of contamination of the marine environment are of relatively minor significance in the Magdalen Islands. There are no large industrial plants discharging toxic substances into the water, and, by early 1998, all municipalities with sewer systems will begin treating their wastewater before releasing it to the Gulf, away from the lagoons. On the other hand, persistent toxic substances do reach the study area through inflows from the St. Lawrence River, but most especially from the atmosphere. Moreover, the islands are vulnerable to oil spills occurring in the southwestern part of the Gulf because they are situated in the centre of the main flow of water masses in the southern Gulf.

Overall, the plant, invertebrate and fish life remain largely uncontaminated by toxic substances, and eating them poses no threat to human health. Birds and fish-eating marine mammals, however, have been found to contain worrisome levels of some toxic substances owing to the phenomenon of biomagnification. Nonetheless, the levels of some contaminants in the food chain of the Gulf have been dropping since the 1970s.

Many sensitive habitats are not protected under the law and are threatened by recreational and tourist activities, particularly motor-vehicle traffic on the islands' beaches and sand dunes.

Résumé

Les Îles-de-la-Madeleine constituent un environnement marin très différent des autres secteurs maritimes du Québec. Cet environnement est caractérisé par la présence de vastes champs de dunes en partie stabilisés par la végétation qui isolent partiellement de la mer des lagunes et des étangs peu profonds. Ces derniers sont abrités des effets perturbateurs des vagues et des glaces et sont propices au développement de marais intertidaux et d'herbiers de Zostère marine utilisés intensivement par les oiseaux en période de nidification ou lors des migrations saisonnières et par plusieurs espèces de poissons. Les nombreux îlots autour des îles principales sont aussi utilisés intensivement par les oiseaux marins et les phoques pour leur reproduction ou comme site de repos.

Les côtes ouvertes sur le golfe sont soumises aux effets perturbateurs des vagues et des glaces. Les plages sont dénudées de végétation et pauvres en faune endobenthique. Par contre, sous le niveau des basses mers, on retrouve une faune benthique beaucoup plus diversifiée et abondante comprenant notamment le Homard d'Amérique, le Pétoncle géant, le Crabe des neiges et plusieurs espèces de poissons de fond comme la Plie rouge, la Plie canadienne et la Morue franche.

Le milieu pélagique autour des îles est caractérisé par la grande diversité et l'abondance du zooplancton en été. Plusieurs espèces d'importance socio-économique, notamment le Hareng atlantique et le Maquereau bleu, utilisent ce milieu pour leur reproduction et leur alimentation.

Les sources locales de contamination du milieu marin sont relativement peu importantes dans le secteur des Îles-de-la-Madeleine. Aucune industrie importante n'y déverse des substances toxiques et toutes les municipalités équipées d'un réseau d'égouts procéderont, d'ici le début de 1998, à l'épuration de leurs eaux usées avant leur rejet dans le golfe, à l'extérieur des lagunes. Par contre, des substances toxiques persistantes dans l'environnement transportées par les eaux du Saint-Laurent et surtout dans l'atmosphère, atteignent le secteur d'étude. De plus,

les îles sont très vulnérables face à des déversements pétroliers dans la partie sud-ouest du golfe parce qu'elles sont situées au centre du principal couloir de transport des masses d'eau dans le sud du golfe.

Dans l'ensemble, les végétaux, invertébrés et poissons sont peu contaminés par les substances toxiques et leur consommation ne présente pas de danger pour la santé humaine. Par contre, certaines de ces substances atteignent chez les oiseaux et les mammifères marins piscivores des niveaux inquiétants en raison du phénomène de la bioamplification. Pour plusieurs substances, le niveau de contamination de la chaîne alimentaire du golfe est toutefois à la baisse depuis les années 1970.

De nombreux habitats sensibles ne font pas l'objet d'une protection légale et sont menacés par les activités récréo-touristiques, notamment par la circulation de véhicules motorisés sur les plages et dans les dunes.

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CHAPTER 1 The Gulf of St. Lawrence, Then and Now

Beginning in the fifteenth century, Basque, Breton, Norman and Portuguese fishers were attracted to the Gulf of St. Lawrence by the huge schools of cod and pods of whales. The fishery became more sedentary in the early eighteenth century with the creation of commercial fishing posts in the natural harbours. During the latter half of the eighteenth century, the deportation of the Acadians and the arrival of the American Loyalists marked the beginning of the colonization of Quebec's huge maritime region. Until then, use of the sea had hardly affected its resources, owing to the sparse population and the sheer size of the Gulf, but that was soon to change.

The first significant threats seem to have come from forestry development in the nineteenth century and the log booms destined for sawmills that sprang up at river mouths. The pace of change accelerated in the middle of the twentieth century with the building of pulp and paper mills and ports to service mining operations, and the intensive spraying of forests with DDT. It was at that time that the fishing industry experienced a profound change with the introduction of trawls, which increased catching power tenfold. It was believed that the Gulf of St. Lawrence was impervious to pollution and that its resources were limitless.

Public awareness was sharply raised in the 1970s with the realization that the Northern gannets on Bonaventure Island were highly contaminated with toxic substances which were threatening their survival and that several fish stocks had collapsed as a result of overfishing.

The general consensus today is that the Gulf of St. Lawrence is a fragile ecosystem and that its resources are limited. Despite its vastness and distance from large industrial centres, the integrity of this ecosystem is threatened by the unbridled exploitation of its resources, the presence of toxic substances and the destruction of wildlife habitats.

Most industrialized countries have agreed to redirect economic activities toward sustainable development. The profit motive alone can no longer govern human endeavour. Given the fragility of our environment and the limits of our planet, sustainable economic development must provide for the multiple use of resources consistent with the quality of human life and the maintenance of biodiversity.

CHAPTER 2 The ZIP Program

Starting in the 1960s, growing public awareness of the degradation of the Great Lakes and the St. Lawrence and Saguenay rivers, along with the urgency of the situation, prompted governments to take concrete, joint action. This paved the way for the 1972 *Great Lakes Water Quality Agreement*. A 1987 amendment added a local use-restoration program (Remedial Action Plan, or RAP). In 1988, the eight American states concerned and the provinces of Ontario and Quebec signed the *Great Lakes Charter* and an agreement to control toxic discharges into the Great Lakes Basin. In response to the poor quality of the waters of the St. Lawrence and its tributaries, the Quebec government launched its wastewater treatment program (PAEQ) in 1978.

In 1989, the federal and Quebec governments decided to combine their efforts under the St. Lawrence Action Plan, which was renewed in 1994 as St. Lawrence Vision 2000 (SLV 2000). One of the objectives of this action plan is to do local environmental assessments to encourage community stakeholders to work together to restore and protect the St. Lawrence and co-ordinate its use (Figure 1). As part of the groundwork for public consultations, SLV 2000 partners review and synthesize current knowledge of the state of the environment in each area.

This report presents the main points of the technical reports¹ and reviews current knowledge of the state of the resources and the present and potential uses of the Magdalen Islands sector (ZIP 21).

¹ The technical reports deal with the physico-chemical aspects of the water and sediments (Gagnon et al., 1997), the biological communities (Mousseau et al., 1997), socio-economic aspects (Bibeault et al., 1997) and human health issues (Duchesne et al., 1997).



Figure 1ZIP program study areas

This effort to synthesize and analyse existing knowledge is meant to provide stakeholders with accessible, objective scientific data for use in establishing their priorities for action. This will make it possible to devise local and regional action plans wherein each partner will work within its sphere of responsibility, but in co-ordination with the other partners.

CHAPTER 3 Characterization of the Magdalen Islands

The Magdalen Islands sector (ZIP 21) includes the islands themselves, as well as the waters and seabed within a 100-km radius of the archipelago (Figure 2).

3.1 Physical Environment

The Magdalen Islands are located in the middle of a large coastal shelf less than 100m deep that occupies the entire southern portion of the Gulf of St. Lawrence and bordered to the north by the Laurentian Channel (Figure 2). This deep trough begins in the St. Lawrence Estuary, runs along the northern shore of the Gaspé Peninsula, crosses the centre of the Gulf of St. Lawrence and the Cabot Strait and ends at the continental shelf break southeast of Newfoundland. The Laurentian Channel (maximum depth 440 m in the study area) is a zone of fine-sediment deposition from the St. Lawrence River system and the erosion of the coastline and the bottom of the Gulf, as well as one of pelagic biological production; the bottom of the channel is covered with silty sediment deposited at a rate of 0.5–1.5 mm per year.

The coastal shelf of the Magdalen Islands (Magdalen Shelf) has shallow banks (East and West Bradelle banks, Magdalen shallows) and elongated troughs that run north-south and join up with the Laurentian Channel (Cape Breton Trough, East and West Bradelle troughs). The bottoms of these troughs are covered with silty sand, and with sand or gravel at depths of less than 50 m. Large areas of rocky outcrops covered with a thin, irregular layer of sand or gravelly sand are located to the north, south and west of the Magdalen Islands.

The Magdalen Archipelago is made up of a series of rocky outcrops (Figure 3). The rocky cores are girdled by cliffs which are constantly eroded by waves. The eroded sand is carried by the littoral currents, forming two long sand bar systems which connect the major islands, as well as large spits at the north and south ends of the archipelago. The sand bars and spits support large stretches of dunes, partly stabilized by vegetation, and partially isolate different-sized lagoons and ponds from the sea.



Figure 2 Limits of the Magdalen Islands sector



Figure 3 The Magdalen Islands

The tides are diurnal (one high tide each day) at neap tide and semi-diurnal at spring tide; mean tidal range is the lowest in the Gulf of St. Lawrence (0.6–0.7 m). The coasts are highly exposed to the prevailing southwesterly and northwesterly winds, as well as to the ocean swell that enters the Gulf through Cabot Strait.

In summer, there are three distinct water masses in the Magdalen Islands sector (Figure 4): the surface layer, the cold intermediate layer and the deepwater layer.



Figure 4 Vertical distribution of water masses in a longitudinal section of the Laurentian Channel

The **surface layer** of the Gulf occupies the upper part of the water column (maximum depth 30–50 m) outside the lagoons. It is a relatively warm layer (maximum approximately 17°C in August), which is less salty than the deep layer (salinity around 29 parts per thousand in summer), and comes mainly from the Gaspé Current. This powerful current carries the waters from the St. Lawrence Estuary and the northwestern Gulf toward the southern Gulf (Figure 5). To the east of Cape Gaspé, these waters wash over the Magdalen Shelf and slowly drift toward Cabot Strait.



Source: Adapted from El-Sabh, 1976.

Figure 5 Surface currents in the Gulf of St. Lawrence in August

The cold **intermediate layer** occupies the water column between 30–50 m and 125 m deep and overlies the bottom of the Magdalen Shelf. This layer is cold (-1 to 2°C) and saltier (salinity 31.5–33 parts per thousand) than the surface layer; it forms in winter when the surface layer cools and mixes with the underlying layer of water.

The **deepwater layer** is confined to the Laurentian Channel at a depth of more than 125 m. This layer is warmer $(2-5^{\circ}C)$ and saltier (salinity 33–35 parts per thousand) than the intermediate layer; these waters originate in the northwest Atlantic and enter the Gulf through Cabot Strait.

The shallow bodies of water (< 10 m deep) located behind the bars and spits demonstrate a wide range of physico-chemical conditions. Two large lagoons (Grande-Entrée Lagoon and Havre-aux-Maisons Lagoon) and the smaller lagoons that make up the Huîtres and Havre-Aubert basins undergo constant exchanges with the Gulf through narrow passes (or gullies). The minor freshwater inflow in these areas is completely masked by the regular exchange of tidal seawater. In summer, the water from these lagoons is a little warmer (maximum approximately 20°C) and just as salty (28–31 parts per thousand) as the Gulf's surface layer. Several bodies of water, however, only sporadically come into contact with the Gulf and are characterized by more stagnant, warmer (maximum approximately 25°C) and less salty water than the lagoons. The largest of these ponds are Havre-aux-Basques Bay and East Pond. These areas are characterized by wide fluctuations in salinity associated with ice melt, precipitation and a variable supply of seawater.

Ice floes reach the Magdalen Islands in late January and generally disappear by early April. In the lagoons and ponds, the layer of ice that completely covers the bodies of water melts in the spring.

3.2 Habitats and Biological Communities

The study area contains a mosaic of aquatic habitats reflecting the many possible combinations of biophysical variables that determine the distribution and abundance of aquatic biota. In order to more easily synthesize the multitude of information available on the subject, habitats have been divided into three main categories: 1) ponds and lagoons, 2) benthic habitats and 3) pelagic habitats.

3.2.1 Ponds and lagoons

The ponds and lagoons have fostered the development of three very productive types of habitat that are attractive to birds and fish: salt marshes, Saltwater cordgrass marshes and eelgrass beds (Figure 6).

The **salt marshes** are intertidal wet meadows dominated by sedges and bulrushes and flooded only at high tide. Nearly half of the 1400 ha of salt marshes on the islands are located on the shores of East Pond. Other large areas are located in the southern part of Havre-aux-Basques Bay and along the sand bars bordering the lagoons. These marshes developed before the closure of the bay in 1956.

Saltwater cordgrass marsh occupies the silty substrates flooded with each tide. Of the 200 ha of Saltwater cordgrass marsh on the Magdalen Islands, nearly 70% is located in the northern part of Havre-aux-Basques Bay; it developed before the closure of the bay in 1956.

Eelgrass beds occupy the permanently submerged sandy substrates in the centre of the lagoons. This aquatic plant community covers approximately 20% of the area of Grande-Entrée and Havre-aux-Maisons lagoons. In Havre-aux-Basques Bay, it occupies a much more restricted area since the closure of the bay in 1956.

The sandy substrates of the lagoons shelter an abundance of invertebrate fauna dominated by marine worms, bivalve molluscs and gastropods. In less exposed areas, the sandy silt is home to beds of Softshell clams. These areas are dominated by such tiny fish species as sticklebacks, Banded killifish, Mummichog and Atlantic silverside. The lagoons offer a larger variety of fauna than do the ponds and are frequented by lobster, herring (which spawn there), Winter flounder, sculpin and mackerel. The anadromous Brook charr frequents several bodies of water.



Source: Adapted from Dryade, 1980.

Figure 6 Distribution of salt marshes, Saltwater cordgrass marsh and dunes in the Magdalen Islands

The abundance of aquatic plant communities, invertebrates and small fish in the ponds and lagoons attracts huge numbers of aquatic birds, which breed and raise their young (dabbling ducks and terns) or feed during migration (geese, ducks, herons and shorebirds).

3.2.2 Benthic habitats

The benthic environment is generally subdivided into five separate zones, based on tidal influence and the bathymetric layering of the water masses in the Gulf (Figure 7): *1*) the *supralittoral zone* is located above the high water mark, *2*) the *mesolittoral zone* is periodically covered and uncovered by the tides, *3*) the *infralittoral zone* comprises bottom areas permanently beneath the surface layer of the water (0–30 m deep), *4*) the *circalittoral zone* is associated with the cold intermediate layer and *5*) the *bathyal zone* consists of the bottom areas of the Laurentian Channel.



Source: Adapted from Brunel, 1991.

Figure 7 Layering of the benthic environment in the Gulf of St. Lawrence by tide and water mass

Habitats of the supralittoral zone. The habitats of the supralittoral zone that are of interest are the tiny islands and reefs used as breeding and resting sites by aquatic birds and seals, and the dunes, which are home to a particular flora, including several rare plants. There are a dozen islands in the Magdalen archipelago that are home to colonies of seabirds and serve as whelping grounds and haulouts for seals; the main ones are Bird Rocks (Rochers aux Oiseaux,
Rochers aux Margaux), Loups-Marins Island, Shag Island, Deadman's Island (Corps-Mort) and Goélands Island.

The sand bars and spits in the Magdalen Islands support characteristic dune vegetation. Inland from the Gulf there is a succession of different habitats: denuded beach with active dunes subject to erosion and sand deposits due to winds, colonized by beachgrass; semi-fixed dunes with denser vegetation cover; and, finally, fixed dunes anchored by low shrubs that form a veritable heath. As a result, the dunes resemble waves of sand, several metres high and several kilometres long, arrayed in lines of one to three rows and, exceptionally, up to 30 rows (as at Les Sillons, for example). The upper part of the beaches and the breaks in the dunes serve as breeding grounds for Piping plovers.

Habitats of the mesolittoral zone. The coasts of the Magdalen Islands facing the Gulf are very exposed to waves and ice floes. The sandy beaches are denuded of vegetation and have very little endobenthic fauna. These habitats are used by gulls, however, which feed on organisms and detritus washed up on the beach. The rocky coasts are regularly stripped by ice. The density and biomass of flora and fauna in this type of habitat increase from the top to the bottom of the foreshore. On coasts regularly eroded by ice, such organisms as barnacles and mussels can only develop in sheltered basins, crevices and rock faces. The lower part of these foreshores is occupied by brown seaweed (commonly known as kelp), which sometimes forms a continuous mat inhabited by periwinkles and gammarids. At high tide, several species of fish and invertebrates feed in these habitats.

Habitats of the infralittoral zone. The infralittoral zone is never uncovered by the tide and so is relatively protected from the destructive effects of waves and ice. Along the beaches, the sandy bottom of this zone is home to several species of large molluscs, such as Razor clams and Hardshell clams. The rocky infralittoral bottom areas support an abundant and diverse flora and fauna. The upper level of this type of habitat (0–12 m) is occupied by kelp beds. The characteristic species of this type of habitat are sea urchins, mussels, anemones, sea cucumbers and lobsters. Giant scallops can be found on the gravelly bottoms, at a depth of 15–35 m.

Habitats of the circalittoral zone. In the circalittoral zone (> 30 m), light penetration is not sufficient for photosynthesis. The biological communities here are made up of predators and organisms that feed on organic particles that settle on the bottom. The greatest concentrations of Snow crab are to be found on the sandy-silty bottoms of the troughs of the Magdalen Shelf (Cape Breton Trough, East and West Bradelle troughs). Canadian plaice is the species that characterizes those bottom areas around the islands having a more heterogeneous grain-size distribution. Cod and several other species of groundfish are less abundant in the bottom areas around the islands than elsewhere in the southern Gulf.

Habitats of the bathyal zone. The slope and bottom area of the Laurentian Channel in the study area are home to redfish and deepsea King crab. This habitat is colonized by several species of groundfish, which migrate there in winter (White hake, Canadian plaice).

3.2.3 Pelagic habitats

The pelagic environment is populated by phytoplankton (plants) and zooplankton (animals), pelagic fish species, seabirds and cetaceans. The food chain is largely based on the production of microscopic algae (primary production) in the surface layer.

Phytoplankton bloom in late April or early May in the southern Gulf, after which the biomass is dominated by diatoms. Primary production rapidly diminishes after this brief and intense flowering period and remains low until the following spring.

Zooplankton comprise several types of animals that drift passively with the currents. They include organisms that spend their whole lives in the pelagic zone (especially copepods), as well as eggs and larvae of benthic organisms and fish. In the southern Gulf, the zooplankton is more abundant and diversified than in other regions of the Gulf. The greatest biomass can be found between the Gaspé and the Magdalen Islands in July and August.

Several species of fish that are commercially harvested in the Gulf use the pelagic environment intensively for spawning (cod, mackerel), the development of larvae and juveniles (cod, mackerel, herring, redfish) and adult feeding (herring, mackerel and smelt). Most larvae of commercial crustaceans and molluscs (Snow crab, lobster, scallops, etc.) develop in the surface layer of the Gulf.

3.3 Fishery Resources

Only a handful of the hundred species of marine algae, the thousand species of invertebrates and hundred species of fish in the study area are harvested. The main species fished commercially, in descending order of value of landings in the study area from 1990 to 1996, are American lobster, Snow crab, redfish, cod, Atlantic mackerel, Atlantic herring, Giant scallop and Canadian plaice. The main species targeted by sport and recreational fishers are Atlantic mackerel and cod.

American lobster. This benthic crustacean is abundant in summer on the rocky infralittoral bottom areas (< 35 m). It migrates to deeper waters in winter. The species is present off all the coasts of the study area and in the lagoons.

The lobster populations in this area are heavily harvested and landings increased significantly between 1973 and 1992, but have since dropped. This increase in catches is the result of greater fishing power through the use of more sophisticated navigation equipment, larger boats and bigger traps. High catch rates and the fact that the size of a lobster at sexual maturity is greater than the minimum legal size mean that egg production in local populations represents only 1% of what it could be if the stocks were not being harvested. Such a low spawning rate is extremely risky and could lead to recruitment failure if conditions become less favourable than they have been in the last 15 to 20 years. Conservation measures, such as marking the telson of berried females (V-notching) and returning them to the water the following year, have been adopted.

Snow crab. The snow crab is a benthic crustacean that abounds on the sandy and silty bottom areas of the circalittoral zone (50–200 m). The Magdalen Islands fishing fleet harvests the southwestern Gulf population (Area 12), whose greatest concentrations are partly located in the East and West Bradelle troughs. The abundance of Snow crab populations is affected by major

natural fluctuations on a cycle of about eight years. The population in the southwestern Gulf peaked in the mid-1980s and in 1994, and experienced an all-time low in the late 1980s. Although the stock is currently of average size, the biomass is expected to start increasing in the year 2000. This population is heavily harvested and annual landings essentially depend on the strength of the year-class harvested each year.

Redfish. Prior to 1995, the largest redfish offshore fishing fleet in Quebec was found in the Magdalen Islands. The two populations of redfish harvested by this fleet winter outside the Gulf. In the spring, they migrate to the Gulf, concentrating along the northern and southern slopes of the downstream portion of the Laurentian Channel. These populations have been in decline since 1992–93 and this fishery has been closed since 1995. There has been no sign that these stocks are recovering since the fishery was closed, and prospects remain bleak.

Cod. Cod was one of the major fishery resources of the study area up to 1993, when a moratorium on cod fishing, still in effect, was imposed. Fleets in the Magdalen Islands harvested the southern Gulf population. This population winters outside the Gulf and migrates to its spawning and feeding grounds, located mainly in the southwestern Gulf, in the spring. The harvestable biomass of this stock reached an all-time low in 1993, as a result of a significant decrease in recruitment since the mid-1980s, attributable primarily to overfishing and abnormally cold oceanographic conditions in the Gulf since 1989. Recent data have revealed that stocks are recovering, but that cod fishing would jeopardize the stock levels.

Canadian plaice. Canadian plaice is the primary flat fish species harvested in the area. The stock harvested by fleets in the Magdalen Islands winters in the Laurentian Channel and migrates to the shallower waters of the Magdalen Shelf in the spring to spawn and feed in the summer. Stocks are low as a result of poor recruitment since the mid-1980s, which is attributed to a large number of immature specimens being caught and thrown back. In 1995, the stock's biomass reached its lowest level since 1977. There are currently signs of improvement (fewer small plaice being discarded); however, the biomass remains low. This fishery has been considerably restricted since 1993.

Atlantic mackerel. The Magdalen Islands is the main area in the Gulf for harvesting Atlantic mackerel. This pelagic fish winters in the Atlantic and migrates to the southern Gulf in summer to spawn and feed. The stock's biomass has been high since 1990. Landings have never exceeded total allowable catches. The harvestable biomass of this fish is expected to increase in the coming years.

Atlantic herring. Local fishing fleets harvest spring and fall herring stocks in the southern Gulf. These stocks undertake major migrations between their wintering grounds in the eastern Gulf and their spawning and feeding grounds located in part in the study area. These populations were subject to overfishing and declined rapidly in the 1970s, although they have since gradually recovered. Herring abundance in the southern Gulf has been high since 1988 as a result of the strong year-classes of 1987 and 1988. No strong year-classes have since been produced.

Giant scallop. The giant scallop is a bivalve mollusc that lives on the bottom at depths of 15 to 35 m. The main beds are located south of the Magdalen Islands. The population was decimated in the 1970s as a result of overfishing and has not recovered. Productivity is low in relation to harvesting intensity, and the fishing of young scallops is jeopardizing the stock's reproductive potential. In order to increase this potential, certain areas have been closed to fishing for several years, the minimum allowable size has been increased and bottom areas have been seeded with juveniles for several years now (see Section 3.8.4).

3.4 Birds

Over 317 species of birds have been reported on the Magdalen Islands. These birds come to the study area to breed (158 species) and raise their young, to feed during spring or fall migration or to winter, or else appear only occasionally or rarely.

3.4.1 Breeding

There are 86 breeding species directly associated with the study area's marine or coastal habitats. Eighty-five colonies, inhabited by 18 species numbering 26 500 breeding pairs, have been counted. The main colonial species are the Northern gannet, Black-legged kittiwake, Common tern and Double-crested cormorant. The colonies are concentrated chiefly on Bird Rocks (Figure 8). The total number of colonial birds in the study area increased from the mid-1970s to 1990, with the exception of the Alcidae and Leach's storm-petrel, for which no chronological data are available, and the Roseate tern, whose tiny population is stable. The Magdalen Islands has the only population of Roseate terns in Quebec and the only colony of Thick-billed murres in the Gulf of St. Lawrence.

In addition to colonial species, one goose, nine dabbling duck, five diving duck, one sea duck and six shorebird (plover, sandpiper) species that breed in isolated pairs in the study area were surveyed. The main species observed at the East Point National Wildlife Area were the Northern pintail, Red-breasted merganser, American black duck and Green-winged teal. The Magdalen Islands and the Southern Gaspé–Chaleur-Bay area are the only regions in Quebec where the Least sandpiper has been reported to nest.

3.4.2 Migration and overwintering

Overall, the study area is not considered an important staging area for geese or ducks during spring or fall migration, nor is it a major wintering ground for waterfowl. In the spring, hundreds of Brants stop over, whereas several thousand birds were observed before 1980. In the fall, a thousand dabbling ducks stop over in the northern part of Havre-aux-Basques Bay. In winter, hundreds of Oldsquaw and other sea and diving ducks can be observed near the coasts before the layer of coastal ice forms.



Source: CDSQ, 1996; Fradette, 1992; Mousseau et al., 1997.

Figure 8 Location of the main bird colonies (50+ pairs) in the Magdalen Islands

Havre-aux-Basques Bay is the main fall staging area in the Gulf for migrating shorebirds. Thirteen species of shorebird representing approximately 30 000 individuals stop on the Magdalen Islands. The main species are Short-billed dowitcher, Semi-palmated sandpiper, Hudsonian godwit and Lesser golden plover.

3.5 Marine Mammals

A dozen species of marine mammals frequent the study area at various times of the year. Baleen whales (Fin whales, Blue whales and Humpback whales) generally do not approach the islands, remaining instead above the slope of the Laurentian Channel. Harbour porpoises, Atlantic whitesided dolphins, Atlantic pilot whales and Minke whales visit the islands irregularly or rarely.

Grey seals calve from mid-January to mid-February on Deadman's Island, after which the population disperses throughout the Gulf until September and returns to the study area in late fall. In summer, Deadman's Island and the shores of Brion Island serve as haulouts. The Grey seal population of Eastern Canada has been growing since the early 1960s. The numbers in the Gulf are estimated at 61 000 individuals.

Harbour seals calve in small colonies throughout the Gulf. The area most frequented by the species in the Magdalen Islands is the vicinity of Grande-Entrée Island, where 32 individuals were spotted in June 1996.

Part of the Harp seal population of Eastern Canada migrates from the Canadian North to the southern Gulf in the fall and calves from late February to mid-March on the pack ice off the Magdalen Islands.

It is estimated that 199 000 seal pups were born in 1994 in the whelping grounds off the Magdalen Islands, representing more than 40% of the baby seals born in Eastern Canada. Prior to calving, females feed intensively in the study area, consuming mostly herring. After calving, the seals disperse to the northern and western Gulf, departing again in May or June. A part of the Hooded seal population of Eastern Canada migrates to the southern Gulf to calve on the pack ice south of the Magdalen Islands in March. In 1991, 2000 seal pups were born there.

In the seventeenth and eighteenth centuries, the largest colony of walruses in the Gulf of St. Lawrence was exterminated through intensive hunting in the Old Harry haulouts. This species has since been sighted only rarely in the Gulf.

3.6 Species at Risk

Eight rare plant, four fish, 12 bird and three marine mammal species in the study area are listed as priority species in need of protection under the St. Lawrence Vision 2000 (SLV 2000) action plan (Appendix 1).

Of the eight priority plant species, two are endemic to the Gulf of St. Lawrence (Gulf of St. Lawrence aster and American spurred gentian) and three are endemic to northeastern North America (Connecticut beggarticks, Common dandelion and Gaspé Peninsula arrowgrass). The largest population of Gaspé Peninsula arrowgrass in Quebec — a total of approximately 100 000 plants — can be found in Havre-aux-Basques Bay. This species occupies the ooze at the fringe between the Saltwater cordgrass marsh and salt marsh The populations of Gulf of St. Lawrence aster and Connecticut beggarticks that colonize this bay, as well as that of Broom crowberry at East Point, are among the largest in the world.

The priority fish species are American shad, Rainbow smelt, Atlantic tomcod and American eel. These species are considered at risk as a result of declining populations in the St. Lawrence Estuary; this may not apply to populations in the study area, whose status is unknown.

Of the 12 priority bird species, five are confirmed breeders in the Magdalen Islands. The islands are the only place in Quebec where Horned grebe breed It is estimated that between 10 and 20 pairs breed on the shores of small freshwater ponds, located mainly at North Dune and East Point. The group that breeds on the Magdalen Islands represents more than 70% of the entire eastern North American population. This group is isolated from the primary breeding ground and may constitute a disjunct population. If this is the case, its protection is critical. The Blue-winged teal and the Northern pintail have suffered a marked decline in numbers in Quebec over the past 30 years. The cause is unknown in the case of the Northern pintail; as for the Blue-winged teal, the drop in numbers is due to a loss of nesting habitat and overhunting in winter in Mexico. The Piping plover is an endangered species in Quebec. Its population worldwide numbered only 5482 individuals in 1991. The Magdalen Islands is the only place where the species has bred in Quebec since 1986. From 1987 to 1994, the population on the islands edged up from 37 to 50 breeding pairs. This species nests in the upper part of the beaches. As mentioned previously, the only place that the Roseate tern has been sighted in Quebec is the Magdalen Islands. It has been spotted regularly since 1972 and breeding was first confirmed in 1983. In 1995, two pairs bred in two separate colonies of Common terns. In decline since the 1930s, the eastern continental population of Roseate terns seems to have stabilized since the 1980s.

The three priority species of marine mammal are the Harbour porpoise, the Harbour seal and the Fin whale. The Harbour porpoise is abundant in the Gulf, but a large number die every year after becoming entangled in fishing nets. The Fin whale population is recovering, while the overall local population of Harbour seals has been declining in the Gulf since the 1970s as a result of disturbance by human activity and the species' sensitivity to toxic substances. Approximately 200 Harbour seals were counted in the Magdalen Islands area in the 1970s, while only 32 were observed in 1996.

3.7 Land Use

3.7.1 Land use patterns

In 1991, 13 991 inhabitants lived in the eight municipalities on the Magdalen Islands, which cover an area of 202 km^2 . A little more than 50% of the area — that is, the islands proper— is designated for rural use, while the sand bars and spits (40% of the area) are

designated as conservation areas (Figure 9). The only urban area is Cap-aux-Meules Island, which is the main service centre in the Magdalen Islands.

3.7.2 Protected areas

The areas protected under provincial and federal legislation cover more than 6600 ha (Figure 10).

The **East Point National Wildlife Area** (684 ha), managed by the Canadian Wildlife Service, was created in 1978 to ensure the integral and permanent protection of migratory birds and their habitats. Hunting is nonetheless sometimes permitted.

The **Rochers-aux-Oiseaux Migratory Bird Sanctuary** (600 ha), also managed by the Canadian Wildlife Service, ensures the integral and permanent protection of bird colonies on Bird Rocks (Rochers aux Margaux and Rochers aux Oiseaux), as well as the marine environment within a 1-km radius of these islets.

Two **No-Hunting Areas**, designed to protect birds during their fall migration, are located in the northern part of Havre-aux-Basques Bay (3500 ha) and near Grosse-Île (1200 ha).

The **Brion Island Ecological Reserve** (650 ha), created in 1988 by the provincial environment ministry (MEF), is to preserve an area representative of the ecological region of the Gulf of St. Lawrence.

Four small **wildlife habitats**, created by the MEF, protect bird colonies. Two of these sites are located on the Cormorandière Cliffs on Entry Island, while the other two are located on Shag Island and Bird Rocks. Fifteen other wildlife habitats are located on private land.



Source: Magdalen Islands RCM, 1987.

Figure 9 Broad land-use designations according to the regional county municipality (RCM) of the Magdalen Islands



Source: Boucher, 1992; Saint-Onge, 1996; UQCN, 1993; MLCP, 1993.

Figure 10 Protected areas in the Magdalen Islands

3.8 Developed Uses

3.8.1 Water supply

The municipalities of the Magdalen Islands draw their water from the water table. Groundwater use by the municipalities of Île-du-Havre-Aubert, Cap-aux-Meules and Fatima totalled 11 120 m^3 per day in 1994. This dependence on groundwater is particular to the islands and raises concerns about salt water seeping into the water table from overpumping. Tourism creates an additional strain on this precious resource, as the number of residents increases in the summer.

3.8.2 Mineral processing

Salt mining began at Grosse-Île in 1983. The mine is made up of 1-km-long galleries beneath North Dune that are more than 223 m below sea level. Approximately 1.2 million tonnes of salt is mined annually. This is the only major mineral resource of marine origin processed in the Gulf of St. Lawrence. The salt, exported by ship, is used mostly for de-icing roads in Quebec.

3.8.3 Commercial shipping and port activities

For the most part, general supplies are shipped weekly to the Magdalen Islands from Montreal to Cap-aux-Meules (April to January) or Matane to Cap-aux-Meules (February and March). In the federal port of Cap-aux-Meules, 76 500 tonnes of merchandise was transshipped in 1993–94, including a considerable volume of petroleum products. At the other commercial port (Havre-Aubert), 15 800 tonnes of merchandise was transshipped.

The Mines Seleine Inc. wharf, in Grande-Entrée Lagoon at Grosse-Île, is used to ship salt from the mine. Nearly 1.2 million tonnes of salt has been transshipped annually from this private port since 1983.

3.8.4 Harvesting of fishery resources for commercial and subsistence purposes

Commercial fishing. Commercial fishing is the chief economic activity in the Magdalen Islands. In 1995, commercial fishing employed 1304 fishers on a full-time and parttime basis on approximately 431 licensed vessels and a maximum of 1071 employees in eight fish processing plants (Figure 11). The value of all landings in 1995 totalled \$38.9 million, while that of processed products was \$54.2 million.

The main ports in the Magdalen Islands, in descending order of volume of landings in 1995, are Cap-aux-Meules, Grande-Entrée, Havre-Aubert, Étang-du-Nord and Millerand.

From 1985 to 1995, the total volume of landings dropped by 37% (particularly between 1991 and 1995), while the value increased by 153%. These opposite trends in the volume and value of landings can be attributed to the fact that higher-value landings (lobster, Snow crab and scallops) increased or were maintained during this period, whereas landings of groundfish (less lucrative species) declined by 96% as a result of moratoria imposed on the fishing of cod (1993) and redfish (1995) and the significant decrease in allowable catches of Canadian plaice.

The economic impact of the collapse of groundfish stocks in the Gulf of St. Lawrence was felt by a large part of the industry and the general public. Consequently, the main redfish processing plant in the Magdalen Islands was forced to close its doors in 1995.

The current state of this economic sector in Quebec can be summarized as follows: 1) traditional resources are either in sharp decline or are being harvested to their fullest; 2) there is a fishing power and fish processing overcapacity; 3) fishing is no longer a profitable activity for many fishers; 4) fishers and fish processing plant employees are undereducated and highly dependent on government transfers; 5) the fishing population is aging considerably and 6) the state of public finances no longer allows for major government support.



Source: DFO, 1996; MAPAQ, 1995.

Figure 11 Landings of main fishery resources in the Magdalen Islands in 1985 and 1995, and location of main fishing harbours and fish and seafood processing plants **Shellfish harvesting on the shore.** Magdalen Island residents harvest Softshell clams in the lagoons and deep-sea dive for Hardshell clams for their personal consumption. Although marginal from an economic standpoint, this activity has significant human health implications because of the potential toxicity of molluscs (see Section 5.1).

Aquaculture. There has been a significant increase in Blue mussel farming in the Grande-Entrée and Havre-aux-Maisons lagoons in the past few years. Production fluctuated between 22 and 68 tonnes between 1990 and 1995. Juvenile scallops are also being bred in the lagoons in an effort to seed fishing grounds south of the Magdalen Islands.

Marine mammal hunting. Only Grey seal and Harp seal hunting are authorized in the Gulf of St. Lawrence. In 1995, 837 hunting licences were issued to professional hunters and their assistants. As a result, 1196 Harp seals and 357 Grey seals were killed. This activity has grown significantly since the late 1980s. In 1996, 13 709 Harp seals were killed in the Magdalen Islands. This considerable increase is attributable to ice conditions that are more favourable for hunting and a greater demand for seal products.

3.8.5 Recreational and tourist activities

The Magdalen Islands offer visitors looking for a change of scenery a variety of unique Quebec landscapes. Nearly 75% of visitors arrive by ferry (Souris–Cap-aux-Meules); others arrive by plane (Havre-aux-Maisons airport). Ferry traffic has gone from a little more than 26 000 passengers in 1993 (return) to nearly 30 000 in 1995, while the total number of visitors increased from 18 500 in 1984 to 30 600 in 1991.

Access to the shoreline. The shoreline is extremely accessible. For the most part, the main road runs along the bars linking the islands and provides direct access to a number of beaches, roadside rest areas and public wharfs (Figure 12). Many smaller roads lead to spectacular panoramas of part or all of the archipelago. A ferry offers daily service between the port at Cap-aux-Meules and Entry Island. Brion Island and Bird Rocks are difficult to access because of a lack of sheltered wharfs. Access to these islands is also restricted. Visits and short



Source: Magdalen Islands Regional Tourism Association, 1995.

Figure 12 Recreational and tourist activities in the Magdalen Islands

stays that are in keeping with conservation objectives may be permitted. Companies do, however, offer boat tours around Brion Island and Bird Rocks.

Accommodation and resorts. The total accommodation capacity in the Magdalen Islands area is 363 rooms in various establishments (1994), 172 camping sites (1995) and 407 cottages (1994).

Beaches, swimming and windsurfing. Swimming and visiting the extensive beaches are extremely popular activities in summer. No beach in the area is part of the MEF's beach environment program. The lagoons are among the best locations in Canada for windsurfing because of the variety of sites, the velocity and constancy of the winds, the pleasant water temperature and the shallowness of the water. Horseback riding on the beaches is another popular activity.

Coastal and marine environment interpretative facilities. Several sites in the study area are devoted to interpreting the coastal environment, such as the East Point National Wildlife Area, the aquarium at Havre-Aubert, the seal interpretation centre at Grande-Entrée, Brion Island and Bird Rocks. It is also possible to take guided tours of Brion Island, Bird Rocks and the dunes, go deep-sea diving to the grottoes and undersea cliffs and take helicopter tours of the Harp seal calving grounds in winter.

Marine heritage interpretation facilities. The hub for this type of activity is Grave in Havre-Aubert, which was designated a historic area by the Quebec cultural affairs ministry in 1983. Among places to visit is the marine museum (Musée de la Mer). Other sites or historical marine museums are located in Old Harry and Anse à la Cabane.

Boat tours and sport fishing. Boat tours to admire the coastal scenery, watch birds and marine mammals or go fishing leave from Cap-aux-Meules, Étang-du-Nord, Havre-aux-Maisons and Grande-Entrée. The extent of this activity is not known, however. It is also possible to fish for mackerel and Rainbow smelt from a number of wharfs in the area.

Deep-sea diving. There is a deep-sea diving service centre in Cap-aux-Meules.

Waterfowl hunting. There are no data available on waterfowl hunting in the Magdalen Islands.

Boating. There are three boat clubs and marinas in the Magdalen Islands (Havre-Aubert, Cap-aux-Meules and Havre-aux-Maisons), with a total of 172 moorings. There are also boat launching ramps at Étang-du-Nord and Fatima and some 20 fishing harbours and public wharfs. Several companies provide sailboat, pedal boat or sea kayak rental services.

Birdwatching. There are a number of interesting sites for birdwatchers and the general public in the Magdalen Islands. There is a birdwatching club in the area and another organization offers educational and birdwatching activities.

CHAPTER 4 Human Activities and Their Main Effects on the Environment

4.1 Physical Changes in the Environment

Physical changes are those resulting from human activities that modify the physical properties of the water (temperature, salinity, suspended sediment, circulation), the seabed (bathymetry, sediment grain-size) and the shores (geomorphology).

Large-scale changes. The construction of hydro-electric dams in the St. Lawrence basin has substantially reduced the input of fresh water to the Gulf during periods of flooding (June), while increasing inputs in winter. Because of a lack of oceanographic data covering the first half of the twentieth century, the impact on the Gulf's marine environment of harnessing the St. Lawrence River is not known.

Since the end of the 1980s, the Gulf of St. Lawrence and a large part of the Canadian Atlantic coast have experienced marked climate cooling, resulting in a significant increase in the extent and duration of ice cover in winter and a cooling of the cold intermediate layer in the troughs of the Magdalen Shelf. Although the relationship between this cooling and the flora and fauna is not yet well established, specialists believe that these abnormal conditions may have affected some populations of invertebrates and fish (particularly cod) by altering their distribution and migration patterns, curbing the growth of individuals and increasing mortality rates for eggs, larvae and even adults.

Local changes. It is estimated that, between 1945 and 1988, 427 ha of shoreline habitat in the study area underwent a physical change ranging from a modification of the current regime to the complete elimination of the current through filling (Figure 13). This figure excludes the infralittoral and circalittoral zones disturbed by the deposition of dredged material and the use



INITIAL HABITATS. Salt marsh: sites 5, 12, 13, 19, 26, 31, 40. Sand and gravel foreshores: sites 2, 3, 4, 6, 7, 11, 14, 15, 16, 20 to 25, 27, 28, 32 to 38. Lagoon barachois: sites 1, 10, 17, 29, 30. Deep water: sites 8, 9, 18, 41.*

*Site not surveyed by Marquis et al.

Source: Marquis et al. 1991.

Figure 13 Coastal and marine habitats in the Magdalen Islands disturbed by physical change between 1945 and 1988

of mobile fishing gear, and dunes disturbed by all-terrain vehicles, pleasure boaters and cottage developments, as well as the zones affected by a reduction in seawater exchanges between the lagoons and the Gulf.

Filling has eliminated 144 ha of habitat, including 65 ha of salt marsh and 38 ha of lagoon environments. These losses are mostly attributable to the construction of Highway 199.

Several commercial ports and fishing harbours must be dredged on a regular basis in order to maintain an adequate depth for boats. From 1985 to 1994, 11 ports in the Magdalen Islands were subject to maintenance dredging. Of these, three were dredged every year and three others, nine out of ten years. The average volume of sediment dredged on each occasion was approximately 9400 m³. The dredged material is dumped in deep waters off the coast, near the dredging sites.

Close to four million cubic metres of sand was dredged between 1980 and 1982 during the creation of a ship channel in Grande Entrée lagoon leading to the Seleine Mines Inc. wharf. Three-quarters of the dredged material was used to create two islets in the lagoon, which were rapidly colonized by dune vegetation. These islets are currently used by terns, gulls and Piping plovers for breeding. The ship channel silts up quickly and requires regular maintenance dredging. In 1985, more than 7000 m³ of sediment was dredged from the channel and, according to the mining company's ten-year plan, an additional 800 000 m³ of sediment will have been dredged between 1991 and the year 2000.

In 1956, the two openings that ensured an exchange of seawater between Havre-aux-Basques Bay and the Gulf were closed with the construction of Highway 199. The lagoon was transformed into a relatively stagnant nontidal pond. The physical changes attributable to this closure include an appreciable rise in average water level, warming of the water, a significant decrease in salinity and an increase in spatial and temporal variations in salinity. Since the closure, the bay can no longer serve as spawning and nursery habitat for several marine species, species diversity has diminished, eelgrass beds have almost entirely disappeared and the Saltwater cordgrass marshes have retreated. The construction of the bridge on Highway 199 in the Havre-aux-Maisons channel and the causeway that crosses the strait between Havre-aux-Maisons and Grande-Entrée lagoons has also led to the filling of Havre-aux-Maisons lagoon with sand.

The dunes, particularly in areas where they are becoming fixed, are considered fragile environments that are highly sensitive to traffic from all-terrain vehicles and pleasure boaters headed for the beach. South Dune and East Point are areas that are showing various signs of degradation as a result of motorized vehicles.

4.2 Pollution

The terms "contamination" and "pollution" do not mean the same thing. When the concentration of a substance in water, sediment or living organisms is higher than the naturally occurring background level, this constitutes contamination of the environment or aquatic biota. Only when the concentration reaches a level where living organisms or developed uses are adversely affected is the term "pollution" used.

Some contaminants such as biodegradable organic matter, bacteria and nutrients (nitrates and phosphates) are not persistent, and environmental quality improves rapidly with distance from the discharge point, as it does when releases of these pollutants cease. However, other contaminants that are persistent in the environment are transported over great distances in the watershed or in the atmosphere, and tend to accumulate in sediments and living organisms. These include polychlorinated biphenyls (PCBs), organochlorine pesticides (DDT, dieldrin and Mirex), polycyclic aromatic hydrocarbons (PAHs), dioxins, furans and mercury.

4.2.1 Main sources of contamination

Sources of contamination can be divided into two broad categories: local sources and distant sources. Local sources are found in the shoreline municipalities of the study area, in the drainage basin of area tributaries or in the water (dredging, shipping) (Figure 14).



Source: Gagnon et al., 1997.

Figure 14 Location of the main local sources of contamination of the marine environment in the Magdalen Islands

Contaminants from distant sources reach the study area by means of currents (water inflow) and atmospheric deposition. They are persistent chemical substances present in the environment.

4.2.1.1 Local sources

Municipal wastewater. Four of the eight municipalities in the Magdalen Islands have been discharging all or part of their wastewater to treatment facilities since September 1997. They are Cap-aux-Meules, Fatima, Havre-aux-Maisons and Étang-du-Nord. Using aerated ponds, these four facilities treat the wastewater of 38% of the total island population. Another municipality (Havre-Aubert) has signed an agreement that will see the commissioning of a facility providing service for part of the municipality by the summer of 1998. Different percentages of the population in these five municipalities are not connected to sewer systems. Their wastewater is discharged into septic tanks and cesspits which, if not properly maintained, can constitute sources of contamination for the marine environment. The three remaining municipalities in the area are not serviced by sewer systems.

In 1994, the treatment plant at Cap-aux-Meules registered 77% for BOD₅ and 92% for suspended solids (SS). Standards for BOD₅ were not respected for part of the year, but those for SS and overflows were. Overflows can, however, constitute major sources of contamination for the marine environment following heavy rainfall.

Industrial wastewater. The only industrial plant targeted under the provincial industrial effluent abatement program (PRRI) is the Canadian Salt Company Ltd. or Seleine Mines Inc. in Grosse-Île, which operates the only salt mine in Quebec. The crushed rock salt is stored in silos before being loaded onto ships in the company's private port on the western shore of Grande Entrée lagoon. Since the process is dry, no effluent is generated.

Hazardous waste sites. The only hazardous waste site officially listed by provincial and federal governments in the 1980s is the Magdalen Islands airport at Havre-aux-Maisons. Hydrocarbons and solvents emanating from sites used for the storage and handling of these products constitute a potential source of contamination for the marine environment. Recently, 800 m^3 of contaminated soil from this site was treated using a biological process.

Shipping and port activities. Shipping represents a potential source of pollution from marine incidents, ballast flushing and the discharging of hold contents directly into the sea, as well as from the transshipment of goods and storage at ports.

To date, there have been no catastrophic oil spills in the study area. A major spill occurred west of the area with the sinking of the *Irving Whale* on September 7, 1970. The barge, carrying 4270 tonnes of heavy fuel oil and 7.5 tonnes of PCBs, remained on the sea bottom, 100 km west of the Magdalen Islands, until its recovery on July 30, 1996. When it sank, 400–600 tonnes of oil spilled into the Gulf and nearly 200 tonnes floated toward the Magdalen Islands, oiling 32 km of shoreline. More than 250 000 bags of oily PCB-contaminated waste were recovered during the clean-up of the beaches and were buried in North and West dunes. Approximately 5000 eiders at an offshore feeding site were soiled by the oil slick after the sinking. In the 25 years following the incident, small quantities of oil were periodically released from the barge and occasionally reached the shores of the islands. During the raising of the barge, approximately 5000 L of oil escaped, but half was immediately recovered. The other half quickly dissipated into the water and the atmosphere. After the barge was raised, it was discovered that only 20% of the original volume of PCBs remained in the barge. Between 190 and 300 kg of PCBs had spilled at the time of the sinking.

Although far less significant, spills occurring during transshipments of petroleum products in ports are much more frequent than those that occur off shore. The main port for transshipping petroleum products in the study area is at Cap-aux-Meules.

Busy ports and marinas are potential sites for organo-tin contamination. These highly toxic compounds come from the antifouling paints used on ship hulls and submerged port infrastructures. The creosote-treated wood used at some wharfs is a source of PAH contamination.

Dredging. The maintenance dredging of ports, fishing harbours and marinas can contribute to contamination by causing the resuspension of toxic substances that would otherwise remain isolated from the aquatic environment in deep sediment layers, or confined to sites away from general circulation. A considerable amount of dredged material has been deposited off the coast of the study area. In most cases, the sediment dumped at these sites is moderately contaminated with heavy metals. 1996 volumes were ten times lower than those in 1985.

Snow dumping sites. Data on the dumping of snow directly into the sea is not available for the study area. Since 1996, all Quebec municipalities have been required to develop a snow disposal plan that precludes direct dumping into the aquatic environment. Such dumping will be prohibited entirely as of November 1, 2000.

Agriculture. In 1991, 24 farmers in the Magdalen Islands were farming 105 ha of land, mostly in the municipality of Étang-du-Nord. The number of farmers and the area of farmland decreased by approximately 66% between 1981 and 1991. The primary crops are hay and grain. Livestock production in the Magdalen Islands is marginal. The area of land treated with chemical fertilizers dropped by 80%, while pesticide use was practically eliminated between 1981 and 1991.

Fish offal disposal at sea. Part of the waste generated by fish processing plants is disposed of at sea. This method of disposal is subject to environmental assessment prior to the issue of a compulsory permit, as stipulated under Part IV of the *Canadian Environmental Protection Act* (CEPA). Since 1995, fish processing plants in the Magdalen Islands are permitted to dump a maximum of 3600 tonnes of waste per year.

4.2.1.2 Distant sources

Water inputs. The Gaspé Current carries all the fresh water from the Great Lakes drainage basin, the St. Lawrence River, the St. Lawrence Estuary and the Saguenay River to the southern Gulf. Although, in the past few decades, considerable amounts of toxic substances that are persistent in the environment have been released into the fresh water that drains these regions,

only a small fraction have reached the Gulf of St. Lawrence. The Great Lakes, the Saguenay Fjord and the St. Lawrence Estuary are natural sinks in which a large part of the fine sediments to which toxic substances adhere are deposited. It is estimated that, between 1950 and 1990, only 3% of the Mirex (an organochlorine pesticide) discharged into the Great Lakes was transported all the way to the Gulf of St. Lawrence and that the amount of PCBs that sedimented in the St. Lawrence Lower Estuary is 100 times greater than the quantity in the entire Gulf. In the case of most toxic substances, particularly mercury, lead, PCBs and DDT, inputs from the Great Lakes and the St. Lawrence have declined since the 1970s.

Atmospheric inputs. Atmospheric deposition in the form of vapour and precipitation in the Gulf of St. Lawrence constitutes a major source of several toxic contaminants, particularly mercury, lead, PCBs, PAHs, dioxins and furans, found in the sediments of the deepest zones of the Gulf and, presumably, the trough of the study area.

4.2.2 Impact of contaminants on resources and uses

The criteria and guidelines that can be used to determine to what extent contaminants found in the water, sediments and organisms pose a threat to aquatic organisms and human health, and also limit certain uses, are described in Appendix 2.

4.2.2.1 Contamination of the water

Data on the contamination of the water from toxic substances in the study area is virtually non-existent. In the other regions of the Gulf, the concentrations measured are typical of coastal waters under the influence of terrigenous inputs and do not exceed the most stringent water quality criteria established for the most worrisome substances.

In 1997, only four shellfish areas of the 14 that were subject to bacteriological water quality monitoring in the Magdalen Islands were closed because the water quality was not good enough to permit the harvesting of molluscs (Figure 15).



Source: Environment Canada, 1997.

Figure 15 Location of shellfish areas in the Magdalen Islands and classification based on bacteriological water quality in 1997

4.2.2.2 Contamination of sediments

Sediments are considered contaminated when they contain heavy metals or certain organic compounds (PAHs, for example) in quantities exceeding the naturally occurring, preindustrial levels of those substances. The concentrations become cause for concern when they are high enough to harm organisms living in or near sediments, on which they depend for their survival. This is called the *apprehended pollution* level. To assist in evaluating sediment quality, three contamination thresholds have been established for the most worrisome substances: the no effect threshold (NET), the minimal effect threshold (MET) and the toxic effect threshold (TET). These thresholds can be used to separate sediments into four categories:

- Uncontaminated: the concentrations are below the NET.
- Slightly contaminated: the levels lie between the NET and the MET.
- Moderately contaminated: the levels are between the MET and the TET.
- Heavily contaminated: the concentrations are higher than the TET.

Laurentian Channel. The silty sediments at the bottom of the Laurentian Channel north of the Magdalen Islands are moderately contaminated with mercury, chromium and arsenic and slightly or not at all contaminated by cadmium, lead, nickel, zinc, copper, DDT, Mirex, PCBs, PAHs, dioxins and furans. In the case of most of these substances, the level of contamination detected is much lower than in the Lower Estuary, where a large percentage of the inputs from the St. Lawrence River is deposited.

Magdalen Shelf. In the 1960s and 1970s, the sediments of the Magdalen Shelf contained the lowest levels of heavy metals in the salt water St. Lawrence. Heavy metals do not have much affinity for such coarse sediment as sand and gravel. The heavy metal levels found in these types of sediment reflect natural background levels for rocks located along the coast and at the bottom of the Gulf, and are not bioavailable for living creatures.

The exception to the rule is the site of the sinking of the *Irving Whale*, 45 km west of the study area, where sediments are highly contaminated with the PCBs that were spilled on the water bottom between 1970 and 1996. Concentrations exceeding background levels in Gulf

sediment were detected within a 300-m radius of the barge. Sediment suction and dredging operations carried out in 1996 made it possible to recover part of the PCBs (220 kg). The sediment within a 50-m radius of the barge site (~ 6000 m^2) is highly contaminated, containing approximately 150 kg of PCBs.

Ports and lagoons. The quality of the sediment at some dozen ports, fishing harbours and lagoons in Grande Entrée was assessed in the 1980s and 1990s prior to dredging operations. Some areas had been highly contaminated with cadmium in the mid-1980s (Pointe-aux-Loups, Cap-aux-Meules and Havre-Aubert) although, just as at a number of ports in the Gaspé, levels seem to have diminished considerably. The commercial port at Cap-aux-Meules is the most polluted area in the Magdalen Islands. The sediments are moderately polluted with PCBs and copper, and high concentrations of PAHs have been found in sediment close to the wharfs. The ports at Grosse-Île, Étang-du-Nord and Île-d'Entrée are also moderately contaminated with mercury.

4.2.2.3 Contamination of the food chain

Aquatic organisms tend to accumulate certain toxic substances in their body tissues at concentrations much higher than those found in ambient water and sediments (*bioconcentration*). *Bioaccumulation* of a contaminant occurs when the rate of assimilation of the substance exceeds the rate of elimination. Hence, concentrations of the contaminant in an organism's body increase as it grows older. Since most aquatic organisms, except for shellfish, are able to regulate their body burdens of heavy metals (except for mercury) and also to quickly metabolize PAHs, they do not bioaccumulate these substances. However, most living organisms are unable to eliminate or quickly metabolize mercury and organochlorine compounds such as PCBs, DDT and Mirex. As a result, these substances become concentrated at every level of the food chain, thus reaching much higher levels in vertebrates than in invertebrates. This phenomenon, called *biomagnification*, has been documented for the St. Lawrence Estuary food chain with respect to PCBs, Mirex and

mercury. For example, PCB levels are 100–1000 times higher in the blubber of Harbour seals than they are in benthic and planktonic invertebrates living in the same environment (Figure 16).



Source: Béland et al., 1992; Gagnon et al., 1990; Hodson et al., 1992; Muir et al., 1990; Wagemann et al., 1990.

* The figure shows the scope of concentrations measured in organisms in the Estuary and Gulf.

** Concentrations of PCBs are much higher in blubber than in muscle.

Figure 16 Biomagnification of PCBs in the food chain of the Gulf of St. Lawrence and the St. Lawrence Estuary

The extent to which marine organisms are contaminated with biomagnified substances depends on their trophic position and the time they spend in contaminated areas. For example, Fin whales are much less contaminated than Harbour seals because they feed primarily on herbivores (euphausiids) and they frequent the Gulf only in summer, whereas Harbour seals eat mainly carnivorous organisms (fish) and live in the Gulf year-round.

Invertebrates and fish. The sketchy data available reveal that invertebrates and fish in the study area do not contain toxic substance loads exceeding the established marketing guidelines. Fish-eating birds and marine mammals, however — especially seals and toothed whales — are more highly contaminated owing to the phenomenon of biomagnification.

Birds. Overall, the level of contamination of aquatic bird eggs in the Gulf of St. Lawrence is three times lower than it is in the Great Lakes and comparable to levels detected on the Canadian Atlantic coast. Contamination by heavy metals is moderate and has no apparent effect on the health of birds. Contamination by organochlorine substances, however, is more worrisome. In monitoring Northern gannet eggs on Bonaventure Island in the Gaspé, for example, particularly high concentrations of PCBs and DDE (a derivative of DDT) were found in the eggs in the late 1960s, followed by a rapid decline in the case of DDE, and a somewhat slower decline in the case of PCBs. The period during which high concentrations of organochlorines were detected in the eggs coincided with eggshell thinning, a decreased hatch rate and a decline in the gannet population beginning in 1966. The decrease in egg contamination coincided with a significant increase in the hatch rate and growth of the gannet population, which, by 1984, had recovered to its 1966 level; it has since continued to increase. The low hatch rate was associated with high concentrations of DDE. The elimination of DDT in forest spraying programs aimed at eradicating the spruce budworm greatly diminished DDE inputs in the marine environment of the study area. Concentrations of PCBs, dieldrin (pesticide) and hexachlorobenzene in seabird eggs in the Gulf, however, declined more slowly because these substances were eliminated more gradually. Lastly, the concentrations of chlordane derivatives did not decrease between 1969 and 1984, since the use of this pesticide was only regulated in Canada in 1978.

The lead shot used in hunting rifles is a major source of contamination in aquatic birds that frequent intensive hunting areas. This shot is ingested by bottom-feeding geese and ducks and can cause serious lead poisoning. None of the zones in the Magdalen Islands presents a high risk of this type of poisoning. The use of nontoxic shot has been compulsory within 200 m of a water source since 1997 and will become mandatory throughout Quebec as of 1998.

Marine mammals. Only sketchy data on the contamination of marine mammals is available for the study area. Overall, seals and Harbour porpoises in the Gulf are more highly contaminated by toxic substances than are baleen whales, but less contaminated than St. Lawrence belugas. Many pathologies identified in the belugas have not been observed in other species. Harp seals which calve in the area surrounding the Magdalen Islands are more contaminated by DDT and PCBs than those which calve on the Labrador coast. DDT concentrations in their blubber, however, have clearly fallen since the 1970s, while concentrations of PCBs have decreased less rapidly.

4.3 Introduced or Expanding Species

Purple loosestrife. Purple loosestrife is a European plant that has invaded the freshwater marshes of the St. Lawrence River. It first appeared in the Magdalen Islands in the 1970s. Purple loosestrife is considered a veritable nuisance in some parts of Canada and the United States because it reduces the diversity of marshland plant communities.

Exotic organisms in ballast water. The ballast water carried by merchant ships may contain large numbers of planktonic and benthic organisms, and ballast dumping is a potential vector for the introduction of exotic species into the marine environment. Some introduced species can have harmful effects on the ecosystem, as is the case with the Zebra mussel in fresh water. The introduction of toxic planktonic algae poses a serious threat for coastal areas and

fishery resources. Marine toxin-producing algae that are responsible for paralytic shellfish poisoning transported from areas where these organisms abound (St. Lawrence Estuary and the Gaspé) all the way to the lagoons of the Magdalen Islands, where they are infrequent visitors. Regulations have been in effect since 1982 for the Seleine Mines Inc. operation in the Grande Entrée lagoon, requiring ships to dump their ballast waters before coming within 20 km of the islands.

4.4 Overfishing

Fishing always tends to reduce the biomass of harvested populations and the average size of the individual fish taken. These normal phenomena do not jeopardize stocks as long as their potential for renewal is maintained. The decline in cod and redfish populations in the late 1980s and early 1990s has been attributed to the fact that fishing effort was too high at a time when environmental conditions were particularly unfavourable for stock rebuilding. As a result, the reproductive potential of the cod and redfish populations was considerably reduced during the period. Other major resources in the area, such as lobster, Snow crab and Canadian plaice, are highly vulnerable to unfavourable oceanographic conditions at present because of the high level of harvesting.

4.5 Disturbance of Birds and Marine Mammals

The large-scale development of coastal and marine recreational and tourist activities in the Magdalen Islands has raised concerns about the impact of the persistent presence of humans in habitats that had been, until recently, relatively inaccessible to the general public.

Cottages and campers located close to ponds used by the Horned grebe for breeding threaten this priority species. Various human activities in the dunes and on the beaches threaten the population of Piping plovers, an endangered species in Quebec. It is estimated that, in the early 1990s, 10% of this species' nests were destroyed every year, primarily as a result of motor vehicles on the beaches. The habitats of the Gulf of St. Lawrence aster, Connecticut beggarticks
and Broom crowberry, three rare priority plant species, are threatened by cottage developments and the use of all-terrain vehicles. Some areas colonized by the aster and crowberry have already been disturbed, particularly on the east side of East Pond.

Marine mammals are sensitive to disturbance from boat traffic. The Grey seal is more sensitive to such disturbance than the Harbour seal, leaving reefs more quickly when a boat arrives.

CHAPTER 5 Human Health Risks

5.1 Consumption of Fish, Crustaceans and Molluscs

Chemical contamination. In general, fish, crustaceans and molluscs in the Gulf of St. Lawrence are not very contaminated by chemicals. Concentrations of most of the main contaminants investigated (mercury, PCBs, DDT, Mirex, dioxins and furans) are below the guidelines set for marketing fish and seafood.

Several studies, including one conducted on fishers on the Lower North Shore, have nevertheless revealed that a population whose consumption of fish and seafood is high is more exposed to the contaminants in these organisms than a population whose consumption is low.

This is confirmed by the data available on the uptake of contaminants by the population of the Magdalen Islands (assessment of exposure of newborns through the blood of the umbilical cord). This data indicates an uptake of lead, PCBs and DDE comparable to the rest of Quebec, but higher for mercury, although mercury uptake still remains well below allowable levels. Health risk estimates for the population of the Lower North Shore tend to reveal that risks are low for the majority of fishers. Since exposure of the population of the Magdalen Islands to mercury seems comparable to that of the population of the Lower North Shore and exposure to organochlorines seems to be lower, health risks for the population of the Magdalen Islands relative to these contaminants can also be considered low.

The consumption of fish and seafood does not pose any risks and offers considerable health benefits. In addition to providing a good source of protein, vitamins, minerals and polyunsaturated fatty acids (particularly omega-3s), eating fish and seafood offers some protection against certain diseases, particularly cardiovascular disorders. Moreover, for pregnant and nursing women, the fatty acids ensure the development of the nervous system in the fetus and child in the first few months of life.

Finally, it is possible to reduce the quantity of organochlorine substances (PCBs, DDE, etc.) ingested by taking certain precautions when preparing fish. Since these substances

tend to accumulate in the fat, it is preferable to avoid eating the skin, viscera or fatty parts of the fish, as well as the cooking juices.

Bacteriological contamination. Discharges of untreated municipal wastewater, inadequate septic tanks and the presence of seabirds can lead to bacteriological contamination of the water in several areas and, consequently, affect the quality of edible molluscs. Bacteriological contamination of the water at harvest sites is a major problem in the Gulf of St. Lawrence. The Magdalen Islands sector is also affected by this contamination, but to a lesser degree; only four of the 14 shellfish harvest sites were closed in 1977.

The consumption of contaminated molluscs can cause digestive and intestinal problems. Since 1990, the Gaspé–Magdalen Islands Public Health Branch has reported five cases of poisoning related to the consumption of shellfish in the region. The extent of the problem nevertheless remains unknown because of under-reporting of intestinal problems, since most cases do not require visits to the doctor or hospitalization.

Molluscs should only be harvested in areas authorized by Fisheries and Oceans Canada. Using data collected through Environment Canada's Shellfish Water Quality Protection Program, the Department advises harvesters on mollusc safety at the various sites. Molluscs that are purchased do not pose any danger since they are systematically inspected.

As for bacteriological and parasitic contamination in fish, most parasites do not pose a threat to human health. The following preventive measures are, however, recommended: avoid eating the skin and viscera and cook the flesh thoroughly. These precautions eliminate the risk of microbiological and parasitic contamination. It is also recommended that fish with obvious external anomalies (e.g. ulcers, bumps on the skin, injuries, etc.) not be eaten.

Contamination by toxic algae. The microscopic alga *Alexandrium* sp. (the main species of toxic algae found in the Gulf) produces a biotoxin that, when ingested by humans, can cause serious symptoms of poisoning, and even death (also called paralytic shellfish poisoning, or PSP). The toxin is transmitted to humans when they eat contaminated bivalve molluscs (Softshell clams and mussels), although the molluscs themselves are not affected by the toxin. This toxin is

also found in the hepatopancreas of lobster (tomalley), as well as the liver of cod, mackerel and other fish that inhabit the Gulf. The concentrations in fish liver are too small, however, to constitute a health risk and the toxin is not present in the flesh.

It appears that the Magdalen Islands area is not affected by the problem of toxic algae. Indeed, given the low concentrations of toxic algae observed in neighbouring waters in the past few years, none of the molluscs analysed were deemed unfit for consumption.

5.2 Waterfowl Consumption

On the basis of samples taken nationwide by the Canadian Wildlife Service, Health Canada has determined that the health risks associated with eating waterfowl meat are negligible. The concentrations of contaminants analysed in the various aquatic bird samples were generally low or below the detection threshold. It is nevertheless possible to reduce exposure to organochlorines to a minimum by using cooking methods that eliminate as much fat as possible, particularly in the case of fish-eating birds. Moreover, it is recommended that any lead shot in the flesh be removed.

Parasites found in waterfowl generally do not pose any health threats. It is recommended, however, that meat be cooked thoroughly in order to eliminate any risk of parasitic or microbiological contamination.

5.3 Seal Meat Consumption

The Quebec ministry of agriculture, fisheries and food (MAPAQ) has established an analysis program to assess the safety of Harp seal meat in the Magdalen Islands. Analyses have shown relatively high levels of mercury and cadmium in seal liver and flesh. The consumption of seal meat is therefore considered a significant source of exposure. Concentrations of organic contaminants (PCBs, Mirex, DDT and others) measured in the various tissue samples were found to be low and well below the guidelines for marketing fish and seafood.

Consequently, MAPAQ recommends that Harp seal livers not be eaten and that the consumption of adult seal meat caught in the Magdalen Islands be limited to one meal per week. There are no restrictions on eating seal pup meat.

5.4 Seaweed Consumption

There is no commercial harvest of edible seaweed in the study area. However, seaweed is harvested for personal consumption and for use in local restaurants.

A study conducted on seaweed samples collected in the Gulf of St. Lawrence and the St. Lawrence Estuary showed the presence of several organic and inorganic contaminants. The levels observed were generally quite low, however, and were often below the detection threshold. Only the presence of iodine and cadmium in certain species of seaweed could potentially pose a human health risk if large quantities were consumed. Soaking and cooking the seaweed in water reduces the concentrations of iodine.

5.5 Recreational Activities

5.5.1 Risks related to poor water quality

Activities involving contact with water, such as swimming and windsurfing, are practised on several beaches in the Magdalen Islands. In 1996, however, none of these beaches were monitored in accordance with the MEF's beach environment program. In 1992, a study on the water quality of the beaches in the Gaspé–Magdalen Islands area revealed that one of the three beaches examined was considered polluted (D rating). The two others received A and B ratings. As for the study area overall, the absence of systems for treating municipal wastewater is likely the main cause of the pollution. The presence of a potential source of contamination such as a polluted watercourse or sewage outfall was detected at all sites where beach water was polluted or of mediocre quality. The presence of pathogenic bacteria in water used for recreational purposes (swimming, windsurfing, water skiing, and seadoos) can cause health problems such as dermatitis, ear infections, conjunctivitis and gastroenteritis.

Given that only recent and regular analyses show with certainty whether the water at a specific site poses a danger for users, practising recreational activities in the Gulf is risky. Before practising a water sport that brings them into contact with the water, it is recommended that users consult local authorities (MEF, Public Health Branch, municipalities) about water quality. Signs prohibiting mollusc harvesting and the proximity of a sanitary or storm sewer are possible indications of poor water quality. Caution should be exercised under these circumstances.

5.5.2 Risks related to physical dangers in the area

Swimming. It is recommended that only supervised swimming areas be visited in order to ensure the safety of swimmers. Lifeguards, buoys, rescue equipment and clear postings about the risks related to currents, tides and waves must be present in order for swimmers to enjoy the safe use of public beaches.

5.6 Technological Accidents

Until now, environmental accidents related to the transport of hazardous goods have had little impact on the health of Magdalen Islanders. Although the sinking of the *Irving Whale* did result in the spilling of approximately 400–600 tonnes of oil 100 km west of the Magdalen Islands between 1970 and 1996, the year it was recovered, the consequences of this technological accident on the health of island residents are considered negligible since the site of the sinking was closed to fishing. There is still the risk of another major spill affecting public health, given the difficult navigation conditions in the Gulf (strong tides, marine currents, etc.).

Most of the spills that have been documented took place in port facilities, during transshipment operations. There have not been any notable effects on health as a result of these incidents.

5.7 Reduction in Fishery Resources

The reduction in fishery resources, the moratoria on fishing and the restrictions imposed by the international market could potentially contribute to the social disintegration of coastal villages in the Gulf of St. Lawrence and indirectly result in an increase in health problems. Today, it is recognized that populations experiencing chronic unemployment are more affected by certain health problems, particularly mental health problems, which can have an impact on physical health. Initiatives that foster the sustainable development of resources are therefore recommended for all shoreline communities in the Gulf.

CHAPTER 6 Toward the Sustainable Development of the Magdalen Islands

Sustainable development of the Magdalen Islands involves reclaiming and preserving for future generations the biodiversity of plant and animal life, their manifold uses and the quality of life associated with these uses. Activities in the area must include continued economic development while guaranteeing resource sustainability and environmental quality. Among the means advocated to achieve sustainable development are:

- Reducing pollution
- Protecting sensitive species and habitats
- Restoring disturbed habitats and resources
- Managing marine fisheries effectively
- Reconciling recreational and tourism development with environmental protection.

Here, we attempt to identify the main environmental issues in the sector and to describe some of the existing programs and activities that foster sustainable development (Table 1). This review is in no way exhaustive and only provides a starting point for discussions with local stakeholders, who will have to establish local strategies and priorities for carrying out an environmental rehabilitation action plan (ERAP).

6.1 Reducing Pollution

At present, 38% of the entire Magdalen Islands population is serviced by wastewater treatment plants. A significant portion of the area's population does not have access to a sewer system and discharges its wastewater into septic tanks and cesspits, whose compliance with standards is unknown. Furthermore, the overflow systems of the existing water treatment networks are sources of contamination during heavy rainfall.

Issues	Assessment of present state relative to sustainable development goals	Present actions for sustainable development		
Pollution Reduction				
• Treatment of municipal and household wastewater	Approximately 38% of the population's wastewater was treated by treatment facilities in 1997. A large portion of the population does not have access to a sewer system. Bacterial pollution in certain areas restricts mollusc harvesting and recreational activities that involve contact with water.	Use of the water related to its bacteriological quality can only be reclaimed by treating wastewater (effective treatment plants or septic facilities) and controlling overflows during rainstorms.		
• Elimination of persistent toxic substances in the environment	Despite a significant reduction in the various sources of contamination in the St. Lawrence drainage basin and the distance of the main sources of contamination, aquatic organisms in the area, particularly fish-eating birds and marine mammals, continue to be exposed to toxic and bioaccumulative substances. In general, the chemical contamination of fishery products does not pose a threat to human health.	A better understanding of the effects of these substances on marine organisms and human health is a major issue in the area.		
Protection of Sensitive Environments and Resources				
• Protected areas	The study area has a number of areas that are protected under current legislation. Several sensitive areas, however, have no legal protection.	Several other sensitive areas require protection.		
• Dunes	Dunes are home to several rare plant species. These very sensitive environments are threatened by all-terrain vehicle traffic.	Measures have been taken to protect dunes from all-terrain vehicles.		
• Priority species	The distribution and status of populations of several priority species in the area are unknown.			
• Piping plover	The nesting grounds of this species are threatened by beach traffic.	Measures have been taken to protect nesting sites and to raise public awareness to the problem.		
Horned grebe	Certain nesting sites of this rare species are disturbed by cottagers.			
• Protection from spills in aquatic environments	The area is vulnerable to oil spills because of the numerous bird colonies and concentrations of aquatic birds.	A regional emergency response team does hold drills on a regular basis.		

 Table 1

 The Main Issues of Sustainable Development in the Magdalen Islands

Restoration of disturbed habitats and resources

Havre-aux-Basques Bay	In 1956, this polyhaline environment was transformed into an oligohaline environment through the elimination of water exchanges with the Gulf following the construction of Highway 199.	The project to reopen this former lagoon is currently in the public consultation phase.		
Ports	Some commercial ports and fishing harbours in the area are moderately contaminated with toxic substances, particularly the port at Cap-aux-Meules, where high concentrations of PCBs were discovered in sediment.	The dredged sediments at Cap-aux-Meules are contained on shore.		
• Site of the wreck of the <i>Irving Whale</i>	High concentrations of PCBs were found in sediment at the wreck site.	Operations took place in 1996 to remove the sediment that was highly contaminated with PCBs.		
Groundfish populations	The populations of cod, Canadian plaice and redfish that frequent the area have been threatened since the early 1990s, as a result of unfavourable climate conditions and overfishing.	In order to promote the recovery of these populations, a number of measures have been taken since 1993 to reduce the mortality rate attributable to fishing, including a moratorium on the fishing of cod and redfish.		
Effective management of commercial fishing				
	Commercial fishing in the area is currently undergoing its worst crisis ever as a result of crashing groundfish stocks. There are progressively fewer jobs available in this industry.	The government has begun a complete overhaul of the fisheries support system, whose main guiding principle is the recovery and conservation of resources.		
Reconciliation of recreational and tourism development with environmental protection				
	Recreational and tourism activities in coastal and marine environments have grown considerably; however, some are a threat to sea birds and marine mammals.	Several measures have been taken to limit the impact of these activities on sensitive environments and resources.		

Despite the distance of the main sources of toxic contaminants, the study area remains exposed and vulnerable to the adverse effects of airborne toxic substances that are persistent in the environment. The lack of recent data makes it impossible to determine specific spatial or temporal contamination patterns or to identify the effects of this contamination.

6.2 **Protecting Sensitive Species and Habitats**

Several important habitats for the study area's plant and animal life are already protected, but other equally important habitats are not. Areas worthy of protection include dunes and intertidal marshes. Local organizations are taking measures to ensure that some of these sites are given some form of protection.

Several zones and sites in the area, such as the aquatic bird gathering areas, the haulouts for Harbour and Grey seals and the areas surrounding the colonies of aquatic birds, are particularly sensitive to oil spills. The Magdalen Islands has no response team in place to deal with oil spills, nor does it have a bird cleaning facility managed by the Canadian Wildlife Service.

This is the only area in Quebec where the Piping plover and Horned grebe currently breed. The Piping plover is an endangered species in Quebec. Its nesting sites are threatened by motorized vehicle traffic on beaches. In recent years, the measures taken to protect the species' nests and a program of public education have reduced nest destruction. In the case of the Horned grebe, the majority of nesting sites are not legally protected. Cottages and campers located close to ponds used by this species are a threat to this disjunct population, which is isolated from the main group that breeds in the West, outside of Quebec.

The status of local populations of certain species considered priorities for protection under the SLV 2000 action plan is not known, as is the case for the American shad, the Rainbow smelt, the Atlantic tomcod and the Harbour seal.

6.3 **Restoring Disturbed Habitats and Resources**

In the past few years, the question of re-establishing regular exchanges of marine water between Havre-aux-Basques Bay and the Gulf has been under consideration. The project has not, however, received unanimous consent.

Some commercial ports and fishing harbours in the Magdalen Islands are moderately contaminated with heavy metals and, in the case of the port at Cap-aux-Meules, PCBs and PAHs. This problem is taken into account during dredging operations. Work has already begun to contain 2800 m³ (1988) and 3600 m³ of sediment within the wharfs. A reorganization of the ferry dock will allow for the containment of an additional 4000 m³ in the fall of 1998. As for the sediment at the *Irving Whale* wreck site, 100 km west of the Magdalen Islands coast, which is highly contaminated with PCBs, operations to remove the sediment took place in 1996.

Several measures have been taken since 1993 to restore populations of groundfish in the southern Gulf of St. Lawrence. Most efforts are aimed at reducing the mortality rate attributable to overfishing. In the case of cod and redfish, a moratorium was imposed and has been in effect since 1993 (cod) and 1995 (redfish). Other measures, such as using wider mesh netting, installing a system for releasing fish from shrimp trawls, closing fishing areas when bycatches of cod exceed a certain threshold and lowering fishing quotas, have considerably reduced cod by-catches from other fisheries. In the case of Canadian plaice, a significant reduction in allowable catches and the use of more selective fishing gear are the main measures adopted to help restore the population. In an effort to increase the lobster population, the use of escape vents that allow young lobsters to escape from the traps have been compulsory since 1994. Furthermore, since 1993, berried females have been marked and, since 1994, thrown back into the water.

Our existing knowledge of the mechanisms responsible for natural fluctuations in animal populations remains sketchy. In order to ensure the sustainable development of fishery resources, the critical stages in the development of species will have to be identified and the physical and biological factors affecting the survival, growth and reproduction of individuals will have to be determined.

6.4 Managing Marine Fisheries Effectively

The recovery and conservation of fishery resources must be accompanied by new approaches aimed at ensuring the survival of the commercial fisheries. The federal government has therefore begun a complete overhaul of the fisheries support system. The guiding principles are as follows: priority must given to the conservation of resources over all other considerations, a balance must be established between the industry's capacity and the tolerance of the resource, fishing must be carried out by professionals to ensure its effectiveness, each enterprise must have several licences so that it is possible to adapt to changes in available resources, a closer and more effective partnership must be established between the industry and government, and aboriginal rights must be respected. The Groundfish Licence Retirement Program (voluntary) and the imposition of new licence fees based on the value of landings are among the main initiatives undertaken since 1993. Fishing industry representatives have also established certain priorities in order to ensure the survival of the industry. They have recognized the importance of increasing the harvesting of underutilized species (Sea urchin, Rock crab, Spiny dogfish, skate, Harp seal, etc.); helping Quebec penetrate new markets, technological innovation, employment training and the development of aquaculture; increasing the added value of products sold; emphasizing the importance of having young people participate at every level in order to ensure their eventual takeover and stopping the exodus of young people to other regions and areas of activity.

6.5 Reconciling Recreational and Tourism Development with Environmental Protection

In the past few years, the Magdalen Islands area has experienced major growth in recreational and tourism activities on its shores as well as in the sea. One of the major issues for the sector will be to ensure sustainable development by protecting wildlife resources and their habitats and the landscapes in which these activities take place. Among other things, it will be necessary to limit the disturbance of birds and marine mammals from growing human pressure in habitats that, until recently, were not accessible to the general public.

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Appendices

1 St. Lawrence Vision 2000 (SLV 2000) Priority Species Present in the Magdalen Islands

Common name	Type of distribution or local status				
Plants (eight of the 110 priority species)					
American spurred gentian	Endemic (Gulf of St. Lawrence)				
Broom crowberry	Peripheral				
Common dandelion	Endemic (northeastern North America)				
Connecticut beggarticks	Endemic (northeastern North America)				
Dwarf huckleberry	Peripheral				
Gaspé Peninsula arrowgrass	Endemic (northeastern North America)				
Gulf of St. Lawrence aster	Endemic (Gulf of St. Lawrence)				
Seaside sandmat	Peripheral				
Reptiles (none of the six priority species)					
Fish (four of the 13 priority species)					
American eel	Unknown				
American shad	Unknown				
Atlantic tomcod	Unknown				
Rainbow smelt	Unknown; spawns in some tributaries				
Birds (12 of the 19 priority species)					
American bald eagle	Visitor				
Barrow's goldeneye	Migrant				
Blue-winged teal	Confirmed breeder				
Caspian tern	Migrant				
Harlequin duck	Visitor				
Horned grebe	Confirmed breeder				
Northern pintail	Confirmed breeder				
Peregrine falcon	Migrant				
Piping plover	Confirmed breeder				
Red-headed woodpecker	Visitor				
Roseate tern	Confirmed breeder				
Yellow rail	Visitor				
Mammals (four of the five priority species)					
Fin whale	Unknown				
Harbour porpoise	Regular in summer and fall				
Harp seal	Year-round resident				
Pygmy shrew	Status unknown				

2 Environmental Quality Criteria

(for assessing loss of use)

Ecosystem component	Reference criterion	Objective
WATER	Raw water (taken directly from a body of water without treatment) (MENVIQ 1990, rev. 1992)	To reduce the risk of infection and treatment costs for drinking water.
	Contamination of aquatic organisms (MEF 1996)	To protect human health from the risks associated with consumption of aquatic organisms.
	Aquatic life (chronic toxicity) (MENVIQ 1990, rev. 1992)	To protect aquatic organisms and their progeny and wildlife that feed on aquatic organisms.
	Recreational activities (primary contact) (MENVIQ 1990, rev. 1992)	To protect human health during the practice of recreational activities in which the whole body is regularly in contact with the water (e.g. swimming, windsurfing).
SEDIMENTS	No effect threshold (NET) (SLC and MENVIQ 1992)	Contaminant levels are below that at which any effects on benthic organisms are observed.
	Minimal effect threshold (MET) (SLC and MENVIQ 1992)	Contaminant levels exceed those at which minor but tolerable effects are observed in most benthic organisms.
	Toxic effect threshold (TET) (SLC and MENVIQ 1992)	Contaminant levels exceed those at which harmful effects are observed in most benthic organisms.
AQUATIC ORGANISMS	Fish marketing guidelines (Health and Welfare Canada 1985)	Maximum acceptable contaminant levels in the tissues of fish, shellfish and crustaceans sold for consumption.
	Fish consumption guidelines (MSSS and MEF 1995)	To prevent harm to human health from eating contaminated fish, shellfish and crustaceans.

3 Glossary

- Anadromous: Refers to fish which, in the course of their life cycle, return from the sea to fresh water to reproduce.
- **Benthos:** All organisms living in contact with the bottom of a body of water, divided into phytobenthos (plants) and zoobenthos (animals).
- **Biomass:** Total mass of living organisms, taken either globally or in systemic groups, by surface or volume unit, in a given biotope at a given moment (e.g. plant, insect, herbivore, carnivore biomass).
- **Brackish:** Refers to water with a salinity between that of fresh water (0.3‰) and that of salt water (35‰).
- Catadromous: Refers to fish that live in fresh or brackish water and migrate to sea to reproduce..
- **Community:** All the living organisms, both plant and animal, occupying the same biotope.
- **Discharge:** Volume of water carried by a watercourse, conduit, etc., in a given unit of time, generally expressed in cubic metres per second (m^3/s) or, in small watersheds, as litres per second (L/s).
- **Disjunct distribution:** Refers to plant species found in an area or areas remote from their main range.
- **Drainage basin:** The entire continental land area drained by a river system, that is, the total precipitation catchment and drainage area. Also called *watershed*.
- **Ecosystem:** An entire physical and chemical environment (biotope) and all the living organisms (biocenosis) living there and able continue doing so indefinitely by virtue of matter and energy inputs.
- **Ecosystem productivity:** Quantity of biomass produced annually maintaining the equilibrium of animal and plant populations.
- **Effluent:** Any liquid released from a source of pollution, whether a residential area (domestic outfall) or industrial plants (industrial outfall). Point-source effluents (sewers): outflow of liquid pollutants at a given place.
- Endemic: Refers to a species that is confined to a particular area.
- Endemic distribution: Refers to a plant species whose range is limited to a well defined area.
- **Foreshore:** That part of the shore lying between the high and low water marks. Also called *mesolittoral* or *intertidal*).
- Habitat: Ecological framework in which an organism, species, population or group of species lives.

Haulout: Stretch of shoreline where seals come out of the water to rest.

Hydrophobic: Refers to toxic substances that show little tendency to dissolve in water.

Minimum flow: Lowest level of water flowing in a watercourse.

- **Nonpoint-source pollution:** Diffuse discharge of pollutants into a given environment. Agricultural run-off is nonpoint-source pollution, since fertilizers and pesticides are spread over large areas.
- **Nutrient:** Simple substance absorbed by plants and used in photosynthesis. Basic nutrients are nitrates, phosphates and silicates.
- **Plankton:** Animal (zooplankton) and plant (phytoplankton) organisms that live suspended in oceans and bodies of fresh water.
- **Primary production:** Quantity of organic matter generated by autotrophic organisms in a given period.
- **Secondary production:** Quantity of organic matter generated by heterotrophic organisms in a given period.
- Sediment regime: Set of streamflow characteristics that influence sediment transport, deposition and erosion..
- Sediment: Particles of soil and other solids formed by the weathering of rocks or other chemical or biological processes, transported by air, water or ice.
- Spawning ground: Place where fish gather to breed.
- **Suspended solids:** Small particles of solid matter (> 0.45 m) floating in a liquid. Also called *suspended sediments* (see Sediment).
- Terrigenous: Refers to substances originating on dry land.
- **Thermal stratification:** Formation of layers of different temperatures in water bodies, with warmer water overlying colder water.
- Tidal range: Vertical distance between high and low tides.

Turbid: Refers to water containing a high concentration of suspended matter.

Turbidity: Cloudiness of a liquid due to the presence of fine suspended matter (clay, silt or micro-organisms).

Waterfowl: Collective term for ducks and geese.

Water mass: Volume of water having relatively homogeneous physical and chemical properties.

Year-class: All of the fish in a stock that were born in a particular year.

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