REGIONAL ASSESSMENT
SOUTHERN GASPÉ–CHALEUR BAY

Regional Assessment
Southern Gaspé–Chaleur Bay

Priority Intervention Zone 20

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Edited by Jean Burton
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Environment Canada – Quebec Region

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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 is to conserve and protect the St. Lawrence River, including the Saguenay River and the marine area, so that people living along the banks can reclaim use of the water in a manner compatible with sustainable development.

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

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

The program encourages 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 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 St. Lawrence Vision 2000.

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

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Management Perspective

The Priority Intervention Zones (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

The Southern Gaspé–Chaleur Bay area extends along the Quebec coast from Matapédia to Cape Gaspé. The shallow, brackish, sheltered environment near Matapédia progressively gives way to a deep-sea environment that merges with the Gulf of St. Lawrence. The area is influenced by fresh water from rivers and streams that chiefly flows along the New Brunswick shore and by the rich salt water of the Gaspé Current that runs toward Matapédia, along the south shore of the Gaspé Peninsula.

The salt marshes and eelgrass beds in the area are confined to environments such as river mouths and tidal ponds (*barachois*), which are sheltered from the disruptive effects of waves and ice. The open seacoast is mainly rocky, with extensive seaweed beds where the dominant predator of a rich and diverse benthic fauna is the American lobster. At greater depths, the seabed is home to large concentrations of Snow crab and is a major feeding ground for Atlantic cod in summer.

The area's pelagic zone is one of the most productive in the Gulf of St. Lawrence thanks to its abundance of zooplankton. It is an important environment for the spawning, rearing and feeding of capelin, Atlantic mackerel, Atlantic herring, Atlantic cod and Canadian plaice. The schools of fish are in turn eaten by Northern gannets, Black-legged kittiwakes and other sea birds.

The coastal landscape and marine biological resources have for decades supported tourism and commercial fishing, major economic activities. In recent years, there has also been a boom in nature appreciation.

The stocks of groundfish in the area in summer, particularly Atlantic cod and Canadian plaice, have been in very poor shape since the late 1980s because of overfishing and abnormally cold water. Despite a moratorium on cod fishing and a sharp reduction in quotas for Canadian plaice, beginning in 1993, neither species has yet shown clear signs of recovery.

The rich environments of the area's barachois have been seriously disturbed by human activities, such as the holding of log booms, the discharge of untreated effluent,

backfilling, dredging, and the building of roads and railway lines that cut the ponds off from the sea.

The area's intertidal zone is heavily contaminated by disease-causing micro-organisms from untreated municipal sewage. In 1996, the sewage of only 36% of the total population of the area's shoreline municipalities was treated in wastewater treatment plants. With the planned commissioning of five new plants by December 1998, this proportion will rise to 59%.

With the exception of a few coastal sites located near specific sources of pollution, the water and sediment of the area is relatively untouched by chemicals. The port of Gaspé (Sandy Beach) is one of the most contaminated aquatic sites in the St. Lawrence ecosystem; sediment around the wharves contains very high concentrations of heavy metals, PCBs and PAHs. The main source of pollution in the port is the offloading of copper ore. The other known site of serious chemical pollution is the New Carlisle barachois, where a lagoon cut off from the sea has been severely contaminated with heavy metals and PCBs from an outfall for untreated municipal sewage.

Although local sources of toxic substances are relatively minor, and although major urban and industrial centres are far away, fish-eating birds and seals in the area are still exposed and vulnerable to the harmful effects of toxic substances (mercury and organochlorines) as a result of biomagnification. For instance, the Northern gannet population of Bonaventure Island dropped sharply in the late 1960s and early 1970s owing to severe DDT contamination. Overall, contamination of the marine food chain by biomagnified toxic substances has been declining since the 1970s, but it remains a cause of concern for certain substances.

Consumption of shellfish, fish and waterfowl from the area does not pose a major risk to human health from chemical pollution, but most shellfish beds along the coast are permanently closed to harvesting because of severe bacterial contamination of the water and high concentrations of marine toxins in shellfish.

Résumé

Le secteur Gaspésie-Sud–Baie-des-Chaleurs comprend les côtes québécoises situées entre Matapédia et le cap Gaspé. De l'amont vers l'aval, on passe progressivement d'un milieu saumâtre peu profond et bien abrité à un milieu marin profond et ouvert sur le golfe du Saint-Laurent. Le secteur est sous l'influence des eaux douces des rivières qui s'écoulent principalement le long de la rive du Nouveau-Brunswick et des riches eaux marines du courant de Gaspé qui sont transportées vers l'amont, le long de la rive sud de la Gaspésie.

Les marais salés et les herbiers de zostère marine du secteur sont confinés aux milieux abrités des effets perturbateurs des vagues et des glaces retrouvées à l'embouchure des rivières et dans les lagunes côtières (barachois). Les côtes donnant directement sur la mer sont surtout rocheuses; on y retrouve d'importants herbiers d'algues marines et une faune benthique riche et diversifiée où le prédateur dominant est le Homard d'Amérique. À de plus grandes profondeurs, les fonds marins abritent des concentrations importantes de Crabe des neiges et constituent une aire importante d'alimentation pour la Morue franche en été.

Le milieu pélagique du secteur est un des plus productifs du golfe du Saint-Laurent avec une production élevée de zooplancton. Ce milieu constitue une aire importante de reproduction, d'alevinage ou d'alimentation pour le Capelan, le Maquereau bleu, le Hareng atlantique, la Morue franche et la Plie canadienne. Les grandes concentrations de poissons sont exploitées à leur tour par les oiseaux marins, notamment par le Fou de Bassan et la Mouette tridactyle.

Le paysage côtier et les ressources biologiques marines supportent depuis des décennies d'importantes activités économiques, notamment le tourisme et la pêche commerciale. Depuis quelques années, les activités d'interprétation du milieu naturel ont connu une grande expansion.

Les stocks de poissons de fond qui fréquentent le secteur en été, notamment ceux de la Morue franche et de la Plie canadienne, sont en très mauvais état depuis la fin des années 1980

en raison de la surpêche et de conditions océanographiques anormalement froides. Malgré l'imposition d'un moratoire sur la pêche à la morue et d'une réduction importante des prises admissibles de Plie canadienne, à partir de 1993, rien n'indique un rétablissement évident de ces stocks.

Les riches milieux que constituent les barachois du secteur ont été considérablement perturbés par diverses activités humaines dont le flottage du bois, le déversement d'eaux usées non traitées, le remblayage, le dragage et l'isolement de la mer par des infrastructures routières ou ferroviaires.

Le secteur est caractérisé par une contamination importante de la zone littorale par les micro-organismes pathogènes provenant des rejets d'eaux usées municipales non traitées. En 1996, seulement 36 p. 100 de la population totale des municipalités riveraines du secteur était desservie par une station d'épuration des eaux usées. Ce pourcentage passera à 59 p. 100 d'ici décembre 1998 avec l'inauguration prévue de 5 nouvelles stations.

À l'exception de quelques sites littoraux situés à proximité de sources ponctuelles de pollution, l'eau et les sédiments du secteur sont peu contaminés par les substances chimiques. Le port de Gaspé (Sandy Beach) est un des sites aquatiques les plus contaminés du système du Saint-Laurent; les sédiments autour des quais contiennent des concentrations très élevées de métaux lourds, de BPC et de HAP. La principale source de pollution dans ce port est le déchargement de minerai de cuivre. L'autre point chaud connu est situé dans le barachois de New Carlisle où une lagune isolée de la mer a été fortement contaminée par les métaux lourds et les BPC provenant d'un émissaire d'eaux usées municipales non traitées.

Malgré l'importance relativement faible de sources locales de substances toxiques et l'éloignement des grands centres urbains et industriels, les oiseaux piscivores et les phoques du secteur sont exposés et vulnérables aux effets néfastes des substances toxiques bioamplifiées (mercure et substances organochlorées). Par exemple, la population de Fous de Bassan de l'île Bonaventure a connu un déclin important à la fin des années 1960 et au début des années 1970 en raison d'une forte contamination par le DDT. Dans l'ensemble, la contamination de la chaîne

alimentaire marine par les substances toxiques bioamplifiées est à la baisse depuis les années 1970 mais demeure inquiétante pour certaines substances.

La consommation de fruits de mer, de poissons et de chair de sauvagine prélevés dans le secteur ne présente pas de risques importants pour la santé humaine en ce qui concerne les substances chimiques. Par contre, en raison de la forte contamination bactérienne de l'eau et de la présence de fortes concentrations de toxines marines dans les mollusques, la plupart des bancs littoraux de mollusques sont fermés en permanence à l'exploitation.

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CHAPTER 1 The St. Lawrence, Then and Now

As early as the 16th century, Basque, Breton, Norman and Portuguese fishermen began coming to the Gulf of St. Lawrence to fish the rich cod banks and hunt whales. This activity became a settled way of life in the early 1700s, with the establishment of commercial fishing stations in natural harbours. In the latter half of the 1700s, the deportation of the Acadians and the arrival of United Empire Loyalists from the United States marked the beginning of a true colonization of Quebec's extensive coastline. Until that point, the low population density and the very size of the Gulf had meant that human use of the aquatic environment had had virtually no impact on its resources. But things would soon change.

The first major impact seems to have been caused by the development of the forest industry in the 19th century and the holding of log booms for sawmills at the mouths of rivers. The pace of change accelerated in the 20th century, with the construction of pulp and paper mills, ports to serve new mining operations, and the intensive spraying of forests with DDT. The fishery underwent profound change as trawlers that increased fishing capacity tenfold were introduced. However, it was still thought that the Gulf of St. Lawrence was safe from pollution, and its resources inexhaustible.

The public suffered a rude awakening in the early 1970s when it was realized that the Northern gannet population of Bonaventure Island was severely contaminated by toxic chemicals that endangered its survival and that fish stocks were collapsing as a result of overfishing.

There is now virtually unanimous agreement that the Gulf of St. Lawrence ecosystem is fragile and that its resources are limited. Despite its vast size and remoteness from big industrial centres, the integrity of the ecosystem is threatened by unchecked harvesting of its resources, the presence of toxic substances and the destruction of wildlife habitats.

Most industrialized countries have now agreed to base their economies on sustainable development. The profit motive alone can no longer govern human activity. Given the fragile nature of our environment and the limitations of our planet, sustainable economic development must provide for versatile use of scarce resources, take into account quality of life for humankind and promote the maintenance of biological diversity.

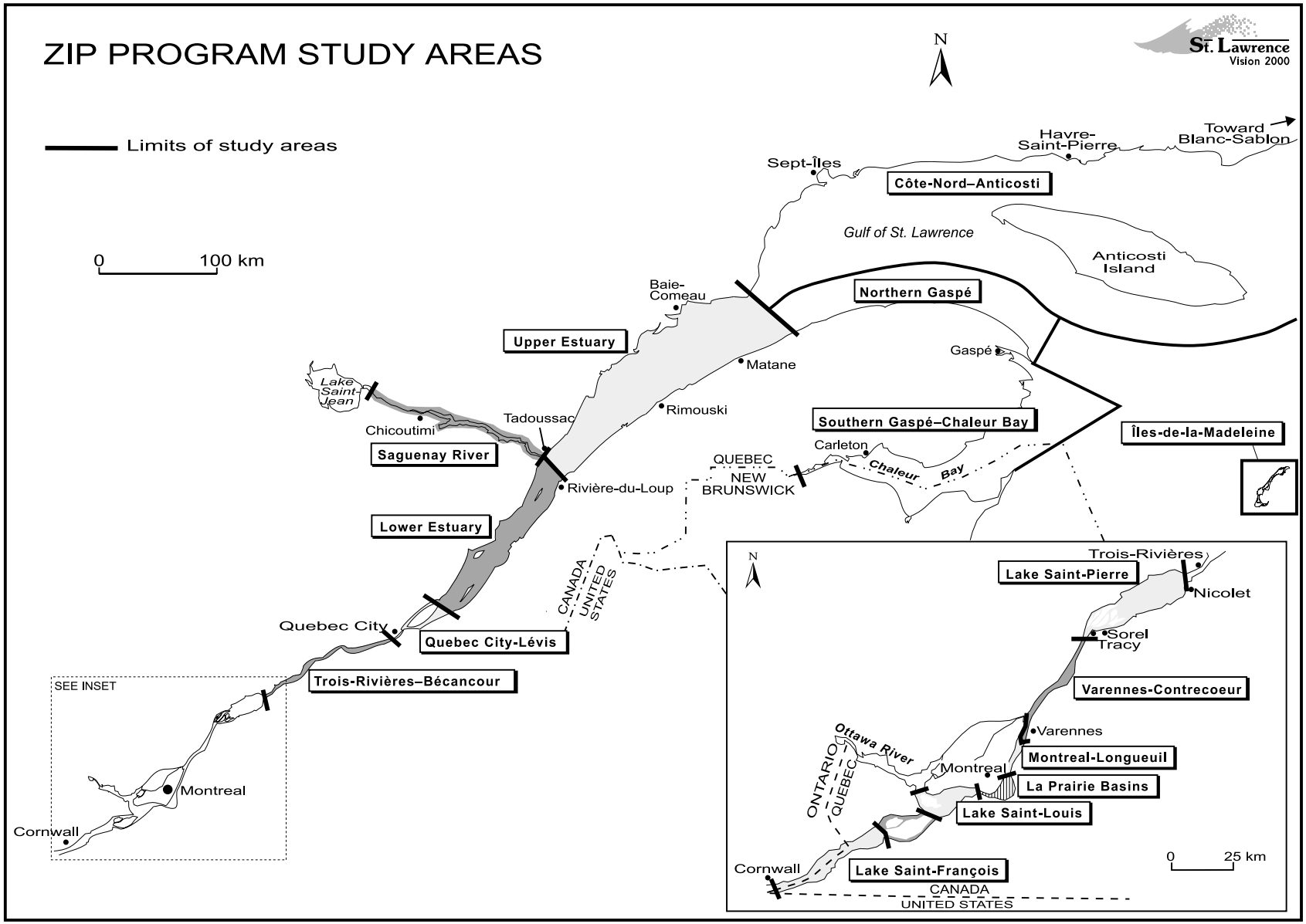
CHAPTER 2 The Priority Intervention Zones Program

Starting in the 1960s, growing public awareness of the degradation of the Great Lakes and the St. Lawrence and Saguenay rivers, along with the evident urgency of the situation, prompted governments to take concrete, joint action. This paved the way for the 1972 *Canada–U.S. Great Lakes Water Quality Agreement*, which was amended in 1987 to add a local use restoration program (remedial action plans, or RAPs). In 1988, Ontario, Quebec and the eight American states concerned signed the *Great Lakes Toxic Substances Control Agreement* and the *Great Lakes Charter*. Out of concern for the poor quality of the water of the St. Lawrence and its tributaries, the Government of Quebec 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 the plan is to draw up a comprehensive state of the environment report to which local stakeholders will be able to refer as they work together to restore and protect the St. Lawrence and reconcile its uses with environmental protection (Figure 1). As part of the groundwork for public consultations, the SLV 2000 partners review and synthesize current knowledge of the state of the environment in each study area.

This report presents the highlights of the four technical reports[1] and reviews current knowledge of the state of the resources and the present and potential uses of the Southern Gaspé–Chaleur Bay area (ZIP 20).

[1] The reports deal with the physico-chemical aspects of the water and sediment (Gagnon et al., 1997), biological communities (Mousseau et al., 1997), social and economic issues (Bibeault et al., 1997), and public health (Duchesne et al., 1997).



Source: Priority Intervention Zones (ZIP) Program - SLV 2000.

Figure 1 ZIP Program study areas

This effort to synthesize and analyse existing knowledge is meant to provide the various riverside stakeholders with accessible, objective scientific data that they can use in setting their priorities for action. They will then be able to draw up and implement action plans locally and regionally, with each partner acting within its sphere of responsibility, but in co-ordination with the others.

CHAPTER 3 Characterization of the Southern Gaspé–Chaleur Bay Area

The Southern Gaspé–Chaleur Bay area is the southern section of ZIP 20 (which also takes in the north shore of the Gaspé Peninsula). The study area includes the Quebec coastline, deep water and seabed situated between Cape Gaspé and the municipality of Matapédia (Figure 2). With regard to certain socio-economic aspects, the area covers all the coastal communities between Cape Gaspé and Matapédia, even though the northern part of the Municipality of Gaspé is located on the north shore of the peninsula. In addition, some sources of contamination are on the New Brunswick side of Chaleur Bay, so they are also included.

3.1 Physical Environment

The study area is located on the western part of the Magdalen Shelf (Figure 3). Bounded to the north by the depths of the Laurentian Channel, this huge platform less than 200 m deep occupies the whole southern part of the Gulf of St. Lawrence. Its relief is characterized by shoals (banks), large islands and trenches running north-south to the Laurentian Channel. The topography of the sea floor in this area is dominated by one of these trenches, called the Chaleur Trough, which begins in Chaleur Bay and runs into the Laurentian Channel off Cape Gaspé. The area can be subdivided into three major distinct physiographic units: (1) the Restigouche River estuary, (2) Chaleur Bay and (3) the fishing banks zone.

Restigouche estuary. Over a distance of approximately 50 km between Matapédia and Miguasha Point, the water of the Restigouche River (the main river feeding into Chaleur Bay) flows through an incised valley and gradually mixes with the sea water. This zone has all the features of a typical estuary environment: shallow water (less than 10 m deep), big tidal range (average range of 2.2 m at Restigouche), very pronounced upstream-downstream salinity gradient and deposition of fine sediment in the intertidal zone in summer, conducive to the development of intertidal marshes.

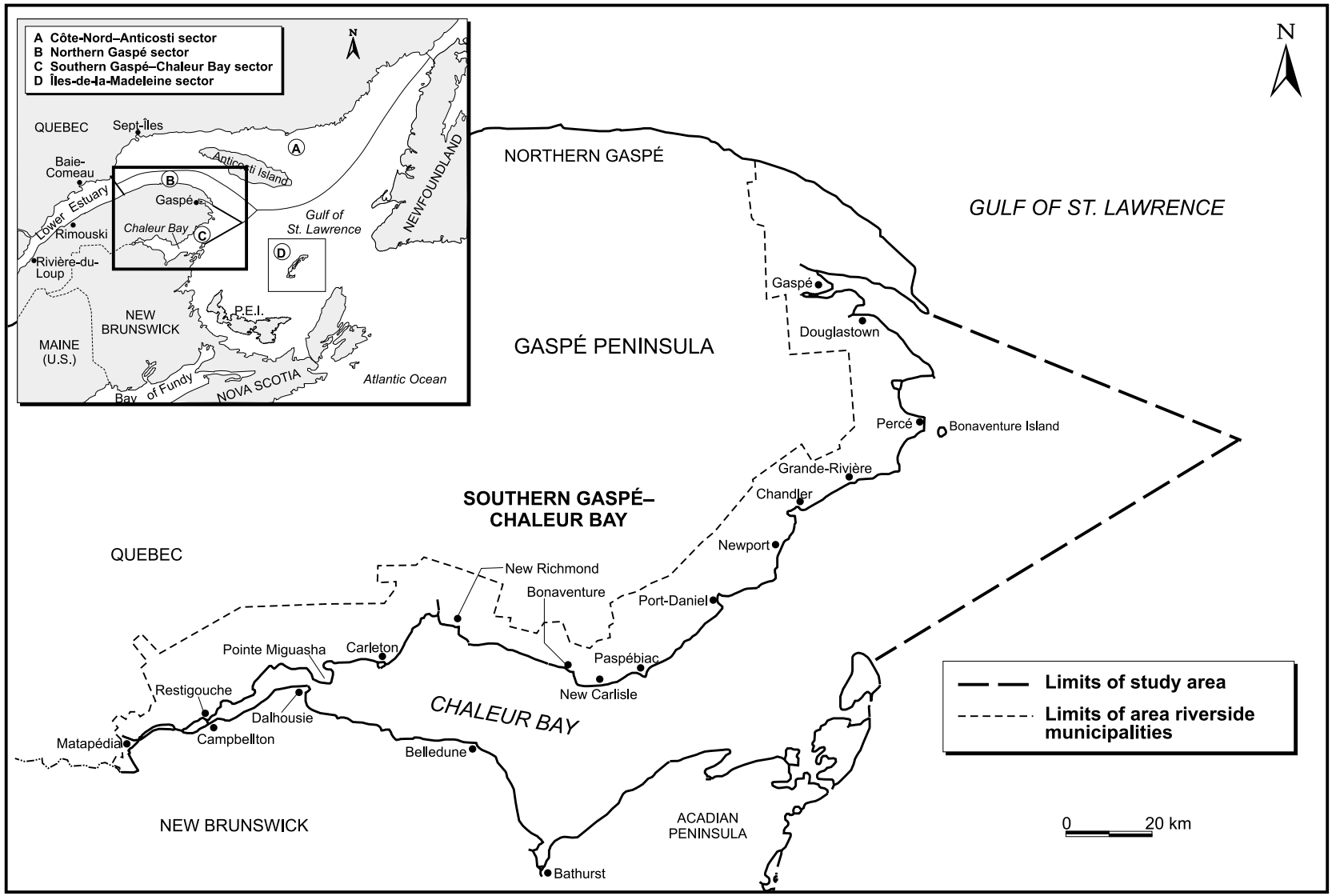


Figure 2 Limits of the Southern Gaspé–Chaleur Bay area and riverside municipalities

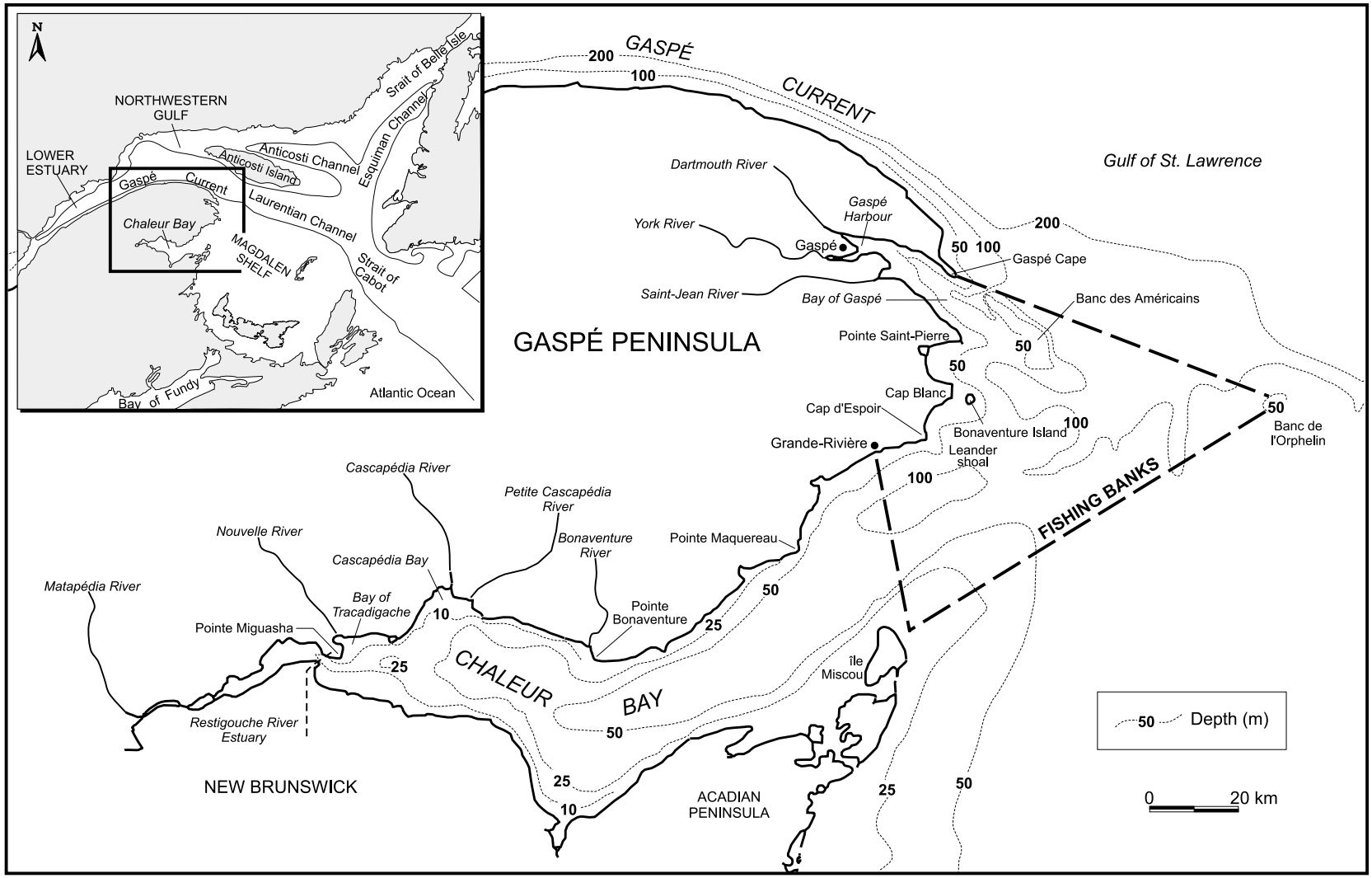


Figure 3 Physiography of Southern Gaspé–Chaleur Bay area

Chaleur Bay. This bay, covering over 3000 km^2, is partially isolated from the rest of the Gulf of St. Lawrence. Over a distance of approximately 150 km from Miguasha Point, it widens and deepens to reach a width of 45 km (Figure 3). Chaleur Bay receives an annual average of 730 m^3/s of fresh water from its drainage basin: 3000 m^3/s when water levels are high (in May) and 220 m^3/s when they are low (in February). Its main tributaries, in descending order of importance, are the Restigouche, Cascapédia, Bonaventure, Petite Cascapédia and Nouvelle rivers.

Chaleur Bay is a saline environment (salinity greater than 17 parts per thousand) except during the spring freshet. In summer, the salinity of the surface water of the bay (depth of 0–30 m) is on the order of 28 parts per thousand, and its temperature can exceed 18°C, making it the warmest coastal water of Quebec, except for the water of the Magdalen Island lagoons. At a depth of more than 30 m, the water of the bay is saltier (> 30 parts per thousand) and remains cold (below 2°C) throughout the year. This water is the glacial intermediate layer of water found in the other areas of the Gulf between the surface layer and the deep layer (more than 200 m) of the Laurentian Channel.

Water circulation in the bay is characterized by the outflow of less salty, warmer surface water along the south shore and the inflow of saltier, colder water along the north shore. The south shore water is a mixture of the fresh water from the rivers with the sea water of the bay; this mixed water is swept towards the south shore by the Coriolis force, while the countercurrent running upriver along the north shore is a branch of the Gaspé Current. This circulation is the cause of a small cyclonic eddy in the eastern part of the bay. Strong, steady, westerly winds cause upwellings of deep water and, in winter, create ice-free areas along the north shore between Paspébiac and Grande-Rivière.

Little scientific work has been done on the sediment dynamics of the bay. Fine sediment cannot be deposited on the seabed in areas where the water is less than 30 m deep because of the strong mixing forces of the tidal currents, waves and storms. The sea bottom here consists of muddy sand. By contrast, the bottom of the Chaleur Trough (with a depth of over

50 m) is less exposed to these forces, and it is in the upstream part of the trough, within Chaleur Bay, that a significant part of the fine sediment from rivers, coastal erosion and local biological production is deposited. The seabed here consists of sandy mud.

The relief of the Quebec shore of Chaleur Bay is more rugged than that of the south shore of the bay, and is dominated by cliffs that are prone to erosion. Eroded material carried by the currents along the shore has formed sand bars that partially close off the mouths of many rivers and link islands to the coast. These sand bars circumscribe, on the land side, various shallow (less than 3 m deep) tidal ponds called *barachois.* Estuarine barachois develop in a closed bay. Their only contact with the sea is through a single narrow passage, and they are fed by fresh water from one or more sources. Lagoon barachois are fed by the sea alone, usually through a single permanent passage.

Fishing banks zone. Between Chaleur Bay and the Laurentian Channel, the marine and coastal environments give directly onto the Gulf of St. Lawrence and are characterized by much more uneven relief than in Chaleur Bay. In this zone, Chaleur Trough merges with Shédiac Trough before reaching the Laurentian Channel. The underwater continuations of the capes of the Gaspé Peninsula and the Acadian Peninsula form banks (shoals) less than 50 m deep (American Bank, Bonaventure Island, Leander Shoal, Miscou Bank, Orphan Bank).

The surface water of this zone is directly affected by the Gaspé Current, which runs along the north shore of the Gaspé Peninsula and carries southward a huge volume of water from the St. Lawrence Estuary and northwestern Gulf (Figure 3). At a depth of over 30 m, there is the colder, saltier water of the glacial intermediate layer. At this location, the bottom of the Chaleur Trough is an environment where virtually no deposition occurs, covered with heterogeneous sediment of glacial origin.

The shoreline consists of a series of promontories, characterized by resistant cliffs (Forillon Peninsula, Point Saint-Pierre, Bonaventure Island, Cape Espoir) and large bays (Bay of Gaspé, Malbaie). Bonaventure Island, off Percé, is the only big island in the Southern Gaspé–Chaleur Bay area. The Bay of Gaspé, a deep trench between two massifs, receives water from the

Dartmouth, York and Saint-Jean rivers. Parts of Gaspé Harbour and the Saint-Jean estuary are barachois isolated from the downstream part of the bay by sand spits.

Since the late 1980s, the Gulf of St. Lawrence and a large part of the Canadian Atlantic coast have experienced a significant climatic cooling that is reflected in a noticeable increase in the extent and duration of ice cover in winter and a cooling of the cold intermediate layer of water at the bottom of the Chaleur Trough and other trenches of the Magdalen Shelf. Although the relationship between this cooling and the flora and fauna is not well established, some experts think that these abnormal conditions may have affected some invertebrate and fish populations (including Atlantic cod) by altering their distribution and migration pattern, reducing the growth of individuals, and increasing the mortality of eggs, larvae, and even adults.

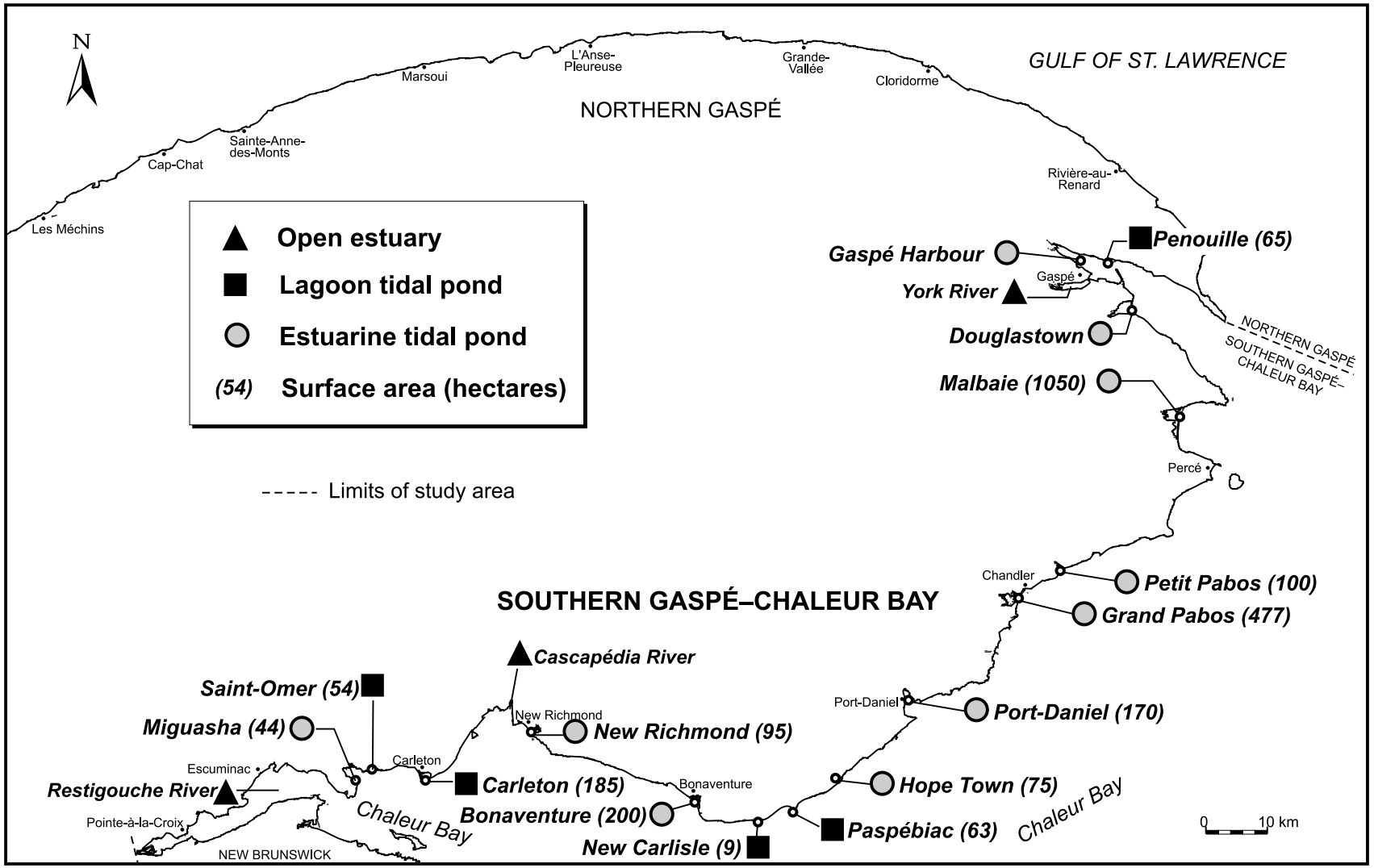
3.2 Aquatic Habitats and Communities

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 organisms. To make it easier to synthesize the vast amount of information that exists on these environments, we have divided them into three main types: coastal, benthic and pelagic.

3.2.1 Coastal environments

Estuaries and lagoon barachois (Figure 4) are particularly conducive to the development of highly productive salt marshes and subtidal eelgrass beds that many fish and aquatic birds use for breeding and feeding. Almost all the 1220 ha of salt marshes and 4000 ha of eelgrass beds in the study area are in these types of environments, which are sheltered from the disturbances of waves and ice.

The *salt marshes* in the area are dominated by salt meadows (1090 ha) that occupy the muddy substrates reached only by the twice-yearly equinoctial tides. The salt-meadow grass marshes (37 ha) and salt-water cordgrass marshes (93 ha) typical of the salt marshes of the St. Lawrence Estuary are found only in the Restigouche estuary and the Bay of Tracadigache,



Source: Bergeron, 1995; Bouchard, 1996; Dorion, 1996; DFO, 1996; Harvey et al., 1995.

Figure 4 Location of main estuaries and tidal ponds (barachois) in the Southern Gaspé–Chaleur Bay area

near Carleton. The salt-meadow grass marshes are covered by the spring tides twice a month, while the salt-water cordgrass marshes are covered by every tide.

In some estuarine barachois and some sheltered bays, as well as in lagoon barachois, there are shallow ponds (or lagoons) that are not directly influenced by fresh water. These environments, which are conducive to the development of *eelgrass beds*, are home to benthic invertebrates dominated by polychaetes, sea worms and bivalves, including Soft-shell clams. The main species of fish are small ones such as sticklebacks, Salt-water minnows and Blackstriped topminnows. Several rivers have no barachois at their mouths, and these estuarine environments provide a migration corridor for anadromous species (Atlantic salmon, Brook charr, Rainbow smelt, Atlantic tomcod) and catadromous species (eels), as well as a wintering area for smelt and Winter flounder, among others.

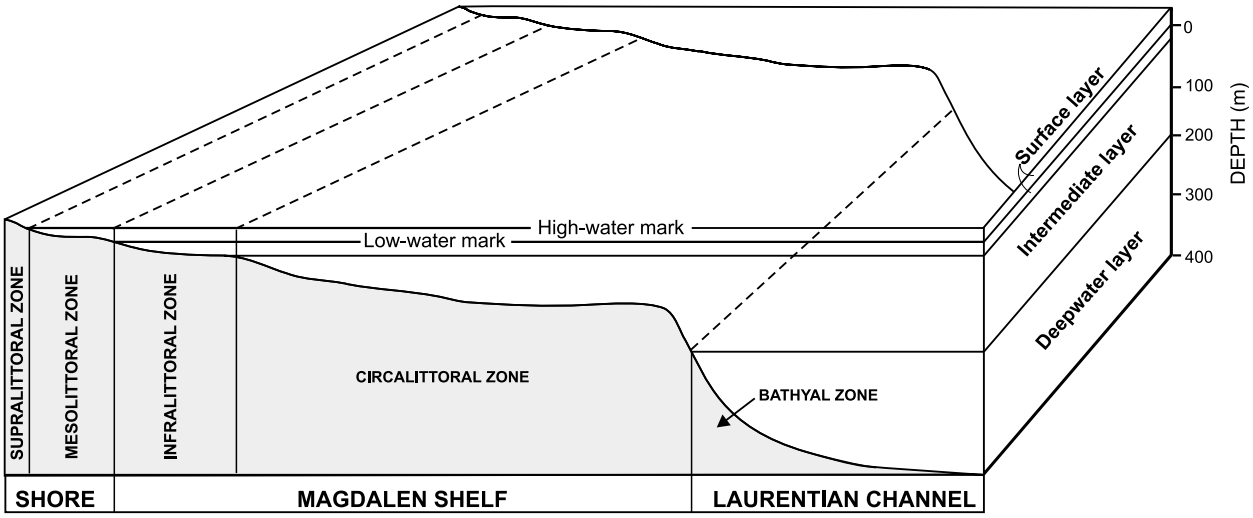
Various species of aquatic birds nest in the saltwater grass communities. Several species of geese and ducks feed in both the cordgrass marshes and eelgrass beds during the spring and fall migrations.

3.2.2 Benthic habitats

The marine benthic environment is generally subdivided into five zones, based on tidal influence and the vertical distribution of water masses in the Gulf (Figure 5): (1) the *supralittoral zone*, above the spring-tide high-water mark; (2) the *mesolittoral zone*, periodically covered and uncovered by the tides; (3) the *infralittoral zone*, permanently covered by a layer of surface water (0–30 m deep); (4) the *circalittoral zone*, covered by the cold, intermediate layer of water; and (5) the *bathyal zone*, consisting of the bottom of the Laurentian Channel, which is therefore not part of the study area.

Supralittoral habitats. The supratidal habitats of interest are the cliffs, islands and reefs where aquatic birds and seals breed and rest. Unlike the north shore of the Gulf, the study area has few islands and reefs, which may explain the relatively small number of seals and

Common eider colonies there. With the exception of Bonaventure Island, Percé Rock and a few small islands, most sea-bird colonies in the area are on cliffs.



Source: Adapted from Brunel, 1991.

Figure 5 Benthic environments in the Gulf of St. Lawrence, by tidal zone and water mass

Mesolittoral habitats. At the far end of coves and on the unsheltered side of sand spits in barachois, the mesolittoral or intertidal zone is made up of bare sand. When the sand is coarse, it supports very little endobenthic fauna. On the other hand, gulls, plovers, sandpipers and other shorebirds find organisms and detritus washed up on the beach, and capelin spawn there. When the environment is more sheltered from waves, the sand mixed with finer sediment supports beds of Soft-shell clams and sea worms actively sought by winter flounder.

The rocky coasts are regularly scoured by ice during the spring break-up. The density and biomass of the flora and fauna of this type of habitat increase from the upper foreshore to the lower. On coasts regularly eroded by ice, organisms like barnacles and mussels can thrive only in ponds and crevices and on sheltered rocky walls. A brown seaweed known as Rockweed is found

along the lower foreshore. It sometimes forms a continuous mat inhabited by periwinkles and gammarids, and many species of fish and invertebrates forage there at high tide.

Infralittoral habitats. This zone, which is always covered by the tide, is protected from the disruptive effects of waves and ice. It is affected by seasonal variations in physico-chemical conditions, but plankton is abundant in summer.

The sandy bottoms of this zone are found mainly in the upstream part of Chaleur Bay and along its southern shore. Species typical of this habitat are sand dollars, clams and rock crabs.

The rocky bottoms of this zone support diverse, abundant flora and fauna. *Kelp forests* are found in the upper part of this type of habitat (0–12 m), especially between New Richmond and Paspébiac. Sea urchins, mussels, anemones, sea cucumbers and lobster are typical of this habitat.

Circalittoral habitats. In the circalittoral zone, over 30 m down, photosynthesis is impossible and communities are made up of creatures which feed on organic particles that settle on the bottom.

The fauna of the sandy seabed around Chaleur Bay at a depth of 30 to 50 m is just as abundant but less varied than that of the muddy-sand seabed. This type of habitat is dominated by echinoderms, including sand dollars. The Giant scallop is typical of this type of habitat.

Off Cape Gaspé and Percé, and on Miscou Bank, the bottom is gravelly and rocky. This is the type of habitat preferred by Atlantic cod.

The muddy-sand bottom on the outer edge of Chaleur Bay at a depth of 50 to 80 m supports abundant, diversified fauna, dominated by molluscs. Brittle stars are typical of this habitat.

The muddy bottom of the Chaleur Trough and the Bay of Gaspé at a depth of over 80 m is home to only small numbers of a few species, mainly polychaetes. Snow crab is a typical species of this environment.

3.2.3 Pelagic habitats

The pelagic environment is populated by phytoplankton (plants) and zooplankton (animals), pelagic fish, sea birds and cetaceans. The food chain of this habitat is based on the production of microscopic algae (primary production) in the surface layer of water.

When the phytoplankton bloom occurs in May and June, the phytoplankton biomass becomes dominated by diatoms. In summer, primary production decreases and microflagellates take over.

Zooplankton consists of a variety of animals that drift passively with the currents. They include organisms that spend their entire life cycle in the pelagic environment, as well as the eggs and larvae of benthic organisms and fish. The zooplankton of the Restigouche estuary is not very diversified, and is dominated by *Acartia clausi*, a small copepod. In Chaleur Bay, the zooplankton is more diversified, with a midsize copepod, *Temora longicornis*, being the dominant species. On the fishing banks, the zooplankton is less diversified and dominated by a large copepod, *Calanus finmarchicus*. In both Chaleur Bay and on the fishing banks, the abundance and diversity of zooplankton increases in June and July, and may remain high until September. The study area is one part of the Gulf of St. Lawrence where zooplankton production is highest.

Several species fished commercially in the Gulf make intensive use of the pelagic environment for breeding (cod, mackerel) and feeding larvae and juveniles (cod, mackerel, herring, capelin) and adults (herring, mackerel, smelt). Sea ducks overwinter in ice-free zones, the extent of which varies considerably with the weather.

3.3 Fishery Resources

Only a few of the 157 species of seaweed, the thousand invertebrate species and the hundred or so fish species in the study area are harvested. The main species fished commercially are, in descending order of value of landings from 1990 to 1996, Snow crab, American lobster, Atlantic cod, Atlantic herring, Canadian plaice, Rainbow smelt, Giant scallop, Atlantic mackerel,

Soft-shell clam and Winter flounder. Atlantic salmon, Rainbow smelt and mackerel are the species most favoured by sport fishers, while many people also enjoy digging for Soft-shell clams.

Snow crab. Snow crab, a benthic crustacean, is the most valuable species in terms of landings. It is abundant on muddy and sandy-mud bottoms of the circalittoral zone (50–200 m deep). The Southern Gaspé fleet fishes in the southwestern Gulf (Area 12), where the main concentrations are found partly in the Chaleur Trough and the Shédiac Trough. The size of the crab population is affected by major natural fluctuations in an approximately eight-year cycle. The crab population in the southwestern Gulf peaked in the mid-1980s and in 1994, and dropped to its lowest point in the late 1980s. Right now, abundance is average, but the biomass is expected to begin increasing again in 2000. The crab population in the southwestern Gulf is heavily harvested, and the value of landings in a given year depends largely on the size of the year classes available for fishing.

American lobster. American lobster is a benthic crustacean that is abundant in summer on rocky infralittoral seabeds (less than 35 m deep). It migrates to deeper water in winter. The species is found all along the shore of the study area, except in the Restigouche estuary. Lobster populations are harvested intensively, and landings have been increasing since 1973. The increase in catches may be due to increased fishing power thanks to the use of more sophisticated navigation equipment, larger vessels and bigger lobster traps, as well as to greater lobster abundance. High harvesting rates and the fact that the size at sexual maturity is greater than the minimum legal size mean that egg production of local populations is only one percent of what it could be if the stocks were left alone. Such a low laying rate is risky, since it could lead to recruitment failure if conditions become less favourable than they have been over the last 15 or 20 years. Conservation measures have been adopted; for example, egg-bearing females are marked and returned to the water, and they must be thrown back if caught again in subsequent years.

Atlantic cod. Atlantic cod was the main fishery resource in the study area from the time of colonization until 1993; a moratorium on fishing the species — still in force — was declared in 1994. The harvestable biomass of the species was at its lowest historical level due to a sharp drop in recruitment since the mid-1980s, thought to be caused by overfishing and abnormally cold water in the Gulf since 1989. The Gaspé fleets were fishing the stocks of the southern Gulf of St. Lawrence, which winter outside the Gulf and in spring return to their breeding and feeding grounds, situated mainly in the southwestern part of the Gulf (including the study area). Recent data indicate that the stocks are recovering, but that their current state is not healthy enough to allow a total reopening of directed fishing of the species without placing it in danger.

Atlantic herring. Atlantic herring is the primary pelagic species harvested in the study area. The fleets fish for herring in spring and fall in the southern part of the Gulf of St. Lawrence. Herring migrate a long way between their wintering ground in the eastern Gulf and their breeding and feeding areas along the shores of the study area. The principal spawning grounds are near Carleton and Grande-Rivière, and the main feeding grounds are on the American Bank and Orphan Bank, as well as in the downstream part of the Gaspé Current. These populations were overfished and declined rapidly in the 1970s, but have since recovered. Herring have been highly abundant in the southern Gulf since 1988, thanks to large year classes in 1987 and 1988, although no large year class has been produced since then.

Canadian plaice. Canadian plaice is the chief flatfish harvested in the study area. The stock fished by Gaspé fleets winters in the Laurentian Channel and migrates to the shallower waters of the Magdalen Shelf in spring to breed and feed for the summer. The stock is in poor shape because of low recruitment since the mid-1980s, attributable to a large number of small fish having been caught and dumped back. In 1995, the biomass of the stock reached its lowest level since 1977. It is now showing signs of improvement (fewer small plaice are being discarded), but the biomass is still low. Fishing of the species has been considerably curtailed since 1993.

Rainbow smelt. Smelt winter in estuaries, and in late May go back up several tributaries of Chaleur Bay to spawn. In summer, they head for colder offshore waters, then return to the estuaries in late autumn. The species is fished commercially in winter in the upstream part of Chaleur Bay, near the mouth of the Restigouche River. It is also caught by ice-fishing enthusiasts at the mouths of several rivers. According to the latest analyses of the Ministère de l'Environnement et de la Faune (MEF), the stock in Chaleur Bay is able to withstand the present harvest level.

Giant scallop. This bivalve lives in fairly dense beds on mixed bottoms (rock, gravel, sand) in the infralittoral zone (15–35 m deep). The Chaleur Bay scallop beds collapsed in the 1970s and have never fully recovered. Scallop fishing is dependent on annual recruitment, but fishing effort is not currently out of proportion with productivity. A recent drop in catches per unit of effort has, however, raised a number of questions about the reproductive biomass.

Atlantic mackerel. This pelagic species winters in the Atlantic and migrates to the southern Gulf of St. Lawrence in summer to breed and feed. The biomass of the stock has been large since 1990. Landings have never exceeded the total allowable catch. Harvestable biomass is expected to increase in the next few years.

Soft-shell clam. This bivalve is abundant on the muddy sand bottoms of the mesolittoral and infralittoral zones (less than 10 m deep). Clams and other filter feeders of these zones may be contaminated by toxic algae or bacteria. The condition of the stocks in the study area is unknown.

Winter flounder. The Winter flounder, a flatfish, winters in the estuaries and spreads out along the coast at depths of less than 40 m in summer. The state of local stocks seems to be satisfactory.

Atlantic salmon. There are 18 salmon rivers in the area. In 1995, 11 were open to sport fishing and on 2 of them (the Matapédia and Cascapédia), Natives practised subsistence fishing. There has been no commercial fishing in the area since 1971. The main rivers, in descending order of size of the yearly run, are the Matapédia, Bonaventure, Cascapédia, York,

Saint-Jean and Dartmouth. The salmon run in all rivers in the area increased significantly between 1985 and 1988 and has been fairly stable since then. The reduced fishing effort over the last three years has allowed more fish to spawn, and thus more eggs to be laid on the spawning grounds.

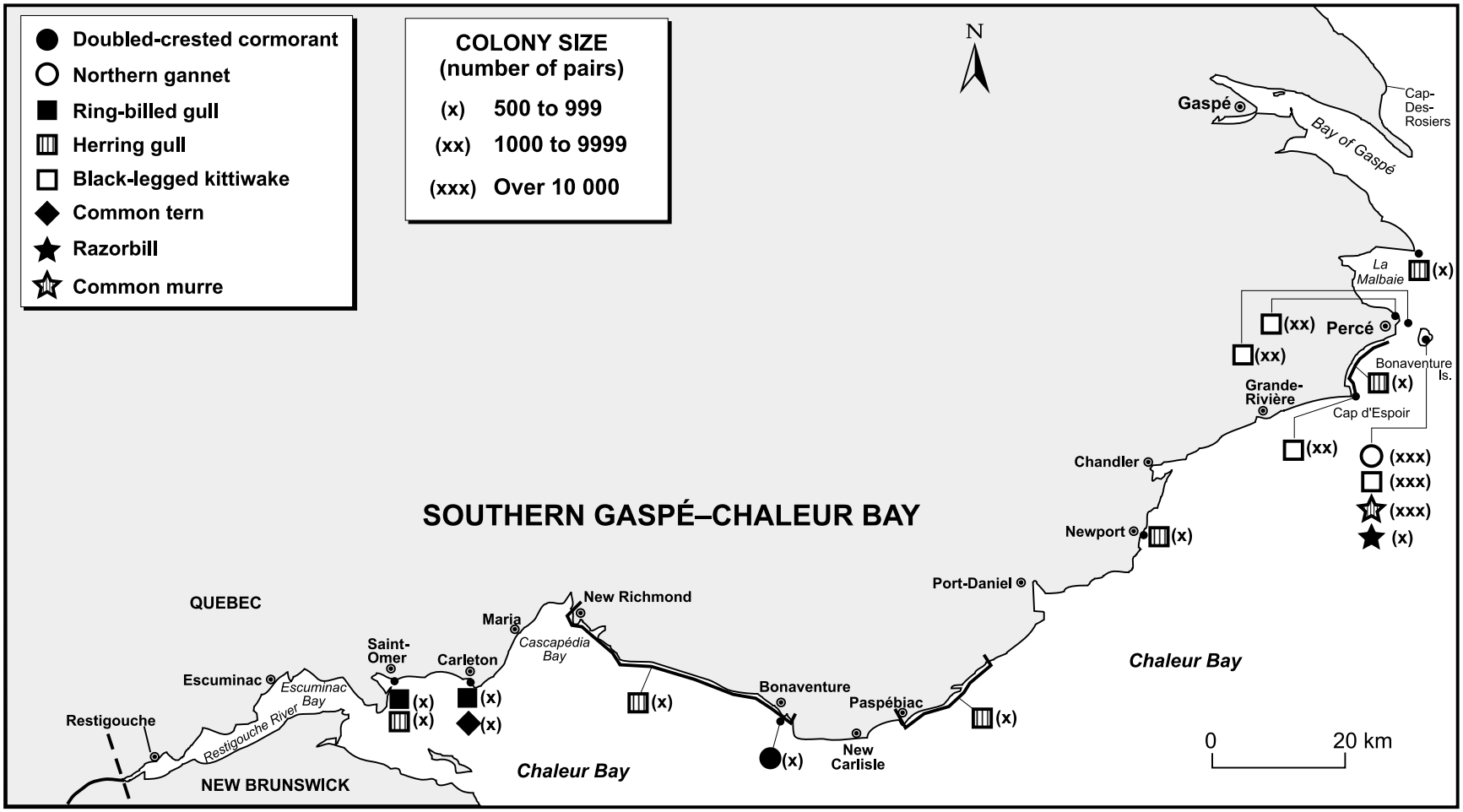
3.4 Birds

Over 320 species of birds have been found on the Gaspé Peninsula, including 161 species that breed there, a higher number than seen in other parts of the Gulf.

3.4.1 Nesting

A total of 73 breeding species are directly associated with the area's marine and coastal environments. There are 135 colonies of 14 species of sea birds (Black-legged kittiwake, Northern gannet, Common murre, Herring gull and Double-crested cormorant, to name but the most numerous) and two species of herons, in colonies numbering over 115 000 breeding pairs (Figure 6). The largest colonies are on Bonaventure Island (Northern gannet, Black-legged kittiwake and Common murre), Percé Rock (Black-legged kittiwake) and Cape Espoir (Black-legged kittiwake). The Northern gannet colony on Bonaventure Island is the largest in North America (32 048 pairs in 1994). The species has been increasing steadily in number throughout the 20th century, except for a temporary drop in the 1970s associated with large amounts of DDT and its derivatives in eggs (see Section 4.2.2.3). The populations of all colonial sea birds, except for the Herring gull, grew significantly between 1979 and 1989. The Common tern population also dropped sharply between 1989 and 1993, probably due to competition for nesting sites from the Ring-billed gull, which has only been in the area since 1982 and whose numbers have been growing very rapidly.

In addition to colonial birds, eight species of dabbling ducks, five diving ducks, two sea ducks and five species of shorebirds (plovers and sandpipers) breed in the study area. There are no recent Golden eagle or Peregrine falcon nesting sites known in the area. Adult Peregrine falcons are occasionally seen around Forillon, where 29 young were released between 1988 and 1992.



Source: Chapdelaine and Brousseau, 1992b; Guillemette, 1994; Hudon and Fortin, 1978.

Figure 6 Location of main bird colonies

3.4.2 Spring migration

In spring, some 20 000 migrating geese and ducks have been counted along the shores of the Gaspé, over half of them scoters and one-quarter of them Canada geese. Chaleur Bay is the part of the Gulf of St. Lawrence where the largest numbers of mergansers and Canada geese are seen in spring. Far fewer eiders are seen here than elsewhere. The main springtime staging areas are in the Restigouche estuary and along the coast, near Bonaventure, where densities of over 1000 sea ducks per kilometre of shoreline have been observed. Elsewhere, birds gather mainly in barachois and sheltered bays (Figure 7).

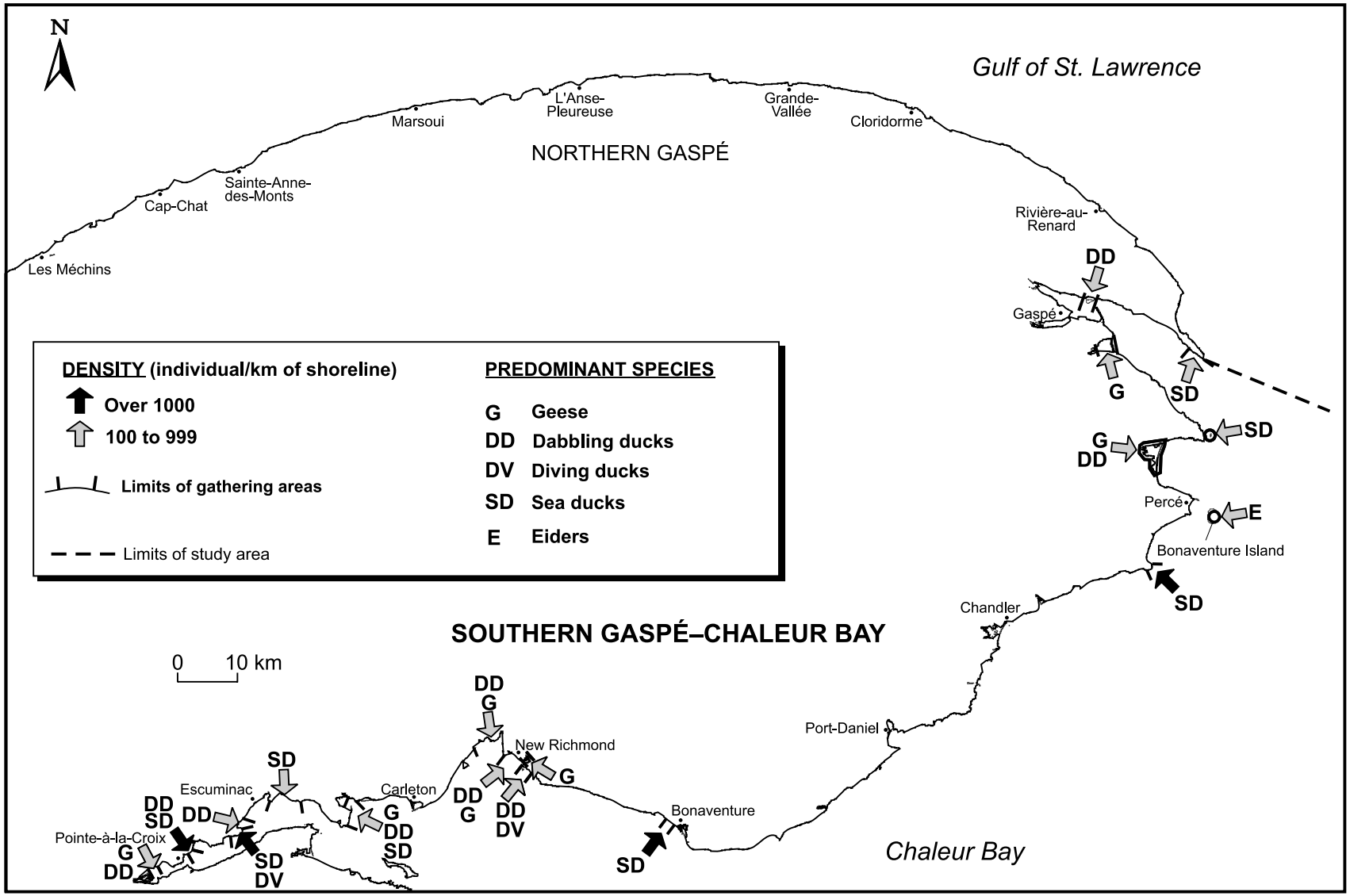
3.4.3 Fall migration

In fall, the number of geese and ducks passing through the area is comparable to that in spring, but there are many more dabbling and diving ducks, and many fewer scoters. The coast between Miguasha and Carleton is the part of the St. Lawrence system where the largest concentrations of migrating mergansers can be seen. The main waterfowl staging areas in fall are the barachois and the Restigouche estuary (Figure 7).

The area is also used in fall by 16 species of migrating shorebirds, but in smaller numbers (fewer than 3500 birds). The dominant species is the Semipalmated sandpiper. The largest flocks can be seen in the barachois at Chandler (Grand Pabos Bay). This site is especially important to the Lesser yellowlegs and the Hudsonian godwit.

3.4.4 Overwintering

Chaleur Bay is not a major overwintering area for ducks. Between 1974 and 1980, fewer than 1000 ducks were counted there. But if there are large ice-free areas, huge flocks of Common eiders and Oldsquaws may be found along the shoreline between Cape Gaspé and Port-Daniel. For example, 60 000 of them were seen off Cape Espoir in 1992.



Source: Adapted from MEF, 1995b and Bourget et al., 1986.

Figure 7 Main waterfowl gathering areas in Southern Gaspé–Chaleur Bay

3.5 Marine Mammals

Eight species of marine mammals have been reported in the study area at various times of year, including six species of whales. There are two species of toothed whales (Harbour porpoise and White-beaked dolphin) and four species of baleen whales (Minke, Fin, Humpback and Blue). A 1996 census found two areas where Harbour seals and Grey seals like to haul themselves out on the rocks: Forillon Peninsula and Percé. Generally speaking, seal populations in the area are small because there are few islands and reefs along the coast. The Grey seal population of the Gulf of St. Lawrence is currently expanding, whereas the Harbour seal populations in several areas of the Gulf have declined sharply since the 1970s.

3.6 Priority Species

There are 17 rare plant species, 6 fishes, 14 bird species, 3 marine mammals and 1 land mammal species in the study area that are listed as priority species in need of protection under the St. Lawrence Vision 2000 action plan (Appendix 1) for the entire St. Lawrence, both freshwater and saltwater habitats.

Two priority plant species (Anticosti aster and Dense whitlowgrass) are endemic to the Gulf of St. Lawrence, two (*Rosa rousseauiorum* and *R. williamsii*) are endemic to the Lower Estuary and Gulf of St. Lawrence, while Gaspé Peninsula arrowgrass and Monarch lady's slipper are endemic to northeastern North America. Arrowgrass and *Rosa rousseauiorum* grow in coastal wetlands, and the other four endemic species grow on cliffs and limestone banks. In the salt meadows of the Bonaventure barachois, there is an isolated population of Macoun's fringed-gentian consisting of only about 60 plants. A recovery plan for the species may be implemented soon.

The priority fish species for the entire St. Lawrence are American shad, Atlantic sturgeon, Rainbow smelt, Atlantic tomcod, American eel, and Atlantic herring. The status granted to the first five species is based on the poor state of the populations of the St. Lawrence Estuary and may not be applicable to the populations of the area under study here, whose state remains

unknown. As for Atlantic herring, the state of the populations of the southern Gulf of St. Lawrence has gradually improved since the late 1970s and can be regarded as good at the moment.

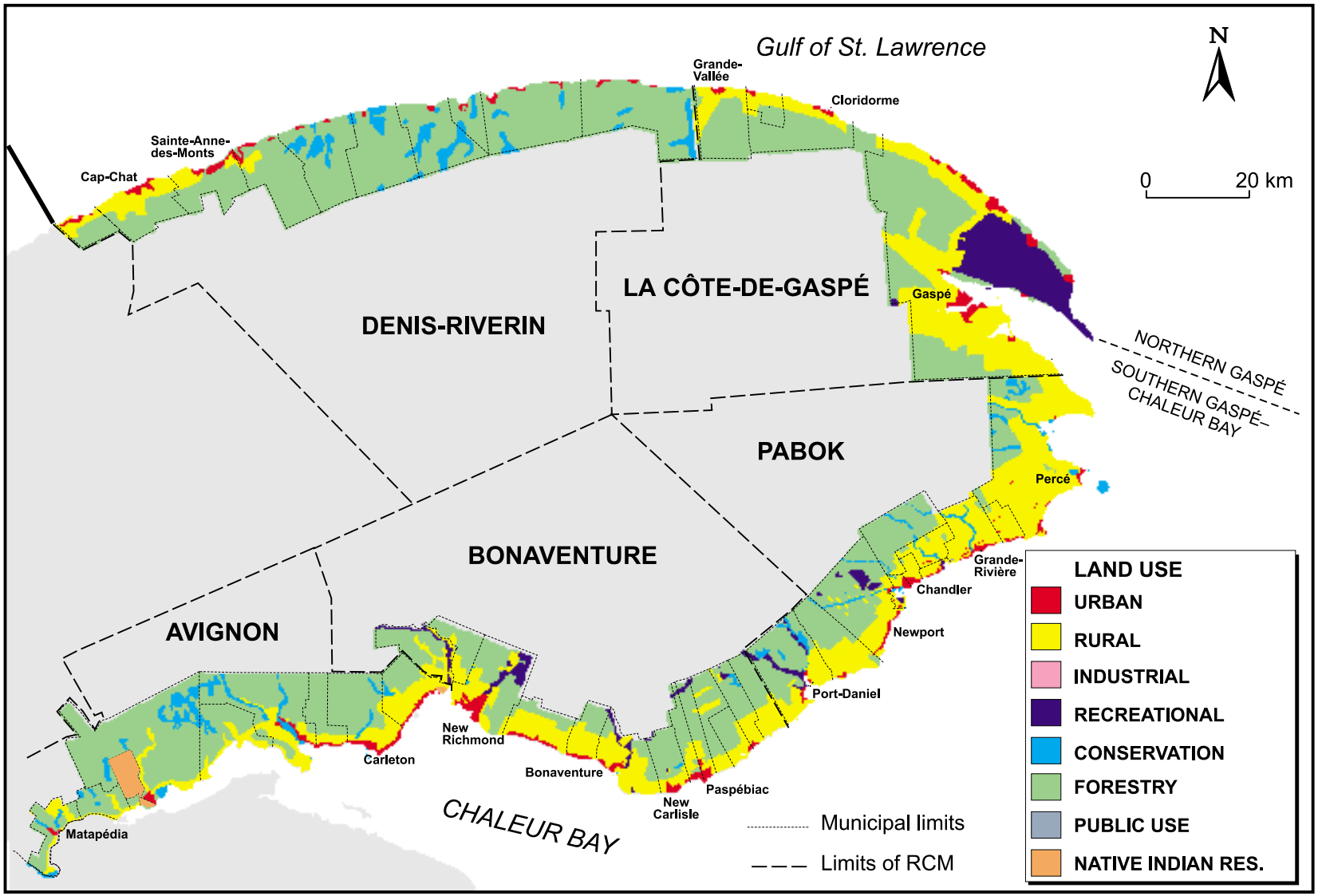
Of the 14 priority bird species, four breed in the study area: the Northern pintail, the Blue-winged teal, the Harlequin duck and the Yellow rail. A fifth species, the Piping plover, has been known to breed on the beaches of Chaleur Bay. The Quebec populations of Northern pintail and Blue-winged teal have dropped sharply over the last 30 years. In the case of the former, the causes for this are unknown, but the decline of the Blue-winged teal would appear to be due to loss of breeding habitat and overhunting in winter in Mexico. The Harlequin duck breeds on the banks of the Port-Daniel, Bonaventure, Madeleine, Sainte-Anne, Hall and Cascapédia rivers. The populations of this species have fallen considerably throughout the 20th century, and hunting has been prohibited since 1990. The Yellow rail breeds in the Percé area and possibly at the mouths of the York, Dartmouth and Saint-Jean rivers. The decline of this species would appear to be caused by the destruction of wetland habitat. The Piping plover, which nests on the upper part of beaches, is very vulnerable to disturbance by pleasure craft and all-terrain vehicles.

The three priority marine mammal species in the study area are the Harbour porpoise, the Fin whale and the Harbour seal. Harbour porpoises are common in the Gulf, but large numbers are killed each year when they get tangled in fishing nets. The Fin whale population is recovering, while the local Harbour seal populations have been falling throughout the Gulf since the 1970s because of disturbance by human activity and because of the animal's sensitivity to toxic substances.

3.7 Land Use

3.7.1 Land-use divisions

In 1991, the 31 riverside municipalities and 2 Indian reserves (3, including Gaspé) of the study area occupied a surface area of 3487 km^2 (4436 if Gaspé is included) and had a population of 51 955 (68 400 if Gaspé is included) (Figure 8). The only municipality with more



Source: RCM of Denis-Riverin, 1986; RCM of La Côte-de-Gaspé, 1987; RCM of Pabok, 1989; RCM of Bonaventure, 1987; RCM of Avignon, 1987.

Figure 8 Broad land-use divisions in the study area, by RCM

than 5000 inhabitants is the town of Gaspé (population 16 400), whose municipal limits extend beyond the study area, north of Cape Gaspé. For the purposes of socio-economic statistics, the town of Gaspé has been classified as part of the Northern Gaspé area, but questions relating to land use are discussed here. The area's population is largely concentrated along the coast, chiefly at the mouths of rivers. A strip of coastal land is devoted to farming, while the hinterland is essentially dedicated to forestry.

3.7.2 Protected areas

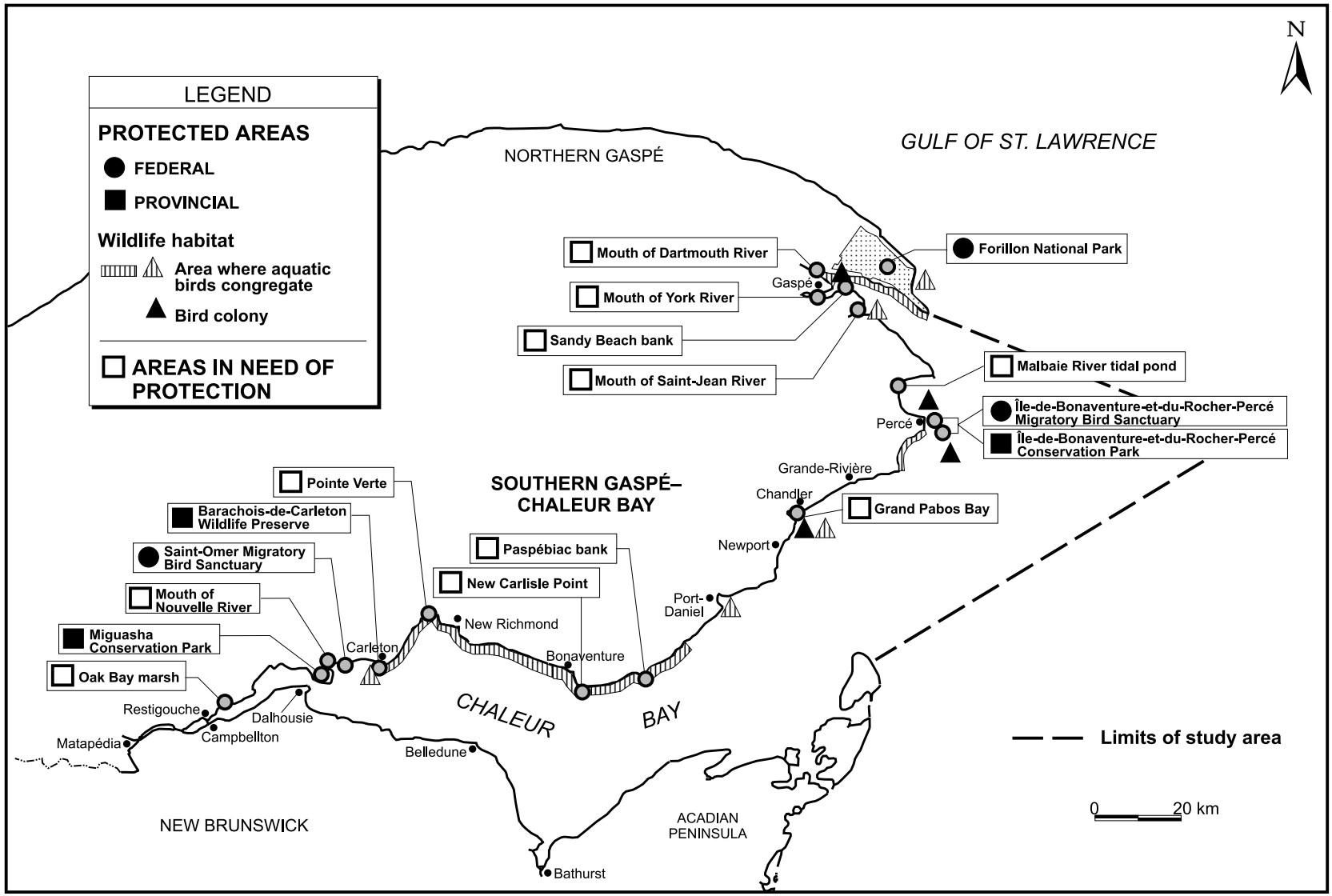
Forillon National Park. Created in 1970, Forillon National Park occupies the eastern tip of the Gaspé Peninsula. The purpose of the park, which covers 244.8 km^2, including 4.4 km^2 of marine environment, is to safeguard a representative area of the natural region of mounts Notre-Dame and Mégantic and a coastal strip of the Gulf of St. Lawrence.

Ile-Bonaventure-et-du-Rocher-Percé Conservation Park. The purpose of this 580-ha provincial park is to safeguard Bonaventure Island and Percé Rock. The site has also been designated a natural district under the *Quebec Cultural Property Act* and also a migratory bird sanctuary.

Migratory bird sanctuaries. The study area counts two migratory bird sanctuaries, both managed by the Canadian Wildlife Service. The 1340-ha Bonaventure Island and Percé Rock sanctuary includes a marine area around the island and rock. The Saint-Omer Bird Sanctuary (60 ha) protects the barachois there. The hunting and harassment of birds is prohibited in migratory bird sanctuaries.

Wildlife preserves. The only wildlife preserve under provincial jurisdiction in the area is the one called Barachois-de-Carleton (10.9 ha), which also protects a Common tern colony and a habitat for many species of fish as well as aquatic birds and shorebirds.

Wildlife habitats. There are 14 small wildlife habitats in the area under the management of the provincial environment ministry (MEF) (Figure 9). Four habitats



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

Figure 9 Protected areas in Southern Gaspé–Chaleur Bay

protect the bird colonies of Bonaventure Island, Percé Rock, the bar at Sandy Beach (Gaspé) and the Mahy islands (Newport). Ten others protect concentrations of aquatic birds spread out evenly along the coast.

Salmon rivers. The banks and watercourses of 18 salmon rivers in the area (Figure 9) are protected by provincial legislation and regulations. This status prohibits logging and cottaging in a strip along the river as well as projects that might affect the riverbed.

Other protected areas. Some sites not officially protected under federal or provincial law are protected by regional county municipality (RCM) zoning. Avignon RCM, for example, has granted conservation status to bird habitats at Maria, Carleton, Nouvelle and Pointe-à-la-Croix, while Bonaventure RCM has designated the barachois of Bonaventure, New Richmond, Paspébiac and Hopetown as sites of ecological interest. These RCMs hope to offer an integral protection of sorts to these sites by using municipal zoning by-laws.

3.8 Developed Uses

3.8.1 Hydro-electric power generation and water supply

The Hall River, a major tributary of the Bonaventure River, is the only area river harnessed for the generation of hydro-electric power. None of the municipalities or industrial plants in the study area draws water from the sea. The largest municipalities in Southern Gaspé–Chaleur Bay drew over 7 500 000 m^3 of water from area rivers and Gulf tributaries in 1994. The firm Gaspésia Co. Ltd. drew 15 353 000 m^3 of water, while Stone Container (Canada) Inc., Chaleur Division, drew 12 802 995 m^3 in 1991. There are two thalassotherapy centres, a provincial government (MAPAQ) research centre in Grande-Rivière, and several fish processing plants which have water intakes in the marine environment.

3.8.2 Shipping and port operations

There are five commercial ports in the study area. The busiest one is at Gaspé (Sandy Beach), which is used mainly for transshipping petroleum products and copper ore (371 500 t

transshipped in 1993–94). The other four ports are at Chandler (51 200 t), Paspébiac (20 000 t), Carleton (8100 t) and Miguasha-Ouest (no data). In summer, a ferry runs between Miguasha and Dalhousie, New Brunswick.

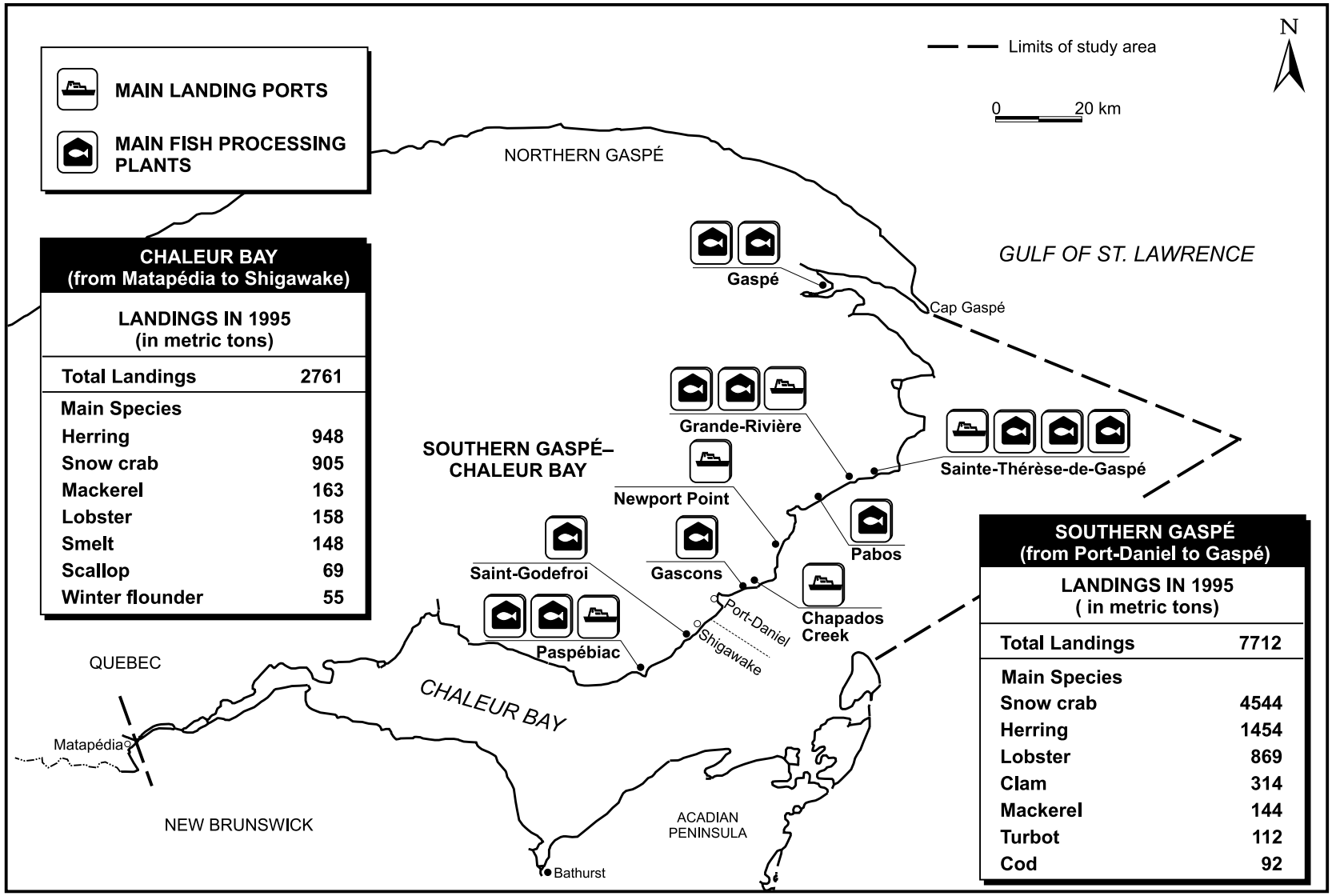
3.8.3 Harvesting of biological resources for commercial or subsistence purposes

Commercial fishing. The Southern Gaspé–Chaleur Bay area is Quebec's main maritime fishing region, and commercial fishing is one of the chief economic activities there. In 1995, the commercial fishery employed over 2000 fishers,[1] either part-time or full-time, on close to 600 vessels, over 2250 workers in some 20 processing plants, and an unknown number of people in the associated service sector (Figure 10). In 1995, the value of landings in the Southern Gaspé–Chaleur Bay area amounted to $56.7 million, and the value of processed marine products to $145 million (Northern Gaspé and Southern Gaspé–Chaleur Bay combined).

The Quebec maritime fishery, especially in the Gaspé, is in severe crisis right now because this sector of the economy is becoming increasingly unable to provide employment to shoreline communities. Between 1985 and 1995, the volume of groundfish landings in the Gaspé dropped by 95% as a result of collapsing fish stocks, but this has been compensated by the rise in the value of landings, thanks mainly to Snow crab. Nonetheless, over the same period, the number of active fishing vessels decreased by 34%, and the number of processing-plant jobs declined by 11% between 1990 and 1995. In terms of landings, Snow crab and lobster are now supporting the fishery in the area.

The present situation of the fishery sector can be summed up as follows: (1) fishery resources are either in poor condition or are not yet being fully exploited; (2) there is a fishing and processing overcapacity; (3) for many fishers, fishing is not profitable, whereas for others it is very profitable; (4) fishers and plant workers are undereducated and highly dependent on

[1] Total for the maritime region, including Northern Gaspé and part of the Lower St. Lawrence.



Source: Fisheries and Oceans, 1996.

Figure 10 Landings of the main fishery resources at ports in Southern Gaspé–Chaleur Bay in 1995 and location of main fishing harbours and fish processing plants

government transfer payments; (5) the fishing population is aging significantly; and (6) with public finances in the state they are, major government support is no longer possible.

Shellfish harvesting along the shore. People living along the shore, especially on upper Chaleur Bay and the Malbaie barachois, dig clams for personal consumption. Although marginal from an economic point of view, this activity has major implications for public health (see Section 5.1).

Aquaculture. Aquaculture in the Southern Gaspé–Chaleur Bay area is currently moribund. So far, all efforts to develop the industry, including some that have involved large investments of public and private funds, have met with failure. A large salmon farm at Saint-Omer went bankrupt twice in the early 1990s, as did a Blue mussel farm in the same town in the late 1980s, and one of the biggest remaining mussel farmers in the area recently shut down operations. A more realistic, partnership-based approach is now being considered.

Native food fishing. Native Indian bands fish the Matapédia and Cascapédia rivers for salmon for their own consumption. From 1989 to 1995, the mean number of salmon they caught was 1018 in the Matapédia and 167 in the Cascapédia. In 1996, the Listuguj Band lobstered around Miguasha.

Hunting sea mammals. Only Grey seals and Harp seals can be legally hunted in the Gulf of St. Lawrence. In 1995, 201 hunting licences were issued for the entire Gaspé maritime region (Northern Gaspé and Southern Gaspé–Chaleur Bay). Only 15 Grey seals were killed and no Harp seals.

Harvesting seaweed. There is currently no commercial harvest of seaweed in Quebec. The usable biomass of kelp on the north shore of Chaleur Bay is estimated to be about 8000 t, which is not enough to justify setting up a colloid-extraction plant. Other seaweed of commercial interest is even less abundant.

3.8.4 Recreation and tourism

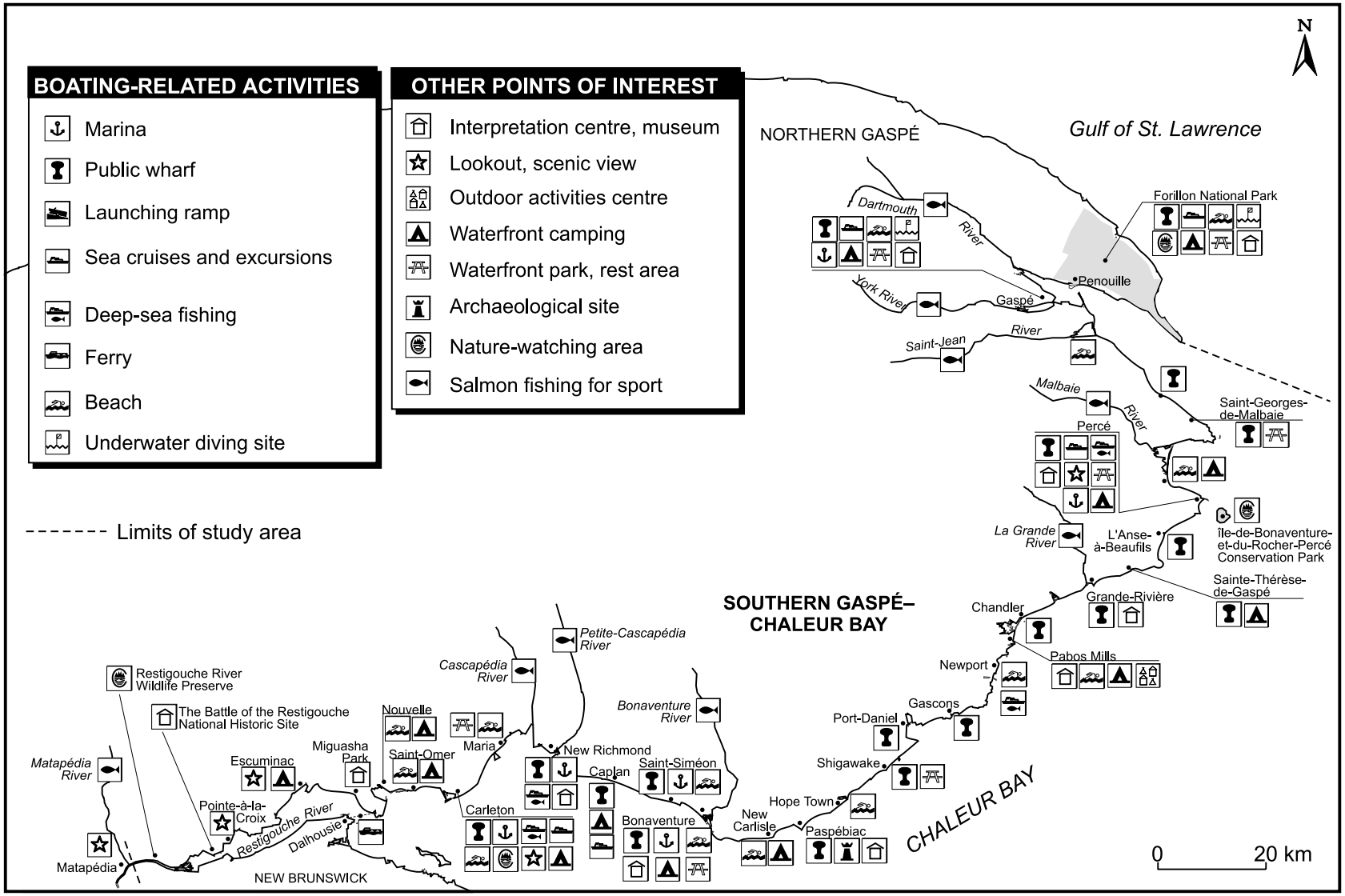
The Gaspé Peninsula has long been popular with tourists and summer residents. Approximately 500 000 visitors tour the Gaspé each year, using the area's accommodations and recreational and tourism facilities.

Accommodations and resorts. For 1994, total accommodation capacity of shoreline communities in the area was 1645 rooms in establishments (2343, including Gaspé). In 1995, there were 892 campsites (1260, including Gaspé). There were also 879 secondary residences in the area (1137, including Gaspé). More than half of all rooms are in Gaspé and Percé alone. The main camping areas are in Forillon National Park, Percé, Carleton and Bonaventure, and the main summer resorts are Gaspé, Percé, Nouvelle and Bonaventure.

Access to the shoreline. The seashore is very accessible in the study area. The main road (Highway 132) runs along the shore over long distances and provides direct access to many public parks, rest areas, public wharves, lookouts, beaches and seaside hiking trails (Figure 11).

Swimming. Swimming is a popular activity in the study area. The most popular beaches are those on the Bay of Gaspé (Penouille, Haldimand) and on Chaleur Bay (Bonaventure, Maria and Carleton), where the water gets warmer than elsewhere along the coast in summer. Several other beaches are visited more sporadically. Most of these beaches are not monitored by the MEF.

Interpretation of natural coastal and marine environments. There are a number of places in the area devoted to the interpretation of the natural coastal and marine environments. The three main ones are Forillon National Park, the conservation park on Bonaventure Island and Percé Rock, and Miguasha Park. Between 150 000 and 200 000 people visit Forillon each year. The park offers visitors a number of activities focusing on sea animals, barachois and cliffs. Bonaventure Island received 75 000 visitors in 1994. Six interpretation activities that look at coastal environments and the Northern gannet colony are organized there. Miguasha Park had 35 700 visitors in 1994. There are other nature-interpretation sites at Carleton (Carleton Bank) and Bonaventure.



Source: ATR de la Gaspésie, 1995; Québec Yachting, 1995.

Figure 11 Boating and recreation in Southern Gaspé–Chaleur Bay

Interpretation of maritime history. A few sites are devoted to interpreting maritime history, like Grande-Grave and Anse-Blanchette in Forillon National Park, the Jacques Cartier Monument in Gaspé, the historic sites of the Pabos commercial fishery complex and the Paspébiac fishing bank, and the Battle of the Restigouche National Historic Site at Pointe-à-la-Croix.

Sport fishing. Between 1990 and 1995, an average of 6500 salmon were caught in the 12 salmon rivers in the study area open for sport fishing (11 rivers in 1995), for an average fishing effort of 25 000 fishing days per year (23 900 fishing days in 1995). The Matapédia, Bonaventure, Cascapédia and Dartmouth rivers were the most popular. Eight salmon rivers in the study area are not yet being fished.

Wharf fishing is also popular in the area. The main species fished are Rainbow smelt and Atlantic mackerel. Ice fishing for Rainbow smelt is growing in popularity. It is practised at the mouth of several rivers, including the Dartmouth, York and Barachois, and around Chandler, New Richmond, Escuminac and Pointe-à-la-Garde. On Chaleur Bay, somewhere around 577 000 fishing days are spent on this type of activity. Between 1988 and 1992, Rainbow smelt catches by sport fishers totalled an estimated 80 t per year, on average.

Deep-sea fishing is another sport that has grown in popularity. Until the decline in groundfish stocks, the main species fished were Atlantic cod and, and to a lesser extent, Atlantic mackerel. There are no recent statistics available on this type of fishing.

Waterfowl hunting. Between 1977 and 1981, an average of 12 500 waterfowl were shot each year along the Gaspé coast, 45% of them on Chaleur Bay. This number accounts for only 3.4% of the birds killed along the St. Lawrence downstream of Cornwall. The main species hunted are Black duck, Green-winged teal and Canada goose. There are no recent data specific to the study area.

Bird watching. There are many wonderful bird watching opportunities in the area. There is an active birders' club: the Club d'Ornithologues de la Gaspésie. In addition to Forillon National Park and the Bonaventure Island and Percé Rock conservation park, there are many

other sites of interest to birders. They are mainly at river mouths and barachois, and on the capes jutting out into the sea (Point Saint-Pierre, Cape Espoir, Miguasha Point and Point à la Croix).

Boating. There are five big yacht clubs and marinas in the study area (in Gaspé, Percé, Bonaventure, New Richmond and Carleton), for a total of just under 250 moorings, either offshore or at docks. There are also 20-odd small-craft harbours, used mainly by fishing vessels, and several boat-launching ramps (Figure 11).

Sea cruises. A dozen firms in the area offer sea cruises to people wishing to admire the coastal landscape or go bird watching, whale watching or deep-sea fishing. The main cruising centres are at Grande-Grave (Forillon National Park), Percé and Carleton. A company in Bonaventure offers sea-kayaking lessons and excursions.

Diving. There are two underwater-diving service centres in the area, one at Cap-aux-Os (Gaspé) and the other at Percé. They are located near the main diving areas: Les Anses (Forillon National Park), Point Saint-Pierre and Percé.

CHAPTER 4 Human Activity and Its Impact on the Environment

4.1 Physical Modification of the Environment

Physical changes are changes to the physical characteristics of water (i.e. temperature, salinity, suspended sediment, circulation), the seabed (bathymetry, sedimentation analysis) and banks and shoreline (geomorphology) as a result of human activity.

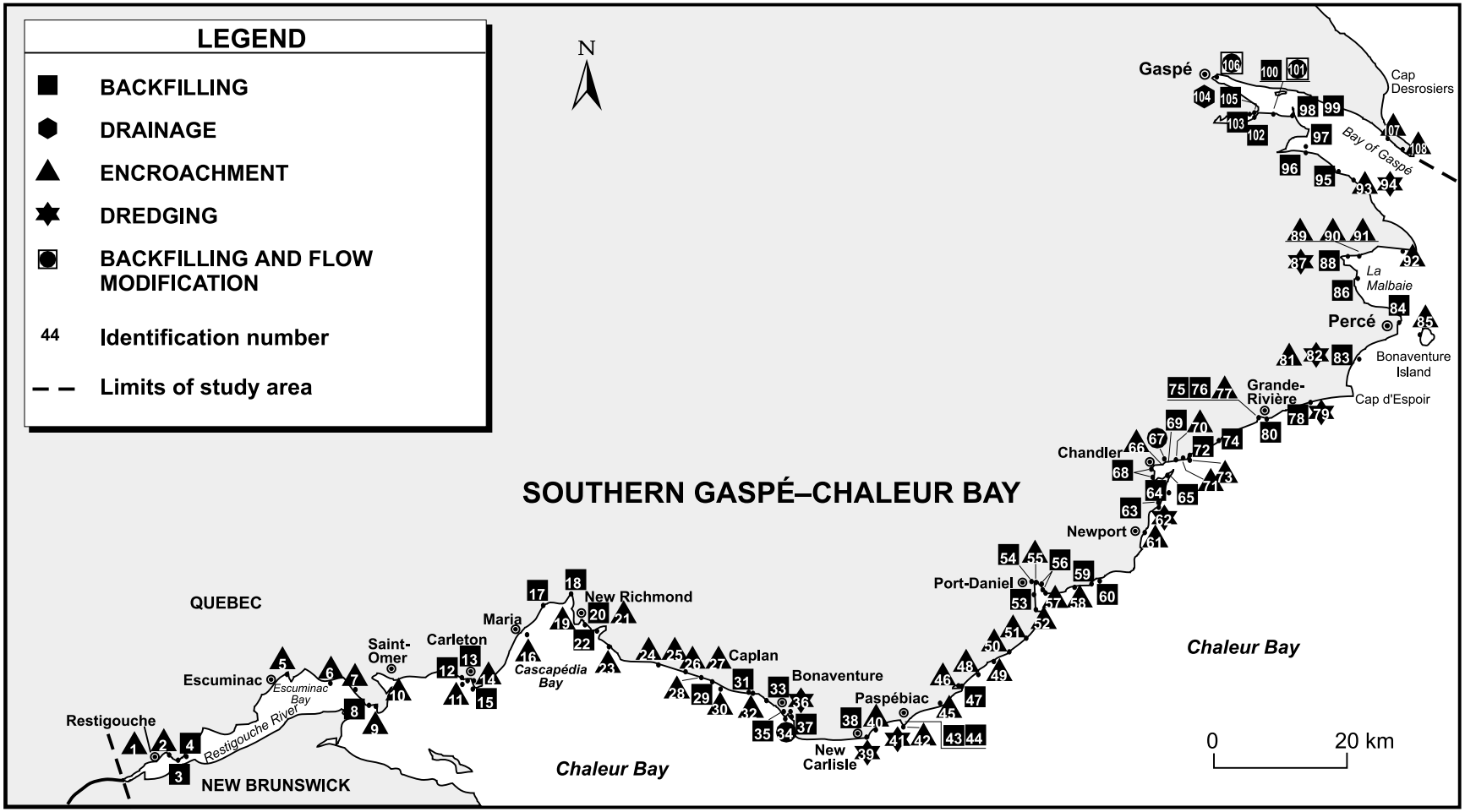
Large-scale changes. The construction of hydro-electric dams in the St. Lawrence drainage basin has considerably reduced the supply of fresh water to the Gulf in the high-water season (June), and increased inflows in winter. Owing to a lack of oceanographic data for the first half of the 20th century, the impact of harnessing the St. Lawrence on the marine environment of the Gulf of St. Lawrence is not known.

Local changes. It is estimated that between 1945 and 1988, a total of 1366 ha of shoreline habitat in the study area underwent an alteration in its physical characteristics, ranging from a change in the current regime to its complete elimination through backfilling (Figure 12). This number does not include the infralittoral and circalittoral environments disturbed by the dumping of dredged material and the use of mobile fishing gear.

Backfilling has eliminated 175 ha of salt marsh and close to 200 ha of shallow subtidal habitat located chiefly in barachois, particularly those at Chandler and Bonaventure.

Many commercial ports, fishing harbours and marinas in the area must be dredged regularly in order to maintain a sufficient depth of water for boats. From 1985 to 1994, maintenance dredging was done in 15 ports in the area; five of these ports had to be dredged virtually every year, and two of them are dredged nine years out of ten. Dredged volumes decreased overall between 1985–1994, except at frequently-dredged sites. The average volume of sediment dredged each time was approximately 2500 m^3. The spoil is dumped in deep water offshore, close to the dredged sites.

Some tidal ponds and estuaries in the area were used to hold log booms for sawmills and pulp and paper mills until the mid-1970s. This is the case of the barachois at Bonaventure



ORIGINAL HABITATS. **Swamp**: sites 53, 68, 97. **Salt marsh**: sites 20, 46, 47, 54, 55, 56, 64, 69, 74, 86 to 88, 96, 99, 106. **Muddy foreshore**: sites 1 to 3, 21, 62, 63. **Sandy-gravelly foreshore**: sites 4, 6, 7, 9, 11, 16, 23 to 30, 32, 33, 40 to 42, 45, 48 to 51, 61, 71 to 73, 80, 84, 95, 98, 100 to 102, 104, 105, 107, 108. **Rocky foreshore**: sites 85, 92. **Estuarine barachois**: sites 10, 34 to 37, 52, 65 to 67, 70, 89 to 91. **Lagoon barachois**: sites 8, 12 to 15, 31, 38, 39, 43, 44. **River estuary**: 5, 17 to 19, 22, 58 to 60, 75 to 79, 81 to 83, 93, 94, 103.

Source: Marquis et al., 1991.

Figure 12 Location of coastal sites subject to physical modification from 1945 to 1988

and New Richmond, of the estuary of the Cascapédia, and of the barachois at Chandler (Grand Pabos); a large part of the Chandler pond was filled with wood waste. The settling of wood debris on the seabed can smother the substrate and cause the formation of an oxygen-depleted layer at the surface of the sediment.

In the barachois at Malbaie, New Carlisle, Bonaventure and New Richmond, the construction of roads and rail lines has reduced the exchange of salt water between the pond and the sea and transformed polyhaline environments into brackish environments.

4.2 Pollution

Contamination and pollution are not the same thing. When a substance's concentration in water, sediment or living organisms is higher than the natural level, the environment or aquatic organisms are said to be contaminated. Only when the concentration reaches a level where it has a negative impact on living organisms or on use of the environment do we talk about pollution.

Easily degradable organic matter, bacteria and nutrients (nitrates and phosphates) do not have long-lasting effects, and environmental quality improves rapidly as soon as discharges cease or as one moves away from the sources of contamination. However, other contaminants that are persistent in the environment are carried over long distances in the hydrographic system or the atmosphere and tend to accumulate in sediment 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

The chief sources of contamination can be split into two broad categories: local sources and distant sources. *Local sources* are to be found in the shoreline municipalities of the study area, in the drainage basins of rivers that flow into the area, or in the sea within the area

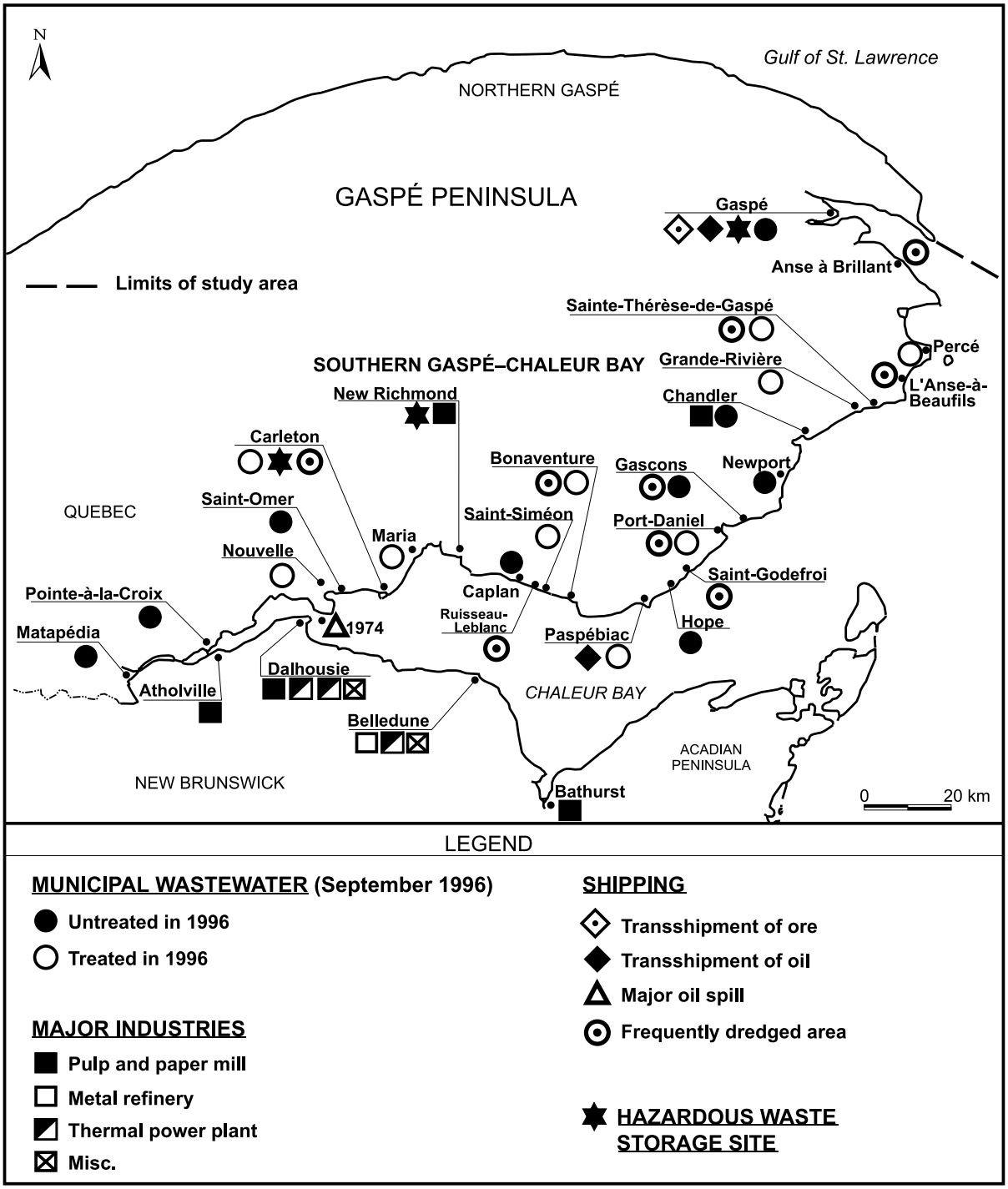
(dredging, shipping) (Figure 13). The data collected by the ZIP research team on local Quebec sources are far more detailed than those on local sources of pollution in New Brunswick (south shore of Chaleur Bay), so we have presented them in a separate section.

Contaminants from *distant sources* are carried to the study area by atmospheric deposition, water masses (water-borne inputs) and migrating fish. These chemical contaminants are persistent in the environment.

4.2.1.1 *Local sources on the Quebec side*

Municipal wastewater. At the end of 1996, 15 of the 31 riverside municipalities in the Southern Gaspé–Chaleur Bay area were having some or all of their sewage treated in 12 wastewater treatment plants. The area's first treatment plant, in Percé, opened in 1989. The plants now in operation process the sewage of 35.8% of the total population of the shoreline municipalities. With the exception of the Percé facility, which uses a biological disk technology, all the plants treat their wastewater by means of aeration lagoons. As of September 30, 1996, the municipalities that had sewer systems but did not treat their wastewater were Gaspé, Chandler, Newport, Gascons, Hope, Caplan, Pointe-à-la-Croix and Matapédia. Between now and December 1998, five new plants will be built in the municipalities of Gaspé (two plants), Chandler, Hope and Pointe-à-la-Croix; this will bring the percentage of the total population that has its sewage treated to 58.7%. Additional plants are possible. In each of these municipalities, some residents are not hooked up to the sewer system, and their wastewater goes into individual septic tanks or cesspits that can contaminate the marine environment.

In 1994, the five treatment plants in the area whose performance was assessed (Percé, Sainte-Thérèse, Paspébiac-Ouest, New Richmond and Carleton) satisfied the discharge requirements in terms of easily degradable organic matter (five-day biological oxygen demand, or BOD_5), suspended solids (SS) and fecal coliform count. As for the overflow facility operating requirement, only the Paspébiac-Ouest plant experienced problems in dry weather. The performance of the existing treatment plants was close to 90% for the BOD_5 and SS load of the



Source: Bibeault et al., 1997; Gagnon et al., 1997; Mousseau et al., 1997.

Figure 13 Location of the main current and potentiel sources of contamination of the marine environment in the Southern Gaspé–Chaleur Bay area

wastewater they processed. However, the overflow facilities can constitute significant sources of contamination of the coastal environment following heavy rainfall.

Industrial wastewater. Three industrial plants in the Southern Gaspé–Chaleur Bay area have been targeted for priority action under the Quebec industrial effluent abatement program (PRRI): Noranda Inc.'s Gaspé Mines Division plant in Murdochville (outside the study area), the Gaspésia Ltd. plant in Chandler, and the Stone Container (Canada) Inc. Chaleur Division plant in New Richmond.

Noranda Inc., Gaspé Mines Division, operates a copper mine and smelter and a sulphuric acid plant in Murdochville. Close to 60% of the ore processed at the smelter is imported by ship and transits through the port of Gaspé (Sandy Beach). The sulphuric acid, a by-product of the smelter, is transported to the port of Gaspé by truck for export.

The wastewater from the smelter process and storage pond is channelled to a settling pond before being discharged into a tributary of the York River. In the early 1990s, this effluent met the requirements for contaminants stipulated in the environmental guideline on the mining industry, with the exception of copper, where the standard was exceeded once in 1992–93. No study has been conducted to determine whether the contaminants discharged by this industrial plant reach the marine environment (Bay of Gaspé).

Gaspésia Ltd. manufactures newsprint at its mill in Chandler using a mechanical pulp mixture produced on site from debarked logs, bisulphite chemical-mechanical pulp made from wood chips produced on site or purchased, and from purchased kraft pulp.

Prior to September 1995, the wastewater from this plant underwent no primary treatment (settling) before being discharged into the Chandler barachois and Chaleur Bay. Since September 1995, the plant's wastewater has been treated by a clarifier (primary treatment) and activated sludge (secondary treatment) before being discharged 185-m offshore. Thanks to such treatment, suspended solid discharge has been reduced by 60%. Discharge of easily degradable organic matter (measured in terms of BOD_5) has fallen from 16.9 t per day in 1994 to less than 1 t in 1996, and the discharge of heavy metals, fatty acids and resin acids has been practically eliminated.

Stone Container (Canada) Inc., Chaleur Division, of New Richmond manufactures unbleached kraft paperboard on site from wood chips and sawdust stored at the mill. The mill uses no bleaching process. Prior to September 1995, only some of the process wastewater was treated by fibre-retention systems and settling before being discharged into Chaleur Bay 1000-m offshore. Changes to the manufacturing process and the installation of primary treatment systems resulted in a 41% reduction in BOD_5 effluent between 1990 and 1995 and a 67% reduction in suspended solids discharged between 1971 and 1995. Since September 1995, wastewater has been treated in an aeration lagoon (secondary treatment) before being discharged. These new facilities reduced BOD_5 by 81% between 1994 and 1996. On the other hand, discharges of suspended solids increased 128% in the same period because the aeration lagoon has no filtration or settling system. Despite this increase, the suspended solids load of the effluent is still below the permissible level set by government regulations. Effluent is discharged over 1-km offshore of Chaleur Bay. The plant's sewage is pumped into New Richmond's municipal sewage system.

Hazardous waste disposal sites. In the 1980s, three hazardous waste disposal or storage sites near the shore in the study area were listed in official provincial and federal government inventories.

The **Stone Container (Canada) Inc. landfill site** in New Richmond was designed for residue and sludge generated in the various stages of paperboard manufacture. The residue contains low levels of metals, fatty acids and resin acids, and no PCBs, volatile hydrocarbons or PAHs. There is a moderate risk that the site may contaminate the New Richmond barachois. The site was seriously contaminated by hydrocarbons in the 1980s. The company is currently examining various ways to attenuate the risk of contamination. A solution should be found some time in 1997.

The **landfill for fuel oil-contaminated solids** in Carleton contains sand, gravel and wood scrap contaminated by fuel oil as a result of the 1974 wreck of an oil tanker in Chaleur Bay. The waste was buried in 1975 in trenches dug in reasonably impermeable soil. There is a

moderate risk that the site may contaminate a stream that flows 1.5 km before it empties into the sea.

At the **Gaspé Airport** there is a high risk that petroleum products lost to the environment during storage and handling may contaminate the mouth of the Saint-Jean River, due to the extreme permeability of the soil of the airport.

Shipping and port operations. Shipping is a potential source of pollution by virtue of shipping accidents, ballast flushing and the discharging of hold contents directly into the sea, and the transshipping and storage of goods in port.

No catastrophic oil spills have yet taken place in the study area. The biggest spill was in 1974, when the *Golden Robin* ran aground at the mouth of the Restigouche River, near Miguasha; 160 t of oil spilled into the sea when the tanks were torn open. Accidental spills of contaminated substances are much more frequent during transshipping operations in port. The main ports for transshipping (and storage) of petroleum products in the area are at Gaspé (Sandy Beach) and Paspébiac.

Transshipping of copper ore in the port of Gaspé (Sandy Beach) occasionally results in major losses of both organic and inorganic contaminants that wind up in the sediment around the wharf. This port is one of the most highly contaminated marine sites in the St. Lawrence system (see Section 4.2.2.2).

Busy ports and marinas are places likely to be contaminated by highly toxic organotin compounds from the antifouling paint applied to boat hulls and underwater port infrastructures. The creosote-treated wood used for some wharves is a source of PAH contamination. Although PAHs are considered a priority substance under the *Canadian Environmental Protection Act*, there is no regulation dealing specifically with PAH-contamination due to creosote use.

Dredging. Maintenance dredging of ports, fishing harbours and marinas is a source of contamination when it stirs up toxic substances that would otherwise have remained isolated from the aquatic environment in deep layers of sediment, or confined at locations unaffected by general circulation. In the past, dredged spoil was dumped at many offshore sites in the study area. In

most cases, the sediment dumped at these sites was moderately contaminated by heavy metals and subject to federal regulations.

Snow. There are no data available on the dumping of snow into the sea in the study area. Since 1996, all municipalities in Quebec have been required to draw up a plan for snow removal that does not involve directly dumping snow into the aquatic environment.

Agriculture. A significant part of the land in the municipalities on Chaleur Bay is given over to farming (23 7000 ha), which may contaminate shoreline areas through runoff containing organic substances, microbes, fertilizers and pesticides. Between 1981 and 1991, the land area treated with chemical fertilizers in Southern Gaspé–Chaleur Bay fell by 39%, while that treated with pesticides rose by 73%. Over this period, organochlorine pesticides were gradually replaced with substances that are less persistent in the environment. Livestock is concentrated in the RCMs of Avignon and Bonaventure. In Southern Gaspé–Chaleur Bay, more than 2100 ha of land is spread with manure or slurry.

Forestry. Hinterland forests are regularly sprayed with insecticides against Spruce budworm and other harmful insects and with herbicides in order to optimize the harvesting of selected species for making pulp and paper. Fenitrothion, a chemical insecticide with low environmental persistence, is being used less and less, whereas the biological insecticide *Bacillus thuringiensis* is being used more and more. DDT, a chemical insecticide that is very persistent in the environment, was used until the mid-1970s, and one of its degradation products, DDE, is still found in wildlife in the study area (see Section 4.2.2.3).

4.2.1.2 Local sources on the New Brunswick side

Several large industrial plants are located on the south shore of Chaleur Bay: three pulp and paper mills (in Atholville, Dalhousie and Bathurst), three thermal power plants (two in Dalhousie and one in Belledune), a chlorine and caustic soda plant in Dalhousie and a lead smelter in Belledune. A chemical fertilizer plant in Belledune was recently shut down. These plants have been major sources of cadmium, lead, mercury and other toxic substances contaminating the south shore of Chaleur Bay (see Section 4.2.2.2).

The municipalities and hazardous waste disposal sites on the south shore of Chaleur Bay and the maintenance dredging of the ports of Dalhousie and Belledune are also significant sources of contamination.

4.2.1.3 Distant sources

Water-borne input. The Gaspé Current carries all of the fresh water from the drainage basin of the Great Lakes, St. Lawrence River, St. Lawrence Estuary and Saguenay River to the southern Gulf of St. Lawrence. Although for several decades large amounts of environmentally persistent toxic substances have been released into the fresh water of this drainage basin, only a small fraction has reached the Gulf. The reason for this is that the Great Lakes, the Saguenay Fjord and the Lower Estuary of the St. Lawrence are natural sinks for most of the fine sediment to which the toxic substances adhere. For instance, it is estimated that between 1950 and 1990, only 3% of the mirex, an organochlorine pesticide, discharged into the Great Lakes actually travelled all the way to the Gulf of St. Lawrence. The amount of PCBs found in the sediment of the Lower Estuary of the St. Lawrence is reportedly 100 times greater than that found in the sediment of all of the Gulf of St. Lawrence. The input of most toxic substances, including mercury, lead, PCBs and DDT, from the Great Lakes and the St. Lawrence has been dropping since the 1970s.

Atmospheric input. Atmospheric deposition in the form of vapour and precipitation on the Gulf of St. Lawrence is one of the main sources, if not *the* main source, of many of the contaminants found in the sediment of the deepest areas of the Gulf and, presumably, of the Chaleur Trough. This is true of mercury, lead, PCBs, PAHs, dioxins and furans, in particular.

Food-chain input. The fall migration of eels from the Lake Ontario Basin to the Atlantic Ocean is a major source of toxic substances to predators. Eels are highly contaminated with PCBs, DDT and mercury, and are one of the main vectors of mirex. The degree of contamination of Lake Ontario eels has dropped considerably in the last 10 years or so, but remains high.

4.2.2 Impact of contaminants on resources and uses

The criteria and guidelines used to determine the extent to which contaminants found in water, sediment and organisms pose a threat to aquatic organisms and human health, and also limit certain types of use, are given in Appendix 2.

4.2.2.1 Contamination of water

Available data on the contamination of water by toxic substances in the study area are very sketchy. Offshore, contaminants from local and distant sources are diluted by relatively uncontaminated salt water; concentrations measured are typical of coastal waters affected by terrigenous deposits and probably do not exceed even the most stringent quality criteria established for all substances of concern. On the other hand, near the port and industrial installations at Belledune, New Brunswick, concentrations of zinc and cadmium in the water and of suspended solids were much higher than they were offshore. There are no data available on the toxic contamination of water on the Quebec shore.

The bacteriological quality of the water at about 40 sites along the Quebec shore is being monitored to determine the health of shellfish waters. In 1995, the bacteriological quality at only three sites was good enough to allow shellfish harvesting in the summer. Shellfishing areas are usually closed because of contamination by municipal effluent, septic tank overflow, agricultural runoff and, in some cases, bird colonies. Some are closed because of contamination by toxic algae or because the water quality has not been fully assessed.

4.2.2.2 Contamination of sediment

Sediment is contaminated when concentrations of heavy metals or of certain organic compounds (such as PAHs) are higher than the naturally-occurring, preindustrial levels. These levels become cause for concern when they are high enough to harm organisms living in or near the sediment and that depend on it for their survival. This is known as the *pollution danger point*. To assess sediment quality, three contamination thresholds for the most worrisome substances have been set: the no effect threshold (NET), the minimal effect threshold (MET) and the toxic effect threshold (TET). These thresholds are used to classify sediment into four categories:

- uncontaminated: level below the NET

- slightly contaminated: level between the NET and MET
- moderately contaminated: level between the MET and TET
- heavily contaminated: level above the TET.

These criteria were developed for freshwater species. They may be applied to the marine environment, but the results should be interpreted cautiously.

Chaleur Trough. The sediment of the upstream part of Chaleur Trough (i.e. eastern Chaleur Bay) is more contaminated by toxic substances than that of the downstream part of the trough and western Chaleur Bay — which is logical, given that suspended solids settle mainly in the upstream part of the trough. Maximum concentrations in the area are still lower than those found in the sediment deposition zones of the Laurentian Channel and correspond to a low level of pollution.

South shore of Chaleur Bay. In the early 1980s, several areas along the south shore of Chaleur Bay were heavily polluted by mercury and cadmium, and moderately polluted by arsenic, lead and zinc. The situation has since improved, however, thanks to efforts to control industrial effluent. Industrial activities in Belledune had been the source of cadmium, lead, arsenic and zinc contamination of sediment in the port and the coastal area downstream. Mercury contamination had been caused by effluent from a chlorine and caustic soda plant in Dalhousie, dredging of the port at Dalhousie, and the dumping of contaminated spoil in open water.

North shore of Chaleur Bay. Outside of barachois and ports, no area moderately or heavily polluted by toxic substances has been found along this shore.

Barachois. The sediment quality in the barachois at Chandler, Paspébiac, New Carlisle and Bonaventure was studied recently. The one at Chandler is slightly polluted. Parts of those at Paspébiac and Bonaventure are moderately polluted by heavy metals and PCBs, and the one at Paspébiac by PAHs. In 1996, it was discovered that a small area of the New Carlisle barachois was highly polluted by a number of heavy metals, arsenic and PCBs, and moderately polluted by other heavy metals and PAHs. Up until 1993, municipal sewage discharged into a section of the barachois partly cut off from the sea may have been the source of this severe contamination; other possible sources of contamination may have contributed intermittently.

Ports. The quality of sediment in some 20 ports in the study area was determined in the 1980s and 1990s during predredging assessments. Several areas were heavily polluted with cadmium in the mid-1980s, but this contamination seems to have since lessened. Abnormally high concentrations of nickel were also found in several ports in the 1980s and 1990s. With the exception of the port at Gaspé (Sandy Beach), there is generally little contamination of ports by other metals (including mercury), PCBs or PAHs. The commercial port at Gaspé (Sandy Beach) is one of the most heavily polluted ports in the St. Lawrence system. For example, in 1986, levels of lead and copper there were 100 times higher than the TET, while levels of cadmium were 10 times higher. The area is also highly polluted by arsenic, chromium, nickel, zinc, PCBs and PAHs. This pollution is caused mainly by the handling of copper ore by Noranda Inc.

4.2.2.3 *Contamination of the marine food chain*

Aquatic organisms accumulate some toxic substances in much higher concentrations than those found in water and sediment; this is called *bioconcentration*. *Bioaccumulation* of a contaminant occurs when an organism absorbs a substance more quickly than it can eliminate it, thus becoming more contaminated the older it gets. Since most aquatic organisms, except shellfish, are able to regulate the concentration of heavy metals (except methyl mercury) in their bodies and can also metabolize PAHs quickly, they do not bioaccumulate these substances. Most living organisms are unable, however, to eliminate or rapidly metabolize mercury and organochlorine compounds like PCBs, DDT and mirex. As a result, these substance become more concentrated at each level of the food chain, and reach much higher levels in vertebrates than in invertebrates. This phenomenon, called *biomagnification*, has been found in the food chain of the St. Lawrence with respect to PCBs, mirex and mercury. PCB levels, for example, are 100 to 1000 times higher in the blubber of Harbour seals than in benthic invertebrates or plankton in the same environment (Figure 14). A marine organism’s degree of contamination by toxic substances depends on its position in the food chain and the amount of time it has spent in contaminated areas. For example, Fin whales are much less contaminated than Harbour seals because they feed

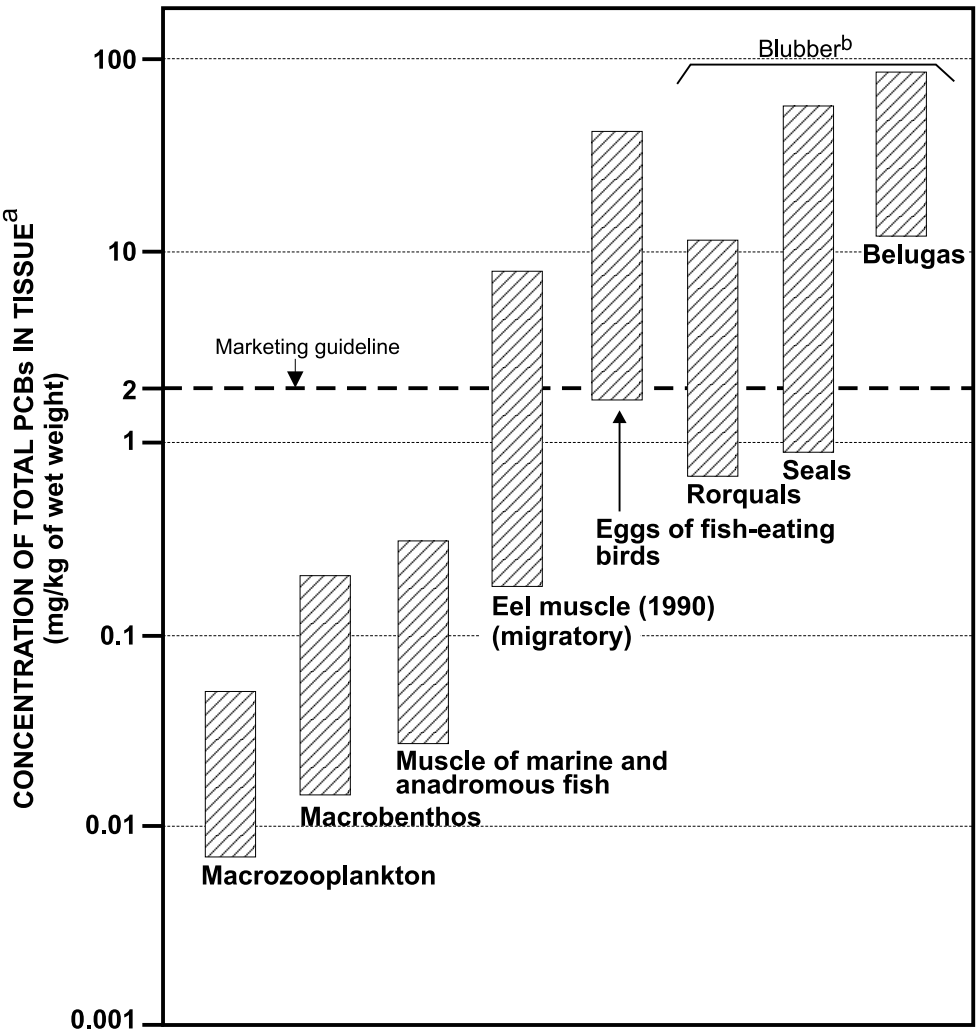
on zooplankton, primarily krill, and live in the Gulf only in summer, while Harbour seals eat mainly carnivores (fish) and live in the Gulf year-round.

Invertebrates and fish. The sketchy data available indicate that invertebrates and fish in the study area do not contain toxic substances in loads exceeding marketing guidelines (Figure 14). Fish-eating birds and sea mammals, on the other hand, especially seals and toothed whales, are much more contaminated owing to biomagnification.

Birds. Overall, the level of contamination of aquatic birds' eggs in the Gulf of St. Lawrence is only one-third of that found in the Great Lakes and is comparable to that found on the Atlantic coast of Canada. Contamination by heavy metals is moderate and has no apparent effect on the health of the birds. Levels of organochlorines in Northern gannet eggs on Bonaventure Island dropped markedly between 1969 and 1994. Concentrations of PCBs, DDE, dieldrin oxychlordane and hexachlorobenzene (HCB) were clearly lower in 1994 than in 1969 (Figure 15). These data appear to indicate an improvement in conditions in the Gulf as far as contamination by organochlorine compounds is concerned. This is even more significant when we consider the gannet's increased capacity for biomagnification, given its high place in the food chain, its diet (mostly mackerel), its long exposure time to contaminants (20-year life span), its vast feeding grounds in the Gulf, and its year-round presence in the Gulf (mid-May to early November). Similar results have been reported for colonies of sea birds in the Maritimes.

Lead shot from shotgun cartridges is a major source of contamination of aquatic birds in areas popular with hunters. Ducks and geese ingest the shot when they feed on the bottom, and can suffer from severe lead poisoning. In the study area, the only place where this risk exists is along the upstream part of the north shore of the Bay of Gaspé. Starting in 1997, the use of non-toxic shot in cartridges will be compulsory throughout the province.

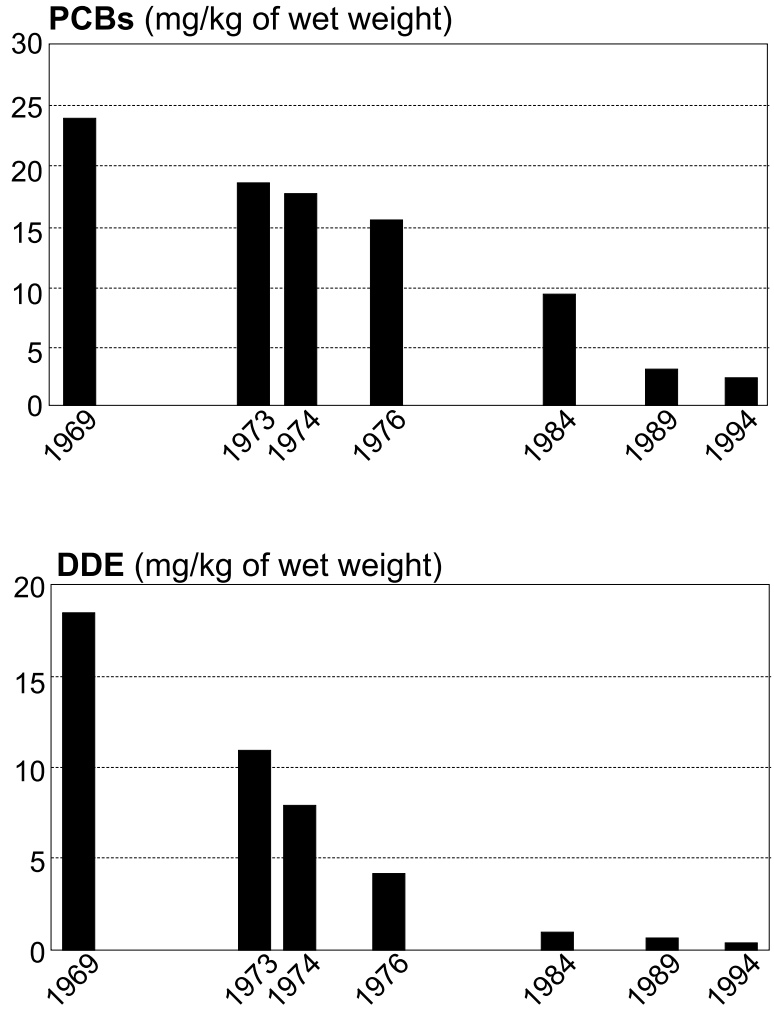
Marine mammals. Only sketchy data are available on the contamination of marine mammals in the study area. Generally speaking, seals and Harbour porpoises in the Gulf of St. Lawrence are more contaminated by toxic substances than are baleen whales (rorquals). On



Source: Béland et al., 1992; Gagnon and Dodson, 1992; Hodson et al., 1992; Hodson et al., 1994; Muir et al., 1990; Wagemann et al., 1990.

a. The figure shows the scope of concentrations measured in organisms in the Estuary and Gulf.
b. Concentrations of PCBs are much higher in blubber than in muscle.

Figure 14 Biomagnification of PCBs in the Estuary and Gulf of St. Lawrence food chain



Source: Adapted from Noble, 1990 and CWS, 1997.

Figure 15 Temporal trends in PCBs and DDE levels in the eggs of Northern gannet on Bonaventure Island, 1969-1994

the other hand, they are less contaminated than the Beluga whales of the St. Lawrence Estuary, which suffer from many types of pathology not seen in other species. The concentration of DDT in the blubber of Harp seals — a species found seldom, if ever, in the study area — has decreased sharply since the 1970s; PCB levels are declining more slowly.

4.3 Introduced or Expanding Species

Purple loosestrife. Purple loosestrife is a European plant that has invaded the freshwater marshes of the St. Lawrence. It made its first appearance on the north shore of the Gaspé Peninsula sometime between 1920 and 1940, and on Chaleur Bay between 1940 and 1960. The spread of the species has been aided by abnormal water-level fluctuations, ice erosion, shoreline development, and livestock grazing. Purple loosestrife is considered a nuisance plant in some parts of Canada and the United States because it reduces the diversity of marshland plant communities.

Non-native organisms. The ballast water of cargo ships may contain large numbers of planktonic and benthic organisms in various stages of development, and ballast flushing is therefore a potential vector for introducing exotic species into the marine environment. Some introduced species can have harmful effects on the ecosystem, as is the case with the freshwater Zebra mussel. The introduction of toxic planktonic algae in particular represents a serious threat to coastal areas and fishery resources. The ports of Dalhousie, Belledune and Gaspé are potential sites where exotic species could be introduced through ships' ballast water.

4.4 Overfishing

Fishing always reduces the biomass of the populations harvested and the average size of the individual fish taken. These normal phenomena do not jeopardize stocks as long as their potential for renewal is not affected. The decline in the cod population of the Gulf of St. Lawrence in the late 1980s and early 1990s has been traced to the fact that the fishing effort was sustained at a time when environmental conditions were particularly unfavourable to renewal

of the resource; this considerably diminished the reproductive potential of the population at that time. Other major fishery resources in the area, such as lobster, Snow crab and Canadian plaice, are currently highly vulnerable to unfavourable oceanographic conditions because they are being harvested intensely.

CHAPTER 5 Human Health Risks

5.1 Consumption of Fish and Shellfish

This section looks at how chemical, bacteriological and toxic contamination in the Gulf of St. Lawrence affects the people of the Southern Gaspé–Chaleur Bay area.

Chemical contamination. In general, the fish and shellfish of the Gulf of St. Lawrence are not very contaminated by chemicals. Concentrations of most of the main contaminants monitored (mercury, PCBs, DDT, mirex, dioxins and furans) are below the fish and seafood marketing guidelines. Several studies, however, especially one of fishers on the Lower North Shore, have shown that people who eat a lot of seafood are more exposed to the contaminants they contain than those who don't.

The only data available on the subject regarding the population of Southern Gaspé–Chaleur Bay concerns newborns (umbilical cord blood) and nursing mothers (breast milk). The data suggest that levels of lead, PCBs and DDE are comparable to those for the Quebec population as a whole, but higher for mercury. This mercury absorption is well below acceptable levels, however. Estimates for the people of the Lower North Shore tend to show that the risk is low for most fishers. As mercury exposure appears to be comparable for the two populations, and as exposure to organochlorines appears to be less for the people of Southern Gaspé–Chaleur Bay, the health risk to them would appear to be just as low.

The health risks associated with aquatic organisms from the Gulf and Chaleur Bay are considered negligible compared with the health benefits. Seafood is rich in protein, vitamins and minerals, and its consumption also seems to provide some protection against certain diseases, including cardiovascular disorders. For pregnant and breast-feeding women, seafood is a good source of polyunsaturated fatty acids (especially omega 3 fatty acids) and nutrients needed for nervous system development of the fetus and the newborn child.

Lastly, it is possible to reduce the quantity of organochlorines (PCBs, DDE, etc.) ingested by taking certain precautions when preparing fish. The toxic substances accumulate in

fat, so it is better not to eat the skin, internal organs or fatty parts of the fish, or the juice from cooking.

Bacteriological contamination. Municipal sewage, nonpoint-source agricultural pollution, substandard cesspits and sea birds all cause bacteriological contamination of water at places in the study area, and this contamination affects the quality of edible shellfish. Bacteriological contamination of harvesting areas is a major problem in the Gulf of St. Lawrence, especially in Southern Gaspé–Chaleur Bay. In 1996, only Point Saint-Pierre was open for harvesting in the summer. All the other shellfish beds were closed or else approved with certain restrictions.

Eating contaminated shellfish can cause digestive and intestinal problems. The Gaspé Peninsula–Magdalen Islands Public Health Branch has reported five cases of shellfish poisoning since 1990. The true scope of the problem is unknown, however, since most intestinal disorders do not require medical attention and so go unreported.

Shellfishing should therefore not be done except in areas approved by the Department of Fisheries and Oceans. Using data gathered through Environment Canada's Shellfish Water Quality Protection Program, the Department advises harvesters as to the safety of shellfish at various sites. Shellfish bought on the market are absolutely safe, as they are inspected systematically.

Although fish may be contaminated by bacteria or parasites, most parasites are not dangerous to humans. Nonetheless, the following preventive measures are recommended: do not eat the skin or internal organs, and cook the fish thoroughly. This eliminates the risk of contamination by bacteria or parasites. As a precaution, it is also advisable not to eat fish with visible abnormalities, such as ulcers, bumps on the skin, or injuries.

Contamination by toxic algae. The microscopic algae *Alexandrium* sp. (the main genus of toxic algae found in the Gulf) produce a biotoxin that, when ingested by humans, may cause potentially fatal paralytic shellfish poisoning, or PSP. The toxin is transmitted to humans when they eat shellfish (clams and mussels) contaminated by the algae, although the shellfish

themselves are not affected. The toxin may also be found in the hepatopancreas (liver, or green part) of lobster and in the liver of cod and other fish of the Gulf.

Toxin concentrations in shellfish are not generally dangerous between Miguasha and Port-Daniel, but are high between Port-Daniel and Cape Gaspé. As mentioned earlier, five cases of PSP have been reported in the Gaspé since 1990.

The best way to avoid health problems is to obey the shellfish harvesting restrictions issued by Fisheries and Oceans. The Department has a program for detecting the toxin in filter feeders. It is also recommended that no more than two lobster livers per day be eaten. As for fish liver, it can be eaten safely, since the level of contamination is too low to be hazardous, but it should be noted that the toxin is not destroyed completely by cooking. The toxin is not found in fish flesh.

5.2 Consumption of Seaweed

Edible seaweed is not harvested commercially in the study area, but it is gathered for personal consumption or for local restaurants.

Analysis of seaweed samples collected in the Gulf and Estuary of the St. Lawrence, including a sampling station on Chaleur Bay (at Bonaventure), found several organic and inorganic contaminants, but levels were generally low, and frequently undetectable. The iodine and cadmium in some species of seaweed may be hazardous to human health, but only if a large amount of seaweed is eaten.

5.3 Consumption of Waterfowl

Based on specimens harvested nationally by the Canadian Wildlife Service, Health Canada has determined that the health risk from eating waterfowl is negligible. Concentrations of contaminants in various specimens were generally low or even undetectable. It is possible, however, to reduce exposure to organochlorines to a minimum through cooking methods that

eliminate as much fat as possible, especially for fish-eating birds. To prevent lead poisoning, the lead shot should be removed from the bird.

Parasites in waterfowl are not generally hazardous to human health, but thorough cooking will eliminate any risk of parasitic or bacterial contamination.

5.4 Recreational and Commercial Activities

Contamination. The bacteriological quality of the water at recreational areas in Southern Gaspé–Chaleur Bay is highly variable over time. A 1992 study of the water quality at several beaches in the area found that, at least once over the summer, the water quality at most sites was mediocre or polluted. A lack of sewage treatment facilities in shoreline municipalities is the main reason for the pollution. Potential sources of contamination, such as streams, rivers or sewage outfalls, were found wherever the water was mediocre or polluted.

Recreational use (swimming, windsurfing, waterskiing, sea-dooing, etc.) of a body of water contaminated by disease-causing bacteria may result in cases of dermatitis, otitis, conjunctivitis, gastroenteritis or other health problems.

In 1996, Beaubassin Beach in Bonaventure was the only beach where water quality was monitored as part of the MEF's *Environnement-Plage* program (rating of A in 1996). As only recent, regular testing would show for certain whether the water at a given location is safe, caution is recommended where the water is not monitored. Before engaging in an activity involving direct contact with the water, people should ask local authorities (MEF, Public Health Branch, municipalities) whether the water is clean. Nearby sewage or rainwater outfalls and notices prohibiting shellfishing are indications that the water quality at a given location may be poor, and caution should be exercised.

Injuries. In 1995, on the Gaspé Peninsula (including Chaleur Bay), 29 incidents involving pleasure craft (mostly motorboats) required assistance from the Canadian Coast Guard's Marine Rescue Subcentre in Quebec City. Mechanical breakdowns were the main cause

of trouble. Generally speaking, serious accidents are due to boaters' lack of training and knowledge, alcohol consumption, or the fact that life jackets are still not being worn much. Drowning, injury, hypothermia and psychological problems resulting from an accident are the main risks associated with boating in the Gulf of St. Lawrence. There were no boating deaths in Southern Gaspé–Chaleur Bay in 1995.

In 1995, the Marine Rescue Subcentre in Quebec City assisted 44 fishing vessels off the Gaspé Peninsula, most of which had some sort of mechanical trouble. This was a 20% decrease from the preceding year. Inadequate maintenance, due to groundfishers' economic problems, appears to be one of the causes of accidents.

5.5 Environmental Disasters

Natural disasters. Risks associated with natural disasters in the Southern Gaspé–Chaleur Bay area are due mainly to flooding. Since 1992, nine floods have caused property damage or necessitated evacuation. Most natural disasters occur along rivers or streams that empty into the Gulf or Chaleur Bay. In storms that coincide with periods of high tides, however, the areas at greatest risk are those on the sea, which means houses and roads along the shoreline are affected.

Although physical health problems (mainly resulting from unhygienic conditions) do not necessarily occur with every event of this type, the psychological and social impact of property damage or evacuation is far from negligible.

Technological disasters. So far, environmental disasters associated with the transport of dangerous goods have had little impact on the health of people living on the Gulf and Chaleur Bay. There is a potential risk, however, given the difficult navigation conditions in the area (strong tides, sea currents, etc.).

Most reported spills actually occurred in port, during transshipping operations. To date, however, these incidents have had little impact on human health.

5.6 Commercial Fishing Crisis

Dwindling fish stocks, moratoriums on fishing, and international market forces may exacerbate the social disintegration observed in coastal villages on the Gulf of St. Lawrence and, indirectly, lead to an increase in health problems among the inhabitants. It is now known that unemployment leads directly to illness: increased admissions for psychiatric problems, higher suicide rates, more cardiovascular disease, decreased immunity, and so on. Action to promote development consistent with sustainable use of resources is therefore highly desirable for all communities on the Gulf.

CHAPTER 6 Toward Sustainable Development of Southern Gaspé–Chaleur Bay

Sustainable development of Southern Gaspé–Chaleur Bay involves restoring and preserving for future generations the biodiversity of plant and animal life, their manifold uses and the quality of life associated with them. Any action taken in the area must ensure economic development while guaranteeing resource sustainability and environmental protection. Among the means advocated to achieve sustainable development are:

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

What we are doing now is attempting to identify the main environmental issues in the area and describe existing programs and measures that foster sustainable development (Table 1). This review is in no way exhaustive and is simply meant to provide a basis for discussion among local stakeholders who will have to set local priorities and develop strategies to implement their ecological rehabilitation action plans (ERAPs).

6.1 Reducing Pollution

Since the early 1990s, major efforts have been devoted to controlling local sources of pollution in the Southern Gaspé–Chaleur Bay area, especially with regard to municipal and industrial effluent. With the commissioning of the sewage treatment plants in Gaspé, Chandler, Hope and Pointe-à-la-Croix in 1997 and 1998, over 58.7% of the total population will have its sewage treated, but it is still too early to say whether these measures will be sufficient to solve the problem of bacteriological contamination of the shoreline habitats. A few municipalities with sewer systems have not yet shown any intention of treating their sewage. In addition, a large part

of the population uses septic tanks and cesspits which may or may not be up to standard, and the overflow systems of existing treatment facilities are still sources of contamination in rainy weather.

Despite its remoteness from the main sources of toxic contamination, the study area is exposed and vulnerable to the deleterious effects of persistent toxic substances in the environment, as shown by the decline of the Northern gannet population on Bonaventure Island in the 1970s. Except for this example, the lack of recent data makes it impossible to identify specific patterns of contamination by place and time and to determine the impact of the contamination.

6.2 Protecting Sensitive Species and Habitats

Although there are a number of protected sites in the study area, several other important plant and wildlife habitats are in need of protected status, including the mouths of the Dartmouth, York and Saint-Jean rivers, the bar at Sandy Beach, the barachois on the Malbaie River, Grand Pabos Bay and Paspébiac bank, the Nouvelle River and the Oak Bay marsh (Restigouche estuary). Local organizations are trying to provide some of these places with some sort of protection.

Many places in the study area, such as spring, fall and winter waterfowl gathering areas, the Harbour seal and Grey seal haulouts, and the waters surrounding the sea-bird colonies are particularly sensitive to oil spills. To limit bird mortality, the Canadian Wildlife Service has established a bird cleaning centre at Forillon to serve the entire eastern Gaspé Peninsula and Chaleur Bay. The port of Gaspé has equipment to deal with oil spills, but similar capacity in Chaleur Bay is apparently limited.

The distribution and status in the study area of populations of many priority plant and animal species requiring protection under St. Lawrence Vision 2000 are unknown.

6.3 Restoring Disturbed Habitats and Resources

A number of studies regarding restoration of disturbed shoreline habitats — the barachois at Chandler (Grand Pabos), Paspébiac, New Carlisle and Bonaventure — have recently

been completed or are underway. On the New Brunswick side, dredging has been done in the port of Belledune since 1993 to decontaminate it. No rehabilitation is yet planned for the port of Gaspé (Sandy Beach). In the case of the heavily-contaminated barachois at New Carlisle, the removal of polluted sediment is currently being studied.

A number of measures have been taken since 1993 to promote the recovery of the groundfish populations of the southern Gulf of St. Lawrence; most aim to reduce mortality caused by fishing. A moratorium on fishing Atlantic cod has been in effect since 1993. Other measures, such as increasing the mesh size of fishing gear, installing a fish escape mechanism on shrimp trawls, closing fishing areas when cod by-catch exceeds a certain limit, and reducing fishing quotas, have helped cut the cod by-catch of other fisheries considerably. In the case of Canadian plaice, a major reduction in allowable catches and the use of more selective fishing gear are the chief measures taken to help the population recover. To improve lobster populations, it has been compulsory since 1994 to have exit holes on lobster traps to allow small specimens to escape. Since 1993, egg-bearing females have been marked and returned to the water, and must be thrown back if caught again in subsequent years.

Our knowledge of the mechanisms responsible for natural variations in animal populations is still incomplete, however. If sustainable development of fishery resources is to be possible, the critical stages in the development of species must be identified, as must the physical and biological factors that have the greatest impact on individual survival, growth and fertility.

6.4 Managing Commercial Fisheries Efficiently

The recovery and conservation of fishery resources must be coupled with new approaches aimed at ensuring the sustainability of commercial fishing. To this end, the federal government has begun a complete overhaul of the fishery support system. The guiding principles being used are that resource conservation is essential and overrides all other considerations, that a balance must be found between the industry’s capacity and the tolerance of the resource, that the fishery must call upon professionals to ensure efficient operations, that each enterprise must hold

several licences in order to make it easier to adapt to changes in resources, that closer partnership between the fishery and government must be effective, and that the rights of aboriginal peoples must be respected. Two of the main measures taken since 1993 are the (voluntary) groundfish licence retirement program and the imposition of new fishing fees based on the value of landings. Industry stakeholders have, for their part, set certain priorities to ensure sustainability, including increasing the harvest of underutilized species (Sea urchin, Common rock crab, Spiny dogfish, ray, Harp seal, etc.), encouraging penetration of the Quebec market, introducing technical innovations, training, developing aquaculture, increasing the value added to products sold, and strengthening the place of youth at all rungs on the ladder to ensure there will be another generation of fishers and to keep young people from leaving for other lines of work and other regions.

6.5 Reconciling Recreational and Tourism Development with Environmental Protection

For many years the area has enjoyed strong growth in recreation and tourism thanks to the attractions of its shores and the sea. One of the major issues in the future will be to ensure sustainable development by protecting wildlife resources and their habitats, as well as the landscapes on which recreation and tourism depend. Among other things, it will be necessary to limit the disturbance of birds and marine mammals caused by increasingly frequent visitors to areas that had formerly been relatively inaccessible to the general public.

Table 1
Main sustainable development issues in Southern Gaspé–Chaleur Bay

Issues	*Assessment of current situation in terms of sustainable development objectives*	*Toward sustainable development*
Reducing Pollution		
• Treatment of municipal, household and agricultural wastewater	The sewage of 59% of the area's population will be sent to a treatment plant by 1998, but several municipalities still have no plans to treat their wastewater. Bacterial pollution restricts shellfishing and recreational activities in some places.	Use dependent on bacteriological quality of water can only be reclaimed by treating wastewater (treatment plants or efficient septic facilities), controlling overflows during rainstorms and controlling agricultural pollution.
• Treatment of paper mill effluent	The two paper mills in the study area have significantly reduced BOD_5 and SS loads, along with the toxicity of effluent discharged into the marine environment. In 1995, both mills started secondary treatment of their effluent.	Regulations require paper mill effluent to be monitored.
• Persistent toxic substances in the environment	Despite a considerable reduction in the various sources of contamination in the St. Lawrence drainage basin and the area's distance from the main sources of contamination, aquatic organisms in the area, especially fish-eating birds and marine mammals, are still exposed to bioaccumulative toxic substances. In general, chemical contamination of seafood is not a human health hazard.	A better understanding of the dynamics of these substances and their effects on marine organisms and human health is a major issue in the study area.
Protecting Sensitive Habitats and Species		
• Protected areas	Many areas in the ZIP are protected by laws and regulations, yet a number of sensitive environments are not legally protected.	Several other sensitive environments are in need of protection.
• Priority species	The distribution and status of the populations of several priority species in the area are unknown.	
• Protection against spills in the aquatic environment	Aquatic environments are vulnerable to hydrocarbon spills because of the many sea-bird colonies and gathering areas. There is an emergency response team in the study area.	A regional response team holds drills on a regular basis.
Restoring Disturbed Habitats and Resources		

Issues	*Assessment of current situation in terms of sustainable development objectives*	*Toward sustainable development*
• Barachois	Most barachois in the area have been adversely affected by filling, dikes, municipal and industrial effluent and log booming.	Several of the most disturbed barachois are now being restored and developed.
• Ports	A few commercial ports and fishing harbours in the area are highly contaminated by toxic substances, especially the port of Gaspé (Sandy Beach), where high concentrations of heavy metals have been found in the sediment.	There are no plans for environmental rehabilitation of any ports right now.
• Groundfish populations	Populations of cod and Canadian plaice in the area have been in very poor condition since the early 1990s due to overfishing and unfavourable climatic conditions.	Since 1993, many measures, including a moratorium on cod fishing, have been taken to reduce mortality due to fishing and thus foster the recovery of these populations.
Managing Commercial Fisheries Efficiently		
	Commercial fishing in the area is now going through the worst crisis in its history, due to the collapse of groundfish stocks, and is less and less able to provide employment to shoreline communities.	The government has begun a complete overhaul of the fisheries support system, with the guiding principal being resource recovery and conservation.
Reconciling Recreational and Tourism Development with Environmental Protection		
	Recreation and tourism in a marine environment is in the midst of a spectacular boom, but some types of activities threaten sea birds and marine mammals.	The impact of some recreational and tourism activities on resources is now being studied.

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Appendices

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1 St. Lawrence Vision 2000 Priority Species Present in Southern Gaspé–Chaleur Bay

Common or Latin name	*Type of distribution or status in the area*
Plants (17 of the 110 priority species)	
Anticosti aster	Endemic (Gulf of St. Lawrence)
Cutleaf daisy	Discontinuous
Dense whitlowgrass	Endemic (Gulf of St. Lawrence)
Dwarf huckleberry	Peripheral
Gaspé Peninsula arrowgrass	Endemic (northeastern North America)
Hooded arrowhead	Discontinuous
Longleaf arnica	Discontinuous
Macoun's fringed-gentian	Discontinuous
Male fern	Sporadic
Mat muhly	Sporadic
Monarch lady's slipper	Endemic (northeastern North America)
Needle beak-sedge	Peripheral
Northern hollyfern	Discontinuous
Rosa rousseauiorum	Endemic (Lower Estuary and Gulf of St. Lawrence)
Rosa williamsii	Endemic (Lower Estuary and Gulf of St. Lawrence)
Scented oakfern	Sporadic
Woolly beach-heather	Sporadic
Reptiles (none of the 6 priority species)	
Amphibians (no priority species)	
Fish (6 of the 14 priority species)	
American eel	Migrant along south shore and found in tributaries
American shad	Migrant along south shore
Rainbow smelt	Year-round resident; spawns in a few tributaries
Atlantic herring	Migrant; spawns along coasts
Atlantic sturgeon	Year-round resident
Atlantic tomcod	Common in spring and summer; spawns in a few tributaries

Common or Latin name	*Type of distribution or status in the area*
Birds (14 of the 19 priority species)	
Bald eagle	Migrant
Barrow's goldeneye	Winter visitor
Blue-winged teal	Confirmed nester
Caspian tern	Visitor
Common moorhen	Visitor
Harlequin duck	Confirmed nester
Horned grebe	Migrant
Least bittern	Visitor
Loggerhead shrike	Visitor
Northern pintail	Confirmed nester
Peregrine falcon	Possible nester
Piping plover	Visitor, former nester
Red-headed woodpecker	Visitor
Yellow rail	Probable nester
Mammals (4 of 5 priority species)	
Fin whale	Common in spring, summer and fall
Harbour porpoise	Common in summer and fall
Harbour seal	Year-round resident
Pygmy shrew	Unknown status

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 protect the health of people who may both drink water taken directly from a body of water and eat aquatic organisms caught there throughout their lives.
	Contamination of aquatic organisms (MEF, 1996)	To protect human health from the threat posed by consumption of aquatic organisms.
	Aquatic life (chronic toxicity) (MENVIQ, 1990, rev. 1992)	To protect aquatic organisms and their offspring, as well as the wildlife that eat them.
	Recreational activities (primary contact) (MENVIQ, 1990, rev. 1992)	To protect the health of humans engaging in a recreational activity in which the entire body is regularly in contact with the water, such as swimming or windsurfing.
SEDIMENT	No effect threshold (NET) (SLC and MENVIQ, 1992)	Contaminant levels below which no effects are seen on benthic organisms.
	Minimal effect threshold (MET) (SLC and MENVIQ, 1992)	Contaminant levels above which minor but tolerable effects on most benthic organisms are seen.
	Toxic effect threshold (TET) (SLC and MENVIQ, 1992)	Contaminant levels above which effects harmful to most benthic organisms are observed.
AQUATIC ORGANISMS	Fish marketing guidelines (Health and Welfare Canada, 1985)	Maximum contaminant levels in the flesh of fish and shellfish that are acceptable for marketing.
	Fish consumption guidelines (MENVIQ and MSSS, 1995)	Prevention of harmful effects of contaminants on human health associated with eating fish and shellfish.

3 Glossary

Anadromous: Refers to fish that, in the course of their life cycle, return from the sea to fresh water to spawn.

Benthos: The plants (phytobenthos) and animals (zoobenthos) that inhabit the bed of a body of water.

Biomass: The amount of living matter, taken as a whole or by systematic group, expressed in terms of a given unit of surface area or volume of habitat at a given time; examples are plant biomass, insect biomass, herbivorous biomass and carnivorous biomass.

Brackish: Refers to water with a salinity level in between that of fresh water (0.3 parts per thousand) and that of salt water (35 parts per thousand).

Catadromous: Refers to fish that live in fresh or brackish water and migrate to the sea to spawn.

Community: All plants and animals living in the same habitat.

Discharge: Volume of water flowing in a water course, pipe, etc., in a given unit of time. Usually expressed in m^3/s, but sometimes in L/s for small drainage basins. Also called *flow*.

Discontinuous distribution: Refers to a plant species found in an area or areas remote from its main range.

Drainage basin: The geographic catchment area from which the water (originating as precipitation) of a particular watercourse or body of water is drawn. Also called *watershed*.

Ecosystem productivity: Biomass produced each year to maintain the balance between animal and plant populations.

Ecosystem: Entire physical and chemical environment (biotope, or habitat) and all the living organisms in it (biocenosis, or community), which can perpetuate itself indefinitely with inputs of matter and energy.

Effluent: General term for any emission, chiefly liquid, from a source of pollution, whether a residential area (municipal effluent, or sewage) or an industrial plant (industrial effluent, or wastewater). Outfalls or sewers: places where liquid pollutants are discharged.

Endemic: Refers to a species that is confined to a particular area.

Estuarine circulation: Movement of water typical of estuaries, characterized by a downstream flow at the surface and an upstream flow at the bottom.

Foreshore: That part of the shore lying between the high and low water marks. Also called *strand*, or *mesolittoral* or *intertidal zone*.

Habitat: Particular environment or place 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.

Non-point source pollution: Pollutants indirectly introduced into a given environment. Agricultural runoff is non-point source pollution, since fertilizers and pesticides are spread over large areas. Also called *diffuse pollution*.

Nutrient: Simple substance absorbed by plants and used in photosynthesis. The basic nutrients are nitrates, phosphates and silicates.

Plankton: Animal (zooplankton) or plant (phytoplankton) organisms that live suspended in oceans or 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: All of the features of the flow of a watercourse 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 (larger than 0.45 µm) floating in a liquid. Also called *suspended particles* or *suspended load* (see Sediment). Abbreviation: SS.

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 solids.

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

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

Waterfowl: Collective name for geese and ducks.

Year class: All the young of a species produced in one annual spawning season.

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