Atlas of Sites of Interest for Conservation along the Estuary and Gulf of St. Lawrence Coastline

Methodology Report

October 2019

Canada

www.planstlaurent.qc.ca

Québec

This document should be cited as follows:

Suggested citing:

Jobin, B., L. Gratton and P. Desautels. 2019. Atlas of Sites of Interest for Conservation along the Estuary and Gulf of St. Lawrence Coastline – Methodology Report. Environment and Climate Change Canada and ministère de l'Environnement et de la Lutte contre les changements climatiques, St. Lawrence Action Plan, Québec, 92 p.

Cover photos: © Thinkstockphotos ou nom auteur

Cat. No. : En154-102/2019E-PDF
ISBN : 978-0-660-32210-0

Aussi disponible en français sous le titre : Atlas des milieux côtiers d'intérêt pour la conservation dans l'estuaire et le golfe du Saint-Laurent - Rapport méthodologique

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Acknowledgments

We would like to thank all those who participated in the production of this atlas by sharing their knowledge, data or time, particularly Jean-François Rail, Josée Tardif, Pierre Aquin and Karine Picard from the Canadian Wildlife Service of Environment and Climate Change Canada; Line Couillard, Jacques Labrecque, Guy Jolicoeur, Vincent Piché, Frédéric Poisson, Tingxian Li and Olivier Pfister from the ministère de l'Environnement et de la Lutte contre les changements climatiques; Normand Villeneuve, Marc Mingelbier, Antoine Nappi, Nathalie Desrosiers, Claudine Laurendeau, Valérie Simard and Marc-Antoine Couillard from the ministère des Forêts, de la Faune et des Parcs; Anne Lagacé from the Department of Fisheries and Oceans Canada; Michèle Dupont-Hébert from the Bureau d'écologie appliquée and Chantal Quintin from the Université du Québec à Rimouski.

Abstract

One of the projects under the biodiversity conservation theme of the St. Lawrence Action Plan is the development of an integrated plan for conserving the St. Lawrence's natural environments and biodiversity. Identifying the sites where the conservation needs are the most urgent was the first step in this integrated planning process leading to the production of the Atlas of sites of interest for conservation in the Estuary and Gulf of St. Lawrence coastal regions. Conservation targets (coarse filter) selected for this atlas are forested areas, inland wetlands, coastal marshes and sandy environments. For each selected targets, sites of interest for conservation were determined up to a representativeness threshold of 20% for a given spatial reference unit (e.g., territorial zones - grouping of ecological districts). To do so, sites with high conservation interest were first selected, those sites being located within or adjacent to protected areas or exceptional forested ecosystems, sites hosting species at risk, sites bordering salmon rivers, or those having unique ecological features. A prioritization analysis was then carried out on conservation targets using a multi-criteria analysis when the 20% representativeness threshold was not reached following the selection analysis. Other sites of interest not covered with the coarse filter targets and representing local sites with high conservation value were also determined (fine filter), such as bird colonies, eelgrass beds, important wildlife elements (critical habitats of species at risk, Bank Swallow and Chimney Swift nesting sites, Harlequin Duck winter concentration sites, breeding and rearing habitat for Rainbow Smelt in the southern St. Lawrence Estuary, etc.), important plant occurrences and salmon rivers.

This atlas describes the regions where many sites of interest for conservation are concentrated. It also compares these sites with existing planning documents. In addition, since the geospatial data associated with these sites are publicly available, this allows users to better visualize the geographical location of the sites of interest and the conservation value associated with each habitat patch of the conservation targets (forested areas, inland wetlands, coastal marshes, sandy environments) using geographic information systems (e.g., ArcGIS). Users will also have the opportunity to adapt the determination of sites of high conservation value given their own spatial territory and conservation objectives.

The development of conservation strategies for natural sites and land-use planning will guide the selection of concrete conservation actions for sites where the need is greatest. Since conservation of natural environments and species at risk is a shared responsibility, this atlas will address the priorities of numerous organizations involved in the conservation of coastal environments, i.e., conservation organizations, municipalities and RCMs, government organizations and academic institutions. In addition, because this atlas is intended to be a tool in landscape and land-use planning, we believe upcoming conservation strategies for natural sites can be oriented towards sites with high conservation value and facing coastal hazards, or include them in the planned review of RCMs' and municipalities' land use and development plans.

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1. Introduction

Since 1988, the governments of Canada and Quebec have been working together to conserve and enhance the St. Lawrence River through the St. Lawrence Action Plan (SLAP, 2015). With the aim of continuing this work while also adapting to emerging issues facing the St. Lawrence, the two governments made a commitment in 2011 to renew this partnership for a period of 15 years. This plan is also known as the Canada–Quebec Agreement on the St. Lawrence (SLAP, 2015). Joint action projects are grouped within three main themes: conserving biodiversity, ensuring sustainable use of the St. Lawrence and improving water quality.

One of the projects aimed at biodiversity conservation involves developing an integrated plan for conserving the St. Lawrence's natural environments and biodiversity. Identifying sites of interest for biodiversity conservation was the first step in the integrated planning process. This led to the production of the current Atlas. The second step in the process will be the development of strategies for land-use planning and for conserving natural environments, in order to focus concrete action on locations where the need is greatest. Together, these two stages of the project – the atlas and the conservation strategies – will constitute the plan for conserving natural environments and biodiversity in the St. Lawrence.

Because this project covers a vast area, the decision was made to produce two separate conservation plans: one for the Quebec portion of the St. Lawrence Lowlands (Jobin et al., 2018) and the other for the coastal environments of the Estuary and Gulf of St. Lawrence. Therefore, this report describes the process leading to the production of the Atlas of Sites of Interest for Conservation along the Estuary and Gulf of St. Lawrence Coastline.

1.1. Why produce an atlas of coastal sites that are priorities for conservation?

Conservation planning for natural environments of interest in southern Quebec is not new. A review of the conservation plans for areas of interest carried out between 2000 and 2016 revealed that many plans had been produced by various stakeholders (governments, municipalities, conservation organizations) and at various spatial scales (municipalities, RMCs, watersheds, etc.) (Lebel, 2014; Dupont-Hébert, 2017). A number of sites that have high ecological value and deserve adequate protection have already been identified in the coastal areas of the Estuary and Gulf of St. Lawrence. How will this atlas be different from the previous planning exercises?

1) Existing conservation plans for the regions of the Estuary and Gulf of St. Lawrence were very useful in guiding the conservation measures implemented at the local or regional scale by the organizations that produced them. However, the majority of those plans cover regions concentrated in the Bas-Saint-Laurent region and the Gaspé Peninsula, which are experiencing the most pressure from human activity. The Atlas of Sites of Interest for Conservation along the Estuary and Gulf of St. Lawrence Coastline will fill in the gaps in regions where conservation planning has not been done and will provide much-needed support to organizations that have limited resources for carrying out such analyses. It will also be a resource for updating existing plans or completing plans for ecosystems that, until now, have not been considered.

2) The analyses conducted for the atlas are based on the latest and most precise data on the distribution of natural environments and of certain taxonomic groups. We also consulted numerous experts specializing in various taxonomic groups so that the atlas will contain the latest and most precise information about the distribution of plant and wildlife species at risk in Quebec and about rare ecosystems such as exceptional forest ecosystems, bird colonies, or important spawning grounds.

3) An analysis of the existing conservation plans shows that past planning exercises have focused mainly on wetlands, forested areas and species at risk. Yet other types of ecosystems or individual elements of importance for maintaining biodiversity are present in the study area and must be located and recognized in order to effectively guide conservation actions. The aim is therefore to bring together, in one atlas, the areas of interest for conservation of the biodiversity found along the Estuary and Gulf of St. Lawrence coastline.

The atlas will focus on sites located along the coast and inland. It is important to specify that sites of interest will not include marine and benthic ecosystems.

1.2. Who is the atlas of coastal sites of conservation interest intended for?

Bringing together the conservation needs for the major ecosystem types of the St. Lawrence Lowlands in a single atlas will address the conservation priorities of many stakeholders involved in conservation in Quebec (Figure 1), primarily conservation organizations, municipalities, RCMs, government organizations, and academic institutions.

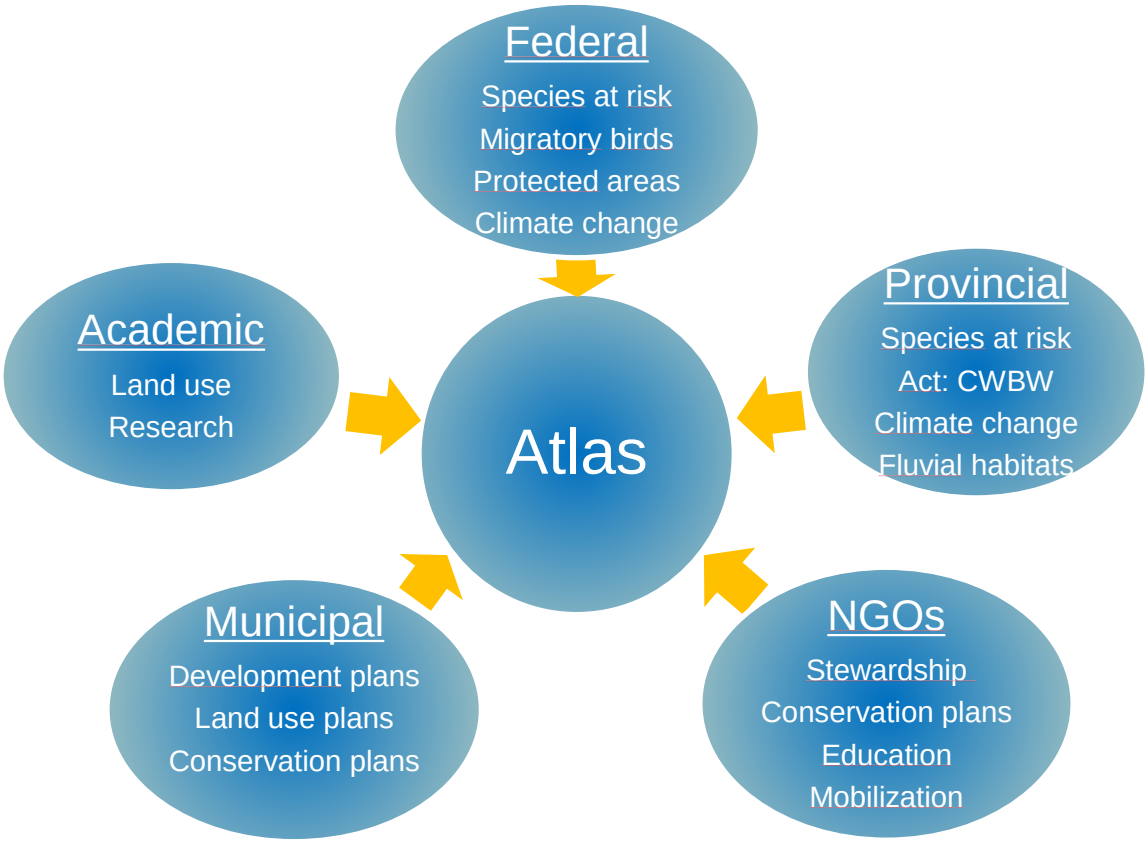

Figure 1. Action priorities for the primary conservation stakeholders in Quebec

Since the responsibility for conservation of natural environments and species at risk is shared by several levels of government, the atlas will address the priorities of the government organizations, both federal and provincial, that are involved in the project. The identification of sites of interest for conservation of migratory bird habitat in the Estuary and Gulf of St. Lawrence will support the bird conservation strategy developed by Environment and Climate Change Canada (ECCC) (ECCC, 2017a). Similarly, identifying important habitat for species at risk will support conservation action by ECCC and the Ministère de l'Environnement et de la lutte contre les changements climatiques (MELLC) and the Ministère des Forêts, de la Faune et des Parcs (MFFP). This will guide RCMs in developing regional plans for wetlands and water bodies by June 2022 as required under the new Quebec legislation, *An Act respecting the conservation of wetlands and bodies of water* (Gouvernement du Québec, 2017). Bringing together the conservation priorities of the different levels of government (federal and provincial) in the same document will pave the way for making optimal use of resources while working toward common objectives, for example, to guide decisions about priorities for action under the federal and provincial funding programs.

Lastly, because the atlas will complement existing land use planning, the results of this project will be useful for organizations that want to know which sites are of high interest for conservation in their respective areas, so that they can target their conservation actions accordingly. Public dissemination of the geospatial data and the analysis methods will enable regional stakeholders to adapt the analyses to their needs and realities. Ultimately,

the intent is that the sites of interest can be taken into consideration in reviews of RCMs' and municipalities' land use and development plans. Thus, the atlas is intended as a tool to assist with land-use planning that will complement the conservation planning exercises already carried out in a number of areas along the Estuary and Gulf of St. Lawrence.

1.3. Conceptual framework: Open Standards for the Practice of Conservation

The "Open Standards for the Practice of Conservation" approach (hereinafter, Open Standards) was used to create the conservation plan for the coastal environments of the Estuary and Gulf of St. Lawrence. The Open Standards are a conceptual framework that is internationally recognized and used in planning projects for the conservation of species, ecosystems and protected areas, regardless of the scale, duration and scope of the conservation initiative. They were created by the Conservation Measures Partnership[7], an international group of organizations dedicated to protecting nature by employing principles that have been tested in various areas of natural resources management. The standards include concepts, methods and a common terminology for planning, managing and implementing conservation projects. The Open Standards set out an adaptive management cycle that helps identify conservation targets, develop strategies, design conservation activities, measure their effects and focus on those that are most effective (Figure 2). They also served as a framework for designing the adaptive management software program Miradi[8]. This software guides managers through the different stages involved in using the Open Standards (CMP, 2013).

The production of an atlas of sites of interest for conservation falls within the first stage: conceptualization. This stage consists of:

- Determining the goal of the planning process
- Deciding who will be part of the project team
- Articulating the project's thematic and/or geographic scope
- Defining the vision to be achieved
- Determine the conservation targets and;
- Evaluate the existing threats.

It also involves presenting an analysis of the situation by identifying, in advance, the enabling conditions and the stakeholders that will play a key role in planning the actions and the monitoring program to be implemented as part of the action plan (CMP, 2013).

[7] www.conservationmeasures.org/

[8] www.miradi.org

Figure 2. Adaptive management cycle for a project according to the Open Standards

2. Goal of the planning process

The biodiversity of the St. Lawrence provides many ecosystem services that benefit communities. Although rich and diversified, it is subject to numerous pressures, and in many ways it remains fragile. Habitat loss and alteration resulting from human activity and disturbance of shoreline resulting from climate change are the main threats to the biological diversity of the coastal environments of the St. Lawrence. Biodiversity conservation is one of the priority issues of the St. Lawrence Action Plan and since the resources available for carrying out conservation projects are limited, it was agreed that it was essential to increase the effectiveness of actions taken and to develop common planning tools for identifying sites of interest and implementing actions for maintaining biodiversity along the St. Lawrence (SLAP, 2015).

The goals to be achieved through the preparation of the conservation plan for the coastal environments of the Estuary and Gulf of St. Lawrence are as follows:

1) First, produce the Atlas of Sites of Interest for Conservation along the Estuary and Gulf of St. Lawrence Coastline, identifying the sites to be prioritized for conservation in order to maintain biodiversity. Specifically, the objectives are as follows:

a) Maintain the remarkable elements of the biodiversity of the Estuary and Gulf of St. Lawrence coastlines, including rare ecosystems, species assemblages, and habitats of rare or unique species.
b) Ensure that, taken together, the sites are representative of each type of ecosystems found in the Estuary and Gulf of St. Lawrence in order to attain the objective of 20% representativeness for each spatial reference unit.

2) Second, carry out one or many action plans to support organizations in developing and implementing conservation strategies and actions.

3. Project team

The governments of Canada and Quebec are working together to conserve and enhance the coastal environments of the Estuary and Gulf of St. Lawrence through the St. Lawrence Action Plan. The Open Standards specify that the initial project team must include key personnel from the organizations involved and external partners whose roles and responsibilities have been clearly defined. The team for implementation of the conservation plan for the coastal environments of the Estuary and Gulf of St. Lawrence is made up of a professional from ECCC, a consultant who specializes in Open Standards, and a consultant in geospatial analyses. Several collaborators contributed to the project, from the ministère de l'Environnement et de la lutte aux changements climatiques, Nature Conservancy of Canada and the Bureau d'écologie appliqué. The composition of the team may change during the management cycle.

In order to make optimal use of existing skills and identify the best knowledge available for carrying out the atlas, the project team reached out to several experts and advisors to whom the team can turn for input and advice, including a few stakeholders in the implementation of the conservation plan. The list of contributors and experts who contributed to the project is found in the "Production team" and "Acknowledgments" section of this report.

4. Vision

A vision statement is a general summary of the desired or ultimate condition of the study area targeted by the project, on which a consensus has been reached among the members of the project team (CMP, 2013). The vision statement guiding the conservation plan for the coastal environments of the Estuary and Gulf of St. Lawrence is as follows:

> *"By 2050, the Estuary and Gulf of St. Lawrence coastlines are recognized for their remarkable biodiversity. In addition to maritime forests, they include barrens, freshwater wetlands, saltmarshes and seagrass beds, beaches and dunes. These environments support many species at risk that depend on the rich habitats they provide, numerous seabird colonies, as well as most salmon rivers in eastern Quebec. The integrity of this natural heritage is made possible by the concerted action of governments at the federal, provincial and municipal levels, conservation groups, and local stewardship committees toward the goal of managing these resources sustainably while adapting to climate change."*

5. Scope of project

The Atlas of Sites of Interest for Conservation along the Estuary and Gulf of St. Lawrence Coastline has a geographic scope, that is, it targets a defined area for which strategies and actions will be implemented to achieve specific conservation objectives (CMP, 2013). The limits of the study area correspond to those of the ecological districts (level 4 of the MELCC's Cadre écologique de reference du Québec [ecological reference framework; CERQ]) bordering the Estuary and Gulf of St. Lawrence. The limits of a few districts have been truncated because they extend far inland from the coastline. This is the case for a few district located in the Lower North Shore (E020204-Buttes du Lac à l'Eau Claire, E020205-Buttes du Lac Auger) and in the Gaspé Peninsula (A040602-Moyen plateau érodé de la rivière Malbaie). In addition, several islands located along the coastline have been added to the study area, notably in the Blanc-Sablon, Harrington Harbour, Mingan, Sept-Îles, Rimouski, Rivière-du-Loup, Baie-Saint-Paul and Percé area. The total land cover of the study area is 33 982 km^2.

The area covered by the atlas extends along the north shore of the St. Lawrence from Cap-Tourmente to Blanc-Sablon. On the south shore of the St. Lawrence, it begins at Kamouraska in the Estuary and encompasses the coastal environments of the entire Gaspé Peninsula as far as Matapedia, where the Restigouche River flows into Chaleur Bay. It includes all of the islands in the Estuary and Gulf of St. Lawrence, except for the Isle-aux-Grues archipelago, which is covered in the Atlas of Sites of Interest for Conservation in the St. Lawrence Lowlands (Jobin et al., 2018). The Magdalen Islands are also excluded, since a number of conservation plans have been produced for them in the past (Bouffard and Poirier, 2002; Turbide and Longuépée, 2008; Cyr and Deraspe, 2012; Attention FragÎles/Groupe de référence en environnement des Îles-de-la-Madeleine, 2012); the most recent is that of the Nature Conservancy of Canada (Monticone et al., 2015). A short description of threats and conservation issues in the Magdalen Islands is presented in section 16. The atlas does not cover the pelagic environment or the marine species managed by Fisheries and Oceans Canada; that federal department has produced the Gulf of St. Lawrence Integrated Management Plan (Fisheries and Oceans Canada, 2013).

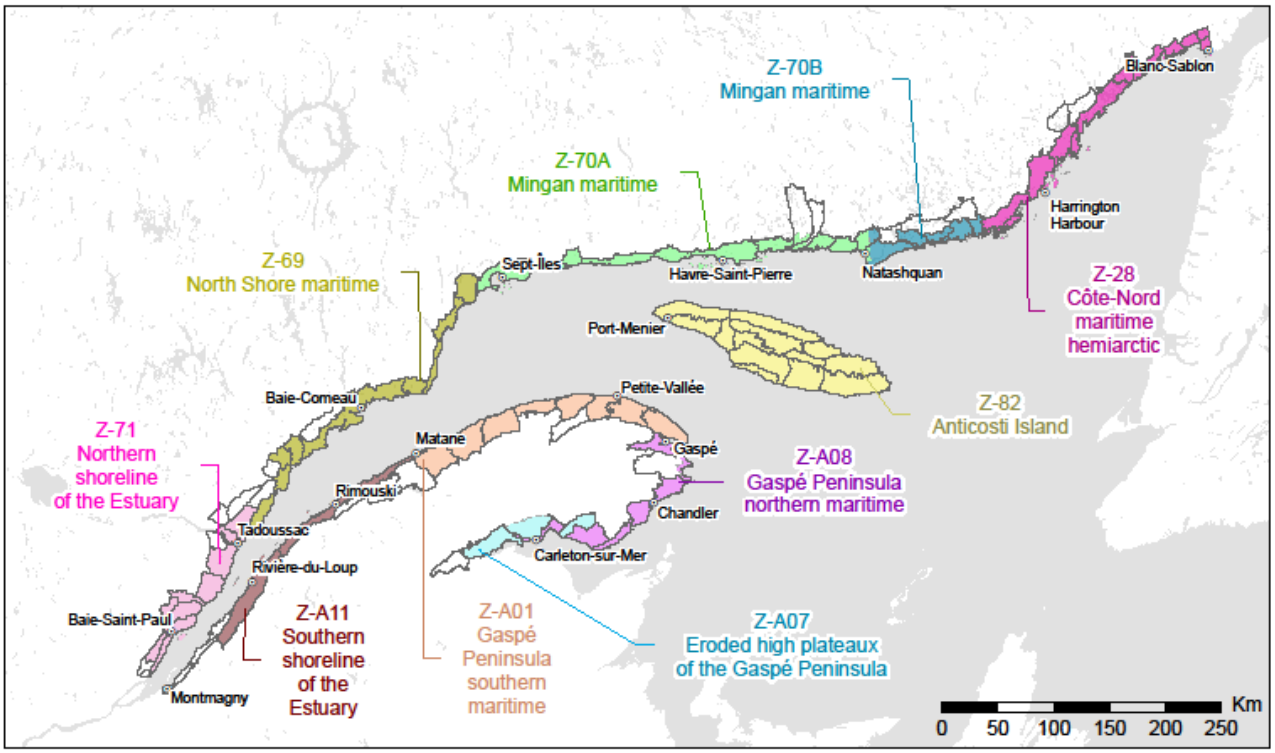

Figure 3.Study area covered by the Atlas of Sites of Interest for Conservation along the Estuary and Gulf of St. Lawrence Coastline

5.1. Spatial reference : territorial zones

To determine areas of conservation interest that reflect regional ecological contexts in achieving representativeness objectives (see Section 11), the ecological districts of the study area were grouped to form 10 territorial zones (figure 3; table 1; F. Poisson, MELCC; pers. comm.). This ecological regionalization comes from the concept of "territorial zones" proposed by Poisson et al. (2016) as part of the development of the Atlas de la biodiversité du Québec nordique [Northern Quebec biodiversity atlas; available in French only]. In the current atlas, only portions of the territorial zones along the Estuary and Gulf were used for analysis. Note that zone Z_70 was divided into two distinct zones (Z_70A and Z_70B) because of different spatial scale and accuracy of available geospatial data related to forests for this region. As such, the respective limits of the Système d'information écoforestière (SIEF) and of the Projet d'inventaire écoforestier du Québec nordique (PIEN) match this limit between zones Z_70A and Z_70B.

Table 1. Territorial zones located in the study area.

Territorial zone	Name	Area (km^2)	Region	Limits
Z_28	Côte-Nord maritime hemiarctic	3 731	Lower North Shore	Blanc-Sablon to Baie des Loups (east of La Romaine)
Z_70B	Mingan maritime	1 585	Lower North Shore	Baie des Loups (east of La Romaine) to the mouth of Natashquan river
Z_70A	Mingan maritime	3 788	Lower North Shore	Mouth of Natashquan river to Port-Cartier
Z_82	Anticosti Island	7 847	Anticosti Island	Anticosti Island
Z_69	North Shore maritime	3 709	North shore of estuary	Port-Cartier à Les Bergeronnes
Z_71	Northern shoreline of the Estuary	3 058	North shore of estuary	Les Bergeronnes to Cap Tourmente
Z_A11	Southern shoreline of the Estuary	2 043	South shore of estuary	Kamouraska to Sainte-Félicité
Z_A01	Gaspé Peninsula southern maritime	4 516	Gaspé Peninsula	Sainte-Félicité to Gaspé
Z_A08	Gaspé Peninsula northern maritime	2 211	Gaspé Peninsula	Gaspé to Carleton-sur-Mer
Z_A07	Eroded high plateaux of the Gaspé Peninsula	1 493	Gaspé Peninsula	Carleton-sur-Mer to Matapédia

6. Ecological context

6.1. Geology, topography, hydrography

The study area includes the coastlines of five natural provinces, as defined in the Cadre écologique de référence du Québec (CERQ). North of the St. Lawrence lie the Southern Laurentians, the Central Laurentians and the Lower North Shore Plateau. At the heart of the St. Lawrence is the natural province of the Estuary and Gulf of St. Lawrence. South of the St. Lawrence are the Appalachians (Li et al., 2014).

The three natural provinces that lie north of the St. Lawrence have a common geological history as the roots of a mountain range that is part of the Canadian Shield, laid down almost 1 billion years ago (bya), during the Grenville orogeny. Metamorphic and intrusive rocks dominate the bedrock, but a small area north of Baie-Johan-Beetz is covered with Mesoproterozoic sedimentary rocks and Paleozoic sedimentary rocks outcrop at Havre-Saint-Pierre and Blanc-Sablon. Most of the bedrock of the islands in the Estuary and Gulf of St. Lawrence is made up of Paleozoic sedimentary rocks belonging to the platform of the St. Lawrence and the Appalachians. Islands located along the Lower North Shore coastline lie on gneissic rocks of Grenville. South of the St. Lawrence, the Appalachians are a strongly folded ancient mountain range that was laid down over a period extending from 480 to 250 million years ago (mya). The bedrock is composed of sedimentary rock (sandstone, limestone and argillite) that has been folded and, in some places, highly deformed (Li et al., 2014).

The topography of the coastal areas varies. On the north shore, the shoreline is mountainous, except for the area located between Magpie and Natashquan rivers, where there is a narrow coastal plain. In the Laurentians, glacial deposits are often shallow and cover the interfluves, while glaciofluvial sand and gravel fill the valley bottoms. Along the Lower North Shore, the bedrock is often exposed, interspersed with shallow glacial deposits on the plateaus and massifs. Extensive peatlands colonize the delta and littoral sand (Li et al., 2014). At altitudes below 100 metres, the terrain of the south shore of the Estuary is relatively flat. Moving inland and toward the Gulf, it becomes increasingly rugged (Robitaille and Saucier, 1998). At Chaleur Bay, the terrain smooths out once more, forming a coastal plain. Glacial deposits – often deep, somewhat stony, and fine-textured – cover most of this terrain. Sand and gravel, sometimes in very thick layers, fill the valley bottoms (Li et al., 2014).

Both north and south of the St. Lawrence, the hydrographic network is very well developed and most often follows the structural direction of the bedrock, which overall is oriented north–south. More than 50 major rivers flow directly into the Estuary and Gulf of St. Lawrence. At their mouths, the dynamics of the nearshore currents and sedimentation lead to the creation of extensive coastal wetlands that are influenced by the semi-diurnal tides (two per day) that cause the water levels and currents to fluctuate (Gagnon, 1998). It is partly because of the tides that freshwater and saltwater mix, causing a rapid increase in the salinity of the water. In the brackish section, salinity increases from 0.5 parts per thousand (0.5 ppt) at Cap-Tourmente to 18 ppt at Isle-aux-Coudres. At Tadoussac, the salinity reaches and 30 ppt (Gagnon, 1998). This strong variation in the salinity of the water directly affects the biodiversity of coastal habitats.

6.2. Climate

According to Litynski's (1988) classification of world climates, the Estuary and Gulf of St. Lawrence falls simultaneously into two climate classifications. The upstream portion of the south shore and Chaleur Bay, in climate class 14, is characterized by moderate temperatures with an annual average between 2.9°C and 6.6°C, a subhumid precipitation regime (800 to 1,359 mm/year) and a long growing season (180 to 209 days). The north shore and the downstream portion of the south shore are in climate class 15, with subpolar temperatures including an annual average of between -0.4 °C and 3.7°C, a subhumid precipitation regime and a moderate growing season (150 to 179 days) (MDDEP, 2002). In winter, ice cover on the north shore is less extensive than on the south shore, and this difference could influence the distribution of some aquatic bird species such as Barrow's Goldeneye (*Bucephala islandica*) (Robert et al., 2003).

6.3. Natural environments and biodiversity of interest

The distinctive biodiversity of these coastal environments notably includes the maritime forests; the saltmarshes; the hundred or so islands, most of them part of archipelagos that dot the Estuary and the Gulf; and the large number of salmon rivers that flow into them.

The diversity of the forests in the study area is particularly influenced by the wide range of latitude, which, from west to east, transitions from the northern temperate zone to the boreal zone. Another contributing factor is the variety of landscapes, from coastal plains on the shores of the Estuary and the Gulf of St. Lawrence and Chaleur Bay to the massifs

in Charlevoix and the Gaspé Peninsula. On the narrow coastal plain at Chaleur Bay and on the south shore of the Estuary, agricultural land use dominates and forest ecosystems are rare, most often limited to soil that is unsuitable for agriculture and to islands. Although they lie within the balsam fir–yellow birch domain, that type of forest is rare there. On exposed sites, it is replaced by balsam fir–white spruce stands better adapted to typically maritime climate phenomena such as high winds and thick fog. The most rigorous conditions of the coastal climate create unique ecosystems: forests with a stunted growth habit (krummholz) and maritime barrens.

At higher altitudes, strong winds and snow also alter tree morphology. On some craggy rock faces, balsam fir and white spruce become stunted and very dense. On peaks and escarpments, sedimentary rock eroded by the freeze–thaw cycle forms shallow alteration deposits, often accompanied by rock outcrops and shallow till. These habitats favour a unique Arctic–alpine flora (Gilbert, 2003). North of the St. Lawrence and on the north shore of the Gaspé Peninsula, coniferous forests predominate, especially balsam fir–white birch and black spruce stands (Robitaille and Saucier, 1998). On the Lower North Shore, near the rocky coast between Natashquan and Blanc-Sablon, short, sparse vegetation grows among the outcrops of rock (Li et al., 2014).

In the St. Lawrence Estuary, the saltmarshes are located mostly on the south shore, where the relatively flat topography of the shorelines is conducive to their formation. In the Gulf, however, they have mostly formed behind spits or barachois built up of sand, gravel or pebbles. There are two types of barachois: an estuarine barachois, which forms at the estuary of a watercourse and is partially closed off by a spit; and a lagoon-type barachois, which forms in a bay and may be fed by one or more tributaries but receives negligible freshwater input (Tremblay, 2002). Both are high-value habitats for wildlife. Their location in the heart of the St. Lawrence migratory corridor makes them important habitats for the conservation of many bird populations (Nature Québec, 2018). Together, the coastal ecosystems support more than 300 species of birds (Pelletier-Gilbert et al., 2011), and the hundred or so Atlantic salmon (*Salmo salar)* rivers that flow into the Estuary and Gulf of St. Lawrence may make it one of the most important locations in North America for this anadromous fish, whose numbers are declining everywhere in its global range (COSEWIC, 2010).

As of January 2016 (for plant species) and February 2016 (for wildlife species), the study area was frequented by 114 terrestrial species at risk (excluding fish and marine mammals), of which 5 are designated endangered, 10 are designated threatened, and 9 are designated species of special concern in Canada under the *Species at Risk Act* (S.C. 2002, ch. 29); and 18 are designated threatened and 9 are designated vulnerable in Quebec, under the Quebec *Act Respecting Threatened or Vulnerable Species* (R.S.Q., c. E-12.01) (Appendix A). In addition, 12 wildlife species and 61 plant species in the study area are likely to be designated threatened or vulnerable in Quebec but are not listed as species at risk in Canada, for example the Nelson's Sparrow (*Ammodramus nelsoni*). In addition, 29 bryophyte species likely to be designated threatened or vulnerable in Quebec have been recorded in the study area.

6.4. Protected areas

Based on the Quebec government's Registre des aires protégées (register of protected areas; MDDELCC, 2018a) and the Protected Natural Habitat Registry in Quebec (RMN, 2018), the protected areas located within the study area of this Atlas represent 2,357 km^2 (6.9% of the study area). The complete list of protected areas appears in Appendix B. The protected areas belong to the following groups:

- Federal protected areas: National Parks, the Marine Park, the National Park Reserve, National Historic Sites of Canada, National Wildlife Areas and Migratory Bird Sanctuaries.
- Provincial protected areas (excluding legally designated wildlife habitats): Quebec provincial parks, ecological reserves, aquatic reserves, biodiversity reserves, wildlife refuges, salmon rivers, designated plant habitats, exceptional forest ecosystems.
- Municipal protected areas: parks of value for recreation, tourism and conservation, and regional urban parks.
- Areas protected by a charter issued by a private organization, by institutions or by individuals whose private land has received recognition as a nature reserve.

Effective protection of biodiversity varies depending on whether the protected areas fall into any of the management categories of the International Union for the Conservation of Nature (IUCN) (Dudley, 2008). Many areas that do not correspond to the conservation status categories recognized by the IUCN have nevertheless received international recognition, including the Charlevoix World Biosphere Reserve and the Manicouagan-Uapishka World Biosphere Reserve. In addition, there are 45 Important Bird Areas (IBAs), which recognize a natural area as being critically important as a corridor for migratory birds (Nature Québec, 2018).

7. Threats

Although many human activities may have locally severe impacts (e.g., port development, mining, hydroelectric and wind power development, industrial development), the threats described here are those that are likely to have a greater impact on ecosystems. The threats are presented in a relative order of importance.

7.1. Climate change

A quarter of the built environment and the main local roads that serve the study area are located along the shoreline, less than 500 m from the water's edge. With a coastline of more than 3,000 km, infrastructure is much more vulnerable to the impacts of climate change (SLAP, 2014). The natural environments of the St. Lawrence ecosystem are also experiencing the effects of rising temperatures – both air and surface water – on wind patterns, storm patterns and coastal dynamics (SLAP, 2014). Coastal habitats are particularly vulnerable to climate change. It is expected that the melt of glacial ice will cause an increase in sea level that will reach the estuary and the gulf. Sea currents will be modified and coastal erosion is likely to increase (Savard et al., 2008). Wetlands and aquatic environments are also very vulnerable to extreme variations in water levels and

temperature; this may in turn affect plants and animals that thrive in these habitats (Pelletier-Gilbert et al., 2011).

In the Lower Estuary of the Gulf of St. Lawrence, one of the major effects of global warming is the loss of sea ice and coastal ice. This loss of coastal ice increases the time during which the coast is exposed to hydrodynamic agents and, consequently, to a greater number of storm events in early winter. These now cause more coastal erosion than would be the case if the St. Lawrence River and Gulf were completely frozen (SLAP, 2014).

Global warming is also responsible for the increase in the relative sea level that has been observed in the Gulf of St. Lawrence and that is part of the global trend of rising sea levels. Rising sea levels already explain some of the hydrosedimentary adjustments of the shoreline, which generally result in increased erosion of the coasts (Bernatchez et al., 2008; Ouranos, 2015). These coastal ecosystems will have to adapt to rising sea levels either by migrating inland or by keeping pace vertically with sea-level rise. This issue becomes critical in inhabited areas, where the movement of natural environments is prevented by infrastructure. Many coastal areas are exposed to this phenomenon, which is termed “coastal squeeze” (Cairns et al., 2012). The rising water temperatures of rivers and of the pelagic environment is one of the impacts of climate change and can also have indirect effects on species and ecosystems in coastal areas (Ouranos, 2015).

7.2. Urban development

As in all the inhabited areas of Quebec, natural environments are exposed to pressures related more directly to human activities. Despite the generalized decline of the population outside major urban centres such as Rimouski (St-Amour et al., 2015), the real estate market is booming. The spectacular landscapes that seaside areas offer make them extremely sought-after locations; steep cliffs, waterfronts, river mouths, coves, sandbanks and beaches are attracting more and more cottage owners. The residential construction sector has seen rising spending since 2004, particularly in the Gaspé Peninsula and the Magdalen Islands (MEIE, 2017) to accommodate young retirees to build second homes.

Urban sprawl and increasing urbanization are resulting in significant changes to natural environments. The filling or levelling of residential lots and the construction of access roads are causing irreversible damage to biodiversity. The methods used to protect shoreline property and infrastructure are usually hard methods (e.g., riprapping and walls) that result in hardening of the shoreline (which can no longer migrate inland), cut off the sources of sediments that replenish beaches, cause lowering of the foreshore, and accelerate the process of erosion at the ends of the hardened sections. This is a world-wide trend which results in the degradation and, in the medium term, the disappearance of coastal ecosystems everywhere where it occurs (Friesinger, 2009).

7.3. Oil and gas exploration and production

According to the Quebec Department of Energy and Natural Resources (MERN, 2018), regions such as the Gaspé Peninsula, the Gulf of St. Lawrence and Anticosti Island could contain potential oil and gas resources. Indeed, exploration work in the Bas-Saint-Laurent region has revealed significant indications of high-quality crude oil in the Matapedia Valley. Despite a long history of exploration in Quebec, there is a serious lack of information associated with hydrocarbon exploration and production activities (CIRAIG, 2014),

notwithstanding the many potential impacts: destruction of habitats for the construction of exploration and production sites; habitat fragmentation; possible contamination of water, soil and sediments; atmospheric emissions, etc. (CIRAIG 2014). Oil and gas exploration is currently concentrated in the Gaspé Peninsula. The projects have been the target of vehement public protests, particularly owing to their proximity to inhabited areas (Environnement vert plus, 2018).

Eventual development of the petroleum potential in the Gulf of St. Lawrence could have serious impacts on coastal ecosystems. Because of marine currents, potential spills from drilling platforms, even those far offshore such as the Old Harry site, could pose a threat to a large part of the Gulf and Chaleur Bay (CIRAIG, 2014; UQAR-UNESCO, 2014). Spills can also occur during the transport of hydrocarbons, and the numerous oil tankers that already transit through the St. Lawrence increase the risks of an oil slick. The threat of hydrocarbon and hazardous substance spills is present along the entire length of the St. Lawrence (St. Lawrence Centre, 1996). This poses a significant threat to the biodiversity associated with the shoreline, particularly seabirds, by affecting not only the plumage of individual birds, but also the availability and quality of their food.

7.4. Tourism and recreational activities

Recreational/tourism activities are an important contribution to the regional economy. However, any activity that is not regulated or not carried out in a manner respectful of the environment can contribute to pressures on natural environments, particularly by causing an increased number of visitors in fragile areas or by attracting negative attention to species more vulnerable to disturbance. Off-road vehicles (ORVs) are very popular in the study area, and despite the efforts made to restrict them to marked trails, the use of motorized vehicles outside trails destroys vegetation and creates ruts in barrens, dunes, beaches, coastal marshes and wetlands. Even supposedly environmentally friendly activities can have negative effects if they are not properly managed. The repeated passage of pedestrians who access very busy sites such as scenic lookouts, shores and beaches can have impacts on vegetation (Pelletier-Gilbert and Breich, 2009; Cyr and Deraspe, 2012). For example, trampling probably explains the decline or disappearance of rare plants at certain locations on Mont Saint-Anne in the Gaspé Peninsula (Coursol, 2010).

These activities are a source of disturbance for wildlife, particularly bird species during the nesting period. Colonial and nesting birds using coastal marshes, dune environments and beaches are particularly vulnerable, and human presence is blamed for the reduction of the populations of bird species, even the disappearance of entire colonies (Nature Québec, 2018). The growing popularity of shallow-draught small craft such as sea kayaks, kiteboards and stand-up paddleboards constitutes an additional source of disturbance by providing access to previously inaccessible barachois, lagoons and islets.

A number of municipalities are counting on the development of tourism infrastructure to promote the natural attractions of their regions. Coastal trail projects continue to proliferate, particularly on the North Shore (Sentier des embruns) and Anticosti Island (Sentier Transanticostien). These projects can have impacts on the integrity of ecosystems, including features for which the initial intention was to draw attention to the importance of conserving them.

7.5. Forestry operations

The forests of the study area show many traces of human activity: cutover areas, logging roads and fires of human origin (Grondin et al., 2007). While insect outbreaks and windthrow control the dynamics of natural disturbances, recent logging activity has promoted the abundance of young forests (Desrosiers et al., 2012). There are evident impacts on the connectivity of mature and old-growth forest stands that facilitates the movement of organisms, the maintenance of the characteristics of old-growth forests other than age (e.g., presence and size of deadwood), and the preservation of an internal forest structure forests and a stand composition that promotes the presence of a variety of ecosystems (Desrosiers et al., 2012).

The network of logging roads, particularly in the Gaspé Peninsula, where it is among the densest in Quebec (1.7 km per km^2), raises certain more local, but widespread, environmental issues such as the erosion and sedimentation of watercourses, the avoidance of logging roads by wildlife, the loss and fragmentation of inland forest habitats, changes in predator–prey dynamics, collisions with wildlife and uncontrolled access to resources (Gauthier and Varady-Szabo, 2014).

7.6. Invasive alien species and problematic native species

The study area has not yet suffered any serious degradation of natural environments by invasive alien plants. However, the data on the distribution of these plants is very fragmentary. Purple Loosestrife (*Lythrum salicaria*), Reed canary grass (*Phalaris arundinacea*), Common Reed (*Phragmites australis*), and Japanese Knotweed (*Reynoutria japonica* var. *japonica*) appear to be well established in several locations (OBAKIR, 2014). Giant Hogweed (*Heracleum mantegazzianum*), whose presence has been more recently observed only very locally, should be closely monitored (OBVNEBSL, 2018).

The fox and the coyote can be considered problematic native species when they threaten the most accessible seabird colonies (Rail, 2009). Cotter and Rail (2007) consider that predation by the Red Fx (*Vulpes vulpes*) may be responsible for the abandonment of certain colony sites by Leach's Storm Petrel (*Oceanodroma leucorhoa*) – for example, on Bonaventure Island.

8. Conservation issues

The study area overlaps the administrative regions[9] of La Capitale-Nationale, Bas-Saint-Laurent, Gaspésie/Îles-de-la-Madeleine and Côte-Nord. Its geographic location and natural features were decisive in the spatial distribution of the human population and in shaping those residents' way of life from a social and economic perspective. With approximately 375,000 inhabitants (St Amour et al., 2015), the density of the population is low and is concentrated along the shoreline. Like most remote resource regions, this

[9] Only the RCMs that lie within the study area are included in the brief socio-economic overview presented here.

area has had difficulty holding on to its population base. Over the last thirty years, there has been an exodus of its population, particularly to the major urban centres (MRNF, 2006).

At the beginning of the colonial period, the economy was based essentially on commercial fishing, but it began to diversify following the various waves of immigration in areas where conditions were the most favourable for agriculture. Today, agriculture is well developed only in the coastal plains, terraces and valleys of the Lower St. Lawrence and of Chaleur Bay in the Gaspé Peninsula (MDDELCC, 2018b). It was not until the end of the 19th century that logging became an important activity, particularly on public land. Even today, the economy of these regions is particularly dependent on the extraction and processing of natural resources (forestry, fisheries) (MEI, 2018; MDDELCC, 2018b). Those flourishing industries have, in turn, experienced crises which took their toll on the regional economy. In the 1980s, the decrease in the supply of timber in public forests and a surtax on lumber forced the closure of paper mills. The collapse of Atlantic Cod populations has had a significant negative impact on fisheries (MRNF, 2006).

To support a still-fragile economy, communities are increasingly turning to other natural resources found in the sea, the forest, the land and the subsoil. In addition to blueberries and Canada Yew, the cultivation of which has expanded in recent years, the harvesting of non-timber forest products (mushrooms, berries, fiddleheads, Labrador Tea, etc.) is a niche that is attracting more and more producers. Agriculture has also experienced a renewal in the past few years with the introduction of new products (e.g., greenhouse crops, cheeses, livestock) (MAPAQ, 2015).

The economic contribution of mining and hydroelectric power (which facilitates aluminum production in particular) is significant only on the North Shore, and also facilitated the establishment of the Port-Daniel cement plant in Chaleur Bay. The Gaspé Peninsula has good potential for the discovery of hydrocarbons (MERN, 2014), and hydrocarbon exploration and production have expanded there in recent years (MERN, 2014). The wind power potential of the region is also one of the best in Quebec, and this industry is expanding rapidly (Hélimax Énergie Inc., 2005). The latter two economic activities in particular have business centres in Gaspé, which has stimulated growth in demand for permanent residences in and around that urban centre.

In addition, cottaging and tourism, which are mainly seasonal activities, contribute significantly to the regional economy. Some regions (Bas-Saint-Laurent and Gaspésie) have a long-standing reputation for strikingly attractive coastal areas and abundant wildlife resources (MDDELCC, 2018b). Spectacular landscapes and the opportunity to observe the local wildlife (whales and seabirds) make the Gaspé Peninsula and the coastline of the Charlevoix region as far as Saguenay nationally and internationally renowned destinations (MRNF, 2006). The access offered by logging roads and numerous outfitters has enabled the development of fish and game resources. In particular, moose hunting and Atlantic Salmon fishing have been popular activities for many years; some salmon rivers have a worldwide reputation among sport fishers. However, the entire study area is currently experiencing a tourism boom driven by visitors' keen interest in the great outdoors, the diverse landscapes and the wide range of activities and products offered.

To meet growing demand, recreation/tourism development, which is accompanied by the construction of visitor infrastructure (cottages and resorts, hotels and lodges, recreational trails), is a major focus of economic development in the study area. Supported by a network of trails, snowmobiles and quads are very popular with the local communities and attract motor sports enthusiasts from elsewhere in Quebec, Canada and the United States (Ministère du Tourisme, 2014). Despite declining demographics, the construction and restoration of cottages and country homes in the panoramic areas is paradoxically booming, fulfilling the dream of many visitors to own or rent a cottage near the sea without leaving Quebec (MRNF, 2006).

However, the sustainability of the landscapes and biodiversity of this vast territory is not guaranteed. Public protected areas account for only 6.9% of the study area[10]. The federal and provincial parks combined account for 2.86% of the coastal areas, and three new biodiversity reserves should be designated in the short-term on Anticosti Island (MELCC, 2018). For a long time, the only protected areas on private land were those established by scientific societies, such as the Société Provancher in 1929 and in 1939 on the Îles aux Basques and Razades Islands. It was only from the 1990s onward that the protection of privately owned land really began to take off with the acquisitions by the Nature Conservancy of Canada, Ducks Unlimited and the Fondation de la faune du Québec, largely of exceptional sites for birds. Since the 2000s, a number of property owners and several municipalities have taken advantage of the opportunity offered by the *Quebec Natural Heritage Conservation Act* to create nature reserves on private land. Over the past several years, local conservation organizations have been established (Le regroupement pour la pérennité de l'île Verte in 2010; Horizon-Nature Bas-Saint-Laurent in 2016) which are dedicated to maintaining biodiversity. The contribution of all these organizations to the protection of natural environments currently represents 15.84 km² (0.05%) of lands that enjoy protection status, and a number of projects are underway. This is made possible thanks to funding from provincial and federal government programs and from private foundations, businesses and individuals.

The establishment of protected areas on public and private land, while desirable in itself and more and more positively perceived by local communities, is not a panacea. The heavy pressures on the coastal areas have had the effects of promoting closer collaboration between the organizations concerned about the degradation of natural resources and environments and of raising the awareness of decision-makers concerning the economic benefits of protecting natural environments and promoting sustainable development. There is a growing number of collaborations between conservation organizations, regional environmental councils, ZIP committees, watershed organizations and municipalities to preserve the quality of the natural heritage. Projects aimed at promoting natural attractions and the maritime heritage are being implemented in coastal areas, a few examples being the Sentier des Embruns on the North Shore, the Sentier Transanticostien and the construction of docks to receive cruise ships.

[10] Does not include the pelagic environment and conservation measures on private land.

9. Conservation targets

Conservation targets represent different components of the natural area which, if effectively protected, conserved or managed, would make it possible to maintain the most representative elements of the biodiversity of the coastal environments the Estuary and Gulf of St. Lawrence. The selection of sites of biodiversity interest as well as conservation strategies and actions will be carried out based on conservation targets. The coarse-filter/fine-filter approach was adopted to determine the conservation targets for the atlas (Lemelin and Darveau, 2006; Gratton, 2010).

9.1. Coarse-filter targets

The coarse-filter targets are intended to capture a large proportion of the biodiversity present in a study area by identifying a series of viable sites representative of the different ecosystems present in the coastal environments of the Estuary and Gulf of St. Lawrence. They therefore make it possible to conserve both the most common types of environments and the most common species. Four (4) coarse-filter conservation targets were selected for the Atlas of Sites of Interest for Conservation along the Estuary and Gulf of St. Lawrence Coastline (Table 2) aiming to determine terrestrial sites of interest, thus excluding water bodies and watercourses (but see section 9.2)

Table 2. Coarse-filter conservation targets selected for the Atlas of Sites of Interest for Conservation along the Estuary and Gulf of St. Lawrence Coastline.

Coarse-filter targets	Type of habitat, ecosystem or plant association
Forested areas	Terrestrial environment: boreal forest; temperate forest
Inland wetlands	Freshwater: marshes, swamps, peat bogs
Coastal marshes	Shoreline: saltmarshes, barachois
Sandy environments	Shoreline: spits, beach berms, dune habitats, tombolo-spits

9.1.1. Forested areas

The study area contains 15 871 km² of forested areas, which is more than 47% of the total surface area. This target includes all of the deciduous, mixed and coniferous forest communities in various successional stages resulting from disturbances, both natural (fire, spruce budworm outbreaks) and human-induced (forestry operations). Its highly varied composition stems from the large land mass it covers, which (from southwest to northeast) includes five bioclimatic domains: sugar maple–basswood, sugar maple–yellow birch, balsam fir–yellow birch, balsam fir–white birch and black spruce–moss (OIFQ, 1996). In maritime environments, it is not unusual to find small edge habitats along the coastlines of the North Shore, the Gaspé Peninsula and Anticosti that support forest communities associated with the balsam fir–white birch domain, but with a high incidence of white

spruce stands (balsam fir stands with white spruce). Due to the moister air and the chemical composition of the soils, these trees show a wide range of growth habits (erect to extremely stunted) shaped by differences in topography and wind exposure (OIFQ, 1996).

There are significant differences between the structure and composition of existing forest stands and those of historical or preindustrial forest portraiture especially in old-growth forests (Desrosiers et al. 2012). In the Gaspé Peninsula, mature stands, according to the estimation method chosen, represented at the beginning of the 20th century from 47.2% to 75% of the forest area of the Gaspé forest (Pinna et al., 2009). On the Côte-Nord, 53% of mature stands were in the white birch and 61% in the moss spruce stands (Giguère, 2011). In 1930, the undeveloped forests of Rimouski, Mitis and Matane were more than 75% composed of stands over 100 years old (Boucher et al., 2009).

In order to sustain large forest mosaics for conserving biodiversity and populations of indigenous species, protection of forest cover at the local and regional scales is key (Poiani et al., 2000; Environment Canada, 2013c). According to Anderson et al. (2006), the majority of environmental processes and ecological interactions in the Appalachian forests require surface areas greater than 10,000 ha. That minimum surface area can also be applied to the temperate forests north of the St. Lawrence. However, in the boreal forest, the natural disturbance regime requires even more space; according to Ricketts et al. (1999), a surface area of up to 2,000 km^2 would be necessary in order for a protected area to be able to maintain all of the biodiversity within it. South of the study area, where human development is more intense, the forests are more fragmented and a network of forest habitats on private land connected to public land would make it possible to offset the impacts of that fragmentation (Bennett, 2003) and preserve the key attributes of forest habitats and the biodiversity – particularly birds – that depends on them.

Forests play a vital role from the economic, social and environmental points of view. In addition to generating employment, the forest mosaic provides an undeniable ecological role by storing large amounts of carbon, promoting soil conservation, providing habitat for many species and helping to produce a host of other services. These not only contribute to the maintenance of biodiversity and ecosystem integrity, but are also of great importance to communities by providing them with a supply of raw materials, regulating the quality of water and air and providing or creating recreational, cultural and educational opportunities (Dupras et al., 2013).

9.1.2. Inland wetlands

The total surface area of inland wetlands is almost 4412 km^2, or 13% of the study area. Some types of freshwater wetlands (ponds, marshes and swamps) form on mineral soil. Others – ombrotrophic and minerotrophic peatlands (bogs and fens, respectively) – form on organic soil. Peatlands are the most widespread, and their distribution varies greatly in different parts of the study area. East of Sept-Îles, there are large peatland complexes on the coastal plain, due to the conditions favouring their formation in this area (hardened surface layer above sand deposits and a clay bottom; cold, moist climate) (CIC, 2019). They are predominantly bogs, and on the North Shore and the Lower North Shore, they make up 15% to 20% of the vegetation cover (Poisson et al., 2016).

Bogs typically contain black spruce stands with sphagnum mosses and black spruce stands with heather where tamarack and balsam fir are locally abundant; they are characterized by a dense shrub layer dominated by heather and a uniform ground cover of mosses, mainly *Sphagnum* spp. Black spruce stands with alder or with holly are found in fen environments, which are richer in nutrients. The open (untreed) peatlands are dominated by heather, sedges (*Carex* spp.), mosses (*Sphagnum* spp.) and lichens. The swamps and marshes are generally limited to narrow strips along rivers and streams and are dominated by black ash (*Fraxinus nigra*), American elm (*Ulmus americana*), speckled alder (*Alnus incana* subsp. *rugosa*) and shrub willow (*Salix* spp.) in the western portion of the study area. Tree species gradually disappear toward the east, giving way to communities consisting mostly of shrub alder and willow, sweet gale (*Myrica gale*) and leatherleaf (*Chamaedaphne calyculata*). They are succeeded by marshes supporting communities of emergent, floating and submerged plants along a water-depth gradient.

The wetlands support typical habitats for many plant and wildlife communities, including species at risk, and for a rich diversity of species that depend on these habitats as feeding and breeding sites during specific periods in their life cycles. They are particularly important as breeding and staging areas for wildfowl.

9.1.3. Coastal marshes

Coastal marshes, including saltwater and brackish marshes, make up 539 km2 (1.6%) of the terrestrial portion of the study area. Along the coast grow different species of plants, depending on the period during which a given spot is submerged by the tide. They include communities of Virginia glasswort (Salicornia depressa), smooth cordgrass (Spartina alterniflora) and saltmeadow cordgrass (Spartina patens) (absent from the north shore of the St. Lawrence), and a saltmeadow made up of many other halyophytic species, including red fescue (Festuca rubra), tundra alkaligrass (Puccinellia tenella), Baltic rush (Juncus balticus) and saltmarsh bulrush (Bolboschoenus maritimus), which are submerged only during the equinoctial tides. The brackish marshes in the St. Lawrence Estuary occur only in the estuaries of tributary rivers or at locations mainly fed by freshwater from the nearby land; saltwater inputs resulting from large tides or flooding are quite frequent there. On the bay and lagoon bottoms, where there is less saltwater, different plants are found, including chaffy sedge (Carex paleacea), bluejoint reedgrass (Calamagrostis canadensis) and prairie cordgrass (Sporobolus michauxianus) (Grandtner, 1967; Couillard and Grondin, 1986).

The ecological interest of coastal marshes and their value to wildlife lies in the wide variety of rich, diverse, high-quality habitats they provide (Tremblay, 2002). A number of them have been identified as Important Bird Areas (IBAs); they are the sites known to be used by colonies of terns and gulls, as staging areas for waterfowl, and frequented by the Yellow Rail (Coturnicops noveboracensis), the Short-eared Owl (Asio flammeus) and Nelson's Sparrow (Ammodramus nelsoni). In addition to being rich in bird life, these coastal marshes are habitats of choice for numerous fish and shellfish species and provide sites that are critical for the survival of populations of the Maritime Ringlet (Coenonympha nipisiquit), a butterfly species that is endangered in Canada (Environment Canada, 2012). Estuaries and saltmarshes are preferred summer habitat for the Striped Bass (Morone saxatilis), the American Eel (Anguilla rostrata) and the Atlantic Salmon, which use them

as feeding and transitional areas on the journey from the ocean to upriver spawning grounds (Monticone et al., 2015).

In addition to offering important habitats for a number of plant and wildlife species, coastal marshes play a key role in purifying water and protecting shorelines from erosion. Many coastal wetlands have also been identified in various conservation plans as being of conservation interest. For example, on the north shore of the St. Lawrence, the saltmarsh at Pointe-aux-Outardes is so recognized, as are the vast saltmarshes at Baie de l'Isle-Verte and Kamouraska on the south shore (Pelletier-Gilbert et al., 2011; CIC, 2019) and the Barachois de Malbaie in Chaleur Bay (Monticone et al., 2015).

9.1.4. Sandy environments

This target consists of shoreline habitats other than coastal marshes and rocky cliffs. It includes beaches, sand spits and dune ridges formed from fine to very fine sands. These habitats account for approximately 740 km representing 7.34% of all marine shorelines in the study area. The backshores and the vegetated dunes are dominated by European lymegrass (*Leymus arenarius*), American searocket (*Cakile edentula*) and beach pea (*Lathyrus japonicus*) (Bernatchez et al., 2008). Generally, these habitats will go through a number of successional stages of vegetation before culminating in forest.

On the shores of the St. Lawrence, sandy ecosystems, whether vegetated (sandspits, beach berms, dune environments, tombolo-spit) or bare (beaches) play an important ecological role (Bernatchez et al., 2008; Bernatchez et al., 2015). Beach and dune systems are terrestrial ecosystems in transition between land and sea. They perform certain unique functions, such as protecting the shoreline thanks to their ability to absorb the impact of storms and prevent flooding. They play a critical role in reducing the risks of natural disasters (Ley de la Vega et al., 2012). Beaches and dunes absorb the energy of waves, thereby limiting shoreline erosion; they prevent flooding and sand accumulation on the adjacent lowlands, in inland water bodies and wetlands, on roads and in and around dwellings. In some locations, they also protect groundwater.

9.2. Fine-filter targets

The fine-filter targets are those that would not have been captured by the coarse filter but represent elements of high importance for the conservation of biodiversity. Sites such as scientifically recognized wildlife habitats and other elements of importance for biodiversity. These fine filter elements will not be used to select or prioritize habitat patches but will be illustrated in addition to the habitat patches that will be selected or prioritized. Five (5) fine-filter targets were selected (Table 3).

Table 3. Fine-filter conservation targets selected for the Atlas of Sites of Interest for Conservation along the Estuary and Gulf of St. Lawrence Coastline.

Fine-filter targets	Type of habitat, ecosystem or plant association
Eelgrass beds	Shoreline: eelgrass beds
Bird colonies	Concentration areas for colonial breeding birds
Important wildlife elements	Various wildlife-related elements (e.g., Chimney Swift roosts, critical habitat and occurrences of species at risk, spawning grounds)
Important plant elements	Various plant-related elements (e.g., critical habitat and occurrences of species at risk)
Salmon rivers	Fresh water: rivers, riparian zones

9.2.1. Eelgrass beds

Eelgrass (*Zostera marina*) beds grow in the shallow water of intertidal and subtidal zones. They are found mainly in bays, lagoons and estuaries of rivers that are sheltered from marine currents (Hanson, 2004). Eelgrass beds have been identified as an important conservation target, given their importance for numerous species found there. Eelgrass beds mapping was produced by Fisheries and Oceans Canada (Martel et al., 2009), and the eelgrass bed boundary in Rimouski Bay has been adjusted by experts (Marc Mingelbier, MFFP, pers. comm., november 2017). In the study area, these habitats are concentrated mostly at Baie de l'Île Verte and Rimouski (Martel et al., 2009). Along the Gaspé coast, eelgrass beds are found mainly at the mouth of the Saint-Jean River, in Baie de Percé and Baie du Grand Pabos, at Saint-Siméon Est and at the mouth of the Cascapédia River. On the North Shore of the St. Lawrence, concentrations of eelgrass are found at Longue Rive, Forestville, Baie aux Outardes, Pointe Lebel, Baie des Homards and Sept-Îles (Martel et al., 2009).

9.2.2. Bird colonies

This target consists of sites where birds nest in mixed colonies, most often on cliffs and permanent and semi-permanent islands in the Estuary and Gulf of St. Lawrence (e.g., Common Eiders (*Somateria mollissima*), Northern Gannets (*Morus bassanus*), Razorbills (*Alca torda*), herons, gulls, terns and cormorants). The majority of colonial bird species forage at sea and breed on the coasts. Breeding sites for marine birds and colonial birds in the area have already been prioritized by the Canadian Wildlife Service to identify the colonies that are conservation priorities (Chapdelaine and Rail, 2004). A review of those priority sites was conducted for this atlas (Jean-François Rail, ECCC-CWS, pers. comm., march 2016). Some colonies in this report have been eliminated while others have been added. The colonies in Chaleur Bay are often linear and extensive (many small groups of breeding birds scattered along the coast). These sites therefore refer to priority coastlines. We have eliminated most of the "potential" sites because they refer to habitats suitable for inland water birds (rails, herons, etc.) and coastal marshes (e.g., Cacouna marsh, Kamouraska marsh) which are considered in the coarse-filter targets. A total of 70 colonies

were selected. Some of the seabird species present in the study area are at risk, including Leach's Storm Petrel, which is likely to be designated threatened or vulnerable in Quebec.

9.2.3. Important wildlife elements

A number of sites that are important for conserving biodiversity were not selected as coarse-filter targets, due to their unique characteristics or because they are associated with human-built structures. The locations of these important wildlife elements within the study area have been identified and included among sites of interest for conservation in the Atlas:

- Critical habitat for the Red Knot: This red knot is (*Calidris canutus* ssp. *rufa*) is a shorebird species listed as endangered in Canada (ECCC, 2017b). Three coastal areas have been designated as critical habitat: the Mingan Islands, Pointe aux Alouettes, and the Barre de Portneuf.

- Critical habitat for the Maritime Ringlet: The maritime ringlet (*Coenonympha nipisiquit*) is a small butterfly species listed as endangered in Canada and threatened in Québec (Environment Canada, 2012). Three areas are designated critical habitats: Marais de Nouvelle, Ruisseau Savoy (near the Saint-Omer barachois) and the Marais de Penouille (Forillon).

- Chimney Swift nesting sites and roosts: The chimney swift (*Chaetura pelagica*) is a small aerial insectivore bird species listed as threatened in Canada. This species now nests almost exclusively in chimneys. Data on roosts and nesting sites were extracted from the SOS-POP database kept by the Regroupement QuébecOiseaux (RQO). Only the R (retained) sites of precision "S" (150 m) were retained. Some sites were used as roosts and/or nesting sites. A total of 17 sites were selected (as of April 2017).

- Bank Swallow nesting sites: The bank swallow (*Riparia riparia*) is a bird species listed as threatened in Canada. It nests in burrows that it digs into soft soils such as the steep banks of rivers and sand pits. Data on nesting sites were extracted from the SOS-POP database. Only the R (retained) sites of precision "S" were retained. In total, 42 sites were selected (as of April 2017). In June 2013, another site (not in the SOS-POP database) was discovered at Mitis Bay in June 2013 by the Comité ZIP sud de l'estuaire and was added.

- Harlequin Duck concentration areas: The harlequin duck (*Histrionicus histrionicus*) is a duck species that nests near the torrential waters of rivers and forages in the rapids of these rivers. During migration and moulting, these ducks frequent rocky shores and gather in a few particular areas in winter. This species is designated Special Concern in Canada and vulnerable in Quebec. Data were obtained from the SOS-POP database (as of April 2017). The sites selected are those where >20

Harlequin Ducks had been recorded in at least two different years. A 200-m buffer zone was created around each point (n=270) and the 48 polygons thus formed were trimmed to the limit of the shoreline, so as to retain only the surface area made up of aquatic environments.

- Breeding and rearing habitat for the Rainbow Smelt, southern St. Lawrence Estuary population: The rainbow smelt (*Osmerus mordax*) is a fish species listed as vulnerable in Quebec. Data were obtained from the Plan de rétablissement de l'éperlan arc-en-ciel au Quebec (Équipe de rétablissement de l'éperlan arc-en-ciel du Québec, 2008) and validated by experts (Marc Mingelbier, MFFP, pers. comm., November 2017). Four sites of importance are located in the study area: Rivière du Loup, Banc de Rivière du Loup, Rivière Fouquette and Rivière des Trois-Pistoles.

- Additional occurrences of species at risk: The presence of wildlife species at risk with a high status of precariousness (endangered or threatened at the federal level, threatened or vulnerable at the provincial level) was used as selection criteria to determine sites of high conservation value (see section 12.1). Sites known to host wildlife species designated as Special Concern in Canada or likely to be listed as threatened or vulnerable in Quebec (as of February 2016) are illustrated in the Atlas as features of interest for conservation.

  For birds, the data was extracted from the CDPNQ and the occurrences of precision "S" were retained: Nelson's Sparrow (n=24), Short-eared Owl (n=6) and Leach's Storm-Petrel (n=3). For reptiles and amphibians, 6 occurrences of precision "S" were extracted from the CDPNQ: Ring-Necked Snake (*Natrix natrix*) (n=4) and Northern Dusky Salamander (*Desmognathus fuscus*) (n=2); and 8 occurrences of precision 6-7-8-9 recorded after 2013 were extracted from the BORAQ database (MFFP): Ring-Necked Snake (n=1) and Snapping Turtle (n=7). For mammals, 13 occurrences of precision "S" were extracted among the 134 occurrences listed in the CDPNQ (excluding bat observations): rock Vole (*Microtus chrotorrhinus*) (n=4), Southern Bog Lemming (*Synaptomys cooperi*) (n=1) and Gaspé Shrew (*Sorex gaspensis)* (n=8); and 20 micromammal occurrences of precision "S" were extracted from the MFFP database (excluding bat observations): Gaspé Shrew (n=8), Rock Vole (n=9) and Southern Bog Lemming (n=3).

9.2.4. Important plant species occurences

Sites known to host plant species at risk are listed in the CDPNQ database. A biodiversity index is assigned to each occurrence according to the degree of precariousness of the species and the importance of the populations associated with these occurrences. Occurrences with a high biodiversity index (B1, B2, B3) were used as selection criteria (see Section 10.3.3). Observation points and occurrences of plant species at risk with a B4 or B5 biodiversity index (n = 290, as of January 2016) are illustrated in the Atlas as features of interest for conservation, for example calcicolous species associated with rocky outcrops and scree slopes.

9.2.5. Salmon Rivers

Rivers flowing into the Estuary and the Gulf of St. Lawrence are particularly important for the survival of all Atlantic salmon populations. More than 100 rivers are concerned (database of the MDDELCC, as of 2010). Maintaining the very high quality of these habitats is essential for this anadromous species in a precarious situation, which needs clear, temperate and well oxygenated rivers and streams with low to moderate gradients and substrates of pebbles and rocks to provide spawning and early fry (COSEWIC, 2010). The salmon rivers present in the study area are illustrated as sites of importance for conservation. The entire stretches of river are illustrated, since they extend beyond the limits of the territorial zones

10. Data sources

Numerous sources of geospatial data have been tapped for the Atlas of Sites of Interest for Conservation along the Estuary and Gulf of St. Lawrence Coastline. The list of databases used for the project appears in Table 4.

Table 4. Sources of biophysical data used to produce the Atlas of Sites of Interest for Conservation along the Estuary and Gulf of St. Lawrence Coastline

DATA	YEAR / Temporal coverage	SOURCE	DESCRIPTION / NOTES
Coarse filter			
Forested areas: Système d'information écoforestière (SIEF) [ecoforestry information system] – 4th decadal survey	2006-2015	MFFP	The data from the 4th ecoforestry survey were used for the entire study area (including Anticosti Island), except for the Upper North Shore (3rd survey).
Forested areas: Programme d'inventaire écoforestier nordique (PIEN) (MRN, 2012).	2005-2009	MFFP	Mapping of vegetation and physical features based on remote sensing techniques (satellite images). For this project, those maps were used to document the area between Manitou and Blanc-Sablon. Satellite images used to produce this data may date back as far as 2005.
Inland wetlands	2016	MDDELCC	Classification of wetlands in southern Quebec from the 4th ecoforestry survey (SIEF); wetland maps from PIEN (see Forested areas, above).
Coastal marshes	2008, 2009	CIC	Marshes along the coastline of the Estuary and the Gulf. Extracted from the Ducks Unlimited Canada regional conservation plans produced in 2008 and 2009 (CIC, 2019).
Sandy environments	2016	ECCC	Mapping of the coastal shoreline identified as sandy beach (ECCC, 2016).
Fine filter			
Eelgrass beds	1995, 2000, 2004, 2009, 2015	Martel et al., 2009	Fisheries and Oceans Canada (DFO) reviewed all of the available data on the presence of eelgrass in the Estuary and Gulf of St. Lawrence, including those of Lemieux and Lalumière (1995), CREGÎM (2004), Comité ZIP Côte-Nord du Golfe (2001) and the Comité côtier Les Escoumins à la rivière Betsiamites (2004). Other surveys were also conducted by DFO (in 2009) and by the Comité ZIP du sud-de-l'estuaire.
Bird colonies	2016	ECCC-CWS	Identification of bird colonies that are conservation priorities; taken from the Québec's Waterbird Conservation Plan (Chapdelaine and Rail 2004) and validated by J.-F. Rail (CWS, pers. comm.). Some colonies were then added to the list and others removed from it.

DATA	YEAR / Temporal coverage	SOURCE	DESCRIPTION / NOTES
Important wildlife elements	Variable	ECCC, MDDELC, MFFP	Wildlife-related elements. Data extracted from: CDPNQ, SOS-POP, BORAQ, small mammals database, species at risk critical habitats. See section 9.2.3 for the data selected.
Important plant elements	2016	CDPNQ	Observation points and occurrences of species that are threatened or vulnerable, or likely to be so designated. Data extracted from CDPNQ (as of January 2016).
Salmon rivers	2010	MDDELCC	Salmon river polygons including 60-m riparian strips along the shores.
Other data used			
Cadre écologique de référence	2016	MDDELCC	The Cadre écologique de référence du Québec (CERQ) is a mapping tool for ecological classification of areas. It is based on the physical elements of ecosystems: geology, terrain, surface deposits, and the configuration and density of the hydrological network.
Base de données topographiques du Québec (BDTQ)	1998 à 2006	MFFP	This database was used to extract data about the road network and hydro rights-of-way that fragment habitats.
Registre des aires protégées au Québec	Winter 2017	MDDELCC	All of the protected areas were selected, excluding the wildlife habitats (waterfowl concentration areas, bird colonies on cliffs, bird colonies on islands or peninsulas, muskrat habitat, heronries, mudflats, habitat of a threatened or vulnerable wildlife species).
Conservation measures on private land	Septembre 2017	RMN	The designation « Milieu naturel de conservation volontaire" [voluntary conservation environment] refers to areas that are not located on crown land. Most are owned by an individual, a non-government conservation organization or a municipality.
Exceptional forest ecosystems (EFEs)	2016	MFFP	EFEs that are ancient, rare, validated and located on public and private land.
National Hydro Network	2016	RNCAN	The linear watercourses and area-type watercourses in this database were used for calculating the prioritization criteria based on the hydrographic network in the study area, particularly in terms of watercourse shoreline length and density.

11. Conservation objectives

Two overarching objectives will guide the process of identifying the sites of interest for conservation:

1. Maintenance of fine-filter or irreplaceable elements

   For certain conservation targets, all the habitat patches are conservation priorities and all of them will be selected to preserve the current biophysical conditions that characterize these areas. For some of them, sustainable use may be compatible with this objective. Thus, all of the coastal marshes are prioritized, since the conservation objective for this target is to maintain all the existing coastal marshes. However, a conservation value will be assigned to each coastal marsh, based on biophysical characteristics or the presence of exceptional elements. The objective of maintaining other conservation targets at their current level will also apply to fine-filter targets such as eelgrass beds, bird colonies, and salmon rivers.

2. Representativeness of all types of ecosystems

   The objective is to determine the sites of interest that are conservation priorities until 20% representativeness is attained in each territorial zone. This objective is based on the objectives of Quebec's Plan Nord and also reflects the 17% Aichi Biodiversity Target.[11] The 20% representativeness refers to the cumulative length or surface area of the habitat patches for each conservation target, relative to the surface area or total length of the target found in each territorial zone. The goal is to attain this representativeness objective for each class of inland wetland, for each forest ecological type and for sandy environments.

12. Method for determining sites of conservation interest

The determination of the sites of conservation interest is based on a selection analysis and a prioritization analysis (Figure 4). In the selection stage, the sites with high importance for conservation are determined based on selection criteria often associated with fine-filter elements. Those sites become essential elements to be conserved, sites that have a high ecological value. They are the sites that make up our "portfolio" of biodiversity that is protected or should be prioritized for protection – for example, sites located within protected areas, or exceptional occurrences of species at risk. They serve as a starting point for attaining the representativeness objectives (e.g., conserve 20% representativeness for each type of wetland).

[11] Target C.11: "By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative, well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes."

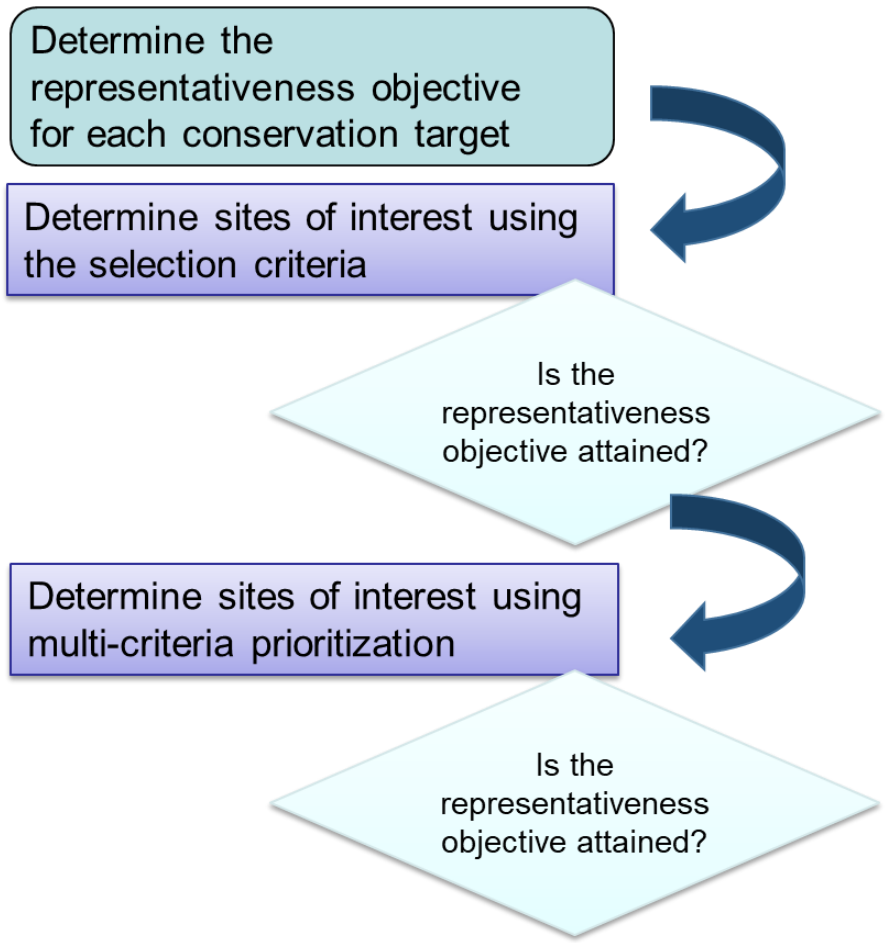

Figure 4. Diagram illustrating the method used for determining sites of interest for conservation

Then, a prioritization analysis of the sites was conducted on some of the conservation targets if the 20% representativeness objective was not attained with the selection process. Multi-criteria analysis was used to rank the habitat patches in order of priority, based on their value in terms of conserving biodiversity and/or maintaining ecological functions. In addition, for forested areas and inland wetlands, sites were retained according to their priority ranking in order to reach the 20% representativeness objective for each forest ecological type and each wetland type in each territorial zone.

Note that the selection analyses and the prioritization analyses were conducted separately for each of the territorial zones, to take into consideration the region's different ecological realities. Lastly, other elements of importance for conservation of biodiversity, including a number of fine-filter targets, were not used to select or prioritize habitat patches but are included amongst sites of interest for conservation (e.g., bank swallow colonies) (see section 9.2).

12.1. Selection analysis

The selection criteria are used to select the sites of high conservation importance. Some of these criteria will be applied to all coarse-filter conservation targets, while others apply to only one target. The selection criteria are as follows:

Public and private protected areas: The habitat patches located entirely or partly in or contiguous to protected areas listed in the Registre des aires protégées au Québec (MDDELCC 2018a; as of January 2017) (except designated wildlife habitats) or protected areas located on private land on which conservation measures (e.g., fee simple ownership and easement in perpetuity, as of September 2017) apply (RMN, 2018). In the study area, there are 97 sites extracted from the Registre des aires protégées au Québec and 67 sites on which conservation measures apply there were retained in the selection process (table 5, appendix B). For example, Île-du-Corossol Migratory Bird Sanctuary near Sept-Îles and the Grand-Lac-Salé ecological reserve on Anticosti Island (data from the Registre des aires protégées au Québec); or the Barachois de Malbaie in Gaspé and the Île-aux-Pommes nature reserve in the Lower St. Lawrence (both voluntary conservation environments; data from the register of protected areas located on privately owned land). Note that it is possible that the same protected site may be listed in the two databases; work is currently underway to harmonize this information.

Table 5. Types of protected areas retained for selection of priority habitat patches

Source	Responsibility	Type of protected area	Number of sites
Registre des aires protégées au Québec	Federal government	National Park	1 (Forillon)
		National Park Reserve	1 (Mingan)
		Marine Park	1 (Saguenay)
		National Wildlife Area	3
		Migratory Bird Sanctuary	12
	Provincial government	Provincial park	7
		Ecological reserve	8
		Projected ecological reserve	1
		Biological refuge	34
		Aquatic reserve	1
		Projected aquatic reserve	2
		Biodiversity reserve	1
		Projected biodiversity reserve	5
		Habitat of a vulnerable plant species	4
	Private	Nature reserve	16
Inventory of protected areas in private land	Private	Voluntary conservation environment	67

Exceptional forest ecosystems (EFEs): The habitat patches located entirely or partly in or contiguous to selected EFEs located on public or private land (n=17; as of January 2016; appendix C). The MFFP recognizes three types of EFEs in Quebec: rare forest, old-growth forest and refuge forest (Groupe de travail sur les écosystèmes forestiers exceptionnels, 1997). These ecosystems help maintain the diversity of species that characterizes the

forest of southern Quebec. On public lands, the EFEs are legally protected by the *Loi sur les Forêts* but this is not the case on private land.

Salmon rivers : Habitat patches located <100 m from a designated salmon river by the MFFP (as of 2010).

Plant occurrences of high conservation value : The habitat patches in which are located observation points of precision "S" associated with the CDPNQ plant occurrences that have a biodiversity index of B1, B2 or B3. Not all of the observation points retained are associated with species' preferred types of habitat, due to the lack of precision of the base map and the fact that the preferred habitats of a number of species do not appear on the maps (talus slopes, rock outcrops/escarpments, beaches, flats). Those observations will be used to determine the habitat patches of interest that are located within the immediate vicinity of each observation. That was the case for multiple points for the species associated with rocky outcrops embedded within forest matrices. In all, 4,256 observation points of precision "S" associated with 88 priority occurrences were retained for the selection analysis (as of January 2016) (Table 6).

Table 6. Number of occurrences that have a biodiversity index of B1, B2 or B3 and number of observation points of precision "S" retained for the selection analysis.

Species	IndBio	Number	
		Occurrences	Points
Alchemilla filicaulis subsp. filicaulis -p09	B2.03	1	2
	B3.02	1	1
Astragalus americanus	B3.11	1	2
Astragalus robbinsii var. fernaldii	B1.05	1	1 764
	B2.01	4	1 210
Boechera collinsii	B3.11	1	0
Boechera quebecensis	B1.05	2	7
	B2.01	2	6
Botrychium ascendens	B2.03	1	1
	B3.02	2	7
Botrychium pallidum	B2.03	1	23
	B3.02	1	7
Botrychium spathulatum	B3.02	1	2
Carex deweyana var. collectanea	B2.01	1	2
Cirsium scariosum var. scariosum	B3.03	2	39
Cypripedium arietinum	B3.02	1	0
Cypripedium parviflorum var. planipetalum	B2.03	3	0
	B3.02	2	0
Cypripedium passerinum	B2.04	1	15
Draba aurea -p01, p09	B2.04	1	48
	B3.03	1	0
Draba pycnosperma	B2.02	1	10
	B3.01	6	68
Erigeron compositus	B3.05	1	36
	B3.11	1	238
Erysimum coarctatum	B3.05	5	51
	B3.11	2	3

Species	IndBio	Number	
		Occurrences	Points
Festuca frederikseniae	B2.03	1	3
	B3.02	2	9
Gaylussacia bigeloviana	B3.05	1	0
Hordeum brachyantherum subsp. brachyantherum	B1.07	1	2
Juncus longistylis	B3.03	1	20
Oxytropis borealis var. viscida	B2.04	1	41
Packera cymbalaria	B3.05	1	5
	B3.11	1	3
Pellaea atropurpurea	B3.11	0	7
Physaria arctica	B3.11	1	11
Platanthera unalascensis	B3.03	1	0
Poa secunda subsp. secunda	B3.05	1	1
Sagina nodosa subsp. nodosa	B3.11	2	0
Sagittaria montevidensis subsp. spongiosa	B3.05	1	0
Schizaea pusilla	B1.04	1	0
Solidago racemosa	B2.03	5	194
	B3.02	2	0
Symphyotrichum anticostense	B2.03	3	227
	B3.02	3	111
Taraxacum laurentianum	B1.05	1	15
	B2.01	6	27
Trichophorum pumilum	B3.05	2	14
Woodsia oregana subsp. cathcartiana	B3.05	1	4
Woodsia scopulina subsp. laurentiana	B3.11	2	20
Total		88	4 256

Wildlife occurrences of high conservation value: The habitat patches in which are located the occurrences associated with species that have a high legal designation in Canada (endangered, threatened) and in Quebec (threatened, vulnerable). This data also refer to designated critical habitats for the Maritime Ringlet and bird occurrences extracted from the Centre de données sur le patrimoine naturel du Québec (CDPNQ). Occurrences with a precision of "S" and a quality rank of "A," "B," "C," "D" or "E" were selected. Occurrences of some species were not retained because their presence in the study area was accidental (Grasshopper Sparrow [*Ammodramus savannarum*], Red-headed Woodpecker [*Melanerpes erythrocephalus*], Loggerhead Shrike [*Lanius ludovicianus*]) or because other, more complete, databases exist (Chimney Swift). In all, 141 occurrences were selected for the following species (as of February 2016): Yellow Rail (13), Golden Eagle [*Aquila chrysaetos*] (8), Harlequin Duck – Eastern population (21), Peregrine Falcon [*Falco peregrinus*] (19), Barrow's Goldeneye – Eastern population (7), Bicknell's Thrush [*Catharus bicknelli*] (5), Least Bittern [*Ixobrychus exilis*] (1), Bald Eagle [*Haliaeetus leucocephalus*] (67). As with the plant occurrences of high conservation value, all of the wildlife occurrences of high conservation value were used to select the habitat patches, even if they were not associated with the species' preferred habitat types.

Irreplaceable habitat patches (C-Plan): The C-Plan[12]. software program can be used to calculate an index of the representativeness of the habitat patches in a spatial reference unit. That index is attributed to each habitat patch based on its surface area as a proportion of the total surface area in the spatial reference unit. In the current project, representativeness was calculated in each of the territorial zones. A habitat patch that supports the only representative of a given habitat class or that is the only site that allows to reach the 20% threshold in a given territorial zone is assigned a value of 1 and is selected.

Table 7 lists the selection criteria for each coarse-filter conservation target, and figure 5 shows, as an example, the distribution of protected areas, EFEs, salmon rivers, and irreplaceable forest ecological type in the territorial zone Z_A01 (Gaspé Peninsula southern maritime) and figure 6 shows, as an example, the distribution of plant and wildlife occurrences and observation points retained for the selection analysis in the territorial zone Z_82 (Anticosti Island).

Table 7. Selection criteria retained for forest ecological type, inland wetlands, coastal marshes and sandy environments

Selection criterion	Forest ecological type	Inland wetlands	Coastal marshes	Sandy environments
Public and private protected areas	X	X	X	X
Exceptional forest ecosystems	X			
Salmon rivers		X	X	
Plant occurrences of high conservation value	X	X	X	X
Wildlife occurrences of high conservation value	X	X	X	X
Irreplaceable habitat patches (C-Plan)	X			

[12] The software documentation is available online: http://marxan.net/cplan

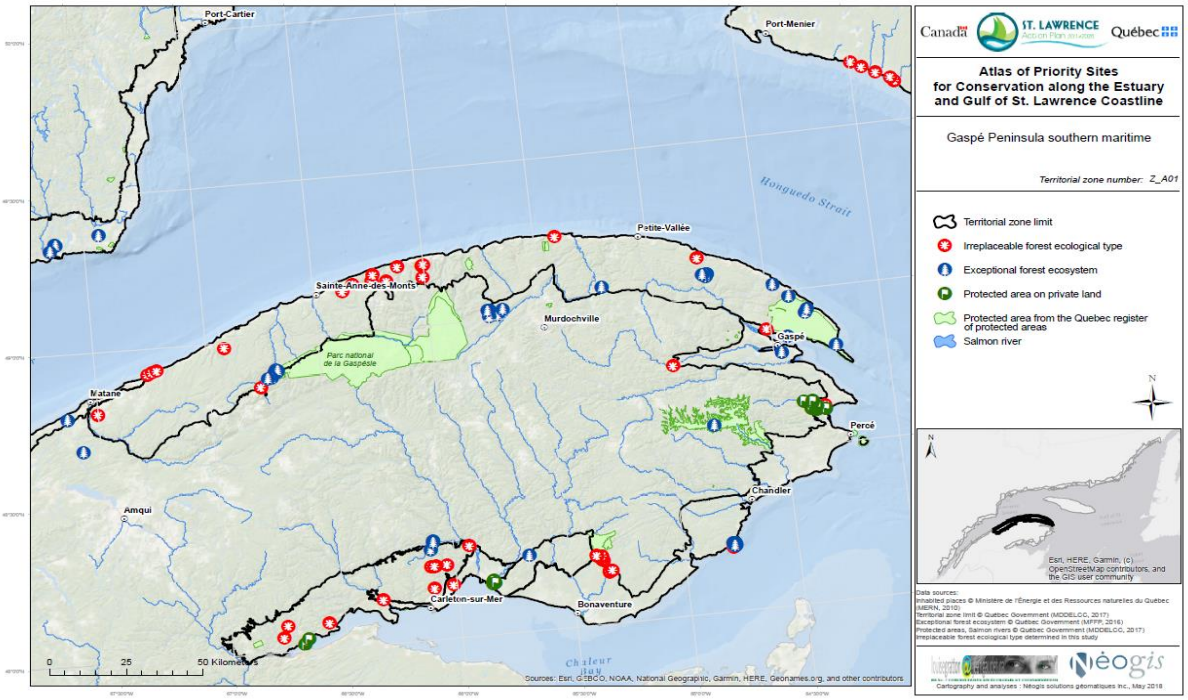

Figure 5. Distribution of protected areas, EFEs, salmon rivers and irreplaceable forest ecological types in the territorial zone Z_A01 (Gaspé Peninsula southern maritime)

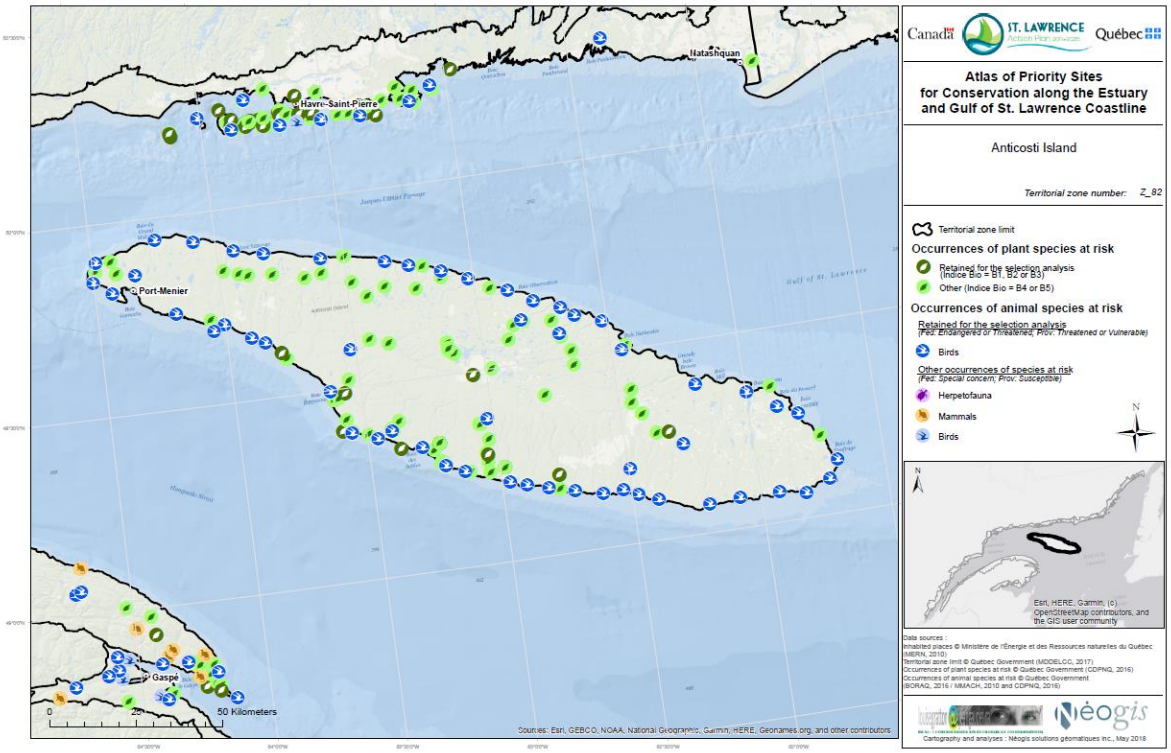

Figure 6. Distribution of occurrences and observation points of plants and wildlife species retained for the selection analysis in the territorial zone Z_82 (Anticosti Island)

12.2. Prioritization analysis

In cases where the 20% representativeness objective was not attained after the selection analysis for each type of ecosystem in a given spatial unit of reference, a multi-criteria prioritization analysis was then conducted to identify priority habitat patches which had the highest conservation value and prioritized them until the minimum 20% representativeness threshold for each type of ecosystem in each territorial zone. The multi-criteria prioritization analysis was carried out on all the habitat polygons. For each target, several criteria to characterize the habitat patches were used to calculate a relative value illustrating their priority for biodiversity conservation or maintenance of ecological functions.

The directory of conservation plans for natural environments of interest that was produced between 2000 and 2016 in southern Quebec (Lebel, 2014; Dupont-Hébert, 2017) was used to synthesize the methodologies for prioritizing the natural environments present in Quebec and to develop this multi-criteria analysis. Prioritization criteria related to the descriptive attributes of the habitat patches were used to assign them a conservation value. The criteria were separated into two classes: primary and secondary. The primary criteria were used to rank the habitat patches and to establish the primary priority classes based on biophysical characteristics considered more important given current knowledge. The secondary criteria were used to obtain a finer prioritization of the habitat patches within each of the primary priority classes. This prioritization method assumes that in cases where the differences in the values for the primary critieria are relatively small, large differences in the values for the secondary criteria could play an important role in conservation of biodiversity and in functionality of the ecosystems. Multi-criteria analysis was used to calculate a priority ranking for each of the sites, including those selected. Separate analyses were conducted for each territorial zone. The steps involved in assigning a priority ranking to each unit of analysis are as follows:

1) Determine the prioritization criteria.
2) Calculate the value of each prioritization criterion.
3) Use correlation matrices to select the criteria to be retained.
4) Calculate the normalized value of each prioritization criterion.
5) Assign each criterion to the primary or secondary priority class.
6) Calculate the sum of the normalized values for the primary criteria.
7) Determine the four priority classes based on that sum (natural breaks).
8) Calculate the sum of the normalized values for the secondary criteria.
9) Rank-order those sums in each priority class.
10) Assign the final priority ranking for each unit of analysis.

For forested areas and inland wetlands, sites were retained according to their priority ranking in order to reach the 20% representativeness objective for each forest ecological type and each wetland type in each territorial zone.

For each coarse-filter conservation target, the Pearson correlation coefficient was calculated for each pair of criteria, first for the entire study area, and second for each territorial zone separately (n=10 zones) to determine whether there was redundancy between criteria. In correlation analyses of the entire study area, the criteria were not

correlated for any of the targets (r2max = 0.10) and therefore are not redundant. At the scale of the territorial zones, the criteria were not correlated for the forest ecological types or the inland wetlands. Only a few high correlations (r2>0.50) were found for some pairs of criteria related to coastal marshes and sandy environments; this was generally due to small sample sizes. The prioritization criteria used for the multi-criteria analyses are as follows (Table 8).

Primary criteria

- Size: For forested areas: surface area (ha) of the forest ecological types. For wetlands: surface area (ha) of the wetland complexes >5 ha. For coastal marshes: surface area (ha) of the coastal marsh complexes >5 ha. For sandy environments: length (m) of shorelines.
- Proximity to other natural environments of the same type: Proximity index (PROX) calculated with Fragstats: Proximity of environments of the same type within a 1-km buffer zone.

Secondary criteria

- Integrity of the buffer zone: For the forest ecological types: proportion of natural environments within a 1-km buffer zone. For the wetlands: proportion of natural environments within a 200 m buffer zone. For coastal marshes and sandy environments: proportion of human-modified environments within a 100 m buffer zone.
- Presence of riparian environments: Contiguity with a riparian environment (watercourse, lake, wetland), calculated as the length of shoreline/surface area in m/ha. Here, that means riparian environments located within or bordering the units of analysis.
- Proportion of old-growth forest: Proportion of old-growth forest or mature stands found within each forest ecological type. Here, that means tolerant deciduous stands or mixed stands dominated by decidous species, in age classes of 120 VIN (vieux inéquiens), VIR (vieux irréguliers) or older; and coniferous or conifer-dominated stands of age class 90 or older.
- Plant diversity: Shannon index calculated for the types of wetlands in the >5 ha wetland complexes.

Table 8. Prioritization criteria selected for forested areas, inland wetlands, coastal marshes and sandy environments.

Class of criterion	Prioritization criterion	Forest ecological types (all)	Inland wetlands (>5 ha)	Coastal marshes (>5 ha)	Sandy environments (all)
Primary	Size	X	X	X	X
	Proximity to other natural environments of the same type	X	X	X	
Secondary	Integrity of the buffer zone	X	X	X	X
	Presence of riparian environments	X	X	X	
	Proportion of old-growth forest	X			
	Plant diversity		X		

13. Data Analyses of the Coarse Filter Conservation Targets

The following sections present the treatment of the data relating to each conservation target of the coarse filter as to the objectives pursued, the determination of the units of analysis, the choice of the prioritization criteria and the methods of calculations retained.

13.1. Forested areas

Unit of analysis : The unit of analysis is the forest ecological type (FET). These clusters exhibit a permanent combination of potential vegetation and common physical features.

Data sources and processing: For 8 of the 10 territorial zones located in the western portion of the study area and south of the St. Lawrence River, the data on forested areas come from the 4th ecoforestry survey of southern Quebec (SIEF) (3rd survey for the Upper North Shore). The FETs used in this study consist of a assemblage of forest types from the ecoforestry map (TYPE_ECO) with the associated drainage class (Appendix D). The ecological types were identified for the forest fragments with surface areas greater than 40 ha that are not fragmented by human activity (urban or agricultural areas). A forest fragment combines adjacent ecoforestry (forest stands) polygons, and the road network was used to fragment them, taking into account a distance of 15 m on either side of the road (30-m total right-of-way). All of the ecological types located within a 40-ha forest fragment were retained in the analyses (no minimum surface area).

In territorial zones Z_28 and Z_70B to the east (Lower North Shore), data come from the Programme d'inventaire écoforestier nordique (PIEN) and unit of analyses were formed by grouping types of surface deposits (appendix D). These groupings are thus a reflection of the type of forest vegetation that can develop there. In total, there are 58,712 FET analyzed. Appendix E shows the number of habitat patches of each FET retained for the representativeness analyzes in the territorial zones.

The surface area of the ecological types ranged from 0.01 ha to 13,932 ha, but only 107 of these ecological types covered more than 1,000 ha. The average surface area was 25 ha. Table 9 presents the descriptive statistics of forest ecological types in each territorial zone

Table 9. Descriptive statistics of forest ecological types in each territorial zone.

Territorial zone	Number	Area (ha)			
		Mean	Standard deviation	Min	Max
Z_28	1 061	77,4	362,3	0,01	9 311,9
Z_69	4 587	21,3	40,4	0,01	1 323,4
Z_70A	4 705	23,3	47,1	0,01	839,6
Z_70B	813	69,1	224,6	0,01	3 631,7
Z_71	7 323	24,7	73,1	0,01	3 363,0
Z_82	18 073	20,1	120,2	0,03	9 578,0
Z_A01	10 489	28,1	176,4	0,01	10 365,7
Z_A07	3 540	31,2	333,0	0,01	13 931,7
Z_A08	5 022	24,4	100,0	0,01	2 865,7
Z_A11	3 099	16,0	24,4	0,01	435,6
Total	58 712	25,0	147,3	0,01	13 931,7

13.2. Inland wetlands

Unit of analysis: Wetland complex >5 ha

Data sources and processing: A wetland complex includes the wetland polygons that are adjacent of each other (Joly et al., 2008; CRECQ, 2012). As with the forested areas, the road network was used to fragment the wetland complexes, taking into account a distance of 15 m on either side of the road (30-m total right-of-way). The data on the distribution of wetlands came from two sources:

1) The classification of humid forest stands in southern Québec produced by MDDELCC (2016) was used to document inland wetlands located south of the 52nd parallel. This classification uses data on forest stands and other information from the 4th ecoforestry survey conducted by MFFP in addition to other information from SIEF to classify the identified wetlands by type (MDDELCC, 2016). Because it was designed for forests, this classification system has certain limits and did not perfectly reflect the ecological reality of the wetlands. However, it did provide a homogeneous database of information about a large part of the study area. The classes of wetlands based on that classification which were analyzed for representativeness are as follows:

    - Marsh: includes marshes, ponds and swamps
    - Shrub swamp

- Treed swamp
- Treed fen
- Treed bog
- Open undifferentiated peatland
- Open fen
- Open bog

The classes of wetlands where disturbances due to human activity were noted (attribute PERTURB in SIEF), the treed undifferentiated peatlands and the harvested peatlands were not retained in the representativeness analyses (n=1,765 polygons not retained). Lastly, wetland complexes that straddled two different territorial zones were attributed to the one in which the wetland surface area was greatest.

2) North of the 49th parallel, wetlands were identified from three types of satellite images: Landsat (resolution: 30 m), Spot (resolution: 15 m) and RapidEyes (resolution: 5 m) (Leboeuf et al., 2012). A dozen classes of wetlands were identified there, based on criteria related to the characteristics of the biotopes (or micro-habitats), particularly the presence, shape and surface area of the ponds, pinches, hollows, flats and plateaus. The data were entered into PIEN. The wetland classes from PIEN for which representativeness analyses were conducted are as follows:

   - MH: wetland (generic class of wetlands; MH: milieu humide)
   - TMR: riparian fen (TMR: tourbière minérotrophe riveraine)
   - TOM: bog–pool system (TOM: tourbière ombrotrophe à mares)
   - TOR: string bog (TOR: tourbière ombrotrophe ridée)
   - TOU: uniform (flat) bog (TOU : tourbière ombrotrophe uniforme)

In all, 8,442 wetland complexes made up of 32,345 wetland polygons (34,110 total polygons minus 1765 polygons not retained) were analyzed. Appendix F shows the number of habitat patches in each class of wetland retained for representativeness analyses in the territorial zones.

The surface area of the wetland complexes ranged from 5 ha to 63,267 ha, but only 38 of these wetland complexes covered more than 1,000 ha. The average surface area was 49 ha. Table 10 presents the descriptive statistics of wetland complexes in each territorial zone.

Table 10. Descriptive statistics of the wetland complexes in each territorial zone.

Territorial zone	Number	Area (ha)			
		Mean	Standard deviation	Min	Max
Z_28	277	83,4	256,4	5,2	3 377,8
Z_69	1 038	41,7	144,8	5,0	2 330,8
Z_70A	1 705	55,4	299,2	5,0	6 429,0
Z_70B	243	102,4	450,9	5,2	5 495,5
Z_71	388	19,8	46,8	5,0	664,3
Z_82	3 058	60,8	1 180,8	5,0	63 266,7
Z_A01	701	18,2	31,4	5,0	482,0
Z_A07	81	13,7	13,3	5,4	91,8
Z_A08	610	19,3	24,8	5,0	269,6
Z_A11	341	36,1	90,3	5,0	1 224,2
Total	8 442	49,4	731,1	5,0	63 266,7

13.3. Coastal marshes

Unit of analysis: Wetland complex >5 ha.

Data sources and processing: A coastal marsh complex includes the wetland classes that are adjacent and connected to the coastline. The data on the distribution of coastal marshes come from the Ducks Unlimited Canada regional conservation plans produced in 2008 and 2009 (CIC, 2019). Only wetlands of the "marsh", "salt marsh", "brackish marsh" and "unclassified" classes that are directly adjacent to the shoreline were retained.

The surface area of the coastal marshes ranged from 5 ha to 12,694 ha, but only 7 of those coastal marshes covered more than 1,000 ha. The average surface area is 145 ha. Table 11 presents the descriptive statistics of the coastal marshes in each territorial zone.

Table 11. Descriptive statistics of the coastal marshes in each territorial zone.

Territorial zone	Number	Area (ha)			
		Mean	Standard deviation	Min	Max
Z_28	56	42,8	122,5	5,0	841,3
Z_69	30	40,2	67,7	5,9	360,5
Z_70A	27	500,3	2 437,1	5,5	12 694,1
Z_70B	71	222,8	1 403,3	5,2	11 796,3
Z_71	21	291,4	626,9	5,9	2 707,1
Z_82	48	110,3	166,5	5,2	871,1
Z_A01	6	12,6	4,8	6,9	21,3
Z_A07	9	101,5	112,0	5,4	373,9
Z_A08	50	21,5	19,8	5,2	119,7
Z_A11	48	139,0	430,5	5,1	2 382,9
Total	366	145,0	932,5	5,0	12 694,1

13.4. Sandy environments

Unit of analysis: The linear segment of a beach.

Data sources and processing: ECCC's maps of segments of shoreline were used to document the sandy environments (ECCC, 2016). The "sand beach or bank" subgroup was the only one selected. A 150-m buffer strip was added on either side of the polylines for the purposes of the selection and prioritization analyses.

The lengths of the beach segments ranged from 0.01 km to 38 km, but only 11 of them were longer than 10 km. The average length was 1.2 km. Table 12 presents the descriptive statistics of the beach segments in each territorial zone.

Table 12. Descriptive statistics of the beach segments in each territorial zone.

Territorial zone	Number	Lenght (km)			
		Mean	Standard deviation	Min	Max
Z_28	27	1,6	2,1	0,1	10,2
Z_69	221	1,0	2,0	0,0	15,6
Z_70A	155	1,4	3,9	0,0	34,9
Z_70B	27	2,5	7,6	0,1	37,8
Z_71	34	0,7	0,5	0,1	1,9
Z_82	12	1,6	0,7	0,4	3,4
Z_A01	22	1,4	2,1	0,1	10,0
Z_A07	3	0,6	0,4	0,3	1,0
Z_A08	35	1,1	1,6	0,1	7,2
Z_A11	88	0,8	0,8	0,0	4,2
Total	624	1,2	2,9	0,0	37,8

14. Results

Since the geospatial data associated with coastal sites of interest for conservation are publicly available, maps illustrating the spacial distribution of these sites are provided here for information purposes. By downloading the data, the user can display them at spatial scale corresponding to his needs.

14.1. Forest ecological types of interest

In all, 58,712 forest ecological types (FETs) were analyzed. No selection analysis or prioritization of forest ecological types was done in zones Z_28 and Z_70B, as the forest cover in those zones is <20% (data from PIEN). Table 13 shows the number of patches selected and prioritized for attaining the representativeness objective of 20% for the FETs in each territorial zone whereas table 14 shows the area covered by the selected and prioritized FETs. Overall, 16% of FETs are considered to be of interest in the study area, ranging from 14% to 18% depending on the territorial zone. The total area of FETs of interest represents one quarter of the total forest area.

Table 13. Total number of forest ecological types (FETs), selected and prioritized to attain the representativeness objective of 20% in each territorial zone

Territorial zone	Total number of FET	Number of FET selected	Number of FET prioritized	Number of FET of interest	% of FET of interets
Z_28	1 061	0	0	0	0
Z_69	4 587	299	399	698	15,2
Z_70A	4 705	378	334	712	15,1
Z_70B	813	0	0	0	0
Z_71	7 323	947	337	1 284	17,5
Z_82	18 073	2 955	297	3 252	18,0
Z_A01	10 489	981	815	1 796	17,1
Z_A07	3 540	132	507	639	18,1
Z_A08	5 022	215	498	713	14,2
Z_A11	3 099	205	254	459	14,8
Total	58 712	6 112	3 441	9 553	16,3

Table 14. Total surface area (ha) of forest ecological types (FETs), selected and prioritized to attain the representativeness objective of 20% in each territorial zone

Territorial zone	Area of FETs (ha)				Area of FETs (%)		
	Total	Selected	Prioritized	Of interest	Selected	Prioritized	Of interest
Z_28	82 148,3	0,0	0,0	0,0	0,0	0,0	0,0
Z_69	97 797,0	9 104,4	12 051,5	21 155,9	9,3	12,3	21,6
Z_70A	109 489,1	11 597,0	12 553,3	24 150,2	10,6	11,5	22,1
Z_70B	56 186,2	0,0	0,0	0,0	0,0	0,0	0,0
Z_71	180 537,6	32 254,0	12 244,3	44 498,3	17,9	6,8	24,6
Z_82	362 799,4	117 635,6	4 885,1	122 520,7	32,4	1,3	33,8
Z_A01	295 069,7	65 910,4	8 660,3	74 570,7	22,3	2,9	25,3
Z_A07	110 605,7	31 941,4	7 238,5	39 179,9	28,9	6,5	35,4
Z_A08	122 645,2	20 010,2	7 791,9	27 802,1	16,3	6,4	22,7
Z_A11	49 540,0	4 627,7	6 395,1	11 022,8	9,3	12,9	22,3
Total	1 466818,2	293 080,5	71 820,1	364 900,6	20,0	4,9	24,9

Although the threshold of 20% representativeness was reached by cumulating the area covered by the selected FETs in zones Z_82 (Anticosti Island), Z_A01 (Gaspé Peninsula southern maritime) and Z_A07 (Eroded high plateaux of the Gaspé Peninsula), additional sites have been prioritized to reach this threshold of 20% for some ecological forest types (Table 14).

Nearly half of the selected FETs are located on Anticosti Island (Z_82), the majority being selected because of their proximity to public protected areas and due to the presence of priority wildlife occurrences (Table 15). Of note, more than 2/3 of the selected forests due to their proximity to exceptional forest ecosystems were located in Z_71 (Northern shoreline of the Estuary), Z_A01 (Gaspé Peninsula southern maritime) and Z_A11 (Southern shoreline of the Estuary) zones.

Table 15. Number of forest ecological types (FETs) selected with each selection criterion

Territorial zone	Public or private protected area	Exceptional forest ecosystem	Irrepleceable habitat patch (C-Plan)	Plant occurrence	Wildlife occurrence	Global
Z_28	0	0	0	0	0	0
Z_69	181	19	12	1	114	299
Z_70A	338	5	2	18	97	378
Z_70B	0	0	0	0	0	0
Z_71	568	50	12	4	401	947
Z_82	1 334	2	5	47	1 734	2 955
Z_A01	805	49	14	17	211	981
Z_A07	61	9	8	4	58	132
Z_A08	55	4	22	23	130	215
Z_A11	147	37	12	13	17	205
Total	3 951	175	87	127	2 762	6 112

On the north shore of the St Lawrence River, forest areas selected as being of interest for conservation are large and concentrated in the Mingan Islands, north of Sept-Îles, at Pointe-des-Monts, north of Escoumins, on both sides of the Saguenay River, and in the mountainous regions that stretch from Cap-Tourmente to Petite-Rivière-Saint-François. On Anticosti Island, it is mainly the forest regions of the western and central parts of the island that stand out, especially those located near the coast.

In Chaleur Bay, the sectors of interest are concentrated in the forest regions north of Carleton-sur-Mer, Bonaventure and Chandler, and in the area of Mount Sainte-Anne near Percé. On the north side of the Gaspé Peninsula, there is a priority axis extending from Forillon National Park to Grande-Vallée and on the foothills of the Chics-Chocs Mountains. Finally, on the south shore of the estuary, the forest landscape is more fragmented than in the rest of the study area. The selected fragments are scattered here and there in this territorial zone but show however a concentration of forests of interest in the Bic region and on the Île-aux-Lièvres.

For example, Figure 7 shows the location of selected and prioritized FETs as well as the conservation value of other FETs in territorial zone Z_71 (Northern shoreline of the Estuary).

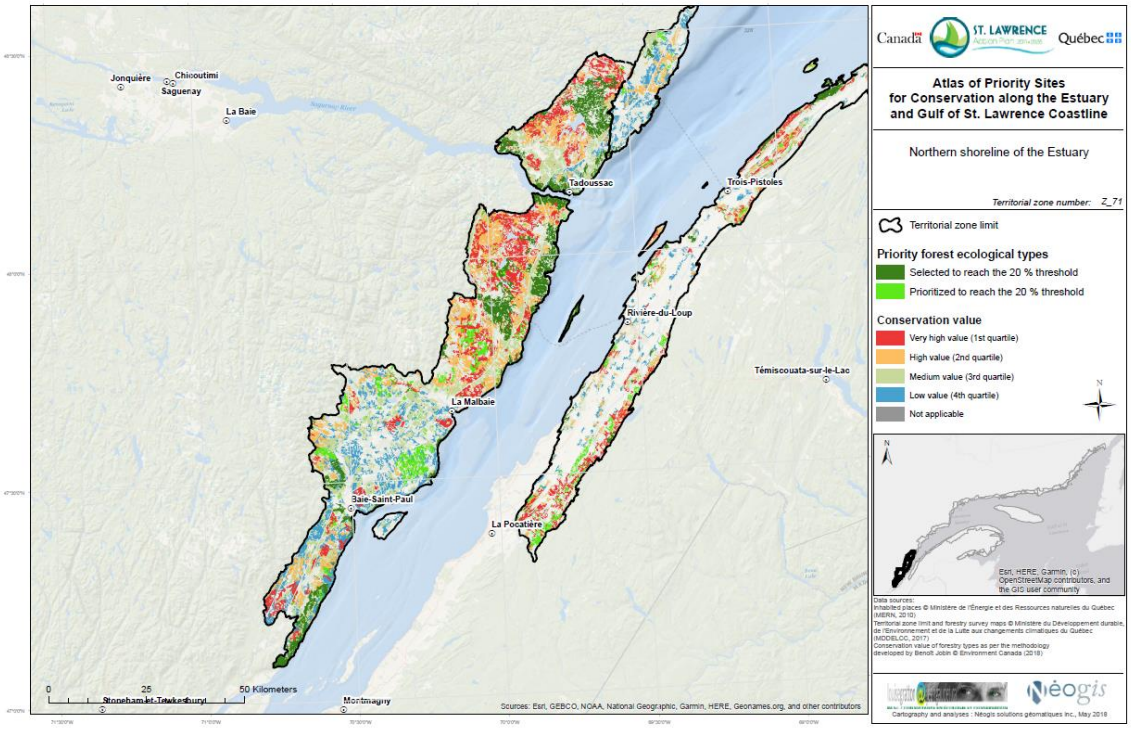

Figure 7. Location of selected and prioritized FETs as well as the conservation value of other FETs in territorial zone Z_71 (Northern shoreline of the Estuary)

14.2. Inland wetlands of interest

In all, 8,442 wetland complexes made up of 32,345 wetland polygons were analyzed. Table 16 shows the number of wetland complexes selected and prioritized to attain the representativeness objective of 20% for each type of wetland in each territorial zone whereas table 17 shows the area covered by the selected and prioritized wetland complexes. Overall, 18.5% of wetland complexes are considered to be of interest in the study area, ranging from 8.5 to 51% depending on the territorial zone. The total area of the wetland complexes of interest, however, represents more than half of the total areas covered by wetlands, ranging from 26% in the territorial zone Z_A08 (Gaspé Peninsula northern maritime) to over 70% in the territorial zone Z_28 (Côte-Nord maritime hemiarctic).

Table 16. Number of total wetland complexes, selected and prioritized to attain the representativeness objective of 20% in each territorial zone

Territorial zone	Total nb of wetland complexes > 5 ha	Nb of selected wetland complexes	Nb of prioritized wetland complexes	Nb of wetland complexes of interest	% of wetland complexes of interest
Z_28	277	142	0	142	51,3
Z_69	1 038	100	10	110	10,6
Z_70A	1 705	264	2	266	15,6
Z_70B	243	27	0	27	11,1
Z_71	388	77	3	80	20,6
Z_82	3 058	707	0	707	23,1
Z_A01	701	86	12	98	14,0
Z_A07	81	13	6	19	23,5
Z_A08	610	59	21	80	13,1
Z_A11	341	15	14	29	8,5
Total	8 442	1 490	68	1 558	18,5

For all territorial zones located on the north shore of the St. Lawrence River, including Anticosti Island (Z_82), the 20% representativeness threshold was reached solely by cumulating the area covered by selected wetland complexes while prioritization analyzes were required to reach this threshold in the territorial areas south of the St. Lawrence River and in Chaleur Bay (Table 17).

Similar to forest areas, nearly half of the selected wetland complexes are located on Anticosti Island (Z_82) mainly because of their proximity to public protected areas or salmon rivers as well as to the presence of priority wildlife species occurrences (Table 18). The proximity of a salmon river has also made it possible to select many riparian wetlands in zones Z_70A (Mingan maritime), Z_69 (North Shore maritime), Z_A08 (Gaspé Peninsula northern maritime) and Z_A01 (Gaspé Peninsula southern maritime).

Table 17. Surface area of total wetland complexes, selected and prioritized to attain the representativeness objective of 20% in each territorial zone

Territorial zone	Area of wetland complexes (ha)				Area of wetland complexes (%)		
	Total	Selected	Prioritized	Of interest	Selected	Prioritized	Of interest
Z_28	23 089,3	16 338,9	0,0	16 338,9	70,8	0,0	70,8
Z_69	43 260,5	10 240,6	5 867,0	16 107,6	23,7	13,6	37,2
Z_70A	94 511,4	34 178,4	8 340,9	42 519,3	36,2	8,8	45,0
Z_70B	24 895,0	13 018,7	0,0	13 018,7	52,3	0,0	52,3
Z_71	7 695,3	1 547,7	1 137,0	2 684,8	20,1	14,8	34,9
Z_82	185 831,8	124 369,6	0,0	124 369,6	66,9	0,0	66,9
Z_A01	12 761,3	2 172,0	1 574,1	3 746,1	17,0	12,3	29,4
Z_A07	1 113,7	153,0	182,9	335,9	13,7	16,4	30,2
Z_A08	11 801,2	1 049,8	2 070,7	3 120,5	8,9	17,5	26,4
Z_A11	12 321,1	389,4	3 879,3	4 268,7	3,2	31,5	34,6
Total	417 280,5	203 458,2	23 051,9	226 510,1	48,8	5,5	54,3

Table 18. Number of wetland complexes selected with each selection criterion

Territorial zone	Public or private protected area	Plant occurrence	Wildlife occurrence	Salmon river	Global
Z_28	128	1	0	25	142
Z_69	18	0	28	55	100
Z_70A	111	6	61	132	264
Z_70B	0	0	0	27	27
Z_71	23	0	32	26	77
Z_82	268	0	310	211	707
Z_A01	37	0	15	43	86
Z_A07	7	0	2	4	13
Z_A08	24	2	19	47	59
Z_A11	15	0	1	0	15
Total	631	9	468	570	1 490

On the north shore of the St. Lawrence River, the vast wetland complexes composed mainly of peat bogs and located in the Harrington Harbor, La Romaine, Natashquan, Havre-Saint-Pierre and Pointe-Lebel regions, near Baie-Comeau, show a high interest in conservation. On Anticosti Island, it is primarily wetlands in the center and east of the island that are of interest.

In Chaleur Bay and on the north side of the Gaspé Peninsula, the wetlands of interest are mainly located along rivers within the peninsula, but large wetland complexes are also noted near Bonaventure, north of Port-Daniel and the Barachois de Malbaie. On the south shore of the estuary, few large wetland complexes are retained except for the large peat bogs east of Rivière-du-Loup, in the Pointe-au-Père area, as well as in the Métis-sur-Mer region. For example, Figure 8 shows the location of selected and prioritized inland wetland complexes as well as the conservation value of other inland wetlands for territorial zone Z_28 (Côte-Nord maritime hemiarctic).

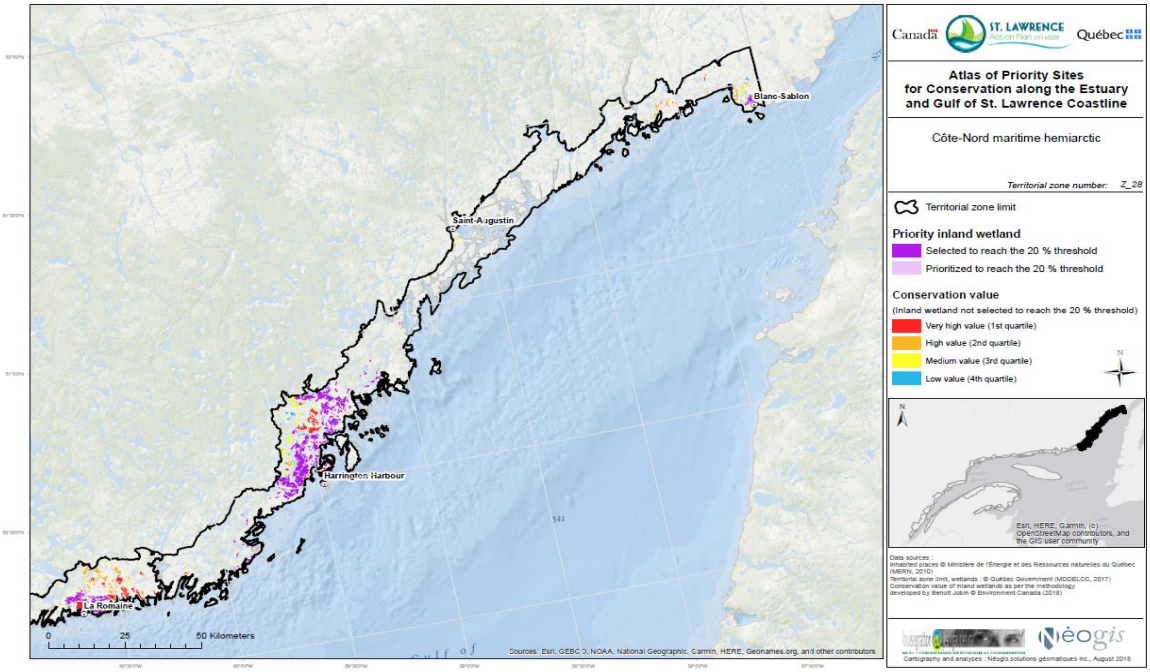

Figure 8. Location of selected and prioritized inland wetland complexes as well as the conservation value of other inland wetlands for territorial zone Z_28 (Côte-Nord maritime hemiarctic)

14.3. Coastal marshes of interest

As mentioned above (Section 11), all coastal marshes are considered of interest since the conservation objective for this target is to maintain all existing coastal marshes. Conservation value has, however, been granted to each coastal marsh based on the presence of unique features or their biophysical characteristics.

Notwithstanding this, the selection and prioritization analyzes were carried out for the 366 coastal marshes present in the study area. Table 19 shows the number of coastal marshes selected and prioritized to attain the representativeness objective of 20% in each territorial zone whereas table 20 shows the surface area of the selected and prioritized coastal marshes. The threshold of 20% representativeness has been largely exceeded in all the territorial zones by cumulating only the surface area of the selected sites. In total, more than half of the sites that were selected have cumulative spatial coverage representing more than 86% of the total area of coastal marshes in the study area, this proportion varying by 43% in zone Z_A01 (Gaspé Peninsula southern maritime) to 96% in zone Z_70A (Mingan maritime). Although site selection exceeds the 20% threshold in all territorial areas, this is fully consistent with our conservation goal of conserving all coastal marshes. Also, despite the fact that the prioritization analysis was not required to reach the 20% representativeness threshold, the conservation value calculated for each coastal marsh with the prioritization criteria makes it possible to order them according to their conservation value.

Table 19. Total number of coastal marshes, selected and prioritized to attain the representativeness objective of 20% in each territorial zone

Territorial zone	Nb of coastal marshes > 5 ha	Nb of selected coastal marshes	Nb of prioritized coastal marshes	Nb of coastal marshes of interest	% of coastal marshes of interest
Z_28	56	31	0	31	55,4
Z_69	30	15	0	15	50,0
Z_70A	27	12	0	12	44,4
Z_70B	71	25	0	25	35,2
Z_71	21	10	0	10	47,6
Z_82	48	34	0	34	70,8
Z_A01	6	3	0	3	50,0
Z_A07	9	3	0	3	33,3
Z_A08	50	37	0	37	74,0
Z_A11	48	33	0	33	68,8
Total	366	203	0	203	55,5

Table 20. Total surface area of coastal marshes, selected and prioritized to attain the representativeness objective of 20% in each territorial zone

	Area of coastal marshes (ha)				Area of coastal marshes (%)		
Territorial zone	Total	Selected	Prioritized	Of interest	Selected	Prioritized	Of interest
Z_28	2 397,8	2 088,2	0,0	2 088,2	87,1	0,0	87,1
Z_69	1 205,6	917,8	0,0	917,8	76,1	0,0	76,1
Z_70A	13 508,2	13 023,2	0,0	13 023,2	96,4	0,0	96,4
Z_70B	15 821,5	14 142,4	0,0	14 142,4	89,4	0,0	89,4
Z_71	6 119,6	3 609,1	0,0	3 609,1	59,0	0,0	59,0
Z_82	5 292,2	4 810,6	0,0	4 810,6	90,9	0,0	90,9
Z_A01	75,4	32,2	0,0	32,2	42,7	0,0	42,7
Z_A07	913,2	589,4	0,0	589,4	64,5	0,0	64,5
Z_A08	1 074,9	801,9	0,0	801,9	74,6	0,0	74,6
Z_A11	6 670,1	5 849,9	0,0	5 849,9	87,7	0,0	87,7
Total	53 078,6	45 864,8	0,0	45 864,8	86,4	0,0	86,4

Table 21 shows the number of coastal marshes selected with each selection criterion. Half of the 203 marshes selected were due to their proximity to public or private protected areas or salmon rivers. In addition, nearly half of the sites selected due to the presence of priority wildlife species occurrences were located in Zone Z_82 (Anticosti Island). It should be noted that no occurrence of plant species at risk was present in coastal marshes.

Table 21. Number of coastal marshes selected with each selection criterion

Territorial zone	Public or private protected area	Plant occurrence	Wildlife occurrence	Salmon river	Global
Z_28	12	0	0	23	31
Z_69	14	0	5	4	15
Z_70A	8	0	7	3	12
Z_70B	1	0	0	24	25
Z_71	9	0	3	2	10
Z_82	7	0	28	14	34
Z_A01	3	0	3	0	3
Z_A07	2	0	2	0	3
Z_A08	13	0	12	33	37
Z_A11	31	0	4	0	33
Total	100	0	64	103	203

On the Lower North Shore, the selected coastal marshes are generally isolated, including some sites in the Saint-Augustin regions and north of Harrington Harbor. There are also large sites selected east of Havre-Saint-Pierre and Natashquan, which are large peat complexes adjacent to the shoreline.

On the north shore of the St. Lawrence River, the selected coastal marshes are located on the north side of Pointe-aux-Outardes, along the coast between Baie-des-Rochers and the Saguenay River, at the mouths of the Malbaie and Gouffre (Baie -Saint-Paul) rivers and in the region of Petite-Rivière-Saint-François. On Anticosti Island, some important coastal marshes are located on the south coast of the island. In the Gaspé Peninsula, several coastal marshes have been selected at the mouths of the Dartmouth and York rivers near Gaspé, as well as the vast marshes of Nouvelle, Pointe-à-la-Croix and Barachois de Malbaie. No coastal marsh has been selected on the north side of the Gaspé Peninsula, their presence is very sporadic. On the south shore of the estuary, the coastal marshes located between Saint-Denis-de-Kamouraska and the Trois-Pistoles River are almost all continuously selected because of the presence of protected areas (e.g. Baie-de-l'Isle-Verte National Wildlife Area). For example, Figure 9 shows the location of the selected and prioritized coastal marshes as well as the conservation value of the other coastal marshes for territorial zone Z_A07 (Eroded high plateaux of the Gaspé Peninsula).

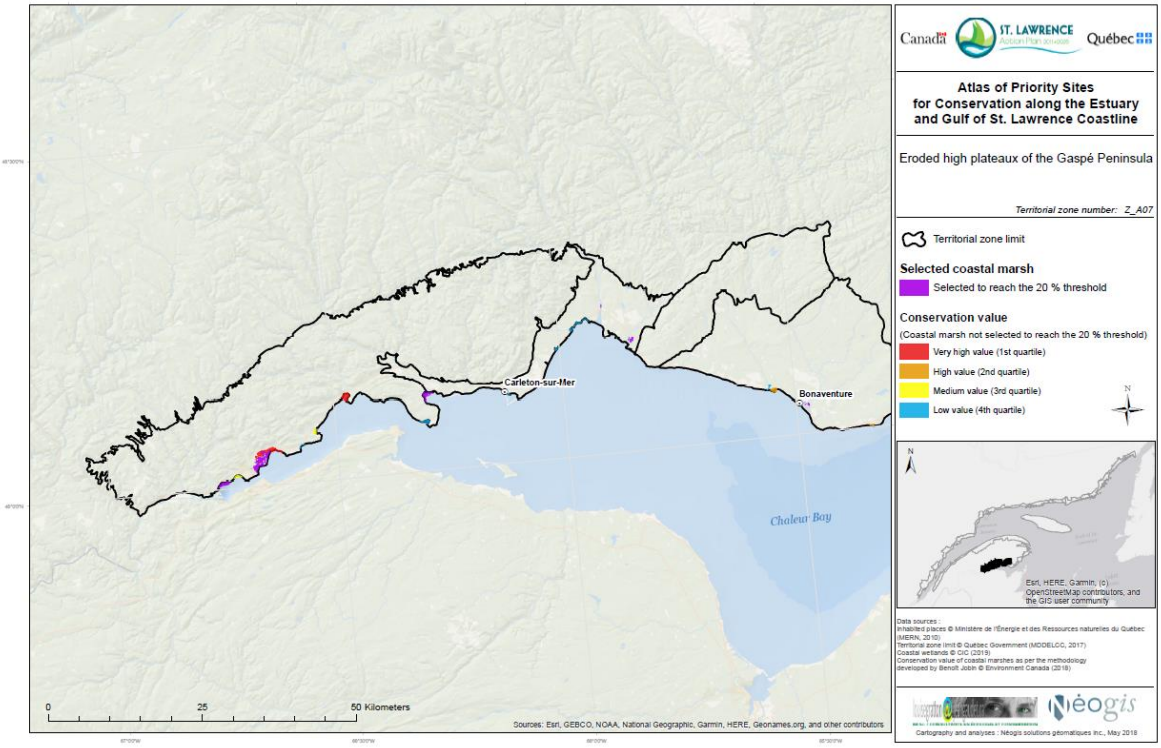

Figure 9. Location of the selected and prioritized coastal marshes as well as the conservation value of the other coastal marshes for territorial zone Z_A07 (Eroded high plateaux of the Gaspé Peninsula)

14.4. Sandy environments of interest

In all, 624 sandy environments were analyzed. Table 22 shows the number of sandy environments selected and prioritized to attain the representativeness objective of 20% in each territorial zone whereas table 23 shows the length of the selected and prioritized sites. The 20% representativeness threshold is almost completely met with the selection analyses, whereas only 6 of the 141 sandy areas of interest have been designated by the prioritization analysis. None of the 27 sandy environments was selected in the Z_70B territorial zone (Mingan maritime), while nearly 2/3 of the 34 sites were selected in the territorial zone Z_71 (Northern shoreline of the Estuary). Overall, the total length of sandy environments of interest represents 37% of the total length of the sandy environments of the study area, this proportion ranging from 21% in the territorial zone Z_A11 (Southern shoreline of the Estuary) to 72% in the territorial zone Z_82 (Anticosti Island).

Table 22. Total number of sandy environments, selected and prioritized to attain the representativeness objective of 20% in each territorial zone

Territorial zone	Nb of sandy environments	Nb of selected sandy environments	Nb of prioritized sandy environments	Nb of sandy environments of interest	% of sandy environments of interest
Z_28	27	5	1	6	22,2
Z_69	221	50	0	50	22,6
Z_70A	155	15	1	16	10,3
Z_70B	27	0	1	1	3,7
Z_71	34	21	0	21	61,8
Z_82	12	8	0	8	66,7
Z_A01	22	4	1	5	22,7
Z_A07	3	0	1	1	33,3
Z_A08	35	9	0	9	25,7
Z_A11	88	23	1	24	27,3
Total	624	135	6	141	22,6

Table 23. Total length of the sandy environments, selected and prioritized to attain the representativeness objective of 20% in each territorial zone

Territorial zone	Length of sandy environments (km)				Length of sandy environments (%)		
	Total	Selected	Prioritized	Of interest	Selected	Prioritized	Of interest
Z_28	44,0	3,4	10,2	13,6	7,7	23,2	30,9
Z_69	222,7	89,7	0,0	89,7	40,3	0,0	40,3
Z_70A	219,5	21,3	34,9	56,2	9,7	15,9	25,6
Z_70B	67,5	0,0	37,8	37,8	0,0	56,0	56,0
Z_71	22,4	10,9	0,0	10,9	48,8	0,0	48,8
Z_82	19,3	13,8	0,0	13,8	71,5	0,0	71,5
Z_A01	30,4	5,6	10,0	15,5	18,3	32,7	51,0
Z_A07	1,7	0,0	1,0	1,0	0,0	57,9	57,9
Z_A08	39,2	18,4	0,0	18,4	46,9	0,0	46,9
Z_A11	73,1	12,3	2,9	15,2	16,8	4,0	20,8
Total	739,9	175,4	96,9	272,3	23,7	13,1	36,8

Table 24 shows the number of sandy environments selected with each selection criterion. The vast majority (79%) of the sites were selected due to their proximity to public or private protected areas, however priority wildlife occurrences were also localized in several sandy areas of the Z_69 territorial zones (North Shore maritme), Z_82 (Anticosti Island), Z_A08 (Gaspé Peninsula northern maritime) and Z_A11 (Southern shoreline of the Estuary). Two sandy environments were selected due to the presence of priority plant occurrences located nearby (<150 m).

Table 24. Number of sandy environments selected with each selection criterion

Territorial zone	Public or private protected area	Plant occurrence	Wildlife occurrence	Global
Z_28	4	1	0	5
Z_69	41	0	19	50
Z_70A	14	0	2	15
Z_70B	0	0	0	0
Z_71	21	0	0	21
Z_82	1	1	7	8
Z_A01	4	0	0	4
Z_A07	0	0	0	0
Z_A08	2	0	7	9
Z_A11	19	0	7	23
Total	106	2	42	135

Very few sandy environments have been selected or prioritized on the Lower North Shore east of Sept-Îles except for certain beaches in the Natashquan and Mingan regions. However, several beaches in the Sept-Îles and Minganie regions have very high conservation values. Elsewhere on the north shore of the river, several sandy environments were selected between Forestville and Baie-Comeau, including the Pointe-Lebel Peninsula, as well as many small beaches in the Charlevoix region east of Malbaie and east of Tadoussac. Eight beach segments were selected on Anticosti Island (zone Z_82) on both sides of the island. Very few beaches are present in the Gaspé Peninsula (Zones Z_A01, Z_A07, Z_A08) so that only 15 of the 60 sandy environments found there are considered of interest for conservation. The majority of the beaches of interest, as well as those with a very high conservation value, are located in the eastern part of the peninsula, for example the Barachois de Malbaie. Finally, on the south shore of the estuary, many beaches of interest are found in the Bic and Rimouski regions. For example, Figure 10 shows the location of the selected and prioritized sandy environments as well as the conservation value of the other sandy environments for the territorial zone Z_A08 (Gaspé Peninsula northern maritime).

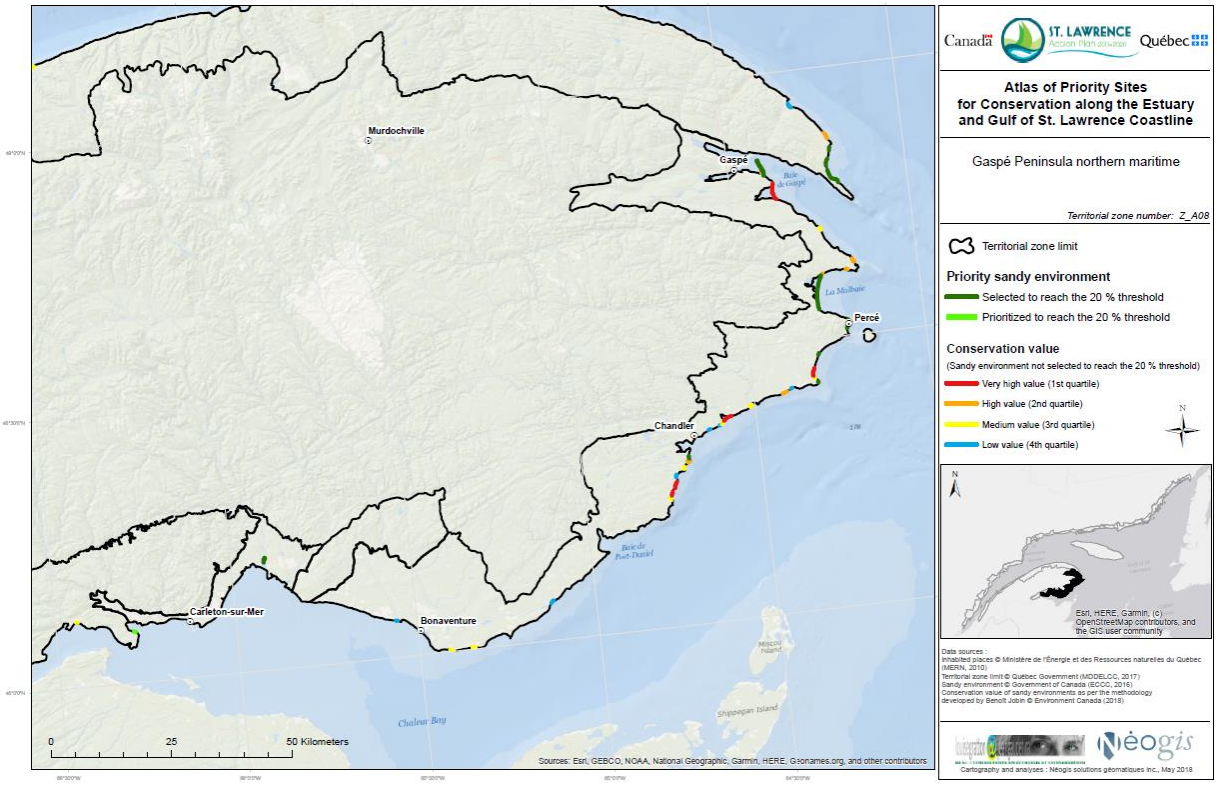

Figure 10. Location of the selected and prioritized sandy environments as well as the conservation value of the other sandy environments for the territorial zone Z_A08 (Gaspé Peninsula)

14.5. Overview of the sites of interest (coarse filter and fine filter)

Figure 11 illustrates, as an example, the distribution of the landscape elements of highest priority for conservation for the territorial zone Z_70A (Mingan maritime), namely the fine-filter elements and the selected habitat patches of each of the four conservation targets (forest ecological types, inland wetlands, coastal marshes, sandy environments) whereas figure 6 illustrates the distribution of the occurrences of species at risk in the territorial zone Z_82 (Anticosti Island). In addition, figure 12 illustrates the distribution of the sites of conservation interest (selection and prioritization) that were used to attain the 20% representativeness objective of each of the four conservation targets for the territorial zone Z_A11 (Southern shoreline of the Estuary).

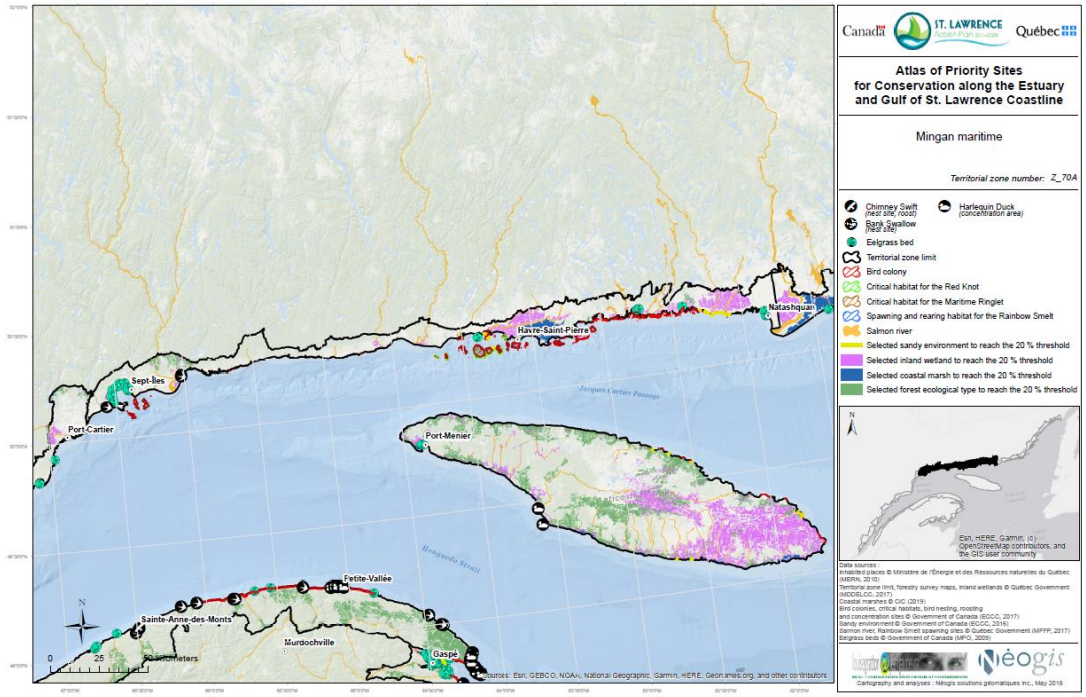

Figure 11. Distribution of the fine-filter elements and the selected habitat patches of each of the four conservation targets for the territorial zone Z_70A (Mingan maritime)

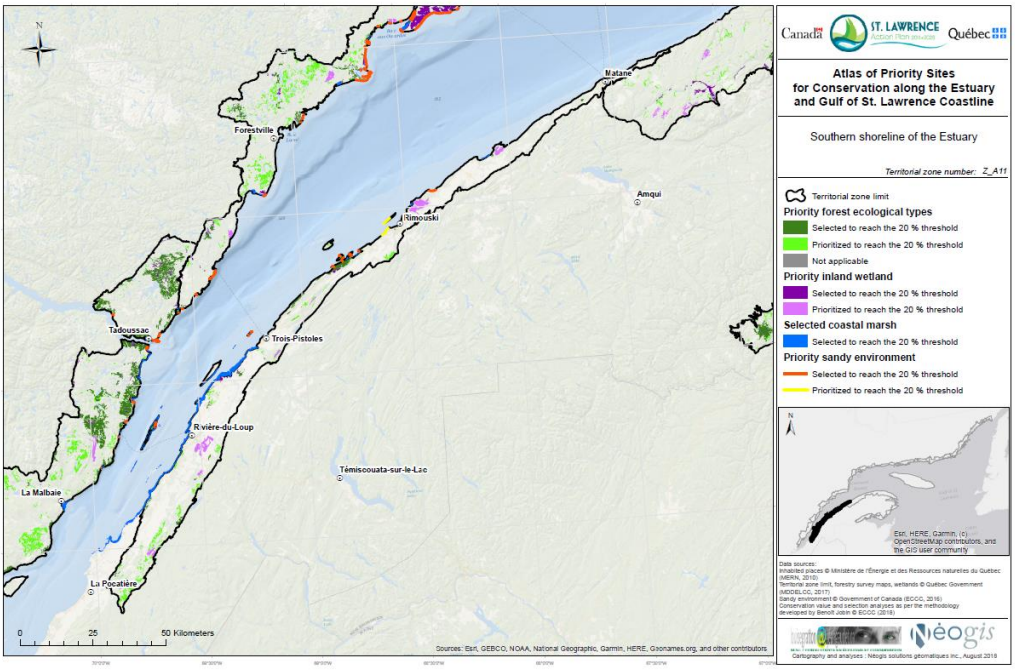

Figure 12. Distribution of the sites of conservation interest (selection and prioritization) that were used to attain the 20% representativeness objective of each of the four conservation targets for the territorial zone Z_A11 (Southern shoreline of the Estuary)

Table 25 shows the relative importance of each territorial zone in terms of maintaining the fine-filter elements. This is a summary analysis based on the distribution of these elements in the study area. Such an analysis would not be relevant for the coarse-filter conservation targets, since sites were selected and prioritized in each territorial zone until the 20% representativeness objective was attained.

Table 25. Relative importance of each territorial zone for maintenance of the fine-filter elements

Region	Territorial zone	Eelgrass beds	Bird colonies	Salmon river	Red knot	Maritime ringlet	Bank swallow	Chimney swift	Arlequin duck	Rainbow smelt	Wildlife occurrence	Plant occurrence
Lower North Shore	28	XXX	XXX	XX							X	X
	70A	XX	XXX	XX	XXX		X				XX	XXX
	70B	XX	XX	XX							X	
Anticosti Island	82	X	XX	XX					X		XXX	XXX
North Shore of the Estuary	69	XX	X	XX			XX				XX	XX
	71	X	X	X	XXX		X	X			XX	X
South Shore of the Estuary	A11	XX	XXX	X			X	XX		XXX	XXX	XX
Gaspé Peninsula	A01	X	XXX	X		XXX	XX	X	XXX		XX	XXX
	A07	XXX	X	XX		XXX					XX	XX
	A08	XX	XXX	XXX		XXX	XXX	X	XXX		XX	XX

XXX: Very high importance; XX: High importance; X: Moderate importance

The following sections present an overview of the sites and landscape elements where conservation measures should be carried out in order to ensure the sustainability of the species and their habitats in each of the large regions of the study area. These regional overviews make it possible to target areas of interest, but the analysis of the geospatial data associated with these results will allow users to more accurately determine the distribution of the sites of high conservation priority according to their specific interests.

14.5.1. Lower North Shore (territorial zones Z_28, Z_70A, Z_70B)

The Lower North Shore region contains many sites of interest for the conservation of biodiversity, particularly fine-filter elements. These include seabird colonies, several of which are Migratory Bird Sanctuaries, ensuring protection of the birds during the nesting periods. Eelgrass beds are also found at many locations along the coast. These two types of sites, seabird colonies and eelgrass beds, are particularly abundant in the regions of Sept-Îles, Havre-Saint-Pierre, La Romaine, the Sainte-Marie Islands, Harrington Harbor,

Saint-Augustin and Blanc-Sablon. Also, most of the major rivers that empty into the Gulf of St. Lawrence are salmon rivers; particular attention should therefore be paid to preserving the integrity of the habitats at the mouths and in the watersheds of those rivers.

More specifically, an analysis of the maps highlights the importance of several areas at the regional scale. Starting from the Labrador border and moving upstream, we note that the Blanc-Sablon area is particularly important for the conservation of several threatened plant species (e.g., Fernald's Milk-vetch (*Astragalus robbinsii* var. *fernaldii*)) and for several seabird colonies. The presence of several eelgrass beds is also noted between Rivière-Saint-Paul and Blanc-Sablon. The regions of Harrington Harbour and La Romaine and the large flats located to the east of Natashquan stand out by reason of the numerous selected inland wetlands and coastal marshes. The sector located between Longue-Pointe-de-Mingan and Havre-Saint-Pierre stands out owing to its high concentration of sites of interest for biodiversity, whether for colonial birds and the Red Knot or for threatened plant species, and for the numerous selected habitat patches of each of the four conservation targets (forests, wetlands, coastal marshes, sandy environments). Fortunately, several of these sites are located within the boundaries of the Mingan Archipelago National Park Reserve. Finally, the presence of several wildlife and plant species at risk was noted in the Baie de Sept-Îles region.

14.5.2. Anticosti Island (territorial zone Z_82)

Anticosti Island is the largest island in the St. Lawrence River. Despite the fact that several forested areas have been degraded owing to the large population of White-tailed Deer (*Odocoileus virginianus*), this island has many natural environments of very high importance for the conservation of biodiversity. The selection analyses also identified extensive peatlands in the eastern part of the island, large forest tracts all around the island, and numerous coastal marshes on the south shore of the island. Anticosti also has several salmon rivers and large bird colonies along the cliffs on the north side of the island; this site has the highest densities of Bald Eagle nests in Quebec, many threatened plant species (e.g., Anticosti Aster (*Symphyotrichum anticostense*)), and Harlequin Duck winter concentration areas at the mouth of the Jupiter River and at Pointe Sud-Ouest. Lastly, the bay of Port Menier is an important site owing to the selected coastal marshes and inland wetlands, and the only known eelgrass beds on Anticosti Island.

14.5.3. North shore of the Estuary (territorial zones Z_69, Z_71)

The sites of conservation interest on the north shore of the Estuary can be divided into two sections: the regions located to the east of the Saguenay River (zone Z_69) and the Charlevoix region (zone Z_71). First of all, for the regions located east of the Saguenay River, the Pointe-aux-Outardes Peninsula west of Baie-Comeau stands out as an exceptional site for biodiversity, with a large concentration of selected wetlands, coastal marshes and sandy environments, as well as several threatened wildlife and plant species. Numerous eelgrass beds are located all around the peninsula. The Pointe-des-Monts area, the estuary of the Saint-Nicolas River to the east of Franquelin, the Baie Laval area near Forestville, and the Pointe à Boisvert to the south of Sainte-Anne-de-Portneuf also stand out due to the number of elements that merit conservation. There are also numerous eelgrass beds in the sheltered bays all along the coast.

In the Charlevoix region, there is no particular concentration of sites of interest. However, the selection of large forest tracts and coastal marshes between Cap Tourmente and Baie-

Saint-Paul, as well as forest tracts, coastal marshes and sandy environments north of Saint-Siméon, particularly in the Baie des Rochers, should be noted. The mouth of the Rivière du Gouffre in Baie-Saint-Paul and the mouth of the Malbaie River in La Malbaie are also of high importance for biodiversity, as is the mouth of the Saguenay River, the site of the Saguenay–St. Lawrence Marine Park, which is recognized for its wildlife, plants and diversity of habitats, including bird colonies and a critical habitat for the Red Knot.

14.5.4. South shore of the Estuary (territorial zone Z_A11)

On the south shore of the Estuary, we note first of all the importance of the coastal marshes stretching from Saint-Denis-de-Kamouraska to Rivière-Trois-Pistoles; these marshes support large populations of Nelson's Sparrow (Rivard et al., 2006) and several Short-eared Owl nesting sites. The islands of the St. Lawrence Estuary, including the Kamouraska Islands, the Pèlerins Islands and the Îles de l'Estuaire NWA, are also of vital importance for the nesting of several seabird species (alcids, seagulls). Bicquette Island hosts the largest colony of the Common Eider in Canada, with some 10,000 nests, representing approximately 30% of the total population in the Estuary (Joint Working Group on the Management of the Common Eider, 2004). Fortunately, many of these islands enjoy protection status, such as those making up the Îles de l'Estuaire NWA, the natural reserve of Île aux Pommes, or private conservation areas such as Île aux Basques and sites on île Verte.

The region of the Parc national du Bic also shows a significant concentration of sites of interest, in terms of forest ecological types, inland wetlands and sandy environments selected owing to the presence of numerous wildlife and plant species at risk. We also note the importance of the extensive peatlands located east of Rivière-du-Loup, in the Pointe-au-Père region, and in the Métis-sur-Mer region. Finally, several other sites deserve particular attention, including the Rainbow Smelt concentration sites and spawning grounds (Rivière-du-Loup, Banc de Rivière-du-Loup, Fouquette River, Rivière des Trois-Pistoles), and the significant eelgrass beds in the regions of Cacouna, Isle-Verte, Trois-Pistoles and in Mitis Bay.

14.5.5. Gaspé Peninsula (territorial zones Z_A01, Z_A07, Z_A08)

The Gaspé Peninsula is distinguished from the other regions by the number and diversity of the fine filter elements found here. First of all, we note large eelgrass beds in Gaspé Bay, the Barachois de Malbaie and Chaleur Bay, particularly in the Pointe-à-la-Croix area, the Miguasha Peninsula, Bonaventure, the riparian zones stretching from Nouvelle to New Richmond, and a number of sheltered bays near Port-Daniel, Chandler, Pabos and Paspébiac. There are also a few eelgrass beds on the north side of the Gaspé Peninsula. Second, the Gaspé Peninsula is home to numerous seabird colonies where the diversity of breeding species is very high. These colonies are often established on long cliffs running along the shore, for example between La Martre and Cloridorme on the north coast of the Gaspé Peninsula, and on the south coast, on the Forillon Peninsula, between Gaspé and Pointe Saint-Pierre, between Grande-Rivière and Cap d'Espoir, between Bonaventure and Saint-Godefroi, and, of course, the Percé region and Bonaventure Island.

Numerous wildlife and plant species at risk have been recorded at various locations, including the critical habitats of the Maritime Ringlet in the Nouvelle and Saint-Omer regions and on Pointe de Penouille in Forillon, the only locations where this species is

found in Quebec. Numerous Bank Swallow colonies have been located in the Gaspé Peninsula, and there are Harlequin Duck winter concentration areas in the Petite-Vallée and Forillon areas, on Bonaventure Island and between Port-Daniel and Chandler. The Forillon Peninsula is also home to small mammals at risk such as the Gaspé Shrew and the Southern Bog Lemming. There are also many salmon rivers in this region.

In addition, there are concentration areas of the habitat patches that were selected, including the forested areas stretching from Forillon to Grande-Vallée and those located north of Carleton-sur-Mer, Bonaventure and Chandler, and in the Mount Sainte-Anne area near Percé, as well as several beaches near Gaspé Bay and Forillon. The following sectors are particularly noteworthy owing to the importance of the elements of biodiversity to be conserved: the Forillon Peninsula, the Percé–Bonaventure Island sector, the sectors of Nouvelle, Pointe-à-la-Croix, Barachois-de-Malbaie and Pointe Saint-Pierre, and those between Chandler and Port-Daniel.

14.6. Comparison with existing planning exercises

As mentioned above, several planning exercises have already made it possible to identify sites and areas of high value for the maintenance of biodiversity in the Estuary and Gulf of St. Lawrence. This atlas is therefore intended to be complementary to those existing documents; it is also very useful for comparing their respective content.

First, the Comité ZIP Côte-Nord produced three documents which describe in detail the coastal habitats with high conservation potential in each of the RCMs within the territory covered by the committee. The sites were selected during discussions with regional stakeholders working in the fields of the environment, tourism and land use management. Almost all the sites selected in their analyses are illustrated in this atlas: for example, Baie des Loups, the Petit Mécatina River delta and Havre Bluff on the Lower North Shore (Bourque et al., 2009); Anse aux Fraises and Pointe Sud-Ouest on Anticosti Island; the mouths of the Sheldrake and Saint-Jean rivers and Lac Salé de Baie-Johan-Beetz in Minganie (Pérot and Provost, 2008); and Île aux Oeufs , Baie des Homards and Baie de Sept-Îles in the RCM of Sept-Rivières (Bourque and Malouin, 2009).

Similarly, the Nature Conservancy of Canada (NCC) has produced conservation plans for natural areas that straddle the study area of the Atlas: Saltwater Estuary (Pelletier-Gilbert et al. 2011), Coastal Habitats of Gaspésie (Pelletier-Gilbert and Breich, 2009), South of the Gulf of St. Lawrence (Monticone et al., 2015), and Forillon Corridor (Gratton et al., 2010). NCC's analysis approach is similar to that used in this atlas, i.e., the determination of conservation targets based on the main ecosystem types (coarse filter) and individual elements of importance (fine filter). Here again, the main sites of interest found in these conservation plans are very similar to those determined in the current Atlas.

NCC is working on their own conservation plan using the data provided by the Atlas to identify the sites of interest for conservation in the coastal habitats of the St. Lawrence Gulf and Estuary (Bolduc et al., in prep.). With its own decision tree, NCC is selecting sites in accord with the organization's conservation objectives on private lands. For this natural area, a total of 9 sectors are considered a priority by NCC, 6 of which had also been selected by Pelletier-Gilbert et al. (2011) in a previous conservation plan covering the estuary and the northern portion of the gulf. These sectors include the Baie-Saint-Paul/La Malbaie, Les Bergeronnes/Portneuf-sur-mer, Pointe-aux-Outardes, Rivière-du-Loup,

Rimouski et Sainte-Flavie/Métis-sur-Mer in the estuary, to which Bolduc et al. (In prep.) have added the bay of Sept-Îles, the islands facing Longue-Pointe-de-Mingan and a coastal stretch between Sainte-Anne-des-Monts et Grande-Vallée in the Gaspé peninsula. In the southern portion of the gulf of St. Lawrence, many of the sites of interest in the Atlas are similar to the ones identified by NCC (Pelletier-Gilbert and Breich, 2009; Monticone et al., 2015), including the Darmouth, York, Saint-Jean, Nouvelle, Pointe-à-la-Garde, Oak Bay and Pointe-à-Bourdeau salt marshes, the Barachois de Malbaie, Mount Sainte-Anne and Pointe Saint-Pierre.

The Atlas also shows a succession of selected forested sites forming an ecological corridor between Forillon National Park and the Gaspésie Highlands. This corridor is in continuity with the one that aims to maintain connectivity on either side of route 137 as identified by Gratton et al. (2010) in the Forillon Natural Area Conservation Plan.

Moreover, NCC and its partners from northeastern United States have produced others documents describing the high value for natural areas and species conservation in trans-border regions. Anderson et al. (2006) have produced a conservation plan for the Northern Appalachian and Acadian Ecoregion where several coastal habitats of the Gaspé peninsula are considered a priority at the ecoregional scale. Also found in this plan, the salt marshes of the bay des Chaleurs as well as several forest ecosystems associated with summits, steep slopes and ravines found inland between Sainte-Anne-des-Monts and Grande-Vallée, in Forillon, Mount Sainte-Anne and in the highlands north of Carleton-sur-mer, including Mount Saint-Joseph.

In the Bas-Saint-Laurent, the coastal marshes of the southern estuary and the large peatlands of the Rivière-du-Loup, Rimouski, Pointe-au-Père and Métis-sur-Mer (Pointe-Leggatt) regions selected among the sites of interest for conservation in the Bas-Saint-Laurent region (Coulombe et al., 2015), as well as the areas of high value for biodiversity in this region (Coulombe and Nadeau, 2013), including the Parc national du Bic and the Baie de l'Isle-Verte, Pointe-au-Père and Métis-sur-Mer regions, are all also selected as sites of interest in the current Atlas.

The production of an atlas of sites of interest for conservation along the Estuary and Gulf of St. Lawrence also makes it possible to address the conservation priorities of the Canadian Wildlife Service concerning the spatial determination of the sites that merit conservation in order to maintain the populations of priority bird species in Bird Conservation Region 8 – Boreal Softwood Shield (Environment Canada, 2013a) and Bird Conservation Region 14 – Atlantic Northern Forest (Environment Canada, 2013b). These documents raise the importance of conserving various types of ecosystems, for example, softwood forest stands, coastal marshes and coastal islands for bird conservation. This atlas therefore makes it possible to spatially represent several habitat components that are considered priorities in these Bird Conservation Region Strategies. At the same time, all the coastal areas of the Estuary and Gulf of St. Lawrence comprise one of the priority regions of the Eastern Habitat Joint Venture, a multipartite initiative aimed primarily at waterfowl conservation in eastern Canada (Eastern Habitat Joint Venture, 2017). In addition, this atlas illustrates the sites of interest for the maintenance of the populations of several species at risk, such as the Red Knot (ECCC, 2017b), the Maritime Ringlet (Environment Canada, 2012), the Spongy Arrowhead (*Sagittaria montevidensis* subsp. *spongiosa*) (Jolicoeur and Couillard, 2006), the Anticosti Aster (Jolicoeur and Couillard, 2007) and Fernald's Milk-vetch (Environment Canada, 2011).

Finally, several regions of interest illustrated in this atlas are located in or near existing protected areas (federal: Saguenay–St. Lawrence Marine Park, Forillon National Park, Mingan National Park Reserve, National Wildlife Areas, Migratory Bird Sanctuaries; provincial: Parc national du Bic, Parc national de l'Île-Bonaventure-et-du-Rocher-Percé, Parc national d'Anticosti, ecological reserves and others). In addition, the recent or planned designation of marine protected areas will make it possible to conserve marine ecosystems that are adjacent to the coastal sites of interest, which will increase the possibilities of maintaining wildlife populations that depend on terrestrial and aquatic environments for their survival (e.g., colonial birds). These include the provincial government's (MDDEFP, 2013) proposed designation of marine areas of the proposed Manicouagan Aquatic Reserve, which surrounds Pointe-Lebel and Pointe-aux-Outardes, one of the sites of importance identified on the north shore of the Estuary in this atlas, as well as the impending designation of Banc-des-Américains Area of Interest, located at the eastern tip of the Gaspé Peninsula, as a federal marine protected area (Gazette du Canada, 2018) will make it possible to conserve the aquatic environments of this region heavily used by colonial birds.

In short, although numerous sites of conservation interest described in this atlas are similar to those already determined during existing planning exercises, the atlas is complementary to the existing plans given the regional prioritization of the coarse-filter targets at the scale of the territorial zones, the addition of certain fine-filter conservation targets (e.g., Bank Swallow colonies, location of species at risk) and the updating of existing data (e.g., bird colonies).

15. Current conservation status of the conservation targets

Figure 13 shows the proportion (%) of the surface area of the sites of interest (selection + prioritization) of the coarse-filter targets that is located in public or private protected areas. Generally, we note that the majority (70%) of the forest ecological types of the Lower North Shore are located in protected areas, while more than 20% of the wetlands and sandy environments are also conserved. Only 2% of the coastal marshes are located in protected areas. Fortunately, the development pressures are limited in this region, which reduces the potential threats to these ecosystems. Less than 20% of the four types of sites of interest on Anticosti Island are located in protected areas, as the majority of the protected sites are within the Parc national d'Anticosti and the ecological reserves. On the north shore of the Estuary (between Cap Tourmente and Port-Cartier), more than 60% of the sandy environments of interest and one quarter of the forest ecological types and coastal marshes of interest already enjoy protection status, while only 2% of the interior wetlands of interest are conserved. A large part of the sites of interest of the four conservation targets located on the south shore of the Estuary (between Kamouraska and Sainte-Félicité) are located in protected areas, this proportion being 87% for sandy environments, 50% for forest ecological types, 22% for wetlands and 20% for coastal marshes. Finally, the sites of interest of the Gaspé Peninsula are also largely conserved, while more than 20% of the surface areas of the four conservation targets are already conserved, nearly half of which are coastal marshes.

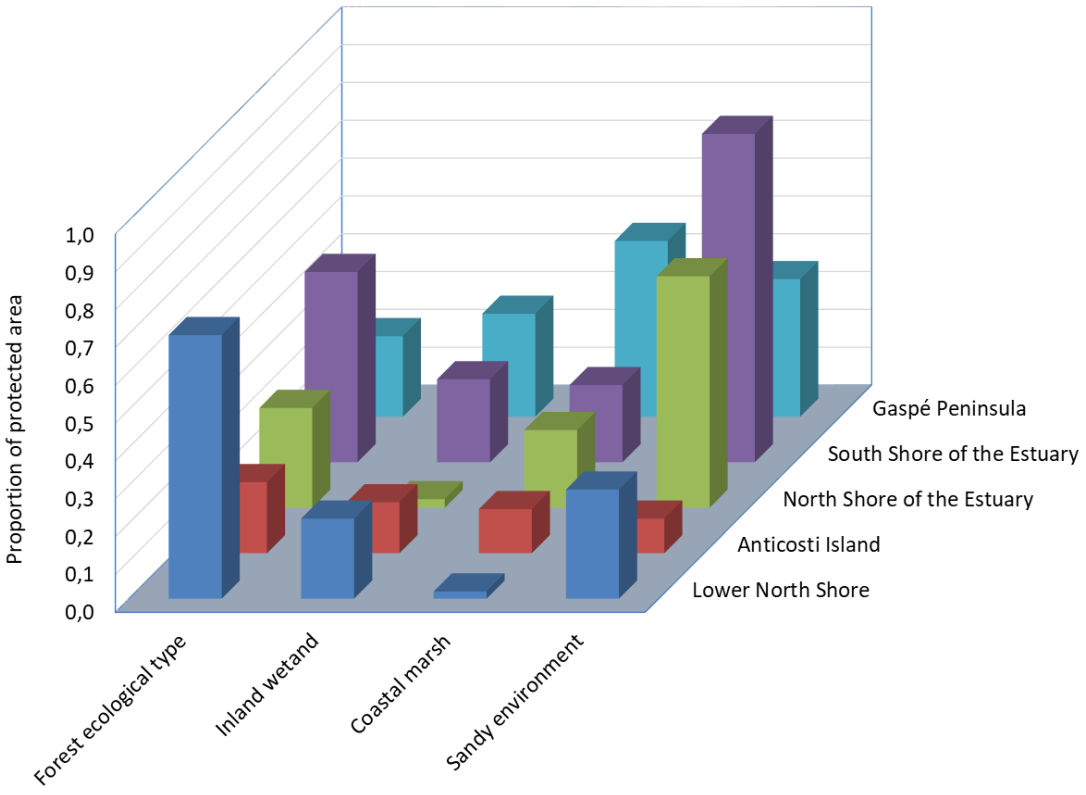

Figure 13. Proportion (%) of the surface area of the sites of interest (selection and prioritization) of the coarse-filter targets that is located in public or private protected areas

Similarly, figure 14 shows the proportion (%) of the fine-filter elements that are located in public or private protected areas. We note immediately that the great majority of the bird colonies on the Lower North Shore and on both shores of the Estuary are protected, as these colonies are largely located in Migratory Bird Sanctuaries or National Wildlife Areas. The critical habitat of the Red Knot at the mouth of the Saguenay River is included within the boundaries of the Saguenay–St. Lawrence Marine Park, while the critical habitat near Mingan is on the foreshore, therefore at the terrestrial limit and outside the Mingan Archipelago National Park Reserve. Similarly, part of the critical habitat of the Maritime Ringlet is already protected by Forillon National Park (Penouille Peninsula) and by voluntary conservation measures in the Nouvelle marsh in the Gaspé Peninsula. Since the eelgrass beds are located in aquatic environments, it is not surprising to note that this type of habitat is not covered by the existing protected areas (apart from the sector of the proposed Manicouagan Aquatic Reserve).

It should also be noted that riparian areas located on either sides (100 m buffer) of salmon rivers are very little conserved throughout the study area, the Regulation respecting forest intervention standards in the domain however limits forest harvesting in a 60-m buffer. Forillon National Park and the Parc national de l'Île-Bonaventure-et-du-Rocher-Percé, for their part, contribute to protecting a large part of the winter habitat of the Harlequin Duck. Finally, apart from a few Bank Swallow nesting sites located on the north shore of the Estuary and of the Gaspé Peninsula, very few of the other important wildlife elements are currently protected (Chimney Swift nests and roosts, Rainbow Smelt habitat and spawning grounds).

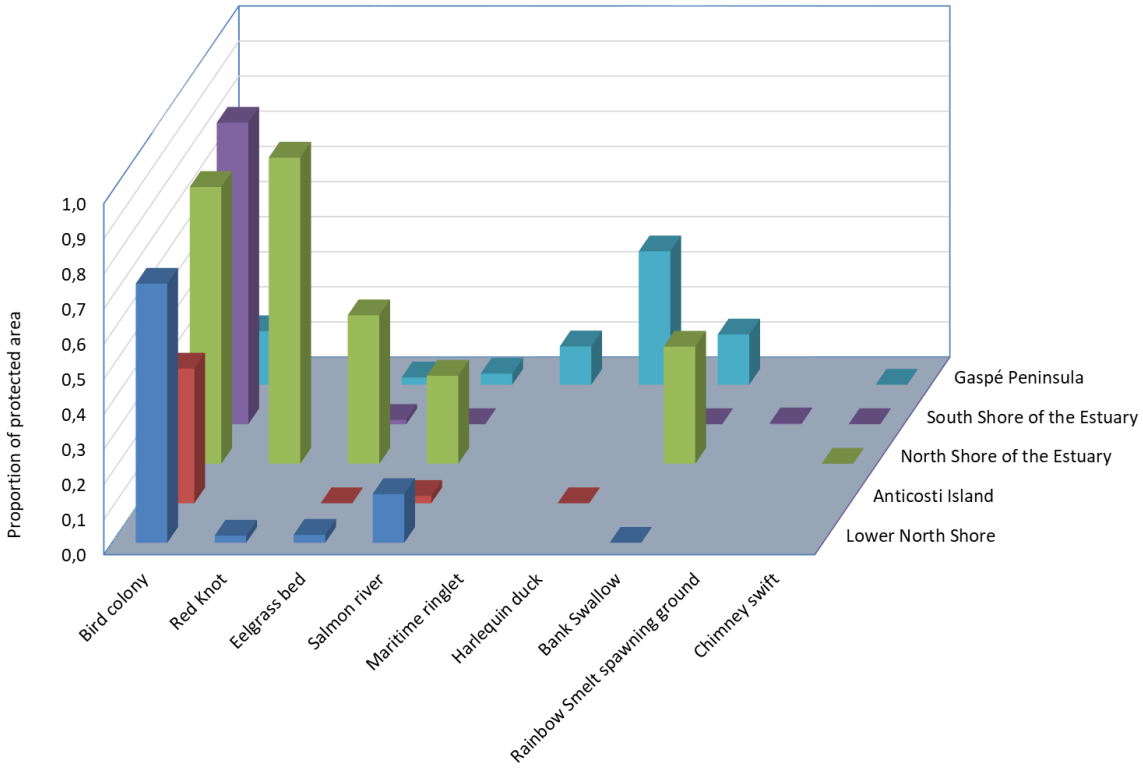

Figure 14. Proportion (%) of the fine-filter elements that are located in public or private protected areas

16. The case of the Magdalen Islands

Since the Magdalen Islands archipelago has already been the subject of several environmental intervention plans (Attention FragÎles / Groupe de référence en environnement des Îles-de-la-Madeleine, 2012) and conservation plans (Bouffard and Poirier, 2002; Cyr and Deraspe, 2012; Monticone et al., 2015). The implementation of which is well underway, it was not deemed relevant to repeat an analysis of the sites of interest for the conservation of biodiversity for this region. However, the main natural features of this area located in the heart of the Gulf of St. Lawrence and the pressures to which they are exposed are summarized here.

16.1. Natural environments and biodiversity of interest

The archipelago, which has a total area of 202 km^2, includes some 15 islands and islets composed mainly of very friable red and grey-green sandstone, sitting atop salt diapirs. Seven are connected to each other by narrow dune ridges: Île de Grande Entrée, Île de l'Est, Grosse-Île, Île de la Pointe-aux-Loups, Île du Havre aux Maisons, Île du Cap aux Meules and Île du Havre Aubert. Two additional islands of significant size are located a little farther away: Entry Island and Brion Island.

The natural environments of the archipelago, which are unique in Quebec, are strongly influenced by the maritime climate and by the exchange dynamics between the St. Lawrence River and the Atlantic Ocean. The strong waves and winds, frequent fog and mild climate have a very particular way of shaping the islands' vegetation (stunted forests)

and especially their dune ecosystems composed of maritime barrens, stabilized and active dunes, and beaches. The beaches give rise to the formation of lagoons and shallow ponds which maintain exchanges with the sea and in particular promote the development of wetland habitats very rich in biodiversity, creating an environment that supports plants and wildlife found nowhere else in Quebec. The islands are well known for their numerous seabird colonies and several bird species at risk, including the Piping Plover (*Charadrius melodus*), the Roseate Tern (*Sterna dougallii*), the Horned Grebe (*Podiceps auritus*) and the Red Knot *rufa* subspecies, and for plants at risk, including the Gulf of St. Lawrence Aster (*Symphyotrichum laurentianum*) and the Bog Huckleberry (*Gaylussacia bigeloviana*).

16.2. Threats

The main threats to this area are climate change, off-road vehicles and the trampling of fragile environments, cottage development and the risks of hydrocarbon spills. The characteristics of the tree stratum have never permitted logging, since there is no allowable cut. Local threats related to the installation of infrastructure are also present (e.g., wind farm).

16.2.1. Climate change

The coastline of the Magdalen Islands is particularly vulnerable to erosion and submersion, being composed of very friable sandstone cliffs, beach berms and low dune ridges (Ouranos, 2016). Storms have always reshaped the islands' shoreline and beaches. However, in recent years, these changes are occurring at an accelerated pace (Cyr and Deraspe, 2012). The ice that used to encircle the islands each winter is gradually disappearing. The period during which the waves are blocked by ice has decreased by 30% since 1960, and by the end of the century there will probably no longer be any winter ice. Storms are battering the islands more frequently and with greater force. As the winter ice disappears and the storms become more powerful, shoreline, cliffs and dunes are eroding more quickly. The most probable scenario predicts a retreat of 38 m on average of the rocky cliffs and an 80 m retreat of the low sandy shores by 2050 (Ouranos, 2008). Coastal erosion has already led to the relocation of road sections and the installation of bank stabilization works.

16.2.2. Human use

Motorized off-road vehicle (ORV) traffic on the dune vegetation creates numerous breaches, in addition to those of natural origin which already riddle the dunes. Winds, sand and waves are driven with force through these breaches, exposing the terrain behind the dunes to high winds, salt spray and saltwater intrusion. Most of the sandy coastline belongs to the public domain and is under the responsibility of the MERN. However, in practice, no local authority has been delegated to assume this responsibility. With more than 300 km of beaches, the Magdalen Islands are the preferred vacation destination of many Quebecers. The numbers of visitors on the beaches in the summer season, when uses are not supervised (heavy ORV traffic, dogs, sand yachts, pedestrians, etc.), has an impact on the vegetation of the stabilized dunes, dominated by beachgrass, a very fragile species susceptible to repeated trampling. The disturbance caused by human activities has a significant impact on the survival of migratory bird populations, particularly during the breeding season and during their fall migration. The situation for species at risk such as the Piping Plover is worrisome.

16.2.3. Residential and cottage sites development

Residential development, establishment of new businesses and the development of cottage sites, which are encroaching on the dune sites prized by many visitors (Cyr and Deraspe, 2012), are also accompanied by backfilling, deforestation and loss of wetlands. Tourism development is also threatening the water table and is creating increased pressure on municipal services (road network, water supply, wastewater treatment, waste management) (Gagnon, 2006).

16.2.4. Hydrocarbon spills

The shores of the Magdalen Islands are vulnerable to offshore hydrocarbon spills. Owing to a moratorium, there is currently no hydrocarbon exploration or production activity underway in the Magdalen Islands region, although the area appears to have a certain potential. The oil potential appears to be low to moderate, but the gas potential is high with the possibility of large deposits. Potential future exploration and production projects involving the Old Harry deposit are giving rise to great concern. In addition, spills can occur during the transport of hydrocarbons, as was the case in September 2014, when a leak in the pipeline between the port and Hydro-Quebec's diesel-fired generating station released 100,000 litres of fuel oil, which required months of clean-up work (Radio-Canada, 2016). To reduce this kind of risk and begin the energy transition that has been a long-standing goal for the islands, a wind turbine project on the Dune-du-Nord has been proposed. Located in a designated plant habitat, the project is controversial and the announcement of the installation of a submarine cable which, beginning in 2025, will reduce the islands' greenhouse gas emissions (GHGs) by 94%, has cast doubt on the project's relevance.

16.3. Conservation issues

Eight islands are inhabited and the density of occupation is relatively high. The population of the islands is 13,000 and, in summer, local residents share the territory with 55,000 visitors. The urbanized areas are built on rocky cores of low relief. The road links and power distribution grid are located on the long dune fields between the rocky cores. The pace of economic activities, focused mainly on fishing and tourism, but also on a few emerging sectors, is particularly intense during the summer and is largely based on the quality of the landscapes, water and marine habitats. Blessed by strong, regular winds, the Magdalen Islands have become a favorite destination for nautical activities such as windsurfing, kitesurfing and surfing. This situation makes it incumbent upon the elected officials and local residents not only to continue the diversification of economic activities and to maintain a certain level of activities year-round, but also to devote attention to maintaining and renewing the ecosystems and resources that support this economy.

The difficulties involved in reconciling protection of the natural environment in the Magdalen Islands with certain uses led to the emergence in 1988 of a citizen movement, Attention FragÎles, which, since its creation, has worked to promote the environmental accountability of residents, developers and visitors. Clear municipal by-laws exist today governing the use of motor vehicles on the beaches, dunes and shores and in the wetlands and requiring dogs to be leashed. The awareness-raising projects and relocation of recreational trails away from fragile environments, which have been carried out by Attention FragÎles in collaboration with the local ATV club, are very encouraging. Attention FragÎles and the Comité ZIP des Îles-de-la-Madeleine have been instrumental in the construction of boardwalks to provide access to the beaches while reducing pressures on

the dune environment from human activities. The scientists and professionals of the Ouranos consortium (2016) have studied the erosion-related phenomena and evaluated various scenarios representing the progression of these problems on the archipelago for the coming years and the options for adaptation of the Magdalen Islands shoreline. Although the primary objective is to protect the infrastructure, these studies could influence the protection and management of natural environments.

In 2001, the Société de conservation des Îles-de-la-Madeleine (SCÎM) was established with the mission of preserving picturesque and historical sites; this organization has been responsible for the protection of 257 ha, including the Buttes des Demoiselles and Boudreau Island. Since 2004, the Nature Conservancy of Canada (NCC) has been acquiring properties on Île de Grande Entrée with the goal of consolidating the protection of the Pointe-de l'Est National Wildlife Area and collaborated with SCIM in the acquisition of properties on the island of Havre-Aubert.

Finally, it is important to point out that there is still a proposal to establish a marine protected area in the Magdalen Islands. In 2004, the Parks Canada Agency (PCA) announced the launch of a feasibility study concerning the possible creation of a National Marine Conservation Area (NMCA). In addition, a recent study was carried out by UQAR-UNESCO (2014) with the objective of conducting a characterization of the natural, social, economic and cultural elements of the Magdalen Islands, assessing the islands' environmental, social and economic issues, and suggesting protection and development scenarios.

17. Conservation strategies in the Open Standards framework

This atlas makes it possible to identify the areas where conservation actions could be implemented. According to the Open Standards framework (CMP, 2013), the atlas includes only the initial steps in the process of developing a conservation plan, i.e., identification of the conservation targets and sites of interest for conservation. To develop an action plan leading to concrete and attainable conservation strategies, several steps must first be completed, by considering first of all the entire Estuary and Gulf of St. Lawrence but, eventually, at the scale of smaller territorial units given the great disparity of the human influence on the study area. These steps, briefly described below and based on CMP (2013) and CNC (2014) are as follows:

- Viability analysis of conservation targets
- Threat analysis
- Situation analysis
- Identification of the goals for each conservation target
- Planning of conservation strategies and actions
- Monitoring plan of the viability of conservation targets and effectiveness of actions

According to the Open Standards, the development of conservation strategies will be based on a detailed analysis of the contributing factors to the most important threats, which will help identify concrete actions to reduce the impact of these threats on conservation targets, all of which accompanied by a series of indicators to measure the effectiveness of the actions implemented.

17.1. Viability analysis of conservation targets

The viability analysis is performed in order to identify the key ecological attributes that will determine the "health" status of conservation targets be it an ecosystem or a specific population of a plant or animal species. More specifically, viability indicates the ability of a conservation target to resist or recover from most natural or human disturbances, and thus survive for many generations. An ecological attribute is an aspect of the biology or ecology of a target that, if it fails or is altered, would lead to the loss or extreme degradation of that target. There are three categories of attributes that determine the health status of a conservation target: size, condition, and geographic context (CMP, 2013). If possible, the three categories of attributes are used to qualify the viability of a target and generally, the number of ecological attributes is limited to five.

Size is a measure of the area occupied by the occurrence of a target (for an ecosystem) or a measure of the abundance of a target's occurrence (for a species or population).

The **condition** is a measure of the biological composition, structure, and biotic interactions that characterize the space in which the target is located.

The **geographic context** is an assessment of the target environment, including: a*) the ecological processes and regimes* that maintain the target's presence such as floods, fire regimes and other natural disturbances; and *(b) connectivity* that allows species-targets to access habitats or resources or enable them to respond to environmental changes through dispersal or migration.

For each ecological attribute, an indicator is determined. This unit of information must be measurable over time in order to document, at the time of the follow-up, changes in the health status or viability of the target over time (see section 17.6). For each indicator, the degree of variation tolerated, or the threshold of viability, establishes minimum criteria identifying a conservation target as "in good condition". This degree of variation corresponds to the limits of natural variation of the target which constitute the minimum conditions for the target to survive. If the attribute is outside these limits, then it is a degraded attribute whose maintenance may require human management interventions. To simplify the analysis of key ecological attributes and classify the status of conservation targets (CMP, 2013), the value of the indicators is ordered in 4 classes:

• Poor: Allowing the indicator to remain in this condition for an extended period will make restoration or prevention of extirpation of the target practically impossible;

• Fair: The indicator lies outside of its range of acceptable variation and requires human intervention for maintenance;

• Good: The indicator is functioning within its range of acceptable variation, although it may require some human intervention for maintenance;

• Very good: The indicator is functioning within an ecologically desirable status, requiring little human intervention for maintenance within the natural range of variation.

17.2. Threat analysis

The list of threats presented briefly in section 7 must be completed and a detailed description drawn up based on a review of the literature specific to the study area. Each threat will be assessed in order to determine those that, in a given time horizon (e.g., 10 years), will have the most critical effects on the maintenance of the targets. To this end, the Open Standards suggest a method of ranking threats which determines the scope, severity and irreversibility of each threat for each target. A preliminary assessment will be validated by experts supporting the project team. Where feasible (depending on the nature of the threat and the data available), mapping showing the spatial footprint and the intensity of specific threats will be produced to support the assessment of their scope and relative severity. From this assessment, the threats will be ranked from highest to lowest and will prioritize actions where the situation is most critical for a given target or set of targets. It is possible that, owing to a lack of data or knowledge, certain threats cannot be assessed. If, in the opinion of the experts, these threats are likely to be significant in the short or medium term, the action plan may include a knowledge acquisition strategy.

17.3. Situation analysis

A situation analysis attempts to describe how past human activities have influenced land use patterns and how, in the near future, these human activities are likely to directly or indirectly affect the biodiversity of the study area. This analysis describes the relationships between the biological environment and the social, economic, political and institutional systems and drivers that affect the conservation targets. A brief description of the current socio-economic situation and emerging trends will make it possible to identify the sectors of activity (e.g., urban sprawl) or specific activities/phenomena (e.g., spread of alien species) that are likely to have impacts on the conservation targets. Based on this situation analysis, the next step is to identify the contributing factors (also called indirect threats or root causes) that drive the most serious direct threats and ultimately influence the conservation targets. Constructing a conceptual model makes it possible to visualize the links (chain of factors) between a threat or threats and the contributing factors. This analysis also seeks to clearly identify the conservation context, i.e., the stakeholders (individuals, organizations, institutions) and the conditions (e.g., interests, regulatory tools, resources) that could constitute either constraints to or opportunities for the implementation of the conservation plan (e.g., new legislation). This part of the analysis helps clarify the interests of the stakeholders and relationships that may warrant particular attention, since they can influence the success or failure of the conservation strategies.

17.4. Identification of the goals for each conservation target

Goals are the explicit statements of what the conservation plan seeks to accomplish in the study area. Goals are linked to the conservation targets and are impact-oriented, measurable, time-limited and specific. They are usually based on the desired future health status for each of the targets established in advance by the viability analysis. Since the targets can include multiple indicators that each have a desired future status, there may be several goals for each target, or several indicators can be combined and incorporated in a single goal statement for a target. Although certain desired future statuses may be attainable during the implementation of the conservation plan (e.g., 15 years), in many cases the period required may be longer (e.g., 25, 50, 100 years or more). The development of such long-term goals enables the project team and the potential partners to understand the magnitude of the actions required to ensure the permanent protection of the full range of biodiversity. In such cases, the purpose of implementation of the conservation plan will be an intermediate goal toward the attainment of the desired future status.

17.5. Planning of conservation strategies and actions

Planning of conservation strategies involves determining where and how to intervene. First, it is necessary to decide which contributing factors should be targeted by one or more interventions and which would be the most likely to attain the goals of the conservation plan; these are the key intervention points. For each of these points, a list of strategies based on the literature, on common practices or on creative measures adopted by the project team and the experts will be produced. Each of the strategies selected must specify the desired result or results following its implementation. The Open Standards suggest starting from the conceptual model to translate each chain of factors into a results chain. This makes it possible to describe the assumptions expressed in terms of expected results regarding the mitigation of a direct threat and the influence exercised on a contributing factor. The strategies are then prioritized to identify the strategies that will most likely have the greatest effects on the conservation of the targets and optimize the stakeholders' primary interests, thereby minimizing possible conflicts or facilitating partner support.

For each of the strategies selected, a set of actions is developed by integrating opportunities and identifying any obstacles to implementation. An action is a measure taken with the goal of carrying out one of the project strategies. The strategies can include a broad array of actions ranging from advocating changes to government objectives and policies and strengthening municipal by-laws, to habitat restoration, land protection, education and awareness-raising. Each action must correspond to a particular set of specific and complementary tasks that must be carried out to attain the desired result. For each action, a clear objective is established, and an indicator makes it possible to monitor the effectiveness of this action; this indicator should be results-oriented, measurable, time-bound, specific and practical.

17.6. Monitoring plan of the viability of conservation targets and effectiveness of actions

Since the Open Standards framework constitutes an adaptive management process, it necessarily entails relying on programs to monitor the effectiveness of the actions taken

to integrate project design, management and monitoring, so that the assumptions explicitly stated prior to implementation can be tested systematically. Monitoring is essential, since it is imperative not only to be able to identify the strategies and actions that have succeeded or failed, but also to understand why. These evaluations will make it easier to justify the continuation of the actions undertaken or to adapt and modify the actions planned in order to increase their effectiveness. Over the longer term, the monitoring process must also provide the information necessary to evaluate the progress made toward attainment of the goals set for each target in the conservation plan.

18. Regional action plans

The development and implementation of an action plan at the scale of such a vast area is an ambitious project. However, several possibilities are considered in order to create a synergy around the production of the atlas and develop implementation tools. In addition to the fact that the data are made available, the project team plans to conduct an analysis aimed at classifying the territorial zones or any other territorial unit deemed appropriate (e.g., ecological districts, watersheds) according to the conservation needs (e.g., concentration of sites of interest or unique sites) and the significant threats anticipated over the short term and medium term. The identification of these territorial units whose situation is the most critical will make it possible to, among other things, focus the implementation of conservation strategies.

Among the tools to be developed, a methodology guide for regional application of the atlas tools is planned, together with a series of webinars emphasizing the use of the data and the process involved in conservation projects at the regional and local scales that have already been carried out or are underway using the Open Standards. Related topics will also be addressed, including the integration of connectivity, ecological services and climate change adaptation in conservation plans.

A round of presentations is also planned with the following objectives: 1) to validate the results of the analyses with regional experts; 2) to present the conservation tools; 3) to initiate with stakeholders the process for undertaking conservation plans at the regional scale; and 4) to identify geographic entities, sectors or sites where pilot projects could be carried out. Inspired by the conceptual framework proposed by Raymond et al. (2017), the pilot projects could serve as a reference to inform, learn lessons and refine the implementation of conservation strategies specific to recurrent issues. The most effective strategies could be transposed to the scale of the study area.

19. Publicly available data

In order to provide guidance for the development of conservation strategies at the regional scale, the information layers as well as the results of the analyses used to determine the sites of interest for conservation targets (forest ecological types, inland wetlands, coastal marshes, sandy environments) are publicly available on the St. Lawrence Global Observatory website (https://slgo.ca). Users can thus have access to this information to more precisely visualize the locations of the sites of interest. In addition, they can conduct their own analyses based on objectives specific to their own interests or to regional realities.

Apart from information on bird colonies that are also publicly available, a request must be made directly to those responsible for certain databases whose public dissemination is restricted. We are thinking here of exceptional forest ecosystems (MFFP), data on threatened and vulnerable species of the CDPNQ (MELCC, MFFP), the critical habitat of species at risk (ECCC, DFO), the data on birds at risk in the SOS-POP database (Regroupement QuébecOiseaux), the Directory of protected areas located on private land (RMN), eelgrass beds (DFO) and spawning grounds and salmon rivers (MFFP). Finally, information on protected areas in the Registre des aires protégées au Québec (MELCC) and the Cadre écologique de référence du Québec (ecological reference framework; CERQ) (MELCC) can be downloaded from the Government of Quebec's open data portal (https://www.donneesquebec.ca/fr/).

20. Conclusion and future prospects

The Atlas of sites of interest for conservation along the Estuary and Gulf of St. Lawrence Coastline provides a summary of current knowledge on the spatial distribution of sites that have high potential for the maintenance of biodiversity. This information is complementary to existing land use planning, supplements current knowledge about the conservation needs of natural environments and biodiversity and will be useful for guiding the conservation actions of the organizations active in the study area.

The production of such an atlas is dependent on the currently available information on existing ecosystems and on the knowledge of the wildlife and plant populations they support. From the beginning of the project, it was obvious that the more limited geospatial information available for the Lower North Shore (east of Natashquan), owing mainly to the difficulty accessing this part of the study area, which limited the collection of biophysical data, would cause disparities in the determination of the sites of conservation interest between this region and the rest of the study area. However, in parallel with the sites of interest already determined by the Comité ZIP Côte-Nord, we are confident that the sites included in this atlas are a fairly accurate reflection of the areas of interest where conservation actions should be focused.

Obviously, the process of determining the conservation actions required to maintain the existing ecosystems will be guided both by the conservation value of the sites and by the threats and pressures they face. Conservation strategies will need to take into account the maintenance of ecosystem integrity, the pressures on ecosystems, and the specific needs of local actors. In this context, the merits of the unified approach of the Open Standards for the Practice of Conservation will become evident. For example, combining the information in this atlas with the results of research aimed at quantifying the susceptibility of coastal environments to coastal hazards (erosion, submersion) would make it possible to focus future conservation actions on the sites most resilient in the face of the presumed effects of climate change (Lebel, 2016). To this end, the laboratory of territorial zone dynamics and integrated territorial zone management of the Université du Québec à Rimouski is currently working to complete a very detailed mapping of the coastal ecosystems with a view to guiding decisions, including the determination of mitigation measures to combat the effects of these coastal hazards. This new mapping may therefore be useful for improving the more specific determination of the sites of interest for the conservation of biodiversity. Similarly, the marked differences in regional realities will ensure that, for the same conservation need, the actions advocated on the North Shore may differ from those envisaged in Chaleur Bay.

In addition, since the results and the geospatial data associated with the sites of interest included in this atlas are available, regional stakeholders will be able to consult more precisely the spatial distribution of the sites of interest and the conservation value associated with each habitat patch of the conservation targets (forest environments, wetlands, coastal marshes, sandy environments) using geographic information systems (e.g., ArcGIS). Users will also be able to adapt the analysis of these data to their territorial reality and based on their own needs. Because this atlas is intended to be a land use planning support tool, it is hopes that the sites of interest identified in the analyses be taken into consideration in reviews of RCMs' and municipalities' land use and development plans.

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Appendix A. Terrestrial species at risk whose presence has been documented in the study area

Common Name	Scientific Name	Status	
		Federal	Provincial
Vascular Plants			
Climbing Fumitory	*Adlumia fungosa*	No Status	Susceptible
Thin-stem Lady's Mantle	*Alchemilla filicaulis* subsp. *filicaulis*	No Status	Susceptible
Pulvinate Pussytoes	*Antennaria rosea* subsp. *pulvinata*	No Status	Susceptible
Red Bearberry	*Arctous rubra*	No Status	Susceptible
Griscom's Arnica	*Arnica griscomii* subsp. *griscomii*	Threatened	Threatened
Southern Milk-vetch	*Astragalus australis* var. *glabriusculus*	No Status	Susceptible
American Milk-vetch	*Astragalus americanus*	No Status	Susceptible
Fernald's Milk-vetch	*Astragalus robbinsii* var. *fernaldii*	Special Concern	Threatened
Eaton's Beggarticks	*Bidens eatonii*	No Status	Susceptible
Collin's Rockcress	*Boechera collinsii*	No Status	Susceptible
Quebec Rockcress	*Boechera quebecensis*	No Status	Threatened
Reflexed Rockcress	*Boechera retrofacta*	No Status	Susceptible
Upswept Moonwort	*Botrychium ascendens*	No Status	Susceptible
Michigan Moonwort	*Botrychium michiganense*	No Status	Susceptible
Pale Moonwort	*Botrychium pallidum*	No Status	Susceptible
Spatulate Moonwort	*Botrychium spathulatum*	No Status	Susceptible
Low Braya	*Braya humilis* subsp. *humilis*	No Status	Susceptible
Calypso	*Calypso bulbosa* var. *americana*	No Status	Susceptible
Round-fruited Sedge	*Carex deweyana* var. *collectanea*	No Status	Susceptible
Glacier Sedge	*Carex glacialis* - P09	No Status	Threatened
Rock-dwelling Sedge	*Carex petricosa* var. *misandroides*	No Status	Susceptible
Prairie Sedge	*Carex prairea*	No Status	Susceptible
Many-headed Sedge	*Carex sychnocephala*	No Status	Susceptible
Meadow Thistle	*Cirsium scariosum* var. *scariosum*	No Status	Threatened
Striped Coralroot	*Corallorhiza striata* var. *striata*	No Status	Susceptible
Vreeland's Coralroot	*Corallorhiza striata* var. *vreelandii*	Candidate	Susceptible
Golden Corydalis	*Corydalis aurea* subsp. *aurea*	No Status	Susceptible
Flat-petal Lady's-slipper	*Cypripedium parviflorum* var. *planipetalum*	No Status	Susceptible
Sparrow's-egg Lady's-slipper	*Cypripedium passerinum*	No Status	Threatened
Showy Lady's-slipper	*Cypripedium reginae*	No Status	Susceptible
Ram's-head Lady's-slipper	*Cypripedium arietinum*	No Status	Vulnerable
Golden Draba	*Draba aurea* - P01	No Status	Susceptible
Dense Draba	*Draba pycnosperma*	No Status	Threatened
Pease's Draba	*Draba peasei*	No Status	Susceptible
Slender-leaved Sundew	*Drosera linearis*	No Status	Susceptible
Wolf-willow	*Eleagnus commutata*	No Status	Susceptible
Cut-leaved Fleabane	*Erigeron compositus*	No Status	Susceptible
Short-rayed Fleabane	*Erigeron lonchophyllus*	No Status	Susceptible
Crowded Wormseed Mustard	*Erysimum coarctatum*	No Status	Susceptible

Common Name	Scientific Name	Status	
		Federal	Provincial
Baffin Island Fescue	*Festuca baffinensis* -p11	No Status	Susceptible
North Atlantic Fescue	*Festuca frederikseniae*	No Status	Susceptible
Roundleaf Orchis	*Galearis rotundifolia*	No Status	Susceptible
Northern Dwarf Huckleberry	*Gaylussacia bigeloviana*	No Status	Threatened
Four-parted Gentian	*Gentianella propinqua* subsp. *propinqua*	No Status	Susceptible
Island Fringed Gentian	*Gentianopsis detonsa* subsp. *nesophila*	No Status	Susceptible
Macoun's Fringed Gentian	*Gentianopsis virgata* subsp. *macounii*	No Status	Threatened
Robinson's Hawkweed	*Hieracium robinsonii*	Candidate	Susceptible
Meadow Barley	*Hordeum brachyantherum* subsp. *brachyantherum*	No Status	Threatened
Wolly Heather	*Hudsonia tomentosa*	No Status	Susceptible
Long-styled Rush	*Juncus longistylis*	No Status	Susceptible
Large False Ground-cherry	*Leucophysalis grandiflora*	No Status	Susceptible
Northern Twayblade	*Neottia borealis*	No Status	Susceptible
St-Lawrence Water-horehound	*Lycopus laurentianus*	No Status	Susceptible
Large-leaved Sandwort	*Moehringia macrophylla* -p01, p05, p11, p12, p17	No Status	Susceptible
Low Water-milfoil	*Myriophyllum humile*	No Status	Susceptible
Sticky Locoweed	*Oxytropis borealis* var. *viscida*	No Status	Susceptible
Foliose Locoweed	*Oxytropis deflexa* var. *foliosa*	No Status	Susceptible
Dwarf Arctic Groundsel	*Packera cymbalaria*	No Status	Threatened
Purple-stem Cliffbrake	*Pellaea atropurpurea*	No Status	Threatened
Arctic Bladderpod	*Physaria arctica*	No Status	Susceptible
Alaska Rein Orchid	*Platanthera unalascensis*	No Status	Susceptible
Sandberg's Bluegrass	*Poa secunda* subsp. *secunda*	No Status	Susceptible
Woodland Pinedrops	*Pterospora andromedea*	No Status	Threatened
Horned Beakrush	*Rhynchospora capillacea*	No Status	Susceptible
Knotted Pearlwort	*Sagina nodosa* subsp. *nodosa*	No Status	Susceptible
Spongy Arrowhead	*Sagittaria montevidensis* subsp. *spongiosa*	No Status	Threatened
Little Curly-grass Fern	*Schizaea pusilla*	No Status	Susceptible
Purple Stonecrop	*Sedum villosum*	No Status	Susceptible
Racemose Goldenrod	*Solidago racemosa*	No Status	Susceptible
Anticosti Aster	*Symphyotrichum anticostense*	Threatened	Threatened
Large-lobed Dandelion	*Taraxacum latilobum*	No Status	Susceptible
Gulf of St. Lawrence Dandelion	*Taraxacum laurentianum*	No Status	Susceptible
Clinton's Clubrush	*Trichophorum clintonii*	No Status	Susceptible
Dwarf Clubrush	*Trichophorum pumilum*	No Status	Susceptible
Twin-stemmed Bladderwort	*Utricularia geminiscapa*	No Status	Susceptible
Swamp Valerian	*Valeriana uliginosa*	No Status	Vulnerable
Cathcart's Woodsia	*Woodsia oregana* subsp. *cathcartiana*	No Status	Susceptible
Laurentian Woodsia	*Woodsia scopulina subsp. laurentiana*	No Status	Susceptible
Arthropods			
Maritime Ringlet	Coenonympha nipisiquit	Endangered	Threatened
Maritime Copper	Lycaena dospassosi	Not at Risk	Susceptible

Common Name	Scientific Name	Status	
		Federal	Provincial
Amphibians			
Northern Dusky Salamander	*Desmognathus fuscus*	No Status	Susceptible
Reptile			
Snapping Turtle	*Chelydra serpentina*	Special Concern	No Status
Ringneck Snake	*Diadophis punctatus*	No Status	Susceptible
Birds			
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*	Not at Risk	Susceptible
Eastern Whip-poor-will	*Antrostomus vociferus*	Threatened	Susceptible
Golden Eagle	*Aquila chrysaetos*	Not at Risk	Vulnerable
Short-eared Owl	*Asio flammeus*	Special Concern	Susceptible
Barrow's Goldeneye	*Bucephala islandica pop. 1*	Special Concern	Vulnerable
Red Knot (*rufa* subspecies)	*Calidris canutus rufa*	Endangered	Susceptible
Bicknell's Thrush	*Catharus bicknelli*	Threatened	Vulnerable
Chimney Swift	*Chaetura pelagica*	Threatened	Susceptible
Common Nighthawk	*Chordeiles minor*	Threatened	Susceptible
Olive-sided Flycatcher	*Contopus cooperi*	Threatened	Susceptible
Yellow Rail	*Coturnicops noveboracensis*	Concern	Threatened
Bobolink	*Dolichonyx oryzivorus*	Threatened	No Status
Rusty Blackbird	*Euphagus carolinus*	Special Concern	Susceptible
Peregrine Falcon *anatum*	*Falco peregrinus anatum*	Special Concern	Vulnerable
Bald Eagle	*Haliaeetus leucocephalus*	Not at Risk	Vulnerable
Harlequin Duck (Eastern pop.)	*Histrionicus histrionicus pop. 1*	Special Concern	Vulnerable
Caspian Tern	*Hydroprogne caspia*	Not at Risk	Threatened
Least Bittern	*Ixobrychus exilis*	Threatened	Vulnerable
Leach's Storm Petrel	*Oceanodroma leucorhoa*	No status	Susceptible
Canada Warbler	*Wilsonia canadensis*	Threatened	Susceptible
Mammals			
Silver-haired bat	*Lasionycteris noctivagans*	No Status	Susceptible
Red bat	*Lasiurus borealis*	No Status	Susceptible
Hoary bat	*Lasiurus cinereus*	No Status	Susceptible
Rock vole	*Microtus chrotorrhinus*	No Status	Susceptible
Woodland vole	*Microtus pinetorum*	Special Concern	Susceptible
Least Weasel	*Mustela nivalis*	No Status	Susceptible
Little Brown Myotis	*Myotis lucifugus*	Endangered	Susceptible
Northern Myotis	*Myotis septentrionalis*	Endangered	Susceptible
Tri-colored Bat	*Perimyostis subflavus*	Endangered	Susceptible
Gaspé Shrew	*Sorex gaspensis*	Not at Risk	Susceptible
Southern bog lemming	*Synaptomys cooperi*	No Status	Susceptible

Susceptible: likely to be designated threatened or vulnerable
List of floristic species updated on January 2016 and February 2016 for the wildlife species

Appendix B. Public and private protected extracted from the Registre des aires protégées au Québec and present in the study area

Lead	Protected area types	Site Name	Territorial zone	Administrative region*	Number of sites
Federal government	National Park	Forillon	Z_A01	11	1
	National Park Reserve	Archipel-de-Mingan	Z_70A	09	1
	Marine Park	Saguenay - Saint-Laurent	Z_71	01, 09, 11, 02	1
	National Wildlife Area	Baie de l'Isle-Verte	Z_A11	01	1
		Pointe-au-Père	Z_A11	01	1
		Cap-Tourmente	Z_71	03	1
	Migratory Bird Sanctuary	Île-à-la-Brume	Z_70B	09	1
		Île-aux-Basques	Z_A11	01	1
		Île-Bonaventure-et-du-Rocher-Percé	Z_A08	11	1
		Île-du-Corossol	Z_70A	09	1
		Baie-de-Brador	Z_28	09	2
		Baie-des-Loups	Z_28	09	1
		Isle-Verte	Z_A11	01	1
		Saint-Augustin	Z_28	09	1
		Saint-Omer	Z_A08	11	1
		Watshishou	Z_70A	09	1
		Îles-Sainte-Marie	Z_28	09	1
Provincial government	Provincial park	Anticosti	Z_82	09	1
		Île-Bonaventure-et-du-Rocher-Percé	Z_A08	11	1
		Gaspésie	Z_A01	01, 11	1
		Miguasha	Z_A07	11	1
		Grands-Jardins	Z_71	03	1
		Bic	Z_A11	01	1
		Fjord-du-Saguenay	Z_71	09, 11, 02	1
	Ecological Reserve	Grande-Rivière	Z_A08	11	1
		Matamec	Z_70A	09	1
		Pointe-Heath	Z_82	09	1
		Manche-d'Épée	Z_A01	11	1
		Mont-Saint-Pierre	Z_A01	11	1
		Ristigouche	Z_A07	11	1
		Grand-Lac-Salé	Z_82	09	1
		Fernald	Z_A01	01, 11	1
	Projected ecological reserve	Matamec (partie nord)	Z_70A	09	1
	Biological refuge	016-001	Z_71	03	1
		021-001	Z_71	03	1
		021-002	Z_71	03	1
		03351R021	Z_71	03	1
		03351R022	Z_71	03	1
		03351R023	Z_71	03	1
		03351R029	Z_71	03	1

Lead	Protected area types	Site Name	Territorial zone	Administrative region*	Number of sites
		03351R030	Z_71	03	1
		03351R031	Z_71	03	1
		03351R032	Z_71	03	1
		03351R033	Z_71	03	1
		03351R034	Z_71	03	1
		09351R023	Z_69	09	1
		09451R001	Z_69	09	1
		09451R002	Z_69	09	1
		09451R008	Z_69	09	1
		09451R033	Z_69	09	1
		09451R042	Z_70A	09	1
		09451R049	Z_70A	09	1
		09551R011	Z_70A	09	1
		09751R001	Z_71	09	1
		09751R058	Z_69	09	1
		09751R060	Z_71	09	1
		09751R063	Z_71	09	1
		09751R064	Z_71	09	1
		09751R065	Z_71	09	1
		09751R066	Z_71	09	1
		09751R075	Z_71	09	1
		09751R161	Z_69	09	1
		09751R162	Z_69	09	1
		09751R163	Z_69	09	1
		09751R164	Z_69	09	1
		09751R202	Z_71	09	1
		09751R304	Z_69	09	1
	Aquatic reserve	Estuaire-de-la-Rivière-Bonaventure	Z_A08	11	1
	Projected aquatic reserve	Rivière Moisie	Z_70A	09	1
		Manicouagan	Z_69	09	1
	Biodiversity reserve	Karst-de-Saint-Elzéar	Z_A07	11	1
	Projected biodiversity reserve	Île-aux-Lièvres	Z_71	01	1
		Côte d'Harrington Harbour	Z_28	09	1
		Côte-de-Charlevoix	Z_71	03	1
		Collines de Brador	Z_28	09	1
		Lac Pasteur	Z_69	09	1
	Habitat of a vulnerable plant species	Falaise-du-Mont-Saint-Alban	Z_A01	11	1
		Montagne-de-Roche	Z_A01	11	1
		Barachois-de-Bonaventure	Z_A08	11	1
		Merritt-Lyndon-Fernald	Z_28	09	1
Private	Nature reserve	Île-aux-Basques-et-des-Razades	Z_A11	01	1
		Baie-de-Mille-Vaches	Z_69	09	1
		Grosse-Montagne (Secteur Moreau)	Z_A11	01	1
		Grosse-Montagne (Secteur Paré)	Z_A11	01	1
		Grosse-Montagne (Secteur Parent)	Z_A11	01	1

Lead	Protected area types	Site Name	Territorial zone	Administrative region*	Number of sites
		Grosse-Montagne (secteur Parent 2)	Z_A11	01	1
		Plaine-Checkley	Z_70A	09	1
		Rivière-Fouquette	Z_A11	01	1
		Rivière-Malbaie	Z_A08	11	1
		Estuaire-de-la-Petite-Rivière-Cascapédia	Z_A08	11	1
		Estuaire-de-la-Rivière-York	Z_A08	11	1
		Îles-de-la-Dartmouth	Z_A08	11	1
		Boisé-de-l'Équerre	Z_71	03	1
		Boisé-de-la-Pointe-Saint-Gilles	Z_69	09	1
		Parc-Languedoc	Z_71	09	1
		Rivière-des-Vases	Z_71	03	1

* 01 : Bas-Saint-Laurent; 02 : Saguenay - Lac-Saint-Jean; 03 : Capitale-Nationale; 09 : Côte-Nord; 11 : Gaspésie - Îles-de-la-Madeleine

Appendix C. Exceptional forest ecosystems present in the study area*

Lead	Site Name	Territorial zone	Administrative region**	Nb of sites
Provincial government	Forêt ancienne de la Petite-Rivière-Godbout	Z_69	09	1
	Forêt ancienne de la Rivière-Angers	Z_A07	11	1
	Forêt ancienne de l'Anse-à-Moreau	Z_69	09	1
	Forêt ancienne de Sault-au-Cochon	Z_71	03	1
	Forêt ancienne du Cap-Brûlé	Z_71	03	1
	Forêt ancienne du ruisseau Blanchet	Z_A01	11	1
	Forêt ancienne du Ruisseau-Matte	Z_A01	11	1
	Forêt rare de la Montagne à McLeod	Z_71	03	1
	Forêt rare de la montagne de l'Ours	Z_71	03	1
	Forêt rare de la Petite Rivière Cascapédia	Z_A07	11	1
	Forêt rare de la Rivière-Laval	Z_69	09	1
	Forêt rare des Escoumins	Z_69	09	1
	Forêt rare du Lac-aux-Canards	Z_71	03	1
	Forêt rare du Lac-des-Cèdres	Z_69	09	1
	Forêt rare du Lac-Nord-Ouest	Z_69	09	1
	Forêt rare du Ruisseau-Couillard	Z_69	09	1
	Forêt refuge de la Colline-Makasti	Z_82	09	1

* Only EFE located on public land and listed in the Registre des aires protégées au Québec are shown
** 01 : Bas-Saint-Laurent; 02 : Saguenay - Lac-Saint-Jean; 03 : Capitale-Nationale; 09 : Côte-Nord; 11 : Gaspésie - Îles-de-la-Madeleine

Appendix D. Grouping of attributes of ecoforest maps from SIEF and the Nordic Ecoforest Inventory Program (PIEN) to form the ecological forest types.

Ecoforest cards from SIEF: Grouping of forest stands of the ecoforestry map (TYPE_ECO) with the associated drainage class

Group	FET Name		Group	FET Name
MJ2	Yellow Birch – Fir Forest		RE2	Black Spruce – Moss or Heather Forest
MJ1	Yellow Birch – Fir- Sugar Maple Forest		RE3	Black Spruce – Sphagnum spp. Forest
RC3	White Cedar – Fir Forest on organic soil		RP1	White or Red Pine Forest
FE3	Sugar Maple – Yellow Birch Forest		RT1	Hemlock Forest
FE4	Sugar Maple – Yellow Birch- Beech Forest		MS2	Fir – White Birch
FE6	Sugar Maple – Red Oak Forest		MS7	Fir – White Birch Maritime Forest
FE5	Sugar Maple – Hophornbeam Forest		MS1	Fir – Yellow Birch Forest
FE2	Sugar Maple – Basswood Forest		RS2	Fir – Black Spruce Forest
MF1	Black Ash – Fir Forest		RS3	Fir – Black Spruce – Sphagnum spp. Forest
LA1	Lichen (or Moss) Barren		RS7	Fir – Black Spruce Maritime Forest
MA1	Freshwater Marsh or Swamp		RS5	Fir – Red Spruce Forest
FO1	White Elm – Black Ash Forest		MS6	Fir – Red Spruce Forest
RB5	White Spruce Forest evolved from browsing		RS1	Fir – White Cedar Forest
RB2	White Spruce Maritime Forest		TOF	Fen
RB1	White Spruce or White Cedar Forest evolved from agriculture		TOB	Bog

Drainage Code	Drainage type
X	Xeric
M	Mesic
S	Subhydric
H	Hydric

Nordic Ecoforest Inventory Program (PIEN): Grouping of types of surface deposits

Code_regr	Category	Description
1A	Glacial deposits	Undifferentiated till (average thickness over 1 m)
1AR	Glacial deposits	Undifferentiated till (average thickness from 25 cm to 1 m)
1B	Glacial deposits	Ablation till (average thickness over 1 m) and drumlins
1BF	Glacial deposits	Frontal moraine of different origins and dead-ice moraine
2A	Glaciofluvial deposits	Ice-contact deposits (esker, kame and kame terrace)
2B	Glaciofluvial deposits	Ice-marginal deposits (Glaciofluvial delta and outwash)
3A	Fluvial deposits	Ancient fluvial deposit
4	Lacustrine deposits	Undifferentiated lacustrine deposit and glaciolacustrine deposit (in shallow water facies < 25 cm)
5	Marine deposits	Marine deposit in deep or shallow water facies
6	Marine coastline deposits	Undifferentiated marine coastline deposit
7	Organic deposits	Undifferentiated organic deposit
8	Slope and alteration deposits	Undifferentiated slope and alteration deposit
9	Wind deposits	Undifferentiated wind deposit and stabilised dune
R	Bedrock	Deposit of different origins (thickness less than 25 cm)

Appendix E. Number of polygons of each forest ecological type (FET) retained for representativeness analyses in the territorial zones

	Territorial zone										
FET	Z_28	Z_69	Z_70A	Z_70B	Z_71	Z_82	Z_A01	Z_A07	Z_A08	Z_A11	Total
SIEF											
FE2m							1			1	2
FE2x										1	1
FE3m		1			166		563	591	203	112	1 636
FE3s					7		6	3		1	17
FE3x					70		55	40	4	27	196
FE4m					8			77		8	93
FE4x					5			11		1	17
FE5m										1	1
FO1h									3		3
FO1s							6	28	4		38
LA1x		3									3
LA2m					1						1
MF1h		1			13		28	1	1	19	63
MF1s		2			4		102	33	49	15	205
MJ1m					4		2	1		11	18
MJ1s							1			4	5
MJ1x							1			23	24
MJ2m							2	1			3
MJ2x							1			2	3
MS1m		111			1 169		1 534	751	1 105	601	5 271
MS1s		64			518		914	336	472	318	2 622
MS1x		111			697		708	326	80	462	2 384
MS2m		254	222		173		1 566	110	155	3	2 483
MS2s		170	181		138		829	19	35	3	1 375
MS2x		521	378		269		498	2	7	3	1 678
MS6m		113	1		665		60		129		968
MS6s		2			165		19		41		227
MS6x		140			665		16		4		825
MS7m			5								5
MS7s			30								30
MS7x		1	47								48
RB1m					175		198	108	262	195	938
RB1s					28		34	1	13	58	134
RB1x					29				2	164	195
RB2m						5					5
RB5m						2 466					2 466
RB5s						850					850
RB5x						629					629
RC3h		12			37		502	50	443	173	1 217
RE1m									1		1
RE1s					1		1				2
RE1x		4	26								30
RE2m		1	7		3	116			1		128
RE2s		94	15		20	591			1	1	722
RE2x		470	100		181	249				23	1 023
RE3h		162	76		43	1 708	62	2	57	108	2 218
RP1m					4						4

	Territorial zone										
FET	Z_28	Z_69	Z_70A	Z_70B	Z_71	Z_82	Z_A01	Z_A07	Z_A08	Z_A11	Total
RP1x					31						31
RS1h					2		159	12	103	20	296
RS1m		2			61		500	318	278	55	1 214
RS1s		14			64		1 248	307	866	206	2 705
RS1x		4	2		137		46	151	40	122	502
RS2m		427	614		329	3 056	88	190	186	1	4 891
RS2s		465	1 053		390	5 785	128	14	95	3	7 933
RS2x		1 302	1 349		914	341	49	51	79	114	4 199
RS3h		131	370		135	2 277	314	6	88	101	3 422
RS5m							53		137	12	202
RS5s							157		75	61	293
RS5x					1		38		3	66	108
RS7m			8								8
RS7s			88								88
RS7x		4	133								137
RT1x					1						1
TOB		1									1
PIEN											
3	8			25							33
5	164			166							330
6	15			26							41
7	171			230							401
9				17							17
1A	37			7							44
1AR	105			19							124
2A	5										5
2B	6			2							8
R	550			321							871
Total	1 061	4 587	4 705	813	7 323	18 073	10 489	3 540	5 022	3 099	58 712

Appendix F. Number of polygons of each class of wetland retained for representativeness analyses in the territorial zones

Class of wetland	Territorial zone										
	Z_28	Z_69	Z_70A	Z_70B	Z_71	Z_82	Z_A01	Z_A07	Z_A08	Z_A11	Total
DUC											
Marsh		169	317		105	461	167	20	131	42	1412
Shrub Swamp		69	131		6	1611	13	2	9	18	1859
Treed Swamp		81	129		57	3533	229	27	139	90	4285
Treed Fen		110	129		177	3196	780	46	544	325	5307
Treed Bog		433	658		70	250	55	6	85	227	1784
Open Peatland		459	3061								3520
Open Fen		313	208		233	8845	227	20	163	60	10069
Open Bog		480	114		165	2162	59	11	89	127	3207
PIEN											
MH	30			22							52
TMR	8			10							18
TOM	146			228							374
TOR				1							1
TOU	269			188							457
Total	453	2114	4747	449	813	20058	1530	132	1160	889	32345

Note: No prioritization was required for the MH class (generic wetland class) from the PIEN in territorial zones 28 and 70B because the 20% representativeness threshold was reached following the selection analyzes.

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