

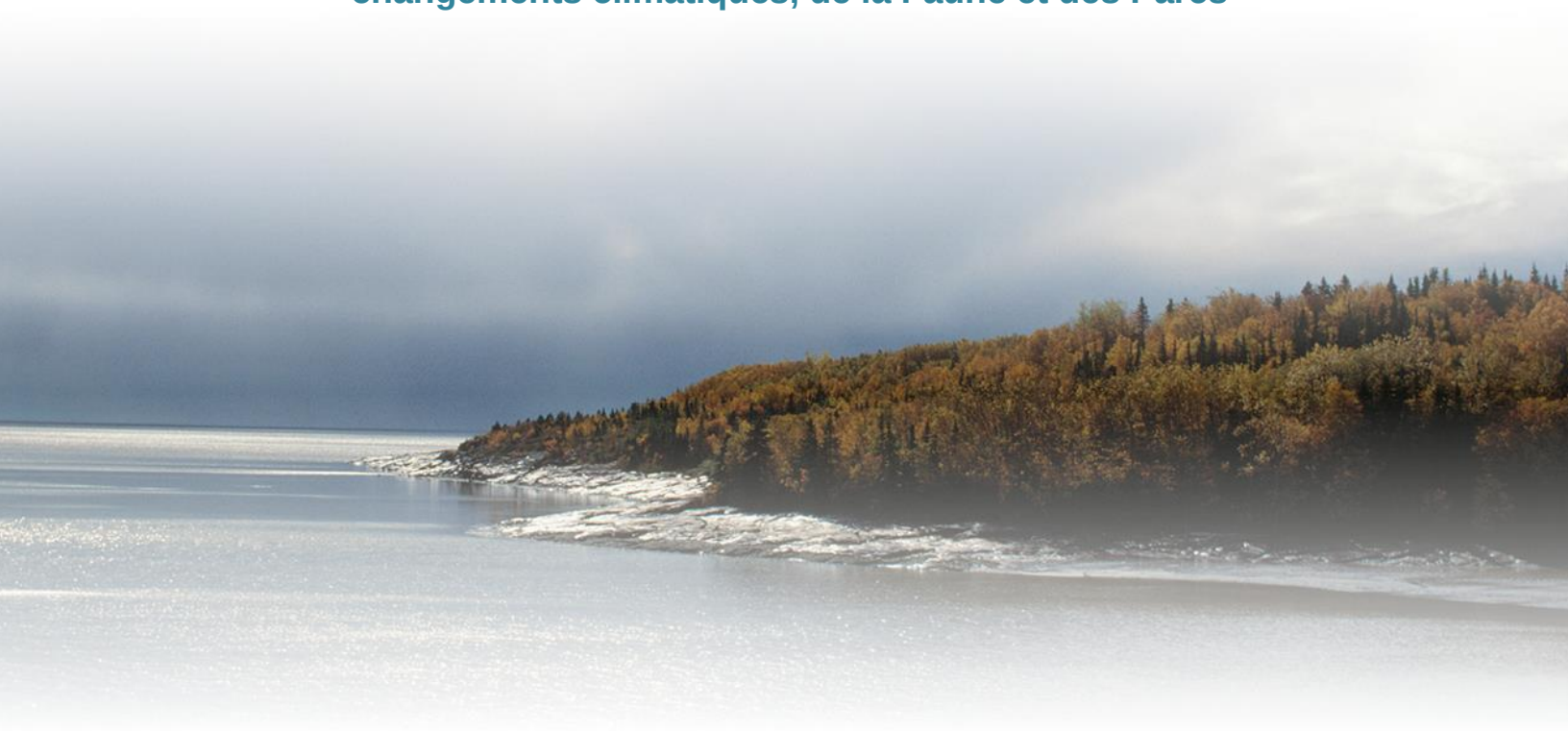


2016–2021 Report

Ecological and Biodiversity Monitoring Program for the Protected Areas of the St. Lawrence and Adjacent Areas

Environment and Climate Change Canada

Ministère de l'Environnement, de la Lutte contre les
changements climatiques, de la Faune et des Parcs



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Abstract

The St. Lawrence River is one of the jewels of Quebec. The province's largest cities are located on its banks, and it is a cornerstone of our economy due to its role in marine transportation. However, human activity has had a clear impact on the river's ecosystems. Concerns about the future of the St. Lawrence River and its riches have helped to lead to the establishment, with the participation of various partners, of the St. Lawrence Action Plan (SLAP). The purpose of SLAP is to better conserve, restore and protect this unique ecosystem. This initiative has encouraged the creation of numerous surveys and monitoring programs that measure the status of some of the resources in the St. Lawrence. However, until recently, the more comprehensive monitoring of the riparian ecosystems along the river has been lacking. Although a number of protected areas can be found along the St. Lawrence River, their ecological integrity has rarely been assessed. A number of questions need to be answered, including what species are present in these areas and how their abundance has changed over time, as well as whether the protected natural environments along the river adequately fulfill their role.

This observation led to the formulation of action 1.1.5 in the St. Lawrence Action Plan: *Implement an ecological and biodiversity monitoring program in and around the protected areas of the St. Lawrence* (SLPA monitoring). The aim of this joint initiative by Environment and Climate Change Canada (ECCC) and the Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs du Québec [Quebec Department of Environment, the Fight Against Climate Change, Wildlife and Parks] (MELCCFP) is to improve the monitoring of both federal and provincial protected areas, in order to assess their status and adequately protect them. The goal during the 2016–2021 period was to align the two governments' visions, in order to reach a compromise between their respective mandates of monitoring ecological integrity and biodiversity. Five aspects are addressed in this report: (1) the environmental threats to the different protected areas; (2) the sites to be targeted in the surveys; (3) joint indicators; (4) methodology, implementation logistics and partnerships; (5) and dissemination of results.

Nine protected areas have been selected for monitoring, extending from Lake Saint-François to the Magdalen Islands. Although the threats to each of these sites vary depending on the degree of surrounding urbanization, most protected areas face a number of threats, which need to be better assessed. The main indicators retained are acoustic bird, anuran and bat surveys; and the monitoring of benthic macroinvertebrates, invasive alien plants, coastal erosion and land use. The common methodology to be used in these surveys has been well defined for the first four indicators, and work is ongoing on the last three, in order to determine the best shared approach. The results dissemination mechanisms used in various existing ecological monitoring programs have been examined, and will inspire the approach adopted for visualizing the indicators (e.g., the St. Lawrence Action Plan). The next steps will involve implementing the SLPA monitoring program, which will entail monitoring three or four protected areas annually. The partners

have also agreed to coordinate their efforts to finalize the methodology for the land use and coastal erosion indicators.

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1. Background

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) ([IPBES Home page](#) | [IPBES secretariat](#)) noted in its most recent reports that biodiversity and nature were declining at a rate unprecedented in human history, with this accelerated rate of extinction causing adverse effects on human populations. Given the urgency of this situation, IPBES has proposed solutions with a view to sustainable development, hoping to reverse these trends. In the case of freshwater ecosystems, these actions notably involve supporting more inclusive water governance and collaborative water management and improving the integration of water resource management and landscape planning at different scales.

In Quebec, with its thousands of lakes and rivers, fresh water is clearly a tremendous asset that must be protected, particularly the majestic St. Lawrence River, which along with the Great Lakes, drains over 25% of the world's freshwater reserves and supports numerous species and habitats. However, despite the importance of this resource to the human populations that live along the river's shorelines, the St. Lawrence ecosystem became increasingly degraded. An alarming picture was painted of the river in 1978, concluding that pollution in the St. Lawrence threatened not only biodiversity, but also recreational and commercial activities in the river ([St. Lawrence River \[gouv.qc.ca\]](#)).

Therefore, in 1988, the governments of Quebec and Canada, in association with a number of collaborators, signed the St. Lawrence Action Plan (SLAP) (<https://www.planstlaurent.qc.ca/en/our-history>), in order to conserve, restore, protect and enhance the St. Lawrence and its riches. In some ways, this effort was ahead of its time, anticipating the collaborative approach currently advocated by IPBES. It helped to improve the protection of the river, reduced pollution and led to the creation of citizen committees involved in the conservation of areas of prime concern in the St. Lawrence (ZIP committees). In 2011, Phase V of SLAP began, aiming to build on previous efforts and ensure the sustainability of the resource. It targeted three priority issues—biodiversity conservation, sustainable use and improved water quality—supported by roughly 50 actions divided into 10 strategic orientations.

The biodiversity conservation component included three strategic orientations: (1) identify, protect, restore and enhance ecologically significant environments; (2) prevent the introduction and control the spread of invasive alien species; and (3) assess the impact of climate change on ecosystems. One of the main achievements under the first strategic orientation was the collaboration between SLAP partners, which fuelled the creation of a number of protected areas. These achievements are an integral part of Objective 1.1 of the 2016–2021 action plan: *Develop common planning tools for identifying areas of interest*. Currently, there are 663 protected areas along the St. Lawrence, 34 under federal jurisdiction and 629 under provincial jurisdiction, and finding new sites of interest remains a priority.

However, gaps remain in the monitoring of these environments, making it sometimes difficult to assess their capacity for ensuring the persistence and sustainability of biological resources. This concern led to the formulation of action 1.1.5, *Implement an ecological and biodiversity monitoring program in and around the protected areas of the St. Lawrence*. This joint initiative by Environment and Climate Change Canada (ECCC) and the Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la

Faune et des Parcs [Quebec Department of Environment, the Fight Against Climate Change, Wildlife and Parks] (MELCCFP) aims to improve the monitoring of protected areas, in order to more accurately assess their status and protect them better. Action 1.1.5 piggy-backs on initiatives already underway, including those by the Quebec biodiversity monitoring network, Réseau de suivi de la biodiversité du Québec (hereafter referred to as the BdQc monitoring program), which is funded under Quebec's Plan d'action contre les changements climatiques 2013–2020 [climate change action plan], as well as those under ECCC's Ecological Monitoring Program for National Wildlife Areas in Quebec (hereafter referred to as the NWA monitoring program), which is still under development.

The objective of this action is to optimize the sharing of data and expertise and facilitate the development and implementation of common ecological monitoring methodologies whenever possible. This report outlines the work that was done between 2016 and 2021 to develop a common methodology for monitoring federal and provincial protected areas. It describes:

- the implementation process
- the implementation timetable
- the sites selected and the threats associated with them
- the selection of monitoring indicators and methodology
- the development of partnerships
- the preliminary results

Since the work on action 1.1.5 will continue during the 2021–2026 period of SLAP, the status of the next steps will also be outlined.

2 Implementation process

2.1 Aligning the provincial and federal visions of the project

The project began during the 2011–2016 period of SLAP, in accordance with ECCC's vision at the time of improving ecological monitoring in national wildlife areas (NWAs) in Quebec, following the lead of other protected area networks in Canada. The initial goal was to establish a biodiversity monitoring program for the protected areas of the St. Lawrence and adjacent areas in order to determine whether these areas were capable of maintaining biodiversity over the long term. The first phase of the project culminated in a literature review and analysis of existing major ecological monitoring programs in North America, more specifically those along the St. Lawrence River. Additionally, it identified the key components to be included in the ecological monitoring program for the NWAs (NWA monitoring program).

The 2016–2021 period of the project began with the onboarding of new professionals. This transition process involved a review of the existing procedures, the purpose of which was to develop a shared vision for the selection of sites, indicators and methodologies. In addition, it helped in identifying and comparing the specific objectives of the actors from the various jurisdictions involved:

- The ECCC team, as a manager of protected areas, seeks to monitor the state of health of the NWAs in Quebec along the St. Lawrence River, by assessing changes in their ecosystems, in the components representative of the biodiversity present, and in the populations of the species at risk that occur there, to ensure their conservation and the sound management of the NWAs.
- Meanwhile, the primary aim of the Government of Quebec's team is to improve BdQc monitoring in order to be able to track changes in the diversity and functioning of ecosystems along the St. Lawrence in the context of climate change.

Despite this difference in objectives, a number of common indicators for assessing the maintenance of biodiversity—i.e., the structural and functional components of ecosystems—were identified. To ensure that the different programs are aligned, some of the sampling methods may be scaled up on either side or, in addition to the common indicators, some indicators may be targeted for additional monitoring by the provincial or federal authority, particularly in the case of BdQc monitoring. This effort to align the two organizations' different visions is reflected in the title of the action: *Implement an **ecological and biodiversity monitoring** program in and around the protected areas of the St. Lawrence* (hereafter referred to as the SLPA monitoring program).

2.2 Goals and objectives of the joint project

Based on this shared vision of ecological and biodiversity monitoring, detailed objectives were formulated in order to better define the sites and bio-indicators for this project:

1. Detect changes and determine the state of health of the targeted protected areas along the St. Lawrence River;
2. Standardize methods and indicators, and pool monitoring networks; and
3. Report on the state of health of targeted protected areas along the St. Lawrence.

In the case of projects specific to the BdQc or NWA monitoring programs, the specific objectives of the program will be pursued.

2.3 Implementation efforts during the 2016–2021 period

After reflecting and deciding on the goals and objectives of SLPA monitoring, the team considered the following five questions:

- What are the specific threats to terrestrial environments located in or along the St. Lawrence River? Which of these are a priority in the context of SLPA monitoring?
- Which indicators would enable us to better assess the state of health of and changes in biodiversity in protected areas along the St. Lawrence River, while taking into account the existing threats and indicators in the federal and provincial monitoring programs? Which joint indicators will the SLPA monitoring program prepare a joint implementation report for?
- Which provincial and federal protected sites will be monitored in the SLPA monitoring program?
- How will SLPA monitoring be implemented in the field? Who will be our partners in this type of project?
- How will our findings be reported? How will project data be managed and analyzed? To whom will our findings be disseminated and in what form?

The first three sets of questions were discussed and addressed in working groups and meetings with experts, mainly between 2016 and 2018. Since 2019, the team has been working on answering the last two sets of questions, but the discussions are still in the initial stages. It should be noted that, owing to the lack of human and financial resources, the internal priorities of both governments and the COVID-19 pandemic in 2020–2022, the project was stalled from 2018 to 2021. In all, the work team met 15 times between 2016 and 2021.

The following sections of this report present the project team's main conclusions and recommendations in relation to the five questions set out above.

3. Potential threats and management challenges

As described in section 1, the St. Lawrence River and associated coastal area are under a variety of environmental and anthropogenic threats. To better identify which indicators would be the most beneficial to track in the SLPA monitoring program, the work team drew on the method developed by Salafsky et al. (2008), as well as on the work of the International Union for Conservation of Nature (IUCN), in order to classify the direct and indirect threats to coastal biodiversity (see also <https://mffp.gouv.qc.ca/nos-publications/classification-biodiversite-menaces/>).

The following threats were identified:

- *Residential and commercial development*: Threats from human settlements or other non-agricultural land uses with a substantial footprint;
- *Agriculture and aquaculture*: Threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture and aquaculture;
- *Energy production and mining*: Threats from production of non-biological resources;
- *Transportation and service corridors*: Threats from long, narrow transport corridors and the vehicles that use them, including associated wildlife mortality;
- *Biological resource use*: Threats from consumptive use of “wild” biological resources, including both deliberate and unintentional harvesting effects, and persecution or control of specific species;
- *Human intrusions and disturbance*: Threats from human activities that alter habitats and species associated with non-consumptive uses of biological resources;
- *Natural system modifications*: Threats from actions that convert or degrade habitat in service of “managing” natural or semi-natural systems, often to improve human welfare;
- *Invasive and other problematic species, genes and diseases*: Threats from non-native and native plants, animals, pathogens/microbes or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance;
- *Pollution*: Threats from introduction of exotic and/or excess materials or energy from point and non-point sources;
- *Climate change and severe weather*: Threats from long-term climatic changes that may be linked to global warming and other severe climatic/weather events outside the natural range of variation that could wipe out a vulnerable species or habitat; and
- *Other threats*.

The potential threats, along with descriptions and anticipated impacts, were compiled in a table and examined to ascertain whether SLPA monitoring could measure these impacts. In addition, indicators known to the collaborating departments that could be used to measure these impacts were determined. The table in **Appendix A** presents the main results of this review process.

4. Site selection

The SLPA monitoring program targets federal and provincial protected areas located along the St. Lawrence River and in adjacent areas. The sites to be monitored under this program were selected in 2016–2017.

For ECCC, the eight NWAs were essential monitoring sites. Scattered along the river between Lake Saint-François and the Gulf of St. Lawrence, these NWAs protect a total of 5,524 ha of very high quality natural environments that provide breeding habitats and staging areas for waterfowl and other avian species.

On the Quebec government side, an analysis was conducted of the protected areas potentially complementary to the eight NWAs, taking into account factors such as the threats faced, level of knowledge of the biodiversity present and ease of site access. A total of 26 protected areas were pre-selected. Following this, a second prioritization exercise was conducted, which took into account:

- the quality of the forest and wetland environments in the protected area
- ease of site access
- opportunities for collaboration and existing monitoring activities
- the requirement for a minimum area of 0.3 km²
- popularity of the site (to better raise awareness among the Quebec public)
- whether the site's geographic location complements that of the NWAs.

Ultimately, nine provincial protected areas were selected in addition to the eight NWAs, for a total of 17 sites targeted for SLPA monitoring. Ecological profiles of the 17 protected areas targeted for SLPA monitoring are presented in **Appendix B**.

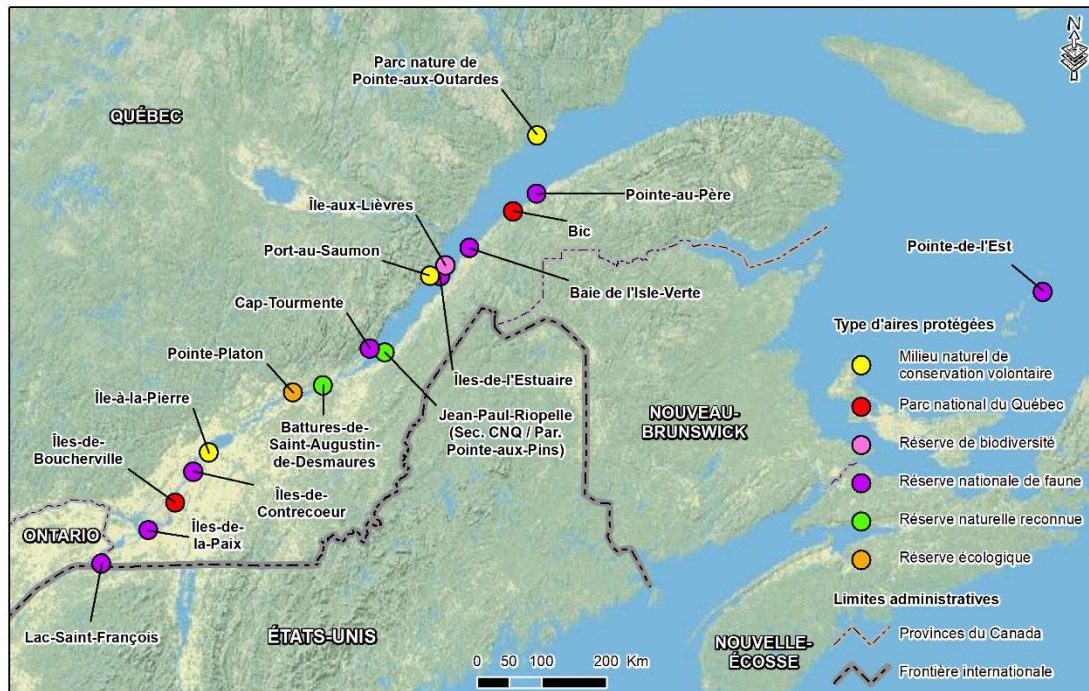


Figure 1. Location of the 17 protected areas in the joint ecological and biodiversity monitoring program for the protected areas of the St. Lawrence (ECCC and MELCCFP 2021)

5. Identification of indicators, methodologies and thresholds

5.1 Indicators

In the context of ecological monitoring, indicators can be defined as a subset of physical, chemical and biological elements and processes of natural systems that are selected to represent the overall health or condition of the system (Parks Canada Agency 2014). According to Warhurst (2002), ecological indicators can be used to visualize phenomena and identify trends, as well as to simplify, quantify and communicate information. All monitoring programs begin with the selection of indicators that make it possible to assess, with minimum investment, the condition of a resource, species, ecosystem or area of land, and, in certain cases, management performance (Environment and Climate Change Canada 2016).

Ecological monitoring indicators were selected for the development of the SLPA monitoring program. Common indicators for the federal and provincial protected areas were chosen that would be indicative of sites' ecological health, as well as being scientifically sound and simple and cost-effective to implement. The indicators to be selected were determined in meetings held between 2016 and 2019 by the federal-provincial working group for this project. In April 2019, eight indicators were chosen for the SLPA monitoring program (**Table I**), and can be divided into three main categories: ecosystems, biodiversity and threats. This initial section could be improved by the addition of supplementary indicators in the future, allowing other ecological components to be taken into account. Ultimately, this would provide a more comprehensive and inclusive picture of the state of health of the protected areas of the St. Lawrence.

Table I. Ecological indicators initially chosen for the joint ecological and biodiversity monitoring program for the protected areas of the St. Lawrence

INDICATOR	TYPE	LEAD
Ecosystems		
Land use	Remote sensing	ECCC
Biodiversity		
Surveys of benthic macroinvertebrate communities	Field	MELCCFP
Acoustic anuran surveys in wetlands and forests	Field	MELCCFP
Acoustic bird surveys in wetlands and forests	Field	MELCCFP and ECCC
Diversity and abundance of seabird populations in coastal environments	Field	ECCC
Bat surveys in wetlands and forests	Field	MELCCFP
Threats		
Invasive alien plant species (IAPS)	Field	MELCCFP
Coastal erosion index	Field	ECCC

Given that the protected areas targeted for SLPA monitoring are distributed along the entire length of the river system (from the Ontario border to the Gulf of St. Lawrence), their ecosystems, biophysical conditions and anthropogenic pressures vary widely. A number of the eight SLPA monitoring indicators apply to all or most of the protected areas, and some are specific to a few areas due to local ecological features or threats related to their regional context. In 2020, a consultant hired by the working group developed or revised the methodologies associated with each indicator for the protected areas targeted in SLPA monitoring, by conducting research, consultations and verifications with conservation experts and stakeholders. **Table II** presents the indicators that will be monitored in each of the 17 protected areas based on the ecological components and conditions in these environments. Currently, between four and seven ecological monitoring indicators will be assessed in each protected area included in the program.

Table II. Indicators selected for each of the 17 protected areas in the joint ecological and biodiversity monitoring program for the protected areas of the St. Lawrence

Indicator	Frequency	Lake Saint-François	Îles de la Paix	Îles-de-Boucherville	Îles de Contrecoeur	Île-à-la-Pierre	Pointe-Platon	Battures-de-St-Augustin-de-Desmaures	Cap Tourmente	Jean-Paul-Riopelle	Port-au-Saumon	Estuary Islands	Île-aux-Lièvres	Baie de L'Isle-Verte	Bic	Pointe-au-Père	Pointe-aux-Outardes	Pointe de l'Est
Land use	5 years	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Coastal erosion index	Annual		X		X	X		X	X			X		X		X	X	X
Invasive alien plant species (IAPS)	5 years	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bat surveys in wetlands and forests	3 years	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X
Acoustic bird surveys in wetlands and forests	3 years	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Acoustic anuran surveys in wetlands and forests	3 years	X	X	X	X	X	X	X	X	X	X		X	X	X		X	
Diversity and abundance of seabird populations in coastal environments	5 years				X							X			X			
Benthic macroinvertebrate communities	5 years						X		X					X				
Number of indicators:		5	6	5	7	6	6	6	7	5	5	5	5	7	6	4	6	5

5.2 Methodologies

Monitoring methodologies were determined for each of the eight indicators in the SLPA monitoring program (**Table III**). Methodologies were selected and developed over the 2017–2019 period, a process that required consultations with experts, and the examination of documents and ecological monitoring data. In addition to being simple and cost-effective to use, the methodologies for the SLPA monitoring indicators are scientifically sound. In 2019, some were tested at certain sites and adjusted accordingly (notably the acoustic bat, bird and anuran surveys). Methodology guides were prepared for most of the indicators (see **Appendix C** for the guide for the multi-species acoustic surveys), and are available upon request. Over the next few years, these methods will be tested at each of the 17 selected sites to ensure that they are suitable.

Table III. Methodologies for assessing the ecological indicators selected for use in the joint ecological and biodiversity monitoring program for the protected areas of the St. Lawrence

INDICATOR	METHODOLOGY
Ecosystems	
Land use	Photo-interpretation Unit: % of area occupied by targeted habitats
Biodiversity	
Surveys of benthic macroinvertebrate communities	Field surveys and taxonomic identification in the laboratory Unit: Benthos health index (BHI _g or BHI _{g-f})
Acoustic anuran surveys in wetlands and forests	Acoustic survey using recordings and post-field identification of vocalizations Unit: Presence/absence of species
Acoustic bird surveys in wetlands and forests	Acoustic survey using recordings and post-field identification of vocalizations Unit: Relative activity index for each species
Diversity and abundance of seabird populations in coastal environments	Boat and ground surveys Unit: Number of nests or nesting pairs of each species
Bat surveys in wetlands and forests	Acoustic survey using recordings and post-field identification of ultrasounds Unit: Relative activity index for each species
Threats	
Invasive alien plant species (IAPS)	Field surveys Unit: Area occupied by each IAPS, in m ²
Coastal erosion index*	Survey using stakes, benchmarks or other markers, carried out using photo-interpretation or a drone survey Unit: Average retreat, in metres

5.3 Thresholds

In addition, the data obtained for each of the SLPA monitoring indicators could be compared with baseline thresholds in order to characterize the condition of the element being monitored (Parks Canada Agency 2011). This aspect was examined between 2016 and 2021, and this process will continue over the next few years.

These thresholds must be determined judiciously, to avoid overlooking situations that could be critical to a species' persistence as well as to avoid unnecessary concern about a situation that reflects the species' natural variability. To promote understanding and support management decisions, indicator values can be categorized according to different status classes. For example, Parks Canada, in its approach to monitoring the ecological

integrity of national parks, defines the following three baseline thresholds: “good,” “fair” and “poor.”

For the NWA monitoring program, methodologies were developed to identify threshold values for most of the indicators, in order to determine the status of the indicators (good, fair or poor). For some indicators that are based on recognized and widely used methodologies, threshold values can be determined using values that have already been identified. For example, the “good” threshold value for the benthos health index (BHI_g) was obtained from monitoring benthic communities. This threshold value of 72.7 separates classes comparable to the baseline (“very good” and “good”) from those that deviate from it (“precarious,” “poor” and “very poor”). It was also suggested that theoretical baseline data in the scientific literature be used as threshold values for certain indicators. In other cases, the existing data must be analyzed or baseline data must be acquired in order to determine the threshold values for an indicator. Consultations and validations with experts are also part of the process of identifying threshold values.

The process of setting threshold values for ecological indicators is closely linked with the management objectives for the targeted protected areas. For example, establishing a maximum population size for a species at risk is not relevant, and it would be more useful to set minimum values below which the risk of extinction is anticipated (Parks Canada Agency 2020). Therefore, considering the type of indicator is important when establishing threshold values, in order to determine whether minimum or maximum values, or values around the mean, are required.

6. Partnerships

Even though the common methodology chosen for the SLPA monitoring program involves only a few indicators, implementing the program is an enormous challenge. The federal and provincial sites selected are spread over more than 1,200 km from Lake Saint-François to the Magdalen Islands in the Gulf of St. Lawrence. Although some sites can be easily monitored by teams from the collaborating departments, external service providers will be required for others. A network of partners will have to be developed to support survey efforts, fieldwork and data collection. The BdQc monitoring program, one of the SLPA monitoring program's two components, is based on this approach, relying on partners such as the Société des établissements de plein air du Québec (SÉPAQ) to carry out monitoring in the field. The collaboration between SÉPAQ and SLAP began in 2021. SÉPAQ has carried out monitoring in the îles-de-Boucherville and Bic provincial parks. The Nature Conservancy of Canada (NCC) would be another possible partner, because it has sites along the river that are included in this action.

The ZIP committees (ZIP stands for Zone d'intervention prioritaire, or Area of Prime Concern), whose chief mandate is to bring together users of the St. Lawrence River, are also potential partners for the SLPA monitoring program.¹ In Quebec, there are currently 12 ZIP committees along the St. Lawrence, between the Ontario border and the Gulf of St. Lawrence. Watershed organizations (organismes de bassin versant or OBVs) are other partners that could be engaged, depending on the needs of the different regions. These partners would be especially important if sites were added in the 2021–2026 phase. Ties could also be established with Canadian national parks such as the Mingan Archipelago National Park Reserve and Forillon National Park. Accordingly, Parks Canada and NCC representatives have been included in the project in future years, i.e., the 2021–2026 phase.

Of course, it is essential to draw on the in-house expertise of the collaborating departments. For example, the coastal erosion indicator has already been developed by the Centre d'expertise en gestion des risques d'incidents maritimes (CEGRIM) [centre of expertise in marine incident management], whose mission is to reduce the vulnerability of riverside and coastal communities and the environment to maritime incidents through best practices based on research and knowledge on river and marine ecosystems, in collaboration with stakeholders in Quebec's maritime areas.

The success of a project of this scale clearly depends on solid partnerships with local players. In the next phase of the project, the implementation of the SLPA monitoring program will include establishing and maintaining ties with various types of organizations. Partnerships will be developed not only for fieldwork and data collection, but also for the analysis and dissemination of the results.

¹ In 2022, an initial partnership was formed with the Rive Nord de l'Estuaire ZIP Committee to carry out field surveys for the SLPA monitoring program at Pointe-aux-Outardes.

7. Reporting on the status of protected areas

As part of creating an implementation plan for the SLPA monitoring program, an easy-to-understand reporting system must be developed to allow decision makers and the public to easily visualize the status (“good,” “moderate” or “poor”) and trend (“improving,” “stable” or “deteriorating”) of each ecological monitoring indicator. One option adopted by a number of organizations, including the St. Lawrence Global Observatory (SLGO), is a status and trend reporting system that uses a colour code and arrows or icons.

The project partners examined this aspect during the 2016–2021 period. Various systems for disseminating the results of existing ecological monitoring programs were looked at, such as those used for Canada’s national parks (Parks Canada Agency 2011b); the Quebec provincial parks, which are managed by SÉPAQ (2014b); lands of the National Capital Commission (Del Degan, Massé et Associés inc. 2005); and SLAP (Working Group on the State of the St. Lawrence Monitoring 2014). These ecological monitoring programs use colours and arrows to simply and intuitively report each indicator’s status (green for “good,” yellow for “moderate” and red for “poor”) and trend (up for “improving,” horizontal [i.e., equal sign] for “stable” and down for “deteriorating”).

The reporting system for the SLPA monitoring program could be based on that of SLAP, which is easy to understand visually and would make it possible to eventually incorporate a global indicator for the status of protected areas along the St. Lawrence in the Overview of the State of the St. Lawrence. The advantage of this system is that it provides a visual depiction of the status of each indicator on the basis of five performance levels, and of changes in its status over time. SLAP’s status and trend reporting system is shown in Figure 2.

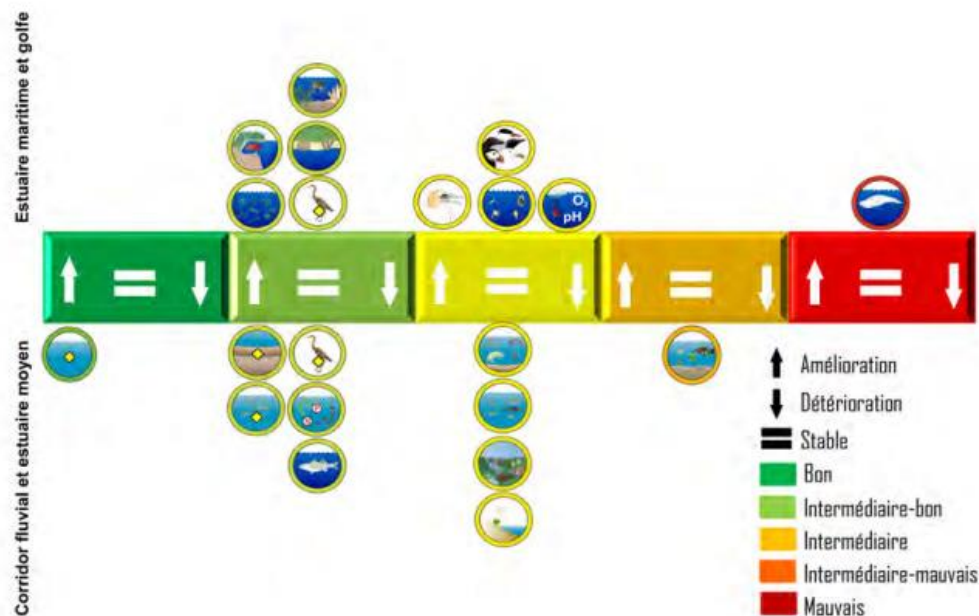


Figure 2. Status and trend reporting system used under the [St. Lawrence Action Plan](#) (Working Group on the State of the St. Lawrence Monitoring 2019)

The approach planned in the SLPA monitoring program for reporting on the status of protected areas is based on the approach used by the State of the St. Lawrence Monitoring Program under SLAP. The status of protected areas along the St. Lawrence could be a new overall indicator developed and incorporated in the State of the St. Lawrence Monitoring report. A “protected areas” indicator would make it possible to report on the status of and changes in protected island and coastal areas along the St. Lawrence using a set of eight indicators (considered sub-indicators) relating to ecosystems, biodiversity and stressors or threats to these natural environments. The monitoring of protected areas carried out for the State of the St. Lawrence Monitoring report would therefore cover all 17 protected areas selected here. Other protected areas could be added if there is interest from the additional federal (Parks Canada) and provincial (SÉPAQ) partners that are included in the implementation of the SLPA monitoring program planned in the 2021–2026 SLAP programming.

At the same time, a project initiated by the BdQC monitoring program in conjunction with Université Laval’s school of design surveyed various target audiences that might be interested in biodiversity data in the context of climate change. Individuals involved in land management or in informing the public on environmental issues (conservation organizations, lobbyists, journalists and teachers) completed questionnaires. The results show an interest in a portal that would provide public access to data, results, plain-language fact sheets and mapping tools. This type of approach has already been implemented by SLGO, which could host some of the results of the SLPA program. MELCCFP, in cooperation with Quebec’s biodiversity science centre, the Centre de la science de la biodiversité du Québec (CSBQ), is also developing the Biodiversité Québec portal. It will present a number of indicators measured in Quebec, including those for the provincial sites in the SLPA monitoring program.

8. Preliminary results

The initial surveys for this project were conducted in 2017 in two protected areas: the Pointe-Platon ecological reserve and the Battures-de-Saint-Augustin-de-Desmaures nature reserve.² The survey sites consisted of coastal marshes, as well as a creek near the Pointe-Platon ecological reserve outside the protected area (no watercourse meeting the monitoring criteria could be found in or near the Battures site). These sites were combined with those in the BdQC monitoring program, including nearby forests and peat bogs.

The results for some of the common indicators for the two protected areas are presented in the following section, giving an idea of some of the information that could be obtained. The data presented were collected in acoustic surveys of bats, birds and anurans in wetland and forest environments, and the survey of benthic macroinvertebrate communities.

8.1 Acoustic bat survey

To estimate the abundance of various bat species, SM3-type automated audio recorders (Wildlife Acoustics) were used to simultaneously record multiple species throughout their active period, that is, when they arrived in spring, when they reproduced or gave birth, when they raised their young in summer, and when they migrated in fall. During the surveys, the devices were programmed to record during various times of peak activity after sunset, from May to September 2017, for a total of 300 minutes of recording time.

Table IV shows the number of passes (call sequences) of the detected species at the two survey sites in 2017, during the various periods of nocturnal activity. Bat passes have been divided into three classes on the basis of the monitoring date and period of activity in the different regions:

- arrival in spring and reproduction: May 20 to July 10
- raising of young in summer: July 10 to August 15
- migration in fall: August 15 to October 11

² Note that the Îles-de-Boucherville and Bic provincial park sites were supposed to be surveyed in 2020, but this was postponed to 2021 because of issues related to COVID-19. As data post-processing is still in progress, only the 2017 surveys are presented.

Table IV. Number of bat passes detected in the 2017 acoustic surveys at the Battures-de-Saint-Augustin-de-Desmaures and Pointe-Platon protected areas (preliminary results)

Site	Species or species complex	1. Arrival in spring and reproduction	2. Raising of young in summer	3. Migration in fall
Battures-de-Saint-Augustin-de-Desmaures	Big Brown Bat Silver-haired Bat	2	0	2
	Hoary Bat	0	0	3
	Little Brown Myotis Northern Myotis Eastern Small-footed Myotis	0	1	0
Pointe-Platon	Big Brown Bat Silver-haired Bat	2	0	0

8.2 Acoustic bird and anuran surveys

Like the acoustic bat survey, the acoustic anuran survey (**Table V**) and acoustic bird survey (**Table VI**) were conducted using automated recorders. Monitoring was carried out from May to June of 2017. Recordings were made during two periods as follows: once every hour from 4 a.m. to 8 a.m. for 15 minutes and once every two hours from 7 p.m. to 3 a.m. for 15 minutes.

Each recording was played back in three-minute segments, and the human listener classified the acoustic signals as abiotic, bird, amphibian, insect, mammal or unknown; in addition, a relative abundance value was determined for each three-minute segment. The type of acoustic signal (song, abiotic, non-vocal or other) and the amplitude and purity of the signal were also compiled, in addition to weather conditions and recording quality.

Table V. Anuran species detected in the 2017 acoustic survey and their abundance. Abundance data reflect the intensity of the acoustic signal. Anurans were detected only at Pointe-Platon.

Species	Date observed (2017)	Abundance*
Northern Leopard Frog (<i>Lithobates pipiens</i>)	May 26	cl1
Green Frog (<i>Lithobates clamitans</i>)	May 26	cl1
	June 21	cl1
Spring Peeper (<i>Pseudacris crucifer</i>)	May 22	cl2
	May 26	cl2

* cl1: acoustic signal emitted by one or a few individuals that can be counted separately, with no overlap; cl2: acoustic signal emitted by a number of discernible individuals, with overlap.

Table VI. Bird species and date detected, along with number of observations, in the 2017 acoustic survey. All the species below were detected during their nesting period or shortly before or after.

Species	Site	Date (2017)	Number of observations
White-throated Sparrow	Battures-de-Saint-Augustin-de-Desmaures	May 21	3
Song Sparrow	Battures-de-Saint-Augustin-de-Desmaures	May 21	2
		May 27	1
	Pointe-Platon	May 20	1
		May 22	2
Swamp Sparrow	Pointe-Platon	May 22	1
Northern Cardinal	Battures-de-Saint-Augustin-de-Desmaures	May 27	1
Red-winged Blackbird	Battures-de-Saint-Augustin-de-Desmaures	May 21	2
		May 27	3
	Pointe-Platon	May 20	3
		May 22	3
		June 7	3
American Goldfinch	Battures-de-Saint-Augustin-de-Desmaures	May 21	2
American Crow	Battures-de-Saint-Augustin-de-Desmaures	May 31	1
		May 21	1
	Pointe-Platon	June 7	1
Blue Jay	Pointe-Platon	May 20	1

Veery	Battures-de-Saint-Augustin-de-Desmaures	May 27	2
	Pointe-Platon	May 20	2
		May 22	2
Tree Swallow	Pointe-Platon	June 7	1
Baltimore Oriole	Battures-de-Saint-Augustin-de-Desmaures	May 21	1
		May 27	1
		May 31	1
American Redstart	Battures-de-Saint-Augustin-de-Desmaures	May 21	3
		May 27	1
		May 31	2
Yellow Warbler	Battures-de-Saint-Augustin-de-Desmaures	May 21	1
		May 27	2
		May 31	1
	Pointe-Platon	May 20	1
		May 22	1
		June 7	3
Common Yellowthroat	Battures-de-Saint-Augustin-de-Desmaures	May 31	1
Passerine sp.	Pointe-Platon	May 20	1
		May 22	1
Northern Flicker	Pointe-Platon	May 20	1
Woodpecker sp.	Battures-de-Saint-Augustin-de-Desmaures	May 21	1
		May 27	1
Downy Woodpecker	Battures-de-Saint-Augustin-de-Desmaures	May 21	1
Bald Eagle	Pointe-Platon	June 7	1
Common Grackle	Battures-de-Saint-Augustin-de-Desmaures	May 27	1
Mourning Dove	Battures-de-Saint-Augustin-de-Desmaures	May 21	1
Philadelphia Vireo	Battures-de-Saint-Augustin-de-Desmaures	May 31	2
		June 7	2
Vireo sp.	Pointe-Platon	June 7	2
	Battures-de-Saint-Augustin-de-Desmaures	May 27	1

8.3 Surveys of benthic macroinvertebrate communities

The surveys of benthic macroinvertebrate communities take place every five years, between September and October. Samples are taken from 100-m stations in watercourses with a coarse substrate and a regular flow. Sampling starts downstream of the station, and

20 samples are taken in the riffles and runs using a kick net to collect the invertebrates. Once the sampling has been completed, the composite sample is preserved in alcohol and taken back to the laboratory where the contents are analyzed and the individuals identified, mainly by genus for the BHI_g, or by family for BHI_{g-f}.

BHI_g is the benthos health index for coarse-substrate streams³ (**Table VII**). It is derived from six variables:

- total number of taxa
- number of EPT taxa (Ephemeroptera, Plecoptera and Trichoptera)
- percentage of EPT taxa excluding *Hydropsychidae*
- percentage of *Chironomidae*
- percentage of the two dominant taxa
- Hilsenhoff biotic index

Table VII. BHI_g quality classes

ISBg	Classe de qualité
 89,2 - 100	Très bon
 72,7 – 89,1	Bon
 48,4 – 72,6	Précaire
 24,2 – 48,3	Mauvais
 0 – 24,1	Très mauvais

Pointe-Platon–Saint-Eustache Creek

Land use in this watershed, which has a drainage area of 24.3 km², is dominated by agriculture (56%), with forests representing 38% ([Atlas de l'eau](#) [water atlas], MELCC). The presence of woodlands, mainly in the downstream portion of the watershed, seems to be conducive to maintaining a healthy macroinvertebrate community (**Table VIII**).

Table VIII. Values obtained for the benthos health index (BHI_g) and its components in Saint-Eustache Creek in 2017.

Saint-Eustache Creek	BHI _g
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³ To learn more about this indicator, see [Macroinvertébrés benthiques](#) [benthic macroinvertebrates] (MELCC) and [Rapport sur l'état des ressources en eau et des écosystèmes aquatiques](#) [report on the state of water resources and aquatic ecosystems] – Fiche Communautés de macroinvertébrés benthiques – substrat grossier [fact sheet on benthic macroinvertebrate communities – coarse substrate] [in French only].

Date	Total no. of taxa	No. of EPT taxa	% EPT excluding <i>Hydropsuchidae</i>	% <i>Chironomidae</i>	% two dominant taxa	BHI	Good
2017-09-21	29	18	38.5	5.0	61.5	3.94	75.5

9. Next steps

As this document illustrates, the initial stages of the joint ecological and biodiversity monitoring program have made it possible to prioritize 8 indicators to be monitored for the 17 protected areas along the St. Lawrence. The next steps involve implementing the SLPA monitoring program. Under the 2021–2026 action plan, three or four protected areas will be monitored each year. It has also been agreed that coordinated efforts will be made to finalize the methodology for the land use and coastal erosion indicators. In addition, the plan is to include protected areas in the Estuary and Gulf of St. Lawrence, such as areas on Anticosti Island, Forillon National Park and the Mingan Archipelago National Park Reserve, in the joint monitoring program.

Specifically, each stakeholder must take steps to keep the SLPA monitoring program moving forward. For ECCC, the next steps will mainly involve the gradual implementation of the surveys planned under the SLPA monitoring program in Quebec NWAs. The year 2022–2023 represented the first year of monitoring for certain indicators, including acoustic surveys of songbirds, bats and anurans, and analyses of habitat areas in three of the eight Quebec NWAs. In these initial years of implementation, ECCC must ensure the quality of its monitoring and its consistency with monitoring carried out by the MELCCFP. This will be validated throughout the data collection periods, as well as during data compilation and analysis. At the same time, ECCC must confirm the interest of local partners in participating in some of the monitoring work.

For the Government of Quebec, field surveys have already begun and will continue in parallel with the work of the Réseau de suivi de la biodiversité du Québec, funded by the Fonds d'électrification et de changements climatiques (FECC). Partnerships with local organizations will continue. The next steps will mainly involve coordinating and aligning data management with ECCC and evaluating ways of presenting and disseminating the results for the indicators. Two protected areas will be revisited for the first time in 2022 to show the five-year variability in acoustic indicators at each site, which will help in defining threshold values.

For the two organizations involved in the SLPA monitoring program, it will be essential to determine the feasibility of monitoring some of the indicators considered and presented in earlier phases. The divergent objectives of the players in the various jurisdictions, associated with the organizational constraints and priorities they experience, lead to differences in the order of priority given to surveys in scheduling. Moreover, data compilation methods must be standardized for clear and effective monitoring of the indicators. Good communication between the participants is also necessary for adapting and adjusting joint working methods. An initial assessment of the state of the ecology and biodiversity in the natural environments covered by the joint monitoring program is expected within the next five years.

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Appendix A

Threats, issues and indicators identified under the ecological and biodiversity monitoring program for the protected areas of the St. Lawrence and adjacent areas

THREAT	SUB-THREAT	SUB-THREAT DESCRIPTION	ISSUES / EXPECTED IMPACT	PROJECT OBJECTIVES	POSSIBLE INDICATORS LINKED TO OBJECTIVES
Residential and commercial development	1.1 Housing and urban areas	Human cities, towns, and settlements including non-housing development typically integrated with housing	- Maintaining habitats - Maintaining biodiversity - Maintaining ecological connectivity - Pollution - Disturbance of wildlife	(1) Monitor extent of urban and industrial development (2) Assess the impact of residential and urban development on protected areas	- Abiotic variables - Wetlands - Land use - Invasive alien plant species
	1.2 Commercial and industrial areas	Factories and other commercial centres	- Increased risk of pollution		
	1.3 Tourism and recreation areas	Tourism and recreation sites with a substantial footprint	- Disturbance of wildlife - Trampling and collection of plants - Habitat degradation or alteration		
Agriculture and aquaculture	2.1 Annual and perennial non-timber crops	Crops planted for food, fodder, fibre, fuel or other uses	- Pollution from fertilizers and pesticides - Loss of habitats adjacent to protected areas		- Abiotic variables - Water levels and flows - Wetlands

	2.2 Wood and pulp plantations	Stands of trees planted for timber or fibre outside of natural forests, often with non-native species	N/A	(1) Track the extent of arable land (2) Assess the impact of agricultural and aquacultural development on protected areas	- Land use - Invasive alien plant species - Monitoring odonates and butterflies in wetlands - Bird surveys in wetlands and forests - Waterfowl diversity and abundance in coastal environments - Benthic communities
	2.3 Livestock farming and ranching	Domestic terrestrial animals raised in one location on farmed or non-local resources (farming); also domestic or semi-domesticated animals allowed to roam in the wild and supported by natural habitats (ranching)	- Pollution from fertilizers, pesticides and excrement - Loss of habitats adjacent to protected areas - Possible disease vectors in wildlife - Coexistence of domestic and wild animals - Land drainage		
	2.4 Marine and freshwater aquaculture	Aquatic animals raised in one location on farmed or non-local resources; also hatchery fish allowed to roam in the wild	N/A		
Energy production and mining	3.1 Oil and gas drilling	Exploring for, developing and producing petroleum and other liquid hydrocarbons	- Pollution - Disturbance of wildlife - Loss of habitats and connectivity		- Wetlands - Land use - Invasive alien plant species

	3.2 Mining and quarrying	Exploring for, developing and producing minerals and rocks	- Water pollution - Loss of adjacent habitats	(1) Assess the potential impact of energy and mining development on protected areas	- Vegetation composition of the herbaceous and tree strata in forests - Bat surveys in wetlands and forests - Bird surveys in wetlands and forests - Phenology and distribution of birds in forests
	3.3 Renewable energy	Exploring, developing and producing renewable energy	- Possible impacts of wind turbines		
Transportation and service corridors	4.1 Roads and railroads	Surface transport on roadways and dedicated tracks	- Habitat fragmentation - Wildlife mortality due to collisions	(1) Assess the impact of road development on protected areas (2) Assess the impact of marine development on protected areas	- Coastal erosion index - Land use - Invasive alien plant species
	4.2 Utility and service lines	Transport of energy and resources	- Loss and destruction of adjacent habitats - Increased vulnerability of wildlife to hunting along utility lines		
	4.3 Shipping lanes	Transport on and in freshwater and ocean waterways	- Bank erosion - Disturbance of wildlife - Risk of accidental spills		
	4.4 Flight paths	Air and space transport	N/A		

Biological resource use	5.1 Hunting and collecting terrestrial animals	Killing or trapping terrestrial wild animals or animal products for commercial, recreation, subsistence, research or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch	- Poaching - Bycatch - Capture of species at risk - Vegetation cutting - Presence of waste - Habitat degradation	(1) Assess the impact of illegal wildlife harvesting on protected areas (2) Assess the impact of illegal plant harvesting on protected areas (3) Assess the impact of forestry on protected areas	- Vegetation composition of the herbaceous and tree strata in forests - Waterfowl diversity and abundance in coastal environments
	5.2 Gathering terrestrial plants	Harvesting plants, fungi and other non-timber/non-animal products for commercial, recreation, subsistence, research or cultural purposes, or for control reasons	- Overexploitation of species - Effects on plants at risk - Degradation of the environment		
	5.3 Logging and wood harvesting	Harvesting trees and other woody vegetation for timber, fibre or fuel	- Habitat destruction and degradation - Disturbance of wildlife - Water pollution		
	5.4 Fishing and harvesting aquatic resources	Harvesting aquatic wild animals or plants for commercial, recreation, subsistence, research or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch	- Overharvesting - Poaching - Bycatch and failure to release		

Human intrusions and disturbance	6.1 Recreational activities	People spending time in nature or travelling in vehicles outside of established transport corridors, usually for recreational reasons	- Disturbance of wildlife - Habitat degradation - Waste - Potential for collection - Vectors of disease and invasive species	(1) Assess the impact of recreational activities on protected areas	- Land use - Invasive alien plant species - Bird surveys in wetlands and forests - Shorebird diversity and abundance in coastal environments - Waterfowl diversity and abundance in coastal environments - Diversity and abundance of seabird populations in coastal environments
	6.3 Work and other activities	People spending time in or travelling in natural environments for reasons other than recreation, military or research activities	- Construction of cottages and outbuildings - Habitat degradation		
Natural system modifications	7.1 Fire and fire suppression	Suppression or increase in fire frequency and/or intensity outside of its natural range of variation	- Changes to natural fire regimes - Changes in plant communities and vegetation regeneration - Changes in wildlife communities and displacement of populations (bats and birds)	(1) Assess the impact of changes in a fire regime on protected areas (2) Assess the impact of changes in a dam regime on protected areas	- Abiotic variables - Water levels and flows - Coastal erosion index - Wetlands - Land use - Invasive alien plant species

			- Destruction of plant and wildlife habitats	(3) Assess the impact of ecosystem modifications (e.g., restoration or creation of wetlands or aquatic environments) on protected areas	- Anuran surveys in wetlands and forests - Bat surveys in wetlands and forests - Bird surveys in wetlands and forests - Shorebird diversity and abundance in coastal environments - Waterfowl diversity and abundance in coastal environments
	7.2 Dams and water management/use	Changing water flow patterns from their natural range of variation either deliberately or as a result of other activities	- Erosion problems - Land flooding - Loss of plant and wildlife habitats - Forest tree species mortality		
	7.3 Other ecosystem modifications	Other actions that convert or degrade habitat in service of "managing" natural systems to improve human welfare	- Secondary effects of controlling invasive or overabundant species on ecosystems and natural processes - Beaver dams		
Invasive and other problematic species, genes and disease	8.1 Invasive non-native/alien species/diseases	Harmful plants, animals, pathogens and other microbes not originally found within the ecosystem(s) in question and directly or indirectly introduced and spread into it by human activities	- Alteration of habitat - Loss of biodiversity - Elimination or decline of native species - Secondary effects of control measures to eradicate IAS	(1) Assess the impact of the introduction and spread of invasive alien species on protected areas (2) Assess the impact of the spread of problematic native	- Abiotic variables - Water levels and flows - Wetlands - Invasive alien plant species - Vegetation composition of the herbaceous and tree strata in forests

	8.2 Problematic native species/diseases	Harmful plants, animals, or pathogens and other microbes that are originally found within the ecosystem(s) in question, but have become "out-of-balance" or "released" directly or indirectly due to human activities	- Alteration of habitat - Loss of biodiversity - Elimination or decline of species	species on protected areas	- Anuran surveys in wetlands and forests - Bat surveys in wetlands and forests - Bird surveys in wetlands and forests - Monitoring odonates and butterflies in wetlands - Shorebird diversity and abundance in coastal environments - Waterfowl diversity and abundance in coastal environments - Diversity and abundance of seabird populations in coastal environments
	8.3 Introduced genetic material	Human altered or transported organisms or genes	- Possible crossbreeding of wild species with GMO crops in protected areas close to farmland		

Pollution	9.1 Domestic and urban waste water	Water-borne sewage and non-point runoff from housing and urban areas that include nutrients, toxic chemicals or sediments	- Degradation of the quality of aquatic habitats or soils - Proliferation of IAS - Changes (appearance or disappearance of species) in the composition of plant and wildlife communities specific to certain soil or water conditions - Infilling of watercourses through sediment transport, modifying land use and the carrying capacity of aquatic ecosystems	(1) Assess the impact of pollution on the quality of watercourses in protected areas (2) Assess the impact of pollution on the quality of terrestrial habitats in protected areas	- Abiotic variables - Coastal erosion index - Water levels and flows - Wetlands - Invasive alien plant species - Anuran surveys in wetlands and forests - Monitoring of odonates in wetlands - Benthic communities
	9.2 Industrial and military effluents	Water-borne pollutants from industrial and military sources, including mining, energy production and other resource extraction industries, that include nutrients, toxic chemicals or sediments	- Degradation of the quality of aquatic habitats or soils - Proliferation of IAS - Changes (appearance or disappearance of species) in the composition of plant and wildlife communities specific to certain soil or water conditions - Genetic mutations and contaminant transport via food chains - Infilling of watercourses through sediment transport, modifying land use and the carrying capacity of aquatic ecosystems		

	9.3 Agricultural and forestry effluents	Water-borne pollutants from agricultural, silvicultural and aquaculture systems that include nutrients, toxic chemicals or sediments including the effects of these pollutants on the site where they are applied	- Degradation of the quality of aquatic habitats or soils - Proliferation of IAS - Changes (appearance or disappearance of species) in the composition of plant and wildlife communities specific to certain soil or water conditions - Genetic mutations and contaminant transport via food chains - Infilling of watercourses through sediment transport, modifying land use and the carrying capacity of aquatic ecosystems		
	9.4 Garbage and solid waste	Rubbish and other solid materials including those that entangle wildlife	- Poisoning of certain wildlife species through ingestion - Soil and groundwater contamination - Visual pollution - Concentration of wildlife at waste disposal sites		
	9.5 Air-borne pollutants	Atmospheric pollutants from point and non-point sources	- Water and soil acidification, which may ultimately modify natural processes and ecosystems - Dust, deposition and air contamination		

	9.6 Excess energy	Inputs of heat, sound or light that disturb wildlife or ecosystems	N/A		
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Climate change and severe weather	11.1 Habitat shifting and alteration	Major changes in habitat composition and location	- Shoreline erosion - Changes in communities and species - Changes in species distribution and phenology - Reduction and disappearance of numerous habitats required for a number of species to reproduce - Proliferation of certain IAS or undesirable species - Biological productivity of ecosystems - Changes in access to and availability of natural habitats	(1) Assess the impact of climate change on protected areas	- Abiotic variables - Water levels and flows - Coastal erosion index - Wetlands - Invasive alien plant species - Vegetation composition of the herbaceous and tree strata in forests - Monitoring odonates and butterflies in wetlands - Bat surveys in wetlands and forests - Bird surveys in wetlands and forests - Anuran surveys in wetlands and forests
	11.2 Droughts	Periods in which rainfall falls below the normal range of variation	- Greater water level and flow fluctuations along the banks of the St. Lawrence River - Changes in riparian habitats, especially the drying of coastal marshes and tributaries - Increased risk of fire - Impacts on plant and wildlife communities		

	11.3 Temperature extremes	Periods in which temperatures exceed or go below the normal range of variation	- Average increase in air and water temperatures - Acclimatization of species - Changes in range		- Phenology and distribution of birds in forests - Shorebird diversity and abundance in coastal environments - Waterfowl diversity and abundance in coastal environments - Diversity and abundance of seabird populations in coastal environments - Benthic communities
	11.4 Storms and flooding	Extreme precipitation or wind events	- Increased coastal erosion in the Estuary and Gulf		
Other	12.1 Legal compliance	Compliance with protected area regulations	- Impact of human activities on protected areas, e.g., encroachment and habitat destruction	(1) Assess the impact of specific issues on protected areas	- Coastal erosion index - Invasive alien plant species - Vegetation composition of the herbaceous and tree strata in forests
	12.2 Safety and infrastructure	Risks to visitor safety associated with the environment, without any impact on habitats or diversity	- Landslides - Falling trees - Drowning - Conflicts with wildlife		

	12.3 Collaboration with stakeholders	Collaboration with local stakeholders and other partners	- Support for habitat and species conservation measures		- Bat surveys in wetlands and forests - Bird surveys in wetlands and forests - Anuran surveys in wetlands and forests - Shorebird diversity and abundance in coastal environments - Waterfowl diversity and abundance in coastal environments - Diversity and abundance of seabird populations in coastal environments
	12.4 Knowledge acquisition	Surveying, monitoring and research needs	- Information gaps preventing sound land management decision making		
	12.5 Habitat and ecosystem management	Specific impacts of certain natural processes on ecosystems or species	- Windthrow - Native wildlife diseases - Insect outbreaks		
	12.6 Species management	Specific impacts of certain species on other species or habitats	- Cormorant droppings - Intensive goose grazing - Predators in seabird colonies		

Appendix B

Ecological profiles of the 17 protected areas targeted in the joint ecological and biodiversity monitoring program for the protected areas of the St. Lawrence

B-1. Lake Saint-François NWA

Area: 1,316 ha

Year created: 1978

Portion of the St. Lawrence: river

General comments: N/A

Habitats: This NWA is recognized as a Wetland of International Importance under the Ramsar Convention. It consists mainly of swamps and marshes made up of sedge and cattail plant communities, Red Maple swamps, and well-drained woods with communities dominated by hawthorns, hickories and maples.

Plants/wildlife: The biodiversity in the NWA is among the most noteworthy in Quebec. It is home to more than 287 animal species and 547 plant species, many of which are at risk. Some 13 species of waterfowl nest in the NWA, including Canada Goose, Mallard, American Black Duck, Wood Duck and Lesser Scaup. During migration, thousands of ducks use the marshes and adjacent open waters. Among the 237 bird species recorded in the NWA, many species of landbirds and waterbirds nest there, including the Northern Waterthrush, Veery and Sandhill Crane. The NWA also hosts one of the largest Sedge Wren populations in Canada. Amphibian and reptile species observed in the NWA include Blue-spotted Salamander, Common Gartersnake and Snapping Turtle.

Threats: The NWA faces a number of threats and management challenges due to its proximity to a large city and the presence of current and past human activities. The main issues are non-point source pollution, the impact of human activities, land fragmentation, the presence of invasive alien species and the development of the surrounding land.

B-2. Îles de la Paix NWA

Area: 129 ha

Year created: 1977

Portion of the St. Lawrence: river

General comments: N/A

Habitats: The NWA consists of low-lying islands with sparse Silver Maple stands, surrounded by beaches and wetlands.

Plants/wildlife: Despite its limited size, the NWA has a wide variety of habitats. It regularly attracts some 130 species of birds. The islands provide nesting sites for several dozen breeding pairs of ducks, as well as food and shelter for nearly 5,000 ducks during spring and 30,000 ducks during fall migration. The NWA is also home to over 150 animal species and 50 plant species, including some species at risk. Birds mostly congregate on the islands during the nesting period. Bird species that nest on the islands' edges include American Black Duck, Mallard, Blue-winged Teal, Green-winged Teal and Northern Pintail. Occasionally, high water levels cause these birds to nest in the forks of trees. Dead trees on the islands provide a large roosting area for Tree Swallows. Black Terns have also been observed at this site. In addition, some mammals visit the islands, including Common Muskrat, American Beaver, American Mink, Coyote and Red Fox.

Threats: The NWA faces a number of threats and management challenges due to its proximity to a large city and the presence of current and past human activities. The main issues are erosion caused by the regulation of water levels in the seaway, the impact of human activities on wildlife species and their habitat, and the presence of invasive alien species. Additional threats to wildlife conservation include hunting and poaching, gaps in scientific knowledge, contaminated sediment and accidental marine spills.

B-3. Parc national des Îles-de-Boucherville [Îles-de-Boucherville provincial park]

Area: 814 ha

Year created: 1984

Portion of the St. Lawrence: river

General comments: N/A

Habitats: The landscape in this provincial park reflects its agricultural past. The habitat primarily consists of abandoned fields with numerous shrubby edges along the shorelines. Boisé Grosbois is the park's largest wooded area. Numerous wetlands, including treed swamps and emergent and floating aquatic grass beds, make up part of the landscape mosaic.

Wildlife: Some 45 species of fish, 7 species of amphibians, 6 species of reptiles, nearly 20 species of mammals (White-tailed Deer, Red Fox, American Mink, Meadow Vole, American Beaver, Muskrat, etc.) and over 240 species of birds have been recorded in the park. The park is a refuge for many bird species. Two wildlife species legally designated as Vulnerable— Northern Map Turtle and Least Bittern—can be found here. The park is also home to the Eastern Red Bat, Dekay's Brownsnake, Short-eared Owl and three bivalve species likely to be designated Threatened or Vulnerable.

Plants: The park is home to over 450 plant species. Willows, *Populus* spp., dogwoods and Staghorn Sumac grow along the shoreline edges. Ash–silver maple stands make up the main woodlands. The park's population of Green Dragon is the third largest in

Quebec, and the only one located in a protected area. A population of Eastern Spring Beauty has also been recorded at this site.

Threats: Climate change (water levels), erosion due to recreational boating, Common Reed invasion, golf courses and agricultural activities (leased farmland)

B-4. Îles de Contrecoeur NWA

Area: 299 ha

Year created: 1981

Portion of the St. Lawrence: river

General comments: N/A

Habitats: The NWA's landscape consists mainly of grassy plains. Many of the low-lying alluvial islands that dot the NWA are submerged during the spring freshet. The islands are subject to the seasonal variations in water levels in the St. Lawrence, and are mainly covered by tall grasses with some tree species, including willows, Silver Maple and Red Ash. Reed Canarygrass, which is popular among waterfowl for nesting, completely covers some islands. Stretches of marsh populated by cattails, *Sagittaria* spp. and submerged Eurasian Water-milfoil beds surround the islands, connecting them together and providing food for thousands of ducklings, adult ducks and other waterfowl during breeding and migration.

Plants/wildlife: The NWA is home to more than 78 bird species, 12 mammal species and over 205 plant species. Species at risk, such as the Short-eared Owl, are occasionally observed here. The islands are the most important nesting site in Quebec for Gadwall and a dozen other species of dabbling duck, including Northern Pintail, American Wigeon and Mallard. Other bird species observed in the NWA include American Bittern, Virginia Rail, Marsh Wren, Wilson's Phalarope, Red-winged Blackbird, Swamp Sparrow and Yellow Warbler. The archipelago is also home to a Ring-billed Gull colony composed of approximately 13,000 breeding pairs. In terms of mammals, Muskrats are commonly observed on the islands, and Striped Skunk, Raccoon, Red Fox, shrews, voles and bats are also seen.

Threats: The NWA faces a number of threats and management challenges, including disturbance caused by unauthorized activities on the islands, the presence of invasive alien species such as Common Reed and Purple Loosestrife, the discharge of heavy metals in the St. Lawrence, and accidental spills.

B-5. Milieu naturel de conservation volontaire de l'Île-à-la-Pierre [Île-à-la-Pierre natural voluntary conservation environment]

Area: 29 ha

Year created: N/A

Portion of the St. Lawrence: river

General comments: N/A

Habitats: Treed swamps, and emergent and floating aquatic grass beds

Wildlife: Many waterfowl species, as well as Osprey and Muskrat, have been observed on this island, and Great Blue Herons and Black Terns also come to feed there. In addition, this protected area borders a bay that is home to a variety of fish species.

Plants: This protected area contains a Silver Maple swamp, and emergent and floating aquatic grass beds. Green Dragon has been recorded on the island and there is one occurrence of Bridle Shiner next to the property.

Threats: Climate change (water levels), erosion caused by recreational and commercial navigation

B-6. Réserve écologique de Pointe-Platon [Pointe-Platon ecological reserve]

Area: 59.38 ha

Year created: 1995

Portion of the St. Lawrence: river

General comments: The Pointe-Platon ecological reserve is located on the south shore of the St. Lawrence River, roughly 60 km west of Quebec City and within the municipal boundaries of Sainte-Croix.

Habitats: The ecological reserve consists of two terraces separated by a relatively steep cliff. On the lower terrace, wetlands and the intertidal zone are interspersed with small, higher-elevation areas.

Wildlife: Little information is currently available on the wildlife present in the ecological reserve. In fall and spring, large concentrations of waterfowl are found in the marshes, as well as Great Blue Herons, a variety of shorebirds, White-tailed Deer and Moose.

Plants: In the ecological reserve, plant communities occur in a sequence—on the lower terrace, mainly influenced by the presence of tides, and on the cliffs and upper terrace, by the depth and type of substrate. An extensive American Bulrush marsh occurs on the thin soils of the lower terrace, which has frequent bedrock outcrops. Red Ash, willow and Speckled Alder stands can be found growing in clayey or silty soils in the depressions there, while Eastern Cottonwood and Balsam Poplar stands populate the elevated portions, which are sandy and well drained. Sugar Maple stands grow on the cliff separating the two terraces, and a young Largetooth Aspen stand can be found on the upper terrace. Some 40 species of vascular plants have been recorded in the intertidal zone at Pointe-Platon; among the eight at-risk species identified, three are found in the ecological reserve: Tuckerman's Quillwort, Estuarine Wildrice and Victorin's Water-hemlock.

Threats: N/A

B-7. Réserve naturelle des Battures-de-Saint-Augustin-de-Desmaures [Battures-de-Saint-Augustin-de-Desmaures nature reserve]

Area: 374 ha

Year created: 2011

Portion of the St. Lawrence: river

General comments: Battures-de-Saint-Augustin-de-Desmaures nature reserve, located entirely within the town of Saint-Augustin-de-Desmaures, extends approximately 11 kilometres along the river. It contains exceptionally high-quality habitats. It is home to numerous plant species, a number of which are at risk, and contains a variety of wildlife habitats.

Habitats: Wooded area (Parc des Hauts-Fonds), shrub swamp, intertidal marsh and submerged aquatic grass bed

Wildlife: The flats serve as an important migratory stopover for many bird species. A number of duck species can be observed, including Common Eider and scoters. In spring, flocks of 20,000 to 30,000 Canada Geese and Snow Geese, as well as 2,000 dabbling ducks, are common. This high-quality habitat attracts over 200 species of birds, which either nest there or, like the Great Blue Heron, use it to feed during the summer. In 2010, acoustic bat surveys along wooded riparian edges in Saint-Augustin-de-Desmaures identified seven of the eight bat species known to occur in Quebec. Some 22 species of fish have been recorded in the flats, which serve as potential spawning areas for many species. The salt ponds that dot the flats at low tide provide suitable spawning habitat for small species such as Banded Killifish and Threespine Stickleback. Furthermore, ten species of marine mussels and eight species of freshwater mussels have been observed on the flats, including the Spike and Elephantear, which are likely to be designated Threatened or Vulnerable in Quebec. The Ring-necked Snake, also included in this category, occurs on the flats, as does the American Shad, a Vulnerable species in the province.

Plants: From dry land to offshore, the flats contain a succession of vegetation communities, including shrub swamp, intertidal marsh and submerged aquatic grass beds, which are found in the salt ponds or are separated from the marsh by an area of bare mud. The shrub swamp is dominated by shrub willows such as Pussy Willow and Heartleaf Willow, which grow in association with Speckled Alder and Red-osier Dogwood and an understory of herbaceous plants, including *Eupatorium* spp. The intertidal marshes are dominated by Common Three-square Bulrush, which grows along with *Sagittaria* spp., Estuarine Wildrice, Common Water-parsnip, Victorin's Water-hemlock, Common Boneset and Eaton's Beggarticks. The submerged aquatic vegetation is characterized by American Eelgrass, Siberian Water-milfoil and Horned Pondweed. A total of 13 species at risk in Quebec or Canada occur here, including Victorin's Gentian, Victorin's Water-hemlock (quality A), Provancher's Fleabane and Parker's Pipewort, all designated Threatened. Five other plant species likely to be designated Threatened or Vulnerable have also been recorded: Virginia False Dragonhead, Eaton's Beggarticks, St. Lawrence Water-horehound, Virginia Water-horehound and Estuarine Wildrice.

Threats: Climate change (water levels), erosion caused by recreational and commercial navigation, recreational and tourism activities

B-8. Cap Tourmente NWA

Area: 2,308 ha

Year created: 1978

Portion of the St. Lawrence: river

General comments: N/A

Habitats: In 1981, this NWA was recognized as a Wetland of International Importance under the Ramsar Convention, the first site in North America to obtain this designation. Its many historic buildings testify to over 400 years of human occupation and farming activities, making it one of Canada's founding sites. Situated at the juncture of the Canadian Shield, the St. Lawrence Lowlands and the Appalachians, the NWA also lies at the confluence of the Upper and Fluvial estuaries of the St. Lawrence. The territory offers contrasting landscapes shaped by the junction of the river, large coastal marshes, plains and mountains, and features a wide range of habitats that are home to a very rich diversity of animal and plant species.

Plants/wildlife: The NWA has more than 180 bird species, 30 mammal species, 22 types of forest stands and 700 plant species. Many of these species are at risk, including the Peregrine Falcon, Bobolink and Butternut. In spring and fall, migratory birds congregate in the narrow corridor formed by the river and the cape's escarpment, and invade the mosaic of habitats in the NWA. This protected area is renowned for its awe-inspiring spectacle of tens of thousands of Greater Snow Geese gathering at the site during migration. In addition to 20 species of waterfowl, around ten species of birds of prey and 30 species of warblers occur here. Wood Duck, Northern Harrier, Pileated Woodpecker, Ruffed Grouse, Scarlet Tanager, Indigo Bunting and American Redstart are not uncommon sightings in spring. The coastal marsh is home to Red-winged Blackbirds, Swamp Sparrows and American Black Ducks, and the NWA contains one of the rare nesting sites for Nelson's Sparrow on the north shore of the St. Lawrence. The presence of the Bobolink is also noteworthy. In winter, the NWA is home to nearly 20 bird species, including Black-capped Chickadee, Blue Jay and Barred Owl. The most common mammals are Muskrat, White-tailed Deer and North American Red Squirrel, but North American Porcupine, Red Fox and Black Bear are occasionally seen.

Threats: The Cap Tourmente NWA faces a number of threats and management challenges, including neighbouring land development, poaching, invasive alien plants and the impact of visitors.

B-9. Réserve naturelle Jean-Paul-Riopelle [Jean-Paul-Riopelle nature reserve]

Area: 47.99 ha

Year created: 2014

Portion of the St. Lawrence: Estuary

General comments: In June 2007, the Nature Conservancy of Canada (NCC) acquired the Pointe aux Pins property on Île aux Grues, also known as the Jean-Paul-Riopelle nature reserve. This 120-acre property includes of a stand of 300-year-old maples, which has been designated an exceptional forest ecosystem (*forêt refuge*, or forest sanctuary, type).

Habitats: High marsh, riparian forest and flats

Wildlife: The ecosystem supports a particularly unique avifauna. The extensive flats on the point have been designated a waterfowl gathering area by the Quebec government. Owing to the proximity of the Cap Tourmente NWA and protected areas for birds in the Côte-du-Sud region, the Jean-Paul-Riopelle nature reserve is an important migratory stopover for waterbirds such as dabbling ducks. The forest ecosystem further inland, due to its location in the main migration corridor for eastern North America, attracts large numbers of birds. Breeding birds found at Pointe aux Pins include Great Horned Owl, Northern Saw-whet Owl and Long-eared Owl.

Plants: The forest, which is composed of sugar maples over 300 years old, also includes Butternut, a tree species designated Endangered in Canada, and six species considered Vulnerable in Quebec. This includes False Mermaidweed, which is restricted to a small number of forested wetlands on islands in the Saint Lawrence. Many species at risk are present on the banks of Pointe aux Pins, including Victorin's Gentian, Victorin's Water-hemlock and Parker's Pipewort, designated Threatened by the Quebec government, and Victorin's Gentian and Victorin's Water-hemlock, designated Threatened and Special Concern, respectively, by the Canadian government. This group of plants, along with about 10 other species, is endemic to the freshwater and brackish-water portions of the St. Lawrence Estuary, meaning that they are not found anywhere else in the world.

Threats: Recreational and tourism activities

B-10. Milieu naturel de conservation volontaire de Port-au-Saumon [Port-au-Saumon natural voluntary conservation environment]

Area: 84.83 ha

Year created: 1968

Portion of the St. Lawrence: Estuary

General comments: One of the core areas of the Biosphere Reserve of Charlevoix, the Port-au-Saumon natural voluntary conservation environment is home to the Centre écologique de port-au-saumon, a discovery hub for the Saguenay–St. Lawrence Marine Park owing to the exceptional protected environment that it represents.

Habitats: Deciduous, mixed and coniferous forests; fens; terrestrial riparian habitats and intertidal marshes

Wildlife: Previous wildlife surveys have identified 39 mammal species, 70 bird species, 7 amphibian species, 3 reptile species, 14 fish species, 128 insect species and 45 marine invertebrate taxa.

Plants: A number of forest stands in this protected area are dominated by intolerant hardwoods, including trembling aspen–red maple–balsam fir stands, balsam poplar stands, white birch–balsam fir stands and red maple–balsam fir stands. There are also various pine forests, including a jack pine–*Cladonia* lichen stand and a red pine stand. Several stands of Black Spruce have also been observed here. A few Eastern white-cedar stands and balsam fir–white birch stands complete the forest portrait. A small fen, which partially dries out in summer, is also present. The portion of the shoreline not subject to daily tides is dominated by Sweet Gale and Hooker's Iris, despite the frequent outcroppings of bare rock in this area. The high marsh features Chaffy Sedge, Scotch Lovage, Red Fescue, Slender Wildrye, Baltic Rush, Creeping Bentgrass, Tall Mannagrass, Seaside Plantain and Common Silverweed. In the low marsh, Sea Milkwort, Hoppner's Sedge, Saltmarsh Sedge, Seaside Arrowgrass, Seaside Buttercup and Red Bulrush grow mainly in fine-grained muddy sediments, eventually giving way to green algae, brown algae and then red algae farther from land.

Threats: Climatic changes (water levels), erosion caused by recreational and commercial navigation, coexisting conservation and recreational uses, and logging and farming activities that ceased in the 1940s and 1950s

B-11. Estuary Islands NWA

Area: 404 ha

Year created: 1986

Portion of the St. Lawrence: Estuary

General: N/A

Habitats: The NWA is composed of rocky islands covered with Balsam Fir, White Birch, White Spruce and herbaceous vegetation. The islands are surrounded by large mudflats or rocky flats occupied by mixed algal communities.

Plants/wildlife: One hundred or more species of birds visit the NWA, a large proportion of which also nest there. In addition, the islands are home to nearly a dozen mammal species. Species at risk that frequent the NWA and its surroundings include Peregrine Falcon, Red Knot and Barrow's Goldeneye. The NWA also hosts large colonies of seabirds that are highly sensitive to human disturbance, such as Common Eider, Razorbill, Black Guillemot, Great Blue Heron, Black-crowned Night Heron, Black-legged Kittiwake, Double-crested Cormorant, Great Black-backed Gull and Herring Gull. The Common Eider colony on Bicquette Island consists of more than 7,000 breeding pairs, making it one of the largest colonies of the species in North America. Some islands in the NWA host the largest colonies of Razorbills and Black Guillemots in the St. Lawrence Estuary. During migration, many waterfowl species frequent the islands, surrounding flats and adjacent waters, and sometimes can be observed in the hundreds or thousands, including Brant, Snow Goose, Black Scoter, Surf Scoter, Long-tailed Duck

and American Black Duck. The most common mammals in the NWA are Muskrat, Red Fox, Snowshoe Hare, Grey Seal and Harbour Seal.

Threats: The Estuary Islands NWA faces a number of threats and management challenges, including wildlife diseases, disturbance of colonial birds by predators and human activities, the presence of invasive alien plant species and the risk of accidental oil spills in the St. Lawrence.

B-12. Réserve de biodiversité de l'Île-aux-Lièvres [Île-aux-Lièvres biodiversity reserve] [proposed]

Area: 1,063 ha

Year created: 2013

Portion of the St. Lawrence: Estuary

General comments: Île aux Lièvres is located across from Rivière-du-Loup and is over 13 km long and up to 1.6 km wide.

Habitats: The shoreline is made up of long sandy beaches, rocky coves and vast tidal flats exposed at low tide. Closed-canopy forest covers around 75% of the island.

Wildlife: The site is of major significance for coastal and marine wildlife. Every spring, thousands of birds, including Razorbills, Common Eiders, Common Murres, Black Guillemots and Black-legged Kittiwakes, come there to nest. With the exception of the occasional presence of the Red Fox, the only terrestrial mammals inhabiting the island are Snowshoe Hare, Muskrat, Meadow Vole and Deer Mice. The Little Brown Myotis also occurs here. The flats are very popular with the wildlife of the Estuary, and provide important brood-rearing habitat for the Common Eider and spawning grounds for Herring, in addition to being widely used by Grey Seals and Harbour Seals.

Plants: Following intensive logging in the 1950s, the forest is now dominated by *Populus* spp. (Trembling Aspen and Balsam Poplar) and Balsam Fir. It has a dense shrub understory, with Canada Yew, Red-osier Dogwood and Squashberry forming impenetrable thickets in some areas.

Threats: Camping, vacationing, hiking and recreational activities

B-13. Baie de l'Isle-Verte NWA

Area: 569 ha

Year created: 1980

Portion of the St. Lawrence: Estuary

General comments: N/A

Habitats: The L'Isle-Verte marsh is one of the largest cordgrass marshes in southern Quebec. It is recognized as a Wetland of International Importance under the Ramsar

Convention. Although the NWA includes only part of the marsh, it forms an important buffer zone between the marsh and human activity to the south. Along with its adjacent areas, the NWA is one of the most important nesting sites in Quebec for the American Black Duck. The NWA is primarily composed of patches of Black Spruce forest, cordgrass marshes, swamps, farmlands and wildlands.

Plants/wildlife: The diverse habitats help to support the year-round presence of a large number of animal species. Over 100 bird species have been recorded in the NWA, many of which potentially breed there. The NWA is also home to numerous species at risk, such as the Peregrine Falcon, Short-eared Owl, Bobolink and Nelson's Sparrow. Thousands of migratory birds stop here every spring and fall, including the Greater Snow Goose, Canada Goose, American Black Duck, Green-winged Teal, Northern Pintail, Common Eider and scoters. Shorebirds such as the Dunlin, Semipalmated Sandpiper and Least Sandpiper are also abundant during migration. The NWA is also home to the Hoary Bat, a species at risk. Other mammal species include the Snowshoe Hare, North American Porcupine, North American Red Squirrel, Woodchuck, Red Fox, Muskrat and American Mink.

Threats: The NWA faces a number of threats and management challenges, including development in adjacent areas, land drainage, the presence of invasive alien species and the risk of oil spills in the St. Lawrence.

B-14. Parc national du Bic [Bic provincial park]

Area: 3,320 ha

Year created: 1984

Portion of the St. Lawrence: Estuary

General comments: Located approximately 15 km from Rimouski, Bic provincial park protects both terrestrial and marine environments. The marine portion of the park comprises several bays that are highly exposed at low tide, revealing numerous boulders. The terrestrial portion of the park comprises rocky islets of varying sizes and elevations, all following the same northeast to southwest alignment. Most of these islets are now connected to the mainland by tombolos, offshore bars formed by sediment deposition due to coastal processes. Pic Champlain, the park's highest summit, rises to 346 m on a massif that forms a barrier between the river and the mainland.

Habitats: The park is characterized by a wide range of habitats, from forests to salt marshes, and therefore has a rich diversity of plants and wildlife.

Wildlife: The park is located in the migration corridor used by most raptor species in eastern Quebec. It also hosts large colonies of seabirds, including a Common Eider colony, one of the most abundant species in the Estuary. The park's haul-out sites are used by many of the seal colonies that feed in the area. Moreover, the park is home to the highest concentration of North American Porcupines on the continent.

Plants: The park contains some 700 species of vascular plants, about one third of Quebec's total. This diverse vegetation is due to the presence of a variety of unique environments. The cliffs exposed to wind and sea spray are ideal for subarctic and

alpine-arctic plants, while the sandy shores of bays are home to wild roses, including two species not found elsewhere in the region. It also contains cordgrass marshes, peat bogs, different types of forest, Rivière du Sud-Ouest and Lac à Crapauds. Approximately 15 of these plant species are at risk and have special status in Quebec.

Threats: Coastal erosion and recreational and tourism activities

B-15. Pointe-au-Père NWA

Area: 22 ha

Year created: 1986

Portion of the St. Lawrence: Estuary

General comments: N/A

Habitats: The NWA features a cordgrass marsh dotted with brackish ponds and shielded from the St. Lawrence by a rocky point. The Sainte-Anne River crosses the marsh from east to west, through a variety of habitats, including an area of brackish ponds colonized by Saltmeadow Cordgrass and Smooth Cordgrass, as well as eelgrass beds and salt meadows with sedges and grasses, bordered by Sweet Gale and other shrubs.

Plants/wildlife: The NWA is part of a small network of bird staging areas that run the length of shorebird migration routes. More than 120 bird species regularly visit the site, and some 15 species nest there. Species at risk, such as the Peregrine Falcon, are occasionally observed.

In the spring, flocks of Least Sandpipers, sometimes made up of more than 500 individuals, congregate at the site. Birds that feed in the marshes include Great Blue Herons, Black-crowned Night Herons and large flocks of geese. In the summer, many birds raise their young and feed on the abundant invertebrates in the small brackish ponds, including the American Black Duck, Mallard, Northern Pintail and Green-winged Teal. During fall migration, the most common species are Red-throated and Common loons. At that time of year, a large number of Canada Geese are also present. Large flocks of Sanderlings, Semipalmated Sandpipers and White-rumped Sandpipers also use this site. Some 10 mammal species are found in the NWA, including Muskrat, Masked Shrew, Meadow Jumping Mouse and Meadow Vole.

Threats: Despite its small size, the Pointe-au-Père NWA faces a number of threats that could potentially undermine its ecological integrity, such as nearby urban and industrial development, disturbance caused by human activity, wastewater contamination and the risk of oil spills associated with marine transportation.

B-16. Parc nature de Pointe-aux-Outardes [Pointe-aux-Outardes nature park]

Area: 100 ha

Year created: 1990

Portion of the St. Lawrence: Estuary

General comments: The Pointe-aux-Outardes nature park is located in the municipality of Pointe-aux-Outardes. Bordered by the vast flats and sandbars of the Battures de Manicouagan and the Batture aux Outardes, this park has been designated a natural voluntary conservation environment.

Habitats: This nature park offers a unique blend of biodiversity, with a range of diverse ecosystems, ranging from boreal forest, peat bogs and alder thickets, to flats, sandbars, sand dunes and beaches. The dunes are made up of sandy alluvial deposits from the river that have accumulated over thousands of years through wind transport, long-shore drift and other processes. These dunes form the core of the Pointe du Bout spit. The nature park lies adjacent to the largest salt marsh on the North Shore, which is part of the proposed Manicouagan aquatic reserve.

Wildlife: The proposed Manicouagan aquatic reserve is home to a Black-crowned Night Heron colony, as well as haul-out sites important for Harbour Seal and Grey Seal breeding, rearing and feeding. It also serves as a key spring and fall staging area for some 500,000 birds (waterfowl, birds of prey, aquatic species, etc.). Approximately 244 bird species have been recorded in the area. The Yellow Rail, a species designated as Threatened, has also been observed.

Plants: The proposed Manicouagan aquatic reserve is also home to the largest remaining eelgrass beds in North America (covering an area of 15 km²). In addition, Woolly Beach-heather, a species likely to be designated Threatened or Vulnerable, has been recorded in the area.

Threats: Camping, vacationing, hiking, and recreational and tourism activities

B-17. Pointe de l'Est NWA

Area: 524 ha

Year created: 1978

Portion of the St. Lawrence: Gulf

General comments: N/A

Habitats: The NWA features a wide diversity of habitats, including red sandstone outcrops, fixed and mobile dunes covered by fragile patches of beach grass, crowberry heaths, salt meadows, coniferous forests, marshes, and brackish and saltwater ponds.

Plants/wildlife: The NWA is currently home to more than 150 bird species and roughly 10 mammal species. During nesting periods, the site's open areas provide suitable habitats for colonial birds and other species, including the American Black Duck, Northern Pintail, Red-breasted Merganser, Greater Scaup, Herring Gull, Great Black-backed Gull and Black-headed Gull. Other species use the forest environments, such as Ruby-crowned Kinglet, Red-breasted Nuthatch, Rusty Blackbird, Blackpoll Warbler, Magnolia Warbler and Fox Sparrow. Two species at risk breed in or near the NWA: the Horned Grebe nests on the edges of ponds in the NWA and the Piping Plover nests on

the sandy shores surrounding the NWA. Numerous shorebird species are observed during fall migration, including Black-bellied Plover, Sanderling and Greater Yellowlegs. Mammals present in the NWA include the Red Fox and Coyote.

Threats: The NWA faces a number of threats and management challenges, including impacts caused by motorized vehicle traffic and the risk of accidental spills associated with marine transportation.

Appendix C

Example of a methodology guide for an indicator

Indicator	Acoustic bird survey in wetlands and forests
Method	Multi-species acoustic surveys



■ SUMMARY

Protected areas	All protected areas
Monitoring frequency	Every 3 years
Monitoring period	Early June
Index or unit measured	Species presence/absence
Project type	Recorded acoustic survey
Contact	Anouk Simard, MELCCFP

■ DESCRIPTION

In general, birds are excellent indicators of the ecological integrity of ecosystem (Morrison 1986). Their high detectability and their use of almost all types of terrestrial habitats have led to the establishment of numerous monitoring programs and the creation of extensive databases. These data were used as the basis of a recent study revealing a major decline of almost 29% in North American avifauna since 1970, representing a net loss of 3 billion birds (Rosenberg et al. 2019). The families of birds affected include New World sparrows and wood warblers. The main cause of this decline is the loss of habitat essential to birds' survival.

The mission of the National Wildlife Areas (NWAs), as well as other protected areas along the St. Lawrence River, reflects this context. These areas protect important habitats for a large number of bird species, which use them as migratory stopovers or as nesting habitat. Together, the protected areas of the St. Lawrence contain a variety of habitats for a large number of species that use them to reproduce. Monitoring birds in wetlands and forests will make it possible to track changes in breeding populations in these areas.

■ FREQUENCY AND MONITORING PERIOD

Surveys are carried out every three years, at the beginning of June. The sampling periods chosen when programming the device are based on the peaks in bird activity over 24 hours. The automated recording device must be programmed to record for 15-minute periods every hour between 4 a.m. and 8 a.m., and for 15-minute periods every two hours between 7 p.m. and 3 a.m., as specified in MELCCFP's multi-species acoustic survey protocol (Dubé 2019).

■ SAMPLING PLAN

The automated recording devices (also known as automated recorders or autonomous recording units, or ARUs) should be installed in locations visited unfrequently by others, as the equipment used is expensive and steps must be taken to ensure that it is not stolen. In addition, the stations must be located at least 200 m from main roads, in order to avoid vehicle noise in the recordings. It is also important to avoid locations close to high-voltage power lines and airports (stations should be positioned more than 200 m from these sites).

The stations must be located on relatively dry ground to prevent the equipment from being submerged in water. Secondly, the device must be installed in a low grove of vegetation to camouflage it. Stations in wetlands must be positioned in an open area (i.e., over 20 m from the forest edge) that is close to the water (i.e., less than 200 m away). In forested areas, stations should be located in a more open area of the forest, as forest cover that is too dense would obstruct sounds.

A total of two to three recording stations could be installed per protected area.

■ FIELD SURVEYS

Recordings with Song Meter SM3BAT

Automated recording devices such as the Song Meter SM3BAT automated recorder (Wildlife Acoustics, 2015, USA) are programmed in advance using specially designed configuration software (e.g., SM3 Configurator from Wildlife Acoustics). This software allows you to set the desired parameters and to ensure error-free programming. The parameters to be programmed include:

- Sampling schedule. The device must be programmed to record every other day. These units will also be used for the bat surveys, but, in general, cannot record acoustic (audible) bird sounds and bat ultrasounds simultaneously, hence the compromise of one day for acoustic and one day for ultrasound recording.
- Sampling periods (see **Frequency and Monitoring Period**)
- The [sampling rate](#) for acoustic recordings must be greater than 24,000 samples/second for good sound quality.

A 32-GB SD memory card is used to transfer the software programs to the automated recording device. The same card is then used to store the recordings and associated data.

Next, the device is installed at the intended sampling station and connected to a solar panel to enable recording over a long period. The exact location of the recorder is saved in a GPS, photos of the site are taken, and the station installation form is completed. In forested areas, the microphones should be pointed towards the most open spot and, in wetlands, towards the nearest water. Microphones must be securely attached to prevent them from falling and to withstand strong winds. Aluminum tape can be applied to cables accessible to squirrels, to prevent them from being chewed

At the end of the season, the device is removed and the data stored on the SD card are saved to a computer.

Recordings with the Song Meter Mini Bat (SMMB)

Automated recording devices such as the Song Meter Mini Bat (SMMB; Wildlife Acoustics, 2020, USA) are programmed in advance using the specially designed configuration software (e.g., Song Meter Mini Configurator). This software allows you to set the desired parameters and to ensure error-free programming. The main parameter to be programmed is:

- Unlike the SM3BAT, the Song Meter Mini Bat does not support alternate-day recording. Although 10 recording blocks are available and can be programmed, simultaneous recording with acoustic and ultrasonic microphones is not possible. The 10 recording blocks can be spread over 24 hours. Table 2 shows a sample configuration of the Song Meter Mini Bat's recording blocks.

Table 1. Song Meter Mini Bat recording blocks

Start time	At SRIS (-00:30)	At Time (12:00)	At SSET (-00:30)	At SSET (+00:30)	At SSET (+01:00)	At SSET (+01:30)	At SSET (+03:30)	At SSET (+04:00)	At SSET (+05:45)
End time	At SRIS (+02:00)	At Time (12:30)	At SSET (+00:30)	At SSET (+01:00)	At SSET (+01:30)	At SSET (+03:30)	At SSET (+04:00)	At SSET (+05 :00)	At SSET (+06:45)
Duration (min)	150	30	60	30	30	120	30	60	60
Type	Acoustic	Acoustic	Acoustic	Ultrasound	Acoustic	Ultrasound	Acoustic	Ultrasound	Ultrasound

A class-10 256-GB SD memory card is used to transfer the software programs to the automated recording device. The same card is then used to store the recordings and associated data.

The unit is then installed at the intended sampling station, and the condition of the batteries is checked (as it should be at every subsequent visit). AA lithium batteries are used. The exact location of the recorder is saved in a GPS, photos of the site are taken and the station installation form is then completed. In forested areas, the microphones should be pointed towards the most open spot and, in wetlands, towards the nearest water. Microphones must be securely attached to prevent them from falling and to withstand strong winds. Aluminum tape can be applied to cables accessible to squirrels, to prevent them from being chewed.

At the end of the season, the device is removed, and the data stored on the SD card are saved to a computer.

■ EQUIPMENT LIST

Table 2. Equipment required for bird surveys

SM3BAT (2015)	SMMB (2020)
SM3 Configurator software	Song Meter Mini Configurator software
SM3BAT automated recorders	SMMB automated recorders
Acoustic microphone with 3-m cable	Formatted 256-GB SD (class 10) memory card
Installation tools (drill, hammer, etc.)	Four AA lithium batteries
Wooden stakes, dark brown paint, plywood, and nuts and bolts for installation	Acoustic Microphone Stub for Mini family
Glue	Installation tools (drill, hammer, etc.)
Bungee cord or strap	Wooden stakes, dark brown paint, plywood, and nuts and nails for installation
Electrical and aluminum tape	
External power cable	
Formatted 32-GB SD (class 10) memory cards	
Batteries / solar panel	Tie wraps
Song recognition software	Velcro
DBH tape, or measuring tape and string	DBH tape, or measuring tape and string
Vegetation description form (one per station)	Vegetation description form (one per station)
Pencils, eraser	Pencils, eraser
Vegetation identification guide	Vegetation identification guide

■ DATA PROCESSING

The recordings are in WAC format. This type of format creates compressed files, enabling more files to be stored on the SD card. Once the files have been transferred to a computer, they are converted to WAV format using software such as WAC2WAV (available free of charge at the following website: <http://eagle.wildlifeacoustics.com/downloads/#wac2wav>). Someone then listens to the recordings and notes the species heard and the type of vocalization (song or contact call). Once identified, the vocalization of an individual bird (song or call) confirms the presence of the species at the station.

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