Ecological Monitoring Program for National Wildlife Areas in Quebec

Volume 1 - Program Overview

Environment and Climate Change Canada
Canadian Wildlife Service
Québec Region

July 2017

Canada

www.planstlaurent.qc.ca

Québec

This document should be cited as follows:

Canadian Wildlife Service. 2017. Ecological Monitoring Program for National Wildlife Areas in Quebec. Volume 1 - Program Overview. Environment Canada, Canadian Wildlife Service, Québec Region. Unpublished report. 76 p. and appendices.

Cover photos: © Thinkstockphotos

Published by Authority of the Ministre du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques du Québec

Cat. No. : CW66-539/1-2016E-PDF
ISBN : 978-0-660-06836-7

Aussi disponible en français sous le titre :

Programme de surveillance écologique des réserves nationales de faune du Québec. Volume 1 - Présentation du programme

Production Team

Canadian Wildlife Service

- Benoît Jobin
- Benoît Roberge
- Sylvain Giguère
- Stéphanie Gagnon
- Marielou Verge
- Stéphane Turgeon

External collaborators

- Jacques Jutras (Ministère des Forêts, de la Faune et des Parcs)
- Anouk Simard (Ministère des Forêts, de la Faune et des Parcs)
- Suzan Dionne (Parks Canada Agency)

Acknowledgements

We would like to thank the staff of the Canadian Wildlife Service and the Science and Technology Branch of Environment Canada for their suggestions and advice at various stages in the indicator selection process:

Matthieu Allard, Yves Aubry, Luc Bélanger, Simon Bourbeau, Louise Champoux, Diane Dauphin, Bruno Drolet, Patrick Labonté, Christine Lepage, Stéphane Légaré, Jean-François Rail, Daniel Robitaille, Jean Rodrigue, and François Shaffer. We would also like to thank our external partners and collaborators for their sound advice on indicator selection and for their participation in the workshop on ecological monitoring programs : Jean Bachand (Baie de L'Isle-Verte National Wildlife Area), Stéphane Campeau (Université du Québec à Trois-Rivières), Sylvie Comtois (City of Montréal), Isabelle Desjardins (MFFP), Suzan Dionne (PCA), Yohan Dubois, (MFFP), Jean-François Giroux (Université du Québec à Montréal), Patrick Graillon (Parcs Québec – Sépaq), Jacques Jutras (MFFP), Michel Lepage (RMN), Lyne Pelletier (MDDELCC), Nathalie Rivard (Sépaq - parc national des Îles de Boucherville), Claude Samson (PCA), Anouk Simard (MFFP), Isabelle Simard (MDDELCC), and Christie Spence (NCC).

MDDELCC : Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques

MFFP : Ministère des Forêts, de la Faune et des Parcs

NCC : National Capital Commission (Gatineau Park)

PCA : Parks Canada Agency

RMN : Réseau des milieux naturels protégés

Sépaq: Société des établissements de plein air du Québec

Abstract

The purpose of ecological monitoring is to assess ecosystem components on a regular basis to detect changes that may be occurring, establish a diagnosis and take action to ensure the continuing integrity and viability of the ecosystems and their components. Most of the protected area networks in Canada have implemented ecological monitoring programs in recent years. Following their lead, the Canadian Wildlife Service – Quebec Region (CWS-QC) has developed an ecological monitoring program to monitor the state of the national wildlife areas (NWAs) in Quebec for which it is responsible, in order to protect their natural attributes.

First, a literature review and an analysis of the major existing ecological monitoring programs in North America, and more specifically those in place along the St. Lawrence River, were carried out to identify the key elements that should be included in the ecological monitoring program for NWAs. A preliminary suite of ecological indicators and methodologies was then selected. The indicators were categorized according to four themes associated with the conservation of the NWAs and the mandate of the CWS: Ecosystems, Pressures/Threats, Biotic Communities, and Species at Risk. Furthermore, to ensure coverage of the avifauna present in the NWAs, indicators corresponding to the four bird groups defined by the North American Bird Conservation Initiative (NABCI)—landbirds, waterfowl, waterbirds and shorebirds—were selected. Lastly, a workshop was held to discuss the selected indicators with experts from organizations that have developed ecological monitoring programs and to obtain their input and advice on the implementation of a monitoring program in the NWAs.

This document provides an overview of the progress made by CWS-QC towards the development of an ecological monitoring program for NWAs in Quebec. It describes the stages in the development of the program, the indicators selected and the methodologies proposed. This monitoring program will be refined over time as new information is gathered, particularly with regard to survey methodologies and protocols.

The implementation of the monitoring program in the NWAs will make it possible to identify the management and protection measures that should be taken when warranted. Furthermore, the monitoring program for the NWAs, all of which are located along the St. Lawrence River, will complement the existing programs and will form an overarching monitoring program for all of the ecosystems along this vast river system.

This document is the first of two reports on the development of a monitoring program for NWAs in Quebec. This document describes the stages in the development of the program, the indicators selected and the methodologies proposed. The second related document, concerning the implementation of the ecological monitoring program for NWAs in Quebec, will provide details on the sampling strategies, work schedule, estimated costs, identification of implementation mechanisms, suggested statistical analysis methods, establishment of thresholds (desired condition) for each indicator, and reporting mechanisms.

Table of Contents

List of tables and figures

List of figures

1. Introduction

Canada has several types of protected areas which were established with the primary objective of conserving natural environments and maintaining biodiversity. Some of these protected areas are managed by various levels of government (federal, provincial, municipal); while others were created by conservation groups (e.g. Nature Conservancy of Canada). Nationally, the federal government is responsible for managing a number of protected areas, the best known being national parks. Other types of protected areas owned or managed by federal institutions with the primary objective of conserving natural environments and maintaining biodiversity include national wildlife areas (NWAs) and migratory bird sanctuaries (MBSs; Environment Canada[1], 2015a).

The creation of protected areas has always been the preferred method of protecting living species. However, the mere act of protecting a space appears to be insufficient to ensure the viability of wildlife populations, owing to the small area occupied by these spaces or the pressures that exist within or around them. Since sound management of protected areas and their ecosystems must be based on credible information, it is essential to have or to acquire basic knowledge of the biological resources and environments found within the protected areas and the ecological processes associated with the ecosystems. Furthermore, knowledge of the pressures and threats that are faced by wildlife species and their habitats and that can affect their viability is crucial for detecting negative trends in specific populations. The rationale for the management actions that should be taken when warranted can thus be based on accurate, credible information.

The traditional role of NWAs and MBSs is to protect important habitat for certain wildlife species, especially migratory birds. However, similar to national parks, the ecological integrity of these protected areas is threatened by various pressures. The implementation of an ecological monitoring network with appropriate indicators is the approach adopted to assess changes that may occur in the ecosystems of Canada's national parks and to evaluate the effectiveness of the management measures put in place (Woodley, 1993). Until recently, however, no such ecological monitoring network had been implemented for NWAs (or MBSs). In this document, the Canadian Wildlife Service – Quebec Region (CWS-QC) presents an overview of the ecological monitoring program for NWAs in Quebec. This document describes the stages in the development of the program, the indicators selected and the methodologies proposed. A second document concerning the implementation of the ecological monitoring program for NWAs in Quebec is currently being prepared. It will provide details on the sampling strategies, work schedule, estimated costs, identification of implementation mechanisms, suggested statistical analysis methods, establishment of thresholds (desired condition) for each indicator, and reporting mechanisms.

1. "Environment Canada" is used in this document to refer to the Department currently called Environment and Climate Change Canada (2016).

2. Ecological monitoring

2.1 Definition

"Environmental monitoring" describes the processes and activities that need to take place to characterise and monitor the quality of the environment (Wikipedia, 2016). In the same vein, the term "ecological monitoring" means assessing various ecosystem components on a regular basis to detect changes that may be occurring, establish a diagnosis, and take action to ensure the continuing integrity and viability of the ecosystems and their components.

There are several different kinds of monitoring programs, each with its own objective: environmental monitoring programs, monitoring programs focusing on one species or group of species, biodiversity monitoring programs, and ecological monitoring programs designed for protected areas (Lepage, 2012). All have the same basic goal: to detect changes and trends over time in the variables of interest, whether these are abiotic variables, demographic trends in wildlife or plant populations, biological diversity, or measurements associated with anthropogenic threats or pressures that could alter the condition of ecosystems. The area covered can range from a single habitat (e.g. a marsh) to an entire ecoregion or province.

2.1 Selection of indicators

Monitoring programs are based on the use of indicators, which can be defined as follows:

> *Indicator: Variables whose purpose is to measure change in a given phenomenon or process. They have three main functions: simplification, quantification and communication.* (Hazel et al., 2006)

With respect to ecosystems, 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 (National Park Service, 2014). Indicators are used to monitor the condition of the characteristics of an environment, whether these consist of biophysical components or the anthropogenic activities and pressures that may be affecting this environment. An indicator serves as an evaluation and decision support tool that provides a relatively objective measurement of a situation or trend.

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. Atkinson et al. (2004) created a table summarizing the characteristics of good monitoring indicators (Table 1).

That is the approach used in recent decades to develop and implement many monitoring programs around the world for the purposes of indicator-based monitoring of protected areas. North America has the Vital Signs Monitoring program, which was developed by the United States National Parks Service and deployed in more than 270 national parks (Fancy et al., 2009), and the Ecological Integrity Monitoring Program for Canadian national parks, which was launched by the Parks Canada Agency in 2005. As of 2010, all 42 national parks in Canada had identified key ecological integrity indicators. Of the

42 parks, 29 had determined the condition of these indicators, and 24 of those 29 had identified their trends (Parks Canada Agency 2010).

In Quebec, provincial parks in the Parcs Québec network have also been subject to ecological integrity monitoring (Ecological Integrity Monitoring Program or EIMP) since 2004 (Sépaq, 2014). Lepage (2012) summarizes the main monitoring programs in place in North America that include indicators of interest to the establishment of a monitoring program for NWAs in Quebec, while Lepage (2013) provides an in-depth analysis of existing ecological monitoring programs in protected and other areas along the St. Lawrence River (see section 7.2).

Table 1. Characteristics of a good monitoring indicator (Atkinson et al. 2004).

Relevant to Management
* Relevant to program goals and objectives; can assess program performance * Relevant to adaptive management process * Appropriate spatial scale * Appropriate temporal scale
Scientifically Defensible
* Biologically pertinent, reflects status and dynamics of system under management * Sufficient scientific basis, supported by published scientific findings or conceptual models
Statistically Powerful and Interpretable
* Directly related to the ecosystem component it is intended to represent or is an acceptable surrogate * Sensitive to changes in the ecosystem component it represents * Indicates cause of change as well as existence of change * Timely, relevant to management timeframe * Anticipatory, serves as an early warning of change * Responsive across necessary range of stress, i.e., provides continuous assessment over wide range of stress (does not “level off”) or complements other monitoring variables to achieve necessary range * Known statistical properties, with baseline data, reference or benchmark available
Measurable and Feasible
* Technically feasible; measurable using standard methodologies * Accurate and precise, with low observer variability and bias * Cost effective * Low impact to system being monitored * Low risk to field personnel * Coordinated with Existing Programs
Coordinated with Existing Programs and Data Sets
* Compatible with already existing monitoring programs’ data collection, or could be modified to be so * If data exist, they are obtainable, preferably as long-term data sets
Easily Understood
* Simple, direct * Communicable, easily interpreted and explained * Documented; methodology supported by complete standard operating procedures

3. Environment Canada National Wildlife Areas

The National Wildlife Areas of Environment Canada (EC) are part of a vast network of protected areas in Canada that also includes national parks, provincial parks, regional parks, and the many other types of habitat conservation areas, such as those managed by non-government conservation groups. The objectives targeted by each of these protected areas complement one another; national parks are generally dedicated to the protection of large ecosystems and natural landscapes, while NWAs are established to protect unique habitats in order to support wildlife, primarily critical habitat for certain bird species during migration.

There are eight NWAs in Quebec, which protect a total of 5,524 ha of habitat (Figure 1, Table 2). These areas were established to protect extremely high-quality natural environments that provide breeding and staging grounds for waterfowl and other bird species. The protection conferred on these areas also benefits a wide range of other animal and plant species, some of which are designated species at risk in Canada or Quebec (Environment Canada, 2015a).

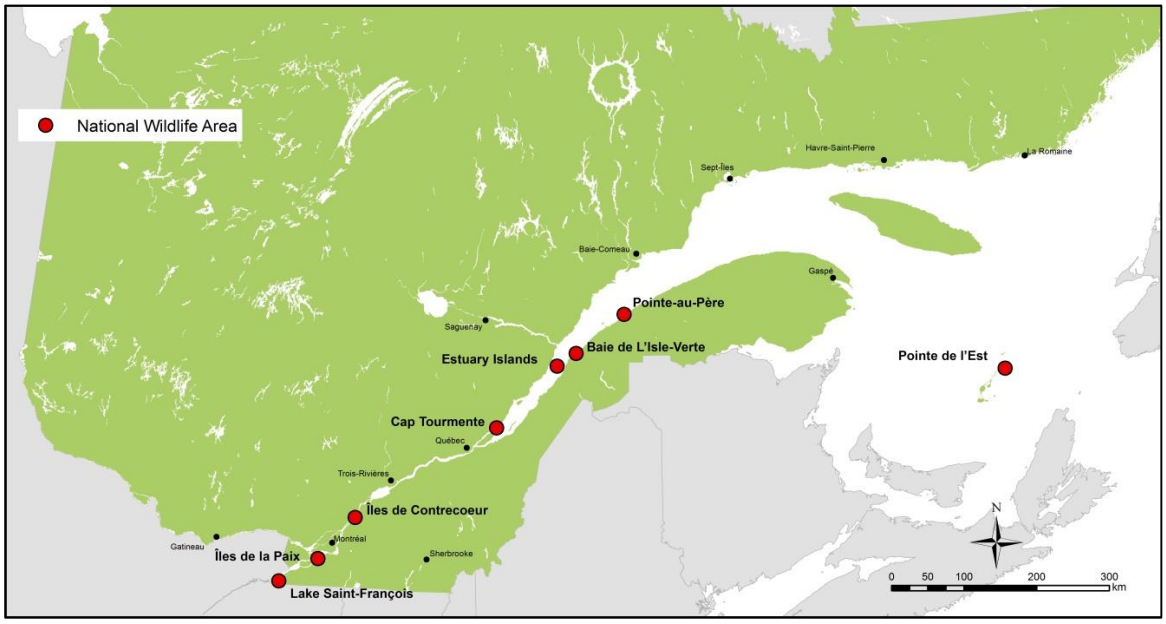

Figure 1. Locations of the eight NWAs in Quebec.

Table 2. Brief description of the eight NWAs in Quebec.

NWA	Year established	Area (ha)	Purpose	Primary Habitats
Lake Saint-François*	1978	1,316	To protect unique wetlands harbouring exceptionally diverse fauna and flora	Marshes, swamps, woodlands, open areas, rivers and streams
Îles de la Paix	1977	129	To protect wetlands for waterfowl breeding and staging	Forested swamps, wet meadows, marshes
Îles de Contrecœur	1981	298	To protect grassbeds and marshes for waterfowl breeding	Grassbeds, marshes, shrub swamps, old fields
Cap Tourmente*	1978	2,308	To protect the bulrush marsh for Greater Snow Goose	Forest, farmland, intertidal marshes

Estuary Islands	1986	404	To protect breeding grounds for colonial birds and Common Eider	Rocky and forested islands, foreshores
Baie de L'Isle-Verte*	1980	322	To protect the *Spartina* marsh for American Black Duck	Farmland, intertidal marshes, woods, swamps, peatland
Pointe-au-Père	1986	22	To protect habitats for migratory birds, including shorebirds	Salt marsh, herbaceous meadow
Pointe de l'Est	1978	724	To protect habitats for migratory birds and breeding grounds for species at risk	Dunes, crowberry heath, ponds, marshes, peatland, forest

* Designated as a Ramsar site (http://www.ramsar.org).

Each NWA faces different threats to habitat and anthropogenic pressures. For example, the Lake Saint-François, Cap Tourmente and Baie de L'Isle-Verte NWAs are located in areas where agricultural activities may affect the quality of the habitats they contain. The Îles de la Paix and Îles de Contrecœur NWAs, meanwhile, are located on the banks of the St. Lawrence and are therefore vulnerable to shoreline erosion, which substantially affects the integrity of natural habitats. Specific indicators will therefore have to be selected in order to monitor the status of the most significant threats to each NWA and identify potential impacts on ecosystems and wildlife communities.

4. Why establish a monitoring program for NWAs in Quebec?

Many concurrent factors led to the establishment of a monitoring program for NWAs in Quebec. First, the implementation of programs for monitoring the integrity of protected areas by organizations across Canada and around the world has highlighted the importance of these programs for ensuring sound management of protected areas. It became clear that a program of this nature was needed for the NWA network. An action plan for assessing and monitoring the ecological integrity of the NWAs was produced (Jobin, 2002) to analyze existing knowledge of the various components of the NWAs (communities, ecosystems, threats) so that an indicator-based monitoring program could be implemented. A number of steps proposed in this action plan were subsequently achieved by preparing a conservation plan for each NWA in Quebec (SCF 2003-2005). These conservation plans provide a detailed summary of knowledge on the biotic communities, habitats, pressures and threats affecting the NWAs, as well as a preliminary list of indicators that could be used in an ecological monitoring program for the NWAs.

The above-mentioned review of biological data on the NWAs highlighted gaps in our knowledge of the distribution and abundance of a number of taxonomic groups, some of which (e.g. chiropters, anurans) had never been the focus of specific surveys. The adoption of the *Species at Risk Act* (SARA) in 2003 also led to an increased interest in updating our knowledge of the importance of NWAs in supporting the populations of various species at risk. A program for surveying wildlife and plant communities was launched with partners in the provincial government for a number of protected areas in southern Quebec. More than 31 areas, including the 8 NWAs in Quebec, were covered by targeted surveys conducted between 2004 and 2009. The results of these surveys updated our knowledge of the wildlife and plant species found in the NWAs and provided

a solid foundation on which to base a monitoring program for the biotic communities in the NWAs.

In addition, CWS-QC is currently updating the management plans for each NWA. These management plans guide decision making on the activities carried out in each NWA with regard to wildlife habitat conservation and enhancement, regulatory enforcement, facility and infrastructure maintenance, and wildlife monitoring. The development of an ecological monitoring program for the NWAs is directly linked to the directions set out in the new NWA management plans.

Since ecological monitoring programs are currently in place in a number of protected areas along the St. Lawrence River, the implementation of a monitoring program in the NWAs, all of which are located along the river, would complement the existing programs. The geographic locations of the NWAs provide an opportunity to gather biological data in parts of the St. Lawrence not currently covered by survey campaigns (Figure 2). Furthermore, the development of a biodiversity monitoring program for protected areas located along the St. Lawrence River is one of the projects included in the biodiversity conservation component of the St. Lawrence Action Plan 2011–2026 (SLAP; http://planstlaurent.qc.ca/en/home.html). The State of the St. Lawrence Monitoring Program (http://planstlaurent.qc.ca/en/state_monitoring.html), which is also part of the SLAP, pools the data collected by various collaborators during their ongoing environmental monitoring activities. This program proposes a suite of 21 indicators representing various components (water, sediment, biological resources, uses, shoreline), several of which have a direct connection to the NWAs. The ecological monitoring program for the NWAs will be able to build on these existing initiatives.

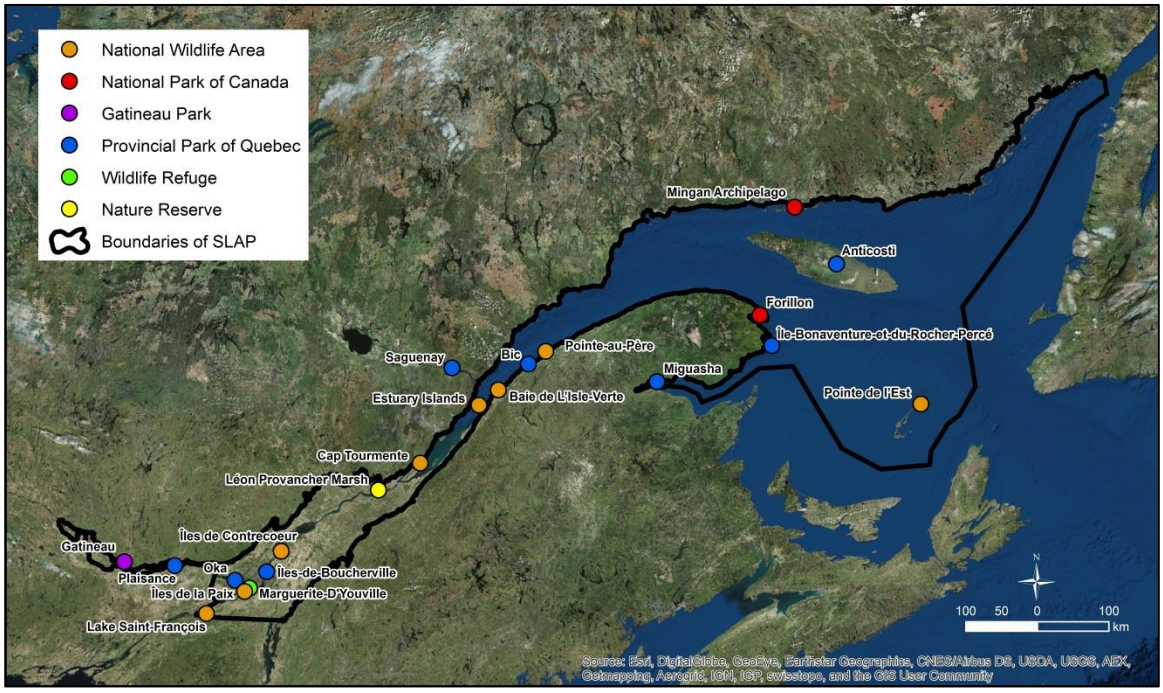

Figure 2. Locations of the NWAs and of the protected areas that have ecological monitoring programs along the St. Lawrence River and its main tributaries.

5. Ecological integrity and ecological monitoring

Generally speaking, the term “ecological integrity” means the degree to which the components and functional processes of the ecosystems present in a natural environment are preserved.

In setting out its mission, the Parks Canada Agency (2000) defines “ecological integrity” as follows:

> *[W]ith respect to an [ecosystem], a condition that is determined to be characteristic of its natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes. (Canada National Parks Act*, section 2(1), October 2000)

Conserving the ecological integrity of a national park means keeping the populations and communities of all of its native animal and plant species at their natural levels of abundance while also maintaining natural regulation processes to the extent possible. The ecological integrity monitoring program developed by Parks Canada therefore seeks to identify indicators that can be used to measure the ecological integrity of various environmental components. The monitoring program developed by Sépaq for provincial parks in Quebec is based on considerations similar to those used by Parks Canada, and its goal is to monitor the ecological integrity of ecosystems based on three attributes: composition, structure and functions (Sépaq, 2014). Measuring ecosystem ecological integrity is a key aspect of both of these monitoring programs.

The NWAs occupy a much smaller area than national and provincial parks do. Whereas the mission of these parks centres on the protection of large ecosystems and natural landscapes, the NWAs were established to protect unique habitats that are vital for supporting the populations of certain wildlife species, primarily critical habitat for certain bird species during migration. Since most of the NWAs in Quebec are small, it is difficult to maintain the ecological integrity of the diverse types of ecosystems they contain because many of the ecological processes occur on a much larger scale (e.g. populations of large predators, insect outbreaks). This objective can be difficult to achieve even in provincial parks, where the desired condition of ecosystems requires that disturbances in areas outside the boundaries of the parks be minimized.

According to Jobin (2002), the “ecological” integrity of NWAs can be defined as follows:

> [translation] *The original characteristics of a protected area as they were when the area was created in order to maintain its native species and biological communities and the physical, chemical and biological condition of the habitats located at this site.*

The purpose of the monitoring program is not to monitor the ecological integrity of NWAs in the strictest sense (as is the case at Parks Canada), but rather to monitor various components of each NWA in order to assess their condition in relation to the purpose of the NWA and its current ability to fulfill that purpose.

6. Purpose and objectives of the ecological monitoring program for NWAs in Quebec

The purpose of the NWA monitoring program is as follows:

> To assess changes in the condition of national wildlife areas in order to ensure sound management and reporting.

The condition of the NWAs refers to their biophysical components and to the anthropogenic pressures and threats that may be affecting their integrity. To consider these factors, four objectives specific to the NWA monitoring program have been set.

Objectives of the monitoring program

1) To assess the stability, degradation or improvement of the **ecosystems** present in the NWAs and of their key **components**.
2) To assess changes in certain **threats** in and around the NWAs.
3) To assess changes in the populations of **species at risk** present in the NWAs.
4) To assess changes in **components representative of biodiversity** present in the NWAs.

Indicators will have to be selected to monitor changes in these four objectives. First, monitoring of the condition of ecosystems is required because ecosystems form the matrix on which wildlife and plant communities are based. For example, monitoring of the rare ecosystems in the NWAs will help determine the role played by these habitats in supporting rare species or specific ecological processes. Indicators to monitor the status of the most significant threats to each NWA should also be selected in order to identify potential impacts on ecosystems and wildlife species. Monitoring of bank erosion or invasive species, for instance, will provide basic information that can be used to take concrete action against these threats.

Although NWAs were established with the purpose of protecting habitats specific to certain species, such as the Cap Tourmente NWA, which was created to protect the bulrush marsh used by Greater Snow Geese[2] during migration, NWAs also play an important role in maintaining various wildlife and plant communities in areas under intense development pressure. Furthermore, many species at risk occur in the NWAs. Periodic monitoring of the presence and abundance of specific wildlife groups that are supported by these protected areas and the species at risk occurring in the NWAs is necessary to ensure their continued presence. Note that monitoring the wildlife groups associated with specific habitats could be more expedient than monitoring the quality of the habitats themselves. For example, it may be more efficient to continue monitoring farmland bird species in the Cap Tourmente NWA in relation to the issue of cultivated

[2] Appendix 5 lists the English and scientific names of the species mentioned in this document.

fields being degraded by intensive browsing by geese than to start a botanical survey program that would require additional, specialized resources.

The selection of indicators related to each of these categories will help NWA managers make informed decisions on the conservation of biological resources and on the threat posed by anthropogenic pressures that can affect the biotic communities present in these NWAs.

6.1 Baseline levels

The purpose of the ecological integrity monitoring program developed by the Parks Canada Agency is to identify indicators for which measurements would be compared with the **baseline levels associated with the "natural" condition** of the environment. Information on, or models of, the original condition of the ecosystems and on the communities originally present must therefore be available. The monitoring program developed by Sépaq for provincial parks in Quebec also seeks to monitor ecological integrity (Sépaq, 2014). However, whereas Parks Canada associates the baseline levels with the "natural" condition of the environment, Sépaq considers the baseline ecological integrity level to be the situation at the time when the monitoring program was first implemented, i.e. year 0 when the first measurements were taken. The goal is therefore to monitor **changes** in the environmental components in relation to their condition at a given point in time.

Since the very concept of ecosystem ecological integrity is difficult to apply to an NWA, it would be unrealistic to endeavour to monitor the ecological integrity of NWAs relative to a baseline level based on the natural condition of the sites, as is done in the Parks Canada monitoring program. Instead, the NWA monitoring program will **measure** the environmental components in order to **compare** them, to the extent possible, to their condition at the time when each NWA was established or when the first reference data became available. It will thus be possible to assess **changes** in the environmental components relative to a baseline condition and to determine whether these components have been altered or maintained over the years.

An observed change in a biophysical attribute of an NWA must be considered in relation to the desired condition for that attribute, because the fact that a change has been measured does not necessarily mean that the desired condition of the attribute has been achieved. It will therefore be necessary to establish a threshold reflecting the desired condition of each indicator in each NWA in order to determine whether the observed change has allowed that threshold to be reached or whether actions must be taken or continued to reach the threshold. These thresholds will be established on the basis of currently available knowledge and described in the document that will follow the present report.

Historical data on the presence and abundance of a number of taxonomic groups found in the NWAs are available and can be used as baseline levels against which future measurements can be compared. The historical data include the daily Greater Snow Goose count conducted in the Cap Tourmente NWA since 1999 and the annual nesting Horned Grebe pair count in the Pointe de l'Est NWA conducted since 1993 (Environment Canada, 2013a). Furthermore, a number of knowledge acquisition and research projects have been carried out over the years in most of the NWAs, and a knowledge review describing those projects in detail was included in the conservation plans produced for

each NWA in the 2000s (SCF, 2003–2005). Wildlife and plant surveys conducted between 2004 and 2009 in each NWA to update knowledge on the presence and abundance of species, including those designated as species at risk at the time, will also be used as baseline data for certain taxonomic groups, because these were the first exhaustive surveys ever carried out for these taxa (e.g. anurans, chiropters). Detailed survey reports are currently being produced for each NWA, including the Îles de Contrecœur NWA (Rivard and Giguère, 2014a) and the Îles de la Paix NWA (Rivard and Giguère, 2014b).

Lastly, other indicators selected for the monitoring program have never been measured in the NWAs; the measurements that will be taken for the first time will serve as the baseline levels (year 0) for monitoring changes in the indicators, similar to the approach used to establish the baseline levels for the EIMP for Quebec provincial parks. Each indicator selected for each NWA will have to be rigorously analyzed to determine the most suitable baseline level, since that is the level relative to which changes in the indicator over time will be assessed.

7. Development of the ecological monitoring program

7.1 Indicator selection process

The process of selecting indicators for the Quebec NWAs involved multiple steps that took more than three years to complete (Table 3).

Table 3. Key steps leading to the selection of indicators for the Quebec NWAs.

Date	Activity
March 2012	Review of existing ecological monitoring programs in North America
Fall 2012 – winter 2013	Detailed analysis of existing ecological monitoring programs for protected areas located along the St. Lawrence River
March 2013	Production of descriptive fact sheets on 53 indicators used along the St. Lawrence River
August 2013	Completion of list of potential indicators (>80 indicators)
December 2013	Selection and ranking of indicators for each NWA (32 indicators selected)
April 2014	Workshop with organizations responsible for existing monitoring programs along the St. Lawrence River
Fall 2014 – winter 2015	Finalization of list of indicators for each NWA

7.2 Review of existing programs

First, it was important to gather information on existing ecological monitoring programs in Quebec, Canada and elsewhere in North America for which indicators of interest had been selected to monitor the status of protected areas similar to the NWAs. An initial literature review was completed in March 2012, and the goals and objectives, indicator selection approach, and certain specific considerations of some of the key existing programs were described (Lepage, 2012). The programs described had been developed for U.S. national parks (Vital Signs), Canadian national parks (ecological integrity

monitoring program for national parks in Canada), Quebec provincial parks (EIMP), and Gatineau Park (Monitoring Program for Gatineau Park's Ecosystems).

A detailed analysis was then carried out to review the existing monitoring programs for protected and other types of areas located along the St. Lawrence River, identify their characteristics, and produce a list of the ecological indicators associated with those programs (Lepage, 2013). The detailed analysis focused on five ecological monitoring programs: 1) the Sépaq program that covers eight Quebec provincial parks; 2) the Parks Canada program that covers Forillon National Park and Mingan Archipelago National Park Reserve; 3) the National Capital Commission (NCC) program for Gatineau Park; 4) the Réseau de milieux naturels protégés (RMN) program that covers two areas along the river; and 5) the program for nature parks in the Greater Montreal Area. There is also the State of the St. Lawrence Monitoring Program, which is part of the St. Lawrence Action Plan (Table 4).

Table 4. Areas covered by an ecological monitoring program along the St. Lawrence River in Quebec (Lepage 2013).

Organization	Area	Program in Place
Parks Canada	Forillon National Park of Canada	Yes
	Mingan Archipelago National Park Reserve	Yes
	Saguenay–St. Lawrence Marine Park	No *
	Grosse Île and the Irish Memorial National Historic Site	No **
Parcs Québec – Sépaq	Plaisance Provincial Park	Yes
	Oka Provincial Park	Yes
	Îles-de-Boucherville Provincial Park	Yes
	Saguenay–St. Lawrence Marine Park	No *
	Fjord-du-Saguenay Provincial Park	Yes
	Le Bic Provincial Park	Yes
	Île-Bonaventure-et-du-Rocher-Percé Provincial Park	Yes
	Anticosti Provincial Park	Yes
	Miguasha Provincial Park	Yes
National Capital Commission	Gatineau Park	Yes
Réseau de milieux naturels protégés	Marguerite D'Youville Wildlife Refuge	Yes
	Léon Provancher Marsh Nature Reserve	Yes
Nature parks in the Greater Montreal Area	14 nature parks	Yes
Partners of the St. Lawrence Plan	Sites along the St. Lawrence River	Yes

** Indicators were used to prepare a profile of the marine park published in 2007, but there is no structured environmental monitoring program in place.*

*** Surveys of species at risk and bats have been carried out, but they are not repeated regularly, nor are they incorporated into an environmental monitoring program (J. Proulx, pers. comm.).*

7.3 Selection of indicators for each NWA

All of the indicators used in these monitoring programs were then examined by a working group made up of representatives of EC and of the ministère du Développement durable, de l'Environnement, de la Faune et des Parcs (MDDEFP) in order to identify those most relevant to the Quebec NWAs. This step resulted in the selection of 53 indicators, for which individual descriptive fact sheets were produced in March 2013 (rationale, methodology, sampling strategy, costs, etc.).

The list of potential indicators was completed in August 2013, taking the following into account:

- Purpose of each NWA
- Threats identified in the NWA management and conservation plans
- Multispecies wildlife inventories (2004–2009)
- Existing monitoring efforts in the NWAs
- List of indicators used along the St. Lawrence River

A number of other indicators were subsequently added to the list of potential indicators that could be selected for any of the NWAs, bringing the total number of indicators to more than 80.

The final selection of indicators for each NWA was made through a collaborative effort by the working group members in December 2013. Their approach was to review each indicator, for each NWA, in order to understand its usefulness and to discuss the proposed methodology and its feasibility, its application in the existing monitoring programs, and its relevance in light of the specific features of each NWA. Once an indicator was selected, it was assigned a relative priority ranking (high, medium, low).

To ensure that all of the objectives of the ecological monitoring program for NWAs were addressed (see section 6), indicators had to be selected under each of the four following themes :

- Ecosystems
- Pressures/Threats
- Biotic Communities
- Species at Risk

The working group members also had to ensure the feasibility of implementing each indicator, its robustness for detecting significant changes, and its scientific rigour as described in existing monitoring programs. They were careful to distinguish between monitoring indicators and research projects designed to address a specific issue (e.g. impact of White-tailed Deer on vegetation). Lastly, because the purpose of the exercise was to develop a rigorous, effective monitoring program for NWAs, the approach used to

select the indicators was based on the concept of choosing the most biologically relevant indicators, regardless of the resources that would be required for future implementation. Adjustments can be made to the final list of selected indicators (to be announced in the related document currently being prepared) as the survey methodologies and sampling plans are chosen.

As a result of this process, 32 indicators were selected (Ecosystems: 3; Pressures/Threats: 16; Biotic Communities: 13) and a preliminary list of almost 35 species at risk that could be monitored was prepared.

7.4 Validation with organizations responsible for existing programs

A workshop with organizations responsible for existing monitoring programs along the St. Lawrence River was held in April 2014. The purpose of the workshop was to share the objectives of the monitoring program being developed, the approach used, and the indicators selected with organizations that had developed their own monitoring programs in order to solicit their opinions and improve the NWA monitoring program. Table 5 lists the organizations and individuals that attended the workshop.

Table 5. Organizations and individuals present at the workshop held in April 2014 to discuss the development of the monitoring program for NWAs.

Organization	Representatives
Environment Canada – Canadian Wildlife Service	Stéphanie Gagnon; Sylvain Giguère; Benoît Jobin; Benoît Roberge; Stéphane Turgeon; Marielou Verge
Ministère des Forêts, de la Faune et des Parcs (MFFP)	Jacques Jutras; Anouk Simard
Parks Canada Agency	Suzan Dionne; Claude Samson
Parcs Québec - Sépaq	Patrick Graillon
Réseau des milieux naturels protégés (RMN)	Michel Lepage
City of Montréal	Sylvie Comtois
National Capital Commission (Gatineau Park)	Christie Spence (phone)

A representative then presented each organization's own monitoring program (objectives, background, indicators selected and rationale), as well as the successes and missteps made during the development and implementation phases. Next, a presentation was given on the NWA network and the progress made towards developing the monitoring program. Lastly, various aspects common to all programs, such as the establishment of the baseline thresholds associated with the indicators, data analysis, methods of disseminating the results to the public, and implementation mechanisms, were discussed.

The meeting was highly instructive, and the participants' experiences yielded numerous recommendations and cautions about the establishment of the program objectives, the selection of indicators, and implementation strategies. Appendix 1 contains the proceedings and main recommendations of the workshop. These recommendations helped refine the objectives of the monitoring program for NWAs and adjust the selection of the indicators over the subsequent months (fall 2014 to winter 2015). By the winter of 2015, there were a total of 18 proposed indicators for the monitoring program,

distributed as follows: Ecosystems: 2; Pressures/Threats: 10; Biotic Communities: 6. For species at risk requiring monitoring, a prioritization grid was produced for each NWA to help determine which species may require monitoring (see section 8.4).

8. Indicators selected for the NWAs

Since the NWAs in Quebec are located all along the river system from the border with Ontario to the Gulf of St. Lawrence, the ecosystems, biophysical conditions and anthropogenic pressures along this gradient are characterized by considerable diversity. Some of the indicators selected apply to all NWAs, some to most NWAs, and some to specific NWAs due to their respective purpose, local ecological features, or threats related to their regional context. Among the general indicators, some complement existing networks in place across the province, such as anuran or bat population monitoring. Others are specific to the species found in each NWA, such as invasive alien species monitoring or species at risk monitoring.

Table 6 lists the indicators selected by program objective and priority ranking in each NWA. Appendix 2 provides a detailed description of the indicators selected for each NWA, and Appendix 3 contains detailed fact sheets on each indicator selected. The following sections describe the rationale for the choices and the features specific to each NWA.

Table 6. Indicators selected for each of the eight NWAs in Quebec.

Selected indicator	Lake Saint-François	Îles de la Paix	Îles-de-Contrecœur	Cap Tourmente	Estuary Islands	Baie de L'Isle-Verte	Pointe-au-Père	Pointe de l'Est
Ecosystems								
Habitat area and distribution	H	H	H	H	H	H	H	H
Quality of exceptional forest ecosystems (EFEs)	M			M				M
Pressures/Threats								
Invasive alien species monitoring	H	H	H	H	H	H	H	H
Bank recession rates and land area lost to erosion		H	H	H	M	M	H	H
Annual monitoring of agricultural fields (types of crops)				M		M		
Eastern Canadian Diatom Index (IDEC)	M			M		M		
Bacteriological and physicochemical water quality (IQBP)	L			L		L		
Benthic invertebrate monitoring	L			L		L		
Monitoring of deformities in amphibians	L			L		L		
Quality of the intertidal marsh				H				
Proportion (%) of forests degraded by Double-crested Cormorants					H			
Monitoring of the ATV trail system and impacts on vegetation								H
Biotic Communities								
Landbird diversity and abundance	H	H	H	H	H	H	H	H
Waterfowl diversity and abundance	H	H	H	M	H	H	L	M
Colonial waterbird diversity and abundance	H	H	H		H	H		H
Shorebird diversity and abundance						M	M	
Anuran diversity and abundance	M	M	M	M		M	M	
Bat diversity and abundance	L	L	L	L		L		L
Species at Risk								
Abundance and distribution of species at risk (see section 8.4)	H	H	H	H	H	H	H	H

Note : **red** = high priority (H); **yellow** = medium priority (M); **green** = low priority (L)

8.1 "Ecosystems" theme

8.1.1 Habitat area and distribution

NWA: All

Priority: High

The availability of habitats and their spatial distribution across the landscape largely dictate the distribution and abundance of wildlife and plant communities in a given area. Furthermore, ecosystems are dynamic and can be altered by natural disturbances (e.g. fire) or anthropogenic disturbances (e.g. logging). Since the core purpose of NWAs is to protect high-quality habitats for plants and animals, particularly nesting birds (see Table 2), it is important to study the spatial and temporal dynamics of the habitats in the NWAs to determine their relative significance in terms of the ecological functions they support. Furthermore, since the NWAs are located in diverse landscape matrices ranging from island environments to areas dominated by intensive agriculture, it is important to understand the changes that can occur in the surrounding landscape and that can have a direct influence on the presence and abundance of wildlife and plant species in the NWAs and on the anthropogenic pressures that can arise around these protected areas. Periodic monitoring of the composition and spatial distribution of habitats in the NWAs will therefore include a peripheral zone adjacent to the NWAs.

The mosaic of heterogeneous habitats protected in each NWA supports a rich biodiversity and many species at risk. The purpose of certain NWAs may also include the protection of a type of habitat specifically sought by a group of species. In addition to monitoring the size and distribution of all types of habitats in the NWAs, the monitoring program will also have to prioritize significant types of habitats in certain NWAs:

- Cap Tourmente: Area and distribution of bulrush marsh.
- Baie de L'Isle-Verte: Area and distribution of Spartina marsh.
- Pointe de l'Est: Area and distribution of freshwater and brackish ponds.

This type of monitoring is already in place in the Quebec NWAs. The spatial distribution of the habitats was studied in the NWAs and in an adjacent zone covering approximately 2 km by analyzing aerial photos taken over two periods essentially corresponding to the years surrounding or preceding the year in which the NWAs were officially established (1960s and 1970s) and analyzing the most recent available data (1990s and 2000s; Maheu-Giroux et al., 2006; Labrecque and Jobin, 2013). The production of a new map of land cover in the NWAs and surrounding area based on recent data sources (high-resolution satellite images or aerial photos) will make it possible to continue this monitoring and detect recent changes in the availability and spatial distribution of the habitats and the peripheral pressures. A number of other indicators may result from these analyses, such as the analysis of habitat fragmentation in and around the NWAs, coastline monitoring in relation to bank erosion, or the proportion of forest degraded by Double-crested Cormorants (see Appendix 3). Monitoring the condition of ecosystems adjacent to the protected areas is also an important concern in provincial parks of Quebec (Sépaq, 2014) and national parks of Canada (Parks Canada, 1997; Soverel et al., 2010).

8.1.2 Quality of exceptional forest ecosystems (EFEs)

NWAs: Lake Saint-François; Cap Tourmente; Pointe de l'Est

Priority: Medium

EFE status is granted to expanses of habitat that help maintain unique components of forest biodiversity (MRN 2001). It is not an official conservation status, but rather a designation aimed at sensitive components that should be covered by protection measures. There are three categories of EFE: 1) rare forests; 2) old-growth forests; and 3) shelter forests (forests providing shelter for threatened or vulnerable species).

Three NWAs in Quebec contain EFEs. There are six in the Lake Saint-François NWA: one shelter forest (Sugar Maple stand with Basswood and American Beech) and five rare/shelter forests (one Red Maple stand on peatland, three Bitternut Hickory stands, one Basswood stand); two in the Cap Tourmente NWA: two rare/old-growth forests (Eastern White Pine stand with Red Pine and Red Spruce); and one in the Pointe de l'Est NWA: one rare/shelter forest (stunted White Spruce stand). These EFEs were designated in order to preserve favourable ecological conditions for maintaining forest stands with a limited distribution that support plant communities of interest.

The ministère des Forêts, de la Faune et des Parcs (MFFP) has developed an indicator for monitoring the integrity of EFEs located on public land and subject to forest management in order to assess the application of protective measures in the area surrounding the EFEs (100 m buffer). In light of the level of protection given to NWAs, this indicator is not applied to EFEs located in NWAs. Remote sensing could be used to assess natural disturbances that could affect EFEs in conjunction with the analysis of changes in the surface area occupied by the various ecosystems (previous indicator).

An EFE quality monitoring protocol has been developed and is now used as part of the EIMP in Quebec. This protocol requires measurements to be taken in the field to quantitatively assess the health of the forest stands (basal area, height, defoliation, etc.) in permanent sample plots. It is recommended that the same protocol be used to monitor the quality of the EFEs present in the NWAs.

8.2 "Pressures/Threats" theme

8.2.1 Invasive alien species monitoring

NWAs: All

Priority: High

Invasive alien species are one of the causes of biodiversity loss around the world (Environment Canada, 2013b). The presence of these species is a major concern for managers of protected areas because their invasive nature can severely disturb the existing ecological balance and harm the ecological integrity of ecosystems. It is important to be vigilant for the arrival of invasive species, whether they are plants or animals, aquatic or terrestrial, mobile or immobile, and to develop appropriate management measures when they are detected in an area. Detection protocols and invasive alien species monitoring must be implemented to facilitate an appropriate response to this threat to the ecosystems in the NWAs.

The monitoring program for NWAs will emphasize the detection and monitoring of invasive alien plant species. Many invasive alien plant species are found in a number of NWAs (Environment Canada, 2015a), and monitoring protocols must be put in place to assess the scope of the threat and measure its trends, especially in sensitive areas (e.g. where species at risk occur). Similarly, detection protocols are needed in areas where invasive species are not yet present, to ensure a swift response if new invasive species are detected. The ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC) is working to implement detection and monitoring protocols for a number of invasive plant species, such as Common Reed and Giant Hogweed, and these protocols will be used in the Quebec NWAs.

The first step is to produce a list of invasive alien plant species known to be present in the NWAs. The degree of invasion (area occupied, impact on habitat) must be assessed, and monitoring protocols must be deployed for species that are considered problematic or pose the highest risk. The second step is to consider implementing detection protocols at sites vulnerable to invasion by alien species. Note that an assessment of the presence and invasive status of such species was initiated in 2015 in the Cap Tourmente, Baie de L'Isle-Verte and Pointe-au-Père NWAs. Recommendations for managing and controlling the more problematic species will be developed for those NWAs.

A research project is currently underway to study the issue of wet meadow invasion by Speckled Alder in the Lake Saint-François NWA. Speckled Alder is not an alien species, but its invasiveness can have a major impact on the habitat of Yellow Rail, a species at risk in Canada. Activities are being carried out to control the size of Speckled Alder stands in wet meadows, and a method for monitoring the presence and density of the stands by analyzing aerial photos is being developed. The suitability of Speckled Alder monitoring as a specific indicator remains to be validated.

Many invasive alien animal species are present in Quebec, and some, such as Zebra Mussel, Round Goby and Red-eared Slider, are being monitored by various organizations, including MFFP (http://mffp.gouv.qc.ca/faune/especes/envahissantes/index.jsp). Most are aquatic species that live in the waters adjoining the NWAs, which means they are outside the NWAs and do not affect their terrestrial ecosystems. Monitoring of these species was therefore not selected for this monitoring program.

The Emerald Ash Borer, a recently introduced pest, has killed thousands of native ash in Quebec, and the Canadian Food Inspection Agency has already launched a program to detect this insect in the province (http://www.nrcan.gc.ca/forests/fire-insects-disturbances/top-insects/13377). This destructive beetle's presence has been confirmed in southwestern Quebec (Outaouais, Montérégie, Montreal, Laurentides regions), and there is little doubt that its impact will soon be felt in the Lake Saint-François, Îles de la Paix and Îles de Contrecœur NWAs. Rather than implement an Emerald Ash Borer detection program in the NWAs, it would be more practical to monitor the effect of this insect on native ash and on forest cover in the NWAs. This issue is currently being examined.

8.2.2 Bank recession rates and land area lost to erosion

NWAs: Îles de la Paix; Îles de Contrecœur; Cap Tourmente; Pointe-au-Père; Pointe de l'Est

Priority: High

NWAs: Estuary Islands; Baie de L'Isle-Verte

Priority: Medium

All of the NWAs are located along the St. Lawrence River and are subject to bank erosion to varying degrees. The wake or wash from passing commercial ships and pleasure craft, wind-generated waves, the influence of the tides, and ice action are all causes of bank erosion and recession in most NWAs. Bank erosion in the Îles de la Paix and Îles de Contrecœur NWAs was extensively monitored from 1998 to 2002, with repeated visits to install marking stakes to quantify bank recession. These monitoring studies clearly revealed significant losses of land area and a major impact on habitat integrity (Dauphin, 2000; Dauphin and Lehoux, 2004). The monitoring was partially continued until 2010 (D. Dauphin, pers. comm.). An assessment of the current state of bank erosion and plans for potential restoration work has been initiated in the Îles de la Paix NWA to reduce this problem (Environment Canada, 2014a).

The Cap Tourmente, Pointe-au-Père and, to a lesser degree, Baie de L'Isle-Verte and Estuary Islands NWAs are also affected by erosion, with vast areas of the high marsh being eroded each year by winter storms and ice action. Clear signs of bank erosion are visible in the marshes in the Pointe-au-Père and Baie de L'Isle-Verte NWAs, where the bank recession rate can be as high as 2 m/year (Bernatchez and Dubois, 2004; Joubert et al., 2012). L'Isle-Verte and Cacouna are among the coastal areas along the St. Lawrence known to be especially vulnerable to erosion. Certain riparian sectors of the Cap Tourmente NWA are also subject to erosion (SCF, 2003d), and a few episodes of severe erosion have been observed over the past few years (Bernatchez, 2015; S. Turgeon, pers. comm.). In recent years, bank erosion, leading to the degradation of coastal habitats (receding by more than 5 m), has been observed on some of the low-lying islands in the Estuary Islands NWA, especially Île aux Fraises and Île Blanche. This phenomenon has also been observed in the eastern part of Île Bicquette. This erosion could be due to storm frequency and intensity as well as to high tides, which can be exacerbated by climate change (Environment Canada, 2014b).

The coastline between the Pointe de l'Est NWA and the Gulf of St. Lawrence is highly dynamic. The narrow strip of land separating the pond known as Étang de l'Est from the Gulf of St. Lawrence eroded by tens of metres between 1976 and 1999, leaving only a slim sandbar (about 50 m) to protect this freshwater environment (Labrecque and Jobin, 2013). If this sandbar were breached, the water level in Étang de l'Est would be affected and the intrusion of saltwater would alter this fragile ecosystem, which is used for nesting by many bird species, including Horned Grebe, an endangered species in Canada.

Models forecasting the potential impact of climate change indicate that the erosion phenomena observed in the Estuary and Gulf of St. Lawrence could be exacerbated with a rise in sea level, an increase in storm intensity, and a decrease in ice cover duration (Bernatchez et al., 2008). The implementation of an erosion monitoring system should

be considered as a means of properly measuring the extent of the phenomenon and its effects on coastal ecosystems. Methods for measuring bank recession and land area lost to erosion can vary from one NWA to another depending on the extent of the erosion and ease of measurement. Coastline mapping and quantification of land area lost to erosion can be carried out through remote sensing in all NWAs and could be complemented by direct measurements taken in the field with marking stakes that are visited periodically. The most appropriate methods for monitoring erosion will be determined at a later date based on the issues specific to each NWA. It may be possible to make use of the bank erosion monitoring network launched by the Laboratory of Coastal Zone Dynamics and Integrated Management and the Canada Research Chair in Coastal Geoscience at the Université du Québec à Rimouski in the early 2000s, since it has set up more than 5,400 monitoring stations along the coastline of the Estuary and Gulf of St. Lawrence to study coastal dynamics and the processes responsible for erosion. Monitoring stations have also been installed in the Cap Tourmente NWA to quantify the extent of coastal erosion in that NWA (Bernatchez ,2015).

8.2.3 Annual monitoring of agricultural fields (types of crops)

NWAs: Cap Tourmente; Baie de L'Isle-Verte

Priority: Medium

Farming is still carried out in two Quebec NWAs, namely Cap Tourmente and Baie de L'Isle-Verte. This activity helps maintain open areas in the landscape, which offer high-quality habitat for a number of nesting and migratory bird species, including some declining and threatened species, such as Bobolink and Eastern Meadowlark. Agricultural operations are regulated by permits, and the locations of cultivated plots, types of crops (cereals, corn, soybean, hayfield, fallow), and producers' names have been recorded since 1995. This information is integrated into a geographic information system (GIS) that visually displays the current and historical distribution of cultivated fields and makes it possible to analyze changes over time. This monitoring is expected to continue.

Nesting birds in open areas in the Cap Tourmente NWAs have also been monitored since 1998 to quantify the demographic trends of this declining group of birds, which includes several species at risk (see section 8.3.1). A survey focusing on these species was carried out in 2015 in Baie de L'Isle-Verte NWA. Most of the point counts used in 2005 were re-surveyed, along with new point counts added to enhance coverage of open areas in this NWA. Annual monitoring of agricultural fields will make it possible to identify the crops grown in these NWAs and correlate them with the results of the bird surveys conducted in those habitats.

8.2.4 Eastern Canadian Diatom Index (IDEC)

NWAs: Lake Saint-François; Cap Tourmente; Baie de L'Isle-Verte

Priority: Medium

The Lake Saint-François, Cap Tourmente and Baie de L'Isle-Verte NWAs are located in agricultural matrices, and agricultural operations even occur in some parts of the Cap Tourmente and Baie de L'Isle-Verte NWAs. The streams that cross these NWAs drain areas likely to accumulate pollutants from agricultural fertilizer application and from human activities occurring in or around the NWAs. A decline in water quality can affect

aquatic communities and in turn affect the terrestrial communities that feed on them. It is important to measure water quality to determine pollutant levels, which will make it possible to identify the sources of the pollution and take appropriate corrective action.

Researchers at the Université du Québec à Trois-Rivières have developed a methodology for assessing water quality using the diatoms (single-cell algae) present in streams (Campeau et al., 2013). The Eastern Canadian Diatom Index (IDEC) measures the activity of diatoms, which are highly sensitive to water quality degradation (eutrophication) caused by inputs of phosphorus, nitrogen and other organic matter. Measurements are typically taken in streams or in agricultural ditches that drain adjacent land in order to assess the condition of the diatom communities by comparing them to communities found in healthy streams.

There are a number of indicators besides the IDEC for assessing the condition of streams located in agricultural areas. The Index of Bacteriological and Physicochemical Water Quality (IQBP) measures physicochemical parameters and provides an indication of which parameters are affecting water quality, such as total phosphorus, fecal coliforms and turbidity (see below). SurVol Benthos, an index based on benthic invertebrate communities, measures the response of benthic organisms to water quality degradation (pollution) and riparian habitat degradation (sedimentation), making it a good indicator of habitat quality (see below). These indicators provide different yet complementary perspectives on water quality in streams located in agricultural areas.

To assess the condition of streams running through the targeted NWAs, a phased approach could be used:

1) Take IDEC measurements to determine whether there is a problem with water quality.
2) If a problem is found, take IQBP measurements to identify the parameters affecting water quality.
3) Measure the quality of the aquatic habitat by measuring benthic communities (SurVol Benthos).

It may therefore be useful to take water quality measurements (IDEC) for a few years (two to three years) to determine whether water pollution issues are in fact present and to follow up by taking IQBP measurements to identify the parameters affecting water quality. Subsequent periodic monitoring of benthic invertebrates (e.g. every three to five years) would assess the effects of the pollutants on habitat quality.

8.2.5 Bacteriological and physicochemical water quality (IQBP)

NWAs: Lake Saint-François; Cap Tourmente; Baie de L'Isle-Verte

Priority: Low

The Quebec government designed the IQBP as a numerical index for measuring the bacteriological and physicochemical quality of water (IQBP; Hébert, 1997). The IQBP measures general water quality in the summer (from May to October) on the basis of its potential uses (swimming, other water-based activities, drinking water supply, protection against eutrophication, protection of aquatic life). It is typically calculated using 10 conventional indicators, also referred to as "sub-indices:" total phosphorus, fecal

coliforms, turbidity, suspended solids, ammonia nitrogen, nitrites/nitrates, total chlorophyll a, pH, five-day biological oxygen demand (BOD5), and percentage of dissolved oxygen saturation. The standard measurements of nitrates/phosphorus/pH provide an indication of water quality, and fecal coliforms are almost always measured to determine bacteriological quality (swimming, drinking water, boating, etc.). This index is easy and relatively inexpensive to use. Multiple samples must be collected throughout the season, because this indicator is highly sensitive to day-to-day variations. It is also possible to calculate a limited index based on six parameters (IQBP6: fecal coliforms, chlorophyll a, total phosphorus, nitrites/nitrates, ammonia nitrogen and suspended solids). The sites where these measurements will be taken in each NWA and the sampling plans will be determined at a later date.

The IQBP is not designed to measure chemical or pesticide contamination of water. The crops grown in the Cap Tourmente and Baie de L'Isle-Verte NWAs require little pesticide use, and the products used are typically not very persistent (herbicides). However, agricultural operations in areas adjacent to the NWAs can lead to water contamination by pesticides, particularly in the Lake Saint-François NWA, which is located in a region with a well-established intensive agriculture sector (corn, soybean). However, the methodologies used to measure pesticide contamination of water bodies are extremely costly and must be closely associated with measurements related to agricultural practices (products used, application dates, weather conditions, etc.). Measurement of pesticide contamination of waters in streams running through the NWAs was therefore not selected. Note, however, that the "monitoring of deformities in amphibians" indicator will measure the response of this species group to the presence of chemical compounds in the environment, including pesticides in aquatic environments.

8.2.6 Benthic invertebrate monitoring

NWAs: Lake Saint-François; Cap Tourmente; Baie de L'Isle-Verte

Priority: Low

Benthic macroinvertebrates are good indicators of water quality in streams because they respond directly to water quality degradation (pollution) and riparian habitat degradation (sedimentation). This indicator is less sensitive to day-to-day variations in water quality and consequently represents the annual and seasonal conditions of the environment. The indicator is complements the IQBP and IDEC.

MDDEFP has produced two documents outlining benthic macroinvertebrate sampling and analysis protocols for different types of stream substrates: coarse (MDDEFP, 2012a) and soft (MDDEFP, 2012b). In addition, the Quebec government (MDDELCC) recently developed a simplified, less costly protocol for coarse-substrate streams: the SurVol Benthos program run by G3E, an education and water monitoring group (http://www.g3e-ewag.ca/programmes/survol/accueil.html). Organisms are identified to the family level, and the sampling methods are less labour-intensive than those of the Standardized Global Biological Index (IBGN). Sampling is performed in the fall, and measurements are taken at the source and mouth of the stream. This new indicator is now used in a number of Quebec provincial parks as part of the EIMP. It should be noted that the SurVol Benthos program is subject to certain specific conditions: the stream must be easy to sample on foot and must drain a watershed of <300 km2, in addition to having a coarse substrate.

For the Lake Saint-François, Cap Tourmente and Baie de L'Isle-Verte NWAs, certain parameters will have to be addressed before a benthic macroinvertebrate sampling program can be launched as a complement to the IDEC and IQBP:

- Identify the streams to be sampled.
- Determine whether these streams are already being sampled.
- Identify the type of substrate (coarse or soft) in these streams.
- Plan the sampling strategy accordingly (SurVol Benthos and/or other).

8.2.7 Monitoring of deformities in amphibians

NWAs: Lake Saint-François; Cap Tourmente; Baie de L'Isle-Verte

Priority: Low

Amphibians are good indicators of environmental quality because their sedentary lifestyle and cutaneous respiration exposes them to local pollution. These organisms are also known to exhibit physical deformities or reduced growth and reproduction when chemical compounds are present in their environment, including pesticides in aquatic environments (Ouellet et al., 1997). The "monitoring of deformities in amphibians" indicator will measure how this species group responds to water quality in the ponds and marshes in which they live. This indicator complements the "bacteriological and physicochemical water quality (IQBP)" indicator, which combines measurements of organic pollution, physicochemical data and nutrients in water.

Studies of deformities in amphibians were conducted by Jean Rodrigue of the CWS in two ponds in the Cap Tourmente NWA from 1997 to 2000. Contrary to expectations, the rate of deformity in the collected amphibians was extremely high, apparently due to the presence of pesticides in the environment (J. Rodrigue, pers. comm.). Basic water quality data (pH, temperature, conductivity) were also collected. It would be useful to return to the Cap Tourmente NWA to take periodic measurements at the same sites using the method employed by J. Rodrigue in the late 1990s (field collection and observation). Similar measurements could be taken in wetland areas of the Lake Saint-François and Baie de L'Isle-Verte NWAs that may contain pesticides, since these NWAs are located in agricultural matrices. Measurements should ideally be taken at the same sites as the other measurements associated with aquatic ecosystem quality (IDEC, IQBP, SurVol Benthos).

8.2.8 Quality of the intertidal marsh

NWA: Cap Tourmente

Priority: High

The Cap Tourmente NWA was established to protect the American Bulrush marsh, the main habitat of Greater Snow Goose during migration. This species feeds on American Bulrush rhizomes at low tide. With the Greater Snow Goose population having expanded from 417,000 in 1993 to more than 950,000 in 2004, the extremely high density of birds has led to intensive browsing of marsh vegetation and consequently lowered the quality of the habitat. From 1971 to 2000, the density of American Bulrush (and other plant species) was periodically measured as part of a bulrush marsh quality monitoring program (Lefebvre et al., 2001). In addition, a research project was carried out from

2004 to 2007 to quantify the impact of goose browsing on bulrush; bulrush stem density was measured in exclosures inaccessible to the geese and at similar sites subject to goose browsing (Girard, 2009). The monitoring showed that goose browsing reduced the density and above-ground biomass of American Bulrush. Since the bulrush marsh is one of the key ecosystems of the Cap Tourmente NWA, it is crucial to reinstate the bulrush marsh quality monitoring program.

The spatial distribution of the bulrush marshes and the stem density of bulrush, Wild Rice and Arrowhead are currently being monitored via remote sensing. The analysis of images taken at different times (1977, 1984 and 2002) has made it possible to measure the extent of the bulrush marshes and the density of the plant communities in four sectors of the St. Lawrence Estuary (Cap Tourmente, Île aux Grues, Cap-Saint-Ignace, Montmagny; Allard, 2008; Allard et al., 2012). New images were obtained in 2011 to continue the monitoring. Note that this monitoring complements the monitoring of habitat area and distribution (see section 8.1.1) because the resolution of the images used to date in the two types of monitoring is different. It should be determined whether both types can be continued using the same data sources.

It is proposed that monitoring of the bulrush marsh be implemented at two spatial scales: 1) quantitative monitoring, possibly using exclosures, for on-site measurement of the impact of goose browsing on local flora (Lefebvre et al., 2001); and 2) monitoring by remote sensing to quantify the spatial distribution of the bulrush marsh at the landscape scale.

8.2.9 Proportion (%) of forests degraded by Double-crested Cormorants

NWA: Estuary Islands

Priority: High

The impact of Double-crested Cormorants nesting on flora is well documented. The droppings of these birds kill the vegetation beneath their nests and completely destroy the plant cover, including the trees in which they nest, within a few years (SCF, 2003e). Double-crested Cormorant colonies are found on certain islands in the Estuary of St. Lawrence and have more than once contributed to destroying all the forested areas on entire islands (Île Blanche, Île Brûlée, Grande Île and Île du Phare; Bédard et al. 1997; SCF, 2003e). Their degradation of forest cover is especially troubling because it directly affects the nesting habitat of Common Eider, a species whose protection is a key part of the purpose of the Estuary Islands NWA. Control of nesting cormorants has been in place for several years to reduce the impact of the colonies on the islands' vegetation (Bédard et al., 1995).

Changes to the forest communities on some islands in the Estuary Islands NWA were measured during two separate periods (1970s and 2000s) by analyzing aerial photographs (Labrecque and Jobin, 2013). Since the Estuary Islands NWA supports large colonies of colonial waterbirds (alcids, larids and Common Eider), including active Double-crested Cormorant colonies (Grande Île and Île aux Fraises), it is important to document the presence of this species and to measure the associated impact on the surrounding vegetation. Remote sensing–based monitoring of the proportion (%) of forest degraded by Double-crested Cormorants is therefore proposed (see the indicator "Habitat area and distribution").

8.2.10 Monitoring of the ATV trail system and impacts on vegetation

NWA: Pointe de l'Est

Priority: High

The Pointe de l'Est NWA has a trail system for all-terrain vehicles (ATVs). The system is made up of officially marked trails, but the NWA is also crisscrossed by other, unofficial trails. ATVs passing repeatedly through sensitive areas (dunes, barrens, etc.) destroy vegetation, including a number of plant species at risk growing on the edges of trails (Bouffard and Poirier, 2002; Attention FragÎles/Groupe de référence en environnement des Îles-de-la-Madeleine, 2012).

A map of the ATV trail system was recently produced by analyzing aerial photographs and taking readings on-site with a GPS device. Efforts are underway to regulate the use of ATVs in the Magdalen Islands, which includes the Pointe de l'Est NWA, in order to limit the impact of this activity on natural habitats. This could lead to the closure of some trails. The creation of other illegal trails in the future also cannot be ruled out. Periodic monitoring of changes in the ATV trail system by analyzing aerial photographs (see the "Habitat area and distribution" indicator) and conducting site visits would help quantify the evolution of this activity in the NWA.

It would also be useful to directly measure the impact of the passage of ATVs on vegetation in the NWA's sensitive areas, including sites containing species at risk associated with dune systems. Field measurements could be taken at specific sites where the repeated passage of ATVs is expected to have a potential impact. The measurements could include the use of indicators from other monitoring programs in Quebec, such as:

1) The program component that involves monitoring the impact of trail use in City of Montreal nature parks, which assesses trail degradation based on eight variables, and the EIMP component that monitors hiking trail rights-of-way, which involves measuring the width of hiking trails according to an established protocol;
2) The implementation of permanent vegetation sample plots as part of the Parks Canada program "Rare Species or Species at Risk Monitoring – Hudsonia tomentosa" or the program for monitoring marine relict species in the coastal dunes of Pointe-Taillon Provincial Park (EIMP): Woolly Hudsonia, Beach Grass, Beach Pea.

8.3 "Biotic Communities" theme

The NWAs were established in the 1970s and 1980s to protect migratory bird habitats, such as the vast wetlands used as staging and/or breeding grounds. Since the Canadian Wildlife Service is responsible for managing migratory bird populations in Canada, in-depth knowledge of the bird communities that use the NWAs during breeding and migration is needed. A periodic survey of breeding bird species will make it possible to measure the response of this wildlife group to the quality of the nesting habitat in the NWAs, to detect demographic trends, and to determine the distribution and abundance of a number of species at risk that are found in the NWAs. The bird-related indicators have been categorized according to four separate groups corresponding to the bird groups defined by NABCI: landbirds, waterfowl, waterbirds and shorebirds. This will

make it easier to link the proposed actions with the recommendations set out in the conservation plans developed for the bird conservation regions (BCRs).

Indicators were also selected to document the importance of the NWAs for other taxonomic groups whose populations are in decline in Quebec and elsewhere in North America, such as anurans (frogs and toads) and chiropters (bats). Monitoring networks for these groups already exist in Quebec, and the addition of the NWAs to these networks will complement the existing spatial coverage along the St. Lawrence River.

8.3.1 Landbird diversity and abundance

NWAs: All

Priority: High

A major breeding bird survey was conducted in each NWA between 2004 and 2006 to update knowledge on the distribution and abundance of breeding birds. Landbirds were then targeted in multispecies surveys in which point counts were established and surveyed in the main ecosystems of the NWAs. Periodic monitoring of breeding birds is proposed in order to properly determine the status of nesting birds and to detect changes that may occur.

The “landbird diversity and abundance” indicator involves performing songbird counts, ideally at the same sites as were used in the 2000s. These counts will employ the listening station method, combining the fixed-radius count technique and the point count technique (Bibby et al., 2000). The locations of the point counts and the sampling frequency remain to be determined. Vegetation monitoring protocols are implemented at the point counts in parallel with the bird surveys, resulting in very fine-scale concurrent monitoring of plant communities.

Certain species or groups of species will require specific survey methods to complement the point count data. The additional surveys are necessary because the presence of these species is better documented through specific survey methods or because the species are present in only certain NWAs. The following specific surveys are proposed:

- Lake Saint-François: Owl monitoring (call playback survey in the spring).
- Îles de la Paix: Potential roosting sites for migrating swallows. Thousands of swallows reportedly use this NWA in August prior to the fall migration (Rivard and Giguère, 2014b). A targeted survey during this period would quantify the actual use of this NWA by swallows and help subsequently determine whether monitoring is needed.
- Îles de Contrecœur: Monitoring of Bank Swallow colonies (visual count).
- Cap Tourmente: Monitoring of Cliff Swallow colonies on buildings (visual count).
- Cap Tourmente: Monitoring of farmland birds and other open-country species, ongoing since 1998 (Gagnon-Lupien, 2012).
- Baie de L’Isle-Verte: Monitoring of Bobolink and other open-country species, surveys conducted in 2005 and 2015.

8.3.2 Waterfowl diversity and abundance

NWAs: Lake Saint-François; Îles de la Paix; Îles de Contrecœur; Estuary Islands; Baie de L'Isle-Verte

Priority: High

NWAs: Cap Tourmente; Pointe de l'Est

Priority: Medium

NWA: Pointe-au-Père

Priority: Low

A number of the NWAs were established to protect habitats used as migratory staging and/or breeding grounds by waterfowl. However, different waterfowl communities use different NWAs. For instance, the NWAs in the Montreal area are heavily used by nesting dabbling ducks, while the Estuary Islands NWA is a popular nesting site for Common Eider, a sea duck. The "waterfowl diversity and abundance" indicator will be used to monitor the status of waterfowl populations based on the species using each NWA and the conservation purpose of each NWA. The effort required and survey methodologies will also vary depending on the species present and the accessibility of the sites:

- Lake Saint-François: Ground brood survey at accessible sites (e.g. Digue aux Aigrettes sector). It is proposed that a helicopter brood survey be carried out (in late June or early July) to address the uncertainty surrounding the actual density of nesting pairs in the NWA and the feasibility of conducting brood surveys at sites that are difficult or impossible to access.
- Îles de la Paix: Helicopter survey of migrating birds in the spring. Helicopter brood survey. Nest search on the ground in selected plots.
- Îles de Contrecœur: Helicopter brood survey. Nest search on the ground in selected plots.
- Cap Tourmente: Ground brood survey at accessible sites. Nest search on the ground in selected plots.
- Estuary Islands: Survey of Common Eider nests during eiderdown harvesting.
- Baie de L'Isle-Verte: Ground brood survey. Nest search on the ground in selected plots. The number of American Black Ducks (and other species) banded each year at the banding station is another proposed indicator.
- Pointe-au-Père: Consultation of existing databases (ÉPOQ, eBird).
- Pointe de l'Est: Ground survey of nesting pairs in ponds.

Ground surveys of waterfowl nests were carried out in the 1990s in the Îles de Contrecœur NWA (Giroux et al., 1992, 1993 and 1995). This technique is labour intensive but could be used in sample plots chosen to be representative of the habitats in the NWA. However, two or three visits per year would be required in order to include early and late nesters. A helicopter survey of migratory birds in the spring in the Îles de la Paix NWA is proposed as a means of quantifying the importance of this NWA to

waterfowl during migration. This survey method is appropriate because much of the NWA will be underwater due to spring flooding. It may be possible to take advantage of the helicopter surveys conducted by the CWS in this area in the spring (C. Lepage, pers. comm.). Furthermore, an analysis of existing databases (ÉPOQ and eBird) could yield useful information on nesting waterfowl in certain NWAs that are easily accessible to the public (Cap Tourmente; Pointe-au-Père).

8.3.3 Colonial waterbird diversity and abundance

NWAs: Îles de Contrecœur; Estuary Islands; Baie de L'Isle-Verte; Pointe de l'Est

Priority: High

NWA: Îles de la Paix

Priority: Medium

Colonial waterbirds primarily consist of the species belonging to the ardeid (herons), alcid (guillemots, murres and penguins) and larid (gulls) families. Bird colonies in MBSs in Quebec have been monitored since 1925 (Lewis 1925; Rail and Cotter 2015). Each colony is visited every five years, and the number of nests or nesting adults of each species is counted. Surveys are typically ground- or boat-based. Five-year monitoring of this type has been carried out in the NWAs containing colonial species since 2006. The colonies found in the NWAs are considerably smaller than those established in the MBSs, however. The following species are known to nest or to have historically nested in the NWAs:

- Îles de la Paix: Historical nesting by Great Blue Heron and Black-crowned Night Heron. Ground- or boat-based nest count.
- Îles de Contrecœur: Known nesting by Ring-billed Gull (Îlet à Lefebvre) and Double-crested Cormorant. Ground-based nest count.
- Estuary Islands: Several colonial species nest on the many islands in this NWA. Partial count during eiderdown harvesting activities on Île Bicquette, Île aux Fraises and Île Blanche: Black Guillemot, Razorbill, Black-legged Kittiwake, Great Black-backed Gull, Herring Gull and Double-crested Cormorant; comprehensive boat survey of islands, including sectors outside the NWA for the Îles de Kamouraska, Îles du Pot and Îles Pèlerins: Black Guillemot, Common Murre, Razorbill, Black-legged Kittiwake, Great Black-backed Gull, Herring Gull, Double-crested Cormorant and Black-crowned Night Heron.
- Baie de L'Isle-Verte: Presence of a Black Guillemot colony on the Cacouna cliffs. Count of adults from the cliff or shore.
- Pointe de l'Est: Known nesting by Black-headed Gull; historical nesting by Common Tern, Roseate Tern, Great Black-backed Gull and Herring Gull nearby (Étang de l'Est).

Since the presence and size of the colonies are constantly changing, the diversity and abundance of these birds must be monitored in the NWAs to detect trends and facilitate the implementation of suitable management measures when needed. Nesting by certain species also needs to be confirmed at a few sites (e.g. ardeids in the Îles de la Paix NWA). Survey methods may vary depending on the targeted species and habitats and

the accessibility of the sites. Note that other waterbird species (i.e. non-colonial, such as rallids) that use inland wetlands (marshes and swamps), will be monitored during the surveys of landbirds or species at risk.

8.3.4 Shorebird diversity and abundance

NWAs: Baie de L'Isle-Verte; Pointe-au-Père

Priority: Medium

The shorebirds that nest in the NWAs are neither diverse nor abundant. These species (e.g. Wilson's Snipe, Killdeer) will be surveyed during the landbird counts. Some NWAs are heavily used by shorebird species during migration, and the diversity and abundance of this bird group must be monitored in order to better quantify the importance of the NWAs to these species. Discussions are in progress to implement a Quebec-wide shorebird monitoring program, which could be based on the Atlantic Canada Shorebird Survey (Y. Aubry, pers. comm.). The NWAs with the highest potential for shorebirds could be selected as survey sites in this program. To be specific, the following surveys should be carried out for shorebird monitoring:

- Baie de L'Isle-Verte: Monitoring of Red Knot and other shorebird species. Ground survey.
- Pointe-au-Père: This NWA used to host high concentrations of shorebirds during migration. However, habitat conditions have changed so much in recent years (end of wastewater releases into the NWA) that this group of birds is now less abundant than in the past. Surveys were conducted in the fall of 2015 to quantify the current use of this NWA by shorebirds during the fall migration. The analysis of the results will help determine whether shorebird monitoring should be implemented.

8.3.5 Anuran diversity and abundance

NWAs: Lake Saint-François; Îles de la Paix; Îles de Contrecœur; Cap Tourmente; Baie de L'Isle-Verte; Pointe-au-Père

Priority: Medium

Anurans (frogs and toads) are good indicators of wetland quality because they live near their birthplace year-round, and their physiology makes them likely to quickly respond to changes in the quality of their habitat. Anuran population monitoring networks are in place at various locations around the world, including in Quebec (St. Lawrence Valley Natural History Society, 2009). The methodology selected for the anuran monitoring program consists of performing acoustic surveys at predetermined listening stations. The listening periods are five minutes long and take place in the evening. An abundance ranking is assigned to each species heard, and all individuals heard are considered, regardless of their distance from the station. Since not all species are active at the same time, three survey periods are planned (April, May and June) to include all species that may be present.

Acoustic anuran surveys were conducted in the NWAs in the 2000s during wildlife surveys. At the time, listening stations were established and surveyed in the main

ecosystems of the NWAs. The planned surveys in the NWAs could cover the same sites as were visited in the 2000s.

8.3.6 Bat diversity and abundance

NWAs: Lake Saint-François; Îles de la Paix; Îles de Contrecœur; Cap Tourmente; Baie de L'Isle-Verte; Pointe de l'Est

Priority: Low

Populations of hibernating bats (chiropters) in northeastern North America have declined markedly in recent years owing to the emergence of a disease (white-nose syndrome) caused by an exotic fungus that is decimating individuals in hibernacula. Mortality associated with white-nose syndrome has reduced populations in infested hibernacula in the eastern United States by more than 75% (Frick et al., 2010), and significant declines have been observed in Quebec hibernacula since the fungus first appeared in 2010. The abundance of Little Brown Myotis and Northern Myotis is thought to have fallen by close to 94% in eastern Canada since the fungus was detected, and white-nose syndrome has caused declines of more than 75% in the known hibernating populations of Tri-coloured Bat in Quebec and New Brunswick (Environment Canada, 2015b). These three species are designated as endangered species in Canada (Environment Canada, 2015b). Since the wildlife surveys conducted in 2004 showed that a number of bat species were using the NWAs, periodic monitoring will make it possible to document the importance of NWAs for this taxonomic group.

The methodology selected for the monitoring network set up by the provincial government consists of conducting acoustic bat surveys using a specialized device equipped with an ultrasonic microphone (Jutras et al., 2012). This device processes echolocation calls into a form audible to humans. The processed calls can thus be simultaneously heard and recorded. Acoustic analysis software is then used to produce sonograms from which species can be identified on the basis of their sound signatures (Charbonneau and Tremblay, 2010).

The location of the bat survey routes in the NWAs remains to be determined. Land routes were surveyed in the Lake Saint-François, Cap Tourmente, Baie de L'Isle-Verte and Pointe de l'Est NWAs in the 2000s; the same routes could be used for the monitoring program. It should be determined whether boat survey routes in the Îles de la Paix and Îles de Contrecœur NWAs could be added to the provincial monitoring network. If that is not possible, listening stations could be established in these NWAs.

8.4 "Species at Risk" theme

8.4.1 Abundance and distribution of species at risk

One of the objectives of the wildlife and plant surveys conducted in the NWAs in the 2000s was to refine our knowledge of the distribution and abundance of species at risk. The quantitative criteria for identifying these species at risk are numerous, but all of the species are rare (low population numbers) and have a very limited distribution or are in a marked decline (population or distribution). Furthermore, many sections of the *Species at Risk Act* apply on federal land. Periodic monitoring is important to measure the status of species at risk populations and to identify possible changes in their demographics or distribution.

A prioritization grid has been produced for each NWA to help determine which species should be considered a priority for monitoring. The first step in producing the grid was to prepare a list of the species at risk known to be present in each NWA. The species on the list were those listed in SARA or the Quebec *Act Respecting Threatened or Vulnerable Species* (LEMV), those designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and awaiting listing in SARA, and bird species likely to be designated threatened or vulnerable in Quebec under the LEMV. The analyses also considered the surrounding land owned by Environment Canada but lacking NWA status (e.g. Gros-Cacouna bird watching site located near the Baie de L'Isle-Verte NWA). Next, the species were ranked according to two criteria: 1) EC's legal responsibility for the species; and 2) importance of the NWA to the Quebec population of the species. The second criterion was determined based on current knowledge of the distribution and abundance of each species in the NWAs and across Quebec by consulting experts and relevant documents (COSEWIC reports, recovery strategies, etc.). Each species was then assigned a weight for each of the criteria.

1) Weight according to EC's legal responsibility (status)

4 pts = Migratory bird species at risk protected by SARA or the LEMV

3 pts = Other species at risk listed in Schedule 1 of SARA

2 pts = Other species at risk protected by the LEMV

1 pt = Migratory birds at risk not protected by SARA or the LEMV (species likely to be designated threatened or vulnerable, COSEWIC)

2) Weight according to the importance of the NWA to the Quebec population

3 pts = High importance

2 pts = Medium importance

1 pt = Low importance

The calculated prioritization index is the product of these two weights:

$$\text{Index} = \text{Weight}_{\text{status}} \times \text{Weight}_{\text{importance}}$$

The prioritization index can be used to rank the species in a specific order. As an arbitrary example, we suggest implementing a monitoring program for species with a prioritization index of 4 or higher (Table 7). Note that this prioritization grid is a decision support tool that can be adapted to consider the attributes specific to each NWA, possible changes in the status assigned to the species, or new information on their distribution and abundance in the NWAs and elsewhere in Quebec. This tool can also be used to determine short-term surveying needs for ascertaining the actual status of certain species in the NWAs (historical or unknown presence – species not listed in Table 7). The species at risk known to occur in each NWA and their prioritization index are listed in Appendix 4.

Table 7. Species at risk with a prioritization index of ≥ 4 in at least one NWA.

Species	Taxonomic Group	Lake Saint-François	Îles de la Paix	Îles de Contrecœur	Cap Tourmente	Baie de L'Isle-Verte	Estuary Islands	Pointe-au-Père	Pointe de l'Est
American Ginseng	Plant	6	0	0	6	0	0	0	0
Butternut	Plant	6	0	0	6	0	0	0	0
Green Dragon	Plant	0	6	2	0	0	0	0	0
Gulf of St. Lawrence Aster	Plant	0	0	0	0	0	0	0	6
Broom Crowberry	Plant	0	0	0	0	0	0	0	6
Victorin's Water-hemlock	Plant	0	0	0	6	0	0	0	0
Purple-stemmed Cliff-brake	Plant	0	0	0	6	0	0	0	0
Wild Leek	Plant	0	0	0	6	0	0	0	0
Maidenhair Fern	Plant	4	0	0	0	0	0	0	0
Wild Ginger	Plant	4	0	0	2	0	0	0	0
Eastern Sand Darter (Quebec populations)	Fish	9	0	0	0	0	0	0	0
Grass Pickerel	Fish	9	6	0	0	0	0	0	0
Snapping Turtle	Reptile	9	9	6	0	0	0	0	0
Eastern Musk Turtle	Reptile	6	0	0	0	0	0	0	0
Northern Map Turtle	Reptile	6	0	0	0	0	0	0	0
Piping Plover (ssp. *melodus*)	Bird	0	0	0	0	0	0	0	12
Roseate Tern	Bird	0	0	0	0	0	0	0	12
Horned Grebe (Magdalen Islands popul.)	Bird	0	0	0	0	0	0	0	12
Peregrine Falcon *anatum/tundrius*	Bird	0	0	0	8	4	8	0	0
Barrow's Goldeneye (Eastern population)	Bird	0	0	0	0	0	8	0	0
Rusty Blackbird	Bird	0	0	0	0	0	0	0	8
Red Knot (ssp. *rufa*)	Bird	0	0	0	0	8	4	4	8
Short-eared Owl	Bird	8	0	0	8	8	0	4	4
Yellow Rail	Bird	8	0	0	8	8	0	0	0
Chimney Swift	Bird	4	0	0	4	0	0	0	0
Golden-winged Warbler	Bird	4	0	0	0	0	0	0	0
Canada Warbler	Bird	0	0	4	0	4	0	0	0
Least Bittern	Bird	4	0	0	4	4	0	0	0
Caspian Tern	Bird	0	4	4	0	0	0	0	0
Bats of the genus *Myotis* *	Mammal	6	3	3	3	3	3	0	3
Tri-coloured Bat	Mammal	6	0	0	0	0	0	0	0

* Northern Myotis and/or Little Brown Myotis

Specific survey protocols already exist for a number of species at risk (e.g. Least Bittern [Jobin et al., 2011], Yellow Rail [Bazin and Baldwin, 2007]). Most species with a high prioritization index will be surveyed in the planned multispecies surveys for the Biotic

Communities monitoring indicators (anurans, birds, bats). The type of data gathered in the surveys will dictate the most appropriate indices for monitoring the distribution and abundance of each species (e.g. relative abundance, density, presence/absence, frequency of occurrence, catch per unit effort).

9. Comparison with existing monitoring programs

The NWA ecological monitoring program focuses on monitoring populations of nesting and migratory birds because the conservation of this wildlife group is the primary mission of the Canadian Wildlife Service. Similarly, monitoring of species at risk is an important part of the program because NWAs are important refuges for a number of species designated as species at risk under SARA. However, many indicators related to the anthropogenic pressures and threats that can affect the ecosystems present in NWAs have also been selected in order to facilitate monitoring.

The other monitoring programs in place in protected areas located along the St. Lawrence River have similar objectives. Indicators associated with ecosystems, species at risk, threats and certain ecological processes have been selected for the ecological monitoring of national and provincial parks, Gatineau Park, nature parks in the city of Montreal and some privately owned protected areas. Several of the indicators frequently used in these monitoring programs have also been selected for the NWA monitoring program:

- Land use and fragmentation
- Monitoring of invasive plant species
- Bacteriological and physicochemical water quality
- Monitoring of benthic invertebrates
- Monitoring of birds
- Monitoring of anurans
- Monitoring of bats
- Monitoring of species at risk

It is worth noting that all of these indicators (apart from species at risk monitoring) are included among the 12 indicators (of a total of 30) with the greatest ecological power for monitoring the ecological integrity of Quebec provincial parks, according to an analysis by 72 experts (Gingras and Graillon, 2012).

A monitoring program implemented in the NWAs, all of which are located along the St. Lawrence, would complement the existing programs and form a monitoring program encompassing all of the ecosystems along this vast river system (see section 4). However, although the indicators may be common to multiple monitoring programs, the methodologies and survey protocols may vary slightly from one program to another. In the NWA monitoring program, special care will be taken to select the survey methods that best harmonize with the existing programs in order to optimize their comparability and complementarity. A detailed analysis of the existing programs and sampling

strategies currently in place along the St. Lawrence, including the indicators used in the State of the St. Lawrence Monitoring Program (http://planstlaurent.qc.ca/en/state_monitoring.html), will maximize the benefits.

10. Strengthening the Quebec NWA monitoring program

A number of other steps and activities are planned to strengthen the Quebec NWA monitoring program. The development and implementation of this monitoring program are part of a broader project under which the protected areas located along the St. Lawrence will be included in an integrated ecological monitoring program. The project is being led jointly by the CWS, MFFP and other collaborators as part of the St. Lawrence Action Plan 2011–2026.

Within the next two years, a document related to the present document will be prepared, providing more details on the sampling strategies for each indicator, the selection of survey sites in each NWA, a work schedule, estimated costs, identification of implementation mechanisms, establishment of thresholds (desired condition) for each indicator, suggested statistical analysis methods, and reporting mechanisms (indicators of the health of the NWAs, format of presentation reports). The next document will seek to incorporate the implementation of the NWA monitoring program into regular CWS activities, such as its spring waterfowl surveys, monitoring of colonial waterbirds, and activities listed in species at risk recovery strategies. The use of provincially standardized survey protocols for certain wildlife groups (e.g. anurans, chiropters, benthic fauna) will make it possible to enter the data gathered in the existing databases and to fill gaps in available information in certain regions located along the St. Lawrence. The proposed monitoring programs will be implemented gradually over the coming years, although some indicators are already subject to periodic monitoring, and data collection activities are already scheduled for 2016. A preliminary report on the status of the NWAs and protected areas along the St. Lawrence is scheduled to be produced after 2021.

11. Conclusion

The role of indicators is to detect changes in the condition of wildlife and plant populations, ecosystems, or anthropogenic pressures and threats, thus facilitating a rapid response based on up-to-date knowledge. The implementation of a monitoring program for NWAs in Quebec is an important tool for ensuring effective management of these areas, particularly with regard to monitoring of populations of migratory birds and species at risk. The creation of an ecological monitoring program for NWAs is recommended in the NWA management plans currently being revised. The usefulness and relevance of this tool have been demonstrated in the other networks of protected areas located along the St. Lawrence (federal parks, provincial parks, etc.).

A number of the indicators selected for the proposed NWA monitoring program will be measured in all (or most) of the NWAs, and some relate to monitoring of wildlife groups:

- Land use and fragmentation
- Monitoring of invasive plant species

- Monitoring of bank and shoreline erosion
- Monitoring of nesting birds
- Monitoring of species at risk
- Monitoring of anurans
- Monitoring of bats

This will make it possible to compare the condition of these NWAs and to assess the contribution of the NWAs to the conservation of these wildlife groups in comparison to the other protected areas along the St. Lawrence. Monitoring of nesting birds representative of each of the four major bird groups (landbirds, waterfowl, shorebirds and colonial waterbirds) is a major contribution of this monitoring program.

Note that the present document describes the steps in the development of the monitoring program, the indicators selected and the methodologies proposed. Since the implementation of a monitoring program is a dynamic, evolving process that can take several years, these elements information will be constantly refined as new data are gathered, particularly in relation to the survey methodologies and protocols. Lastly, the implementation process will greatly depend on the available resources and partnership opportunities, which means that some proposed actions may be brought forward, postponed or cancelled.

12. References

Allard, M. 2008. *Analyse spatio-temporelle de l'évolution des marais à scirpe de l'habitat migratoire de la Grande Oie des Neiges à l'aide de l'imagerie IKONOS et de photographies aériennes*. Mémoire de maîtrise, Université de Sherbrooke, 147 p.

Allard, M., R.A. Fournier, M. Grenier, J. Lefebvre and J.-F. Giroux. 2012. *Forty years of change in the Bulrush marshes of the St. Lawrence Estuary and the impact of the Greater Snow Goose*. Wetlands 32: 1175-1188.

Atkinson, A.J., P.C. Trenham, R.N. Fisher, S.A. Hathaway, B.S. Johnson, S.G. Torres and Y.C. Moore. 2004. *Designing Monitoring Programs in an Adaptive Management Context for Regional Multiple Species Conservation Plans*. U. S. Geological Survey. Sacramento, California, 69 p.

Attention FragÎles/Groupe de référence en environnement des Îles-de-la-Madeleine 2012. *Plan stratégique d'intervention en environnement pour le territoire des Îles de la Madeleine*. [http://psie-tim.attentionfragiles.org], july 2015.

Bazin, R. and F.B. Baldwin. 2007. *Canadian Wildlife Service standardized protocol for the survey of Yellow rails (Coturnicops noveboracensis) in Prairie and Northern Region*. Environment Canada, Canadian Wildlife Service. Unpublished report, 22 p.

Bédard, J., A. Nadeau and M. Lepage. 1995. *Double-crested cormorant culling in the St.Lawrence River estuary*. Colonial Waterbirds 18 (Special Publication 1): p. 78-85.

Bédard, J., A. Nadeau and J.-P.L. Savard 1997. *Les communautés terrestres des îles de l'estuaire du Saint-Laurent : oiseaux et plantes forestières*. Service canadien de la faune, Région du Québec, Série de Rapports techniques No. 302, 158 p.

Bernatchez, P. 2015. *Suivi de l'érosion des berges dans la Réserve nationale de faune du Cap-Tourmente (2007 à 2014).* Rapport présenté au ministère de l'Environnement du Canada par le Laboratoire de dynamique et de gestion intégrée des zones côtières et la Chaire de recherche en géoscience côtière, Université du Québec à Rimouski. 8 p.

Bernatchez, P. and J.-M. Dubois. 2004. *Bilan des connaissances de la dynamique de l'érosion des côtes du Québec maritime laurentien*. Géographie physique et Quaternaire 58 (1) : p. 45-71.

Bernatchez, P., C. Fraser, S. Friesinger, Y. Jolivet, S. Dugas, S. Drejza and A. Morissette. 2008. *Sensibilité des côtes et vulnérabilité des communautés du golfe du Saint-Laurent aux impacts des changements climatiques*. Laboratoire de dynamique et de gestion intégrée des zones côtières, Université du Québec à Rimouski. Rapport de recherche remis au Consortium OURANOS et au FACC, 256 p.

Bibby, C.J., N.D. Burgess, D.A. Hill, and S.H. Mustoe. 2000. *Bird Census Techniques*, 2nd ed. Academic Press, London. 302 p.

Bouffard, V. and P. Poirier. 2002. *Plan de conservation des habitats d'espèces en péril aux Îles-de-la-Madeleine*. Attention FragIles.

Campeau, S., I. Lavoie, and M. Grenier. 2013. *Le suivi de la qualité de l'eau des rivières à l'aide de l'indice IDEC*. Guide d'utilisation de l'Indice Diatomées de l'Est du Canada (version 3). Département des sciences de l'environnement, Université du Québec à Trois-Rivières, 25 p.

Charbonneau, P. and G. Tremblay, 2010. *Création d'une banque de référence pour l'identification des chauves-souris au Québec*. Le Naturaliste canadien 134 (1) : p. 50-61.

Dauphin, D. 2000. *Influence de la navigation commerciale et de la navigation de plaisance sur l'érosion des rives du Saint-Laurent dans le tronçon Cornwall - Montmagny*. SLV2000. Ministère des Transports du Québec. Rapport final. 103 p. + cartes + annexes.

Dauphin, D. and D. Lehoux. 2004. *Bilan de la sévérité de l'érosion dans le Saint-Laurent dulcicole (Montréal – archipel de Berthier-Sorel, incluant les Îles-de-la-Paix) et stratégies de protection recommandées pour les rives à plus grande valeur biologique*. Environnement Canada, Service canadien de la faune, Région du Québec. 231 p. + annexes.

Environment Canada. 2013a. *Recovery Strategy for the Horned Grebe (Podiceps auritus), Magdalen Islands Population, in Canada*, Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. iv + 19 pp.

Environment Canada. 2013b. *Invasive Alien Species in Canada*. Government of Canada. [http://www.ec.gc.ca/eee-ias/Default.asp?lang=En], april 2016.

Environment Canada. 2014a. *Îles de la Paix National Wildlife Area Management Plan*. Environment Canada, Canadian Wildlife Service, Quebec, 38 p.

Environment Canada. 2014b. *Management Plan for the Estuary Islands National Wildlife Area [Proposed]*. Environment Canada, Canadian Wildlife Service, Québec, 55 p.

Environment Canada. 2015a. *Protected Areas*. Government of Canada. [http://www.ec.gc.ca/ap-pa/Default.asp?lang=En&n=7FC45404-1], april 2016.

Environment Canada. 2015b. *Recovery Strategy for Little Brown Myotis (Myotis lucifugus), Northern Myotis (Myotis septentrionalis), and Tri-colored Bat (Perimyotis subflavus) in Canada [Proposed]*. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. ix + 110 pp.

Fancy, S.G., J.E. Gross and S.L. Carter. 2009. *Monitoring the conditions of natural resources in US National Parks*. Environmental Monitoring and Assessment 151: p. 161-174.

Frick, W., J. Pollock, A. Hicks, K. Langwig, S. Reynolds, G. Turner, C. Butchkoski and T. Kunz. 2010. *An emerging disease causes regional population collapse of a common North American bat species*. Science 329: 679-682.

Gagnon-Lupien, N. 2012. *Impacts des pratiques agricoles modernes sur les oiseaux champêtres à la Réserve nationale de faune du cap Tourmente. Suivi de 1998 à*

2010. Environnement Canada, Service canadien de la faune, Région du Québec. Rapport non publié. 17 p.

Gingras, J. and P. Graillon. 2012. *L'expertise de 72 scientifiques permet de bonifier le Programme de suivi de l'intégrité écologique*. Bulletin de conservation 2012-2013. Parcs Québec et SÉPAQ, p. 15-17. [http://www.sepaq.com/pq/conserver/bulletin_conservation.dot], july 2015.

Girard, M. 2009. *Impact de la Grande Oie des neiges sur les marais à scirpe de l'estuaire du Saint-Laurent, Québec*. Mémoire de maîtrise, Université du Québec à Montréal, 80 p.

Giroux, J.-F., M. Caron, M. Picard and S. Carrier. 1992. *Effet du contrôle des prédateurs sur la nidification des canards à la Réserve nationale de faune des Iles de Contrecœur*, Environnement Canada, Service canadien de la faune, Région du Québec. Rapport non publié.

Giroux, J.-F. and M. Picard. 1993. *Utilisation de l'habitat par les couvées de canards à la réserve nationale de faune des îles de Contrecœur*, Rapport présenté au Service canadien de la faune, Université du Québec à Montréal, Département des sciences biologiques, Montréal. 32 p.

Giroux, J.-F., F. Saint-Pierre, J. Lefebvre and S. Lapointe. 1995. *Contrôle des prédateurs et nidification des canards à la Réserve nationale de faune des Iles de Contrecœur en 1994*. Université du Québec à Montréal. 12 p.

Hazel, F., M. Doyle, S. St. Jean and S. Courtenay (editors). 2006. *Proceedings of the First Workshop on Nearshore Marine Monitoring, February 7th – February 9th 2006*. Bedford Institute of Oceanography, Halifax, NS, 20 p.

Hébert, S. 1997. *Développement d'un indice de la qualité bactériologique et physico-chimique de l'eau pour les rivières du Québec*. Québec, ministère de l'Environnement et de la Faune, Direction des écosystèmes aquatiques, envirodoq EN/970102, 20 p. et 4 annexes. [http://www.mddelcc.gouv.qc.ca/eau/sys-image/glossaire2.htm]

Jobin, B. 2002. *Développement d'un plan d'action pour évaluer et assurer le suivi de l'intégrité écologique des Réserves nationales de faune et des Refuges d'oiseaux migrateurs au Québec*. Environnement Canada, Service canadien de la faune, région du Québec. iv, 28 p. et 3 annexes.

Jobin, B., R. Bazin, L. Maynard, A. McConnell and J. Stewart. 2011. *National Least Bittern Survey Protocol*. Technical Report Series No. 519, Environment Canada, Canadian Wildlife Service, Quebec Region, Quebec, 26 p.

Joubert, J.-É., É. Bachand and A. Lelièvre-Mathieu. 2012. *Rapport de caractérisation du marais de la Réserve nationale de Faune de Pointe-au-Père. Les communautés végétales du marais maritime de Pointe-au-Père et caractérisation géomorphologique.* Présenté à Environnement Canada. Comité Zone d'Intervention Prioritaire du Sud-de-l'Estuaire, printemps 2012. 37 p.

Jutras, J., M. Delorme, J. Mc Duff and C. Vasseur. 2012. *Le suivi des chauves-souris du Québec.* Le Naturaliste canadien 136 (1) : p. 48-52.

Labrecque, S. and B. Jobin. 2013. *Dynamique des habitats et des pressions périphériques dans les Réserves nationales de faune des Îles-de-la-Paix, des Îles-de-Contrecœur, des Îles-de-l'Estuaire et de la Pointe de l'Est*. Environnement Canada, Service canadien de la faune, région du Québec, Québec. 81 p.

Lefebvre, J., A. Reed, J.-F. Giroux, N. Plante and L. Bélanger. 2001. *Suivi de la végétation du marais à scirpe de la Réserve nationale de faune du Cap Tourmente (1971-2000)*. Série de rapports techniques No. 371, Service canadien de la faune, Région du Québec.

Lepage, M. 2012. *Principaux programmes de surveillance écologique d'intérêt pour les Réserves nationales de faune*. Pour Environnement Canada, Service canadien de la faune, Région du Québec. 27 p. et annexes.

Lepage, M. 2013. *Revue et analyse des programmes de surveillance écologique en vigueur le long du Saint-Laurent*. Pour Environnement Canada, Service canadien de la faune, Région du Québec. 33 p.

Lewis, H. F. 1925. *The new bird sanctuaries in the Gulf of St. Lawrence*. Canadian Field-Naturalist 39: p. 177-179.

Maheu-Giroux M., S. de Blois and B. Jobin. 2006. *Dynamique des paysages de quatre Réserves nationales de faune du Québec : Suivi des habitats et des pressions périphériques*. Université McGill, Département de sciences végétales et Environnement Canada, Service canadien de la faune, Région du Québec. 67 p. + annexes.

Ministère des Ressources naturelles (MRN). 2001. *Les écosystèmes forestiers exceptionnels du Québec. Éléments clés de la diversité biologique*. Ministère des Ressources naturelles, Gouvernement du Québec. 16 p. [http://www.mffp.gouv.qc.ca/forets/connaissances/connaissances-ecosystemes.jsp]

Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs (MDDEFP). 2012a. *Indice d'intégrité biotique basé sur les macroinvertébrés benthiques et son application en milieu agricole – Cours d'eau peu profonds à substrat grossier*, Québec, Direction du suivi de l'état de l'environnement, ISBN 978-2-550-66035-4 (PDF), 72 p. (dont 7 annexes).

Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs (MDDEFP). 2012b. *Élaboration d'un indice d'intégrité biotique basé sur les macroinvertébrés benthiques et mise en application en milieu agricole – Cours d'eau peu profonds à substrat meuble*, Québec, Direction du suivi de l'état de l'environnement, ISBN 978-2-550-65630-2 (PDF), 62 p. (incluant 10 annexes).

National Park Service. 2014. *Monitoring the Condition of Natural Resources*. [http://science.nature.nps.gov/im/monitor], july 2015.

Ouellet, M., J. Bonin, J. Rodrigue, J.-L. DesGranges and S. Lair. 1997. *Hindlimb deformities (Ectromelia, Ectrodactyly) in free-living anurans from agricultural habitats*. Journal of Wildlife Diseases 33: p. 95-104.

Parks Canada. 1997. *State of the Parks 1997 Report*. Canadian Heritage, Parks Canada, Ottawa.

Parks Canada Agency. 2000. *Unimpaired for Future Generations? Protecting Ecological Integrity with Canada's National Parks*. Vol. I A Call to Action. Vol. II Setting a New Direction for Canada's National Parks. Report of the Panel on the Ecological Integrity of Canada's National Parks. Ottawa, Ontario.

Parks Canada Agency. 2010. *Performance Report for the period ending March 31, 2010*. 84 p. [http://www.pc.gc.ca/eng/docs/pc/rpts/rmr-dpr/03312010.aspx], april 2016.

Rail, J.-F. and R. Cotter. 2015. *Seventeenth census of seabird populations in the sanctuaries of the North Shore of the Gulf of St. Lawrence, 2010*. Canadian Field-Naturalist 129(2): 152–158.

Rivard, A. and S. Giguère. 2014a. *Bilan des inventaires fauniques et floristiques à la Réserve nationale de faune des îles de Contrecœur, 2004 et 2006*. Environnement Canada, Service canadien de la faune, région du Québec, Québec. 36 p. + annexes.

Rivard, A. and S. Giguère. 2014b. *Bilan des inventaires fauniques et floristiques à la Réserve nationale de faune des îles de la Paix, 2004 et 2006*. Environnement Canada, Service canadien de la faune, région du Québec, Québec. 35 p. + annexes.

Service canadien de la faune (SCF). 2003a. *Plan de conservation de la Réserve nationale de faune du Lac Saint-François*. Environnement Canada, Service canadien de la faune, Région du Québec. 109 p. et annexe.

Service canadien de la faune (SCF). 2003b. *Plan de conservation de la Réserve nationale de faune des îles de la Paix*. Environnement Canada, Service canadien de la faune, Région du Québec. 41 p. et annexes.

Service canadien de la faune (SCF). 2003c. *Plan de conservation de la Réserve nationale de faune des îles de Contrecœur,* Environnement Canada, Service canadien de la faune, Région du Québec. 34 p. et 2 annexes.

Service canadien de la faune (SCF). 2003d. *Plan de conservation de la Réserve nationale de faune du cap Tourmente*. Environnement Canada, Service canadien de la faune, Région du Québec. 64 p. et annexes.

Service canadien de la faune (SCF). 2003e. *Plan de conservation de la Réserve nationale de faune des îles de l'estuaire*. Environnement Canada, Service canadien de la faune, Région du Québec. 76 p. et annexes.

Service canadien de la faune (SCF). 2003f. *Plan de conservation de la Réserve nationale de faune de Pointe-au-Père*. Environnement Canada, Service canadien de la faune, Région du Québec. 52 p. et annexe.

Service canadien de la faune (SCF). 2004. *Plan de conservation de la Réserve nationale de faune et du Refuge d'oiseaux migrateurs de la baie de L'Isle-Verte.* Environnement Canada, Service canadien de la faune, Région du Québec. 70 p. + annexes.

Service canadien de la faune (SCF). 2005. *Plan de conservation de la Réserve nationale de faune de la Pointe de l'Est*. Environnement Canada, Service canadien de la faune, Région du Québec. 59 p. + annexe.

Société des établissements de plein air du Québec (Sépaq). 2014. *Ecological integrity monitoring program (EIMP)*. Parcs Québec Network. Société des établissements de plein air du Québec, Québec, Québec. 85 p. and appendices.

Société d'histoire naturelle de la vallée du Saint-Laurent. 2009. *Programme du suivi des populations d'amphibiens du Québec. Manuel du participant : Protocole de suivi des parcours routiers*. Préparé par la Société d'histoire naturelle de la vallée du Saint-Laurent pour le ministère des Ressources naturelles et de la Faune. Montréal. 13 p.

Soverel, N., N.C. Coops, J.C. White and M.A. Wulder. 2010. *Characterizing the forest fragmentation of Canada's national parks*. Environmental Monitoring and Assessment 164: p. 481-499.

Woodley, S. 1993. *Monitoring and measuring ecosystem integrity in canadian national parks*. Pp. 155-176. Dans S. Woodley, J. Kay et G. Francis (éds.). Ecological integrity and the management of ecosystems. Sponsored by Heritage Resources Centre, University of Waterloo, and Canadian Parks Service, Ottawa. St. Lucie Press, U.S.A.

Appendix A. Proceedings of the consultation workshop of April 14, 2014

EXPERT CONSULTATION WORKSHOP
ON ECOLOGICAL MONITORING OF NATIONAL WILDLIFE AREAS (NWAs)
April 14, 2014
Environment Canada – Canadian Wildlife Service
Estimauville Building – 7th Floor – Laurentides Room

Organizations and individuals present

Organization	Representatives
Environment Canada – Canadian Wildlife Service	Stéphanie Gagnon; Sylvain Giguère; Benoît Jobin; Benoît Roberge; Stéphane Turgeon; Marielou Verge
Ministère des Forêts, de la Faune et des Parcs (MFFP)	Jacques Jutras; Anouk Simard
Parks Canada Agency (PCA)	Suzan Dionne; Claude Samson
Parcs Québec – Sépaq	Patrick Graillon
Réseau des milieux naturels protégés (RMN)	Michel Lepage
City of Montreal	Sylvie Comtois
National Capital Commission (Gatineau Park)	Christie Spence (phone)

Suggestions and advice: general comments

- The first thing to do is clearly identify the purpose and objectives of the program. What is the program intended to do: monitor (changes in) the ecological integrity of the site? Monitor management actions? Both?
- Align the selected indicators with national and regional priorities: makes them more acceptable to management.
- Select and rank the indicators based on the NWA's management priorities and purpose.
- All management actions must be considered in relation to their impact on the system.
- Also consider the legal framework and changes known to have occurred in the ecosystems over the years to develop the indicators.
- The primary function of a monitoring program is to detect changes, not necessarily to explain them. However, it may be useful (albeit expensive) to collect data on certain explanatory variables.
- The development of a monitoring program may take years, its implementation is dynamic, periodic review (addition and elimination of indicators, changes to protocols, etc.); always evolving; may take years to make it operational.
- Start implementing the monitoring program with a few simple indicators that yield results quickly.

Appendix A (continued)

- Weight the indicators based on their importance to the site (e.g., purpose of the NWA).
- Reporting methods vary depending on whether the target audience is managers, the general public or scientists.
- Use of volunteers to implement the indicators is not recommended. Proper supervision and training are often required. A number of participants mentioned volunteers becoming disengaged after a few years.
- Implementation for long-term consistency and rigour: in-house employees, summer students, interns.
- Depending on the area, citizen scientists may be a very advantageous option. Data are collected by volunteers but as part of a recognized large-scale program (e.g. BBS, PlantWatch).
- Develop indicator selection, sampling strategy and implementation scenarios based on available human and financial resources.
- Development of sampling strategies and cost estimate: Anouk and Claude already have evaluation grids that they can share with us.
- It may be better to establish a budget plan for each measurement or indicator (rather than for the program as a whole) to make it easier for management to understand and accept.
- PCA has developed guidelines associated with the indicators. Important tool.
- PCA is more focused on monitoring the condition of the indicators and sites, whereas Sépaq is more focused on monitoring changes.
- In addition to the monitoring programs in place, a number of organizations (e.g. Sépaq, Gatineau Park) also conduct shorter-term research projects, which are often more costly to implement.
- Gatineau Park and the City of Montreal focus their monitoring on valued natural habitats or habitats with high ecological value (these habitats are often identified by studies conducted in advance of the monitoring).

Suggestions and advice: specific indicators

- Invasive species: identify the species to be monitored, select an early detection protocol, select a protocol for monitoring invaded sectors (known presence of invasive alien species).

Appendix A (continued)

- EFE monitoring: check whether MRN has a monitoring protocol (other than the EIMP protocol) and, if so, compare the methodologies.

- EFE monitoring: identify possible conflicts with the NWA's purpose (e.g. increasing surface area to the detriment of another type of habitat).

- Plant communities: PCA uses permanent plots (e.g. Smithsonian), but it is not necessary to monitor vegetation in all ecosystems in a protected area (i.e. target the more important ecosystems).

- Hunting: it may not be useful to quantify hunting pressure outside the NWA, since birds can be redirected to the NWA (safe zones). It is important to properly determine whether the monitoring is in keeping with the purpose of the NWA (e.g. one purpose of the Îles de la Paix NWA is to provide nesting habitat, not really for migration, so is it relevant to monitor hunting pressure?).

- Erosion monitoring: determine whether it is a natural process or due to human activities and act accordingly. Use of remote sensing and reference markers (marking stakes).

- Monitoring of benthos vs. IQBP: benthos is more integrative, whereas IQBP and pesticides must be measured repeatedly.

- Pesticides: measure bioaccumulation in organisms (plants, eggs) rather than in water.

- Detection and monitoring of Emerald Ash Borer necessary? Monitor the effects of ash mortality instead?

- Anuran monitoring: if listening stations are used, the data cannot be incorporated into the Quebec monitoring network (anuran routes). It seems to be possible to make routes from a boat, in keeping with the protocol. Species monitored provincially = Wood Frog, Northern Spring Peeper, American Toad.

- Chiropter monitoring: talk about species at risk monitoring instead, do not necessarily retain in the indicators.

- It does not seem possible to make a chiropter route according to Quebec's standardized protocol in some NWAs. However, there is a fixed-station protocol that would be advantageous for a number of NWAs (e.g. especially for islands).

- Monitoring of visitor numbers: not very useful, difficult to quantify, difficult to know what they are doing in the NWA.

- Draw a link between the habitats' function and the selected indicators. A number of abundance indicators are proposed; clarify the link with the site's function (nesting? Feeding?).

Appendix A (continued)

- Impact of hunting: not just disturbance and harvest, but possible impact on habitat (access, invasive plants, etc.).

- Rank the species at risk to be monitored in order of priority: according to a prioritization grid (e.g. Parks Canada Agency, COSEWIC) and according to the function of the habitats present in the NWA for those species.

- Consider developing indicators to monitor communities or guilds.

- Satellite images may help save labour and money for various measurements and indicators.

Establishment of baseline thresholds

- Can be done step by step based on available information: historical data, literature, most recent data, expert opinions.

- The thresholds do not need to be established before the program is launched.

- Varies from indicator to indicator.

- A threshold is always arbitrary.

- Thresholds can be established on the basis of response capabilities (financial and human resources).

- Threshold = decision point. If a measurement exceeds the threshold, questions need to be asked: is the threshold right? Is the measurement accurate? Variability of the measurement?

- Confirm the thresholds: consult experts, look at existing monitoring programs, adjust the thresholds to suit the program objectives.

- Distinguish trends from conditions: an upward trend does not necessarily imply an acceptable condition (e.g. populations of species at risk).

Statistical analyses

- The type of analysis varies greatly depending on the data gathered.

- Analyze the variability of historical data: helps determine the value of a possible indicator.

- Analyses of trends: A threshold of 0.20 at Parks Canada Agency indicates a significant trend (enough to detect a change, trigger an alert). Sampling strategies are determined based on this threshold. A threshold of 0.05 would be too stringent and would require excessively costly sampling.

Appendix A (continued)

Reporting

- The reporting method varies depending on whether the target audience is managers, the general public or scientists.
- The public reporting system must be clear and must be interpreted properly by managers so that they understand that certain trends may take years to change even if multiple actions are taken.
- The required reporting frequency will have to be determined.
- Classifying trends as green/yellow/red is a powerful communication tool; suitable for managers and the public.
- If an indicator changes colour (yellow ➔ red), clearly explain the reasons.
- If long-term trends are targeted for certain indicators, other indicators and management targets must be established in order to report on medium-term trends.
- It is also important to have management targets related to the desired condition of a protected area.
- PCA uses the 1/3 rule to assign an overall score based on a combination of indicators (incorporating various other subindicators or measurements).

Implementation

- Selection of sampling sites outside the NWA? Difficult to sell to managers (have to justify the extra cost). One possibility is to point out that these sites can help us achieve our mandates (e.g. migratory birds). Partnerships with local organizations should be developed
- Volunteers vs. citizen scientists.

Appendix A (continued)

Self-assessment of existing programs

Patrick Graillon (Sépaq – Parcs Québec)

- Success: Choosing simple indicators that cost little to implement and are suitable for long-term use.
- Misstep: Launching the program too fast; needed to validate certain indicators.
- Future challenge: Making a clear distinction between management objectives and researchers' expectations.

Claude Samson (Parks Canada Agency)

- Success: High scientific validity of the program.
- Misstep: Understood differently by managers and by scientists.
- Future challenge: Keep the program going; long-term commitment.

Anouk Simard (MFFP)

- Success: Collaboration of many stakeholders, poll.
- Misstep: Objectives not specific enough; why was so-and-so done?
- Future challenge: Convincing managers, maintaining the program in the long term.

Michel Lepage (RMN)

- Success: Raising awareness among protected area managers.
- Misstep: Volunteer involvement declining over time.
- Future challenge: ---

Sylvie Comtois (City of Montreal)

- Success: Acquisition of knowledge on multiple parks.
- Misstep: ---
- Future challenge: Convincing elected officials; allocation of resources.

Benoît Jobin
April 16, 2014
Corrected May 1, 2014
Translated March 2016

Appendix B. List of indicators selected for each NWA (January 2016)

Lake Saint-François NWA

Theme	Indicator	Proposed method
Ecosystems	Habitat area and distribution	Remote sensing
	Quality of exceptional forest ecosystems (EFEs)	Remote sensing, permanent sample plots
Pressures / Threats	Invasive alien species monitoring	List of invasive species present, detection and monitoring
	Eastern Canadian Diatom Index (IDEC)	Diatom sampling, laboratory analysis
	Bacteriological and physicochemical water quality (IQBP)	Water sampling, laboratory analysis
	Benthic invertebrate monitoring	SurVol Benthos
	Monitoring of deformities in amphibians	CWS protocol
Biotic Communities	Landbird diversity and abundance	Point counts
		Owl monitoring (call playback)
	Waterfowl diversity and abundance	Ground and helicopter brood surveyl
	Anuran diversity and abundance	Acoustic surveys
	Bat diversity and abundance	Acoustic surveys
Species at Risk	American Ginseng, Butternut, Maidenhair Fern, Wild Ginger, Eastern Sand Darter (Quebec populations), Grass Pickerel, Snapping Turtle, Eastern Musk Turtle, Northern Map Turtle, Short-eared Owl, Yellow Rail, Chimney Swift, Golden-winged Warbler, Least Bittern, Bats of the genus Myotis *, Tri-coloured Bat	Specific protocols, monitoring of biotic communities

* Northern Myotis and/or Little Brown Myotis

Appendix B (continued)

Îles de la Paix NWA

Theme	Indicator	Proposed method
Ecosystems	Habitat area and distribution	Remote sensing
Pressures / Threats	Invasive alien species monitoring	List of invasive species present, detection and monitoring
	Bank recession rates and land area lost to erosion	Marking stakes, remote sensing
Biotic Communities	Landbird diversity and abundance	Point counts
		Potential swallow roosting site during fall migration
	Waterfowl diversity and abundance	Helicopter survey (migration, brood), ground nest search
	Colonial waterbird diversity and abundance	Nesting by Great Blue Heron and Black-crowned Night Heron must be determined. Ground- or boat-based nest count.
	Anuran diversity and abundance	Acoustic surveys
	Bat diversity and abundance	Acoustic surveys
Species at Risk	Green Dragon, Grass Pickerel, Snapping Turtle, Caspian Tern	Specific protocols, monitoring of biotic communities

Appendix B (continued)

Îles de Contrecœur NWA

Theme	Indicator	Proposed method
Ecosystems	Habitat area and distribution	Remote sensing
Pressures / Threats	Invasive alien species monitoring	List of invasive species present, detection and monitoring
	Bank recession rates and land area lost to erosion	Marking stakes, remote sensing
Biotic Communities	Landbird diversity and abundance	Point counts
		Visual count of Bank Swallow colonies
	Waterfowl diversity and abundance	Helicopter survey (brood), ground nest search
	Colonial waterbird diversity and abundance	Ground-based nest count of Ring-billed Gull (Îlet à Lefebvre) and Double-crested Cormorant nests.
	Anuran diversity and abundance	Acoustic surveys
	Bat diversity and abundance	Acoustic surveys
Species at Risk	Snapping Turtle, Caspian Tern, Canada Warbler (migration?)	Specific protocols, monitoring of biotic communities

Appendix B (continued)

Cap Tourmente NWA

Theme	Indicator	Proposed method
Ecosystems	Habitat area and distribution	Remote sensing
	Quality of exceptional forest ecosystems (EFEs)	Remote sensing, permanent sample plots
Pressures / Threats	Invasive alien species monitoring	List of invasive species present, detection and monitoring
	Bank recession rates and land area lost to erosion	Marking stakes, remote sensing
	Annual monitoring of agricultural fields (types of crops)	On-site mapping and GIS digitizing
	Eastern Canadian Diatom Index (IDEC)	Diatom sampling, laboratory analysis
	Bacteriological and physicochemical water quality (IQBP)	Water sampling, laboratory analysis
	Benthic invertebrate monitoring	SurVol Benthos
	Monitoring of deformities in amphibians	CWS protocol
	Quality of the intertidal marsh	Remote sensing, vegetation survey
Biotic Communities	Landbird diversity and abundance	Point counts
		Visual count of Cliff Swallow colonies on buildings
		Monitoring of farmland birds and other open-country specie
	Waterfowl diversity and abundance	Ground brood survey and nest search
	Anuran diversity and abundance	Acoustic surveys
	Bat diversity and abundance	Acoustic surveys
Species at Risk	American Ginseng, Butternut, Victorin's Water-hemlock, Purple-stemmed Cliff-brake, Wild Leek, Peregrine Falcon anatum/tundrius, Short-eared Owl, Yellow Rail, Chimney Swift, Least Bittern	Specific protocols, monitoring of biotic communities

Appendix B (continued)

Estuary Islands NWA

Theme	Indicator	Proposed method
Ecosystems	Habitat area and distribution	Remote sensing
Pressures / Threats	Invasive alien species monitoring	List of invasive species present, detection and monitoring
	Bank recession rates and land area lost to erosion	Marking stakes, remote sensing
	Proportion (%) of forest degraded by Double-crested Cormorants	Remote sensing
Biotic Communities	Landbird diversity and abundance	Point counts
	Waterfowl diversity and abundance	Survey of Common Eider nests during eiderdown harvesting
	Colonial waterbird diversity and abundance	Boat survey, partial count during eiderdown harvesting
Species at Risk	Peregrine Falcon anatum/tundrius, Barrow's Goldeneye (Eastern population), Red Knot (ssp. rufa)	Specific protocols, monitoring of biotic communities

Appendix B (continued)

Baie de L'Isle-Verte NWA

Theme	Indicator	Proposed method
Ecosystems	Habitat area and distribution	Remote sensing
Pressures / Threats	Invasive alien species monitoring	List of invasive species present, detection and monitoring
	Bank recession rates and land area lost to erosion	Marking stakes, remote sensing
	Annual monitoring of agricultural fields (types of crops)	On-site mapping and GIS digitizing
	Eastern Canadian Diatom Index (IDEC)	Diatom sampling, laboratory analysis
	Bacteriological and physicochemical water quality (IQBP)	Water sampling, laboratory analysis
	Benthic invertebrate monitoring	SurVol Benthos
	Monitoring of deformities in amphibians	CWS protocol
Biotic Communities	Landbird diversity and abundance	Point counts
		Monitoring of Bobolink and other open-country species
	Waterfowl diversity and abundance	Ground brood survey and nest search, American Black duck (and other species) banding data
	Colonial waterbird diversity and abundance	Count of Black Guillemots (Cacouna) from the cliff or shore
	Shorebird diversity and abundance	Ground survey of Red Knot and other shorebird species
	Anuran diversity and abundance	Acoustic surveys
	Bat diversity and abundance	Acoustic surveys
Species at Risk	Red Knot (ssp. rufa), Short-eared Owl, Yellow Rail, Peregrine Falcon anatum/tundrius, Canada Warbler, Least Bittern	Specific protocols, monitoring of biotic communities

Appendix B (continued)

Pointe-au-Père NWA

Theme	Indicator	Proposed method
Ecosystems	Habitat area and distribution	Remote sensing
Pressures / Threats	Invasive alien species monitoring	List of invasive species present, detection and monitoring
	Bank recession rates and land area lost to erosion	Marking stakes, remote sensing
Biotic Communities	Landbird diversity and abundance	Point counts
	Waterfowl diversity and abundance	Consultation of existing databases (ÉPOQ, eBird)
	Shorebird diversity and abundance	Ground survey
	Anuran diversity and abundance	Acoustic surveys
Species at Risk	Red Knot (ssp. rufa), Short-eared Owl	Specific protocols, monitoring of biotic communities

Appendix B (continued)

Pointe de l'Est NWA

Theme	Indicator	Proposed method
Ecosystems	Habitat area and distribution	Remote sensing
	Quality of exceptional forest ecosystems (EFEs)	Remote sensing, permanent sample plots
Pressures / Threats	Invasive alien species monitoring	List of invasive species present, detection and monitoring
	Bank recession rates and land area lost to erosion	Marking stakes, remote sensing
	Monitoring of the ATV trail system and impacts on vegetation	Remote sensing, vegetation survey
Biotic Communities	Landbird diversity and abundance	Point counts
	Waterfowl diversity and abundance	Ground survey of nesting pairs in ponds
	Colonial waterbird diversity and abundance	Ground survey (Black-headed Gull, Common Tern, Roseate Tern)
	Bat diversity and abundance	Acoustic surveys
Species at Risk	Gulf of St. Lawrence Aster, Broom Crowberry, Piping Plover (ssp. melodus), Roseate Tern, Horned Grebe (Magdalen Islands popul.), Rusty Blackbird, Red Knot (ssp. rufa), Short-eared Owl	Specific protocols, monitoring of biotic communities

Appendix C. Fact sheet on each indicator selected (January 2016)

Indicator: Habitat area and distribution

Theme: Ecosystems

NWAs: All

Priority: High

Rationale: The availability of habitats and their spatial distribution across the landscape dictate the distribution and abundance of wildlife and plant communities in a given area. These habitats are dynamic, and monitoring is required to study their spatial and temporal changes.

Protocol/methodology: Remote sensing (high-resolution satellite images or aerial photos).

Derived indicators:

- Monitoring of forest stand dynamics
- % of open water in emergent marshes
- % of open water in developed marshes
- Area planted to perennial and annual crops
- Diversity of mosaic of habitats
- Wildlife and plant potential of ecosystems
- Area of wet meadows invaded by Speckled Alder
- Width of green corridors connected to the NWA
- Habitat dynamics and fragmentation in and around the NWAs
- Occurrence of natural disturbances that can affect EFEs
- Coastline mapping and quantification of land area lost to erosion
- Proportion (%) of forests degraded by Double-crested Cormorants (Estuary Islands NWA)
- Mapping of ATV trail system (Pointe de l'Est NWA)

Notes/details: Monitoring already underway (two periods analyzed: 1960s/1970s and 1990s/2000s); photo interpretation; 2-km buffer around the NWAs.

Appendix C (continued)

Indicator: Quality of exceptional forest ecosystems (EFEs)

Theme: Ecosystems

NWAs: Lake Saint-François, Cap Tourmente, Pointe de l'Est

Priority: Medium

Rationale: Health of rare forest ecosystems that are sensitive to environmental changes.

Protocol/methodology: Quadrat sampling (EIMP protocol).

Derived indicators: None

Notes/details: Measurements taken in the field to quantitatively assess the health of forest stands (basal area, height, defoliation, etc.) in permanent sample plots.

Possibility of using remote sensing to assess the presence of natural disturbances that could affect EFEs (see "Habitat area and distribution" indicator).

Appendix C (continued)

Indicator: Invasive alien species monitoring

Theme: Pressures/Threats

NWAs: All

Priority: High

Rationale: Threat to native species, habitats and ecosystems.

Protocol/methodology: MDDELCC protocols for detecting and monitoring invasive plant species (contact: Isabelle Simard).

Derived indicators: None

Notes/details: The final protocol remains to be determined (list of species, degree of invasion, types of habitat; quadrats).

Possibility of monitoring invasive species by remote sensing? Biopterre has identified the spectral signatures of a few species (check with Isabelle Simard).

Activities are being carried out to control the size of Speckled Alder stands in wet meadows in the Lake Saint-François NWA, and a method for monitoring the presence and density of the stands by analyzing aerial photos is being developed. Make it a separate indicator?

Monitoring of invasive alien animal species is not planned, since most are aquatic species that live in the waters adjoining the NWAs and therefore do not affect the terrestrial ecosystems of the NWAs.

Monitoring of the impact of Emerald Ash Border on native ash trees and on forest cover in the NWAs may be possible. To be determined.

Appendix C (continued)

Indicator: Bank recession rates and land area lost to erosion

Theme: Pressures/Threats

NWAs: Îles de la Paix, Îles de Contrecœur, Cap Tourmente, Pointe-au-Père, Pointe de l'Est
Priority: High

NWAs: Estuary Islands; Baie de L'Isle-Verte
Priority: Medium

Rationale: Net loss of habitat (including species at risk habitat); threats to the integrity of the NWAs.

Protocol/methodology: Varies depending on the NWA.

- Remote sensing: coastline mapping and quantification of land area lost to erosion
- Marking stakes: field measurements and periodic visits
- See the bank erosion monitoring network launched by the Laboratory of Coastal Zone Dynamics and Integrated Management and the Canada Research Chair in Coastal Geoscience at the Université du Québec à Rimouski. Report recently produced for Cap Tourmente.

Derived indicators: None

Notes/details: The methodology remains to be determined.
See the "Habitat area and distribution" indicator.

Appendix C (continued)

Indicator: Annual monitoring of agricultural fields (types of crops)

Theme: Pressures/Threats

NWAs: Cap Tourmente, Baie de L'Isle-Verte (agricultural activity in the NWA)

Priority: Medium

Rationale: The types of crops and spatial location of the cultivated fields directly affect farmland birds.

Protocol/methodology: On-site observation and mapping.

Derived indicators: None

Notes/details: Manually record the types of crops grown each year and number the habitat polygons in a GIS.

Appendix C (continued)

Indicator: Eastern Canadian Diatom Index (IDEC)

Theme: Pressures/Threats

NWAs: Lake Saint-François, Cap Tourmente, Baie de L'Isle-Verte (agricultural activity in the watershed)

Priority: Medium

Rationale: Degradation of water quality by human activities (agriculture, wastewater, bank alteration) can affect wildlife and plant communities in streams. The IDEC is a good indicator of water quality because diatoms are highly sensitive to water quality degradation (eutrophication) caused by inputs of phosphorus, nitrogen and other organic matter.

Protocol/methodology: Protocol developed by the Université du Québec à Trois-Rivières (Campeau et al., 2013).

- In streams and drainage ditches.
- Generally one sampling campaign per year (mid-August to late September).
- One sample can be taken upstream and one downstream.
- Collect data over two to three years to accurately identify the issue.
- Approximately $300/sample.

Derived indicators: None

Notes/details: It may be useful to take water quality measurements (IDEC) for a few years (two to three years) to determine whether water pollution problems exist and to follow up by taking IQBP measurements to identify the parameters affecting water quality. Subsequent periodic monitoring of benthic invertebrates (e.g. every three to five years) would provide an indication of the effects of the pollutants on habitat quality.

Appendix C (continued)

Indicator: Bacteriological and physicochemical water quality (IQBP)

Theme: Pressures/Threats

NWAs: Lake Saint-François, Cap Tourmente, Baie de L'Isle-Verte (agricultural activity in the watershed)

Priority: Low

Rationale: Degradation of water quality by human activities (agriculture, wastewater, bank alteration) can affect wildlife and plant communities in streams.

Protocol/methodology: Protocol established by MDDELCC (Hébert, 1997).

Derived indicators: None

Notes/details: The IQBP is typically calculated using 10 conventional indicators, also referred to as "sub-indices:" total phosphorus, fecal coliforms, turbidity, suspended solids, ammonia nitrogen, nitrites/nitrates, total chlorophyll a, pH, five-day biological oxygen demand (BOD_5), and percentage of dissolved oxygen saturation. The standard measurements of nitrates/phosphorus/pH provide an indication of water quality, and fecal coliforms are almost always measured to determine bacteriological quality (swimming, drinking water, boating, etc.).

Possibility of calculating a limited index based on six parameters ($IQBP_6$). See the MDDELCC's Réseau-rivières program.

Makes it possible to take corrective action (e.g. wider riparian buffers in NWAs, approach of farmers upstream of the NWA if the source of pollution is in the watershed).

Appendix C (continued)

Indicator: Benthic invertebrate monitoring

Theme: Pressures/Threats

NWAs: Lake Saint-François, Cap Tourmente, Baie de L'Isle-Verte (agricultural activity in the watershed)

Priority: Low

Rationale: Response of organisms to water quality degradation (pollution) and riparian habitat degradation (sedimentation). This is an index of habitat quality.

Protocol/methodology: SurVol Benthos (MDDELCC). Applicable to coarse-substrate streams. Applicable under certain conditions: the stream must be easy to sample on foot and must drain a watershed of <300 km^2 (in addition to having a coarse substrate).

Derived indicators: None

Notes/details:
- Identify the type of substrate (coarse or soft) in the streams.
- Suggestion: Measure the IQBP for abiotic measurements of water quality for a few years and periodically monitor benthic invertebrates (every three to five years?) if water pollution issues are found to be present.

This indicator complements the IQBP and IDEC.

SurVol Benthos is now used in the EIMP.

Appendix C (continued)

Indicator: Monitoring of deformities in amphibians

Theme: Pressures/Threats

NWAs: Lake Saint-François, Cap Tourmente, Baie de L'Isle-Verte (agricultural activity in the watershed)

Priority: Low

Rationale: Amphibians are good indicators of environmental quality because their sedentary lifestyle and cutaneous respiration exposes them to local pollution. Pesticides can affect amphibian growth (e.g. deformities).

Protocol/methodology: Protocol established by the CWS (field collection and observation). See Jean Rodrigue.

Derived indicators: None

Notes/details: Data were gathered in two ponds in the Cap Tourmente NWA from 1997 to 2000. Contrary to expectations, the rate of deformity in the collected amphibians was extremely high. Basic water quality data (including pesticides) were collected.

This indicator complements the "bacteriological and physicochemical water quality (IQBP)" indicator, which combines measurements of organic pollution, physicochemical data and nutrients in water. The sites where the measurements will be taken remain to be determined but should ideally be the same as those where the other measurements associated with aquatic ecosystem quality (IDEC, IQBP, SurVol Benthos) will be taken.

Appendix C (continued)

Indicator: Quality of the intertidal marsh

Theme: Pressures/Threats

NWA: Cap Tourmente

Priority: High

Rationale: The Cap Tourmente NWA was established to protect the American Bulrush marsh (Greater Snow Goose habitat).

Protocol/methodology:
Indicator measured at two spatial scales:
1) Quantitative monitoring using exclosures for on-site measurement of the quality of the bulrush marsh (density, biomass) and the impact of goose browsing on local flora. See the protocol developed by the CWS (Josée Lefebvre).
2) Monitoring by remote sensing to quantify the spatial distribution of the bulrush marsh at the landscape scale.

Derived indicators: None

Notes/details: The quality of the bulrush marsh was monitored from 1971 to 2000. A research project aimed at quantifying the impact of goose browsing on bulrush was conducted from 2004 to 2007.

The bulrush marsh is currently being monitored via remote sensing. The analysis of images taken at different times (1977, 1984 and 2002) has made it possible to measure the extent of the bulrush marsh and the density of the plant communities in four sectors of the St. Lawrence Estuary (Cap Tourmente, Île aux Grues, Cap-Saint-Ignace, Montmagny; Allard, 2008; Allard et al., 2012), and new images were obtained in 2011 to continue the monitoring.

This monitoring complements the monitoring of habitat area and distribution (see section 8.1.1) because the resolution of the images used to date in the two types of monitoring is different. It should be determined whether both types can be continued using the same data sources.

Appendix C (continued)

Indicator: Proportion (%) of forest degraded by Double-crested Cormorants

Theme: Pressures/Threats

NWA: Estuary Islands

Priority: High

Rationale: High densities of nesting cormorants can greatly alter island vegetation.

Protocol/methodology Remote sensing: analysis of aerial photos. Possibility of field surveys.

Derived indicators: None

Notes/details: Active colonies of Double-crested Cormorants are still present in the Estuary Islands NWA (Grande Île, Île aux Fraises and Île Bicquette [on the reefs next to the island]).

Changes in the forest communities on certain islands in the Estuary Islands NWA have been measured via remote sensing (Labrecque et Jobin, 2013).

Appendix C (continued)

Indicator: Monitoring of the ATV trail system and impacts on vegetation

Theme: Pressures/Threats

NWA: Pointe de l'Est

Priority: High

Rationale: ATVs passing repeatedly through sensitive areas (dunes, barrens, etc.) destroy vegetation, and a number of plant species at risk occur in this NWA. It is important to measure the impact of this activity on vegetation growing on the edges of trails.

Protocol/methodology:
Two series of indicators are proposed:
1) Monitoring of the trail system by photo interpretation.
2) Monitoring of vegetation along trails: trail width, permanent sample plots.

See the protocols used in the EIMP (Parcs Québec; trail width) and in the city of Montreal (trail use).

Also see the Parks Canada Agency vegetation monitoring indicator (*Hudsonia tomentosa*) and the EIMP for Pointe-Taillon Park (monitoring of marine relict species in the coastal dunes).

Derived indicators: Number and length of illegal trails in sensitive areas.
Monitoring of vascular plants (dune and wetland environments).

Notes/details: None

Appendix C (continued)

Indicator: Landbird diversity and abundance

Theme: Biotic Communities

NWAs: All

Priority: High

Rationale: The core purpose of NWAs is to protect habitat for migratory birds and species at risk. Monitoring of nesting birds makes it possible to measure the response of this wildlife group to the quality of the nesting habitat in the NWAs.

Protocol/methodology: Acoustic surveys at predetermined listening stations, combining the fixed-radius count technique and the point count technique.

Other specific protocols

- Lake Saint-François: Owl monitoring (call playback survey in the spring).
- Îles de Contrecœur: Monitoring of Bank Swallow colonies (visual count).
- Cap Tourmente: Monitoring of Cliff Swallow colonies on buildings (visual count).
- Cap Tourmente: Monitoring of farmland birds and other open-country species, ongoing since 1998 (Gagnon-Lupien, 2012).
- Baie de L'Isle-Verte: Monitoring of Bobolink and other open-country species, surveys conducted in 2005 and 2015.
- Protocols for specific species at risk: Sedge Wren (Lake Saint-François NWA); Chimney Swift (multiple NWAs).

Derived indicators: None

Notes/details: Songbird surveys were conducted in almost all NWAs in the 2000s. The same point counts would be used.

Vegetation monitoring protocols at the point counts are implemented in parallel with the bird surveys, resulting in very fine-scale concurrent monitoring of plant communities.

Îles de la Paix NWA: Potential roosting site monitoring for migrating swallows. Thousands of swallows reportedly use this NWA in August prior to the fall migration (Rivard and Giguère, 2014b). A targeted survey during this period would quantify actual use of this NWA by swallows and help subsequently determine whether monitoring is needed.

Appendix C (continued)

Indicator: Waterfowl diversity and abundance

Theme: Biotic Communities

NWAs: Lake Saint-François; Îles de la Paix; Îles de Contrecœur; Estuary Islands; Baie de L'Isle-Verte
Priority: High

NWAs: Cap Tourmente; Pointe de l'Est
Priority: Medium

NWA : Pointe-au-Père
Priority : Low

Rationale: The core purpose of NWAs is to protect habitat for migratory birds and species at risk. A number of the NWAs were established to protect habitats used as staging and/or breeding grounds by waterfowl.

Protocol/methodology: The effort required and survey methodologies will vary depending on the species present and the accessibility of the sites. See section 8.3.2, which outlines the proposed surveys in each NWA.

Derived indicators: None

Notes/details: Besides nesting habitat quality, nest density may be affected by a number of other factors, such as hunting pressure, weather and predation. It is suggested that nest density be calculated on a per-species basis (with the approximate surface area of the islands at the time), using the data gathered by J.-F. Giroux in 1992, 1993 and 1994. This will show whether actual densities are sufficient to detect long-term trends that are biologically valid and interpretable (J.-F. Giroux, pers. comm.).

Plan for two or three visits per year in order to include early and late nesters.

The brood survey in the Îles de Contrecœur NWA would assess the nest density of resident Canada Geese and their potential impact on vegetation in the NWA.

Take advantage of the helicopter surveys regularly conducted in the spring by the CWS near the Îles de la Paix NWA (C. Lepage, pers. comm.).

Consider using existing databases (ÉPOQ and eBird) to extract information on nesting waterfowl in certain NWAs that are easily accessible to the public (Cap Tourmente; Pointe-au-Père).

Appendix C (continued)

Indicator: Colonial waterbird diversity and abundance

Theme: Biotic Communities

NWAs: Îles de Contrecœur; Estuary Islands; Baie de L'Isle-Verte; Pointe de l'Est
Priority: High

NWA: Îles de la Paix
Priority: Medium

Rationale: The core purpose of NWAs is to protect habitat for migratory birds and species at risk. A number of NWAs receive high densities of nesting individuals of several colonial species.

Protocol/methodology:
Survey methods will vary depending on the species targeted:

- Îles de la Paix: Historical nesting by Great Blue Heron and Black-crowned Night Heron. Ground- or boat-based nest count.
- Îles de Contrecœur: Known nesting by Ring-billed Gull (Îlet à Lefebvre) and Double-crested Cormorant. Ground-based nest count.
- Estuary Islands: Many colonial species nest on the many islands in the NWA. Partial count during eiderdown harvesting activities on Île Bicquette, Île aux Fraises and Île Blanche: Black Guillemot, Razorbill, Black-legged Kittiwake, Great Black-backed Gull, Herring Gull and Double-crested Cormorant; comprehensive boat survey of islands, including sectors outside the NWA for the Îles de Kamouraska, Îles du Pot and Îles Pèlerins: Black Guillemot, Common Murre, Razorbill, Black-legged Kittiwake, Great Black-backed Gull, Herring Gull, Double-crested Cormorant and Black-crowned Night Heron.
- Baie de L'Isle-Verte: Nesting by a Black Guillemot colony on the Cacouna cliffs. Count of adults from the cliff or shore.
- Pointe de l'Est: Known nesting by Black-headed Gull; historical nesting by Common Tern and Roseate Tern (to be confirmed with F. Shaffer).

Derived indicators: None

Notes/details: Nesting by certain species also needs to be confirmed at a few sites (e.g. ardeids in the Îles de la Paix NWA).

Survey methods may vary depending on the targeted species and habitats and the accessibility of the sites.

Other waterbird species (e.g. rallids) that use inland wetlands (marshes and swamps) will be monitored during the surveys of landbirds or species at risk.

Appendix C (continued)

Indicator: Shorebird diversity and abundance

Theme: Biotic Communities

NWAs: Baie de L'Isle-Verte; Pointe-au-Père

Priority: Medium

Rationale: The core purpose of NWAs is to protect habitat for migratory birds and species at risk. Some NWAs are heavily used by a number of shorebird species during migration, and the diversity and abundance of this bird group must be monitored.

Protocol/methodology: Survey methods will vary depending on the species targeted:

- Baie de L'Isle-Verte: Monitoring of Red Knot and other shorebird species. Ground survey.
- Pointe-au-Père: Ground surveys during migration periods. Surveys were conducted in the fall of 2015 to quantify the current use of this NWA by shorebirds during fall migration. The analysis of the results will help determine whether shorebird monitoring should be implemented.

Derived indicators: None

Notes/details: None

Appendix C (continued)

Indicator: Anuran diversity and abundance

Theme: Biotic Communities

NWAs: Lake Saint-François; Îles de la Paix; Îles de Contrecœur; Cap Tourmente; Baie de L'Isle-Verte; Pointe-au-Père

Priority: Medium

Rationale: Anurans are sensitive to pollution and to human activities. They are good indicators of the condition of wetlands.

Protocol/methodology: Protocol developed for anuran population monitoring in Quebec.

Acoustic surveys at predetermined listening stations. The listening periods are five minutes long and take place in the evening. An abundance ranking is assigned to each species heard, and all individuals heard are considered, regardless of their distance from the station.

Derived indicators: None

Notes/details: Acoustic anuran surveys were conducted in the NWAs in the 2000s during wildlife surveys. At the time, listening stations were established and surveyed in the main ecosystems of the NWAs. The planned surveys in the NWAs could cover the same sites as were visited in the 2000s.

Surveys along the 8-km route? The protocol states that listening stations spaced 800 m apart can make up for a lack of roads or trails.

How to integrate anuran routes on the islands? Do them by boat?

Appendix C (continued)

Indicator: Bat diversity and abundance

Theme: Biotic Communities

NWAs: Lake Saint-François; Îles de la Paix; Îles de Contrecœur; Cap Tourmente; Baie de L'Isle-Verte; Pointe de l'Est

Priority: Low

Rationale: Bats are vulnerable to human activities. Bat populations in northeastern North America have declined markedly in recent years.

Protocol/methodology: Methodology developed for the monitoring network set up by the provincial government.

Acoustic bat surveys using a specially designed device.

Survey along predetermined routes.

Derived indicators: None

Notes/details: Land routes were surveyed in the Lake Saint-François, Cap Tourmente, Baie de L'Isle-Verte and Pointe de l'Est NWAs in the 2000s; the same routes could be used for the monitoring program.

It should be determined whether boat survey routes in the Îles de la Paix and Îles de Contrecœur NWAs could be added to the provincial monitoring network. If that is not possible, listening stations could be established in these NWAs.

This monitoring will involve surveying bat species at risk.

Appendix D. Species at risk present in each NWA and calculated priority index (January 2016)

Lake-Saint-François NWA

Species	Taxon. group	SAR status	COSEWIC status	Provincial status	Presence	Weight status	Weight importance	Index
Snapping Turtle	Reptile	Special concern	Special concern	No status	YES	3	3	9
Eastern Sand Darter (Quebec popul.)	Fish	Threatened	Threatened	Threatened	YES	3	3	9
Grass Pickerel	Fish	Special concern	Special concern	LDTV	YES	3	3	9
Short-eared Owl	Bird	Special concern	Special concern	LDTV	YES	4	2	8
Yellow Rail	Bird	Special concern	Special concern	Threatened	YES	4	2	8
American Ginseng	Plant	Endangered	Endangered	Threatened	YES	3	2	6
Butternut	Plant	Endangered	Endangered	LDTV	YES	3	2	6
Eastern Musk Turtle	Reptile	Threatened	Special concern	Threatened	YES	3	2	6
Northern Map Turtle	Reptile	Special concern	Special concern	Vulnerable	YES	3	2	6
Bats of the genus Myotis *	Mammal	Endangered	Endangered	No status	YES	3	2	6
Tri-coloured Bat	Mammal	Endangered	Endangered	LDTV	YES	3	2	6
Chimney Swift	Bird	Threatened	Threatened	LDTV	YES	4	1	4
Golden-winged Warbler	Bird	Threatened	Threatened	LDTV	YES	4	1	4
Least Bittern	Bird	Threatened	Threatened	Vulnerable	YES	4	1	4
Maidenhair Fern	Plant	No status	No status	Vulnerable	YES	2	2	4
Wild Ginger	Plant	No status	No status	Vulnerable	YES	2	2	4
Blanding's Turtle (Great Lakes / St. Lawrence population)	Reptile	Threatened	Threatened	Threatened	YES	3	1	3
Monarch	Insect	Special concern	Special concern	No status	YES	3	1	3
Eastern Wood-Pewee	Bird	No status	Special concern	No status	YES	1	3	3
Sedge Wren	Bird	No status	Not at risk	LDTV	YES	1	3	3
Bald Eagle	Bird	No status	Not at risk	Vulnerable	YES	2	1	2
Rock Elm	Plant	No status	No status	Threatened	YES	2	1	2
Ostrich Fern	Plant	No status	No status	Vulnerable	YES	2	1	2
Bobolink	Bird	No status	Threatened	No status	YES	1	1	1
Barn Swallow	Bird	No status	Threatened	No status	YES	1	1	1
Bank Swallow	Bird	No status	Threatened	No status	YES	1	1	1
Wood Thrush	Bird	No status	Threatened	No status	YES	1	1	1
Canada Warbler	Bird	Threatened	Threatened	LDTV	?			0
Red-headed Woodpecker	Bird	Threatened	Threatened	Threatened	Historic	4	0	0

* Northern Myotis and/or Little Brown Myotis

Îles de la Paix NWA

Species	Taxon. group	SAR status	COSEWIC status	Provincial status	Presence	Weight status	Weight importance	Index
Snapping Turtle	Reptile	Special concern	Special concern	No status	YES	3	3	9
Grass Pickerel	Fish	Special concern	Special concern	LDTV	YES	3	2	6
Green Dragon	Plant	Spec. conc. (Schedule 3)	Special concern	Threatened	YES	2	3	6
Caspian Tern	Bird	No status	Not at risk	Threatened	YES	4	1	4
Bats of the genus Myotis *	Mammal	Endangered	Endangered	No status	YES	3	1	3
Barn Swallow	Bird	No status	Threatened	No status	YES	1	1	1
Eastern Wood-Pewee	Bird	No status	Special concern	No status	YES	1	1	1
Common Nighthawk	Bird	Threatened	Threatened	LDTV	?			0
Monarch	Insect	Special concern	Special concern	No status	?			0
Ostrich Fern	Plant	No status	No status	Vulnerable	?			0

* Northern Myotis and/or Little Brown Myotis

Appendix D (continued)

Îles de Contrecœur NWA

Species	Taxon. group	SAR status	COSEWIC status	Provincial status	Presence	Weight status	Weight importance	Index
Snapping Turtle	Reptile	Special concern	Special concern	No status	YES	3	2	6
Canada Warbler	Bird	Threatened	Threatened	LDTV	YES migration	4	1	4
Caspian Tern	Bird	No status	Not at risk	Threatened	YES	4	1	4
Bats of the genus Myotis *	Mammal	Endangered	Endangered	No status	YES	3	1	3
Bank Swallow	Bird	No status	Threatened	No status	YES	1	3	3
Green Dragon	Plant	Spec. conc. (Schedule 3)	Special concern	Threatened	YES	2	1	2
Bald Eagle	Bird	No status	Not at risk	Vulnerable	YES migration	2	1	2
Barn Swallow	Bird	No status	Threatened	No status	YES	1	1	1
Sedge Wren	Bird	No status	Not at risk	LDTV	YES	1	1	1
Common Nighthawk	Bird	Threatened	Threatened	LDTV	?			0
Monarch	Insect	Special concern	Special concern	No status	?			0
Short-eared Owl	Bird	Special concern	Special concern	LDTV	Historic	4	0	0
Ostrich Fern	Plant	No status	No status	Vulnerable	?			0
Nelson's Sparrow	Bird	No status	Not at risk	LDTV	Historic	1	0	0

* Northern Myotis and/or Little Brown Myotis

Cap Tourmente NWA

Species	Taxon. group	SAR status	COSEWIC status	Provincial status	Presence	Weight status	Weight importance	Index
Peregrine Falcon anatum/tundrius	Bird	Special concern	Special concern	No status	YES	4	2	8
Short-eared Owl	Bird	Special concern	Special concern	LDTV	YES	4	2	8
Yellow Rail	Bird	Special concern	Special concern	Threatened	YES	4	2	8
American Ginseng	Plant	Endangered	Endangered	Threatened	YES	3	2	6
Butternut	Plant	Endangered	Endangered	LDTV	YES	3	2	6
Victorin's Water-hemlock	Plant	Special concern	Special concern	Threatened	YES	3	2	6
Purple-stemmed Cliff-brake	Plant	No status	No status	Threatened	YES	2	3	6
Wild Leek	Plant	No status	No status	Vulnerable	YES	2	3	6
Chimney Swift	Bird	Threatened	Threatened	LDTV	YES	4	1	4
Least Bittern	Bird	Threatened	Threatened	Vulnerable	YES	4	1	4
Monarch	Insect	Special concern	Special concern	No status	YES	3	1	3
Bats of the genus Myotis *	Mammal	Endangered	Endangered	No status	YES	3	1	3
Bobolink	Bird	No status	Threatened	No status	YES	1	3	3
Bald Eagle	Bird	No status	Not at risk	Vulnerable	YES	2	1	2
Wild Ginger	Plant	No status	No status	Vulnerable	YES	2	1	2
Eastern Meadowlark	Bird	No status	Threatened	No status	YES	1	2	2
Barn Swallow	Bird	No status	Threatened	No status	YES	1	2	2
Wood Thrush	Bird	No status	Threatened	No status	YES	1	2	2
Bank Swallow	Bird	No status	Threatened	No status	YES anecdotic	1	1	1
Eastern Wood-Pewee	Bird	No status	Special concern	No status	YES	1	1	1
Nelson's Sparrow	Bird	No status	Not at risk	LDTV	YES	1	1	1
Loggerhead Shrike (ssp. migrans)	Bird	Endangered	Endangered	Threatened	Historic	4	0	0
Common Nighthawk	Bird	Threatened	Threatened	LDTV	?			0
Canada Warbler	Bird	Threatened	Threatened	LDTV	?			0
Maidenhair Fern	Plant	No status	No status	Vulnerable	Historic	2	0	0
Ostrich Fern	Plant	No status	No status	Vulnerable	?			0

* Northern Myotis and/or Little Brown Myotis

Appendix D (continued)

Baie de L'Isle-Verte NWA

Species	Taxon. group	SAR status	COSEWIC status	Provincial status	Presence	Weight status	Weight importance	Index
Red Knot (ssp. rufa)	Bird	Endangered	Endangered	LDTV	YES migration	4	2	8
Short-eared Owl	Bird	Special concern	Special concern	LDTV	YES	4	2	8
Yellow Rail	Bird	Special concern	Special concern	Threatened	YES Cacouna	4	2	8
Peregrine Falcon anatum/tundrius	Bird	Special concern	Special concern	No status	YES	4	1	4
Canada Warbler	Bird	Threatened	Threatened	LDTV	YES	4	1	4
Least Bittern	Bird	Threatened	Threatened	Vulnerable	YES	4	1	4
Monarch	Insect	Special concern	Special concern	No status	YES	3	1	3
Bats of the genus Myotis *	Mammal	Endangered	Endangered	No status	YES	3	1	3
Nelson's Sparrow	Bird	No status	Not at risk	LDTV	YES	1	3	3
Bobolink	Bird	No status	Threatened	No status	YES	1	2	2
Barn Swallow	Bird	No status	Threatened	No status	YES	1	1	1
Bank Swallow	Bird	No status	Threatened	No status	YES	1	1	1
Common Nighthawk	Bird	Threatened	Threatened	LDTV	?			0

* Northern Myotis and/or Little Brown Myotis

Estuary Islands NWA

Species	Taxon. group	SAR status	COSEWIC status	Provincial status	Presence	Weight status	Weight importance	Index
Peregrine Falcon anatum/tundrius	Bird	Special concern	Special concern	No status	YES	4	2	8
Barrow's Goldeneye (Eastern population)	Bird	Special concern	Special concern	Vulnerable	YES	4	2	8
Red Knot (ssp. rufa)	Bird	Endangered	Endangered	LDTV	YES migration	4	1	4
Bats of the genus Myotis *	Mammal	Endangered	Endangered	No status	YES	3	1	3
Monarch	Insect	Special concern	Special concern	No status	?			0

* Northern Myotis and/or Little Brown Myotis

Pointe-au-Père NWA

Species	Taxon. group	SAR status	COSEWIC status	Provincial status	Presence	Weight status	Weight importance	Index
Red Knot (ssp. rufa)	Bird	Endangered	Endangered	LDTV	YES migration	4	1	4
Short-eared Owl	Bird	Special concern	Special concern	LDTV	YES	4	1	4
Nelson's Sparrow	Bird	No status	Not at risk	LDTV	YES	1	1	1
Monarch	Insect	Special concern	Special concern	No status	?			0

Pointe de l'Est NWA

Species	Taxon. group	SAR status	COSEWIC status	Provincial status	Presence	Weight status	Weight importance	Index
Piping Plover (ssp. melodus)	Bird	Endangered	Endangered	Threatened	YES	4	3	12
Roseate Tern	Bird	Endangered	Endangered	Threatened	YES	4	3	12
Horned Grebe (Magdalen Islands popul.)	Bird	Endangered	Endangered	Threatened	YES	4	3	12
Rusty Blackbird	Bird	Special concern	Special concern	LDTV	YES	4	2	8
Red Knot (ssp. rufa)	Bird	Endangered	Endangered	LDTV	YES migration	4	2	8
Gulf of St. Lawrence Aster	Plant	Threatened	Threatened	Threatened	YES	3	2	6
Broom Crowberry	Plant	No status	No status	Threatened	YES	2	3	6
Short-eared Owl	Bird	Special concern	Special concern	LDTV	YES	4	1	4
Bats of the genus Myotis *	Mammal	Endangered	Endangered	No status	YES	3	1	3
Nelson's Sparrow	Bird	No status	Not at risk	LDTV	YES	1	2	2
Monarch	Insect	Special concern	Special concern	No status	?			0

* Northern Myotis and/or Little Brown Myotis

Appendix E. English and scientific names of species mentioned

Taxon. group	English Name	Latin Name
Plant		
	American Beach Grass	*Ammophila breviligulata*
	American Ginseng	*Panax quinquefolium*
	Beach Pea	*Lathyrus maritimus*
	Broom Crowberry	*Corema conradii*
	Butternut	*Juglans cinerea*
	Common Reed	*Phragmites australis*
	Common threesquare	*Schoenoplectus pungens*
	Giant Hogweed	*Heracleum mantegazzianum*
	Green Dragon	*Arisaema dracontium*
	Gulf of St. Lawrence Aster	*Symphyotrichum laurentianum*
	Maidenhair Fern	*Adiantum pedatum*
	Ostrich Fern	*Matteuccia stuthiopteris*
	Purple-stemmed Cliff-brake	*Pellaea atropurpurea*
	Rock Elm	*Ulmus thomasii*
	Speckled Alder	*Alnus rugosa*
	Victorin's Water-hemlock	*Cicuta maculata var. victorinii*
	Wild Ginger	*Asarum canadense*
	Wild Leek	*Allium tricoccum*
	Woolly Hudsonia	*Hudsonia tomentosa*
Mollusc		
	Zebra mussel	*Dreissena polymorpha*
Insect		
	Emerald Ash Borer	*Agrilus planipennis*
	Monarch	*Danaus plexippus*
Fish		
	Grass Pickerel	*Esox americanus vermiculatus*
	Eastern Sand Darter (Quebec populations)	*Ammocrypta pellucida*
	Round Goby	*Neogobius melanostomus*
Reptile		
	Blanding's Turtle (Great Lake /St.Lawrence popul.)	*Emydoidea blandingii*
	Eastern Musk Turtle	*Sternotherus odoratus*
	Northern Map Turtle	*Graptemys geographica*
	Red-eared Slider	*Pseudemys scripta elegans*
	Snapping Turtle	*Chelydra serpentina*
Bird		
	American Black Duck	*Anas rubripes*
	Bald Eagle	*Haliaeetus leucocephalus*
	Bank Swallow	*Riparia riparia*
	Barn Swallow	*Hirundo rustica*
	Barrow's Goldeneye (Eastern population)	*Bucephala islandica*
	Black Guillemot	*Cepphus grylle*
	Black-crowned Night Heron	*Nycticorax nycticorax*

Taxon. group	English Name	Latin Name
Bird		
	Black-headed Gull	*Chroicocephalus ridibundus*
	Black-legged Kittiwake	*Rissa tridactyla*
	Bobolink	*Dolichonyx oryzivorus*
	Canada Gose	*Branta canadensis*
	Canada Warbler	*Wilsonia canadensis*
	Caspian Tern	*Sterna caspia*
	Chimney Swift	*Chaetura pelagica*
	Cliff Swallow	*Petrochelidon pyrrhonota*
	Common Eider	*Somateria mollissima*
	Common Murre	*Uria aalge*
	Common Nighthawk	*Chordeiles minor*
	Common Tern	*Sterna hirundo*
	Double-crested Cormoran	*Phalacrocorax auritus*
	Eastern Meadowlark	*Sturnella magna*
	Eastern Wood-Pewee	*Contopus virens*
	Golden-winged Warbler	*Vermivora chrysoptera*
	Great Black-backed Gull	*Larus marinus*
	Great Blue Heron	*Ardea herodias*
	Greater Snow Goose	*Chen caerulescens*
	Herring Gull	*Larus argentatus*
	Horned Grebe (Magdalen Islands popul.)	*Podiceps auritus*
	Killdeer	*Charadrius vociferus*
	Least Bittern	*Ixobrychus exilis*
	Loggerhead Shrike (ssp. migrans)	*Lanius ludovicianus migrans*
	Nelson's Sparrow	*Ammodramus nelsoni*
	Peregrine Falcon anatum/tundrius	*Falco peregrinus anatum/tundrius*
	Piping Plover (ssp. melodus)	*Charadrius melodus melodus*
	Razorbill	*Alca torda*
	Red Knot (ssp. rufa)	*Calidris canutus rufa*
	Red-headed Woodpecker	*Melanerpes erythrocephalus*
	Ring-billed Gull	*Larus delawarensis*
	Roseate Tern	*Sterna dougallii*
	Rusty Blackbird	*Euphagus carolinus*
	Sedge Wren	*Cistothorus platensis*
	Short-eared Owl	*Asio flammeus*
	Wilson's Snipe	*Gallinago delicata*
	Wood Thrush	*Hylocichla mustelina*
	Yellow Rail	*Coturnicops noveboracensis*
Mammal		
	Little Brown Myotis	*Myotis lucifugus*
	Northern Myotis	*Myotis septentrionalis*
	Tri-coloured Bat	*Perimyotis subflavus*

Environment and Climate Change Canada
Environnement et Changement climatique Canada