Proposed

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Action Plan Series

Recovery Strategy and Action Plan for the Striped Bass (*Morone saxatilis*), St. Lawrence River population, in Canada

Striped Bass

2019

Canada

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For copies of the recovery strategy and action plan, or for additional information on species at risk, including Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports, residence descriptions, action plans, and other related recovery documents, please visit the SAR Public Registry.

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Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of a recovery strategy for species listed as extirpated, endangered, or threatened, and are required to report on progress five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Fisheries and Oceans is the competent minister under SARA for the St. Lawrence River Striped Bass and has prepared this combined recovery strategy and action plan, pursuant to Sections 37 and 47 of SARA. In preparing this recovery strategy and action plan, the competent minister has considered, as per Section 38 of SARA, the commitment of the Government of Canada to conserving biological diversity and to the principle that, if there are threats of serious or irreversible damage to the listed wildlife species, cost-effective measures to prevent the reduction or loss of the species should not be postponed for a lack of full scientific certainty. To the extent possible, the recovery strategy and action plan was prepared in cooperation with the Parks Canada Agency, the Government of Quebec (ministère des Forêts, de la Faune et des Parcs), academic experts, First Nations representatives, and fisheries and non-governmental organizations representatives in accordance with subsections 39(1) and 48(1) of SARA.

As stated in the preamble to SARA, success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this recovery strategy and action plan, and will not be achieved by Fisheries and Oceans Canada or any other jurisdiction alone. The cost of conserving species at risk is shared amongst different constituencies. All Canadians are invited to join in supporting and implementing this strategy and plan for the benefit of the St. Lawrence River Striped Bass population and Canadian society as a whole.

This recovery strategy and action plan contains information on the recovery measures to be taken by Fisheries and Oceans Canada and other jurisdictions or organizations involved in the conservation of the species. Implementation of this recovery strategy and action plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

Acknowledgements

Fisheries and Oceans Canada wishes to thank Marthe Bérubé (DFO), Myriam Bourgeois (DFO) and Alexandra Valentin (DFO), who drafted this document with the invaluable collaboration of the Recovery Team (see Appendix B), as well as Brigitte Lévesque (DFO) for preparing the maps, Florence Boucher-Boisclair (DFO) for the section assessing the socio-economic impact and benefits, and Renée Langevin (Environment and Climate Change Canada) for the information pertaining to National Wildlife Areas and Migratory Bird Sanctuaries. Where possible, this document was prepared in collaboration with the Parks Canada Agency, the Ministère des Forêts, de la Faune et des Parcs of the province of Quebec, academic experts, First Nations representatives, as well as fisheries and non-governmental organizations representatives. Fisheries and Oceans Canada would like to thank all the individuals and organizations that contributed to the recovery of the St. Lawrence River Striped Bass population.

Executive Summary

The St. Lawrence River Striped Bass population[1] (*Morone saxatilis*) has been listed as extirpated under the *Species at Risk Act* (SARA) since 2011. This recovery strategy and action plan is an update and improvement of the 2011 recovery strategy (Robitaille *et al.* 2011). It is considered one in a series of documents for this species that are linked and should be taken into consideration together, including the Committee on the Status of Endangered Wildlife in Canada Status Report (COSEWIC 2012).

Four other native Striped Bass populations have been recorded in Canada. COSEWIC has classified them into two designatable units, i.e. Bay of Fundy and Southern Gulf of St. Lawrence. In 2012, COSEWIC reassessed the status of Striped Bass in Canada, and the St. Lawrence River population was reclassified as endangered.

The Striped Bass population that is the subject of this recovery strategy and action plan was reintroduced in the St. Lawrence River beginning in 2002 using individuals from the Miramichi River. The historic population was decimated in the 1960s. It was determined that the recovery of the new population is biologically and technically feasible.

The Striped Bass owes its name to the seven or eight dark horizontal stripes that mark its pale sides. Striped Bass is an anadromous species that spawns in fresh water and develops to maturity at sea. This fish is associated with estuaries and coastal habitats in the American Northeast. Spawning, incubation and initial development of fry occur in fresh or slightly brackish waters. From the juvenile stage onward, the Striped Bass is more tolerant of changes in environmental conditions. It can meet its food needs by travelling through estuarine and coastal areas. Since its reintroduction in the River, the Striped Bass has been spawning naturally, and there has been some increase in population abundance and distribution (DFO 2017a). Its distribution (based on an area frequented by at least 10% of Striped Bass marked for telemetric monitoring) extends from Gentilly (upstream) to Rivière-Ouelle (downstream) on the south shore, and to the Saguenay fjord (including it), on the north shore. However, numerous Striped Bass observations have been reported well beyond this area, overlapping the neighbouring population in the southern Gulf of St. Lawrence.

The main threats to the species are described in Section 5 and include: infrastructure development; St. Lawrence Seaway maintenance; wharf maintenance, marinas and access channels; local modification of the riparian environment; ship wave action; temporary or permanent barrier creation; invasive species; diseases and parasites; incidental commercial and sport catches; illegal catches; oil leaks and spills during transport; possible leaks during oil and gas exploration and development activities; agricultural pollution (nutrient and sediment load, pesticides); and municipal and industrial effluents.

This recovery strategy and action plan outlines the measures that provide the best chance of achieving the population and distribution objectives for the species, including measures to address threats to the species and to monitor its recovery. The quantitative population and distribution objectives for the Striped Bass in the St. Lawrence River are to meet the COSEWIC criteria that would allow the population to shift from its current endangered status (COSEWIC 2012) to that of a species of special concern.

[1] formerly called the St. Lawrence Estuary population

Section 7 describes the various actions needed in terms of stocking, inventory and monitoring; research; management and coordination; and stewardship and outreach activities that provide the best chance of achieving the objectives.

The critical habitat of the St. Lawrence River population includes an array of geographic locations where the Striped Bass performs its essential life cycle processes. Critical habitat has been identified for: (i) adult feeding (May–October; two areas); (ii) adult overwintering (November–April; two areas); (iii) reproduction (May–June; two areas); and (iv) larvae and juvenile growth and feeding (June–November). Table 6 and Figures 3 and 4 (Section 8) describe and illustrate the critical habitat. The critical habitat is defined as accurately as possible based on the best information available. The functions and features required to support the species' life cycle processes are also specified. This recovery strategy and action plan identifies the critical habitat of the St. Lawrence River Striped Bass as an array of geographic locations in the River or Upper Estuary of the St. Lawrence River, as detailed in Section 8. Due to insufficient information, certain habitats that appear to be significant cannot be designated in this recovery strategy and action plan. The schedule of studies outlines the research required to potentially identify other critical habitat that may be needed to achieve the population and distribution objectives for the species.

It is anticipated that the protection of this species' critical habitat from destruction will be accomplished through a SARA Critical Habitat Order made under subsections 58(4) and (5), which will invoke the prohibition in subsection 58(1) against the destruction of the identified critical habitat.

Recovery Feasibility Summary

After analysis, it was determined that the recovery of the St. Lawrence River Striped Bass population is feasible, both technically and biologically. The following conditions have been met:

1. **Individuals capable of reproduction are available.** Monitoring shows that Striped Bass spawn naturally in the St. Lawrence River; it also shows increases in the abundance and distribution of its population (DFO 2017a). It is yet difficult to determine the relative contributions of stocking and natural spawning to the observed increases. Given the natural variability in recruitment, stocking could continue in the coming years to increase the number of spawners, if necessary.

2. **Suitable habitats are available to support the species.** The biological data collected show that habitats that are suitable for the growth and reproduction of the St. Lawrence River Striped Bass are available (DFO 2017a).

3. **The following key threats can be mitigated or avoided:**
    a. Incidental catches: Striped Bass fishing is prohibited. Incidentally caught specimens must be released, and commercial and sport fishers are made aware of the mandatory release of incidentally caught Striped Bass. In addition, any sport fishing can be prohibited in some key Striped Bass aggregation areas, at least during the spawning period.
    b. Dredging operations: Maintenance of harbours, ports, marinas and waterways is regulated. Dredged sediments disposal sites are selected to minimize impacts. Furthermore, when dredged sediments are contaminated, they should be deposited in land disposal sites.
    c. Habitat disruption and destruction: Given the existing regulatory framework, activities and practices can be modified to eliminate or reduce their impact.

4. **Effective techniques and measures exist to ensure species recovery.** When conditions are favourable, the establishment or recovery of Striped Bass populations can be quick (Field 1997). The recovery actions required to achieve the population and distribution objectives for this species are indicated in this recovery strategy and action plan.

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1. Introduction

The Striped Bass (*Morone saxatilis*) disappeared from the St. Lawrence River in the 1960s. It was reintroduced into the River in 2002. In 2004, when it was first assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), the "St. Lawrence Estuary population" was classified as extirpated. In 2011, it was listed as extirpated under the *Species at Risk Act* (SARA). In 2012, COSEWIC assessed the reintroduced population referred to as the "St. Lawrence River population" and classified it as endangered, which may lead to a change in its status under Schedule 1 of SARA. This document uses the new denomination St. Lawrence River Striped Bass population.

This document combines a recovery strategy and an action plan for the St. Lawrence River Striped Bass population. A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets objectives and identifies the main areas of activities to be undertaken. An action plan details the recovery planning in support of the strategic direction set out in the recovery strategy for the species. This combined recovery strategy and action plan also provides basic information on the species and threats to it, as well as information on its critical habitat.

This document is part of a series of documents on the St. Lawrence River Striped Bass. These documents must be taken into consideration together and consulted for further information as needed. In particular, this recovery strategy and action plan incorporates information from the Status Report by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2012). It also draws from information presented in a research document on the species' habitat (Valiquette *et al.* 2017) and a Science Advisory Report in support of critical habitat identification (DFO 2017a). These last two documents are the result of a peer review process conducted under the Canadian Science Advisory Secretariat of Fisheries and Oceans Canada. The purpose of this process is to provide the information and scientific advice needed to implement the *Species at Risk Act* based on the best available scientific data, data analysis and expert opinions.

2. COSEWIC[2] Species Assessment Information

Assessment date: November 2012

Common name (population): Striped Bass - St. Lawrence River population

Scientific name: *Morone saxatilis*

Status: Endangered

Reason for designation: This population was assessed as Extirpated in 2004 and is the subject of a re-introduction effort, using fish from the Miramichi River, that has resulted in natural spawning, some increase in abundance, and an increase in distribution. It is, however, unclear if the population is self-sustaining without continued supplementation. The population is susceptible to by-catch in commercial fisheries, and although the threat of dredging has been reduced, it is still operating.

Canadian Occurrence: Quebec, Atlantic Ocean

Status History: Designated Extirpated in November 2004. Status re-examined and designated Endangered in November 2012.

3. Species Status Information

Table 1. Summary of existing protection and other status designations assigned to the Striped Bass

Jurisdiction	Authority/ Organization	Year(s) Assessed and/or Listed	Status/ Description	Designation level
Canada	COSEWIC	2012	Endangered	St. Lawrence River population
Canada	NatureServe	2012	Vulnerable to at risk	N2N3
Canada	*Species at Risk Act*	2011	Extirpated in Canada	St. Lawrence River population
International	NatureServe	1996	Not at risk	G5

[2] From the 2012 Status Report

The St. Lawrence River Striped Bass population is protected under Section 32 of SARA:

> "*No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species.*" [Subs. 32(1)]
>
> "*No person shall possess, collect, buy, sell or trade an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species, or any part or derivative of such an individual.*" [Subs. 32(2)]

Under Section 73 of SARA, the competent minister may enter into an agreement with a person, or issue a licence to a person, authorizing the person to engage in an activity affecting a listed wildlife species, any part of its critical habitat or the residences of its individuals.

4. Species information

4.1 Description

The Striped Bass (*Morone saxatilis*) is a fish with an elongated, laterally compressed body and a triangular head (Figure 1). It has two separated dorsal fins, the first of which is spiny. The caudal fin is forked. The first three rays of the anal fin are spiny. The pelvic fins are located in the thoracic position. The cheeks and opercula are covered with scales. The colour of the back varies from dark olive-green to black, and the belly is white. The pale or silvery sides are marked with seven or eight dark horizontal stripes following the contour of the scale rows. None of these stripes extend onto the head.

Figure 1. Striped Bass (*Morone saxatilis*).
Source: Fédération québécoise des chasseurs et pêcheurs (FédéCP).

This anadromous fish is strongly associated with estuaries and coastal waters. It travels in these waters in compact schools of same-sized fish, feeding on invertebrates and fish (see Section 4.3 Needs of the Species). In the St. Lawrence, the Striped Bass can live up to 20 years and reach a total length of 90 cm (Vladykov 1953).

4.2 Population abundance and distribution

The Striped Bass is found in watercourses throughout eastern North America, from the St. Lawrence River to the north of Florida. It disappeared from several locations in Mexico and the United States and was introduced in other locations in Africa, Europe and the United States. In Canada, five native Striped Bass populations have existed in three distinct areas corresponding to the three designatable units recognized by COSEWIC (2012): Bay of Fundy, Southern Gulf of St. Lawrence and St. Lawrence River. The historical St. Lawrence River Striped Bass population mainly extended from Lake Saint-Pierre to Baie-Saint-Paul on the northern shore, and to Isle-Verte on the southern shore (COSEWIC 2004). Today, its range (Figure 2) extends beyond these limits (DFO 2017a).

In 2002, following a favourable opinion on the feasibility of reintroducing a Striped Bass population in the River (Comité aviseur sur la réintroduction du bar rayé 2001), a reintroduction program began. Between 2002 and 2016, 2,995 spawners, over 34,500,000 larvae and more than 18,000 juvenile Striped Bass, produced using spawners from the Southern Gulf population, were stocked in the St. Lawrence River. Several monitoring methods (e.g., incidental catches, telemetry, standardized recruitment survey) were implemented to assess the parameters of the reintroduced population, to document the survival and establishment of the species, to characterize its movements, and to identify its spawning and rearing habitats. Since then, it has been shown that adult Striped Bass spawn naturally in the Estuary. Signs of natural spawning were observed in 2008 (Bourget *et al.* 2008, Pelletier 2009), and the first spawning ground was identified in 2011 in the first recovery strategy. This spawning ground is located at the mouth of the Rivière du Sud at Montmagny.

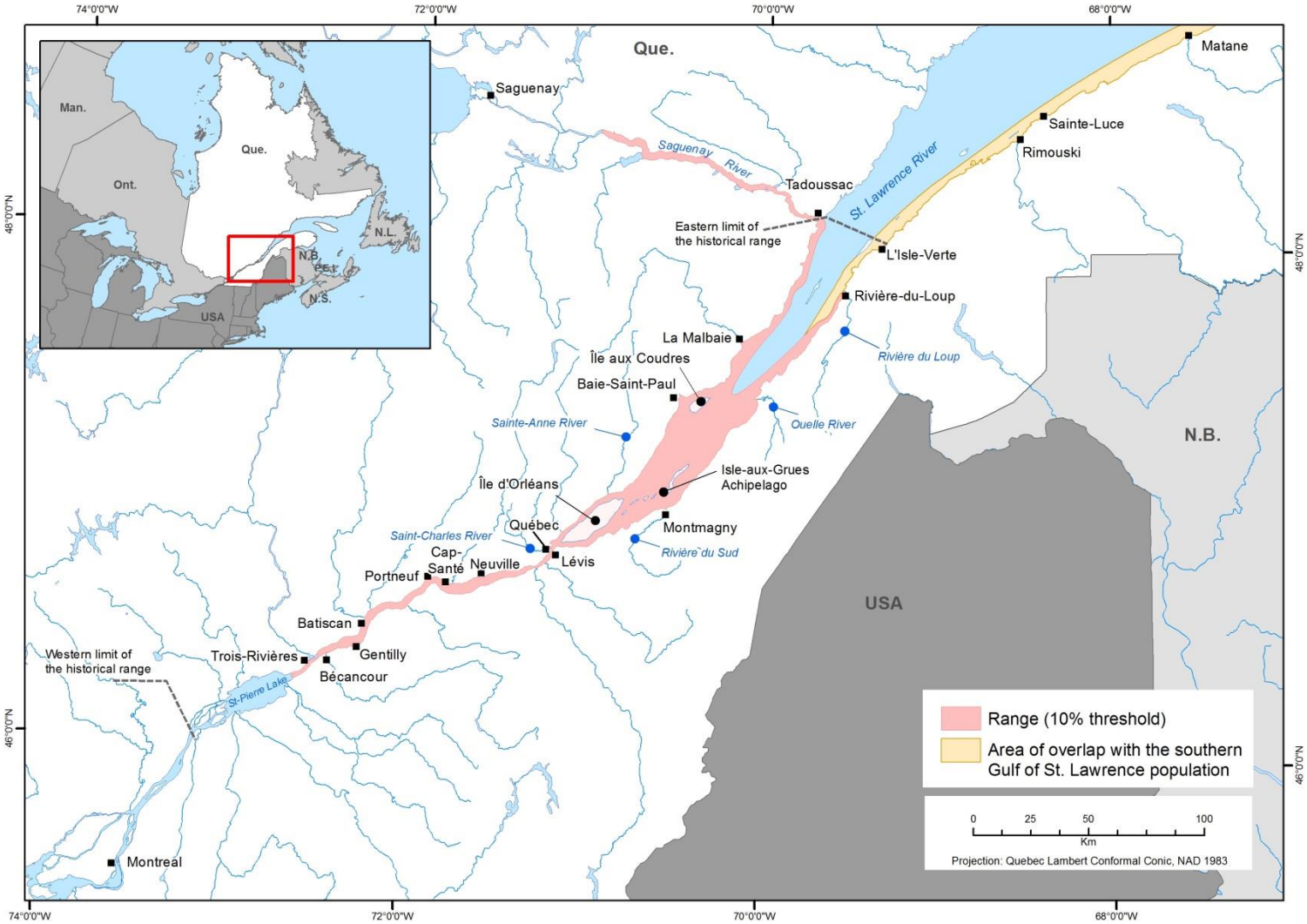

Figure 2. Range of the St. Lawrence River Striped Bass.

Although almost all St. Lawrence River Striped Bass observations (99.6%) are reported between Québec City and Rivière-du-Loup (Dussureault *et al.* 2014), Striped Bass were also observed up to the Montréal area, as well as in the Saguenay and as far as Sheldrake (Middle North Shore). Downstream, there is an area of overlap with the neighbouring population in the Southern Gulf of St. Lawrence (Figure 2). A few Striped Bass from the southern Gulf of St. Lawrence population are also found in the St. Lawrence River (Dussureault *et al.* 2014). The range of the new Striped Bass population was defined as the area frequented by at least 10% of the Striped Bass tagged for telemetric monitoring (DFO 2017a). According to this criterion, the range extends from Gentilly (upstream) to Rivière-Ouelle (downstream) on the south shore, and to the Saguenay Fjord (including it) on the north shore (Figure 2). Species distribution downstream from the mouth of the Saguenay River is still imprecise due to a lack of receivers for collecting data. Since the efforts to reintroduce the Striped Bass are relatively recent, a follow-up will have to be done in the coming years to confirm whether the habitats currently used by the population will be the same in the future (DFO 2017a). The area of overlap between Sainte-Luce and Cap-Gaspé in Quebec has not been assigned to a designatable unit in the COSEWIC report.

Research has shown that seasons play a major role in the spatial and temporal distribution of Striped Bass. In spring and summer, Striped Bass disperse over large areas (likely feeding areas) upstream and downstream, extending not only into the Upper Estuary, but also upstream into the River Estuary and the fluvial stretch. Many Striped Bass also move toward the Lower Estuary and the Saguenay River. The arrival of fall initiates a movement to return to overwintering sites (DFO 2017a). In winter, the Striped Bass population overwinters in two restricted areas, one located near Québec City and the other one, south of Île aux Grues (detailed in Section 8.1.3 on critical habitat). Between the two areas, the Chenal des Grands Voiliers may be used minimally as a winter travel route (DFO 2017a). During the month of May, which coincides with the spawning period, individuals disperse. Dispersion is even more pronounced through the entire system after the spawning period, in June.

The St. Lawrence River population may consist of at least two groups using the territory differently, i.e. one group with more limited movements and another with more extensive movements. Analyses should be undertaken to define and document these migratory groups further (DFO 2017a).

4.3 Needs of the species

The species is characterized by irregular recruitment, which can be affected by the conditions encountered during the early stages of life. Recruitment variability could be amplified in Canadian populations, as they are at the northern limit of the species' range. The harsher climatic conditions to which these populations may be exposed could result in the death of young-of-the-year who have not yet reached a sufficient size (estimated at 10 cm) to survive the fasting of the first winter (COSEWIC 2012 and references included). Furthermore, the growth conditions in Canadian waters are such that the maximum size of Striped Bass is under one metre, though very few individuals survive long enough to achieve this size. The largest known specimen, captured in North Carolina in 1891, weighed 56.8 kg and measured 1.82 m (Raney 1952).

Of all the habitats used by the Striped Bass during its life cycle, the most important for the maintenance of the population appear to be the habitats used for spawning and by early life stages (Albrecht 1964; Auld and Schubel 1978; Dudley and Black 1978; Kernehan *et al.* 1981;

Jessop 1990, 1991; Melvin 1991; Van den Avyle and Maynard 1994). Spawning begins as water temperatures rise above 10 °C and may continue until water reaches 19 °C in May and June. Female Striped Bass are highly fecund, averaging 50,000 eggs per kg of body weight. Striped Bass eggs are released directly into the stream and remain suspended in the water column. Eggs normally hatch within three days of fertilization. During incubation, egg survival is highly dependent on abiotic environmental parameters, particularly temperature, salinity, dissolved oxygen and the presence of a moderate current creating some turbulence and keeping the eggs suspended in the water column during incubation (Cooper and Polgar 1981; Greene *et al.* 2009; DFO 2011). Egg characteristics appear to be specific to the population of each watercourse. For example, eggs laid in high-energy pools are larger and heavier, have a lower surface-volume ratio, and contain more saturated and mono-unsaturated fatty acids than eggs laid in pools with lower energy (Bergey *et al.* 2003).

Larvae survival also depends on physical variables such as temperature, salinity and dissolved oxygen. A sufficiently abundant food supply is also required upon resorption of the yolk sac at the onset of feeding (Cooper and Polgar 1981). This key period occurs approximately when larvae are 8 days of age and measure 6 mm to 7 mm. In natural environments, the rate of survival of larvae that have exhausted their yolk reserves is directly related to the abundance of zooplankton in their environment (Kernehan *et al.* 1981; Martin *et al.* 1985). In Chesapeake Bay, the density of Striped Bass in the first stages of development has been shown to vary according to distance from the maximum turbidity zone, among other factors (North and Houde 2003). Given the characteristics of these zones and larvae behaviour, larvae are likely to remain in waters where prey abundance is high. The St. Lawrence also has a maximum turbidity zone between Île d'Orléans and Île aux Coudres. This zone contains high densities of zooplankton, including the copepod *Eurytemora affinis*, and is a known rearing ground for Rainbow Smelt and several other fish species (Sirois and Dodson 2000). St. Lawrence Striped Bass may also spend the early stages of their development there. After 35 to 50 days in the larval stage, the young reach a length of 20 mm and show the typical shape of the Striped Bass, which they will maintain into adulthood.

From the juvenile stage onward, the Striped Bass is more tolerant of changes in environmental conditions. It can meet its food requirements by travelling in estuarine and coastal environments, often in schools of same-sized individuals. Despite the higher tolerance to changes in temperature and salinity of juveniles than of eggs or larvae, the spatial variability of environmental conditions within a watershed can be a determining factor in the growth and survival of Striped Bass during its first year of development (Greene *et al.* 2009; COSEWIC 2012; Cook *et al.* 2010).

Sub-adult and adult Striped Bass frequent coastal habitats and estuarine environments (Bain and Bain 1982). During their first two years, they feed primarily on invertebrates, but gradually become piscivorous, chasing schools of soft-rayed fish, particularly clupeids (e.g., American Shad, Alewife, etc.) (Trent and Hasler 1966; Manooch 1973; Austin 1980; Gardinier and Hoff 1982; Dew 1988). In the St. Lawrence River, their main prey consists of smelt and Clupeidae. In summer, the movement of Striped Bass appears to follow that of their prey. Adult Striped Bass tolerate and withstand variations in salinity, temperature, pH or turbidity (Talbot 1966; Auld and Schubel 1978; Setzler *et al.* 1980). In the fall, Striped Bass migrate upstream and overwinter in fresh and brackish waters to avoid the cold winter ocean waters. The aggregation of Striped Bass in these overwintering zones may increase the risks of mortality due to environmental accidents or adverse changes in habitat.

5. Threats

5.1 Threat assessment

The main threats to the recovery of the St. Lawrence River Striped Bass are characterized in Table 2. They are described in more detail in Section 5.2.

Table 2. Threat assessment for the St. Lawrence River population. Threat assessment criteria are defined beneath the table and categorized in Appendix C.

Category	Threat	Likelihood of occurrence [a]	Level of impact [b]	Causal certainty [c]	Threat risk [d]
Habitat loss or degradation	**Infrastructure modification and development**	Threat known or very likely to occur	High	High	High
Habitat loss or degradation	**St. Lawrence Seaway maintenance and development**	Threat known or very likely to occur	Medium	Medium	Medium
Habitat loss or degradation	**Maintenance of wharves, marinas and access channels**	Threat known or very likely to occur	Medium	High	Medium
Habitat loss or degradation	**Local modification of riparian environment**	Threat known or very likely to occur	Low	High	Low
Habitat loss or degradation	**Wave action from boats**	Threat likely to occur	Unknown	Very low	Unknown
Habitat loss or degradation	**Installation of temporary or permanent barriers**	Low	Unknown	Very low	Unknown
Biological threats	**Invasive species**	Threat likely to occur	Medium	Low	Medium
Biological threats	**Diseases and parasites**	Low	Low	Low	Low
Use of biological resources	**Incidental commercial catches**	Threat known or very likely to occur	Low	Very high	Low

Category	Threat	Likelihood of occurrence [a]	Level of impact [b]	Causal certainty [c]	Threat risk [d]
Use of biological resources	**Incidental sport catches**	Threat known or very likely to occur	Low	Very high	Low
Use of biological resources	**Illegal catches**	Threat known or very likely to occur	Unknown	Very high	Unknown
Pollution	**Leaks and spills from oil shipping**	Threat known or very likely to occur	Medium	Very high	Medium
Pollution	**Leaks and spills from oil and gas exploration and production**	Low	Medium	Very high	Low
Pollution	**Agricultural pollution: nutrient and sediment loading**	Threat known or very likely to occur	Low	Very low	Low
Pollution	**Agricultural pollution: pesticides**	Threat known or very likely to occur	Unknown	Very low	Unknown
Pollution	**Municipal effluents, industrial effluents and ship-source pollution spills**	Threat known or very likely to occur	Unknown	Very low	Unknown

[a] Likelihood of occurrence: the probability of a specific threat occurring for a given population over 10 years or 3 generations, whichever is shorter.

[b] Level of impact: the magnitude of the impact caused by a given threat, and the level to which it affects the survival or recovery of the population.

[c] Causal certainty: the strength of evidence linking the threat to the survival and recovery of the population.

[d] Population-level threat risk: the product of likelihood and level of impact as determined using a risk matrix approach.

5.2 Description of threats

Infrastructure modification and development

The development of harbour and road infrastructure (including capital dredging and backfilling/offloading of dredged material) may have significant impacts on habitats, especially given their permanent nature. For example, between the Québec City and Île d'Orléans bridges, riparian and aquatic habitats have already suffered considerable losses over more than 20 kilometres because of road and port development. That infrastructure eliminated several hundred hectares of habitat that were used by the Striped Bass before its disappearance (Robitaille *et al.* 2011; DFO 2011). An example of an impact related to dredging is the offloading of dredged material near many islands downstream of Québec City, modifying major Striped Bass rearing areas, which may have contributed to the disappearance of the species in the 1960s (COSEWIC 2012).

The risk associated with infrastructure development can vary depending on its location and scope. Construction work may, or may not, pose risks that vary according to the time the work is carried out. Risks associated with construction work and infrastructure that are likely to affect critical habitat, especially when the critical habitat is limited in size, generate the greatest concern. For example, given that only two known spawning grounds appear to support the entire population, infrastructure projects near important habitats like these could have a tremendous impact. Flow, depth, salinity and temperature conditions - which are closely tied to spawning as well as egg and larval dispersion - could change, for example, because of the erection of walls and/or retaining walls, encroachment, or capital and maintenance dredging. This is especially true for Striped Bass eggs, which require specific hydrodynamic conditions (see Section 4.3 Needs of the Species).

Given the permanent nature of infrastructure, the risk generated by this threat is high, especially if the development affects an area of critical habitat.

Maintenance and development of the St. Lawrence Seaway

In the past, capital dredging has been of great concern as it may have contributed to the disappearance of the Striped Bass in the 1960s (COSEWIC 2012; DFO 2011). Indeed, the summer rearing areas for immature Striped Bass, located on the periphery of several islands in the St. Lawrence, were modified by the offloading of dredged material (Robitaille 2001). This change relegated Striped Bass from the extirpated population to a few areas along the southern shore, which quickly became highly frequented fishing areas (Robitaille and Girard 2002). Since 1854, over 200,000,000 m^3 of sediment has been removed from the river bed, particularly upstream of Québec City (Villeneuve 2001), to clear the Seaway. However, since 1998, most of the work being done is to maintain the navigation channel.

Currently, maintenance dredging mostly takes place in the fluvial stretch and Upper Estuary. This is for the Batiscan, Portneuf, Bécancour Bend and Traverse Cap-Santé anchorage areas. The most significant work is carried out in the Traverse du Nord, between Île d'Orléans and the northern tip of Île aux Grues, where about 50,000 m^3 per year is dredged from an area about 30 kilometres long and 300 metres wide. Dredged sediments were historically deposited south of Île Madame, southeast of Île d'Orléans. Since 2009, one or two alternative sites have been located off the coast of Sault-au-Cochon, but it is possible that the resulting impact may not have been assessed for all the fish species found at those sites (Dubé 2013). However,

dredging activities are generally coupled with mitigation measures, such as appropriate timing and the selection of non-dispersive sites.

Juvenile and immature Striped Bass would be the most likely life stages to be affected by Seaway dredging activities (DFO 2011), especially since they are present in the riverine habitats of the fluvial stretch and Upper Estuary. Maintenance dredging, however, is carried out on a completely different scale than capital dredging. The main impacts of dredging work are: reduced availability of prey; fish dispersion being physically blocked by an increased current in the channel; increased turbidity, particularly upstream of Québec City where water quality is affected (DFO 2011; MDDEFP 2013); release of contaminants; and modification of substrates and habitats (more erosion and submerged plants outside of the channel, as reported in Allard 2015).

The risk level for this threat is medium given that most of the work performed today is maintenance. That said, capital dredging work may be considered, particularly to increase vessel capacity in a context of declining water levels in the fluvial stretch or to deepen the River Estuary, in which case the risk level would increase.

Maintenance of wharves, marinas and access channels

Lower dredging volumes generally required for the maintenance of wharves, marinas and channels, as well as mitigation measures (such as onshore disposal of contaminated sediment) decrease the risk associated with dredging activities. In the Upper Estuary, sediments from the Îsle-aux-Grues wharf and the Berthier-sur-Mer wharf are deposited south of Grosse-Île (Canadian Hydrographic Service 2012). However, the most significant risk of this maintenance work is its location. For example, spawning sites could be seriously affected, as flow, salinity and temperature conditions are closely tied to spawning and larval dispersal. As a result, maintenance of the Montmagny wharf is more concerning given that a spawning ground is located directly in the harbour, at the mouth of the Rivière du Sud.

The risk associated with this threat therefore remains medium.

Local modification of riparian environment

Dewatering, filling, vegetation removal, rockfilling, and the construction of retaining walls contribute to the degradation of the riparian environment, where important habitats are found, particularly for fish at younger life stages such as juvenile fish that use aquatic grass beds for shelter and feeding.

The cumulative effect of these activities should be considered, but the concern and the risk associated with this threat are low at the population level. Moreover, a significant portion of the range for early stages is not highly urbanized.

Wave action from boats

Ship-generated waves cause bank degradation and reduce the quality and diversity of coastal habitats. Unlike spring flooding, this type of constant erosion (in summer) prevents the establishment of aquatic vegetation. This phenomenon is observed from Cornwall to Montmagny, where 15% of banks are exposed to erosion and 85% of that erosion is explained by wave action from boats (Dauphin 2000). Juvenile Striped Bass feed in riparian habitats in a part of this more sensitive area, south of Île d'Orléans up to Montmagny.

The level of impact and risk associated with this threat remain unknown.

Installation of temporary or permanent barriers

Examples of this threat include dams, temporary dykes and marine turbines. Bridge and marine turbine projects have been proposed in recent years in the Striped Bass range. Issues were raised related to the interconnectedness of spawning habitats, feeding areas and wintering sites (Valiquette *et al.* 2016). However, there are currently no dams or turbine projects in the St. Lawrence River where Striped Bass live.

Marine turbines are a relatively new, ever-developing technology. Depending on the type of marine turbine and site selected, some impact is possible, including avoidance behaviour or injury and death of fish or larvae (e.g., due to mechanical contact with turbines, pressure changes and cavitation[3]).

The level of impact and risk associated with this threat remains unknown.

Invasive species

In 2016, Grass Carp (a type of Asian Carp) were caught in the St. Lawrence for the first time. The species could eventually become established in the area between Montréal and Île d'Orléans. As a mainly planktivorous species, they could compete with the early life stages of the Striped Bass, which feed on plankton, and seriously alter the aquatic grass bed habitats where they feed and shelter. Asian Carp also carry parasites and diseases, which pose an additional risk (MFFP 2016).

Mainly because of the threat of Asian Carp, the risk associated with this threat is deemed medium, although Grass Carp discoveries in the St. Lawrence River in 2016 heighten concerns.

Diseases and parasites

Viral hemorrhagic septicemia is an infectious disease associated with mass fish mortality. It is present in the Great Lakes Basin and the Maritimes, and has been observed in the Miramichi River, in Striped Bass from the Southern Gulf population (Robitaille *et al.* 2011). However, the Striped Bass used for stocking in the St. Lawrence River were disease-free. Other diseases can affect Striped Bass populations (Gervasi 2015), but none have been observed in the St. Lawrence River Striped Bass population.

In the southern Gulf of St. Lawrence, Striped Bass often carry the nematode *Philometra sp.,* although this does not seem to affect their condition (S. Douglas, DFO, pers. comm.). The St. Lawrence River population was probably a carrier historically (Séguin *et al.* 2007).

For the moment, the level of concern and risk associated with diseases and parasites are low.

[3] Cavitation involves bubble formation and violent pressure changes that may injure fish.

Incidental commercial catches

Incidental catches of Striped Bass mainly occur in eel traps in September and October. The current risk is considered low, however, and is lower than it was at the time of the former bass population. In fact, the mesh of the eel traps has been adjusted to avoid catching Rainbow Smelt, which also benefits juvenile Striped Bass. In addition, a licence retirement program for eel fishing licences was implemented in 2009, and only 21 of the original 190 permits remain active (DFO 2017a). A pilot project is underway to test a new measure to further mitigate the risk by improving the survival rate of released fish. This measure consists of collecting and keeping incidentally caught fish in flat-bottomed open vats during low tide to allow them to escape at high tide. Holding vats are effective in increasing the survival rate of incidentally caught Striped Bass (Guy Verreault, MFFP, pers. comm.). According to monitoring conducted among commercial fishers, incidental catches in fyke nets and American Shad nets should be negligible (DFO 2010).

The risk associated with this threat is considered low.

Incidental sport catches

Since the abundance of Striped Bass has increased significantly and this species exhibits gregarious behaviour, incidental catches are observed much more frequently and over a larger area than during the last scientific assessment of this threat (DFO 2010). Catches are now reported from Montréal to Sheldrake (Middle North Shore) and along the Saguenay River. While incidental catches are somewhat concerning, this threat is deemed low risk, given that release is mandatory and given the significant awareness campaign that accompanied this measure (DFO 2010). The Quebec government also recently closed fishing areas in particular cases where individuals were aggregating at a spawning site and the concentration of fish was likely to cause significant incidental catches.

The risk related to this threat is low.

Illegal catches

Striped Bass fishing is prohibited in the St. Lawrence River up to Forestville (on the north shore) and Rimouski (on the south shore). Although there is no data available to measure the actual significance and risk related to illegal Striped Bass catches, the threat is present and raises concerns. Several factors may influence illegal Striped Bass catches. These include the popularity and enthusiasm of sport fishing, which concerns the striped bass population of the Southern Gulf of St. Lawrence. The territory targeted by this fishery was expanded in 2018 to include the Northern Gulf of the St. Lawrence and a part of the estuary, up to a line between Rimouski and Forestville. Also, the species' gregarious behaviour while they are congregated at certain sites means that they are quickly spotted, which often leads people to believe them to be very abundant. In addition, living in a riparian environment means that Striped Bass are easy to access, which increases risk. Mass media also perpetuate the perception that the species is abundant and even harmful to other harvested species, such as Sea Trout and Atlantic Salmon.

No reliable information is available at present; the level of impact and risk associated with this threat therefore remain unknown.

Leaks and spills from oil shipping

Accidental spills from vessels can occur in the event of a collision, grounding, fire or explosion. Navigation conditions are particularly difficult between Québec City and the Traverse du Nord exit because of tides, frequent storms, fog and currents. Despite mitigation measures (e.g., St. Lawrence pilots, double hulls), this threat raises a major concern, especially since this area is highly frequented by Striped Bass. The transportation of oil via pipelines is also concerning, especially in a context where a project under consideration would cross over from Quebec to New Brunswick, along the St. Lawrence.

Exposure to oil can cause fish to die in the hours following a spill, or later. Exposure to contaminated water or sediments can also cause sub-lethal effects that could limit chances of survival and reproduction and subsequently affect population recruitment (Dupuis and Ucan-Marin 2015). Riverine habitats where juveniles feed are the most at risk for fish, since these habitats are more confined, and less hydrodynamic. Also, if a spill occurs, oil may drift to less salty coastal waters, where oil solubility and bioavailability could progressively increase (Dupuis and Ucan-Marin 2015). The early stages of life, especially eggs and larvae, are considered much more sensitive than adults (National Research Council 2005), especially since pelagic eggs and larvae (located in the water column) are likely to follow the same path as an oil slick (Fodrie and Heck 2011). Aggregation of Striped Bass in wintering sites could increase the risk of mortality due to environmental accidents or adverse changes in habitat.

The likelihood of occurrence is significant, and the impacts are documented. The risk related to this threat is deemed medium.

Leaks and spills from oil and gas exploration and production

Since 1997, the Government of Quebec has maintained a permanent moratorium on the allocation of licences for oil and gas exploration and production in the waters of the St. Lawrence River and the St. Lawrence Estuary.

As the St. Lawrence River Striped Bass population is found less frequently in the Gulf of St. Lawrence, this threat is of little concern as long as this moratorium is in place.

Agricultural pollution

Poor agricultural practices and nutrient overloading promote erosion and sediment, nutrient and pesticide runoff into watercourses. The most significant impacts of these practices are visible in Lake Saint-Pierre, where water quality is altered by pesticides (Hudon and Carignan 2008), and where aquatic grass beds are receding in favour of proliferating filamentous algae, stimulated by nutrients (de la Chenelière *et al.* 2014). However, this threat is less prevalent in the area that is most frequented by Striped Bass, downstream of Portneuf.

The risk posed by nutrient and sediment loading to Striped Bass is considered low. The risk for pesticides is unknown but raises some concern. The adult Striped Bass is an upper trophic level predator and is therefore very vulnerable to contaminants accumulated in both sediment and the food chain (COSEWIC 2012).

Municipal and industrial effluents and ship-source spills

The species is sensitive to contamination, as mentioned above. Commercial shipping vessels occasionally discharge substances (e.g. oily water) in addition to presenting an oil spill risk (Innovation maritime 2014). Transport Canada recorded pollution spills for 1% of vessels monitored in Canadian waters in 2013-2014. Most spills were under 10 litres, but some were larger (Environment and Climate Change Canada 2016). These kinds of spills are also reported in the St Lawrence River. Spills are most likely to occur within a port or an oil handling facility during the loading or unloading of a ship (Innovation maritime 2014). Spills and their cumulative impacts could pose a threat, especially in more susceptible areas, such as the Rivière du Sud basin[4], which houses a spawning ground.

The risk posed by local sources of contamination - municipal and industrial effluents - could not be categorized. Overall, the risk associated with this threat is unknown.

6. Population and Distribution Objectives

The Recovery Potential Assessment conducted in 2005 (DFO 2006) did not set a quantitative recovery target for the St. Lawrence River Striped Bass population. However, a qualitative target has been established: a self-perpetuating population with areas of occupancy and occurrence similar to those of the extirpated population.

There are no abundance estimates for the former population that can be used as a reference point for the recovering population. Quantitative, historical and recent data on abundance, distribution and life history are insufficient.

Given the designation criteria used by COSEWIC in its 2012 assessment, the overall objective of this document for the recovery of the St. Lawrence River Striped Bass population is as follows:

> Within five years, meet the criteria that would allow the population to shift from its current endangered status (COSEWIC 2012) to that of a species of special concern, which is achievable from a biological perspective.

The population and distribution objectives establish, insomuch as possible, the number of individuals or populations (their geographic distribution is specified) necessary for the recovery of the species. The population and distribution objectives for the St. Lawrence River Striped Bass are as follows:

> *Population objective:* An increasing population of more than 10,000 mature individuals. Current data confirm an increase in abundance and distribution. The trend seen in recruitment monitoring already indicates a gradual increase in the population.
>
> *Distribution objective:* Viable populations with an increasing range (compared to 2012 data[5]) over an area close to the historic range (mainly from Lake Saint-Pierre to Baie Saint-Paul on the northern shore and L'Isle-Verte on the southern shore), and an area of

[4] Common name given to the mouth of the Rivière du Sud (see figure 3, zone B)
[5] 2012 is chosen for reference as the first year a standardized sampling network was formed

occupancy with good-quality habitats. According to current data, the species already seems to have a larger distribution area than it did historically. Current data also confirms the existence of at least a second reproduction site and suitable habitats for all life cycle functions. These factors suggest that this population is less vulnerable.

It is difficult to establish more accurate quantitative population and distribution objectives for the St. Lawrence River Striped Bass population at this time. However, work currently underway will be used to set a quantitative objective within a few years. The proposed population and distribution targets may be reassessed once research projects on population dynamics and the support capacity of the St. Lawrence River for the Striped Bass have been finalized.

7. Broad Strategies and General Approaches to Meet Objectives

The successful recovery of this species depends on measures taken by various organizations and jurisdictions, including Fisheries and Oceans Canada. It requires the commitment and cooperation of many stakeholders who will be involved in implementing the strategies and measures set out in the recovery strategy and action plan.

Broad strategy 1: stocking, inventory and monitoring

- Approach 1-1: population status and monitoring
- Approach 1-2: stocking

Broad strategy 2: research

- Approach 2-1: research on habitat components and environmental conditions
- Approach 2-2: population research

Broad strategy 3: management and coordination

- Approach 3-1: fishery management
- Approach 3-2: habitat management

Broad strategy 4: stewardship and outreach

- Approach 4-1: outreach

7.1 Actions already completed

The previous Recovery Strategy (Robitaille *et al.* 2011) subdivided recovery efforts into five recovery objectives: 1) increase the number of Striped Bass; 2) determine the habitats used by the Striped Bass population; 3) monitor the status of the Striped Bass population; 4) monitor the status of certain components of the ichthyological community (prey, predators, competitors) in relationship with the Striped Bass; and 5) protect the Striped Bass population and its most important habitats. To achieve these objectives, the previous strategy recommended a series of recovery measures and established a schedule of studies required to identify critical habitat. DFO reported on the progress made between 2011 and 2016 in implementing these recovery measures and in carrying out these studies (DFO 2017b). The following is a summary of that progress.

- A reintroduction program has been underway since 2002; however, the species is now reproducing naturally in the St. Lawrence River. The captive rearing program is under the sole responsibility of the Quebec government. Given the technical difficulties the program has faced in achieving these objectives and the considerable evidence of successful natural reproduction, the program will be reviewed in the very near future to determine whether these efforts should continue.

- Genetic methods have been developed to identify Striped Bass eggs and larvae.

- Biological reference parameters (e.g., condition, growth rate and annual recruitment) have been established to monitor reproductive success.

- A network for monitoring incidental catches was created in 2003. This network continues to collect Striped Bass observations from commercial, recreational and scientific fishing.

- A standardized sampling network has been in place since 2013 that includes 100 stations along both the southern shore (between Bécancour and L'Isle-Verte) and the northern shore (between Trois-Rivières and La Malbaie), including the main islands between those areas. It allows for monitoring the evolution of the new population, evaluating interannual variations in reproductive success, and establishing the young-of-the-year abundance index.

- Since 2011, a vast fixed-station passive hydroacoustic telemetry network has been used to monitor adult Striped Bass fitted with hydro acoustic transmitters in the St. Lawrence system and its main tributaries. The data collected is used in the determination of habitat locations and their use.

- Several areas have been identified as part of the species' critical habitat: two adult feeding areas, two adult overwintering areas, two spawning sites as well as a riparian area for larval and juvenile growth.

- Since 2014, all fishing has been banned in some aggregation sites during the spawning period under the *Quebec Fishery Regulations* (1990), SOR/90-214, (e.g. the mouth of the Rivière du Sud [periodic ban] and the mouth of the Rivière-Ouelle [year-round ban]). These measures can be reassessed as needed.

- Along the St. Lawrence River, upstream from Forestville (on the north shore) and Rimouski (on the south shore), all Striped Bass caught incidentally by commercial or recreational fishers must be released, with the exception of certain specimens caught by fishers with wildlife management licences participating in the monitoring network; instead, they submit their catches to the Government of Quebec for monitoring purposes (DFO 2010). When releasing live fish, fishers must take care to cause the least harm possible (*Quebec Fishery Regulations* [1990], SOR/90-214, pursuant to the *Fisheries Act*).

- The Île Madame dredged material disposal site has been relocated, and contaminated sediment is disposed of at onshore sites.

- An extensive campaign for reporting and releasing catches has been carried out, especially among sport fishers. About 12,000 permanent posters have been placed at

strategic locations on river access sites downstream from Lake Saint-Pierre since 2005, and 10,000 stickers have been distributed to sport fishers since 2011.

- DFO conducted a scientific review to assess the habitat required for the survival and recovery of the St. Lawrence Striped Bass (DFO 2017a; Valiquette *et al.* 2017; DFO 2016).

7.2 Strategic direction for recovery

This recovery strategy and action plan includes a description of the measures that provide the best chance of achieving the population and distribution objectives for the St. Lawrence River Striped Bass, including measures to address the threats to the species and monitor its recovery. The proposed measures aim to guide not only activities that Fisheries and Oceans Canada must undertake, but also those for which other jurisdictions, organizations and individuals can play a role. As new information is obtained, these measures and their priority level may change. Fisheries and Oceans Canada strongly encourages all Canadians to participate in the conservation of the St. Lawrence River Striped Bass through the implementation of the measures outlined in this recovery strategy and action plan.

Tables 3 and 4 present the measures identified to support the recovery of the St. Lawrence River Striped Bass. The implementation of these measures will depend on the involvement of Fisheries and Oceans Canada and other partners in the recovery efforts. If your organization wishes to participate in one of these measures, please contact Fisheries and Oceans Canada, Québec Species at Risk Management Division (lep-sara-qc@dfo-mpo.gc.ca).

Implementation of this recovery strategy and action plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

Table 3. Measures to be undertaken collaboratively by Fisheries and Oceans Canada and its partners. See Appendix D for a list of the acronyms used.

#	Recovery Measures	Approach	Priority [a]	Threats or Objectives addressed	Suggested Partner(s)	Timeline
1	Define the range west of Lake Saint-Pierre and on the North Shore from east of the Saguenay River to Baie-Comeau.	1-1	High (in the west) Low (North Shore)	Objective: To attain distribution objective	**MFFP** **Academic sector** **DFO** FN	Three years
2	Pursue monitoring of population abundance and status using standard indicators and protocols, notably recruitment monitoring to estimate young-of-the-year abundance.	1-1	High	Objective: To attain population objective	**MFFP** **Academic sector** **DFO** FN	Ongoing
3	Determine adult abundance indicators and establish protocols to monitor these indicators.	1-1	High	Objective: To attain population objective	**MFFP** **Academic sector** **DFO**	Three years
4	Determine the relative significance of the area of overlap between the Gulf of St. Lawrence and the St. Lawrence River Striped Bass populations and assess the contribution of each population.	1-1	High	Objective: To attain distribution objective	**MFFP** **Academic sector** **DFO**	Five years (three years if based on telemetry)
5	Assess the capacity of the St. Lawrence River to support juvenile Striped Bass and develop a quantitative recovery target that takes population dynamics into account.	1-1	High	Objective: To attain population and distribution objectives	**MFFP** **Academic sector** **DFO** FN	Five years
6	Monitor pathogens and parasites and, as required, assess the invasive species situation related to Striped Bass.	1-1	Low	Threat: Invasive species and pathogens	**MFFP** **Academic sector** **DFO** FN	Ongoing
7	Monitor the status of important habitats, notably spawning habitat.	1-1	High	Objective: To attain distribution objective	**MFFP** **Academic sector**	Five years

#	Recovery Measures	Approach	Priority [a]	Threats or Objectives addressed	Suggested Partner(s)	Timeline
					DFO FN	
8	Determine factors that could limit growth in some juveniles (0+) and prevent them from growing large enough to survive the winter (e.g., delayed spawning, low-quality rearing habitats, growth-limiting parasites).	2-1	Medium	Objective: To attain population objective	**Academic sector** **MFFP** DFO	Three years
9	Define the unique structure of the Striped Bass aggregation that frequents the Rivière-Ouelle, record site fidelity and, if possible, find the reason the site is used.	2-2	Medium	Objective: To attain population and distribution objectives	**MFFP** **Academic sector** DFO	Five years
10	Determine contingents and establish their importance and their contribution to the recovery of the population.	2-2	Low	Objective: To attain population and distribution objectives	**MFFP** **Academic sector** **DFO** FN	Ten years
11	Conduct a new assessment of the impact of different fisheries (commercial, recreational, First Nations and illegal fisheries) on recovery.	3-1	High	Threats: Incidental catches	**MFFP** **DFO** FN	Two years
12	In collaboration with commercial fishers, continue to engage in the activities of the bycatch monitoring network established in 2003 and collect data to assess demographic parameters.	3-1	High	Threat: Incidental commercial catches	**MFFP** **Commercial fishing** DFO	Ongoing
13	In collaboration with fishers, monitor incidental catches in sport and commercial fishing.	3-1	High	Threat: Incidental commercial catches	**MFFP** **Commercial fishing** DFO	Ongoing
14	Disseminate relevant information and ensure field surveillance and monitoring by protection officers.	3-1	High	Threat: Illegal catches	**MFFP** **DFO**	Ongoing
15	Incorporate information on Striped Bass needs when assessing proposed projects in or near a body of water.	3-2	High	Threat: Habitat loss or degradation	**Industry** **MFFP** **DFO**	Ongoing

#	Recovery Measures	Approach	Priority [a]	Threats or Objectives addressed	Suggested Partner(s)	Timeline
16	Encourage sport fishers to adopt behaviour that helps with Striped Bass conservation (e.g., information and outreach about releases).	4-1	High	Threat: Incidental catches	**MFFP** **DFO** **NGO** **FN**	Ongoing
17	Encourage commercial fishers to implement measures that improve the survival rates of Striped Bass accidentally caught in fixed gear.	4-1	High	Threat: Incidental catches	**MFFP** **DFO** **NGO** FN	Ongoing
18	Encourage commercial fishers to monitor incidental catches in fishing gear.	4-1	High	Threat: Incidental catches	**MFFP** **DFO** **NGO**	Ongoing
19	Encourage municipalities, RCMs and other governmental and administrative authorities to ensure that Striped Bass needs are taken into account in management practices that affect aquatic environments, and to take appropriate corrective action in the field (e.g., including considerations in water management plans, action plans, ecological rehabilitation plans and regional integrated management plans).	4-1	Medium	Threat: Habitat loss or degradation	**MFFP** **MDDELCC** **DFO** **Agricultural sector** **Municipalities** **NGO** **FN**	Ongoing
20	Encourage good agroenvironmental practices and take appropriate corrective action in the field.	4-1	Low	Threat: Habitat loss or degradation	**MFFP** **MDDELCC** **Agricultural sector** **DFO** **NGO** **FN**	Ongoing
21	Support, encourage and inform stakeholders interested in the aquatic environment and the general public, in order to promote protection measures for the Striped Bass and its habitat.	4-1	High	All threats	**MFFP** **DFO** **NGO** **FN**	Three years
22	Develop a campaign to raise public awareness of the Striped Bass and demonstrate its importance, as well as the difference between the St. Lawrence River and Gulf populations (social marketing, brand image).	4-1	High	All threats	**MFFP** **DFO** **NGO** **FN**	Three years

Table 4. Measures that represent opportunities for other jurisdictions, organizations or individuals to lead. See Appendix D for a list of the acronyms used.

#	Recovery Measures	Approach	Priority [a]	Threats or Objectives addressed	Suggested jurisdictions or Organizations	Timeline
23	Stock the river with up to 10,000 individuals per year. Ideally these individuals should be tagged in order to track them and assess the contribution of stocking compared to natural spawning.	1-2	Low	Objective: To attain population objective	**MFFP**	Five years
24	Implement, by regulation, management measures to protect Striped Bass at critical times or sites (e.g., fishery closures).	3-1	High	Threats: Incidental and illegal catches	**MFFP**	Ongoing

[a] "Priority" indicates the degree to which the measure contributes directly to the recovery of the species or if the measure is an essential precursor to a measure that contributes to the recovery of the species:

- "High" priority measures are considered likely to have an immediate or direct influence on the recovery of the species.
- "Medium" priority measures are important, but considered to have an indirect or less immediate influence on the recovery of the species.
- "Low" priority measures are considered important for expanding the knowledge base about the species and mitigating threats.

7.3 Narrative to support the recovery planning table

Some measures from the recovery planning tables are justified below.

Regarding population status and monitoring:

- Measure 1 is explained by the need to acquire knowledge on the species' new range to support management, outreach and stewardship measures. Priority is given to documenting the area west of Lake Saint-Pierre because of higher anthropogenic pressure in this part of the Striped Bass' range.
- Measure 2 is a reliable and standard indicator of population status.
- Measure 3 is significant from a management perspective for determining the extent to which the recovery target has been reached.
- Measure 4 provides information on the limits of the distribution of the river's population and that of the neighbouring population (Southern Gulf of St. Lawrence population) so that appropriate management measures can be put in place for each population..
- Measure 5 makes it possible to continue characterizing the habitats occupied by juveniles so as to identify those that are conducive to growth and, from there, determine the support capacity of the environment for the population. This is an important management measure for determining a recovery target.
- Measure 6 is low priority for recovery; few mitigation or prevention measures are available.
- From a management perspective, measure 7 is important to identify management and protection measures to implement as required.
- Stocking (measure 23) must continue since the contribution of artificial reproduction compared to natural spawning and the variability of recruitment has not been assessed and the persistence of recent gains is unknown.

Regarding research:

- Measure 8 could yield results likely to provide some perspective on the results obtained through recruitment monitoring.
- Measure 9 is relatively important because the Rivière-Ouelle has emerged as the site with the highest concentrations of adults (particularly females) during the spawning season (May-June). The latest report from Quebec's Ministère de la Forêt, de la Faune et des Parcs (MFFP) suggests that this area is not used for spawning, but it may nevertheless play a significant role for gonad maturation and provide high quality habitat for feeding (MFFP 2016, unpublished data).
- Measure 10 is considered lower priority compared to others. The data obtained would help with interpreting monitoring data. It should be noted that the contingents are not genetically different because the population has only been introduced recently.

Regarding management and coordination:

- Measure 11 should be carried out in a relatively short timeframe to confirm whether the authorization allowing fishers to engage in commercial fishing activities with releases

meets the conditions required by this document. The previous program recommended an assessment be conducted within a maximum of five years.

- Implementation of measures 12 and 13 is high priority to determine and justify adjustments to fisheries management measures.
- Measure 14 is high priority considering the growing popularity of Striped Bass sport fishing in Quebec.
- Measure 15 is high priority, especially given that critical habitat areas are identified.
- Measure 24 is high priority to minimize disturbances as much as possible during critical periods, such as spawning periods.

Regarding stewardship and outreach:

- Measures 16, 17 and 18 are high priority because they would engage fishers in Striped Bass conservation.
- Measures 19 and 20 are designed to get the municipal and agricultural sectors involved in Striped Bass conservation.
- Measures 21 and 22 are high priority because they would improve public awareness of the Striped Bass.

8. Critical Habitat

8.1 Identification of the species' critical habitat

8.1.1 General description of the species' critical habitat

Under the *Species at Risk Act*, critical habitat is defined as "*the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species.*" [Subs. 2(1)]

In addition, SARA defines the habitat of an aquatic species as: "[...] *spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced.*" [Subs. 2(1)]

The critical habitat of the St. Lawrence River Striped Bass population is defined as accurately as possible, using the best available information. The functions and features required to support the life cycle processes of the species are also specified.

In summary, the critical habitat identified for the St. Lawrence River Striped Bass population consists of an array of geographical locations in the River or Upper Estuary of the St. Lawrence, where the Striped Bass performs its essential life-cycle functions (reproduction, growth, feeding and overwintering).

- The critical habitat identified for adult feeding corresponds to two areas: one on the northern shore (around Île aux Coudres) and the second along the southern shore between Québec City and Rivière-Ouelle. These areas provide access to a sufficient quantity and quality of prey at temperatures suitable for feeding, from May to October.

- The critical habitat identified for overwintering adults includes two areas. The first is located south of Île aux Grues, and the second, between Québec City and Île d'Orléans. These areas provide the temperature and oxygen concentration conditions required for survival from November to April, and are also prime locations close to spawning grounds.
- Two critical habitat areas for reproduction have been identified: the Rivière-du-Sud basin at Montmagny, and the intertidal zone, at the end of the Port of Québec.[6] The various features (temperature, salinity, flow and hydrodynamics) of these areas are suitable for gonad maturation and spawning, which takes place from May to June, and conducive to the survival and transportation of eggs to fry-rearing areas downstream.
- The critical habitat for larval and young-of-the-year (0+) feeding and growth has been identified as an intertidal riparian zone with a low tide depth of 0-5 metres[7]. This area falls within a bounding box that begins at Lévis and extends downstream to Rivière-du-Loup on the southern shore, and to Petite-Rivière-Saint-François on the northern shore (including the islands and shoals between Québec City and Île aux Grues). The identified critical habitat is characterized by the very productive estuarine waters, typical of the St. Lawrence's estuarine transition zone (ETZ) and its coastal waters. These waters are used between June and November and have features conducive to larval and juvenile survival and feeding (salinity, temperature, turbidity, production and retention of prey, and frequent presence of aquatic grass beds).

It is not clear if the critical habitat identified in this recovery strategy and action plan is sufficient to achieve the population and distribution objectives for the species. The schedule of studies outlines the research required to identify other areas of critical habitat as needed and to obtain further information and details on the identified critical habitat to achieve the population and distribution objectives for the species.

8.1.2 Information and methods used to identify critical habitat

The critical habitat for the St. Lawrence River Striped Bass population was identified, as well as possible, based on the best available information. This information was mostly generated by the research projects identified in the schedule of studies for the previous recovery strategy (Robitaille *et al.* 2011). The results of these projects were published in a Research Document from the Canadian Science Advisory Secretariat (Valiquette *et al.* 2017). They were used as a basis for a science advisory report, following a peer review by experts from MFFP, the Université du Québec à Chicoutimi (UQAC) and DFO in March 2016 (DFO 2017a).

Overall, information and projects presented in the science advisory report were used to determine and characterize (non-exhaustively) the habitats used by the Striped Bass at various stages of its life cycle (larvae, juveniles [0+], adults) and at different times of the year (spawning period [May–June], open water period [May–October] and overwintering period [November–April]). This approach helped identify a critical habitat composed of a diverse array of habitats where the Striped Bass performs functions essential to its life cycle (reproduction, growth, feeding and overwintering).

[6] In the Beauport sector.

[7] Reference is taken from the Canadian Hydrographic Service chart datum, defined as the Lower Low Water, Large Tide.

Adult feeding habitat

The adult feeding habitat was characterized using a telemetry study. Between 2011 and 2015, a network of receivers was deployed along the St. Lawrence's northern and southern shores, between Montréal and Sainte-Luce, and from Montréal up to and including the Saguenay Fjord. The network was active during the open water period, between May and October. This period is associated with a water temperature above 10 °C, considered suitable for feeding. The network of receivers monitored the movement of Striped Bass equipped with acoustic transmitters. The results showed that the Striped Bass disperse over a large territory to feed. The critical habitat for adult feeding has been identified as the area used by at least 50% of marked individuals between May and October. Two feeding areas were defined using this approach.

Adult overwintering habitat

Adult overwintering areas were also characterized using telemetry. A network of receivers was deployed in winter, between November 2014 and April 2015. This period is associated with a water temperature below 10 °C. Below this threshold, Striped Bass stop feeding. The winter network had a limited number of receivers deployed in the St. Lawrence River between Portneuf and Rivière-du-Loup. Constrained by ice, the winter network offers limited spatial coverage and resolution compared to the open-water network. Nevertheless, the winter network is used to document areas of the River and Upper Estuaries where Striped Bass return from areas furthest downstream beginning in early September (based on information from the open-water network). The critical habitat for wintering adults was designated as the areas where the marked Striped Bass are most concentrated between November and April. Two wintering areas were defined using this approach. Movements were observed between these areas, but the data were considered too fragmented to identify a migration corridor as critical habitat.

Reproduction habitat

The Striped Bass spawning period is considered to extend from May to June. The species is known to use pre-spawning staging areas that, like spawning grounds, play a critical role for reproduction. Individuals aggregate there to take advantage of environmental conditions conducive to gonad maturation. These pre-spawning staging areas are not necessarily spawning grounds and may be several kilometres away. Spawning sites are characterized by abiotic attributes (temperature, salinity, oxygen, current) suitable for egg incubation and hydrodynamics conducive to their transportation to fry-rearing areas.

Two approaches were used to define reproduction habitat: searching for aggregations of adults in spawning condition, and searching for eggs and larvae. Between 2011 and 2015, 14 sites located at the mouth of rivers or in various areas along the St. Lawrence River were sampled during this period, mainly using nets, for a total of 1,389 hours. The 14 sites were selected because their abiotic features were suitable for Striped Bass reproduction or because fishers had reported aggregations of mature Striped Bass there (Pelletier *et al.* 2010). Sampling effort varied among sites. Two sites associated with large aggregations of Striped Bass in spawning condition were sampled more intensely and recurrently (at least two years): the mouth of the Rivière du Sud at Montmagny (at the basin) and the Beauport area at Québec City (including Beauport Bay, the mouth of the Saint-Charles River and the end of the port, in the Beauport sector of the Port of Quebec). In addition, in May and June 2015, the fixed open-water telemetry network made it possible to document the use of these two sites by adults equipped with acoustic transmitters. In 2011, ichthyoplankton sampling, coupled with genetic testing, revealed the presence of Striped Bass eggs in the mouth of the Rivière du Sud at Montmagny (Côté *et al.* 2012). In 2014, a high concentration of Striped Bass larvae was observed downstream from Québec City, especially in the Île d'Orléans Channel. Circulation patterns also support the

hypothesis that these larvae came from the Beauport area at Québec City (Pascal Sirois, UQAC, pers. comm.).

Based on these various studies, the Québec City harbour area (at Beauport) and Rivière-du-Sud basin (at Montmagny) stand out as significant aggregation areas used for spawning. The Rivière-du-Sud basin at Montmagny was designated a spawning area in 2011. The area in the far end of the Port of Québec, at Beauport, is also recognized as a spawning site following recent confirmation of the presence of Striped Bass eggs and larvae in this area in 2016 (Eliane Valiquette, MFFP, comm. pers.). In these two areas, predictable aggregations of adults in prime reproduction conditions (full and functioning gonads, empty stomach, male-female sex ratio favouring males, and water temperature between 13°C and 18°C) have been observed. In addition, these aggregations are observed only in May and June, when temperatures are conducive to reproduction, and occur in areas with suitable hydrodynamics to transport eggs to fry-rearing areas observed downstream. Despite aggregations of mature adults in May–June in the downstream portion of the Rivière-Ouelle, this river had several atypical features for reproduction habitat (very high female-male sex ratio, nearly no males in spawning condition, full stomach, fish on-site during the entire open-water period). It has recently been suggested that females aggregating in the Rivière-Ouelle could be benefitting from conditions conducive to gonad maturation (Anne-Marie Pelletier, MFFP, pers. comm.). However, no studies have been conducted to verify this hypothesis. For these reasons, the Rivière-Ouelle was not selected as critical habitat for reproduction. However, this area is included in the critical habitat for adult feeding, which takes place mainly from May to October (described above).

The entire Rivière-du-Sud basin at Montmagny has been identified as critical habitat. This designation includes all sites where Striped Bass were caught during the spawning season. This designation is in recognition of how important the hydrodynamic conditions in the basin are for reproduction. At Québec City (Beauport sector), the critical habitat was defined to include sites with aggregations of adults in spawning condition. All of these sites are located along the shore at the end of the Port, in the intertidal area. It is clear that adults leave the identified area at low tide to seek refuge in areas located further offshore. However, these areas could not be located based on the information available. They are therefore not included in the identified critical habitat (but their location is listed in the schedule of studies).

Habitat for larval and young-of-the-year growth

Information on the habitats used by the St. Lawrence River population larvae and juveniles is still fragmentary, since several studies are underway. Available information was considered sufficient to identify critical habitat, but insufficient to do so separately for the larvae and juveniles. The critical habitat was therefore identified based on the entire growth period of larvae and juveniles, which takes place mostly from June to November. The first half of this period is considered critical to the survival and growth of larvae, which are particularly sensitive to variations in abiotic conditions such as temperature, salinity and oxygen concentration, as well as the availability of prey. The second half of the period is considered particularly critical for the growth of young-of-the-year, which must reach a minimum size of 10 cm by the end of the growing season to survive their first winter (COSEWIC 2012 and included references).

It was considered acceptable to identify a common critical habitat for the two stages, given that the young-of-the-year habitat seems to include the larval habitat. Indeed, available information indicates that larvae are found mainly in two areas of the St. Lawrence Estuary: between Montmagny and L'Islet-sur-Mer, along the southern shore (Côté *et al.* 2012), and downstream of Île d'Orléans (Pascal Sirois, UQAC, pers. comm.). These two areas are included in the ones

where large aggregations of young-of-the-year are found, as determined based on annual recruitment monitoring by MFFP from 2013 to 2015 (Valiquette *et al.* 2017; DFO 2017a).

Critical habitat was defined by combining two types of information presented in the science advisory report: potential habitats defined for larvae and young-of-the-year, and annual recruitment monitoring (DFO 2017a). More specifically, based on knowledge acquired on the needs of the Striped Bass and its habitat use during its first year of life, the science advisory report (DFO 2017a) identified potential habitats. These habitats correspond to the intertidal and riparian zones between 0 and 5 metres deep, within a large geographically delineated area. The critical habitat was identified as the area – within this area of potential habitats – where young-of-the-year were caught during 2013–2015 recruitment monitoring (excluding the geographic sites farthest upstream and downstream). The critical habitat includes Anse Sainte-Anne (at La Pocatière). This area was designated critical for juveniles between September and October in the previous recovery strategy (Robitaille *et al.* 2010). The knowledge acquired since the previous strategy confirms the importance of Anse Saint-Anne as a critical habitat.

This identification method does have the following limitations. The annual recruitment monitoring survey was developed to provide a standardized abundance index for young-of-the-year. Since it is conducted in September, the survey does not necessarily provide a complete picture of habitat use for the entire growing season (June–November). Moreover, the survey does not indicate the specific habitat features that juveniles seek out for feeding and growth, since the sites were selected to ensure homogeneous catchability of individuals between sites. Projects underway at UQAC should help answer these questions (Pascal Sirois, UQAC, pers. comm.).

8.1.3 Identification of critical habitat

Geographic information

Striped Bass critical habitat consists of an array of geographic locations where the species performs its essential life cycle functions (reproduction, growth, feeding and overwintering). Critical habitat was identified for (i) adult feeding (two areas), (ii) adult overwintering (two areas), (iii) reproduction (two areas), and (iv) larval and juvenile growth (intertidal area, 0–5 m deep over a large geographic area), as described in Table 6 and shown in Figures 3 and 4. It should be noted that, due to a lack of available information, it was not possible to identify critical habitat for sub-adults (individuals 1–3 years of age).

i. Adult feeding: 122 km^2 area stretching along the northern shore of the St. Lawrence for about 45 km, around Île aux Coudres, between Sault-au-Cochon and Cap-aux-Oies; 560 km^2 area stretching 115 km from Québec City, along the Chenal des Grands Voiliers south of Île d'Orléans, to the mouth of the Rivière-Ouelle, including the area around Île aux Grues (Figure 3 and Table 5).
ii. Adult overwintering: 113 km^2 area between the Île aux Grues southern shore and the shoreline; 12 km^2 area between Québec City, Lévis and the southwestern tip of Île d'Orléans (Figure 3 and Table 5).
iii. Reproduction: the Rivière-du-Sud basin area (0.24 km^2), including the area delimited by the dam (Points 3 and 4) and a line connecting the ferry wharf (Point 1) and Pointe aux Oies (Point 2) (Figure 3, Area B; Table 5); the area at the end of the Port of Québec at Beauport (0.036 km^2) delimited by the 0-m isobath of the marine charts from Point 2 to Point 3, closing off at the shore at Points 1 and 4 (Figure 3, Area A; Table 5).

iv. Larval and juvenile growth: intertidal riparian zone (290 km^2) and area with 0–5 metre low tide depths (482 km^2) within the bounding box between Lévis (upstream of the Chaudière River mouth), Rivière-du-Loup on the southern shore, and Petite-Rivière-Saint-François on the northern shore. The bounding box includes the islands and shoals between Québec City and Île aux Grues (Figure 4).

For adult feeding and overwintering habitats as well as for reproduction habitat, the locations of the functions, features and attributes of the critical habitat were determined using a critical habitat parcel approach. However, for habitat for larval and young-of-the-year growth, the locations of the functions, features and attributes of the critical habitat were determined using a bounding box approach. With the critical habitat parcel approach, the critical habitat is the exact area delineated by the identified boundaries, and it is understood that this area supports the functions and features necessary for the species' survival or recovery, as described in Table 6. By contrast, with the bounding box approach, the critical habitat is not comprised of the entire area within the identified boundaries, but only those areas within the identified geographical boundaries where the described biophysical features and the function it supports occur, as described in Table 6.

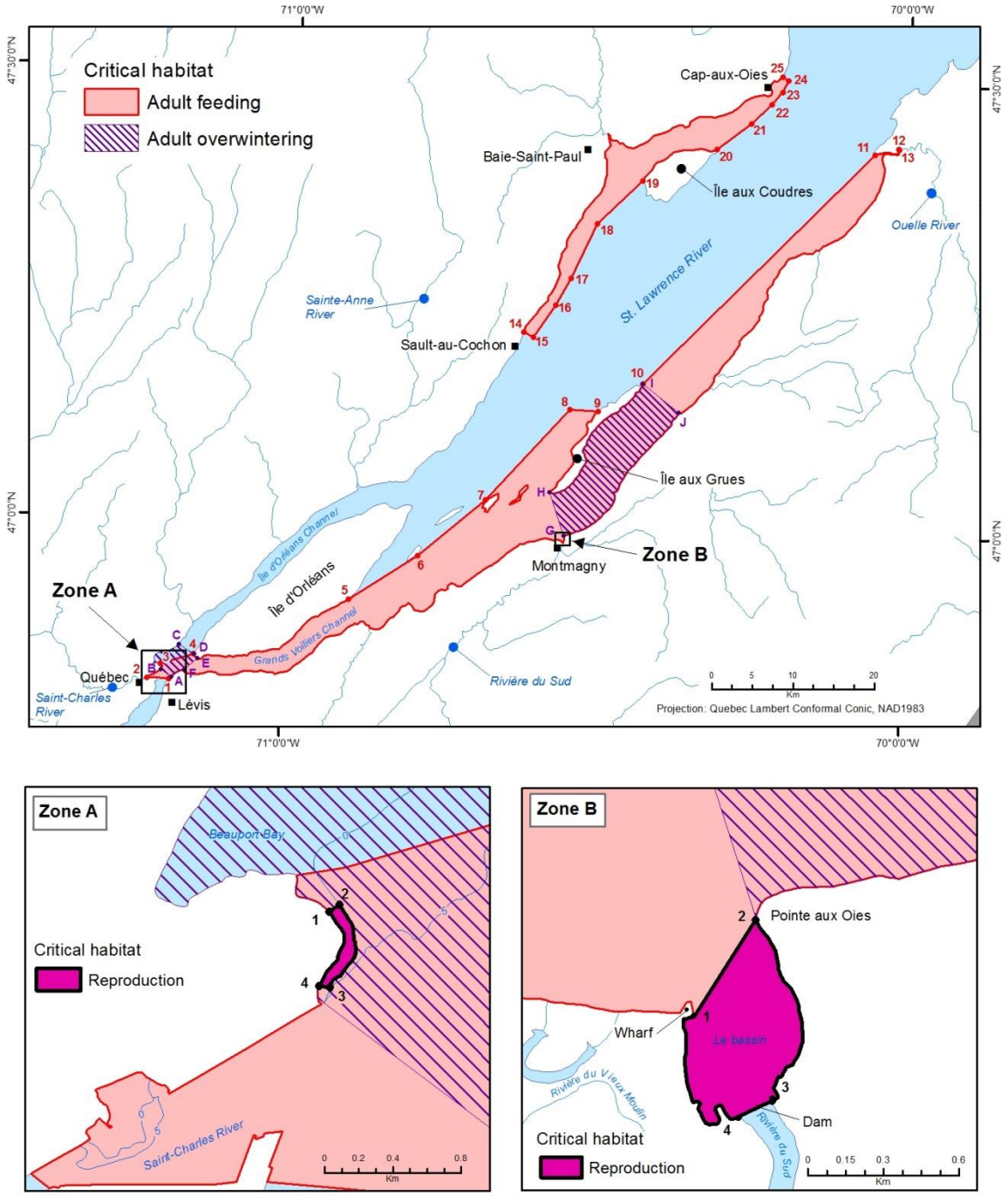

Figure 3. Top: Map showing the critical habitat identified for adult feeding (May–October) and overwintering (November–April). Bottom: Detailed maps illustrating the critical habitat identified for reproduction (May–June), in the area at the end of the Port of Québec at Beauport (Unit A) and in the Rivière-du-Sud basin at Montmagny (Area B). The detailed geographical coordinates are described in Table 5. In Area A, the 0-metre isobath corresponds to nautical charts of the Canadian Hydrographic Service, defined as the Lower Low Water, Large Tide.

Table 5. Geographic coordinates of points delimiting the critical habitat identified for adult feeding, adult overwintering and reproduction, as illustrated in Figure 3.

Adult feeding

Point	Latitude	Longitude
1	46° 49’ 19” N	71° 10’ 48” W
2	46° 49’ 21” N	71° 12’ 55” W
3	46° 50’ 19” N	71° 11’ 41” W
4	46° 51’ 03” N	71° 08’ 30” W
5	46° 55’ 02” N	70° 53’ 40” W
6	46° 58’ 04” N	70° 47’ 03” W
7	47° 01’ 54” N	70° 40’ 41” W
8	47° 08’ 03” N	70° 32’ 41” W
9	47° 07’ 59” N	70° 29’ 58” W
10	47° 09’ 55” N	70° 25’ 38” W
11	47° 25’ 29” N	70° 03’ 29” W
12	47° 25’ 54” N	70° 01’ 07” W
13	47° 25’ 52” N	70° 01’ 05” W
14	47° 13’ 09” N	70° 37’ 24” W
15	47° 12’ 49” N	70° 36’ 26” W
16	47° 15’ 01” N	70° 34’ 21” W
17	47° 16’ 47” N	70° 32’ 56” W
18	47° 20’ 28” N	70° 30’ 29” W
19	47° 23’ 25” N	70° 26’ 09” W
20	47° 25’ 38” N	70° 18’ 57” W
21	47° 27’ 24” N	70° 15’ 38” W
22	47° 28’ 41” N	70° 13’ 39” W
23	47° 29’ 32” N	70° 12’ 39” W
24	47° 30’ 19” N	70° 12’ 07” W
25	47° 30’ 32” N	70° 12’ 41” W

Adult overwintering

Point	Latitude	Longitude
A	46° 49’ 27” N	71° 10’ 36” W
B	46° 49’ 56” N	71° 11’ 36” W
C	46° 51’ 38” N	71° 09’ 58” W
D	46° 51’ 03” N	71° 08’ 30” W
E	46° 50’ 44” N	71° 08’ 06” W
F	46° 49’ 58” N	71° 09’ 23” W
G	46° 59’ 41” N	70° 32’ 57” W
H	47° 02’ 31” N	70° 34’ 27” W
I	47° 09’ 55” N	70° 25’ 38” W
J	47° 08’ 05” N	70° 22’ 04” W

Reproduction *(Québec City sector, area A)*

Point	Latitude	Longitude
1	46° 50’ 13” N	71° 11’ 34” W
2	46° 50’ 14” N	71° 11’ 32” W
3	46° 49’ 59” N	71° 11’ 33” W
4	46° 49’ 59” N	71° 11’ 36” W

Reproduction *(Montmagny sector, area B)*

Point	Latitude	Longitude
1	46° 59’ 24” N	70° 33’ 12” W
2	46° 59’ 36” N	70° 33’ 01” W
3	46° 59’ 13” N	70° 32’ 57” W
4	46° 59’ 11” N	70° 33’ 03” W

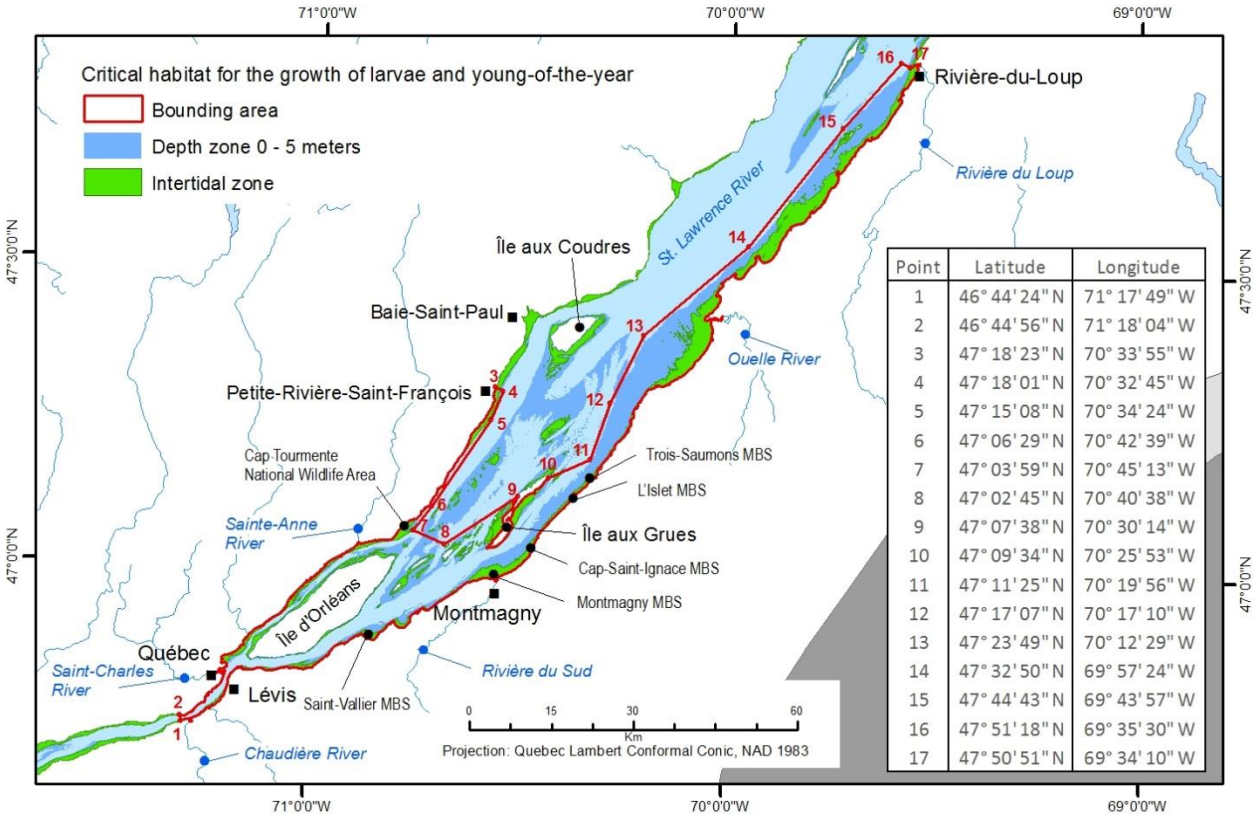

Figure 4. Bounding box (in red) where the critical habitat identified for larval and juvenile growth (June–November) includes the intertidal zone (in green) and the zone of low tide depths from 0 m to 5 m (in blue). The zero reference is from Canadian Hydrographic Service nautical charts, defined as the Lower Low Water, Large Tide. MBS: Migratory Bird Sanctuary.

Biophysical functions, features and attributes

Table 6 presents a summary of the best information available on the functions, features, and attributes associated with each Striped Bass life cycle stage and geographic location (see complete references in Section 4.3 Needs of the species). Please note that not all attributes in Table 6 must be present in order for a feature to be identified as critical habitat. If a feature, as described in Table 6, is present and capable of supporting the associated function(s), the feature is considered critical habitat for the species, even though some of the associated attributes might be outside of the range indicated in the table.

Table 6. General summary of the biophysical functions, features, attributes and location of critical habitat necessary for the St. Lawrence River Striped Bass population survival or recovery.

Geographic Location	Life Stage	Function [a]	Feature(s) [b]	Attribute(s) [c]
Area located on the northern shore of the Upper Estuary, around Île aux Coudres; and area beginning at Québec City, following the Chenal des Grands Voiliers south of Île d'Orléans until just downstream of the Rivière-Ouelle, including the area surrounding Isle-aux-Grues (Figure 3, top map)	Adults	Feeding and adult feeding-related migration (May to October)	• Estuarine waters	• Availability of sufficient quality and quantity of prey • Water temperature above 10 °C
Québec City area and area south of Île aux Grues (Figure 3, top map)	Adults	Adult overwintering (November to April)	• Estuarine waters	• Sufficient temperature for survival (≥ -1.5 °C, according to the literature) • Dissolved oxygen concentrations greater than 5 mg/L
End of the Port of Québec at Beauport (St. Lawrence River Estuary) (Figure 3, Area A)	Adults and eggs	Reproduction (May-June)	• Confluence area at the mouth of a river, under tidal influence • Hydrodynamics: complex currents	• Water temperature between 13 °C and 18 °C; beyond that, fish leave the area • Currents with changing direction and force (from none to strong) depending on tides • Shear zone (between strong currents and the calmer water area) which create a rotary current • Moderate current, enough to keep eggs in suspension • Hydrodynamics sufficient to oxygenate eggs (dissolved oxygen concentration threshold of 5 mg/L, according to the literature)
Rivière-du-Sud basin (Upper St. Lawrence Estuary) (Figure 3, Area B)	Adults and eggs	Reproduction (May-June)	• Mouth of a river under tidal influence • Basin consisting of channels and islets	• Channels with a minimum depth of 1.5 m and islets (exposed at low tide) • Water temperature between 13 °C and 18 °C for

Geographic Location	Life Stage	Function [a]	Feature(s) [b]	Attribute(s) [c]
			• Hydrodynamics: at the foot of a waterfall raised by a concrete sill; water discharge canal for a hydroelectric plant	spawning; eggs tolerate temperatures up to 23 °C • Salinity < 0.2‰ at low tide and from 0.2‰ to 2.5‰ at high tide (due to influence of strong freshwater discharge from the river's spring flooding) • Moderate current, enough to keep eggs in suspension • Hydrodynamics sufficient to oxygenate eggs (dissolved oxygen concentration threshold of 5 mg/L, according to the literature)
Intertidal riparian zone with low tide depths of 0–5 metres, within the bounding box, between Lévis (upstream of the Chaudière River mouth) and Rivière-du-Loup on the southern shore and Petite-Rivière-Saint-François on the northern shore. The bounding box includes the islands and shoals between Québec City and Île aux Grues. (This designation includes Anse Sainte-Anne, the critical habitat identified in 2011.) (Figure 4)	Larvae and young-of-the-year	Rearing (growth and feeding) (June to November)	• Riparian habitat and shoals in estuarine zones	• Intertidal zone with low tide depths of 0–5 m • Heterogeneous environment • High salinity gradient (larvae prefer a salinity below 0.1‰) • Thermal front area • Unique circulation pattern that improves local turbidity and concentration of prey • Availability of sufficient quality and quantity of prey (for larvae: zooplankton-copepods and cladocerans; for juveniles: mysids, sand shrimp, Atlantic tomcod, smelt, clupeidea) • Often associated with the presence of aquatic grass beds

[a] Function: Life cycle processes of listed species that occur in the critical habitat (e.g., spawning, fry rearing, growth, feeding and migration). Dates indicate the period during which the function usually takes place in critical habitat.

[b] Feature: Features describe *why* the habitat is critical. These are the essential structural components that allow for the functions required to meet the needs of the species. Features can change over time and are usually composed of one or more attributes. Modification or disruption of the feature or one of its attributes may affect the function and its ability to meet the biological needs of the species.

[c] Attribute: Attributes are the measurable properties or characteristics of the feature. Attributes describe how the identified features support the functions identified as necessary to the species' life cycle process.

The function of adult feeding and foraging-related migration is supported, from May to October, by the presence of estuarine waters with temperature above 10 °C and a sufficient quantity and quality of prey. According to the literature, Striped Bass stop feeding below the 10 °C temperature threshold (COSEWIC 2012). The adult Striped Bass is an opportunistic high trophic level predator. Its favourite prey is fish, particularly smelt and *Clupeidae* (*Ibid.*).

The adult overwintering function is associated with the period running from November to April, supported by estuarine waters characterized by temperatures and dissolved oxygen levels considered necessary for survival. According to the literature, the threshold values for temperature and oxygen are -1.5 °C and 5 mg/L, respectively (DFO 2014). Temperature data collected during the telemetric survey by MFFP indicate minimum values around 0 °C for both sites (Eliane Valiquette, MFFP, pers. comm.).

The reproduction function occurs from May to June. Striped Bass spawn at the mouth of two rivers, at the confluence of the St. Lawrence and under tidal influence. Hydrodynamics are considered a key feature for reproduction; currents play a dual role by both keeping the eggs in suspension and ensuring their proper oxygenation (at least 5 mg/L of dissolved oxygen; DFO 2014, Greene *et al.* 2009). Spawners aggregate and spawn in these areas as soon as the temperature reaches 13 °C; they leave the area when the temperature exceeds 18 °C (DFO 2017a; Valiquette *et al.* 2017). According to the literature, eggs tolerate temperatures between 14 °C and 23 °C (Greene *et al.* 2009). Spawning occurs in fresh or slightly brackish water.

The salinity values measured in the Rivière-du-Sud basin at Montmagny vary between 0.2‰ and 2.5‰. The large inflow of fresh water from the river to this area helps maintain low salinity in the basin, despite the tides from the Upper St. Lawrence Estuary. Hydrodynamics are influenced by tides and by the presence of the dam and the discharge canal from the hydroelectric plant. Hydrodynamics in the basin also shape the channels and islets (exposed at low tide), with slight shifts in location from year to year. Fish use the channels to enter the basin at high tide. Few individuals are observed at low tide, but the channels, with a minimum depth of 1.5 m, offer favourable conditions to keep eggs in suspension (Pelletier *et al.* 2010; DFO 2017a).

In the area of the Port of Québec City in Beauport, hydrodynamics are characterized by a gyre and a choppy area. These features are associated with the presence of a shear zone between the currents at the confluence of the Saint-Charles River and the St. Lawrence River on one side, and the calmer waters of Beauport Bay on the other, all of which is regulated by the tide.

The larval and young-of-the-year growth function is supported from June to November by riparian habitats and shoals in the intertidal zone where depths vary from 0 m to 5 m (DFO 2017a; Valiquette *et al.* 2017). These habitats are located in estuarine waters, mainly in the estuarine transition zone (ETZ) of the Upper St. Lawrence Estuary (Gagnon *et al.* 1993). The ETZ offers a highly heterogeneous environment characterized by high turbidity as well as high salinity and temperature gradients caused by the combination of fresh water from the river and saltwater from the Atlantic. The ETZ is a very dynamic area, where the combined effects of river currents and tides contribute to mix water bodies together and stir up marine and coastal sediment. The mixing of water bodies also results in precipitation of nutrients and organic matter. The waters of the ETZ are consequently brackish and turbid, which promotes extensive plankton production which remains in the ETZ because of the estuarine water circulation pattern. This also occurs locally in coastal areas of the ETZ, where tributaries also support local processes.

According to North and Houde (2003 and 2006), larval distribution is closely related to saline fronts in the estuaries, which govern the distribution and abundance of prey for Striped Bass in the early stages of their life cycle. This theory seems to be true for the St. Lawrence River Striped Bass population. Indeed, the rearing area for larvae from the Montmagny spawning ground is located at the boundary of the 0.1% saline front (Côté 2012). An area where high larvae concentrations are found, downstream of Île d'Orléans, is also characterized by a saline front (Morissette *et al.* 2016). Juvenile distribution is more extensive than larval distribution: juveniles are found in various areas in the riparian zone of the St. Lawrence Estuary (DFO 2017a and included references). This distribution is consistent with the fact that juvenile Striped Bass are more tolerant to variations in abiotic conditions than larvae and that their diet is more diverse.

Juveniles seek out aquatic grass bed habitats for both shelter and food (Côté 2012; COSEWIC 2012). The area identified as critical habitat for larvae and young-of-the-year is characterized by the presence of the main wetlands recorded in the St. Lawrence Upper Estuary (Environment and Climate Change Canada 2013).

The critical habitat identified for larvae and juveniles is associated with the availability of prey of sufficient quantity and quality. Approximately eight days after hatching, the larva has depleted its yolk reserves and starts to feed. The literature mentions that larval survival rate is directly dependent on the abundance of available zooplankton (Kernehan *et al.* 1981) and that larval condition is directly related to copepod and water flea density (Miller 1977; Martin *et al.* 1985). These two groups of species are the dominant species of zooplankton in the ETZ (Cusson 2011 and included references). After Striped Bass reach the juvenile stage, their diet diversifies to include mysids, sand shrimp, Atlantic tomcod, smelt and clupeidea (Robitaille 2010; COSEWIC 2012).

Work is underway to define the specific habitat features that ensure optimal larval and juvenile feeding and growth for the St. Lawrence Striped Bass population (Pascal Sirois, UQAC, pers. comm.). With this information, it will eventually be possible to accurately identify the critical habitat features for these life stages.

The following anthropogenic features are excluded from the critical habitat: permanent artificial structures already in place in the delineated areas (e.g., marinas, docks, pontoons). It is recognized that maintenance or replacement of these structures may be required.

Summary of the population and distribution objectives for the critical habitat

Currently, it is known that the population can reproduce naturally, that its abundance is increasing and that its range in some areas has exceeded that of the historical population. Without reliable quantitative indicators that measure population size, distribution and support capacity, it is currently impossible to quantify the contribution of the identified critical habitat to the species' recovery. However, this identified critical habitat should contribute to the recovery of the species since it includes two known spawning sites and a series of habitats that allow the Striped Bass to perform its life cycle processes.

Thus, the identified critical habitat corresponds to areas that the Minister of Fisheries and Oceans, based on the best available information currently available, considers necessary to partially achieve the population and distribution objectives required for the species' survival or recovery. Additional critical habitat areas may be identified in updates to this document.

8.2 Schedule of studies to identify critical habitat

More in-depth studies are required to identify other areas of critical habitat, specify the limits of the currently identified critical habitat and improve knowledge of the functions, features and attributes of the currently identified habitat required to achieve the population and distribution objectives set for the species, as well as to protect critical habitat against destruction. The following table describes these studies, many of which have already begun or are well underway.

Table 7. Schedule of studies to identify/refine critical habitat

Study Description	Rationale	Timeline
Finish characterization of the Port of Québec area (at Beauport) as a spawning area	All available information (concentration of mature individuals in spawning condition, sex ratio, water temperature, time of residence in the sector, hydrodynamics) indicate that the Port of Québec area (at Beauport) is a staging area essential for reproduction as well as a spawning ground. Striped Bass eggs and larvae need to be formally identified to confirm the function of spawning area. Preliminary genetic results confirm the presence of Striped Bass eggs and larvae in the Beauport area (Québec City) in 2016. These analyses have yet to be finalized.	2018–2021
Specify the size of the area used by adult Striped Bass during the spawning season (May-June) in the Beauport area at Québec City	Scientific sampling conducted by MFFP between 2013 and 2016 at the mouth of the Saint-Charles River, Beauport Bay and the end of the port indicate that Striped Bass aggregate in a riparian area at the end of the Port during the spawning period (May-June). Sampling is limited to shallow riparian areas (intertidal zone and 0–2 m zone) under tidal influence; however it is likely that Striped Bass also use the deeper area located further offshore. An analysis of acoustic telemetry data collected in 2015 (available at MFFP) should provide a preliminary answer to better define the critical habitat.	2018–2021
Characterize hydrodynamics in heavily used habitats during the spawning period	Hydrodynamics are recognized in the literature as a key feature for Striped Bass reproduction. Hydrodynamics in the Rivière du Sud spawning ground at Montmagny help disperse eggs and larvae to areas suitable for their survival and development. Fragmentary information suggests a similar situation in the Port of Québec area (at Beauport), where hydrodynamics help transport larvae to suitable areas located downstream in the maximum turbidity zone. This information still needs to be improved through modelling; a modelling assessment is available from Environment and Climate Change Canada.	2020–2021
Locate and characterize other important habitats for the reproduction period	Since 2011, MFFP has conducted sampling at the mouths of 14 rivers or areas that could potentially support Striped Bass reproduction. The Rivière-du-Sud basin (at Montmagny) has been identified as a spawning ground. Genetic egg and larval testing has also confirmed the presence of a spawning ground in the Beauport area at Québec City. The Rivière-Ouelle has not stood out as a spawning ground, but was found to be a pre-spawning aggregation site likely conducive to gonad maturation. Given that the Striped Bass population is growing, the inventory of potential spawning grounds must be updated by integrating the most up-to-date information about observations of spawning Striped Bass in the field. The team has therefore determined priority areas for the inventory, including the Rivière du Loup, Côte-de-Beaupré, the Rivière Etchemin and the area between Trois-Rivières and Québec City. In addition, a recent study (UQAC) suggests that the chemical composition of the otolith[a] core may be used to locate spawning sites. For the time being, available	2018–2023

Study Description	Rationale	Timeline
	data suggest the presence of a spawning ground in an oligohaline environment[b], but its location has yet to be established.	
Complete the determination and characterization of overwintering areas	Telemetry network data for the winter network (only one year available: November 2014 to April 2015) suggest that Striped Bass are mainly concentrated south of Île aux Grues and, to a lesser extent, in the Québec City area. In both areas, the temperature decreases gradually during the fall, stabilizing at around 0 °C between early January and late March. The number of Striped Bass detected in the Québec City area remained stable throughout the winter. However, south of Île aux Grues, the quantity of Striped Bass detected decreased significantly, from 43 in December to 15 in January, then 6 in March. The destination of Striped Bass leaving the area is unknown.	2019–2024
Specify the role of the Chenal des Grands Voiliers during the overwintering period	Based on telemetry studies, from October to April Striped Bass aggregate mainly south of Île aux Grues and, to a lesser extent, in the Québec City area. Movements of fish between these areas were observed between November and April (data limited to one year). It has been suggested that the Chenal des Grands Voiliers, which links these two areas, is used as a winter route. It remains to be determined if this channel is a migratory corridor critical to the overwintering function.	2019–2024
Locate and characterize the habitat of the young-of-the-year during their first winter	The standardized recruitment survey for September indicates that young-of-the-year (0+) are distributed over a large geographic area in early fall. This sampling takes place at a depth of 0–2 m. Where juveniles take shelter during the winter and more precisely whether their distribution contracts (as seen in adults) is unknown. Available data on the chemical composition of otoliths from juveniles (1+) suggest that a fraction of young-of-the-year overwinters in the oligohaline and mesohaline[b] areas of the St. Lawrence Estuary. However, these observations are limited in scope because the low winter growth rate could mask the chemical signature associated with individuals' return to fresh water. Winter sampling is not feasible with the means currently available due to the dangers associated with winter conditions. New approaches and methodologies will therefore have to be developed to study the winter habitat of young-of-the-year.	2018–2028
Characterize habitat attributes that are important for young-of-the-year growth and ultimately determine habitats associated with better growth rates	The MFFP standardized recruitment survey indicated a bimodal frequency of size classes in young-of-the-year caught in September. It was suggested that this bimodality may be due to delayed spawning or more or less productive habitats. Given that young-of-the-year must reach a certain size to survive their first winter, it is important to identify and characterize the habitats associated with favourable growth rates. Work is underway (UQAC) to characterize young-of-the-year habitat use in riparian zones along the River Estuary and the Upper Estuary. This work is still to be completed.	2018–2021
Determine whether aquatic grass beds are a significant habitat for feeding juveniles	In the literature, aquatic grass beds are recognized as a physically and trophically significant habitat for the Striped Bass. In the past, it was suspected that the Striped Bass disappearance was associated with the loss of these habitats. The importance of aquatic grass beds for successful juvenile recruitment has not yet been assessed for the current population.	2018–2023
Characterize larval use of the area identified as critical habitat for	In 2012, MFFP published a report documenting the presence of eggs and larvae along the southern shore of the Upper Estuary, indicating that they originated from the Rivière-du-Sud basin (at Montmagny). Work currently underway (UQAC) documents an area at the downstream point of Île d'Orléans with a high larval concentration. As part of the regional peer review	2018–2021

Study Description	Rationale	Timeline
larvae and young-of-the-year (0+)	on the assessment of the habitat required for Striped Bass survival and recovery, experts proposed the hypothesis that the Beauport area of Québec City may be the point of origin for this larval concentration. This work is still to be completed.	
Locate and characterize the habitat of sub-adults	Available data are mainly on young-of-the-year (MFFP standardized recruitment survey) and adults (telemetry, net sampling). For this reason, the habitat of sub-adults (1–3 years) is very poorly documented.	2018–2028
Characterize Striped Bass use of the upstream section of the River (between Montréal and Québec City)	In the extirpated population, the riverine section of the St. Lawrence (beginning upstream from Lake Saint-Pierre and ending upstream of Québec City) was an important area for Striped Bass aged 3+ from November to June. For the current population, telemetry data indicate that adult Striped Bass return to the riverine portion between Lake Saint-Pierre and Québec City in May and likely return downstream in June. Telemetry has not detected individuals upstream of Lake Saint-Pierre. However, there are reports of adult Striped Bass caught by recreational fishers in the Montréal area. Given that no Striped Bass were marked upstream of Lake Saint-Pierre and that most Striped Bass were marked downstream from Québec City, the available telemetry results provide little information on the portion of the river upstream from Québec City. A complementary study is therefore required.	2018–2023

a A calcium carbonate structure in the inner ear of vertebrates

b An oligohaline area is slightly salty, and a mesohaline area is moderately salty.

8.3 Activities likely to result in the destruction of critical habitat

The following examples of activities likely to result in the destruction[8] of critical habitat (Table 8) are based on known human activities that are likely to occur in and around critical habitat and would result in the destruction of critical habitat if unmitigated. The list of activities is neither exhaustive nor exclusive and has been guided by the threats described in Section 5. The absence of a specific human activity from this table does not preclude or restrict the Department's ability to regulate that activity under the SARA. Furthermore, the inclusion of an activity does not result in its automatic prohibition, and does not mean the activity will inevitably result in destruction of critical habitat. Every proposed activity must be assessed on a case-by-case basis and site-specific mitigation will be applied where it is reliable and available. Where information is available, thresholds and limits have been developed for critical habitat attributes to better inform management and regulatory decision making. However, in many cases knowledge of a species and its critical habitat's thresholds of tolerance to disturbance from human activities is lacking and must be acquired.

[8] Destruction occurs when there is temporary or permanent loss of a function of the critical habitat at a time when it is required by the species.

Table 8. Activities likely to result in the destruction of critical habitat

Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Pollution	Effluent discharge (wastewater) from municipal, industrial and agricultural sectors	Increased turbidity Increased nutrient load Eutrophication Increased contaminants Destruction of aquatic grass beds Prey mortality and decrease in prey quality by bioaccumulation in the food chain	All (survival and fertility)	River mouth Riparian habitat in estuarine areas Estuarine waters	Prey availability Aquatic grass beds
Pollution	Accidental oil spills and leaks from ship and pipeline transportation	Increased contaminants Destruction of aquatic grass beds Prey mortality	All (survival and fertility)	River mouth Riparian habitat in estuarine areas Estuarine waters	Prey availability Aquatic grass beds
Habitat loss or degradation	Dredging	Physical destruction of habitat Changes to flow regimes Increased turbidity Release of contaminants Decreased water quality	Reproduction Larval and juvenile growth	River mouth and hydrodynamic conditions (spawning sites) Riparian habitat in estuarine areas	Currents (intensity and circulation patterns) Oxygen concentration Availability of suitable prey
Habitat loss or degradation	Backfilling Offloading of dredged material	Physical destruction of habitat Substrate alteration Changes to flow regimes Increased turbidity	Reproduction Larval and juvenile growth	River mouth and hydrodynamic conditions (spawning sites) Riparian habitat in estuarine areas Shoals	Currents (intensity and circulation patterns) Oxygen concentration Availability of suitable prey
Habitat loss or degradation	Dam or dyke construction Water level manipulation	Changes to flow regimes Reduction in hydrodynamics, below the threshold required to keep eggs in suspension	Reproduction	River mouth downstream from dam & hydrodynamics (spawning sites)	Currents (intensity and circulation patterns) Oxygen concentration
Habitat loss or degradation	Shore development (e.g. dewatering, encroachment, aboiteau, retaining walls, riprap)	Physical destruction of habitat Changes to flow regimes Loss of riparian vegetation and wetlands (loss of shelter and food source)	Reproduction Larval and juvenile growth	River mouth & hydrodynamics (spawning sites) Riparian habitat in estuarine waters	Currents (intensity and circulation patterns) Oxygen concentration Aquatic grass beds Prey availability

Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Habitat loss or degradation	Infrastructure development (e.g. port, roads, docks)	Physical destruction of habitat Changes to flow regimes Loss of riparian vegetation and wetlands (loss of shelter and food source)	Reproduction Larval and juvenile growth	River mouth & hydrodynamics (spawning sites) Riparian habitat in estuarine waters	Currents (intensity and circulation patterns) Oxygen concentration Aquatic grass beds Prey availability

8.4 Proposed measures to protect critical habitat

Under SARA, critical habitat must be legally protected from destruction within 180 days of being identified in a recovery strategy or action plan. For the Striped Bass critical habitat, it is anticipated that this will be accomplished through a SARA critical habitat order made under subsections 58(4) and 58(5), which will invoke the prohibition in subsection 58(1) against the destruction of the identified critical habitat.

For those areas of critical habitat located within Cap Tourmente National Wildlife Area and migratory bird sanctuaries (Saint-Vallier, Montmagny, Cap-Saint-Ignace, l'Islet and Trois-Saumons; Figure 4), a description of the critical habitat will be published in the *Canada Gazette* pursuant to subsection 58(2). Ninety days following publication in the *Canada Gazette*, the subsection 58(1) prohibition against destroying critical habitat will apply.

9. Evaluation of Socio-Economic Costs and of Benefits

The *Species at Risk Act* requires an evaluation of the socio-economic impacts of the action plan. The evaluation of the action plan includes the costs and benefits of its implementation [SARA 49(1)(e), 2003]. This evaluation addresses only the incremental socio-economic costs of implementing this action plan from a national perspective as well as the social and environmental benefits that would occur if the action plan were implemented in its entirety, recognizing that not all aspects of its implementation are under the jurisdiction of the federal government. It does not address cumulative costs of species recovery in general nor does it attempt a cost-benefit analysis. Its intent is to inform the public and to guide decision making on implementation of the action plan by partners.

Furthermore, the conservation of species at risk is an important component of the Government of Canada's commitment to conserving biological diversity under the *International Convention on Biological Diversity*. The Government of Canada has also made a commitment to protect and recover species at risk through the Accord for the Protection of Species at Risk. The specific costs and benefits associated with this action plan are described below.

Firstly, this evaluation identifies the main stakeholders (Section 9.1) that may be affected by or involved in the implementation of the recovery measures set out in Tables 3 and 4 of this document. Section 9.2 looks at whether the implementation of these measures could entail additional costs for stakeholders. Then, Section 9.3 looks at the benefits of implementing the

plan. Lastly, Section 9.4 assesses the distributional impacts of implementing recovery measures for the St. Lawrence River Striped Bass.

9.1 Stakeholder profiles

The Striped Bass recovery measures indicated in Tables 3 and 4 are grouped into four strategies: 1) stocking, inventory and monitoring; 2) research; 3) management and coordination; and 4) stewardship and outreach. Potential partners who may be involved in carrying out the action plan are also indicated in these tables.

Stocking, inventory and monitoring measures

DFO's main partners in implementing stocking, inventory and monitoring measures would include the Government of Quebec (Ministère de la Forêt, de la Faune et des Parcs du Québec [MFFP]), the academic sector (Université du Québec à Chicoutimi [UQAC]) and First Nations. (Measure 3 – Table 3).

Research measures

Research would involve the academic sector (UQAC), the federal and provincial governments and First Nations.

Management and coordination measures

Management and coordination measures would be carried out by the federal and provincial governments in collaboration with the commercial fishing industry (e.g., eel fishers). Commercial and recreational fishers could contribute through the monitoring network by reporting incidental catches from commercial and sport fishing (measure 12 in Table 3). First Nations and municipalities could also be involved in habitat management at some levels.

Stewardship and outreach measures

Stewardship and outreach activities would be carried out partly by non-governmental organizations with the collaboration of federal and provincial governments. First Nations, fishers, municipalities and the agricultural sector could also become involved.

9.2 Socio-economic costs of implementing the action plan

Many of the measures set out in this plan are ongoing initiatives within the federal government and by its partners that would be pursued even if the action plan did not exist. Although these measures can affect some of the stakeholders identified above, carrying them out would not systematically result in additional socio-economic costs for these stakeholders.

For the moment, the available information is not sufficient to quantitatively assess the additional socio-economic costs of implementing the Striped Bass action plan. Consequently, the costs are assessed in qualitative terms, since most of the information that DFO has is of this type.

Stocking, inventory and monitoring measures

Half of the recovery measures included in the Striped Bass action plan involve stocking, inventory and monitoring measures. The stocking activities build on projects already underway at MFFP. The inventory and monitoring activities are also a continuation of initiatives already

undertaken by DFO and its partners. Certain measures go beyond the scope of Striped Bass recovery and involve acquiring knowledge on the species. It is therefore realistic to think that many of the inventory and monitoring activities listed in Tables 3 and 4 would be conducted by DFO and its partners even in the absence of an action plan.

The inventory and monitoring measures of which the Department of Fisheries and Oceans should be in charge would be funded from regular programs and would not result in additional costs. Other measures taken by the provincial government (Ministère des Forêts, de la Faune et des Parcs du Québec [MFFP]), academia or First Nations could also be partially funded by existing federal programs.

It is therefore anticipated that carrying out stocking, inventory, and monitoring measures would not result in additional costs to the stakeholders concerned.

Research measures

The action plan identifies three research measures for acquiring better knowledge of the Striped Bass that may extend beyond the recovery of the species. It is realistic to think that the research activities listed in Tables 3 and 4 would be conducted by DFO and its partners, even in the absence of an action plan, and therefore would not result in additional costs.

Management and coordination measures

There are five management and coordination measures listed in the Striped Bass action plan that would involve DFO, MFFP and industry. Management and coordination by DFO would be funded from regular programs and therefore would not result in additional costs. Measures involving the provincial government, the industry as well as commercial and recreational fishers could be partially funded by the federal government's existing programs.

Stewardship and outreach measures

Most of the stewardship and outreach activities outlined in the Striped Bass action plan are currently underway. Their main objective is to inform users of the St. Lawrence and the general public (sport fishers, commercial fishers, First Nations, shoreline residents, municipalities, etc.) of the importance of protecting the Striped Bass for its recovery. However, some stakeholders who choose to get involved in the recovery of the Striped Bass and implement stewardship and outreach measures may incur additional costs. DFO does not have enough information at this stage to quantify these costs, but they would vary based on the extent of the outreach activities undertaken. These additional costs may, in some cases, be funded through existing federal programs.

9.3 Benefits of implementing the action plan

Implementing the measures outlined in the action plan will contribute positively to achieving the long-term recovery objective for the recovery of the St. Lawrence River Striped Bass in order to meet the criteria that would allow the population to shift from its current endangered status (COSEWIC, 2012) to that of special concern.

The benefits from the recovery of the St. Lawrence River Striped Bass are difficult to quantify. Protection and recovery of species at risk can have both benefits and costs. However, the *Species at Risk Act* recognizes that "wildlife, in all its forms, has value in and of itself and is valued by Canadians for aesthetic, cultural, spiritual, recreational, educational, historical, economic, medical, ecological and scientific reasons" (SARA 2003). Healthy and self-sufficient

ecosystems that support diverse species, including species at risk, contribute positively to the livelihoods and quality of life of all Canadians. A review of the literature confirms that Canadians care about species preservation and conservation in its own right. The actions taken to preserve a species, like protecting and reclaiming habitat, are also important. Furthermore, the more an action contributes to a species' recovery, the more the public values such actions (Loomis and White 1996; Fisheries and Oceans Canada 2008).

Quebec residents attach significant importance to sport fishing. The return of Striped Bass to Chaleur Bay in the Gaspé Peninsula boosted recreational tourism by attracting a large number of sport fishers in the region. Having a new star sport-fishing species like the Striped Bass provides a tremendous opportunity to develop and promote a fishery in eastern Quebec, which would complement the current Atlantic Salmon fishery. A 2015 investigation on Striped Bass sport fishing in the Gaspé Peninsula showed that, in the new fishery's second year, over 7,300 fishing days were spent on Striped Bass, representing at least $1 million in economic benefits. If the recovery of the Striped Bass could allow for a sport fishery to return to the St. Lawrence Estuary, some regions could reap considerable socio-economic benefits.

9.4 Distributional impacts

A large number of stakeholders will participate in the implementation of the actions set out in this plan and will incur costs that will vary according to their involvement. Considering that most of the measures outlined in the action plan are related to the existing St. Lawrence River Striped Bass recovery strategy and are the continuation of activities already underway, additional costs for DFO and its partners should be low.

The benefits of enacting the Striped Bass action plan, however, will extend to all Canadians, given the economic value that the Canadian people place on Striped Bass recovery and habitat protection.

10. Measuring Progress

A report on the implementation of the recovery strategy and action plan (pursuant to Section 46 and 55 of SARA) will be produced through the evaluation of progress made in implementing the key strategies and measures proposed in Section 7.2 (Tables 3 and 4). A report on the ecological and socio-economic impacts of the action plan (under section 55 of SARA) will be produced by evaluating the results of the monitoring of the species' recovery and long-term viability and by evaluating the implementation of the action plan.

11. Activities Permitted by the Recovery Strategy

SARA states that: "*Subsections 32(1) and (2), section 33 and subsections 36(1), 58(1), 60(1) and 61(1) do not apply to a person who is engaging in activities that are permitted by a recovery strategy, an action plan or a management plan and who is also authorized under an Act of Parliament to engage in that activity, including a regulation made under section 53, 59 or 71.*" [Subs. 83(4)]

The following activities are permitted by this recovery strategy:

11.1 Fishing activities

In Quebec, Striped Bass fishing is not permitted in the St. Lawrence River, upstream of a line linking Forestville (Île Patte de Lièvre) to Rimouski (Pointe à Santerre), but some are caught incidentally during certain commercial, recreational and First Nation fishing activities. However, the release of these fish is mandatory under the *Quebec Fishery Regulations* (1990) (SOR/90-214), which were adopted under the *Fisheries Act*, R.S.C., 1985, c. F-14. In 2010, a science advisory report was prepared to assess the impact of incidental Striped Bass catches from commercial and recreational fishing on the population's survival and recovery. Despite knowledge gaps about the biology of this population and its vulnerability to incidental catches, the science advisory report from this Committee concluded that fishing activities in freshwater and marine environments, as practised, were unlikely to impact the overall survival and recovery of the Striped Bass population (DFO 2010). Five recommendations were made in this report to mitigate the impact of fishing on Striped Bass mortality rates and to monitor the population:

1. Implement mitigation measures (i.e., mandatory catch release) to reduce the potential impact of commercial and recreational fishing on the Striped Bass population.
2. Take steps to ensure that incidental Striped Bass catches are recorded.
3. Promote awareness among fishermen.
4. Maintain a monitoring network focused in part on incidental catches of Striped Bass by commercial fishers and authorizing the collection of specimens.
5. Re-evaluate the impact of incidental catches within five years, or sooner, if changes are observed in Striped Bass vulnerability to incidental catches from commercial and sport fishing.

The recovery team considers that this report—stating that fishing activities in freshwater and marine environments, as practised, are not likely to affect the survival and recovery of the St. Lawrence River Striped Bass—is still relevant and that its conclusions remain valid. However, the impact of incidental Striped Bass catches from commercial and recreational fishing on the survival and recovery of the population should be revaluated soon.

Pursuant to subsection 83(4) of SARA, the present recovery strategy authorizes fishers to carry out fishing activities under a First Nation communal licence, a sport fishing or commercial fishing licence, subject to the following conditions:

- fishing is carried out in accordance with a communal fishing licence issued under the *Aboriginal Communal Fishing Licences Regulations*, SOR/93-332;
- fishing is carried out in accordance with a sport or commercial fishing licence issued under the *Quebec Fishery Regulations* (1990) SOR/90-214;
- any person who incidentally catches a Striped Bass while fishing shall release it back to the water from which it was caught without delay and, if the fish is alive, release it in a manner that causes the least possible harm to the fish.

A monitoring network was set up to document the establishment of Striped Bass, to assess population parameters, to trace their movements and to verify the occurrence of natural spawning. Commercial fishers who are part of the network must possess a permit for the capture of wildlife for scientific, educational or wildlife management purposes (SEG licence) issued by the MFFP, authorizing them to keep incidentally caught Striped Bass and deliver them to MFFP biologists.

In accordance with subsection 83(4) of SARA, the present recovery strategy authorizes fishers who carry out commercial fishing or are fishing for scientific, educational or wildlife management purposes, to retain Striped Bass, subject to the following conditions:

- fishing is carried out in accordance with a commercial fishing licence targeting another species and with a permit for the capture of wildlife for scientific, educational or wildlife management purposes (SEG permit) issued under the *Quebec Fishery Regulations* (1990) SOR/90-214;
- any person who incidentally catches a Striped Bass while fishing must deliver it to the MFFP biologists responsible for Striped Bass and according to the dates and conditions of the SEG permit referring to the species.

For activities not listed above that are likely to affect the St. Lawrence River Striped Bass population in a manner not in keeping with SARA, licences issued under Section 73 may be obtained by contacting Fisheries and Oceans Canada. http://www.dfo-mpo.gc.ca/species-especes/sara-lep/permits-permis/index-eng.html

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Appendix A: Effects on the Environment and Other Species

In accordance with the Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals, SARA recovery planning documents incorporate strategic environmental assessment (SEA) considerations throughout the document. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or achievement of any of the Federal Sustainable Development Strategy's goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the recovery strategy and action plan itself, but are also summarized below in this statement.

The SEA concluded that the recovery strategy and action plan will have a clear positive impact on the environment by encouraging the recovery of the St. Lawrence River Striped Bass population and will not generate any significant negative impacts. In addition, the reintroduction and recovery of the Striped Bass in the St. Lawrence River contributes to restoring the biodiversity of this ecosystem. The possibility of the Striped Bass' recovery having a negative impact on other species, particularly on prey species or competitors, was assessed using a risk analysis (Robitaille 2000) prior to the reintroduction. The analysis concluded that Striped Bass should not markedly reduce the abundance of the species on which it feeds. Some specific preliminary dietary studies conducted by MFFP and DFO show the opportunistic behaviour of the Striped Bass in its feeding and do not indicate any significant impact on the prey species mentioned above. However, it is expected that there will be a reallocation of trophic resources between this fish and other predators. Nevertheless, concerns arise for certain species at risk, such as salmon or sea trout.

Appendix B: Record of Cooperation and Consultation

Recovery strategies and action plans must be prepared in cooperation and consultation with other affected jurisdictions, organizations, parties and persons, as outlined in Sections 39 and 48 of the *Species at Risk Act*. Fisheries and Oceans Canada used a consultative process to solicit participation in the development of the recovery strategy and action plan. The Department used a recovery team including representatives from federal and provincial governments as well as experts from the academic sector, First Nations, NGOs and sport and commercial fishers. Information on participation is presented below.

Recovery Team Member	Organization of Origin
Marthe Bérubé	DFO, Species at Risk Management Division
Myriam Bourgeois	DFO, Species at Risk Management Division
Alexandra Valentin	DFO, Species at Risk Management Division
Jean-Louis Provencher	Parks Canada, Natural Resources Conservation Branch
Valérie Bujold	MFFP, Direction de la gestion de la faune de la Gaspésie
Marc-Antoine Couillard	MFFP, Direction de l'expertise sur la faune aquatique
Karine Gagnon	MFFP, Direction de la gestion de la faune du Saguenay
Catherine Gaudreau	MFFP, Direction de l'expertise sur la faune aquatique
Valérie Harvey	MFFP, Direction de la gestion de la faune de la Capitale-Nationale-Chaudière-Appalaches
Michel Legault	MFFP, Direction de l'expertise sur la faune aquatique
Léon L'Italien	MFFP, Direction de la gestion de la faune de la Capitale-Nationale-Chaudière-Appalaches
Geneviève Ouellet-Cauchon	MFFP, Direction de l'expertise sur la faune aquatique
Julien Mainguy	MFFP, Direction de l'expertise sur la faune aquatique
Simona Motnikar	MFFP, Direction de la gestion de la faune de la Capitale-Nationale-Chaudière-Appalaches
Anne-Marie Pelletier	MFFP, Direction de la gestion de la faune du Bas-Saint-Laurent
Frédéric Sheehy	MFFP, Protection de la faune, Saguenay-Lac-Saint-Jean
Éliane Valiquette	MFFP, Direction de l'expertise sur la faune aquatique
Guy Verreault	MFFP, Direction de la gestion de la faune du Bas-Saint-Laurent
Amélie D'Astous	Bureau du Nionwentsïo des Hurons-Wendat
Hugo Mailhot Couture	Grand Conseil de la Nation Waban-Aki
Pascal Sirois	Université du Québec à Chicoutimi
Michel Baril	Fédération des Chasseurs et Pêcheurs du Québec
Guillaume Bourget	Regroupement des Organismes de bassins versants du Québec
Bruno Ouellet	Pêcheries Ouellet
Jean-Éric Turcotte	Stratégies Saint-Laurent

The draft recovery strategy and action plan has been submitted to Québec government and concerned First Nations for consultation. Public, First Nation organization and other stakeholder input will be sought through the publication of the proposed document on the Species at Risk Public Registry for a 60-day public comment period. Comments received will inform the final document.

Appendix C: Threat Assessment Categories

Probability of occurrence	Definition
Known threat or threat very likely to occur	This threat has been observed in 91% to 100% of cases.
Likely	The probability that this threat occurs is between 51% and 90%.
Unlikely	The probability that this threat occurs is between 11% and 50%.
Very unlikely	The probability that this threat occurs is between 1% and 10%, or less.
Unknown	There is no data or prior knowledge on the appearance of this threat now or in the future.

Level of impact	Definition
Extreme	Significant decline in the population (71–100%) and possibility of extinction.
High	Significant population loss (31–70%) or threat compromising the survival or recovery of the population.
Medium	Moderate population loss (11–30%) or threat likely to jeopardize the survival or recovery of the population.
Low	Little change in the population (1–10%) or threat unlikely to jeopardize the survival or recovery of the population.
Unknown	No previous data, knowledge or documentation to guide the assessment of the severity of the threat to the population.

Causal certainty	Definition
Very high	Irrefutable proof indicates that the threat will occur and that the extent of the effects on the population can be quantified.
High	Conclusive evidence establishes a causal relationship between the threat and population declines or danger to survival or recovery.
Medium	Evidence establishes a causal relationship between the threat and population declines or danger to the survival or recovery.
Low	There is limited evidence supporting a theoretical link between the threat and population declines or danger to the survival or recovery.
Very low	There is a plausible, unproven link indicating that the threat leads to a decline in the population or endangers its survival or recovery.

Appendix D: Acronyms

Acronym	Description
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSAS	Canadian Science Advisory Secretariat
DFO	Department of Fisheries and Oceans
ETZ	Estuarine transition zone
FédéCP	Fédération des chasseurs et pêcheurs du Québec [Quebec Federation of Hunters and Anglers]
FN	First Nations
MBS	Migratory Bird Sanctuaries
MDDELCC	Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques [Quebec Department of Sustainable Development, the Environment and the Fight against Climate Change]
MFFP	Ministère de la Faune, des Forêts et des Parcs [Quebec Department of Wildlife, Forests and Parks]
MTMDET	Ministère des Transports, mobilité durable et Électrification des transports [Quebec Department of Transportation, Sustainable Mobility and the Electrification of Transportation]
NGO	Non-governmental organization
RCM	Regional county municipality
SARA	Species at Risk Act
UQAC	Université du Québec à Chicoutimi