Species at Risk Act
Recovery Strategy Series
Action Plan Series

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

Striped Bass

2021

Canada

Recommended citation:

Fisheries and Oceans Canada. 2021. Recovery Strategy and Action Plan for the Striped Bass *(Morone saxatilis)*, St. Lawrence River population, in Canada. *Species at Risk Act* Recovery Strategy Series and Action Plan Series. Fisheries and Oceans Canada, Ottawa. vi + 65p.

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Cover illustration: Space for Life, Biodôme de Montréal

Également disponible en français sous le titre
« Programme de rétablissement et plan d'action du bar rayé (*Morone saxatilis*), population du fleuve Saint-Laurent, au Canada »

ISBN 978-0-660-38577-8
Catalogue no. En3-4/105-2021E-PDF

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 and action plan for listed extirpated, endangered, or threatened species and are required to report on progress five years after the publication of the final documents on the Species at Risk Public Registry, and every subsequent five years following.

This document has been prepared to meet the requirements under SARA of both a recovery strategy and an action plan. As such, it provides both the strategic direction for the recovery of the species, including the population and distribution objectives for the species, as well as the more detailed recovery measures to support this strategic direction, outlining what is required to achieve the objectives. SARA requires that an action plan also include an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation. It is important to note that the setting of population and distribution objectives and the identification of critical habitat are science-based exercises and socio-economic factors were not considered in their development. The socio-economic evaluation only applies to the more detailed recovery measures (that is, the action plan portion).

The Minister of Fisheries, Oceans and the Canadian Coast Guard is the competent minister under SARA for the St. Lawrence River Striped Bass population 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, Indigenous groups, and representatives of sport and commercial fisheries and non-governmental organizations 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 among 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.

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 (DFO) 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 and Sarah Jacques (DFO) for preparing the maps, Florence Boucher-Boisclair (DFO) for the section assessing the socio-economic impact and benefits, and finally, 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, Indigenous groups, and representatives of sport and commercial fisheries and non-governmental organizations. DFO would like to thank all the individuals and organizations that contribute to the recovery of the St. Lawrence River Striped Bass population.

Executive summary

In Canada, five native populations of Striped Bass have existed in three distinct areas that correspond to the three units designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC): the Bay of Fundy, the Southern Gulf of St. Lawrence, and the St. Lawrence River.

The St. Lawrence River Striped Bass population[1] (*Morone saxatilis*) has been listed as Endangered under the *Species at Risk Act* (SARA) since 2019. 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 should be taken into consideration together, including the COSEWIC status report (COSEWIC 2012), a recovery potential assessment (DFO 2006), and a science advisory report in support of critical habitat identification (DFO 2017a).

The Striped Bass population that is the subject of this recovery strategy and action plan is the one that is currently present in the St. Lawrence River (contemporary population). This population was introduced in the St. Lawrence River beginning in 2002, under a reintroduction program involving the hatchery breeding of individuals collected in the Miramichi River. It was determined that the recovery of the contemporary population is biologically and technically feasible. The historical population in the river disappeared in the 1960s, due to overfishing and the destruction of its habitat.

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 the reintroduction of the Striped Bass in the St. Lawrence River, the population has reproduced naturally and there has been some increase in its abundance and distribution. It is now well established in its range, which extends upstream, from the entrance of Lac Saint-Pierre (from Sorel, and including the Rivière Richelieu) to downstream Rivière-du-Loup, on the south shore and the Saguenay Fjord (including the waters of the fjord) on the north shore. In addition, the species is likely to be observed both upstream and downstream of this main range, but this varies from year to year. In the summer, there seems to be some geographic overlap between the St. Lawrence River population and the southern Gulf of St. Lawrence population. This phenomenon has been documented in the waters of the Gulf, the Lower Estuary and the Saguenay River, but it is dynamic, difficult to define geographically, and variable from year to year.

Threats to the species are described in section 5 and include: infrastructure development; St. Lawrence Seaway maintenance; wharf marinas and access channels maintenance; local modification of the riparian environment; ship wave action; temporary or permanent barrier creation; aquatic invasive species; diseases and parasites; incidental sport and commercial catches; illegal catches; oil leaks and spills during transport; possible leaks during oil and gas

[1] formerly called the St. Lawrence Estuary population

exploration and development activities; agricultural pollution (nutrient and sediment load, pesticides); and municipal and industrial effluents.

Population and distribution objectives establish, to the extent possible, the number of individuals and their geographic distribution, that is necessary for the recovery of the species. In the absence of sufficient data to establish precise and specific objectives, the population and distribution objectives for the St. Lawrence River Striped Bass population are based on the COSEWIC criteria that would allow the population to improve its species status under SARA from endangered to special concern. Work is underway to refine these objectives to be more specific to the St. Lawrence River Striped Bass population.

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

Critical habitat (section 8) is identified to the extent possible, using the best available information, and provides the functions and features necessary to support the species' life-cycle processes and to achieve the species' population and distribution objectives. The critical habitat of the St. Lawrence River population includes a series of geographic locations in the fluvial or Upper Estuary of the St. Lawrence River where the Striped Bass performs its essential life cycle processes, including: (i) adult feeding (May to October; two areas); (ii) adult overwintering (November to April; two areas); (iii) reproduction (May to June; two areas); and (iv) larvae and juvenile growth and feeding (June to November; one area). All identified critical habitat must be protected throughout the entire year to ensure that it can fulfill its critical functions for the species when needed. Due to insufficient information, certain habitats that may 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 areas 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.

The action plan portion of this document provides the detailed recovery planning in support of the strategic direction set out in the recovery strategy section of the document. The action plan outlines what needs to be done to achieve the population and distribution objectives, including the measures to be taken to address threats and monitor recovery of the species, as well as the required measures to protect critical habitat. An evaluation of the socio-economic costs of implementing the action plan and the benefits to be derived from its implementation is provided in Section 9.

Recovery feasibility summary

The recovery of the St. Lawrence River Striped Bass population is believed to be biologically and technically feasible. Recovery feasibility is determined according to four criteria outlined by the Government of Canada (2009)[2]:

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). Given the natural variability in recruitment, and to prevent a series of poor years from jeopardizing the efforts already made, stocking capacity will be maintained in the coming years.

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.

[2] Government of Canada. 2009. Species at Risk Act Policies [Draft]. *Species at Risk Act*, Policies and Guidelines Series. Ottawa, Ontario. Environment Canada. 48 pp.

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1. Introduction

The Striped Bass (*Morone saxatilis*) disappeared from the St. Lawrence River in the 1960s (historical population). In 2004, when it was first assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), the "St. Lawrence River population"[3] was designated as Extirpated. In 2011, it was listed as Extirpated under the *Species at Risk Act* (SARA).

The reintroduction of Striped Bass in the St. Lawrence River began in 2002, under a Quebec reintroduction program involving hatchery breeding in Quebec. The individuals used for breeding came from the southern Gulf of St. Lawrence population and were captured in the Miramichi River. In 2012, COSEWIC reassessed the status of the Striped Bass in Canada, incorporating data on the reintroduced population (contemporary population), and designated the "St. Lawrence River population" as Endangered. Its status under SARA has been modified accordingly; as of 2019, the "St. Lawrence River population" is listed as Endangered on schedule 1 of SARA.

Shortly after it was listed as Endangered on schedule 1 of SARA, COSEWIC re-examined the application of its criteria and modified the way it defined the St. Lawrence River Striped Bass population. COSEWIC now considers that the population resulting from the reintroduction program (contemporary population) is not part of the wild population (historical population) and, consequently, re-assessed the "St. Lawrence River population" as Extinct. This document deals with the contemporary Striped Bass population, which corresponds to the "Striped Bass, St. Lawrence River population" currently listed as an Endangered species under SARA based on the 2012 COSEWIC assessment.[4]

Although the St. Lawrence River population is not fished, the species is generally prized by recreational anglers. Historically, a number of Indigenous communities in Quebec have harvested the species from Trois-Rivières to New Brunswick, giving it the names ji'gaw (Mi'kmaq), nokahkehke (Wolastoqiyik) or etionnonson (Huron-Wendat). The Abenaki, Huron-Wendat, Wolastoqiyik, Mi'kmaq and Innu continue to show interest in the species in a contemporary context of fishing and conservation (Richard 2016; AGHAMM 2017; AMIK 2017; Arsenault 2017; Lechasseur 2018).

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, while the action plan portion provides the detailed recovery planning that supports the strategic direction set out in the recovery strategy portion. Action planning for species at risk recovery is an iterative process. The timing of implementation of the measures in this combined recovery strategy and action plan may be modified in the future depending on the progression towards recovery. This recovery strategy and action plan also provides fundamental information on the species, its threats and its critical habitat.

This recovery strategy and action plan is part of a series of documents on the St. Lawrence River Striped Bass population that should be taken into consideration together, including the COSEWIC status report (COSEWIC 2012), a research document on the species' habitat

[3] At the time, the population was referred to as the "St. Lawrence Estuary population."
[4] COSEWIC expects to reassess the Striped Bass, St. Lawrence River population status in 2022.

(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 (DFO) to provide the information and scientific advice needed to implement the SARA based on the best available scientific data, data analysis and expert opinions. In addition, the report by L'Italien et al. (2020) was used to complete the recovery strategy and action plan presented here in its final form. The final version of the document also takes into account the comments and information provided by various stakeholders following the posting of the proposed version in the Species at Risk Public Registry for a 60-day public comment period in 2019 (DFO 2019b).

2. COSEWIC 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 reintroduction 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 (COSEWIC): The species was designated Extirpated in November 2004, based on information on the historical population that disappeared from the St. Lawrence in the late 1960s. The species was assessed as Endangered in November 2012, based on information on the population introduced in the river beginning in 2002. In November 2019, COSEWIC published an addendum to its 2012 status report, in which it revised its assessment of the St. Lawrence River Striped Bass population, designating it as Extinct. COSEWIC, as a result of modifying its criteria, now considers that the introduced population is not part of the wild population and consequently, considers the wild population to be extinct. A new assessment of all the Striped Bass populations in Canada (including Striped Bass currently present in the St. Lawrence River) is expected in 2022.

3. Species status information

Table 1. Summary of existing protection and other status designations assigned to the Striped Bass. Separate information is provided for the contemporary Striped Bass population (introduced beginning in 2002), which is the subject of this recovery strategy and action plan, and for the historical population.

Jurisdiction	Authority/ Organization	Designation level	Status/ Description	Year(s) assessed and/or listed
Canada	COSEWIC	Population (contemporary)	Endangered	2012
Canada	NatureServe	Population (contemporary)	Imperiled - Vulnerable (N2N3)	2012
Canada	COSEWIC	Population (historical)	Extinct	2019
Canada	*Species at Risk Act* (SARA)	Population (contemporary)	Endangered	2019
Canada	NatureServe	Population (historical)	Presumed extinct (SX)	2020
International	NatureServe	Species	Secure (G5)	2020

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." [subsection 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." [subsection 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 River, 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 Lac 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, including the Saguenay River (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 2019, 3,372 spawners, over 35,000,000 larvae and more than 25,634 juvenile Striped Bass, produced using spawners from the Southern Gulf of St. Lawrence population, were stocked in the St. Lawrence River. Several monitoring methods (for example, incidental catches, telemetry, standardized recruitment monitoring) were implemented to assess the parameters of the contemporary 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 St. Lawrence Estuary, where the first signs of natural spawning since the reintroduction program began were observed in 2008 (Bourget et al. 2008; Pelletier 2009). According to the results of spawner surveys, and the sampling of eggs, larvae, and young-of-the-year, there are two spawning areas that actively contribute to the recovery and maintenance of the population. One is located at the mouth of the Rivière du Sud at Montmagny, and the other at the eastern end of the port facilities in Beauport, in Québec City (figure 3; Côté 2012; L'Italien et al. 2020).

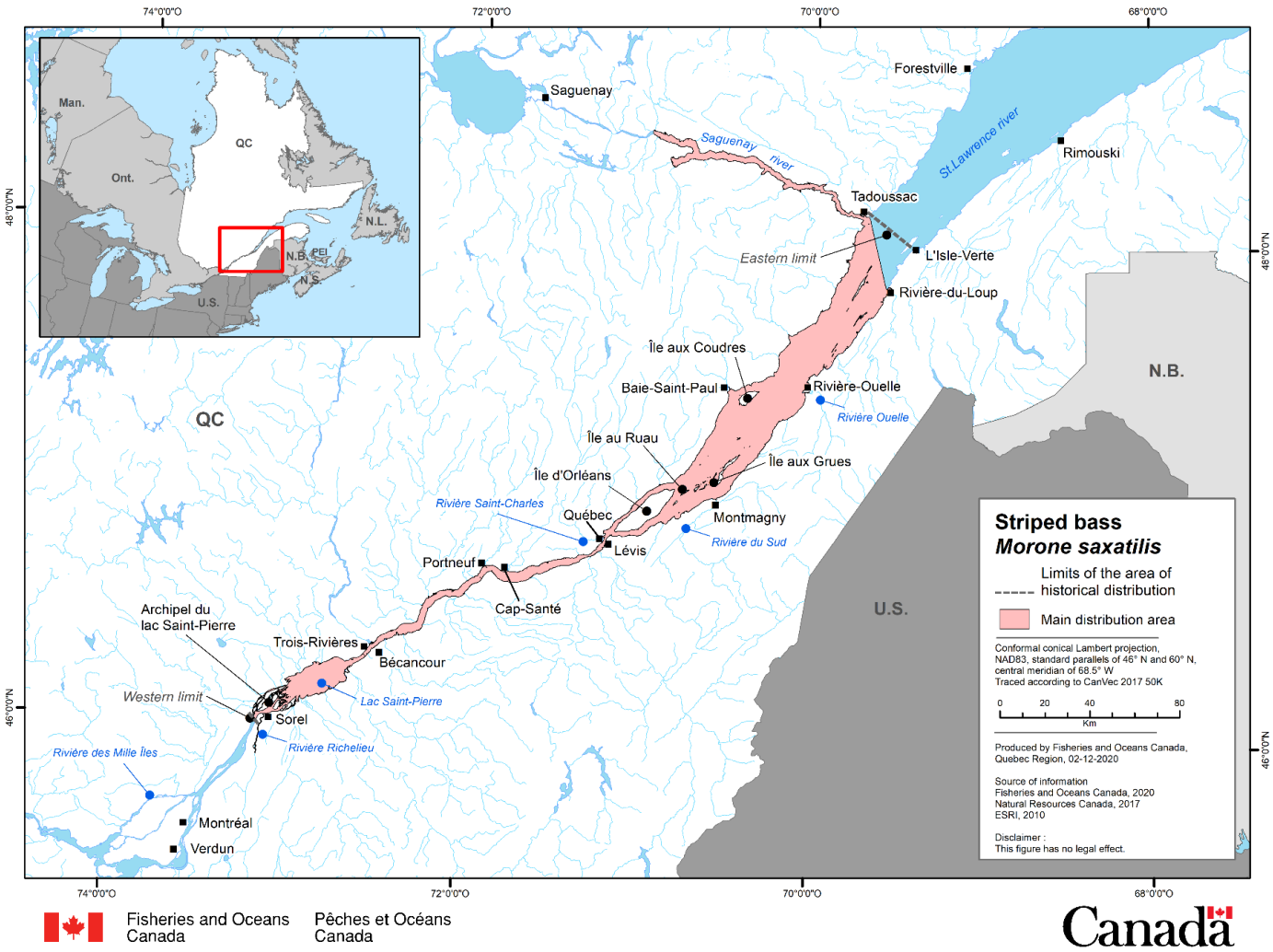

Figure 2. Main range of the Striped Bass of the contemporary population of the St. Lawrence River. In addition, observations outside this well-established range have been recorded, notably upstream as far as the Montreal region and downstream as far as the Lower North Shore and the coast of the Gaspé Peninsula. Limits of the historical distribution also appear on the map. (Source: Valiquette et al. 2018; L'Italien et al. 2020; Équipe de rétablissement 2019; É. Valiquette, pers. comm.)

On the basis of the information obtained to date, the main range of the St. Lawrence River Striped Bass extends from Sorel (upstream) to a line that runs between Rivière-du-Loup on the south shore and Tadoussac on the north shore (downstream) (Valiquette et al. 2018; L'Italien et al. 2020; 2019 Recovery Team; É. Valiquette, pers. comm.). This range includes the Rivière Richelieu (to below Saint-Ours Dam) and the Saguenay River (figure 2). A smaller number of Striped Bass observations come from further upstream, as far as Montreal (in the Rivière des Mille Îles, the Rivière Saint-François, and in the St. Lawrence itself as far as Verdun) (MFFP, unpublished data; FédéCP, pers. comm.). St. Lawrence River Striped Bass are also observed downstream of their main range, in the Côte-Nord region and along the coast of the Gaspé Peninsula as far as Chaleur Bay, but these records vary from season to season and from year to year (MFFP, unpublished data; Valiquette et al. 2018).

Research has shown that seasonality plays a major role in the spatial and temporal distribution of the St. Lawrence River Striped Bass. In spring, aggregations of adults form in and near the spawning areas in the fluvial estuary and the Upper Estuary of the St. Lawrence River (L'Italien et al. 2020). In 2019, these aggregations were also observed in the Archipel du Lac Saint-Pierre and in the Rivière Richelieu (MFFP, unpublished data; FédéCP, pers. comm.). After the spawning season ends in June, Striped Bass disperse downstream, probably to feed. Although most remain in the Upper Estuary of the St. Lawrence River, others travel as far as the Lower Estuary and the Gulf of St. Lawrence. The St. Lawrence River population may consist of at least two groups, or contingents, each of which uses the territory differently: one with more limited movements and another with more extensive movements. Analyses are required to better define and document these migratory contingents (DFO 2017a). In fall, adults begin migrating to the overwintering areas in fresh or brackish water (DFO 2017a). One of these areas is located near Québec City, with another south of Île aux Grues (see details 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). According to the most recent data and observations, Striped Bass overwinter in the area that includes Lac Saint-Pierre, its archipelago and in the Rivière Richelieu (MFFP, unpublished data). Subadult Striped Bass adopt seasonal migratory behaviour and could make up migratory contingents as well (Morissette 2016). They remain near the spawning areas in spring, then disperse downstream to the oligohaline zone of the St. Lawrence River Estuary, probably overwintering largely in the Estuary's mesohaline zone (Morissette 2019).

According to the information available, the St. Lawrence River Striped Bass population is not geographically isolated from the neighbouring population of Striped Bass in the southern Gulf of St. Lawrence. The summer ranges of the two populations overlap in the waters of the Gulf of St. Lawrence, the Lower Estuary of the St. Lawrence River, and the Saguenay River. However, this phenomenon is dynamic, difficult to define geographically and variable from year to year (Valiquette et al. 2018; MFFP unpublished data). Since the efforts to reintroduce Striped Bass are relatively recent, the status of the species is still evolving in the field. Surveys must be conducted in the next few years to determine if the areas currently used by the population continue to be used in the future (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 that have not yet reached a sufficient size (estimated at 10 cm) to survive the fasting of the first winter (COSEWIC 2012 and references therein). 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 habitats for the maintenance of the population appear to be those 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 typically begins as water temperatures rise above 10 °C and may continue until water reaches 19 °C in May and June (COSEWIC 2012). Female Striped Bass are highly fecund, averaging 50,000 eggs per kg of body weight (COSEWIC 2012). 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 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 old 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 the St. Lawrence River, the maximum turbidity zone (MTZ), located between Île d'Orléans and Île aux Coudres, supports high densities of zooplankton, including the copepod *Eurytemora affinis*. The MTZ is known to be a fry-rearing or feeding area for Rainbow Smelt, Atlantic Sturgeon and several other fish species, including Striped Bass (Sirois and Dodson 2000; Munro et al. 2007; Winkler et al. 2016; Vanalderweireldt 2019). The conditions found in the MTZ also provide shelter from predators, as well as an osmotic environment favourable to the survival of Striped Bass larvae (Vanalderweireldt 2019; L'Italien et al. 2020).

At the end of the 35 to 50-day larval period, juvenile Striped Bass measure roughly 20 mm in length and have acquired the species' typical shape (notably, scales and fins), which they will maintain into adulthood. From the juvenile stage onward, the Striped Bass is more tolerant of changes in environmental conditions, for example temperature and salinity changes. It can meet its food requirements by travelling in estuarine and coastal environments, often in schools of

same-sized individuals. 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). From July, young Striped Bass are also observed upstream (up to Saint-Nicolas primarily) and downstream of the MTZ, in perhaps less energetically favourable habitats where their growth is slower, but which are likely to give them access to new resources while reducing intraspecific competition. This adaptability could increase the population's survival potential, although the winter survival of smaller individuals has yet to be demonstrated (Vanalderweireldt 2019).

Adult and subadult (1 to 3 years for the St. Lawrence River population) Striped Bass frequent coastal and estuarine habitats (Bain and Bain 1982). Subadults are generally distributed in oligohaline and mesohaline sectors (salinity of between 2 and 12). Also, subadults almost always frequent near-shore habitats (between 5 and 9.9 m) and are concentrated on shoals and reefs, around islands and islets, and in shallow water. Notably, they are is found in aquatic beds consisting of eelgrass or similar species. Preferred habitats are also those that concentrate potential invertebrate prey (polychaete [bristle] worms, gammarids [scuds], mysids, crangonidae) and young fish (shad, herring, smelt, alewives, sticklebacks, and killifish) (Morissette 2019).

As they grow, Striped Bass gradually become piscivorous, primarily targeting schools of soft-rayed fish, particularly clupeids (for example, American shad and alewife) (Trent and Hasler 1966; Manooch 1973; Austin 1980; Gardinier and Hoff 1982; Dew 1988). In the St. Lawrence River, the main prey species are Rainbow Smelt and clupeids. In the summer, Striped Bass movements appear to be coordinated with those of their prey to a great extent. In the fall, Striped Bass migrate to fresh and brackish waters to overwinter, where cold seawaters can be avoided. The confinement of Striped Bass in these overwintering areas may increase the risks of mortality due to environmental accidents or adverse changes in the habitat. Adult Striped Bass are tolerant of, and can withstand, variations in salinity, temperature, pH and turbidity (Talbot 1966; Auld and Schubel 1978; Setzler et al. 1980).

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	Low	Medium	Very high	Low
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 three 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 km 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).

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 areas appear to support the entire Striped Bass population of the St. Lawrence River (L'Italien et al. 2020), infrastructure projects near important habitats like these could have a decisive 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. These types of changes have the potential to affect Striped Bass eggs in particular, because they 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

The dredging of the St. Lawrence Seaway continued until the end of the 20th century, peaking in 1959 (Allard 2015). This major capital dredging project, unprecedented for its time, had this advantage of definitively opening the interior of the continent to commercial shipping. However, it also had permanent impacts on fish, notably creating a physical barrier to dispersal due to the increased current in the channel and indirectly leading to the alteration of substrates and habitats through erosion and the growth of submerged plants outside the channel (Allard 2015).

In the case of Striped Bass, the disposal of dredged sediments in open water has been of great concern because, in combination with other unfavourable conditions, 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 River, were then modified by the offloading of dredged material (Robitaille 2001). This change had the effect of relegating Striped Bass from the historical population into limited areas along the southern shore, which quickly became highly frequented fishing areas (Robitaille and Girard 2002).

The situation today is completely different. Since 1999, dredging has mainly involved annual maintenance work to provide a safe depth in the shipping channel. The volume of sediments involved, around 85,000 m^3 annually, cannot be compared to those resulting from the historic capital dredging required to construct the Seaway. However, this maintenance dredging is

greater in scope than the smaller-scale operations that are conducted around municipal docks, which only represent a few thousand m^3. Today, maintenance dredging operations must comply with federal and provincial requirements, notably involving contamination and disposal sites, which was not the case in the past. Furthermore, owing to our continually improving knowledge of fish habitat, tangible progress can be made in species protection, for example, when selecting equipment and sites and the timing of work. For instance, in 2009, the disposal of dredged sediments at a site off Île Madame was prohibited to protect a downstream habitat where juvenile Atlantic Sturgeon concentrate (Dubé 2013).

Currently, maintenance dredging of the Seaway takes place in the fluvial stretch and Upper Estuary, in the areas of Bécancour, Lac Saint-Pierre (biannually), and Traverse Cap-Santé. 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 km long and 300 m wide. Dredged sediments from the Traverse du Nord are disposed at the site of Banc du Cap Brûlé and Sault-au-Cochon, located downstream of Île au Ruau, in the MTZ. Smaller volumes of sediments, between 1,000 m^3 and 2,300 m^3, are disposed of at eight smaller sites upstream of Québec City.

In general, the impacts associated with maintenance dredging are the alteration of water quality, salinity, currents and sediment transport; changes to erosion and sedimentation processes; and the destruction and alteration of wildlife habitats (DFO 2011; SODES 2000 cited in Allard 2015), which may also be associated with lower prey availability (DFO 2011).

For the Striped Bass, the risk level associated with maintenance dredging is deemed medium. According to experts, juvenile and immature individuals are the most likely to be affected by dredging operations in the Seaway (DFO 2011), since they are abundant in the Upper Estuary and are likely to feed in the MTZ. If capital dredging work[5] were being considered, it would undoubtedly have more significant impacts and potentially lead to a greater risk level. However, depending on the scope of the work, a process to assess and examine environmental impacts would be required, including sediment management options.

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. However, the most significant risk of this maintenance work is its location. For example, spawning areas could be more affected, as flow, salinity and temperature conditions are closely tied to spawning and larval dispersal. As a result, maintenance is more concerning at the Port of Québec and the Montmagny wharf given the nearby spawning areas.

The risk associated with this threat therefore is medium.

[5] The Sustainable Navigation Strategy for the St. Lawrence: 2004–2011, under the St. Lawrence action plan, contained a measure to evaluate the possibilities of capital dredging at certain strategic points in the navigation channel. The Quebec government's marine transportation action plan for 2018 to 2023 also contains a measure to study the possibility of doing dredging work to increase the depth of the channel upstream of Québec City.

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 Striped Bass range for early life stages is not highly urbanized.

Wave action from boats

Ship-generated waves cause bank degradation and thus reduce the quality and diversity of coastal habitats. Unlike spring flooding (a one-time annual event), 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 portion of this area more sensitive to wave action, 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 areas of the St. Lawrence River where Striped Bass are present.

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 (for example, due to mechanical contact with turbines and cavitation[6]).

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

Aquatic invasive species

In 2016, Grass Carp (a type of Asian Carp) were caught in the St. Lawrence River for the first time. The species could eventually become established in the area between Montréal and Île d'Orléans. Early life stages of carp, which are primarily planktivorous, could compete with young stages of Striped Bass, which are planktivorous as well. Adult carps, which feed almost exclusively on aquatic plants, could also severely alter the aquatic grass bed habitats that Striped Bass use for shelter and feeding. Asian Carps also carry parasites and diseases, which pose an additional risk (MFFP 2016).

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

Mainly because of the threat of Asian Carps, the risk associated with this threat is deemed medium. 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 of St. Lawrence 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. In the Miramichi River, all of the Striped Bass aged one year or younger that were examined in 2011 (40 specimens) were infected. Although mortality could be high in severely affected young Striped Bass, as soon as the fish reaches 2 to 3 years of age, the risk of mortality is generally considered low (Measures et al. 2017). The St. Lawrence River Striped Bass population was probably a carrier historically (Séguin et al. 2007), and Striped Bass from the Miramichi River that were released in the St. Lawrence and recaptured at Rivière-Ouelle were carriers (Measures et al. 2017).

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

Incidental commercial catches

Incidental catches of Striped Bass occur in Atlantic Sturgeon nets (Léon L'Italien, MFFP, pers. comm.) and also in eel traps in September and October mainly. The current risk is considered low and lower than it was at the time of the historic Striped Bass population. 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 remained active in 2017 (DFO 2017a). A new measure can 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 at 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 more common today in the area where the species is protected by a ban on Striped Bass fishing; also, the area where the ban occurs is larger than during the last scientific assessment of this threat (DFO 2010). Release is mandatory in this area closed to Striped Bass fishing. This measure was accompanied by a major awareness campaign (DFO 2010). In addition, the Quebec government also recently closed fishing areas in specific cases where Striped Bass were aggregating at a reproduction site or when the concentration of fish was likely to result in significant incidental catches. The risk of significant

incidental catches of the St. Lawrence River Striped Bass is low downstream of the closed area in the St. Lawrence River. Studies have shown there is a preponderance of Striped Bass from the southern Gulf of St. Lawrence population (Valiquette et al. 2018).

Although incidental catches have caused some concern, given the measures in place, the risk related to this threat is deemed low.

Illegal catches

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 the impact and risk associated with illegal Striped Bass catches. These factors include the popularity and enthusiasm of sport fishing, which relates to 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 St. Lawrence Estuary, up to a virtual line set between Rimouski (at Pointe à Santerre) and Forestville (at Île Patte de Lièvre)[7]. West of this line, all fishing for Striped Bass in the St. Lawrence River is prohibited. Also, the species' gregarious behaviour while they are congregated at certain sites means that they are quickly spotted, which often leads people to believe that they are very abundant. In addition, inhabiting a riparian environment means that Striped Bass are easy to access, which increases the risk. Mass media also perpetuate the perception that the species is abundant and even harmful to other harvested species, such as anadromous Brook Trout and Atlantic Salmon.

No reliable information associated with this threat is available at the time of publishing; the level of impact and risk 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. In Canada, these types of risks are mitigated by a strict regulatory framework and the implementation of numerous prevention measures, including several measures that are specific to the St. Lawrence River. In particular, pilotage is compulsory for all ships of a certain size travelling up and down the St. Lawrence River between Les Escoumins and Montreal; all large tankers carrying crude oil must be double hulled; surveillance programs are implemented (inspection of foreign ships; aerial surveillance); the shipping channel is marked, dredged and kept free of ice; and water levels and ice conditions are regularly monitored and made available. Improvements have been made, for example, in the response to spills. In this context, the number of oil spills has been declining in Canada for the last 40 years, as is the case elsewhere in the world (Council of Canadian Academies 2016; Transport Canada 2020a).

Despite this context of safety and the low probabilities in terms of the frequency of major accidents (WSP Canada Inc. 2014), some concerns remain over oil shipping. A spill in the crowded and environmentally sensitive St. Lawrence River could have significant impacts (Transport Canada 2020b). Other conditions represent additional risk factors, including for example, the difficult navigation conditions, particularly between Québec City and the outlet of the Traverse du Nord (a confined waterway subject to high waves, fog and sometimes strong, unpredictable currents); the considerable increase in the transport of oil and other substances

[7] Since 2019, fishing for Striped Bass has also been permitted in most tributaries emptying into the area where catches of Striped Bass are allowed.

such as liquefied natural gas in Canada; locally, the annual transit through the Traverse du Nord of several oil tankers headed for the south shore (across from Québec City), among others (Innovation maritime 2014); as well as the increase in tanker traffic travelling eastward from Montreal since the reversal of Enbridge's Line 9B pipeline. Reflecting these concerns about marine oil transportation, an independent report produced on behalf of Transport Canada (WSP Canada Inc. 2014) suggested that the environmental risks related to an oil spill in the St. Lawrence River may appear very high. However, the safety measures in place, including double hulls for large vessels, make the probability of a major spill very low (WSP Canada Inc. 2014). Pipelines transporting oil along the St. Lawrence River could also raise concerns should such projects come to fruition.

In the specific case of fish, 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, for example, structural, genetic and immune-system damage (Boudreau et al. 2019) and 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), although their behaviour is highly variable depending on the type of mixture and the nature of the components (Boudreau et al. 2019). The early stages of life, especially eggs and larvae, are considered much more sensitive than the adult stage (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). Containment of Striped Bass in wintering sites could increase the risk of mortality due to environmental accidents or adverse changes in habitat.

Given the fact that numerous measures are in place to counter this threat and the low probability of it actually occurring, the risk related to this threat is considered low.

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. Consequently, 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 Lac 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 of the St. Lawrence River most frequented by Striped Bass, i.e. from Portneuf downstream.

The risk posed by nutrient and sediment loading to Striped Bass is considered low. The risk associated with pesticides is unknown but raises some concern. The adult Striped Bass is an upper trophic level predator and therefore is 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. In addition to the risk related to spills of oil described earlier, shipping vessels occasionally discharge other substances (for example, oily water). Transport Canada recorded pollution spills for 1% of vessels monitored in Canadian waters in 2013 to 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 vulnerable areas, like the littoral zones where juveniles feed or, for example, in the basin of the Rivière du Sud [8] or the Québec City port area, where spawning areas are located.

The risk posed by local sources of contamination, namely municipal and industrial effluents, could not be categorized. Overall, the risk associated with this threat is unknown. Transport Canada (2020b) stresses, however, that even a small spill of hazardous and noxious substances could be detrimental in an environmentally sensitive area. Small spills are also likely to occur more often than large ones (Innovation maritime 2014).

6. Population and distribution objectives

The population and distribution objectives establish, to the extent possible, the number of individuals and their geographic distribution, that is necessary for the recovery of the species.

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-sustaining population with areas of occupancy and occurrence similar to those of the historical population.

There are no abundance estimates for the historical St. Lawrence River Striped Bass population that can be used as a reference point for the contemporary population. Quantitative data, both historical and recent, on abundance, distribution and life history are insufficient to establish precise and specific objectives for the St. Lawrence River Striped Bass population, both for abundance and distribution. In this context, the overall objective of this document for the recovery of the St. Lawrence River Striped Bass population has been established based on the criteria used by COSEWIC[9] for the status assessment of species. This overall objective is:

> Within five years, meet the criteria that would allow the population to improve its current species status under SARA from endangered to special concern, which is achievable from a biological perspective.

Based on the COSEWIC criteria necessary to shift to a status of special concern, 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

[8] Common name given to the mouth of the Rivière du Sud (see figure 3, zone B)
[9] COSEWIC quantitative criteria and guidelines for the Status Assessment of Species.

recruitment monitoring already indicates a gradual increase in the population. It remains to be determined whether the target of 10,000 individuals would maintain the population at a viable and self-sustaining level.

Distribution objective: viable populations with an increasing range (compared to the situation when surveys were established [10]) over an area close to the historic range (mainly from Lac Saint-Pierre to Baie Saint-Paul on the northern shore and L'Isle-Verte on the southern shore), and an area of 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 spawning area and suitable habitats for all life cycle functions. These factors suggest that this population might now be less vulnerable to certain threats.

The current population and distribution objectives may be reassessed once the studies on population dynamics and the support capacity of the St. Lawrence River for the Striped Bass have been completed.

7. Broad strategies and general approaches to meet objectives

Successful recovery of this species is dependent on the actions of many different jurisdictions. It requires the commitment and cooperation of the constituencies that will be involved in implementing the directions and measures set out in this recovery strategy and action plan.

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 certain components of the ichthyological community (prey, predators, competitors), their status and relationship with the Striped Bass; and 5) protect the Striped Bass population and its most important habitats. To achieve these objectives, the previous recovery 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.

- The program to reintroduce the Striped Bass in the St. Lawrence River began in 2002. Current data (proportion of adults derived from stocking, young-of-the-year abundance) indicate that stocking is no longer required in the short and medium term. Stocking was halted in 2019 and 2020. To prevent recovery from being jeopardized by a series of poor spawning seasons, the decision was made to maintain expertise at the government fish hatchery (Baldwin-Coaticook) so that fish rearing can be quickly restarted using wild individuals if required. The captive rearing program is under the sole responsibility of the Quebec government.

[10] Based on the telemetry survey and the young-of-the-year survey that began in 2011 and 2013 respectively.

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

- Biological reference parameters (for example, 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 sport, commercial, 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 areas 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, (for example, 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 sport or commercial fishers must be released, with the exception of certain specimens caught under wildlife management licences by fishers participating in the incidental fishing monitoring network (DFO 2010). Those fishers submit their catches to the Government of Quebec for monitoring purposes. 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 in 2009, to the Banc du Cap Brûlé and Sault-au-Cochon sites. These two sites are deemed to be fairly stable (bathymetric profile) and storms and twice-daily mixing are expected to limit benthic colonization, so that the anticipated impacts should be very minor and short lived. Also, sediments contaminated at levels exceeding the frequent effect concentration (FEC) are disposed of at onshore sites.

- The planning process for the creation of marine protected areas takes into account the St. Lawrence River Striped Bass, its habitat and its conservation, through a joint Canada-Québec project of marine protected area in the St. Lawrence Estuary (DFO 2019a).

- An extensive campaign for reporting and releasing catches has been carried out and continues, especially among sport fishers. About 12,000 permanent posters have been placed at strategic locations on river access sites downstream from Lac Saint-Pierre since 2005, and 10,000 stickers have been distributed to sport fishers since 2011.

- A science review was conducted under the auspices of DFO's Canadian Science Advisory Secretariat and with the close collaboration of the Ministère des Forêts, de la Faune et des Parcs du Québec (MFFP) to assess the habitat required for the survival and recovery of the St. Lawrence Striped Bass (DFO 2017a; Valiquette et al. 2017; DFO 2016).

- In 2012, MFFP published a report documenting the presence of eggs and larvae along the south shore of the Upper Estuary, indicating that they came from the basin of the Rivière du Sud (Montmagny).

- The presence of larvae downstream of Île d'Orléans has also been associated with spawning in the Beauport area of Québec City. Based on the information available (concentration of mature individuals in spawning condition, sex ratio, water temperature, residence time in area, hydrodynamics), an area essential for reproduction (pre-spawning staging and spawning) is located in the Beauport area (at the end of the port facilities at the mouth of the Rivière Saint-Charles in Québec City).The formal identification of Striped Bass eggs and larvae allowed the function of the spawning area to be confirmed.

- Between 2015 and 2018, a network of receivers providing spatial data was deployed at a fine scale to specify the extent of the area used by adult Striped Bass in the Beauport region of Québec City during the spawning season (May-June). The methodology used and characterization of the spawning area are described in L'Italien et al. 2020.

- Research at the Université du Québec à Chicoutimi (UQAC) documented the use of an area frequented by larvae and young-of-the-year (0+) spawned in the Québec City area. The results were published in a doctoral thesis (Vanalderweireldt 2019).

7.2 Measures to be taken to implement the recovery strategy and action plan

This recovery strategy and action plan provides 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 be taken to address threats to the species and monitor its recovery, to guide not only activities to be undertaken by DFO, but those for which other jurisdictions, organizations and individuals have a role to play. As new information becomes available, these measures and the priority of these measures may change. DFO strongly encourages all Canadians to participate in the conservation of the St. Lawrence River Striped Bass by undertaking measures outlined in this recovery strategy and action plan.

Tables 3 and 4 identify the measures to be undertaken to support the recovery of the St. Lawrence River Striped Bass. The recommended measures correspond to the following strategies and approaches:

Broad strategy 1: survey, monitoring and stocking

- 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

Implementation of these measures will be dependent on a collaborative approach, in which DFO is a partner in recovery efforts, and cannot implement the measures alone. All Canadians are invited to join in supporting and implementing this recovery strategy and action plan; some of the measures identified represent opportunities for other jurisdictions, organizations or individuals to lead for the recovery of the species. If your organization is interested in participating in one of these measures, or in obtaining information on the funding sources available to carry out some of the outlined activities, please contact Fisheries and Oceans Canada, Québec Species at Risk Management Division (lep-sara-qc@dfo-mpo.gc.ca).

The measures included in this recovery strategy and action plan to be implemented by DFO will be subject to the availability of funding and other required resources. As indicated in the tables below, partnerships with specific organizations will provide expertise and capacity to carry out some of the listed recovery measures. However, the identification of partners is intended to be advisory and carrying out these actions will be subject to each group’s priorities and budgetary constraints.

Table 3. Measures to be undertaken collaboratively by Fisheries and Oceans Canada and its partners (main partners are shown in bold type). See appendix D for a list of the acronyms used.

#	Recovery measures	Approach (details in section 7.2)	Priority [a]	Threats or objectives addressed	Suggested partner(s)	Timeline [b]
1	Define the range west of Lac 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** First Nations (FN)	Three years
2	Pursue monitoring of population abundance and status using MFFP standard indicators and protocols, notably recruitment monitoring to estimate young-of-the-year abundance and the monitoring of adults.	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 determine 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 aquatic species situation related to Striped Bass.	1-1	Low	Threat: Invasive aquatic species and pathogens	**MFFP** **Academic sector** **DFO** FN	Ongoing

#	Recovery measures	Approach (details in section 7.2)	Priority [a]	Threats or objectives addressed	Suggested partner(s)	Timeline [b]
7	Monitor the status of important habitats, notably spawning habitat.	1-1	High	Objective: To attain distribution objective	**MFFP** **Academic sector** **DFO** FN	Five years
8	Determine factors that could limit growth in some juveniles (0+) and prevent them from growing large enough to survive the winter (for example, delayed spawning, low-quality rearing habitats, growth-limiting parasites).	2-1	High	Objective: To attain population objective	**Academic sector** **MFFP** DFO	Three years
9	Characterize the unique structure of the Striped Bass aggregation that frequents the Rivière Ouelle, record site fidelity and 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 of adults and juveniles 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 on recovery (Indigenous, sport and commercial fisheries, as well as illegal fisheries).	3-1	High	Threats: Incidental catches	**MFFP** **DFO** FN	Two years
12	In collaboration with commercial fishers, continue to monitor bycatch and collect data to assess demographic parameters.	3-1	High	Threat: Incidental commercial catches	**MFFP** **Commercial fishing** DFO	Ongoing
13	In collaboration with sport fishers, monitor incidental catches and at the same time gather data to guide population monitoring efforts.	3-1	High	Threat: Incidental sport fishing catches	**MFFP** **Sport fishing** **FN** DFO	Ongoing
14	Disseminate relevant information and ensure field surveillance and monitoring by protection officers.	3-1	High	Threat: Illegal catches	**MFFP** **DFO**	Ongoing

#	Recovery measures	Approach (details in section 7.2)	Priority [a]	Threats or objectives addressed	Suggested partner(s)	Timeline [b]
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** FN	Ongoing
16	Encourage sport fishers to adopt behaviour that helps with Striped Bass conservation (for example, 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 municipalities, regional county 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 measures in the field (for example, 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** **MELCC** **DFO** **Agricultural sector** **Municipalities** **NGO** **FN**	Ongoing
19	Encourage best agri-environmental practices and take appropriate corrective measures in the field, for rivers where this is relevant.	4-1	Low	Threat: Habitat loss or degradation	**MFFP** **MELCC** **Agricultural sector** **DFO** **NGO** **FN**	Ongoing
20	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
21	Develop a campaign to raise public awareness of the Striped Bass and highlight the importance of its role, as well as the difference between the St. Lawrence River and Southern Gulf of St. Lawrence populations (social marketing, brand image).	4-1	High	All threats	**MFFP** **DFO** **NGO** **FN**	Three years

[a] "Priority" indicates the degree to which the measure contributes directly to the recovery of the species or 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

[b] "Timeline" reflects the amount of time required for the measure to be completed from the time the recovery strategy and action plan is published as final on the Species at Risk Public Registry.

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** (details in section 7.2)	**Priority** [a]	**Threats or objectives addressed**	**Suggested jurisdictions or organizations**	**Timeline** [b]
22	Maintain expertise on Striped Bass at the Baldwin-Coaticook fish hatchery so that rearing can be quickly restarted using wild individuals if required.	1-2	High	Objective: To attain population objective	**MFFP**	Five years
23	Implement, by regulation, management measures to protect Striped Bass at critical times or sites (for example, 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 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

[b] "Timeline" reflects the amount of time required for the measure to be completed from the time the recovery strategy and action plan is published as final on the Species at Risk Public Registry.

7.3 Narrative to support the recovery planning and implementation tables

Some measures from the recovery planning and implementation tables (tables 3 and 4) are justified below.

Regarding population status and monitoring:

- Measure 1 is explained by the need to know the species' range to support management, outreach and stewardship measures. Priority is given to documenting the area west of Lac 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 sort out 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 a low priority for recovery; few mitigation or prevention measures are available.
- Measure 7 is important to identify management and protection measures to implement as required.
- Measure 22 is required in order to ensure that a series of poor spawning seasons do not jeopardize recovery efforts.

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 location with the highest concentrations of adults (particularly females) during the spawning season (May-June). The latest report from MFFP indicates that this area is not used for spawning but nevertheless remains important for reproduction. It very likely plays a significant role for gonad maturation and provides high quality habitat for feeding (L'Italien et al. 2020, MFFP 2016).
- Measure 10 is considered a 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 within a relatively short timeframe to confirm whether the authorization allowing fishers to engage in commercial fishing activities with releases

that meet 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 a high priority to determine and justify adjustments to fisheries management measures.
- Measure 14 is a high priority considering the growing popularity of Striped Bass sport fishing in Quebec.
- Measure 15 is a high priority, especially given that critical habitat areas are identified.
- Measure 23 is a high priority to minimize disturbances as much as possible during critical periods, such as spawning periods.

Regarding stewardship and outreach:

- Measures 16 and 17 are a high priority because they would engage fishers in Striped Bass conservation.
- Measures 18 and 19 are medium and low priorities designed to get the municipal and agricultural sectors involved in Striped Bass conservation.
- Measures 20 and 21 are a 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

Critical habitat is defined in the *Species at Risk Act* (SARA) 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." [subsection 2(1)]

Also, SARA defines habitat for 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." [subsection 2(1)]

For the St. Lawrence River Striped Bass population, critical habitat is identified to the extent possible, using the best available information, and provides the functions and features necessary to support the species' life-cycle processes and to achieve the species' population and distribution objectives.

This recovery strategy and action plan identifies critical habitat for the St. Lawrence River Striped Bass population as a series 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 is described in more detail as follows:

- 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 the cities of Lévis 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 is 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 basin of the Rivière du Sud at Montmagny, and an area located at the eastern end of the port facilities at Beauport in Québec City. 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 mainly in or near the MTZ.
- The critical habitat for larval and young-of-the-year (0+) feeding and growth has been identified as corresponding to an intertidal riparian zone with a low tide depth of 0 to 5 metres[11]. This zone 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, at the confluence of fresh water and salt water. 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).

While certain areas of the critical habitat may only be used by the Striped Bass or be critical at particular life stages and times of the year, all of the identified critical habitat must be protected throughout the entire year to ensure that it can fulfill its critical functions for the species when needed.

It has not been determined whether 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 research required to identify additional critical habitat and acquire more detailed information about the critical habitat identified to achieve the species' population and distribution objectives.

8.1.2 Information and methods used to identify critical habitat

Critical habitat for the St. Lawrence River Striped Bass population was identified using 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 by DFO's Canadian Science Advisory Secretariat (Valiquette et al. 2017). They were used as a basis for a science advisory report that was produced through a peer review process involving scientific and recovery experts from MFFP, the Université du Québec à Chicoutimi (UQAC) and DFO in March 2016 (DFO 2017a). Additional information was used to identify critical habitat for reproduction in the area near the

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

end of the port facilities at Beauport. This information was obtained from an analysis of telemetry data gathered from 2015 to 2018 as part of a port development project. These data were analyzed by MFFP scientific experts and the results were published in a ministry report (L'Italien et al. 2020).

Overall, information and projects presented in the DFO science advisory report and in the MFFP 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 to June], open water period [May to October] and overwintering period [November to April]). This approach allowed identification of critical habitat composed of diverse habitats where the Striped Bass performs functions essential to its life cycle (reproduction, growth, feeding and overwintering).

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 River's northern and southern shores, between Montréal and Sainte-Luce along the south shore, and for the north shore, 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 and that it uses more intensely the area defined here as critical habitat. 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 (figure 3).

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 overwintering 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. MFFP data and observations by sport fishers indicate that Striped Bass also overwinter in the area encompassing Lac Saint-Pierre and its archipelago as well as the Rivière Richelieu (MFFP, unpublished data). The location and characterization of these habitats have not been completed yet.

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 areas, play a critical role for reproduction. Individuals aggregate in pre-spawning staging areas 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 from them. Spawning areas are characterized by abiotic attributes (temperature, salinity, oxygen, current)

suitable for egg incubation and hydrodynamics conducive to their transportation to fry-rearing areas.

Three approaches were used to define reproduction habitat: searching for and characterizing aggregations of adults in spawning condition, searching for eggs and larvae, and lastly, locating adults during the spawning season.

Between 2011 and 2015, to characterize aggregations of adults in spawning condition, 14 sites located at the mouth of rivers or in various areas along the St. Lawrence River were sampled, mainly using nets, for a total of 1,389 hours. The sites investigated were chosen because of their suitability for Striped Bass reproduction based on the abiotic conditions present or because sport or commercial fishers had reported aggregations of mature individuals there in spring (Valiquette et al. 2017). 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 scale) and the Beauport area at Québec City (including Beauport Bay, the end of the port facilities and the mouth of the Rivière Saint-Charles.

With regard to search efforts for larvae and eggs, 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 for the first time on the north shore downstream of Québec City, especially in the Île d'Orléans Channel. The circulation patterns suggest that they did not come from the Rivière du Sud site, but from a different location (Vanalderweireldt 2019) and are also consistent with the hypothesis that these larvae came from the Beauport area at Québec City (Pascal Sirois, UQAC, pers. comm.). Striped Bass eggs and larvae were collected near the two main spawning areas over several years between 2011 and 2016. This egg and larval production is reflected in the significant presence of young-of-the-year downstream from the spawning grounds, which has been observed in several studies conducted in the St. Lawrence River since 2011, but particularly in the monitoring of young-of-the-year abundance initiated in 2013 (L'Italien et al. 2020).

During May and June 2015, a fixed-station telemetry network in open water was used to document the locations of adults off Beauport and in the Rivière du Sud during the spawning season, using individual adults fitted with acoustic transmitters. From 2015 to 2018, additional efforts were made to document the use of the Beauport area at a finer spatial scale. Between 10 and 25 additional acoustic receivers were positioned at the southwestern tip of Beauport Bay, as part of a port development project. The number of receivers and their location were adjusted from year to year to optimize monitoring. The fine-spatial-scale telemetry data obtained then underwent a kernel analysis. This analysis models the probabilities of finding an individual in an area defined by all localizations. This approach was used to locate the species' preferred habitat in the Beauport area during the spawning season (for details on the methodology used, see L'Italien et al. 2020).

Based on these various studies, the area located at the end of the port facilities at Beauport (in Québec City) and the basin of the Rivière du Sud (at Montmagny) stand out as significant sites used as pre-spawning staging areas and as spawning areas. 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 mainly in or near the MTZ. The presence of eggs and larvae was confirmed in both areas. The fine-scale telemetry results confirm the intensive use of the Beauport area during the reproduction season.

Despite aggregations of mature adults in May to 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 been determined that the females aggregating in the Rivière Ouelle were likely taking advantage of the favourable conditions for gonad maturation (L'Italien et al. 2020). 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 basin of the Rivière du Sud at Montmagny has been identified as critical habitat. This designation includes all sites where Striped Bass were caught during the spawning season, and recognizes how important the hydrodynamic conditions in the basin are for reproduction. In Québec City, the critical habitat identified is near the mouth of the Rivière Saint-Charles, at the eastern end of the port facilities at Beauport. The critical habitat polygon was defined on the basis of the net sampling, which allowed a portion of the critical habitat along the shoreline to be identified in 2019 (method and habitat presented in DFO 2019b), as well as on the basis of the species' centre of activity, determined using telemetry, as illustrated in figure 39 in L'Italien et al. (2020). The centre of activity corresponds to the area, within the space defined by all localizations, that is more intensely frequented by Striped Bass (according to the modelling of telemetry data). The concentration of adults in this location is thought to reflect the attractiveness of the habitat characteristics for reproduction.

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 references therein).

It was considered acceptable to identify a common critical habitat for the two life stages, given that the young-of-the-year habitat include the larval habitat. Available information indicates that larvae are found mainly in two areas in the upstream portion of the MTZ, more specifically between Montmagny and L'Islet-sur-Mer on the south shore and downstream of Île d'Orléans on the north shore. Large numbers of young-of-the-year are found throughout the MTZ, as well as slightly upstream and downstream of this area, as determined and validated based on annual recruitment monitoring by MFFP during the 2013 to 2018 period (L'Italien et al. 2020; Vanalderweireldt 2019; Valiquette et al. 2017; MPO 2017a, Côté 2012).

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, the science advisory report identified potential habitats based on knowledge acquired about the needs of the Striped Bass and its

habitat use during its first year of life. 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 to 2015 recruitment monitoring (excluding the geographic sites at the extreme 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 for this species (Robitaille et al. 2011). The knowledge acquired since the previous recovery strategy confirms the importance of Anse Saint-Anne as critical habitat.

This critical habitat identification method has the following limitations. The annual recruitment monitoring survey was developed to provide a standardized abundance index for young-of-the-year. Since the survey takes place in September, it does not necessarily provide a complete picture of habitat use for the entire growing season (June to November). Moreover, the survey did not indicate the specific habitat features that juveniles seek out for feeding and growth, since the sites were selected to ensure a uniform probability of capture for individuals between sites.

8.1.3 Identification of critical habitat

Geographic information

Striped Bass critical habitat consists of several 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 (composed of the intertidal area, 0 to 5 m deep over a large geographic area), as described in table 6 and shown in figures 3 and 4. Due to a lack of available information, it was not possible to identify critical habitat for subadults (individuals 1 to 3 years of age).

i. Adult feeding: 122 km^2 area stretching along the northern shore of the St. Lawrence River 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 basin of the Rivière du Sud 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, zone B; table 5); the area at the end of the Port of Québec at Beauport, in Québec City (1.00 km^2), as defined by a polygon, closing off at the shore at Points 1 and 10 (figure 3, zone A; table 5).
iv. Larval and juvenile growth: intertidal riparian zone (290 km^2) and area with 0 to 5 metres low tide depths (482 km^2) within the bounding box between Lévis (upstream of the Rivière Chaudière 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 (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.

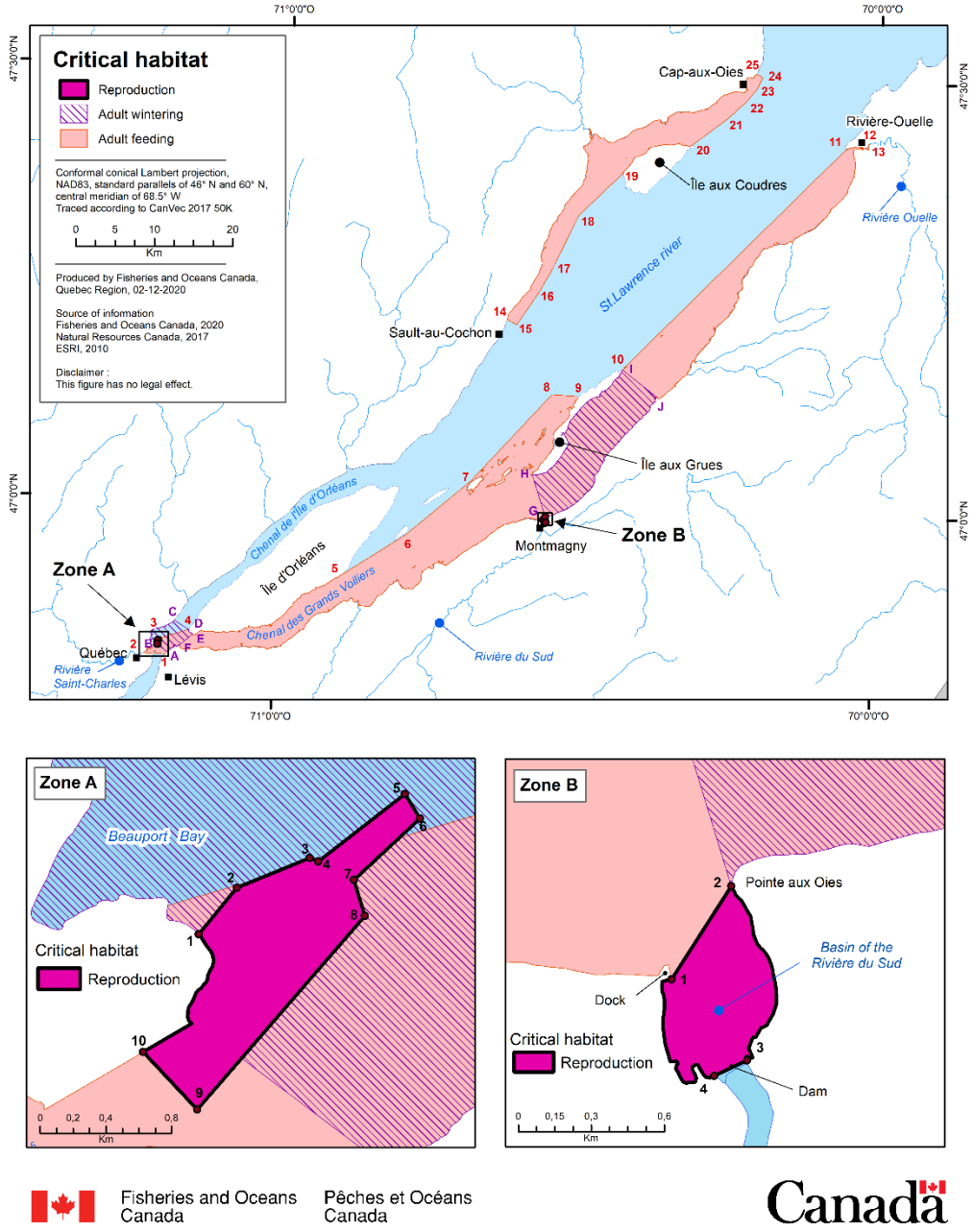

Figure 3. Top: map showing the critical habitat identified for adult feeding (May to October) and overwintering (November to April). Bottom: detailed maps illustrating the critical habitat identified for reproduction (May to June), at the end of the Port of Québec at Beauport (zone A) and in the basin of the Rivière du Sud at Montmagny (zone B). The detailed geographical coordinates are described in table 5. All of the identified critical habitat must be protected throughout the entire year to ensure that it can fulfill its critical functions for the species during the time periods (identified within brackets) where these functions are needed.

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° 30' 00” 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' 36" N	70° 33' 01" W
H	47° 02' 27" N	70° 34' 25" W
I	47° 09’ 55” N	70° 25’ 38” W
J	47° 08’ 05” N	70° 22’ 04” W

Table 5. continued

Reproduction (Québec City sector, zone A)

Point	Latitude	Longitude
1	46° 50' 13,2" N	71° 11' 34,0" W
2	46° 50' 22,5" N	71° 11' 24,0" W
3	46° 50' 29,0" N	71° 11' 03,4" W
4	46° 50' 28,3" N	71° 11' 00,9" W
5	46° 50' 42,3" N	71° 10' 36,0" W
6	46° 50' 37,6" N	71° 10' 32,0" W
7	46° 50' 25,0" N	71° 10' 50,0" W
8	46° 50' 17,8" N	71° 10' 46,0" W
9	46° 49' 38,6" N	71° 11' 33,0" W
10	46° 49' 49,4" N	71° 11' 49,0" W

Reproduction (Montmagny sector, zone 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

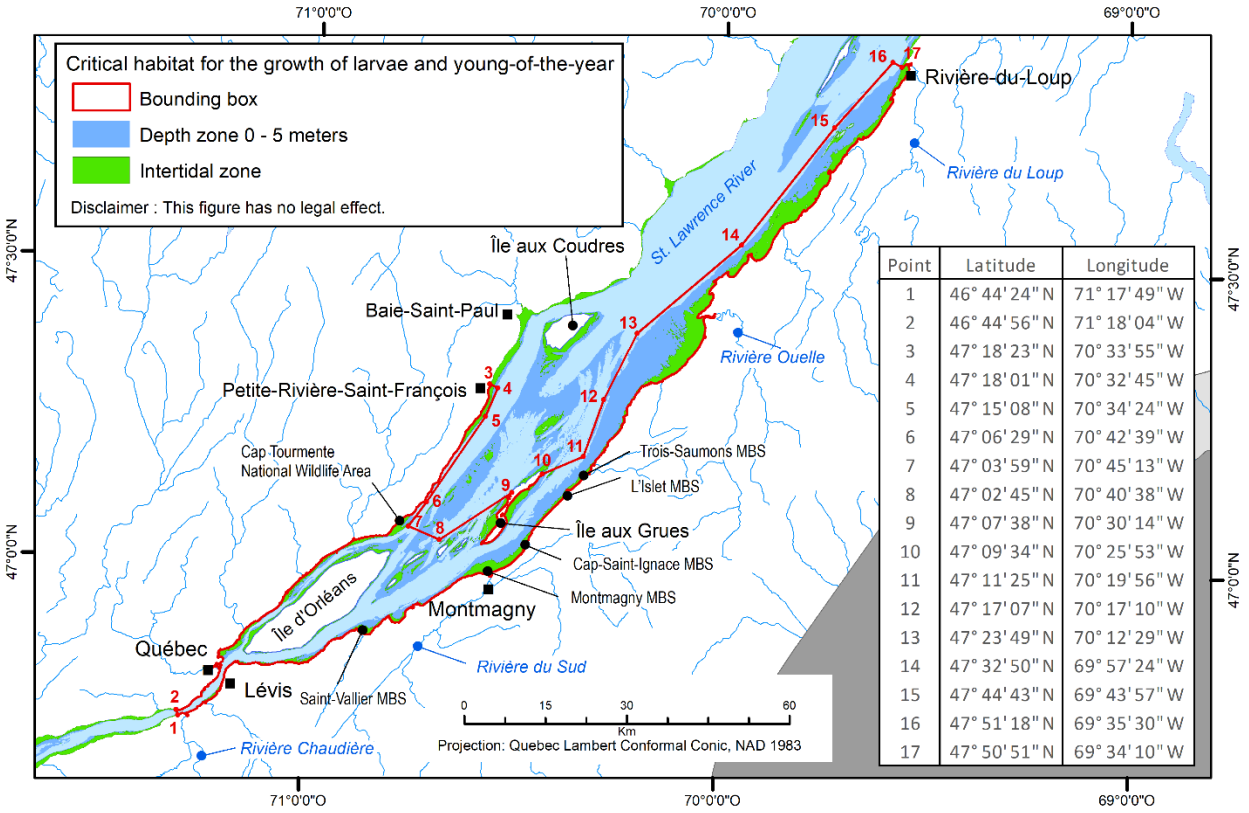

Figure 4. Map showing the critical habitat for larval and juvenile growth identified as the intertidal zone (in green) and the zone of low tide depths from 0 m to 5 m (in blue) within the bounding box (in red). The zero reference is from Canadian Hydrographic Service nautical charts, defined as the Lower Low Water, Large Tide. MBS: Migratory Bird Sanctuary. The identified critical habitat must be protected throughout the entire year to ensure that it can fulfill its critical functions from June to November.

Biophysical functions, features and attributes

Table 6 summarizes the best available information on the functions, features, and attributes for each Striped Bass life stage and geographic location (see complete references in section 4.3 Needs of the species). Note that not all attributes in table 6 must be present for a feature to be identified as critical habitat. If the features as described in table 6 are 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 survival and recovery of the St. Lawrence River Striped Bass population.

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 (Fluvial estuary of the St. Lawrence River) (figure 3, Area A)	Adults and eggs	Reproduction (May to 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 (area between strong currents and

Geographic location	Life stage	Function [a]	Feature(s) [b]	Attribute(s) [c]
				calmer water) which creates 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)
Basin of the Rivière du Sud (Upper St. Lawrence Estuary) (figure 3, Area B)	Adults and eggs	Reproduction (May to June)	• Mouth of a river under tidal influence • Basin consisting of channels and islets • Hydrodynamics: at the foot of a waterfall raised by a concrete sill; water discharge canal for a hydroelectric plant	• Channels with a minimum depth of 1.5 m and islets (exposed at low tide) • Water temperature between 13 °C and 18 °C for 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 to 5 metres, within the bounding box, between Lévis (upstream of the mouth of the Rivière Chaudière) and Rivière-du-Loup on the southern shore and Petite-Rivière-Saint-François on	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 to 5 m • Heterogeneous environment • High salinity gradient (larvae prefer a salinity below 0.1‰) • Thermal front area • Unique circulation pattern that improves local

Geographic location	Life stage	Function [a]	Feature(s) [b]	Attribute(s) [c]
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)				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, rainbow 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: 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 rainbow 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 and takes place in fresh or slightly brackish water. Striped Bass spawn in areas located at the mouth of two rivers, at the confluence of the St. Lawrence River 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). The two areas retained as critical habitat have specific hydrodynamic conditions that have been associated with Striped Bass spawning areas in the literature, that is, strong currents and current reversals caused by the topography of the environment (L'Italien et al. 2020 andreferences therein). 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).

The salinity values measured in the basin of the Rivière du Sud 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 Rivière Saint-Charles 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 to 5 m (DFO 2017a; Valiquette et al. 2017). These habitats are located in estuarine waters, mainly in the area where fresh and salt water converge in the Upper Estuary of the St. Lawrence (Gagnon et al. 1993). This area 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. It 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 this area are consequently brackish and turbid, which promotes extensive

plankton production which remains in the area because of the estuarine water circulation pattern. This also occurs locally in coastal areas, 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 area is located at the boundary of the 0.1‰ saline front (Vanalderweireldt 2019). 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 references therein). This distribution is consistent with the fact that juvenile Striped Bass are more tolerant to variations in abiotic conditions than larvae and the fact that their diet is more diverse.

Juveniles seek out aquatic grass bed habitats for both shelter and food (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 cladocerans density (Miller 1977; Martin et al. 1985). These two groups of species are the dominant species of zooplankton in this zone where fresh and salt waters converge (Cusson 2011 and references therein). After Striped Bass reach the juvenile stage, their diet diversifies to include mysids, sand shrimp, Atlantic tomcod, rainbow smelt and clupeidea (Robitaille 2010; COSEWIC 2012).

Recent studies have defined the habitat characteristics that ensure optimal feeding and growth of larval and juvenile Striped Bass in the St. Lawrence River population (Vanalderweireldt 2019). They highlight the importance of fry-rearing areas in the Upper Estuary for Striped Bass.

Note that existing permanent anthropogenic structures that may be present within the delineated areas (for example, marinas, docks, pontoons) are specifically excluded, unless said structures are maintaining critical habitat. It is understood that maintenance or replacement of these structures may be required at times[12].

Summary of the critical habitat's contribution to achieving the population and distribution objectives

Currently, it is known that the Saint Lawrence River population of Striped Bass reproduces 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, it is considered that this identified

[12] Depending on the type of maintenance or replacement, permits may be required to conduct the work.

critical habitat should contribute to the recovery of the species since it includes the two known spawning areas recognized as significant for the population 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, based on the best available information, the Minister of Fisheries and Oceans and the Canadian Coast Guard considers necessary to partially achieve the species' population and distribution objectives required for the survival and recovery of the species. Additional critical habitat may be identified in future updates to the recovery strategy and action plan.

8.2 Schedule of studies to identify critical habitat

Further research is required to refine the boundaries of the currently identified critical habitat in order to: refine the understanding of the functions, features, and attributes of the currently identified critical habitat necessary to support the species' population and distribution objectives; protect the critical habitat from destruction; and, identify additional areas of critical habitat.The following table describes these studies, many of which have already begun or are well underway. It is likely that completing these studies will lead to the discovery of further knowledge gaps that need to be addressed.

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

Study description	Rationale	Timeline
Locate and characterize other important habitats during the reproduction season	Since 2011, MFFP has conducted sampling at the mouths of 14 rivers or areas that could potentially support Striped Bass reproductive activities. The basin of the Rivière du Sud (at Montmagny) has been confirmed as a spawning area. The presence of a spawning area at Beauport (Québec City) has also been confirmed due to the presence of Striped Bass eggs and larvae there, and its location has been precisely determined using telemetry (L'Italien et al. 2020). A recent study (Vanalderweireldt 2019) indicates that the distribution of Striped Bass larvae closely corresponds to the location of these two spawning areas. The Rivière Ouelle has not emerged as a spawning area, but more as a pre-spawning aggregation site that is likely conducive to gonad maturation. Given that the Striped Bass population is increasing, the inventory of potential spawning areas must be continued by integrating the most up-to-date information on observations of Striped Bass in the field during the reproduction season.	2021 to 2023
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 area at Montmagny help disperse eggs and larvae to areas suitable for their survival and development. A similar situation exists in the Port of Québec area (at Beauport), where hydrodynamics help transport larvae to suitable areas located downstream in the MTZ (Vanalderweireldt 2019). The hydrodynamics of potential spawning grounds should be documented.	2021 to 2023

Study description	Rationale	Timeline
Complete the determination and characterization of overwintering areas	Downstream, 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. Upstream, a new overwintering sector has been located, encompassing Lac Saint-Pierre and its archipelago and the Rivière Richelieu (unpublished MFFP data). Studies are continuing to better characterize overwintering areas.	2021 to 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.	2021 to 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 to 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[a] 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.	2021 to 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 fluvial estuary and the Upper Estuary of the St. Lawrence River, relative to the size that allows survival in winter. This work is still to be completed.	2021

Study description	Rationale	Timeline
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.	2021 to 2023
Locate and characterize the habitat of subadults	Available data are mainly on young-of-the-year (MFFP standardized recruitment survey) and adults (telemetry, net sampling). For this reason, the habitat of subadults (1 to 3 years) is very poorly documented.	2021 to 2028
Characterize Striped Bass use of the upstream section of the St. Lawrence River (between Montréal and Québec City)	In the extirpated population, the fluvial section of the St. Lawrence River (beginning upstream from Lac 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 fluvial portion between Sorel and Québec City in May and likely return downstream in June. Today, Striped Bass are well established in the upstream portion of the river, as far as Sorel and including the Rivière Richelieu, and there are records of individuals near Montreal. The function of this part of the range and its importance in population dynamics still needs to be better documented.	2021 to 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 Examples of activities likely to result in the destruction of critical habitat

The following examples of activities likely to result in the destruction[13] 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 DFO's ability to regulate that activity under 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 available and reliable. 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 of its critical habitat's thresholds of tolerance to disturbance from human activities is lacking and must be acquired.

[13] 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. Examples of 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 sectors 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 sectors 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 areas) Riparian habitat in estuarine sectors	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 areas) Riparian habitat in estuarine sectors Shoals	Currents (intensity and circulation patterns) Oxygen concentration Availability of suitable prey

Threat	Activity	Effect pathway	Function affected	Feature affected	Attribute affected
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 and hydrodynamics (spawning areas)	Currents (intensity and circulation patterns) Oxygen concentration
Habitat loss or degradation	Shore development (for example, 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 and hydrodynamics (spawning areas) Riparian habitat in estuarine waters	Currents (intensity and circulation patterns) Oxygen concentration Aquatic grass beds Prey availability
Habitat loss or degradation	Infrastructure development (for example, 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 and hydrodynamics (spawning areas) 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

SARA requires that the action plan component of the recovery document[14] (action plan) include an evaluation of the socio-economic costs of the action plan and the benefits to be derived from 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. An estimate of the costs and benefits associated with this action plan are described below.

This evaluation does not address the socio-economic impacts of protecting critical habitat for Striped Bass. Where a SARA Critical Habitat Order will be used for critical habitat protection, the development of the Order will follow a regulatory process in compliance with the Cabinet Directive on Regulatory Management, including an analysis of any potential incremental impacts of the Critical Habitat Order. This analysis will be included in the Regulatory Impact Analysis Statement for the Order.

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 examines whether the implementation of these measures could entail additional costs for stakeholders. Then, section 9.3 examines the benefits of implementing the action 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) surveys, monitoring and stocking; 2) research; 3) management and coordination; and 4) stewardship and outreach. Potential partners that may be involved in carrying out the action plan are also indicated in these tables.

Survey, monitoring and stocking, measures

DFO's main partners in implementing survey, monitoring and stocking measures would include the Government of Quebec (MFFP), the academic sector (Université du Québec à Chicoutimi [UQAC]) and First Nations. (measure 3 in table 3).

Research measures

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

[14] That is, tables 3 and 4 and section 9

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 (for example, eel fishers). Recreational and commercial fishers could contribute through the monitoring network by reporting incidental catches from sport and commercial 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, the sport fishing community and commercial fishing industry, municipalities and the agricultural sector could also become involved.

9.2 Socio-economic costs of implementing the action plan

The cost of the measures are assessed in qualitative terms below. 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, their implementation would not systematically result in additional socio-economic costs for these stakeholders, or the measures could be funded, at least in part, by existing federal government programs.

In addition, fisheries and fish habitat are already managed under the *Fisheries Act.* The action plan does not involve any additional costs or constraints with respect to the requirements of other existing legislative tools.

Survey, monitoring and stocking measures

Half of the recovery measures included in the Striped Bass action plan involve survey, monitoring and stocking measures. The survey and monitoring activities are also a continuation of initiatives already undertaken by DFO and its partners. The stocking activities build on projects already underway at MFFP. Certain measures go beyond the scope of Striped Bass recovery and involve acquiring knowledge on the species. It is therefore realistic to conclude that many of the survey 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 survey and monitoring measures under DFO’s responsibility would be funded through existing annually funded government programs and would not result in additional costs. Other measures taken by the provincial government, academia or Indigenous partners could also be partially funded by existing federal programs.

It is therefore anticipated that carrying out survey, monitoring and stocking 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 six management and coordination measures listed in the Striped Bass action plan that would involve DFO, MFFP or 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 recreational and commercial 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 River and the general public (for example, sport fishers, commercial fishers, First Nations, shoreline residents, municipalities) of the importance of protecting the Striped Bass for its recovery. Some stakeholders who choose to get involved in the recovery of the Striped Bass and implement stewardship and outreach measures may incur additional costs. However, these additional costs could be covered, at least in part, through existing federal programs. Some measures could also entail additional costs for the federal government, some of which could be covered 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 under SARA, to that of special concern.

The benefits from the recovery of the St. Lawrence River Striped Bass are difficult to quantify. The protection and recovery of species at risk can have both benefits and costs. 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). Self-sustaining and healthy ecosystems with their various elements in place, including species at risk, contribute positively to the livelihoods and quality of life of all Canadians. A review of the literature confirms that Canadians value the preservation and conservation of species in and of themselves. In addition, the more an action contributes to the recovery of a species, the higher the value the public places on such actions (Loomis and White 1996; DFO 2008).

Quebec residents attach significant importance to sport fishing. The presence of Striped Bass from the population of the southern Gulf of St. Lawrence, in the northern Gulf and in the Lower Estuary, boosted recreational tourism by attracting a large number of sport fishers, which complements 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 St. Lawrence River Striped Bass population could allow for a sport fishery to return to the St. Lawrence River and 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[15]. 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 a continuation of activities already underway, additional costs for DFO and its partners should be low.

The benefits of implementing 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.” [subsection 83(4)]

The following activities are permitted by this recovery strategy as described in the sub-section below:

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 First Nation, recreational and commercial 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 DFO science advisory report assessed the impact of incidental Striped Bass catches from recreational and commercial 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 concluded that fishing activities in freshwater and marine

[15] This section estimates costs associated with implementing the action plan only; costs to be compliant with prohibitions and requirements resulting from listing or orders to protect critical habitat are assessed in Regulatory Impact Analysis Statements that accompany Critical Habitat Orders.

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 (that is, 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 recreational and commercial fishing.

The recovery team considers that this report is still relevant and that its conclusions remain valid. However, the impact of incidental Striped Bass catches from recreational and commercial fishing on the survival and recovery of the population should be re-evaluated.
Pursuant to subsection 83(4) of SARA, the present recovery strategy authorizes fishers to incidentally catch individuals or striped bass, St. Lawrence River population, 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 commercial fishing licence issued under the *Quebec Fishery Regulations* (1990) SOR/90-214;
- sport fishing with or without a license is carried out in accordance with the *Quebec Fishery Regulations* (1990) SOR/90-214; and
- any person who incidentally catches a Striped Bass while fishing must 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 that are part of the network must possess a licence for the capture of wildlife for scientific, educational or wildlife management purposes (SEM licence) issued by the MFFP, authorizing them to keep incidentally caught Striped Bass and deliver them to MFFP biologists responsible for the species.

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 licence for the capture of wildlife for scientific, educational or wildlife management purposes (SEM licence) issued under the *Quebec Fishery Regulations* (1990) SOR/90-214; and
- 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 SEM licence referring to the species.

For persons engaging in activities not listed above that are likely to affect the St. Lawrence River Striped Bass population in a manner that will contravene SARA, are encouraged to contact Fisheries and Oceans Canada, at the following address: 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, the *Species at Risk Act* 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. Although there are some concerns, specific preliminary dietary studies conducted by Ministère de la Faune, des Forêts et des Parcs du Québec and Fisheries and Oceans Canada show the opportunistic behaviour of the Striped Bass in its feeding and do not indicate any significant impact on the prey species (Michel Legault, pers. comm.).

Appendix B: record of cooperation and consultation

Recovery strategies and action plans must be prepared in cooperation and consultation with other affected jurisdictions, organizations, affected parties and others, 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 experts from federal and provincial governments and from the academic sector, as well as representatives from First Nations, non-governmental organizations, and sport and commercial fishers. The following individuals collaborated in the production of the recovery strategy and action plan as members of the Équipe de rétablissement pour le bar rayé du fleuve Saint-Laurent [St. Lawrence River Striped Bass Recovery Team].

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
Bernard Leblanc	DFO, Conservation & Protection Direction
Jean-Louis Provencher	Parks Canada, Natural Resources Conservation Branch
Martin Arvisais	MFFP, Direction de la gestion de la faune de la Capitale-Nationale-Chaudière-Appalaches
Geneviève Brosseau	MFFP, Direction de la protection de la faune de la Côte-Nord
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
Dominique Lapointe	MFFP, Direction de l'expertise sur la faune aquatique
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, Direction de la Protection de la faune du 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
Marc-André Savard	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

Recovery team member	Organization of origin
Bruno Ouellet	Pêcheries Ouellet
Jean-Éric Turcotte	Stratégies Saint-Laurent

The draft recovery strategy and action plan was submitted to the Québec government and relevant First Nations for consultation. Public, Indigenous and stakeholder input was sought through the publication of the proposed document on the Species at Risk Public Registry for a 60-day public comment period. Comments received have been taken into account in the production of 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 to 100%) and possibility of extinction.
High	Significant population loss (31 to 70%) or threat compromising the survival or recovery of the population.
Medium	Moderate population loss (11 to 30%) or threat likely to jeopardize the survival or recovery of the population.
Low	Little change in the population (1 to 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	Fisheries and Oceans Canada
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
MELCC	Ministère de l'Environnement et de la Lutte contre les changements climatiques du Québec [Quebec Department of the Environment and the Fight against Climate Change]
MFFP	Ministère de la Faune, des Forêts et des Parcs du Québec [Quebec Department of Wildlife, Forests and Parks]
MTQ	Ministère des Transports du Québec [Quebec Department of Transportation]
MTZ	Maximum turbidity zone
NGO	Non-governmental organization
RCM	Regional county municipality
SARA	Species at Risk Act
UQAC	Université du Québec à Chicoutimi