PROPOSED

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Striped Bass *(Morone saxatilis)*, St. Lawrence Estuary Population, Canada

Striped bass



Stocking of a Striped Bass, Saint-Michel-de-Bellechasse, 2005.

June 2011

Pêches et Océans Canada
Fisheries and Oceans Canada
Canada

About the *Species at Risk Act* Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003 and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

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 goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency, and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (http://www.sararegistry.gc.ca/approach/act/default_e.cfm) outline both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the *Species at Risk Act* and recovery initiatives, please consult the SARA Public Registry (http://www.sararegistry.gc.ca/).

Recovery Strategy for the Striped Bass *(Morone saxatilis)*, St. Lawrence Estuary Population, Canada (PROPOSED)

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PREFACE

Under the *Species at Risk Act* (SARA), the Minister of Fisheries and Oceans is a "competent minister" for the recovery of the striped bass, St. Lawrence Estuary population. This recovery strategy was developed in accordance to section 37 of SARA. The development of this recovery strategy was led by Fisheries and Oceans Canada – Quebec Region with the ministère des Ressources naturelles et de la Faune du Québec. It has been prepared in collaboration with the members of the St. Lawrence Estuary Striped Bass Recovery Team (Part 4) and in consultation with aboriginal communities, organizations and government agencies. The proposed recovery strategy meets SARA requirements in terms of content and process (sections 39–41).

Success in the recovery of the striped bass, St. Lawrence Estuary population, depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Fisheries and Oceans Canada or any other party alone. In the spirit of the national *Accord for the Protection of Species at Risk*, the Minister of Fisheries and Oceans invites all Canadians to join Fisheries and Oceans Canada in supporting and implementing this strategy for the benefit of the species and Canadian society as a whole. Fisheries and Oceans Canada will support implementation of this strategy to the extent possible, given available resources and their overall responsibility for species at risk conservation. Implementation of the strategy by other participating jurisdictions and organizations is subject to their respective policies, appropriations, priorities, and budgetary constraints.

The goals, objectives and recovery approaches identified in the strategy are based on the best existing knowledge and are subject to modifications resulting from new information. The competent ministers will report on progress within five years. This strategy will be complemented by an action plan that will provide details on specific recovery measures to be taken to support conservation of the species. The competent ministers will take steps to ensure that, to the extent possible, Canadians interested in or affected by these measures will be consulted.

AUTHORS

The present document was written by Jean Robitaille, M.Sc., of the Coopérative des conseillers en écologie appliquée de Québec, with the collaboration from members of the St. Lawrence Estuary Striped Bass Recovery Team (see Section 4 for list of members).

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STRATEGIC ENVIRONMENTAL ASSESSMENT

In accordance with the *1999 Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*, the purpose of a Strategic Environmental Assessment (SEA) is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally-sound decision making.

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 on non-target species or habitat.

This recovery strategy will clearly benefit the environment by promoting the recovery of the striped bass. The reintroduction of striped bass in the St. Lawrence could contribute to restoring this ecosystem's biodiversity (Comité aviseur sur la réintroduction du bar rayé, 2001). The potential for the strategy to inadvertently lead to adverse effects on other species, particularly preys or competitors, was considered. The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects. Refer to the following sections of the document, in particular: Habitat and Biological Needs; Ecological Role; Limiting Factors; Approaches Recommended to Meet Recovery Objectives and Effects on Other Species.

FOREWORD

Until the end of the 1960s, the St. Lawrence River was home to a native population of striped bass (*Morone saxatili*), an anadromous fish typical of eastern North American estuaries and coastal waters. The striped bass population of the St. Lawrence proved to be quite resilient and, since the 19th century, had been the object of intensive commercial and sports fisheries. The striped bass fishery was characterized by periods of great abundance and plentiful harvests alternating with years of scarcity during which the population was able to recover. However, the population recovery which was expected in the early 1960s failed to materialize and the striped bass disappeared completely in the following years. Analysis of biological data collected between 1944 and 1962 indicates a reduction in the distribution range of this fish, a period coinciding with the expansion and regular dredging of the Traverse du Nord, the Île d'Orléans section of the shipping channel. Changes to habitats used by immature striped bass may have compounded the effects of the fisheries and brought mortality rates to a level the population could no longer support.

By the end of the 1960s, the striped bass no longer appeared in the reported catches of commercial and sports fishermen in the St. Lawrence. As a result of this prolonged absence, the fishing community concluded that the striped bass was likely extirpated. In 1980, the Comité pour la sauvegarde des espèces menacées au Québec (COSEMEC), the first organization to address the issue of threatened species in Quebec, added the striped bass population of the St. Lawrence to a list of priority species (COSEMEC, 1981) and undertook the first steps towards a comprehensive study of the subject (Beaulieu 1985). The disappearance of this population was first acknowledged by Quebec authorities (Trépanier and Robitaille 1995) and then by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Robitaille 2004).

In 2001, a committee of specialists on the striped bass and fisheries issued a favorable assessment of the possibility of reintroducing striped bass in the St. Lawrence combined with a monitoring program targeting this population and the biological community components that could be affected, and an action plan was drafted (Comité aviseur sur la réintroduction du bar rayé 2001). Several organizations lent their support to the project or contributed in various ways (Appendix 2). In 2002, a reintroduction program, including the breeding of fish in Quebec hatcheries, was developed in Quebec using striped bass captured in the Miramichi River in New Brunswick. Between 2002 and 2009, more than 6,300 striped bass, over 60 mm in length (ages 0+ to 6+) and 6.5 million larvae, 2 to 4 mm long, were stocked to assist the recovery of the striped bass population of the St. Lawrence Estuary. The reintroduction program, which aims to stock up to 50,000 autumn fry (Comité aviseur sur la réintroduction du bar rayé 2001), is slated to begin in the coming years. The striped bass which have been stocked to date have consisted of surplus individuals taken from the breeding program.

The authorities responsible for the protection of wildlife species at risk in Quebec and Canada have agreed to combine their resources and their expertise to ensure the success of this wide-ranging initiative. The present recovery strategy for the striped bass of the St. Lawrence Estuary constitutes the first step in this concerted action.

EXECUTIVE SUMMARY

The striped bass (*Morone saxatilis)* is a spiny fish with an elongated, laterally compressed body and a triangular head. It can reach up to 90 cm in length in the St. Lawrence. It is an anadromous species typical of eastern North American estuaries and coastal waters. Spawning, incubation, and early larval development occur in freshwater and the juveniles migrate downstream to brackish water and eventually salt water to feed and grow for several years before reaching maturity.

In Canada, five native striped bass populations have existed in three distinct sectors corresponding to the three designatable units recognized by the COSEWIC: the Bay of Fundy, the Southern Gulf and the St. Lawrence Estuary. The St. Lawrence Estuary population, which is the object of the present recovery strategy, was designated extirpated in Canada in November 2004, after having disappeared in the late sixties. However, a reintroduction program has been under way since 2002. Between 2002 and 2009, more than 6,300 striped bass measuring over 60 mm in length (ages 0+ to 6+) and 6.5 million larvae, 2 to 4 mm long, were stocked in the St. Lawrence between Saint-Pierre-les-Becquets and Rivière-Ouelle.

The St. Lawrence Estuary Striped Bass Recovery Team has identified twelve threats to the survival and recovery of the species, arranged in three general categories: threats to habitat, threats due to the harvesting of individuals and biological threats. After analysis, the recovery of the striped bass of the St. Lawrence Estuary has been deemed both biologically and technically feasible. The recovery goal is to restore, over the next ten years, a striped bass population capable of reproducing and sustaining itself in the St. Lawrence Estuary and of integrating itself into the biological community without disturbance.

To reach this goal, five objectives have been identified:

1. Increase the number of striped bass;
2. Identify the habitats used by the striped bass;
3. Monitor the status of the striped bass population;
4. Monitor the status of certain components of the ichthyological community (prey, predators, competitors) in relationship with the striped bass;
5. Protect the striped bass population and its most important habitat.

To reach these objectives, 19 recovery measures related to five general strategies have been formulated: 1) Inventory and monitoring; 2) Acquisition of knowledge; 3) Artificial production and stocking; 4) Protection, restoration and stewardship; and 5) Outreach.

Given the knowledge gaps and the absence of a quantitative recovery target, thorough identification of critical habitat is not feasible at this time. One segment of the critical habitat can nonetheless be identified, based on the best available information. This is the zone of juvenile (age 0+) concentration located at Anse Sainte-Anne, at La Pocatière during the fall, from September 1 to October 31. A schedule of studies required to identify critical habitat has been established to acquire the necessary information to further identify critical habitat in the action plan, which will be developed within the next five years.

The recovery goal, objectives and approaches presented in this strategy are based on the best available knowledge and may change if new information becomes available. The competent minister will issue a progress report within five years.

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1. BACKGROUND

1.1. Species Assessment Information from COSEWIC

Common Name: Striped Bass (Population of St. Lawrence Estuary)

Scientific Name: *Morone saxatilis* (Walbaum, 1792)

Date of Assessment: November 2004

COSEWIC Status: Extirpated in 2004.

Reason for Designation: The population from the St. Lawrence Estuary has disappeared as a consequence of illegal fishing, with the last record dating from 1968.

Canadian Occurrence: Quebec

Status History: Designated extirpated in November 2004. Assessment based on a new status report.

1.2. Description

The striped bass (*Morone saxatilis*) is a spiny 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 thoracic. The cheeks and opercula are covered with scales. The striped bass has a dark olive-green to black back and a white belly. On the pale or silvery sides, there are seven or eight horizontal dark stripes following the scale rows. None of these stripes extends onto the head.



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

This fish is well adapted to estuaries and coastal waters. It travels along the coast in compact schools of same-size fish, feeding on invertebrates and fish (see Section 1.4 Needs of the Striped Bass). In the St. Lawrence, the striped bass can live up to twenty years and reach a total length of 90 cm (Vladykov 1953).

1.3. Populations and Distribution

1.3.1. Distribution

1.3.1.1. GLOBAL RANGE

The natural range of the striped bass (excluding areas where it was introduced by humans) extends along the Atlantic coast of North America, from the St. Lawrence River to the St. Johns River in northeast Florida. Native striped bass populations have also existed in the tributaries of the Gulf of Mexico, from the Suwannee River in northwestern Florida to Lake Pontchartrain in Louisiana (Lee *et al.* 1980; Bain and Bain 1982).

The species was introduced in the common estuary of the Sacramento and San Joaquin rivers, on the Pacific coast, in 1879 (Bonn *et al.* 1976), and gradually became established in other rivers along the west coast of the United States (Hart 1973; Lee *et al.* 1980; Setzler *et al.* 1980).

The striped bass can live in freshwater and, in certain cases, may even complete its life cycle there (Scruggs 1957). It has been introduced as a sports species in numerous lakes and reservoirs in the United States, Mexico, Ecuador, Russia, Latvia, France, Portugal, Turkey and South Africa (Lee *et al.* 1980; Setzler *et al.* 1980; Froese and Pauly 2007). In some of these locations, the populations reproduce naturally (Lee *et al.* 1980; Setzler *et al.* 1980; Froese and Pauly 2007). Elsewhere, the striped bass thrives well but cannot reproduce and on-going stocking programs are required to maintain population numbers (Lee *et al.* 1980).

1.3.1.2. CANADIAN RANGE

In Canada, five native striped bass populations have existed in three distinct sectors corresponding to the three designatable units recognized by the COSEWIC (Figure 2): the Bay of Fundy, the Southern Gulf and the St. Lawrence Estuary (Robitaille 2004). The populations in the St. John, Annapolis and Shubenacadie rivers belong to the Bay of Fundy group, feeding in that bay during the summer and possibly coming into contact there. These three populations also frequent waters which, during the summer, are home to striped bass migrating from American rivers.



Figure 2. Location of the five rivers in eastern Canada that have supported striped bass populations.
The filled-in circles indicate extant populations and the open circles indicate rivers in which no spawning activity has been observed for 20 years or more. Inset, range of North American native populations.

There is only one known spawning population in the southern Gulf, that of the Miramichi River. Striped bass have been captured in several estuaries and along the coast between Percé and Margaree, on Cape Breton Island (Melvin 1991). However, these fish all seem to originate in the Miramichi River, where the only known striped bass spawning ground in the entire southern Gulf is found (Bradford *et al.* 1995; Robichaud-LeBlanc *et al.* 1996; Douglas *et al.* 2003). The southern Gulf population is believed to be isolated from both the Bay of Fundy populations and the migratory bass from American rivers. All recaptures of striped bass tagged in the southern Gulf were reported in this sector, except for one in Maryland (Hogans and Melvin 1984).

The third group also contains a single population, that of the St. Lawrence Estuary, which occupied a roughly 300 km stretch of the fluvial and estuarine[1] portion of the river. With respect to the striped bass population of the St. Lawrence Estuary, the distribution of recaptures in a mark-release program between 1944 and 1962 suggests that it was isolated from the other Canadian populations (Beaulieu 1962; Robitaille 2001). Of the 3,009 tagged specimens, 310 were recaptured, all within the sector between Lake Saint-Pierre and Kamouraska. It is mainly in this portion of the St. Lawrence that most of the striped bass captures were made by sports and commercial fishermen (Figure 3). Commercial captures were also regularly recorded in the St. Lawrence Estuary between 1920 and 1965, though none were recorded in the southern Gulf between 1935 and 1968 (Leblanc and Chaput 1991; Douglas *et al.* 2003). All available data seem to indicate that the St. Lawrence striped bass population is distinct from other Canadian populations.

[1] The St. Lawrence Estuary extends from the outflow of Lake Saint-Pierre to a line between Pointe-des-Monts and Matane.

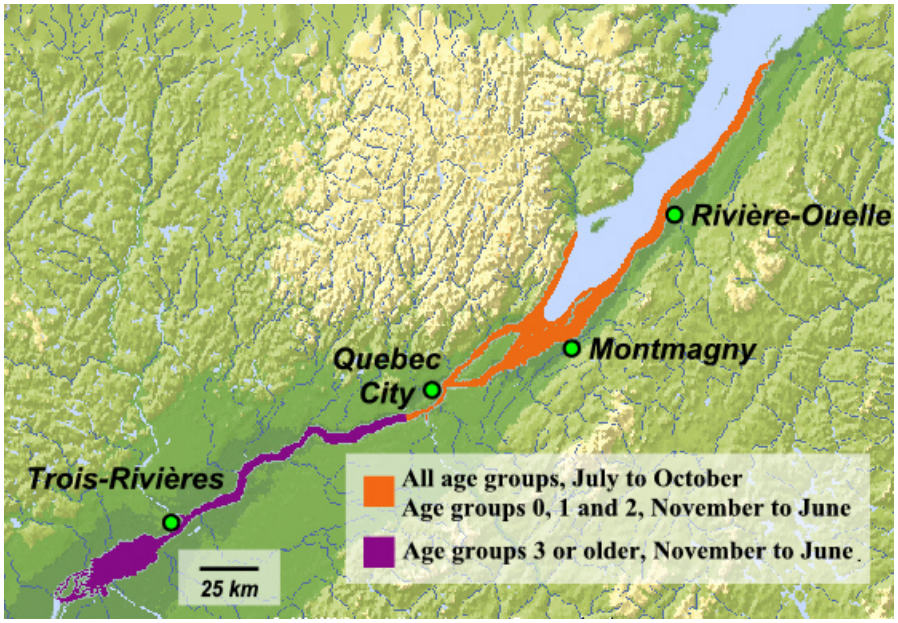


Figure 3. Range of the historic population of St. Lawrence Estuary striped bass.
The movement of three-year and older striped bass upstream seems to be linked to spawning activity. Shown are only the areas where striped bass were regularly captured each year before the start of the population decline in the 1950s which terminated in the disappearance of the population.

In 2002, following an action plan for the reintroduction of striped bass in the St. Lawrence (Comité aviseur sur la réintroduction du bar rayé 2001), a reintroduction program was developed in Quebec, which included fish breeding in Quebec hatcheries using striped bass captured in the Miramichi River in New Brunswick. Between 2002 and 2009, more than 6,300 striped bass measuring over 60 mm in length (ages[2] 0+ to 6+) and 6.5 million larvae, 2 to 4 mm long, were stocked in order to promote the recovery of the striped bass population of the St. Lawrence Estuary. The aim of the reintroduction program, which will stock up to 50,000 autumn fry (Comité aviseur sur la réintroduction du bar rayé 2001), is to establish a population capable of self-reproducing. Since being reintroduced, striped bass have been captured in the sector once occupied by the extirpated population, between Lake Saint-Pierre and Rivière-du-Loup (DFO 2010a, b; Pelletier *et al.* 2010).

The present recovery strategy is concerned with the striped bass population reintroduced in the St. Lawrence Estuary (known as the new population), intended to replace the one which disappeared in the late sixties (known as the historic population).

[2] Age is expressed in years.

1.3.2. Population Trends

1.3.2.1. GLOBAL POPULATION TRENDS

Within the natural range of the striped bass, the status of the different populations varies greatly. The species is globally listed as common, widespread and abundant, but at the national and subnational levels, status varies considerably (Table 1). Some eastern American coastal rivers contain abundant populations characterized by lengthy migrations between the Bay of Fundy and northern Florida. The abundance and omnipresence of these migrating fish seem to indicate a general global abundance of the species. However, several spawning populations disappeared during the 20th century, including, for example, most of those in the tributaries of the Gulf of Mexico.

Table 1. Status of the striped bass according to NatureServe (NatureServe 2009).

Range	Conservation Status Rank*
Global (G)	
For the entire North American populations	G5
National (N)	
Canada	N3?
United States	N5
Subnational (S)	
Canada	British Columbia (SNR), New Brunswick (S2), Nova Scotia (S1), Prince Edward Island (S2N), Quebec (SX)
United States	Alabama (S5), Arizona (SNA), Arkansas (SNA), California (SNA), Colorado (SNA), Connecticut (S3), Delaware (S5), District of Columbia (S4), Florida (SNR), Georgia (S5), Illinois (SNA), Indiana (SNA), Kansas (SNA), Kentucky (SNA), Louisiana (S4), Maine (S5), Maryland (S5), Massachusetts (S5), Mississippi (SH), Missouri (SNA), Navajo Nation (SNA), Nebraska (SNA), Nevada (SNA), New Hampshire (S4), New Jersey (S4), New Mexico (SNA), New York (S4), North Carolina (S4), North Dakota (SNA), Ohio (S5), Oklahoma (SNA), Oregon (SNA), Pennsylvania (S4), Rhode Island (SNR), South Carolina (SNR), Tennessee (SNA), Texas (SNA), Utah (SNA), Virginia (S4), Washington (SNA), West Virginia (SNA)

* The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment: G: Global; N: National; and S: Subnational (i.e., state or province). The numbers have the following meaning: 1 = critically imperilled; 2 = imperilled; 3 = vulnerable; 4 = apparently secure; 5 = secure; X: presumed extinct or extirpated; H: possibly extinct or extirpated; N: non-breeding; NA: not applicable —a conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities; NR: unranked—national or subnational conservation status not yet assessed http://www.natureserve.org.

1.3.2.2. CANADIAN POPULATION TRENDS

In 2004, in Canada, in the three rivers where spawning populations had previously existed (the St. John, Annapolis and St. Lawrence rivers), no sign of reproductive activity had been observed

and no capture of striped bass of local origin had been confirmed in over twenty years (Robitaille 2004). However, since the reintroduction of striped bass in the St. Lawrence, signs of natural reproduction were observed in 2008 (Bourget *et al.* 2008; Pelletier 2009). The populations in the Shubenacadie River (Bay of Fundy population) and the Miramichi River (Southern Gulf of St. Lawrence population) still appear capable of producing new individuals (Robitaille 2004).

1.4. Needs of the Striped Bass

1.4.1. Habitat and Biological Needs

The striped bass is an anadromous fish typical of the estuaries and coastal waters of North America (Scott and Scott 1988). Spawning, incubation and early larval development occur in freshwater in the spring. The young subsequently move downstream to brackish water and then on to salt water where they feed and grow until they reach maturity, approximately 3 years for males and 4 or 5 years for females (Berlinsky *et al.* 1995; Douglas *et al.* 2003; Powles 2003). In Canada, striped bass reproduce during three or four weeks beginning around the end of May and early June, in fresh or slightly brackish water. The spawning ground of the striped bass of the St. Lawrence Estuary has never been located, but available data seems to indicate that it lies in Lake Saint-Pierre or just downstream from there in the adjacent section of the fluvial estuary (Montpetit 1897; Vladykov and Brousseau 1957; Beaulieu 1962; Cuerrier 1962; Magnin and Beaulieu 1967; Robitaille 2001).

Of the various habitats used by the striped bass during its life cycle, the most important for the maintenance of the population appears to be the spawning, incubation and rearing habitats (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). Egg survival to hatching is closely tied to the physicochemical properties of the incubation habitat, particularly temperature, dissolved oxygen and the presence of a moderate current (Cooper and Polgar 1981). The duration of incubation is a function of temperature. The highest hatching rates (87%) and larval survival rates in the first 24 hours (76%) are obtained at 18^{o}C (Morgan *et al.* 1981). At that temperature, the eggs hatch approximately 48 hours after fertilization (Pearson 1938; Raney 1952). Egg survival rapidly declines when the water temperature exceeds 23^{o}C and gradually declines as water temperature drops below 17^{o}C, with almost no eggs surviving at temperatures below 12^{o}C (Morgan and Rasin 1973; Rogers *et al.* 1977). Two other factors, sufficient dissolved oxygen and the presence of a current, may have a combined effect on egg survival. The eggs are generally heavier than water and, in the absence of current, sink to the bottom, where they are more exposed to anoxia, a lack of oxygen (Chittenden 1971; Rawstron *et al.* 1989). The presence of a moderate current creates low turbulence levels, which keep the eggs suspended in the water column during incubation.

The survival of the larvae, like the eggs, also depends on physical variables, including temperature and dissolved oxygen. However, an additional requirement, i.e., a sufficiently abundant food supply, comes into play upon resorption of the yolk sac and the onset of feeding (Chittenden 1971; Rawstron *et al.* 1989). This key period occurs approximately on the eighth day of existence of the larvae, when they measure 6 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). It has been shown that in Chesapeake Bay, where the eggs and larvae are transported from several rivers where striped bass are known to spawn, the density of individuals in the first stages of development varies according to distance from the point of maximum turbidity (North and Houde 2003). Environmental characteristics and vertical migration of larvae in the water column, depending on the tides, enables them to maintain their position in the estuary, in areas where there is an abundance of prey. A zone of maximum turbidity also exists in the St. Lawrence, between Île d'Orléans and Île aux Coudres. This zone contains high densities of zooplankton, including the copepod *Eurytemora affinis*, and is known as a rearing ground for rainbow smelt (*Osmerus mordax*) and other fish species (Sirois and Dodson 2000). The striped bass of the St. Lawrence may also spend the early stages of their development there. After 35 to 50 days in the transformational larval stage, the young reach a length of 20 mm and possess the typical shape of the striped bass which they will maintain into adulthood.

Immature and adult striped bass frequent coastal and estuarine habitats (Bain and Bain 1982). During their first two years, they feed primarily on invertebrates, but gradually become piscivorous, chasing schools of soft-rayed fish, particularly juvenile clupeids (Trent and Hasler 1966; Manooch 1973; Austin 1980; Gardinier and Hoff 1982; Dew 1988). In summer, the movement of striped bass appears to follow that of their preferred prey. Adult bass tolerate and withstand variations in salinity, temperature, pH or turbidity (Talbot 1966; Auld and Schubel 1978; Setzler *et al.* 1980). Canadian striped bass populations typically migrate upstream in the fall and overwinter in fresh and brackish waters to avoid the cold winter ocean waters. The confined presence of striped bass in these overwintering zones may increase the risks of mortality due to environmental accidents or poaching.

The striped bass has a life expectancy of up to 30 years (Secor 2000). The largest known specimen, captured in North Carolina in 1891, weighed 56.8 kg and measured 1.82 m (Raney 1952). The growing conditions in Canadian waters are such that the maximum size of striped bass is less than 1 m. This figure is an estimate because very few individuals survive long enough to reach their maximum size. The largest striped bass caught in the St. Lawrence Estuary measured 91.5 cm (total length) and weighed 10.9 kg. After an examination of its scales, its age was estimated at 19 years (Vladykov 1953).

1.4.2. Ecological Role

Typical of estuarine environments, the striped bass is highly dependent on the quality of the habitats it frequents during its life cycle, particularly the fluvial environments where it spawns. An abundant striped bass population is an indicator that a river and its estuary are in good condition and that the harvest rate is adequate (Bain and Bain 1982).

The striped bass does not build a nest and does not care for its offspring. Females discharge a large quantity of eggs into the water column. A tiny proportion of these eggs survive into adulthood. During the first weeks of their existence, most of the larvae will be preyed upon by various aquatic organisms (e.g., insects, invertebrates, fish) (Smith and Kernehan 1981; McGovern and Olney 1988; Monteleone and Houde 1992; Andreasen 1995). The survival rate of striped bass increases, however, after their first summer (Goodyear 1985).

At the adult stage, the striped bass, together with other fish, birds and mammals, occupies a high trophic level within the estuarine and coastal communities of North America (Hartman and Brandt 1995a). The species is adapted to estuaries, where it is one of the most important piscivorous species and an important component of the biodiversity of the aquatic ecosystem. It is able to withstand rapid variations in temperature, turbidity and salinity in these environments (Bain and Bain 1982). It moves along the coast in compact, same-size schools in search of food, especially at night (Koo et Wilson 1972). Consequently, the reintroduction of striped bass in the St. Lawrence would contribute to the restoration of biodiversity in this ecosystem (Comité aviseur sur la réintroduction du bar rayé 2001).

In an estuary which opens onto both fresh and salt waters, striped bass may compete with other piscivorous species (Hartman and Brandt 1995a, b). This may be the case in the St. Lawrence. According to striped bass fishermen at the wharf in Lotbinière, yellow walleye (*Sander vitreus*) avoid waters in which striped bass hunt in groups (C. Mélançon, undated manuscript). According to active fishermen surveyed during the 1940s, 1950s and 1960s, yellow walleye and sauger *(S. canadense)* were present in the St. Lawrence Estuary but captures of these species were less frequent before the disappearance of the striped bass (Robitaille and Girard 2002). The increase in abundance of yellow walleye may be explained by the fact that this species, and possibly others, have partially occupied the ecological niche vacated by the striped bass. If this is the case, the return of the striped bass may lead to a physical displacement (periodical or permanent) of walleye to other habitats and a subsequent reallocation of resources.

1.4.3. Limiting Factors

The known limiting factors are of particular concern during the early stages of development when fish are sensitive and less mobile. The reproductive strategy of this species is based on a very high rate of fecundity which offsets the high mortality rate during the early developmental stages. The striped bass is a highly fecund fish. Upon reaching sexual maturity at about 4 or 5 years of age, females carry approximately 53,000 eggs, a number which will grow as the fish increases in size, reaching about one and a half million eggs in ten-year-old individuals (Paramore 1998).

The existence and integrity of adequate environments for spawning, incubation and larval development, providing satisfactory water flow, temperature and water quality, are essential for the survival of a striped bass population (Albrecht 1964; Dudley and Black 1978; Kernehan *et al.* 1981; Jessop 1990, 1991; Melvin 1991; Van den Avyle and Maynard 1994). Survival to the end of the larval stage seems to be a key factor in year-class strength (Cooper and Polgar 1981) and thus in adult abundance several years later (Goodyear 1985; Ulanowicz and Polgar 1980). In the structure of the adult population, year classes that were produced in years in which conditions were favourable for spawning often dominate (Polgar 1981; Cooper and Polgar 1981; Goodyear 1985).

The striped bass population of the St. Lawrence Estuary may be exposed to further limiting factors because it lives at the northern limit of the species` range (Robitaille 2004). The harsher climactic conditions which the northern populations of this species must confront may result in a variable mortality according to size (Hurst and Conover 1998). It is estimated that juveniles that reach at least 100 mm in length by the end of their first growing season have a better chance of

surviving the prolonged fast of their first winter under the ice than do smaller individuals (Bernier 1996; Bradford and Chaput 1997).

Another limiting factor relative to the biology of the striped bass of the northern populations is the confinement of individuals during the winter. The concentration of a high proportion of spawners in a restricted area may aggravate the repercussions of an episode of accidental mortality or increase the vulnerability of the fish to poaching. Three-year and older striped bass of the historic population used to migrate to Lake Saint-Pierre in the fall, where they would winter. Many of these individuals were the size of spawners and, consequently, naturalists at that time believed that this congregation of fish was in preparation for spawning activity, though this activity was never directly observed (Montpetit 1897; Vladykov 1947; Vladykov and Brousseau 1957; Cuerrier 1962; Magnin and Beaulieu 1967). It is impossible to foresee whether the striped bass of the new population will gather in Lake Saint-Pierre and the surrounding waters. To date, most of the captures of large striped bass in the Upper Estuary during the cold season have been concentrated in the plume of discharged water from the Gentilly 2 nuclear generating station (see section 1.5 *Threats*). This facility may be somewhat attractive for the species and could affect the winter distribution of adult striped bass. Concentrations of adult striped bass have also been observed in the spring by sports fishermen in the basin of the Rivière du Sud in Montmagny (Pelletier *et al.* 2010; DFO 2010a, b).

Finally, striped bass must have access to abundant food resources during the summer, without which their condition may deteriorate and the incidence of disease increase (Overton *et al.* 2000). They can, however, migrate to other areas to satisfy their needs.

1.5. Threats

According to the COSEWIC status report (Robitaille 2004), Canadian striped bass populations may be threatened by overfishing, modifications to spawning habitat due to changes in water flow, and by pollution. In addition, as mentioned in the preceding section, they may be exposed to further limiting factors because they are at the northern limit of the species` range (Robitaille 2004).

The following evaluation of threats to the survival and recovery of the striped bass combines two main sources: observations of factors which seem to have had a negative effect on the historic population; and phenomena which are presently active in the estuary and which affect fish populations in that environment. At present, the analysis of these two sources and the assessment of the relative importance of the different threats are based on the practical experience and the judgement of the members of the Recovery Team. Over the next five years, new information on the recovering population and the consequences of any new incidents which may occur will be incorporated in the threats classification.

1.5.1. Threats Classification

The Recovery Team has assessed each threat according to six parameters (Table 2):

1. **Extent**: spatial extent of the threat in the species range: widespread or localized.
2. **Occurrence**: current status of the threat: past, current, imminent or anticipated.
3. **Frequency**: the frequency with which the threat occurs in the species range: unique, continuous or recurrent (annual, seasonal or other).
4. **Causal Certainty**: the level of certainty that it is a threat to the species: high, moderate or low.
5. **Severity**: the severity of the threat in the species range: high, moderate or low.
6. **Overall Level of Concern**: the degree of attention and the resources which the Recovery Team believes must be devoted to the threat to mitigate or eliminate it, taking into account the current capability for action: high, moderate or low.

Table 2. Classification of threats to the striped bass population of the St. Lawrence Estuary.

Threats	Extend	Occurrence	Frequency	Causal Certainty	Severity	Overall Level of Concern
Habitat						
Habitat disturbance due to dredging	Localized	Current	Recurrent (seasonal)	High	Moderate	High
Disturbance and destruction of habitat	Widespread	Current	Continuous	Low	Low to Moderate	High
Discharge from the Gentilly 2 nuclear station (thermal attraction and decompression of gases)	Localized	Current	Recurrent (seasonal)	Low	Unknown	Moderate
Contamination	Widespread	Current	Continuous	Moderate	Unknown	Moderate
Obstacles to migration	Localized	Anticipated	Continuous	Low to High	Low to High	Low
Eutrophication	Widespread	Current	Continuous	Low	Unknown	Low
Climate change	Widespread	Current	Continuous	Low	Low	Low
Harvesting of Individuals						
Accidental captures in the recreational fishery	Widespread	Current	Continuous	Moderate	Low	Low
Accidental captures in the commercial fishery	Widespread	Current	Recurrent (seasonal)	High	Low to Moderate	Low
Poaching	Widespread	Imminent	Continuous	Moderate	Low	Low
Biological						
Exotic invasive species	Widespread	Current	Continuous	Low	Unknown	Low
Parasites and pathogens	Widespread	Current	Continuous	Low	Low	Low

1.5.2. Threats Description

1.5.2.1. THREATS TO HABITAT

Fish habitat is comprised of the spawning grounds and nursery, rearing, food supply and migration upon which the survival of the fish depends, directly or indirectly. It includes the physical, chemical and biological attributes of the environment which are essential in the life cycle of the fish. It identifies the freshwater, estuarine and marine environments which, directly or indirectly, support fish stocks which are or could be the object of commercial, subsistence and recreational fisheries. The Recovery Team has identified a number of threats which may have a negative effect on the habitat of the striped bass of the St. Lawrence.

Habitat Disturbance Due to Dredging: Data and observations indicate radical changes in the distribution of immature striped bass before the disappearance of the species, coinciding with dredging and maintenance operations in the Traverse du Nord, the section of the shipping lane adjacent to Île d'Orléans (Robitaille 2001; Robitaille and Girard 2002; G. Labrecque, extirpated population technicians/biologists, pers. comm. 1990). According to project workers and local residents who observed the work being done, the dredged material was deposited in the area immediately surrounding the channel and on the banks of the nearest islands (Robitaille and Girard 2002). In the 1950s, analysis of recaptures of tagged fish by biologists of the Marine Biology Laboratory of the Department of Marine Fisheries (Vladykov 1945; Beaulieu 1962) revealed a change in the distribution of immature individuals aged from 1 to 2 years, previously abundant along the southern section of Île d'Orléans. Beginning in 1957, recaptures of these fish were only recorded along the South Shore, between Saint-Vallier and Rivière-Ouelle (Robitaille 2001). Observations by fishermen at the time corroborate this change in distribution: according to them, striped bass very rapidly became scarce around Île d'Orléans, Île Madame and Île au Ruau. Striped bass could only be caught on the South Shore or around the Montmagny Islands (Robitaille and Girard 2002) (Figure 4).

Changes to the aquatic environment which may have resulted from dredging and the dumping of dredged materials were reported over an extensive area, from Île Madame to the downstream end of Île aux Oies (Robitaille and Girard 2002). In several locations, an accumulation of silt or sand was observed on the river bottom, gradually decreasing water depth (Figure 4). Some of the channels between the islands, used by smaller vessels during low tide (for example, the passage between Île Madame and Île Ruau) were no longer navigable after the widening of the Traverse du Nord (Robitaille and Girard 2002). Over the years, shoals, such as the banks at Île au Ruau, also began to appear at ebb tide (Robitaille and Girard 2002).

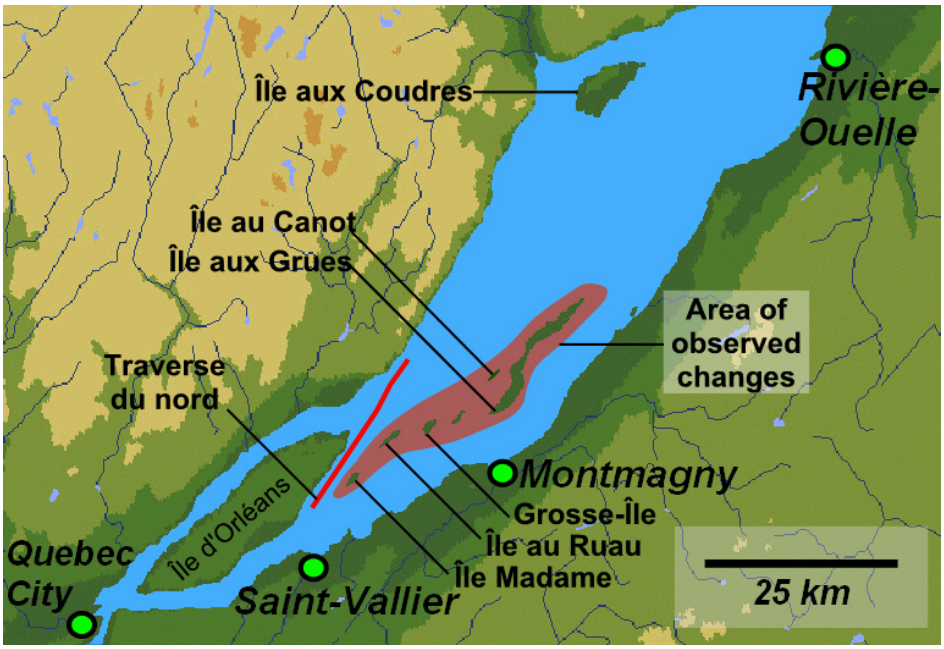


Figure 4. **Map of a section of the St. Lawrence Estuary where, according to local fishermen, the accumulation of sand may have reduced water depth between Île Madame and Île aux Grues (in pink).**
Adapted from Robitaille and Girard (2002).

Maintenance work on the shipping lane is still required on an annual basis in order to remove the sand which accumulates there. Several locations within the striped bass range must be dredged, particularly in Lake Saint-Pierre, near Bécancour, and at the Traverse du Nord. However, dredging practices have changed in recent decades; dredged material is now deposited in designated areas, chosen according to their dispersion capacity. The maintenance of the shipping lane continues, nevertheless, to have an impact on aquatic wildlife. Studies have revealed the negative effects which the dumping of dredged material has on benthic fauna and on the feeding grounds of Atlantic sturgeon (*Acipenser oxyrinchus*) and lake sturgeon (*A. fulvescens*) (Hatin *et al.* 2007; Nellis *et al.* 2007; McQuinn and Nellis 2007). In the estuary, the shipping lane is the largest area which is regularly dredged. This activity may increase in the coming years with the increase in marine traffic, the presence of increasingly larger vessels and decreasing water levels due to climate change. In addition, a great number of sites (docks, marinas, access channels) also require periodical dredging.

Consequently, the Recovery Team believes that this threat warrants a high level of concern and that additional research is necessary on the effects that dredging has on the striped bass.

Disturbance and Destruction of Habitat: The loss and destruction of habitats (bank-hardening, construction of walls, roads and docks, flood-plain and swamp infilling) may significantly modify the habitat of aquatic species. Practices such as these are still common and may be detrimental to the recovery of the striped bass in the St. Lawrence Estuary, particularly in Anse Sainte-Anne at La Pocatière, identified as critical habitat.

In 2004, an inventory was conducted of several sites[3] where juvenile striped bass had been captured before the disappearance of the species and this revealed that some of these sites had undergone major changes. The most remarkable seems to be the fishing zone in Saint-Grégoire de Montmorency, where striped bass of all sizes had once been caught (A. Michaud, extirpated population technician/biologist, pers. comm.1990). This area is just downstream of what was once the Maizerets Flats and the Bay of Beauport, an important wetland adjacent to Quebec City. Between 1945 and 2008, in the area between the Saint-Charles River and the Île d`Orléans bridge, an estimated 360 ha of aquatic and riparian habitat was lost due to backfilling for the port of Quebec City and the construction of a highway in the 1970s (Robitaille *et al.* 1988). A major portion of one location where striped bass were caught in abundance disappeared beneath the highway (Robitaille 2005) and one section of the wetland is now cut off from the river by an embankment and the flow of water, regulated by the tides, must pass through concrete culverts.

Not all the encroachment on the riparian environment is so extensive, but the Recovery Team deems that the cumulative loss of these important habitats for juvenile development may reduce the estuary`s carrying capacity for the reintroduced striped bass population and the entire aquatic community, warranting a high level of concern.

Discharge from the Gentilly 2 Nuclear Station (thermal attraction and decompression of gases): The Gentilly nuclear station (located near Trois-Rivières), which has been operating since 1983 on the south shore of the upper estuary, discharges hot water which attracts several fish species during the cold season. Reintroduced adult striped bass were regularly captured in this area between 2006 and 2009, during the fall, winter and spring (Hydro-Québec Production 2007; Alliance Environnement inc. 2008). In comparison, in 2009, no winter captures of the species were reported in the fishing zones around the power station, in places such as the dock in Bécancour, in Sainte-Angèle-de-Laval or in Lake Saint-Pierre and its archipelago, where the recreational fishery was monitored from January to March. It is impossible to determine with certainty whether the striped bass are spawning in the plume of warmer water and, consequently, whether the eggs and larvae are being transported to the colder neighbouring waters where they are exposed to a thermal shock (Donaldson *et al.* 2008). However, among the specimens captured in this area in March, females were present that required only a slight pressure on the abdomen to discharge their eggs. At this stage, females are ready to spawn and the eggs survive in the environment only briefly (DFO 2010a, b). The thermal attraction created by the discharged water from the power station may thus have important consequences if a high proportion of spawners from the reintroduced striped bass population frequent this area, though this is not yet confirmed by the available data (DFO 2010a, b).

Furthermore, the discharged water from the power station is saturated with gas, which produces symptoms of gas disease in some fish species (Mikaélian 1999; Lair 2006, 2007). In the subcutaneous tissue of channel catfish (*Ictalurus punctatus*), gas bubbles which lead to inflammation and possible infection have been observed (Lair 2006). It is impossible to gauge, from the available data, the significance and the scope of this phenomenon outside the channel of

[3] In the St. Lawrence Estuary, specimens of juvenile striped bass captured in fixed gear between 1946 and 1962, from Neuville and Rivière Ouelle, were preserved (Robitaille 2005).

discharged water. Striped bass captured in this area have presented no signs of gas disease (Aecom Tecsult inc. 2009).

It is presently impossible to determine whether a significant percentage of adult striped bass frequents this area during the winter months, but it will be important to study how the striped bass use this area. Studies are presently under way. In light of the uncertainty as to a possible impact on the survival and recovery of the striped bass, the Recovery Team, as a precautionary measure, has judged the level of concern of this threat as moderate.

Contamination: Many industrial, municipal and agricultural contaminants from the entire St. Lawrence Basin and the Great Lakes reach the estuary. They are able to accumulate in the food chain and, through bio-amplification, reach high levels in the flesh of organisms at the top of the food chain, including striped bass. Some of the effects of these contaminants, either direct or synergetic, have been observed in aquatic organisms. Among the substances considered to be contaminants, the focus initially was on those that produce primary toxic effects (Korn and Earnest 1974; Hall 1991). However, it has since been shown that the introduction into aquatic environments of several families of synthetic compounds (e.g., antioxidants, detergents, organometallics, steroids, organochlorines, organo-nitrates) can cause hormonal disruptions in aquatic organisms, leading to such things as femininization and inhibition of gamete production (Aravindakshan *et al.* 2004).

Bioassays of mercury in the scales of specimens from the historic population revealed that the exposure of striped bass to this metal reached a peak in the mid-1940s, decreased during the following decade and then increased again during the 1960s (Desjardins *et al.* 2003, 2006). However, there exists no information to suggest that the level of mercury in the historic and the new populations could affect the viability of the species. As for the other contaminants likely to affect the striped bass, information is either incomplete or unavailable.

The Recovery Team is unable to assess the gravity of the threat which contaminants pose for the new population of striped bass but, as a precautionary measure, considers the level of concern to be moderate.

Obstacles to Migration: Obstacles to the free movement of striped bass may: 1) fragment the habitats used by the fish over the course of a year; and 2) isolate populations from one another. Before the disappearance of the species, 1+ year-old striped bass often traveled along the coast in schools searching for food during the summer (Beaulieu 1962; Robitaille 2001). In October, mature striped bass from the St. Lawrence began a migration towards the Upper Estuary and Lake Saint-Pierre, in preparation for spawning (Montpetit 1897; Vladykov 1947; Vladykov and Brousseau 1957; Magnin and Beaulieu 1967; Robitaille 2001). Construction projects or the introduction of obstacles along these routes may affect the migration of the new population. The effects that the obstacles may have can vary depending on the nature of the construction projects and their location relative to the migration route of the striped bass.

The Recovery Team considers the level of concern of this threat to be low because there presently exist no major obstacles to the movement of striped bass within their distribution range.

Eutrophication: Domestic sewage systems and the spread of manure and fertilizers on agricultural land contribute to the eutrophication of aquatic environments. This can disrupt local biological communities through the spread of stringy algae and of cyanobacteria, habitat degradation (e.g., the spawning grounds of rainbow smelt), the prevalence of tolerant species, incidences of anoxia, and other phenomena. Eutrophication may alter aquatic habitats in the tributaries which drain agricultural lands and in the alluvial fans where they empty into the river.

Besides the degradation of local habitat and an indirect effect stemming from a decrease in the abundance of certain prey species, according to the Recovery Team this factor does not appear to constitute a serious threat to the recovery of the striped bass in its entire distribution area. It has thus been given a low level of concern.

Climate Change: In the medium and long term, the St. Lawrence Estuary may undergo many changes brought on by climate warming: decreases in freshwater flows, a rise in sea level, advance of the saline front, lengthening of the growth season, changes in the biological community of the estuary, etc. An increase of 0.7 ºC in air temperature during the last century has been recorded (Environment Canada 2001, Lemmen and Warren 2004, Environment Canada 1999). According to the different climate forecast models for 2050, average air temperature during the summer may rise by 2 to 4 ºC in Quebec (Bourque and Simonet 2007). In the long term, these changes may affect the aquatic habitats in the estuary and, consequently, the striped bass.

The Recovery Team considers it unlikely that, based on inter-annual variations in weather conditions, there will be negative impacts on striped bass due to climate change. The level of concern for this threat is thus low. If necessary, the situation will be reviewed and considered in the future action plan.

1.5.2.2. THREATS DUE TO THE HARVESTING OF INDIVIDUALS

The historic striped bass population was subjected to intense commercial and recreational fishing, and poaching, right up to the time of its disappearance (Caron 1877; Montpetit 1897; Beaulieu 1985; J. Brousseau, A. Michaud, G. Labrecque, extirpated population technicians/biologists, pers. comm. 1990; Robitaille and Girard 2002). At that time, the number of catches was not regulated and size limits, introduced near the end, were not generally respected (A. Michaud, extirpated population technician/biologist, pers. comm. 1990). The use of fixed fishing gear, extensive throughout the estuary, resulted in abundant captures of juveniles that would die at low tide (G. Labrecque, extirpated population technician/biologist, pers. comm. 1990). Mortality due to fishing, already high, increased after habitat modifications reduced the range of immature striped bass (Robitaille 2001).

Today, the management of fisheries resource exploitation is much more structured. In 2005, sports fishing for striped bass was prohibited in the St. Lawrence downstream of the Quebec City bridge and the prohibition was extended to cover all of Quebec in 2007. Furthermore, the directed commercial fishery of striped bass is no longer sanctioned. However, there is still a by-catch of striped bass by commercial and sports fishermen. Under the *Quebec Fishery*

Regulations of the *Fisheries Act*, striped bass must be immediately released when caught, in the area where they are caught and with due precaution not to injure the fish if it is still alive.

In order to assess and monitor the impact of the fisheries, a network to monitor accidental captures of striped bass has been created. This network is composed mainly of commercial fishermen who have been issued a permit for the capture of wildlife for scientific, educational and wildlife management purposes (SEG) [4]. They are authorized to keep striped bass that are accidentally captured, in order to give them to the biologists of the ministère des Ressources naturelles et de la Faune du Québec (MRNF) for analysis. Since 2009, any live striped bass over 20 cm long that are captured must be released. In addition to the information gathered by this network, there are observations of caught and released striped bass which sports fishermen report to the Centre de données sur le patrimoine naturel du Québec (CDPNQ[5]). In 2005, the Fédération québécoise des chasseurs et pêcheurs (FédéCP), in collaboration with the MRNF, conducted a widespread awareness campaign to inform commercial and sports fishermen about the reintroduction of striped bass, the mandatory catch and release regulation, and the importance of reporting captures to the CDPNQ. Between 2003 and 2009, 507 striped bass were brought to MRNF biologists for analysis and 163 observations were recorded. These data made it possible to compile the first biological status report on the reintroduced population (Pelletier 2009) and to better identify habitat use (Pelletier *et al*. 2010).

In 2009, the DFO conducted an analysis of the possible impact of accidental captures in the commercial and recreational fisheries on the survival and recovery of the striped bass population of the St. Lawrence Estuary (DFO 2009). The analysis concluded that: "*overall, freshwater and marine environment fisheries as they are currently carried out, are not very likely to have an impact on survival and recovery of the striped bass population in the St. Lawrence Estuary*". The Recovery Team has thus determined that the level of concern for this threat is low in all three areas: commercial fishery, recreational fishery and poaching.

Accidental Captures in the Recreational Fishery: Sports fishermen in the estuary may accidentally catch striped bass but they are obliged to release them immediately. Analysis of the impact of the fisheries has concluded that the mandatory release of captured fish, together with the awareness campaign carried out, makes it unlikely that recreational fishing will harm the survival and recovery of the striped bass (DFO 2009).

Accidental Captures in the Commercial Fishery: The risk of accidental capture of striped bass in commercial fishing gear varies according to location and season. The greatest risk for the new population, as it was for the historic population, comes from fixed gear designed to trap American eels (*Anguilla rostrata*) in the Middle Estuary. Since being reintroduced, some striped bass have been caught in fixed nets set for American shad (*Alosa sapidissima*) and in fyke nets, but these captures are negligible according to the commercial fishery monitoring reports (DFO 2009).

[4] A special permit issued by the MRNF for the capture of animals for scientific, educational or wildlife management purposes (SEG permit).

[5] http://www.cdpnq.gouv.qc.ca/index-en.htm

The number of eel traps in the St. Lawrence Estuary has declined dramatically since the 1950s. Presently, most of them are set in the Middle Estuary in September. In 2009, the number of authorized traps in the river and in the estuary saw a 73% drop, from 190 to 51 traps (about 35 are set each year). There are now only 21 commercial eel fishermen operating within the distribution range of the striped bass between Saint-Romuald and Rimouski (one fisherman near Quebec City and 20 others between Île d'Orléans and the mouth of the Saguenay River on the North Shore and Rimouski on the South Shore). As mentioned in the analysis of the impact of accidental catches (DFO 2009: "*the sector where juvenile striped bass were very vulnerable prior to their disappearance is no longer a sector where the fishing effort is significant*".

Analysis of the impact of the fisheries has concluded that all the freshwater and marine commercial fisheries have no or almost no impact on the survival and recovery of the striped bass except for the fyke nets and eel traps whose impact was deemed low and moderate respectively (DFO 2009). Should an increase in by-catches present a problem, measures may be implemented to redress the situation (e.g., closure of selected fishing zones).

Poaching: This activity is much harder to evaluate because of the lack of reliable data. According to the available information, there is no indication of an illegal fishery specifically targeting striped bass since its reintroduction.

1.5.2.3. BIOLOGICAL THREATS

Exotic Invasive Species: Several exotic species have established themselves in the St. Lawrence River and Estuary. Exotic species can alter ecosystems and their ecological functions and may represent a threat to the striped bass (e.g., competition for habitat and food resources, restructuring of the food chain, predation).

The introduction of non-native organisms seems to have begun in the 19th century and has accelerated dramatically during the last decades. It is estimated that at least 185 exotic species have colonized the Great Lakes Basin since 1980, 88 of which have moved into the St. Lawrence River (Ricciardi 2006; NCRAIS 2009; De Lafontaine, Environment Canada, pers. comm. 2009). Several fish species have been introduced including the tench (*Tinca tinca*) and the round goby (*Neogobius melanostomus*). The latter has rapidly become quite abundant in several sections of the St. Lawrence, including the area once used by the striped bass.

The impact of invasive species on the new striped bass population has not yet been determined and is not currently known. The Recovery Team consequently considers this threat as a low level of concern because no major impact on the striped bass population is foreseen.

Parasites and Pathogens: Necropsies performed on striped bass of the historic population revealed that several specimens had unidentified parasitic worms in their digestive tracts and abdominal cavities (J. Brousseau, laboratory notes). One of these worms may be the *Philometra sp*. (Séguin *et al.* 2007), a parasite which was also found in wild striped bass transferred from the Miramichi River to the St. Lawrence in 2005. In the southern Gulf of St. Lawrence, striped bass are often carriers of the *Philometra sp.* nematode and their general condition does not appear to be affected (S. Douglas, DFO, pers. comm. 2005).

The new population of striped bass will likely be host to a number of parasites, as are other fish species in the St. Lawrence, and may be exposed to certain pathogens, such as viral hemorrhagic septicemia (VHS) which is present in the Great Lakes Basin and in the Maritimes. VHS was first identified in 2005 and 2006 in the Great Lakes and is associated with mass mortalities in numerous fish species in the area. To date, no case of VHS has been detected in Quebec (C. Brisson-Bonenfant, MRNF, pers. comm. 2009). Several analyses were conducted prior to the implementation of the action plan for the reintroduction of striped bass from the Miramichi River. They showed that the risk of introducing new parasites or pathogens in the St. Lawrence was low (Robitaille 2000). After striped bass infected with VHS were discovered in the Miramichi River, captures of fish from that river ceased as part of the reintroduction program. Additional analyses at the hatchery confirmed that the individuals kept for reproduction in captivity were not carriers of VHS.

Parasites and pathogens do not presently appear to constitute a threat to the survival and recovery of the population, the Recovery Team considers this a low level of concern. It is however important to take the necessary precautions to ensure that the stocking of striped bass does not introduce new parasites and pathogens in the St. Lawrence.

1.6. Actions Already Completed or Under Way

The Comité aviseur sur la réintroduction du bar rayé (2001), composed of striped bass and fisheries specialists, released a statement supporting the introduction of this species in the St. Lawrence (Appendix 2). An agreement was signed between DFO - Gulf Region, and the MRNF to allow the sampling of up to 2,000 juvenile striped bass each year in the Miramichi River in New Brunswick. Representatives from the recreational and commercial fisheries and from aboriginal communities were then consulted to obtain their approval for the reintroduction project.

In 1999, and from 2002 to 2006, juvenile striped bass were captured in the Miramichi River and transported to the Baldwin-Coaticook hatchery in Quebec in order to develop and serve in artificial reproduction. The survival rate of the transferred striped bass in hatcheries proved to be greater than anticipated. Beginning in 2002, the St. Lawrence River was stocked with surplus fish from this program (Table 3), usually as part of a media event advertising the reintroduction of striped bass. As previously mentioned, between 2002 and 2009 more than 6,300 striped bass, over 60 mm long (age 0+ to 6+), and almost 6.5 million larvae, 2 to 4 mm long, were released into the St. Lawrence between Saint-Pierre-les-Becquets and Rivière-Ouelle. The stocking of striped bass produced in hatcheries began in 2006; these were initially surplus larvae that could not develop in hatchery environments because the necessary installations were not yet available. The Baldwin-Coaticook hatchery was renovated to permit the production of this species and, after a few years of trials and readjustments, is very close to success in producing fry, the preferred stage for stocking. The goal of the reintroduction program is to stock 50,000 autumn fry yearly with the objective of reaching a population capable of self-reproduction (Comité aviseur sur la réintroduction du bar rayé 2001). Methods of tagging larvae (chemical tagging), juveniles and adults (microchips) will provide the means to identify which of the striped bass captured in the St. Lawrence were stocked and which are of natural origin and to track abundance levels over time.

Table 3. Number of striped bass stocked in the St. Lawrence, by age group and length

Age (length)	Year								Total
	2002	2003	2004	2005	2006	2007	2008	2009	
0 (2-4 mm)					1,035,000	3,240,000		2,200,000	**6,475,000**
0 (+ 60 mm)	1,050	1,062	0	516	0	0	0	0	**2,628**
1	0	6	0	0	0	725	0	132	**863**
2	0	0	493	199	0	600	769	0	**2,061**
3	11	0	0	112	139	0	94	256	**612**
4					141				**141**
6				16					**16**
Total	**1,061**	**1,068**	**493**	**843**	**1,035,280**	**3,241,325**	**863**	**2,200,388**	**6,481,321**

In 2005, fishing of this species was prohibited downstream of the Quebec City bridge and the prohibition was extended to cover all of Quebec in 2007. In 2005, the FédéCP and the MRNF launched an awareness program informing sports fishermen how to identify the species and advising them to release all catches immediately and report captures to the Centre de données du patrimoine naturel du Québec (CDPNQ). Hundreds of notices were posted around docks, marinas and boat ramps, all along the river and the estuary.

In 2004, a network to monitor accidental catches of striped bass in commercial fishing gear was established, supplemented by observations reported to the CDPNQ (Bourget *et al*. 2008). Various biological and morphometric parameters of striped bass conserved at the MRNF are being analyzed in laboratories. The data gathered by this network have confirmed that the reintroduced striped bass are developing well in the St. Lawrence and are occupying a distribution range similar to that of the historic population. In 2008, this data helped show that natural spawning had occurred in the estuary because 38 striped bass individuals born that year (age 0+) were captured, and no stocking had occurred for this age group that year (Pelletier 2009). A report on the biology of the new striped bass population was produced (Pelletier 2009) and new information became available on habitat use (Pelletier *et al.* 2010). In addition, necropsies ensured regular monitoring of diseases and parasites (Guy Verreault, MRNF, pers. comm. 2010).

The results of analyses of the data and specimen collections of the extirpated population will also be used to facilitate the reintroduction of the striped bass. These data were used to document the biology and exploitation of the extirpated population (Robitaille 2001), the food sources of juveniles (Robitaille 2005), and the population`s exposure to mercury contamination (Desjardins *et al.* 2003, 2006).

1.7. Knowledge Gaps

When the striped bass population of the St. Lawrence Estuary disappeared at the end of the 1960s, it had been the object of scant research, focused primarily on its movements (Beaulieu 1962), its feeding habits (Brousseau 1955) and its development (Magnin and Beaulieu 1967). Further analyses were made possible through the additional collection of data and specimens (Robitaille 2001, 2005, 2010; Desjardins *et al.* 2003, 2006). It is not possible at the present time

to determine to what extent the biological descriptors of the historic population may apply to the reintroduced population. Regular monitoring of the latter is first required.

Recovery activities are difficult to plan due to the lack of information on present day spawning grounds, the reproductive process, and the early stages of development. It will be necessary to locate the various habitats used during the different stages in the life cycle, particularly the habitats vital for spawning and larval development. This will make it possible to ensure the protection of these habitats and to accumulate measurements on abundance and survival during these critical stages. It will also enable the identification of the environmental parameters which influence the vitality of cohorts of the new striped bass population.

It is equally important to offer a description of the interspecific relationships of striped bass with other aquatic organisms, particularly prey, predator and competing fish species. A better understanding of this network of interactions will provide valuable indicators of the health of the striped bass population and of the species it interacts with. This will ensure that the recovery of the striped bass will not be achieved at the cost of other species endemic to the estuary. Finally, special attention should be paid to the threats listed above (see Section 1.5), particularly the ones of greatest concern, in order to formulate precise assessments of the risks they present and, if need be, to develop the appropriate mitigation measures.

2. RECOVERY

2.1. Recovery Feasibility

The recovery of the striped bass population of the St. Lawrence Estuary is deemed feasible because it meets the four following conditions:

1. Availability of Individuals with Reproductive Capability:

Stocking of striped bass in the St. Lawrence begun in 2002 and six years later mature individuals with spawning capability were once again present in the system. Thanks to the monitoring network, juveniles aged 0+ were captured in 2008 though no stocking had occurred for that age group that year. This confirms the presence of a spawning population of striped bass in the St. Lawrence. Further stocking over the next few years, combined with natural reproduction, should augment their number. At the present time, it is impossible to determine if the number of stocked individuals is sufficient to ensure recovery of the population and continued stocking is thus recommended.

2. Availability of Adequate Habitat to Support the Species:

The fact that striped bass have been captured in several areas along the St. Lawrence River and Estuary suggests that the recovering population occupies a range comparable to that of the historic population. Biological data collected to date indicates that the growth conditions for striped bass of the new population are good (Pelletier 2009). Furthermore, as previously mentioned, naturally-spawned juveniles have been captured. This is an indication that there exist adequate habitats for spawning, incubation and larval development, though these habitats have not yet been located or quantified.

3. Elimination or Mitigation of Threats:

Several threats to the recovery of the striped bass have been identified in the present recovery strategy. Some of these threats, however, can be eliminated or mitigated. For example:

Accidental captures: The striped bass fishery is presently closed and accidental captures must be immediately released. In 2005, an awareness campaign was carried out among sports fishermen to inform them about the mandatory release of striped bass by-catches and to encourage them to report these catches to the CDPNQ. Several commercial fishermen are also involved in monitoring the striped bass population and have been issued SEG permits which authorize them, within strict guidelines, to keep accidental captures and deliver them to the MRNF.

Habitat disturbance due to dredging: Dredging practices have evolved since the time when the striped bass population disappeared and are now designed to limit impacts on the ecosystem. During the 1970s, designated deep-water sites were used to dump dredged material. In 2009, the Coast Guard stopped using the dump site just south of Île Madame (adjacent to the historic feeding grounds of immature striped bass). This site should be closed to all users as of 2011.

Disturbance and destruction of habitat: The 1960s and 70s saw the destruction of extensive areas of fish habitat. Today, all development projects likely to cause habitat disturbance or destruction must receive authorization from the DFO, under the *Fisheries Act*, the ministère du Développement durable, de l'Environnement et des Parcs (MDDEP), under the *Environment Quality Act*, or the ministère des Ressources naturelles et de la Faune (MRNF), under the *Act Respecting the Conservation and Development of Wildlife*.

4. Availability of Efficient Recovery Techniques and Measures:

In the United States, the striped bass has been the subject of a great many articles in scientific and technical journals. Numerous recovery techniques and measures are available and have been proven to work in different fields. The measures implemented to date for the St. Lawrence population include production in captivity, stocking and the mandatory release of accidental catches.

To reintroduce striped bass in the St. Lawrence, the goal of the initial program was to stock 50,000 fry each year (Comité aviseur sur la réintroduction du bar rayé 2001), which was to begin in the next few years. However, due to the high survival rate of striped bass kept in captivity at the Baldwin-Coaticook fish hatchery, stocking of surplus individuals began earlier than expected and some of these have begun to spawn in the St. Lawrence. It would appear that the development of a new population has already started.

The striped bass of the historic St. Lawrence population, subjected to overfishing at the pre-spawning stage, was never adequately protected, unlike some of the American populations. The large migratory populations of the east coast (Hudson River, Roanoke River, Chesapeake Bay) remained at very low levels of abundance for over twenty years (1970s and 80s) and this decline in population could not be explained. When a federal law was passed prohibiting all fishing of striped bass in the states along the Atlantic coast, populations recovered in less than five years (Field 1997). When conditions are right, the establishment or recovery of a striped bass population may be achieved rapidly. This may also prove to be the case for the new population of striped bass in the St. Lawrence, given that all fishing has been prohibited.

2.2. Recovery Goal

The goal of the recovery strategy is to restore, over the next ten years, a striped bass population capable of reproducing and sustaining itself in the St. Lawrence Estuary and of integrating itself into the biological community without disturbance.

2.3. Population and Distribution Objectives

Population: It is presently impossible to establish a quantitative population objective. There are no estimates of historic population numbers to serve as guidelines for the recovering population. The qualitative population objective is the recovery of a self-sustaining, viable population.

Range: From the fisheries data on the historic population and analyses of mark-recapture data, it is possible to make a provisional identification of the range that the new population may cover.

At the present moment, striped bass seem to occupy the same distribution zone, but it is impossible to determine the precise area. It is, however, important to note that the habitats frequented by juvenile striped bass, before the disappearance of the species, have been severely reduced since the 1960s, especially around Quebec City and the along the North Shore. This could alter the new population`s range. This habitat loss may also have reduced the carrying capacity of foreshore habitat for juveniles, which may impact the entire population in unforeseeable ways. Changes have also occurred in the biological community of the estuary. Native species such as rainbow smelt and Atlantic tomcod (*Microgadus tomcod*) have undergone decreases in abundance while other species, such as yellow walleye, have increased in numbers. Some exotic species, such as the round goby, have moved into the area. It is impossible to determine whether the area`s carrying capacity in terms of predator fish, and the striped bass in particular, has been altered. Taking into account these changes and the existing knowledge gaps, the distribution range objective can only be described qualitatively: it should include all adequate habitat.

Data gathered by the monitoring network will help fill the knowledge gaps and will serve to define quantitative population and distribution objectives

2.4. Recovery Objectives

The following list of objectives takes into account the fact that several of the stages outlined in the working document of the Comité aviseur sur la réintroduction du bar rayé have been completed (see Section 1.6 Measures Completed or Underway). The objectives described below are designed to contribute towards the same goal without, however, repeating work already done.

2.4.1. Increase the Number of Striped Bass

The first objective is to increase the present number of striped bass in the St. Lawrence by stocking 50,000 autumn fry each year, the same number put forward in the MRNF action plan for the reintroduction of striped bass (Comité aviseur sur la réintroduction du bar rayé 2001). In order to officially begin the reintroduction program, the survival of fry in hatcheries needs to improve because presently the survival rate of larvae is excellent, but the present rate of mortality before reaching the fry stage is too high to produce the 50,000 fry proposed in the MRNF plan. Until now, the stocked specimens have been the surplus individuals bred in the hatcheries (considered surplus based on the requirements of spawning stock and the space available for the development of larvae).

Initial data on the new population, particularly concerning development and the start of natural reproduction, suggest that the recovery of the striped bass has already begun. However, the species is noted for its irregular recruitment, which is dependent on a variety of conditions in the habitats where early development occurs. It is thus vital to continue the stocking initiative for several more years.

2.4.2. Identify Habitats Used by the Striped Bass Population

The objective here is to fill critical gaps in our knowledge of the new, as well as the historic, populations. More data is required on the areas where spawning, incubation and larval

development occur. Also required is a more precise determination of the present boundaries of some other habitats, the approximate limits of which have been deduced from data on the historic population (e.g., spawning, incubation and larval development grounds, summer feeding grounds, migration routes, and overwintering grounds).

More information is required on the habitats used by striped bass during the different stages in the life cycle and during the different seasons to ensure the protection of the population. This will also enable researchers to design sampling strategies to identify the parameters of population dynamics.

2.4.3. Monitor the Status of the Striped Bass Population

This objective is to monitor the status of the population by identifying the biological and dynamic characteristics of the recovering striped bass population, the natural production and survival of new individuals and the total range being used.

These data, collected on a regular basis, will provide a comprehensive overview of the striped bass population (e.g., fecundity, survival in the different stages, and factors which most influence population dynamics) and will be used to determine quantitative population and distribution objectives. They will also make it possible to conduct regular evaluations of the stocking protocol in order to avoid disrupting the natural reproduction of the striped bass.

2.4.4. Monitor the Status of Certain Components of the Ichthyological Community (Prey, Predators, Competitors) in Relationship to the Striped Bass

The recovery of the striped bass may provoke changes within the biological community of the estuary. The fourth objective is to acquire biological data on the fish in the estuary that interact with striped bass: prey, predators and competitors. In order to make the proper adjustments to the reintroduction program, it is necessary to develop indicators to identify which changes within the biological community are caused by the reintroduction of striped bass.

2.4.5. Protect the Striped Bass Population and its Most Important Habitats

This objective is directly connected to the second objective. Once the habitats used by the striped bass have been located, it will be possible to determine which are the most vital (in terms of their function and the proportion of the population located there during certain periods of the year) and consequently implement the appropriate protective measures. Habitats necessary to the survival or recovery of the striped bass may be designated critical habitat under the SARA.

2.5. Approaches Recommended to Meet Recovery Objectives

The measures required to reach these objectives are presented in Table 4, together with their levels of priority, the strategies they represent and, where appropriate, the threats they address.

The level of priority distinguishes between measures considered **essential, necessary** or **desirable** in order to reach the objectives. The "Strategy" column identifies which of the following five categories of actions the measures fall under:

1. Inventory and monitoring
2. Acquisition of knowledge
3. Artificial production and stocking
4. Protection, restoration and stewardship
5. Outreach

Table 4. Recovery planning, striped bass population of the St. Lawrence Estuary.

Objective	Recommended Measures	Priority	Strategy	Threat Addressed
Increase the number of striped bass.	Implement the production plan proposed by the Comité aviseur sur la réintroduction du bar rayé (2001) in order to stock 50,000 fry each year. The production of striped bass must be based on a reproduction plan which optimizes the genetic diversity of stocked fish as much as reproduction in captivity can allow. All specimens should be marked so that, in the course of the monitoring program, individuals spawned in hatcheries can be distinguished from those spawned in the wild. The number of striped bass being stocked may be reduced if monitoring of the wild striped bass population and its prey indicates that stocking is disrupting the natural reproduction of the striped bass or is significantly impacting prey populations.	Essential	1, 3	
Identify habitats used by the striped bass population.	Study, locate and characterize the areas where early development occurs: spawning, incubation, larval and juvenile development.	Essential	1, 2	Habitat
	Conduct further research on the most important threats to striped bass habitat.	Essential	1, 2	Habitat
	Study, locate and characterize other habitats used by the striped bass: migration routes, overwintering grounds.	Necessary	1, 2	Habitat
	Develop geomatics software to make habitat data available to consultants, developers, project analysts, etc.	Desirable	4, 5	Habitat
Monitor the status of the striped bass population.	Maintain and standardize the monitoring of captures in commercial fishing gear.	Essential	1	Harvesting
	Extend the geographical range of the monitoring program through experimental fisheries in the entire distribution range.	Essential	1, 2	
	Develop an indicator of population status with respect to the estuary`s carrying capacity.	Essential	1, 2	
	Develop a means of assessing autumn fry abundance as a recruitment indicator.	Necessary	1, 2	
	Monitor the natural deposit of eggs in spawning grounds, incubation and the survival of wild individuals during the summer and autumn.	Desirable	1, 2	
	Facilitate the recording of accidental captures of striped bass.	Desirable	1, 2	Harvesting

Table 4 (cont.). Recovery planning, striped bass population of the St. Lawrence Estuary.

Objective	Recommended measure	Priority	Strategy	Threat Addressed
Monitor the status of certain components of the ichthyological community (prey, predators, competitors) in relationship with the striped.	Monitor these fish species in the area frequented by striped bass during the growth season and beyond.	Necessary	1, 2	Biological
	Develop indicators to identify changes that may be caused by the presence of striped bass.	Necessary	2	Biological
	Gather and analyse data on the feeding requirement of species that may compete with striped bass.	Desirable	1, 2	Biological
Protect the striped bass population and its most important habitats.	Promote the implementation of protective measures for striped bass and their habitats.	Essential	4	Habitat; harvesting
	Ensure that, where need be, environmental assessments take into account possible impacts on striped bass and their habitats.	Essential	4	Habitat
	Inform sports and commercial fishermen of the measures aimed at protecting striped bass and their habitats.	Necessary	4, 5	Harvesting
	Inform interested organizations about the aquatic environment and the general public about the measures aimed at protecting striped bass and their habitats.	Desirable	4, 5	Habitat; harvesting
	Assess the relevance of undertaking habitat restoration projects.	Desirable	4	Habitat

2.6. Measuring Progress

To be able to evaluate the implementation and progress of the recovery strategy, a list of performance indicators for each objective is presented in Table 5. These performance indicators will help determine whether the recovery methods are having a positive impact on the species. They will also assist in evaluating whether or not the recovery objectives are being met and assessing the level of progress being made.

Table 5. Performance indicators for the recovery strategy objectives.

Objective	Performance Indicators
1. Increase the number of striped bass.	- Increase in the number of striped bass in the St. Lawrence River and Estuary and in conjunction with stocking initiatives: ✓ Development of a reproduction plan to optimize the genetic diversity of stocked striped bass. ✓ Chemical tagging of larvae: assess efficiency of tagging. ✓ Marking (fry to adults): assess the efficiency of marking, associated mortality, percentage of losses. ✓ Estimation of survival of striped bass produced artificially, according to developmental stage at time of stocking. ✓ Determine the proportion of the increase in numbers attributable to stocking of fry**.**
2. Identify habitats used by striped bass.	- Delineation and characterization: ✓ of spawning, incubation and larval development habitats; ✓ of juvenile habitats; ✓ of habitats of striped bass one year and older; ✓ of migration routes; ✓ of overwintering habitats. - Identification of main threats to habitat. - Development of geomatics software.
3. Monitor the status of the striped bass population.	- Development of an abundance indicator for autumn fry, distinguishing between artificial and natural origins. - Maintenance of a monitoring network for captures of striped bass in commercial fixed fishing gear in the St. Lawrence Estuary and standardization of protocol. - Facilitated recording of striped bass (CDPNQ). - Availability of database on the biological characteristics and the abundance of striped bass one year and older. - Development of an indicator of the condition of the striped bass population.
4. Monitor the status of certain components of the ichthyological community (prey, predators, competitors) in relationship with the striped bass.	- Availability of database on the biological characteristics and the abundance of fish species which may be prey, predators or competitors of the striped bass, particularly the vulnerable species. - Development of a useful indicator of the condition of their populations and of the changes in abundance which may be attributable to the presence of striped bass.
5. Protect the striped bass population and its most important habitats.	- No record of losses or additional degradation of important habitat for the striped bass, with recourse, if necessary, to: ✓ the provisions of the various federal laws, including SARA, the *Fisheries Act*, the *Canadian Environmental Assessment Act* and Quebec law, including the *Act Respecting the Conservation and Development of Wildlife* and the *Environment Quality Act*; ✓ Quebec fishing regulations; ✓ the support of organizations with an interest in aquatic environments and of the general public; ✓ outreach to organizations involved in environmental assessments in aquatic environments.

2.7. Critical Habitat

2.7.1. General Identification of the Striped Bass, St. Lawrence population Critical Habitat

Critical habitat is defined in the *Species at Risk Act* (2002) subsection 2(1) 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 a recovery strategy or in an action plan for the species."* (subsection 2(1)).

SARA defines habitat for aquatic species at risk 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 striped bass, St. Lawrence population, critical habitat is identified to the extent possible, using the best available information. The critical habitat identified in this recovery strategy is necessary for the recovery of the species, but is insufficient to achieve the population and distribution objectives for the species due to inadequate information. In particular, the specific location of spawning, incubation and larval development habitats and the biophysical features that support their function, are unknown at this time. The schedule of studies outlines the studies required to refine the knowledge of these features and their attributes, and the overall critical habitat, that are necessary to support the population and distribution objectives for the species.

2.7.1.1. INFORMATION AND METHODS USED TO IDENTIFY CRITICAL HABITAT

The identification of critical habitat requires an understanding of the environmental needs of species during the different stages of its development, as well as of the quality and uses made of the habitat by the species throughout its range. It is also necessary to know the minimum number of individuals and the range required in order to ensure the maintenance of a viable and self-sufficient population. Information on the historic and reintroduced populations of striped bass in the St. Lawrence Estuary is incomplete and is based primarily on accidental captures in the recreational and commercial fisheries. This lack of information has constrained efforts to identify and characterize the habitats being used by the species. In addition, there is very little data available on the functions, features and attributes (i.e. chemical, physical and biological) of the habitats used.

The available data on habitat quality assessment and habitat use by the striped bass of the St. Lawrence Estuary were analyzed in two research documents, one by Pelletier *et al.* (2010) for the reintroduced population (data from 2002 to 2009) and one by Robitaille (2010) for the historic population. These documents were reviewed during a scientific peer review meeting in April 2010 (DFO 2010a, b). This analysis showed that since being reintroduced, the striped bass of the St. Lawrence Estuary has been using the same range as the historic population to complete all the stages of its life cycle. This range extends from Lake Saint-Pierre to Rivière-du-Loup.

However, for the reintroduced population, there is no available information on the location of habitats used for spawning, incubation and larval development. For juveniles (age 0+), since being reintroduced, they have been captured in eel traps in September and October from La Pocatière to Kamouraska, and mostly in Anse Sainte-Anne (96% of captures). At this stage, it is clear that Anse Sainte-Anne is an important habitat for juveniles. Mature and immature do not appear to favour any one habitat but rather move about according to the movements and abundance of their prey. Concentrations of adult-size striped bass have been observed in spring in the basin of the Rivière du Sud in Montmagny and several individuals have been captured during the fall, winter and spring in the plume of warm water discharged by the Gentilly 2 nuclear station.

Data analysis of the historic and reintroduced striped bass populations has helped to identify important functions of the different habitats used at certain development stages (e.g., spawning, incubation and larval development habitat, wintering). However, the location of the habitats providing these functions, and the features that support them, will have to be determined by further studies before other critical habitat can be designated (MPO 2010a, b).

2.7.1.2. IDENTIFICATION OF CRITICAL HABITAT: GEOPHYSICAL

Since the reintroduction of striped bass in the St. Lawrence Estuary, the established monitoring network in collaboration with eel fishermen has identified a zone of concentration of juveniles during the fall (from September 1 to October 31). Between 2005 and 2009, 193 juveniles were captured between La Pocatière and Kamouraska, 186 (96 %) of which were in Anse Sainte-Anne (Pelletier *et al.* 2010). Taking into account the restricted size of the population and the number of fish stocked, the capture of 186 juveniles in this area is quite significant.

Before the disappearance of the striped bass, the first yearly captures of juveniles in fixed fishing gear began in July in Neuville and moved steadily downstream in August to Rivière-Ouelle in September (Robitaille, 2010). Juvenile striped bass are now being captured once again in Rivière-Ouelle and during the same time period as before the species disappeared. In early July, the juveniles are not very mobile and may be obliged to feed on local prey. As summer advances, their swimming capabilities augment and they become more resistant to changes in temperature, turbidity and salinity (Robitaille 2010). They may then migrate towards salt water, as do the striped bass of the Miramichi River at the same developmental stage (Robichaud-Leblanc *et al.* 1996). This may explain why juveniles were captured in Rivière-Ouelle beginning only at the end of August when they were longer than 65 mm (Robitaille 2010). Because the number of eel traps has decreased considerably since the 1960s, it is not possible at this time to locate the habitats used by juveniles upstream of La Pocatière. The schedule of studies for the identification of critical habitat, along with the action plan, should help fill these knowledge gaps.

For the St. Lawrence Estuary striped bass population, critical habitat is identified as the zone of juvenile (age 0+) concentration in Anse Sainte-Anne in La Pocatière during the fall, from September 1 to October 31. Given the present knowledge gaps and the fact that no quantitative recovery objective has been established for the species, the identification of critical habitat is incomplete at this time. However, at this stage, since the population is only just beginning to show signs of recovery and is consequently still vulnerable, and even though limiting factors

mostly impact the early life stages (i.e. eggs and larvae), this rearing habitat for juveniles should be considered as critical habitat.

The general location of critical habitat is shown in Figure 5. Facing the municipalities of Saint-Roch-des-Aulnaies, La Pocatière and Rivière-Ouelle, an area bounded to the west by the old dock of Saint-Roch-des-Aulnaies (N 47˚18'56.4" ; W 70˚10'18.1") and following the high water line east to the dock at Rivière-Ouelle (N 47˚29'10.2" ; W 70˚01'10.2"). From there, offshore of Rivière-Ouelle (N 47˚29'29.8" ; W 70˚01'57.8"), then west along the 5 m isobath of the marine charts to offshore of Saint-Roch-des Aulnaies (N 47˚21'19.6" ; W 70˚13'46.1"). The total area of critical habitat covers 146.3 km².

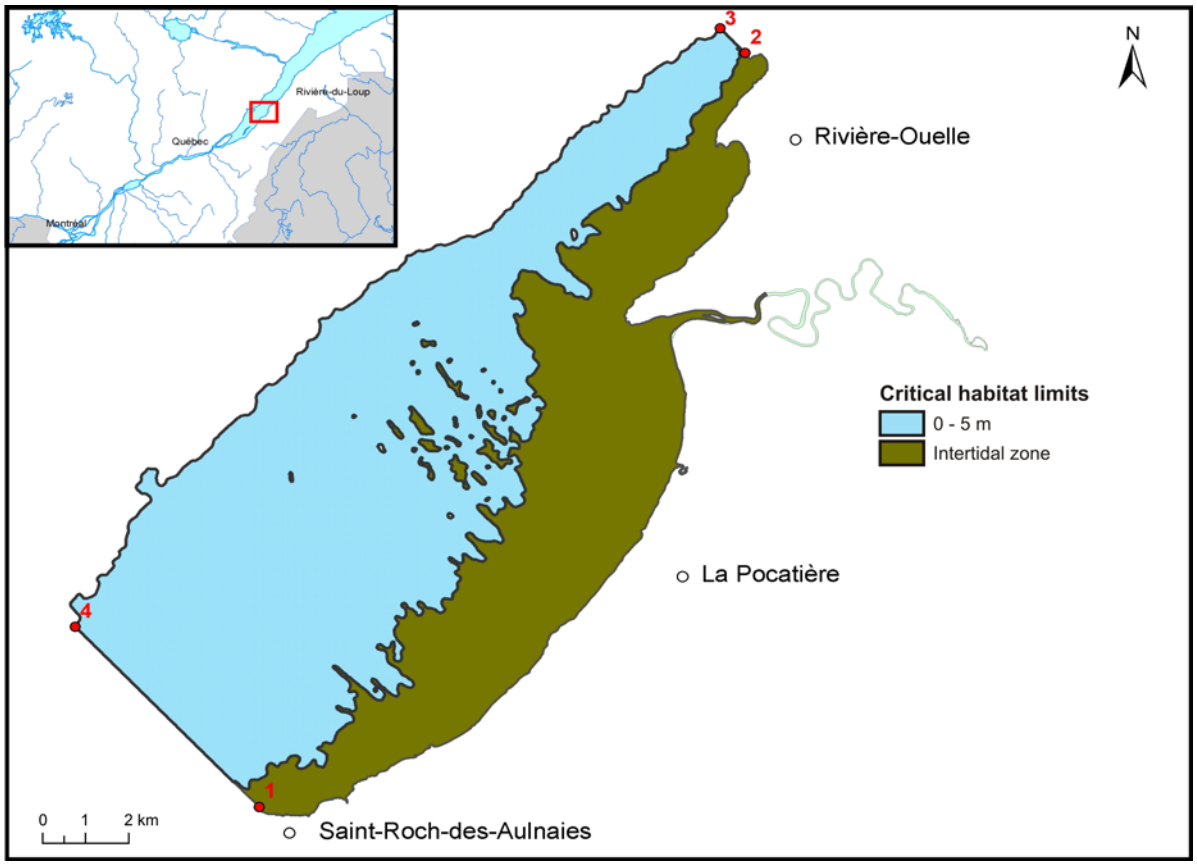


Figure 5 Delineation of critical habitat in the intertidal zone and 0 to 5 m depth zone of Anse Sainte-Anne in the St. Lawrence Estuary. Adapted from Pelletier *et al.* 2010.
Point 1: N 47˚18'56,4" ; W 70˚10'18.1" / Point 2: N 47˚29'10.2" ; W 70˚01'10.2" / Point 3: N 47˚29'29.8" ; W 70˚01'57.8" / Point 4: N 47˚21'19.6" ; W 70˚13'46.1".

Following the Science Advisory Report (DFO 2010a, b) and using the best available information, the St. Lawrence Estuary Striped Bass Recovery Team indicated that this area is important and of high quality for the species (especially for juveniles), and that this habitat is required to reach the species` recovery objectives. The schedule of studies to identify critical habitat (see Section 2.7.3) has been designed to enable the acquisition of information necessary to complete or re-evaluate this identification. Further information will serve to better understand the role of Anse Saint-Anne in the recovery of the striped bass of the St. Lawrence Estuary,

revealing its unique functions, features and attributes and the range of the juveniles during summer and fall.

2.7.1.3. IDENTIFICATION OF CRITICAL HABITAT: BIOPHYSICAL FUNCTIONS, FEATURES AND THEIR ATTRIBUTES

Anse Saint-Anne in La Pocatière is identified as critical habitat because it is a rearing area for juveniles during the fall (i.e. rearing function). The feature of this habitat, or its structural component, is the presence of a bay characterized by several specific and indispensable attributes required to maintain its function:

- availability of sufficient quantity and quality of prey species (ichthyoplanktonic retention zone), e.g., larvae of rainbow smelt, Atlantic herring (*harengus harengus*) and capelin (*Mallotus villosus*);
- thermal front area;
- high salinity gradient;
- unique circulation pattern that may contribute to increased local turbidity and greater concentration of preys (fish larvae);
- low tide depth from 0[6] to 5 m.

Pelletier *et al*. (2010) presented the following description of the habitat in which juveniles were captured between La Pocatière and Kamouraska. This territory is an extensive intertidal zone characterized by extremely heterogeneous abiotic phenomena. The shoals and strong current circulation produce variations in the salinity gradient that can shift rapidly from 10 to 18%. The coastal area in this sector constitutes an ichthyoplanktonic retention zone of larvae composed primarily of rainbow smelt, Atlantic herring and capelin. The circulation of the water mass creates an important thermal front characterized by a temperature drop of 6 to 7 °C downstream of Rivière-Ouelle. The surface sediments are varied, changing from coarse to finer particles from east to west.

Once again, according to Pelletier *et al*. (2010), this habitat could be favourable to juvenile striped bass. According to the literature, juveniles are found in abundance in the sheltered bays of the estuaries where they feed primarily on small invertebrates during their first year (Robichaud-Leblanc *et al.* 1997). They will tolerate salinity levels up to 15% and temperatures between 12 and 23 °C (Bains and Bains 1982).

Anse Sainte-Anne may thus be a feeding ground for juvenile striped bass. The colder, saltier water downstream of Kamouraska could limit the range of juveniles (DFO 2010a, b). Consequently, Anse Sainte-Anne may be the most downstream feeding ground, used just prior to the winter (when feeding ceases), making it an extremely important site at this developmental stage for striped bass. It has been shown that in the Miramichi River, the size of juveniles is an important factor in survival during the winter because the feeding and growth season is short and winters are harsh. Juveniles must accumulate enough energy reserves to survive the winter which lasts at least 6 months (Robichaud-LeBlanc 1997). The situation may be similar for the striped bass of the St. Lawrence Estuary. In addition, analyses of juvenile striped bass of the historic

[6] Corresponds to the chart datum (CD) derived from the mean level of low water at spring tide.

population reveal no indication of movements upstream or downstream at the onset of the cold season. For example, in Montmagny or in Rivière-Ouelle, where striped bass aged 0+ were captured during the fall, individuals aged 1+ would be captured the following spring (Robitaille 2010).

The biomass of potential prey in Anse Sainte-Anne is considerable and the unique circulation pattern may contribute to the concentrations of prey and juvenile striped bass (DFO 2010a, b). D'Anglejan (1981) explains how exchanges between the independent water circulation of the Anse Sainte-Anne plateau, the silty flats of the intertidal zone and the Rivière Ouelle increases local turbidity. This concentration of suspended matter promotes primary production which is beneficial to the larvae of forage-fish and, consequently, to juvenile striped bass who feed on them.

Data collected between 2002 and 2009 by the MRNF demonstrate that rainbow smelt make up most, approximately 75%, of the fish larvae community in Anse Sainte-Anne. The remaining 25% consists of Atlantic herring larvae and capelin larvae (Guy Verreault, MRNF, unpublished data). The analysis of the stomach contents of striped bass captured before the disappearance of the species revealed that clupeids and rainbow smelt were the main fish consumed by juvenile striped bass (Robitaille 2010). In addition, a review of the literature on the diet of the striped bass revealed that juveniles primarily consumed fish of the *clupeidae* family, such as *Alosa* spp and Atlantic herring, and shrimp of the *mysidacea* group (Walter *et al.* 2003).

To identify Anse Sainte-Anne as critical habitat is justified since it is a zone of juvenile concentration during the fall and will help ensure the recruitment and recovery of the species. The identified area covers 146.3 km² of sub-littoral and intertidal zone with a low tide depth from 0 to 5 m (Figure 5). Despite the fragmentary nature of information on habitat use by the reintroduced striped bass population, identification of this zone of juvenile concentration during the fall as critical habitat is a precautionary measure; particularly since juveniles were observed there before the disappearance of the striped bass and this area may be a vital feeding ground prior to the cold season (most downstream site).

A 940 km^2 area of potential habitat consisting of a 320 km² intertidal zone and a 620 km² zone of low tide depths from 0 to 5 m was located between Neuville and Kamouraska (Pelletier *et al.* 2010). It is still too early to gauge the importance of this potential habitat but it will be possible to use Anse Sainte-Anne as a starting point in identifying critical habitat further upstream. The inventories which are part of the schedule of studies and the action plan will contribute to a better understanding of habitat use by striped bass in Anse Sainte-Anne and in the sector of the identified potential habitats. A more comprehensive description of habitat functions, features and attributes is also required.

Table 6 summarizes the essential functions, features and attributes of the striped bass critical habitat identified in this recovery strategy. At this time, critical habitat has been identified in the Anse Sainte-Anne where rearing functions for juveniles are supported. Data analysis of the historic and reintroduced striped bass population (DFO 2010a, b) has helped to identify important functions that would take place in other types of habitat (e.g., spawning and nursery), but these habitats have not been located yet. The schedule of studies to identify critical habitat

aims to acquire the knowledge required to locate some of these habitats as well as other rearing habitats, particularly in the area of potential habitat identified by Pelletier *et al.* (2010). This should help identify other critical habitats.

Table 6. Summary of the functions, features and attributes of critical habitat.

Function	Feature(s)	Attribute(s)
• Spawning *probably a function of the critical habitat, but not located*	• Unknown	• Unknown
• Nursery (incubation and larval development habitats) *probably a function of the critical habitat, but not located*	• Unknown	• Unknown
• Rearing (growth habitat for juveniles)	• Bay	• Availability of sufficient quality and quantity of prey species (ichthyoplanktonic retention zone); • Thermal front area; • High salinity gradient; • Unique circulation pattern may contribute to increased turbidity and greater concentration of preys (fish larvae); • Low tide depth from 0 to 5 m.

2.7.2. Activities Likely to Result in the Destruction of Critical Habitat

Since habitat use is often temporal in nature, every activity is assessed on a case-by-case basis and site-specific mitigation is applied where it is reliable and available. The *Government of Canada Species at Risk Act Policies*, (2011 [draft]) describes destruction of critical habitat in the following manner: "*Destruction of critical habitat would result if any part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from single or multiple activities at one point in time or from cumulative effects of one or more activities over time*."

The critical habitat of the striped bass may be destroyed by human activities which modify the features or attributes necessary for the rearing function of the Anse Sainte-Anne critical habitat. Juveniles` presence in this bay (i.e. feature) could be explained by several attributes of the habitat: availability of sufficient quality and quantity of prey (ichthyoplanktonic retention zone), thermal front area, high salinity gradient, unique circulation pattern that may contribute to increased turbidity and greater concentration of preys (fish larvae), and low tide depth from 0 to 5 m.

Dredging of the sea-bed and riparian modifications in the flood-plain such as infilling are examples of anthropogenic activities that are likely to result in the destruction of critical habitat of the striped bass by altering one or several attributes of Anse Sainte-Anne, such that it would not serve its function (table 7). It is important to mention that any human activity in Anse Sainte-Anne must be assessed on a case-by-case basis to determine if it is likely to destroy a feature of

critical habitat, or its attributes such that the function is no longer available to the species when it is required.

The activities described in this table (table 7) are neither exhaustive nor exclusive and have been guided by the General Threats described in section 1.5 of this recovery strategy. The absence of a specific human activity does not preclude, or fetter the department`s ability to regulate it pursuant to SARA. Furthermore, the inclusion of an activity does not result in its automatic prohibition since it is destruction of CH that is prohibited. In every case, where information is available, thresholds and limits are associated with attributes to better inform management and regulatory decision-making. However, in many cases, the knowledge of a species and its critical habitat may be lacking, in particular information must be acquired in terms of threshold of tolerance of the species or its habitat to disturbance from human activities.

Table 7. Examples of activities that are likely to result in the destruction critical habitat

Activity	Affect- Pathway	Function Affected	Feature Affected	Attribute Affected
• Dredging	• Modification of ocean floor and circulation pattern; • Changes in turbidity levels.	• Rearing	• Bay	• Availability of sufficient quantity and quality prey species (ichthyoplanktonic retention zone); • Thermal front area; • High salinity gradient; • Unique circulation pattern may contribute to increased turbidity and greater concentration of preys (fish larvae); • Low tide depth from 0 to 5 m.
• Riparian modifications	• Physical loss of habitat; • Modification of supplies of terrestrially derived food; • Changes in turbidity levels; • Loss of riparian vegetation:	• Rearing	• Bay	• Availability of sufficient quantity and quality prey species (ichthyoplanktonic retention zone); • Unique circulation pattern may contribute to increased turbidity and greater concentration of preys (fish larvae).
• Infilling	• Physical loss of habitat and loss of oceanographic processes.	• Rearing	• Bay	• Availability of sufficient quantity and quality prey species (ichthyoplanktonic retention zone); • Thermal front area; • High salinity gradient; • Unique circulation pattern may contribute to increased turbidity and greater concentration of preys (fish larvae); • Low tide depth from 0 to 5 m.

2.7.3. Schedule of Studies to Identify Critical Habitat

This recovery strategy includes an identification of critical habitat to the extent possible, based on the best available information. Further work is required to identify additional critical habitat necessary to support the population and distribution objectives for the species. To complete the identification of critical habitat, it is important to describe the distribution of striped bass according to season and developmental stage and to characterize the habitats used in order to understand what they provide to the species (Table 8). Once the habitats have been located and characterized, it will be possible to identify the habitats necessary for the recovery of the species. The schedule will be instrumental in reaching objective 2.4.5 of the present recovery strategy and completing the identification of critical habitat required for the forthcoming action plan. The ranking of studies according to developmental stage and the schedule itself are conditional on an increase in population. They will be updated in the forthcoming action plan.

Table 8. Schedule of studies to identify the critical habitat of the striped bass of the St. Lawrence Estuary.

Study Objectives	Priority Level	Timeline
Locate and characterize spawning habitats (mature individuals in the spring) and incubation habitats (end of spring- early summer).	High	2011-2016
Locate habitats of larval development (end of spring-early summer).	High	2011-2016
Locate and characterize juvenile development habitats (summer-autumn).	High	2011-2016
Locate and characterize habitats used during the winter for all developmental stages (end of autumn-winter).	Moderate	2011-2018
Locate and characterize habitats used by immature individuals (spring-summer-autumn).	Low	2011-2020
Locate and characterize habitats used by mature individuals (summer-autumn).	Low	2011-2020

2.8. Existing and Recommended Approaches to Habitat Protection

The *Species at Risk Act* provides for the protection of the critical habitat of a listed species. The habitats of the striped bass are also protected under other Canadian laws including the *Fisheries Act*, the *Canadian Environmental Protection Act* and the *Canadian Environmental Assessment Act.* The provisions of these acts must be enforced in order to prevent disturbance, degradation or destruction of habitat in areas likely to contain spawning grounds, incubation habitats or habitats of larval development and consequently to protect the species.

In Quebec, protection of fish habitat is provided by the *Act Respecting the Conservation and Development of Wildlife* and the *Environment Quality Act*. In addition, shorelines are afforded protection under the *Politique de protection des rives, du littoral et des plaines inondables (*Protection policy for lakeshores, riverbanks, littoral zones and floodplains*),* the *Cities and Towns Act* and the *Act Respecting Land Use Planning and Development.*

2.9. Effects on Other Species

Prior to the reintroduction of striped bass in the St. Lawrence Estuary, a risk analysis was conducted (Robitaille 2000). This document, approved by the members of the Comité aviseur sur la réintroduction du bar rayé, presents a review of the scientific and technical literature on the possible biological repercussions of reintroducing striped bass, including the effects on predators and competitors. The risk analysis concludes that the reintroduction of striped bass in the St. Lawrence Estuary should not lead to any significant decreases in the abundance of prey species. If the striped bass population recovers, a reallocation of trophic resources may occur between this species and other predators. The quantity of food resources consumed by the striped bass would not necessarily add to the quantity presently consumed by the piscivores in the area; the increased competition for resources may force other predators to expand their range or alter their diet. An evaluation of the effects on prey abundance would need to take into consideration not only the quantity of prey consumed by striped bass, but also the amount no longer consumed by other, displaced predators. This risk analysis, though, does not eliminate the need for adequate monitoring of the biological communities in this sector of the St. Lawrence. It does suggest, however, that the monitoring program should not be concentrated exclusively on just a few predator species, such as the vulnerable rainbow smelt and American shad, but should extend to other elements of the community, particularly the principal piscivores (Robitaille 2000).

The goal of the striped bass recovery strategy (Section 2.2 Recovery Goal) takes these knowledge gaps into account and stipulates that the recovery of the striped bass in the St. Lawrence Estuary must not cause significant disturbance to the biological community presently in place. In order to gauge the possible impacts the reintroduction of striped bass may have on the biological community, one of the recovery objectives formulated (Section 2.4 Recovery Objectives) calls for the monitoring of "the status of certain components of the ichthyological community (prey, predators, competitors) in relationship with the striped bass" and several measures to this end have been proposed (Section 2.5 Approaches Recommended to Meet Recovery Objectives). If significant changes to the biological community appear attributable to the reintroduction of striped bass, adjustments will be made to the recovery strategy.

2.10. Recommended Approach for Recovery Implementation

The implementation of the recovery strategy will require an adaptive management approach. As new data is accumulated and progress is made in the recovery, or if new environmental conditions indicate that the proposed recovery measures are no longer appropriate, revised and more efficient approaches will be implemented. It is also recommended that the striped bass be part of all recovery initiatives targeting associated species.

2.11. Statement on Action Plan

If possible, the action plan (one or several chapters) will be developed within the five years following the approval of the recovery strategy. This delay allows for the acquisition of more information required to complete, as much as possible, the identification of critical habitat.

2.12. Activities Permitted by the Recovery Strategy

The *Species at Risk Act* stipulates that "*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)). Under subsection 83(4) of the *Species at Risk Act*, "*Subsections 32(1) and (2), section 33, subsections 36(1), 58(1), 60(1) and 61(1) and regulations made under section 53, 59 or 71 do not apply to a person who is engaging in activities in accordance with conservation measures for wildlife species under a land claims agreement.*"

2.12.1. Fisheries

Although fishing for striped bass is prohibited in the St. Lawrence, accidental captures occur in the commercial and sports fisheries. The immediate release of this fish is mandatory, according to the *Quebec Fishery Regulations (1990),* SOR/90-214 of the *Fisheries Act,* R.S.C., 1985, c. F-14.

In 2009, a committee of experts from the MRNF and DFO was formed to evaluate the impact of accidental captures of striped bass in the commercial and sports fisheries on the survival and recovery of the population. Despite the lack of data on the biology of the population and its vulnerability to accidental captures, the committee concluded that the freshwater and marine fisheries, as they are presently carried out, are unlikely, over all, to impact the survival and recovery of the striped bass population of the St. Lawrence Estuary (DFO 2009).

The committee report contained five recommendations to mitigate the impact of the fisheries, as a cause of mortality, on the striped bass population of the St. Lawrence Estuary and to monitor the population:

1. Implement mitigation measures (e.g., mandatory release of catches) to reduce the possible impact of the commercial and sports fisheries on the striped bass population;
2. Take the necessary steps to ensure that accidental captures are recorded;
3. Promote awareness in the fishing industry;
4. Maintain a monitoring network focused in part on the accidental captures of striped bass by commercial fishermen and authorizing the collection of specimens;
5. Re-evaluate the impact of accidental captures within five years, or sooner if changes are observed in the vulnerability of striped bass to accidental captures in the commercial and sports fisheries.

In accordance with subsection 83(4) of SARA, the present recovery strategy authorizes fishermen to carry out sport or commercial fishing subject to the following conditions:

- fishing is carried out in accordance with a sport or commercial fishing license issued under the provisions of the *Quebec Fishery Regulations (1990),* SOR/90-214;
- any person who accidentally captures a striped bass while fishing shall without delay return the fish to the waters in which it was caught and, if the fish is alive, release it in a manner that causes the least harm to the fish.

A monitoring network has been set up to document the establishment of striped bass which have been stocked, to evaluate population parameters, to trace their movements, and to verify the occurrence of natural reproduction. Commercial fishermen who are part of the network must possess a permit for the capture of wildlife for scientific, educational or wildlife management purposes (SEG permit) issued by the MRNF authorizing them to keep accidentally captured striped bass and deliver them to MRNF biologists.

In accordance with subsection 83(4) of SARA, the present recovery strategy authorizes fishermen to carry out commercial fishing and the capture of striped bass for scientific, educational or wildlife management purposes, subject to the following conditions:

- fishing is carried out in accordance with a commercial fishing license and a permit for the capture of wildlife for scientific, educational or wildlife management purposes (SEG permit) issued under the provisions of the *Quebec Fishery Regulations (1990)*, SOR/90-214;
- any person who accidentally captures a striped bass while fishing must deliver it to the MRNF biologists responsible for striped bass and following the dates and conditions of the SEG permit referring to the species.

Furthermore, in accordance with subsection 83(4) of SARA, the present recovery strategy authorizes fishermen to fish under the provisions of an aboriginal communal fishing licence, subject to the following conditions:

- fishing is carried out in accordance with a communal licence issued under the provisions of the *Aboriginal Communal Fishing Licences Regulations*, SOR/93-332;
- any person who accidentally captures a striped bass while fishing shall without delay return the fish to the waters in which it was caught and, if the fish is alive, release it in a manner that causes the least harm to the fish.

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4. MEMBERS OF THE ST. LAWRENCE ESTUARY STRIPED BASS RECOVERY TEAM

Name	Position	Organization
Alain Gosselin / Serge Tremblay	Co-chair	MRNF – DEX Chaudière-Appalaches
Marthe Bérubé	Co-chair	DFO – SRMD Quebec Region
Julie Boucher	Coordinator	MRNF – Service biodiversité et maladies de la faune
Michel Baril	Member	Fédération québécoise des chasseurs et pêcheurs
Jacinthe Beauchamp	Member (drafting of report)	DFO – SRMD Quebec Region
Suzan Dionne	Member	Parks Canada
Catherine Gaudreault	Member	MRNF – Direction des stations piscicoles
Michel Legault	Member	MRNF – Service de la faune aquatique
Yves Mailhot	Member	MRNF – DEX Mauricie et Centre-du-Québec
Bruno Ouellet	Member	Association des pêcheurs d'anguilles du Québec
Jean Robitaille	Member (drafting of report)	Coopérative des conseillers en écologie appliquée de Québec
Pascal Sirois	Member	Université du Québec à Chicoutimi
Guy Trencia	Member	MRNF – DEX Chaudière-Appalaches
Diane Villeneuve	Member	Hydro-Québec
Guy Verreault	Member	MRNF – DEX Bas-Saint-Laurent

APPENDIX 1. LIST OF ACRONYMS

CDPNQ	Centre de données sur le patrimoine naturel du Québec
COSEMEQ	Comité pour la sauvegarde des espèces menacées au Québec
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DEX	Direction de l'Expertise
DFO	Fisheries and Oceans Canada
FédéCP	Fédération québécoise des chasseurs et pêcheurs
MDDEP	Ministère du Développement durable, de l'Environnement et des Parcs
MRNF	Ministère des Ressources naturelles et de la Faune du Québec
NCRAIS	National Center for Research on Aquatic Invasive Species
SARA	*Species at Risk Act*
SEA	Strategic environmental assessment
SEG	Permit for the capture of wildlife for scientific, educational or wildlife management purposes, issued by MRNF
SRMD	Species at Risk Management Branch
VHS	Viral hemorrhagic septicemia
ZEC	Zone d'exploitation contrôlée (Controlled harvesting zones)
ZIP	Comité Zone d'intervention prioritaire (Area of prime concern)

APPENDIX 2. ORGANIZATIONS THAT HAVE PROVIDED SUPPORT FOR THE REINTRODUCTION OF STRIPED BASS IN THE ST. LAWRENCE

- Association des pourvoyeurs de pêche aux petits poissons des chenaux inc.
- Boy Scout Movement
- Casting Club de Québec
- Comité Zone d'intervention prioritaire (ZIP) de Québec et Chaudière-Appalaches
- Comité ZIP Des Deux Rives
- Comité ZIP du lac Saint-Pierre
- Comité ZIP du Sud-de-l'Estuaire
- Coopérative des conseillers en écologie appliquée de Québec
- Corporation de la sauvagine de l'Isle-aux-Grues
- Corporation pour la restauration de la pêche à l'île d'Orléans
- Fédération des gestionnaires de zones d'exploitation contrôlée (ZEC) du Québec
- Fédération des pourvoyeurs du Québec
- Fédération des trappeurs gestionnaires du Québec
- Fédération québécoise des chasseurs et pêcheurs
- Fédération québécoise pour le saumon Atlantique
- Fondation de la faune du Québec
- Fondation Héritage Faune
- Fondation Hydro-Québec pour l'environnement
- Ministère des Ressources naturelles et de la Faune
- Saint-Laurent Vision 2000
- Société des établissements de plein air du Québec