POTENTIAL IMPACT OF ACCIDENTAL CAPTURES BY COMMERCIAL AND RECREATIONAL FISHERIES ON THE SURVIVAL AND RECOVERY OF THE STRIPED BASS (*MORONE SAXATILIS*) POPULATION IN THE ST. LAWRENCE ESTUARY

Context

In November 2004, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed three "designatable units" of striped bass (*Morone saxatilis*, Walbaum, 1972). The units in the southern Gulf of St. Lawrence and Bay of Fundy were designated as threatened, while the one[1] in the St. Lawrence Estuary was designated as extirpated since the species' disappearance was observed in the late 1960s (COSEWIC, 2004).

Although the original striped bass population in the St. Lawrence Estuary disappeared several decades ago, a new population is currently rebuilding. In 2002, the Ministère des Ressources naturelles et de la Faune du Québec (MRNF) initiated a reintroduction strategy in order to establish a new population able to reproduce and sustain itself (Advisory committee on the reintroduction of the striped bass in the St. Lawrence, 2001).

Fisheries and Oceans Canada (DFO), as the responsible jurisdiction for aquatic species under the *Species at Risk Act* (SARA), has undertaken consultations on whether to add the St. Lawrence Estuary striped bass population to the SARA's list of species at risk. In 2006, a recovery potential assessment (RPA) for the striped bass was conducted to provide scientific information to support the listing scenarios (DFO, 2006). This information concerned the status of these three populations and the threats that jeopardize their survival and recovery. For the St. Lawrence Estuary population, the available data was limited because this population has disappeared since the sixties and the information from the reintroduced population was quite patchy. However, since this assessment, the striped bass situation in the St. Lawrence Estuary has changed. Stocking has continued and some evidence seems to indicate the establishment of a new striped bass population in the estuary.

In the event the striped bass is added to SARA, the Act states 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.*" (*Species at Risk Act,* section 32(1)). These prohibitions would be applied to the reintroduced population. However, activities that might affect a species listed under the SARA could be permitted in certain circumstances, either by issuing permits (section 73(3)) or within the framework of a recovery strategy (section 83(4)). Although commercial and recreational fishing for this species is prohibited in Quebec, striped bass are regularly captured accidentally during certain commercial and recreational fishing activities. According to the *Quebec Fishery Regulations* under the *Fisheries Act*, a person who catches a striped bass shall forthwith return the fish to the water from which it was caught, and,

[1] The designatable unit of the St. Lawrence Estuary is composed of only one population, the St. Lawrence Estuary population.

where the fish is alive, release the fish in a manner that causes the least harm to it. In light of this information, it is thus critical to assess in further detail the significance of various fishing activities as source of mortality for the reintroduced striped bass population in the estuary.

Consequently, the Species at Risk Management Branch presented a request for science advice on August 27th, 2009, on the impact of commercial and recreational fisheries on the survival and recovery of the striped bass population in the St. Lawrence Estuary. This advice, which is complementary to the recovery potential assessment conducted in 2006 (DFO, 2006), must consider new data available in order to determine if commercial and recreational fishing activities can be authorized through issuing permits according to sections 73(3) or based on a recovery strategy under section 83(4) of the SARA. In other words, this advice must determine whether commercial and recreational fishing activities represent an allowable harm for the new striped bass population. It will be used to support the decision to add or not the species to the SARA and for preparing the DFO-MRNF joint recovery strategy currently being drafted by the St. Lawrence striped bass recovery team. Since the recommendation for adding or not the species to the SARA is expected shortly, it was decided to formulate this advice under the Science special response process due to time constraints. This document was co-authored by the DFO and the MRNF and was peer reviewed on October 5th, 2009, in order to review the information presented.

Background

Biology and Ecology

Striped bass is an anadromous percoid that moves between freshwater spawning habitats and brackish or salt water feeding sites to complete its life cycle. Spawning, incubation and the larval stage usually occur in freshwater. Once in the juvenile stage, young-of-the-year (YOY) move to the nearshore habitats of estuaries and then gradually downstream towards saline environments throughout the summer. Both YOY and adult striped bass return to estuaries or freshwater habitats in the fall to spend the winter, apparently to escape the cold winter seawater. As striped bass grow, they become high order predators. Their diet shifts to include invertebrates and soft-rayed fish such as American shad (*Alosa sapidissima*), Atlantic herring (*Clupea harengus harengus*), rainbow smelt (*Osmerus morax*) and Atlantic tomcod (*Microgadus tomcod*).

In the St. Lawrence Estuary, prior to its disappearance, striped bass primarily occupied the area between Lake St. Pierre and Kamouraska (Figure 1). Downstream from Île d'Orléans, captures were mostly reported in the Montmagny archipelago and along the south shore. During the growing season, from July to October, striped bass concentrated between Quebec and Kamouraska and moved to shallow water along islands and coasts. Successive age groups are distributed based on an upstream-downstream gradient, the young were concentrated upstream (i.e. around Île d'Orléans and along the Montmagny archipelago) and older individuals downstream. With the arrival of winter, one and two year-old fish stayed in the same area, while older individuals migrated upstream to Lake St. Pierre (Robitaille, 2001). Since their reintroduction in 2002, striped bass have been captured between Montreal and Rimouski and they always seem to concentrate on the south shore between Lake St. Pierre and Rivière-du-Loup.

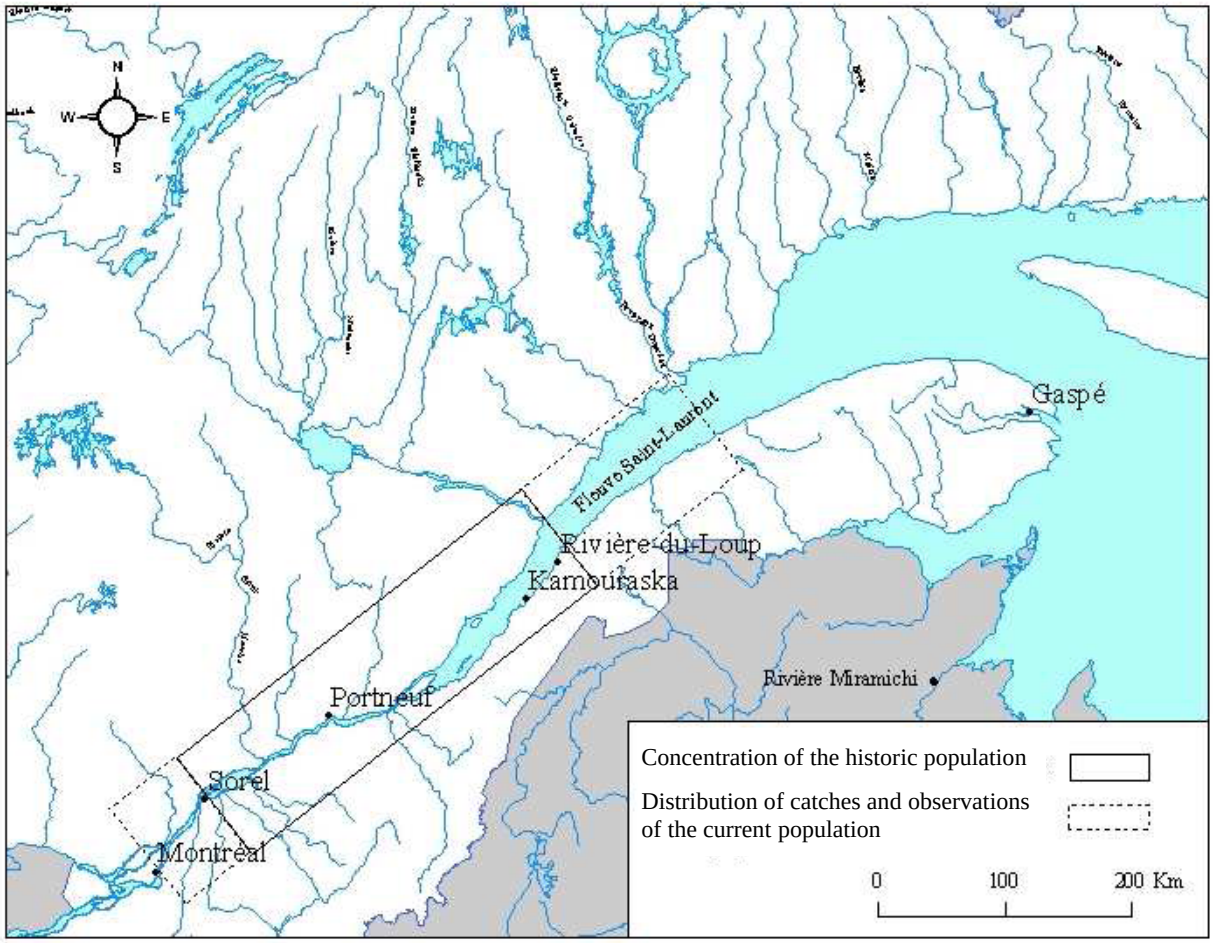

Figure 1. Distribution range of the historic and reintroduced striped bass population based on historic information as well as captures and observations made between 2003 and 2008. From Pelletier, 2009.

Population Disappearance and Reintroduction

The striped bass population in the St. Lawrence Estuary disappeared in the late 1960s. Commercial catches were reported up to 1965, and the last recreational fishery catches were made in 1968 (Robitaille and Girard, 2002). An analysis of the data collected on the striped bass population in the St. Lawrence Estuary over the last two decades of their existence suggests that the population's disappearance was due to over-exploitation and to the disruption of their habitats (Robitaille, 2001).

In 2002, the Ministère des Ressources naturelles et de la Faune du Québec decided to reintroduce the striped bass in the St. Lawrence Estuary in order to establish a new population able to reproduce and sustain itself. Juvenile striped bass were transferred from the Miramichi River in New Brunswick to the Baldwin-Coaticook fish farm in Quebec to allow them to grow and be used for artificial spawning. So far, the stocked fish have been primarily the surplus individuals at the fish farm (based on the needs identified as spawners required for annual spawning of YOY). However, larvae and individuals born at the fish farm were also introduced. Therefore, since 2002, more than 6,300 striped bass larger than 60 mm (ages 0+ to 6+) and nearly 6.5 million larvae of 2-4 mm have been introduced to the St. Lawrence between Saint-

Pierre-les-Becquets and Rivière-Ouelle. The reintroduction strategy is aimed at introducing up to 50,000 fall fry in order to create a population that can sustain itself (Advisory committee on the reintroduction of striped bass, 2001). Since 2003, juvenile and adult striped bass that were introduced have been tagged with a micro-tag. Since 2007, larvae have been chemically tagged in order to determine the origin (i.e. stocked individuals or from natural setting) of individuals captured accidentally.

Monitoring Network and Portrait of the New Population

A monitoring network was implemented in 2004 in order to document the establishment of seeded striped bass, to assess the population's parameters, locate their movements and monitor the occurrence of natural spawning (Bourget *et al.,* 2008; Pelletier, 2009). The data collected via this monitoring network stem from 3 sources: 1) reported captures by commercial fishermen; 2) data collected during ichthyological inventories conducted by the MRNF and 3) observations of striped bass captures by recreational fishermen sent to the Centre de données sur le Patrimoine naturel du Québec (CDPNQ).

Several groups of commercial fishermen received a wildlife management permit[2] in order to conserve all striped bass found dead or alive in their fishing gear and return them to the MRNF biologists in charge of striped bass. The first commercial fishermen who were solicited to participate in the monitoring network were those harvesting eels with traps between Portneuf and Sainte-Luce. American shad and Atlantic sturgeon (*Acipenser oxyrynchus*) gillnet commercial fishermen joined the network in 2006 and 2007, followed in 2009 by fishermen using fyke nets. The contribution to the monitoring network by commercial fishermen has been very significant and the information gathered by this group represents more than 95% of reported mentions.

The monitoring network helped gather data on 528 striped bass individuals captured between Montreal and Rimouski between 2004 and 2008, 411 of those were recovered for analyzing biological characteristics. Using this data, a report on the biology of the new striped bass population was produced by Pelletier (2009). 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.

A monitoring network that solicits the participation from fishermen and that covers a large portion of the striped bass population's historic distribution was an effective and inexpensive tool for documenting the recovery of striped bass in the estuary. The biological monitoring of this new population is an essential element that will help optimize future stocking strategies in order to provide this population a proper reconstruction within the existing biological community in the St. Lawrence Estuary (Pelletier, 2009). Furthermore, it will help gather the necessary data in order to assess current and future fishery impacts and eventually the species' status. Due to the relatively high number of striped bass captures, in relation to the number of introduced individuals, a new condition was added to the MRNF wildlife management permit in 2009 in order to limit the monitoring impacts on the population's survival and recovery. Permit holders must release all striped bass of over 20 cm in total length captured live and keep dead individuals of 20+ cm and all individuals of less than 20 cm (dead or alive), which are mostly YOY. The YOY are examined in the laboratory to determine whether they are from the fish farm (i.e. tagged larvae) or from a natural setting.

[2] Special permit issued by the MRNF for capturing wild animals for scientific, educational or wildlife management purposes (SEG permit).

Impact Analysis of Accidental Catches of Striped Bass by Commercial and Recreational Fisheries

Commercial Fisheries

In order to assess the possible impact of accidental catches of striped bass by commercial fishermen on the population's survival and recovery, the different types of commercial fishing activities were analyzed both in freshwater and marine environment. As previously mentioned, there is no authorized striped bass commercial fishery in the St. Lawrence River and Estuary. Consequently, all striped bass captured accidentally during the commercial fishery must be released, except for fishermen participating in the monitoring network and who hold a wildlife management permit. If a striped bass is captured accidentally, it can easily be identified.

For each type of commercial fishery, the possible impact on the survival and recovery of the striped bass population has been evaluated considering the fishing plan conditions and comments from experts consulted. The impact on the striped bass recovery was estimated in three steps:

1) Capture probability assessment;
2) Mortality risk assessment associated with accidental catches;
3) Impact assessment on the survival and recovery according to steps 1 and 2 and weighting based on the gear's actual use or any other features.

Step 1: The vulnerability of striped bass to accidental catches by fishing gear (i.e. catch probability) was estimated based on two sources of information presented in the fishing plans (e.g. authorized fishing period, mesh size) and the knowledge of experts consulted. The vulnerability was analyzed according to two aspects:

1) Time-space probability: vulnerability of striped bass to capture by fishing gear according to their development stage and habitat or area where the fishing gear is used during the authorized fishing period;
2) Probability associated with fishing gear features: theoretical vulnerability of striped bass to capture according to the characteristics of the gear used (e.g. mesh size) regardless of the habitat or area where the gear is installed and the authorized fishing period.

Step 2: The second step for evaluating the impact of each type of fishery on the striped bass population's survival and recovery is the mortality risk assessment following catches in fishing gear. In fact, fishing gear can be very effective in accidentally catching striped bass, but if these individuals can be released alive following their capture, the risk of mortality will be nil or almost.

Step 3: For each type of fishery, the impact on the striped bass population's survival and recovery was estimated from the two first steps. For example, a type of fishery with a high capture probability and a nil or almost nil risk of mortality would have a marginal impact on the population's survival and recovery. The impact on survival and recovery was then weighted using knowledge from the experts consulted in order to account for the actual use of the fishing gear or any other feature of the fishery. In fact, for several types of fisheries, the actual number of gear used in the striped bass distribution range did not reach the number of gear permitted in the fishing plans. In addition, for marine species fisheries, the number of gear permitted is provided for a wider area than that occupied by the striped bass population in the St. Lawrence

Estuary. Consequently, fishing pressure is lower than the fishing effort permitted and should be considered in the impact assessment on the population's survival and recovery.

The risk level assessment at each step was done according to the following scale:

- nil or almost nil (N)
- low (L)
- moderate (M)
- high (H)

Two summary tables (i.e. one for freshwater and diadromous species and one for marine species) present the results of this assessment. These tables are followed by an explanatory text for each type of gear which presents the information that was used to evaluate the catch probability and the risk of mortality as well as to weight the impact on survival and recovery.

Commercial fishery for freshwater and diadromous species

This portrait of commercial fisheries (Table 1) was prepared using the 2009-2010 MRNF fisheries management plan. It targets the fisheries carried out in the St. Lawrence from the Quebec-Ontario border up to the port of Rimouski and that are managed by the government of Quebec under the *Quebec Fishery Regulations* under the *Fisheries Act*. It is important to note that there may be annual changes in fishing procedures. Any new commercial fishery or any significant change of procedures for a particular type of fishery (e.g. fishing period extended) should be evaluated considering the possible impacts on the striped bass population in the St. Lawrence Estuary.

Table 1. Impact assessment on the survival and recovery of the striped bass population in the St. Lawrence Estuary for the different types of commercial fisheries for freshwater and diadromous species in the St. Lawrence from the Quebec-Ontario border up to the port of Rimouski. The descriptions of the fishing gear and usage periods presented are the minimum and maximum values and from the 2009-2010 MRNF fishery management plan (for specific features for a given fishing sector, please refer to the 2009-2010 MRNF fishery management plan). Risk level: N = nil or almost nil, L = low, M = moderate and H = high.

Gear	Targeted species	Description of gear and authorized fishing effort*	Period	Catch probability		Risk of mortality	Impact on survival and recovery
				Time-space	Gear features		
Eel trap	- American eel	- maximum of 150 gears in the distribution range.	- April 1st to December 31st.	N	N	L	**N**
Gillnet (fixed or drifting)	- American shad	- mesh of 13 to 15 cm; - maximum of 46 gears for 1,998 fathoms in the distribution range.	- May 1st to June 30th.	L	M-H	L (drifting) H (fixed)	**N**
Gillnet	- Rainbow smelt	- mesh of 3.2 cm minimum; - maximum of 43 gears for 1,062 fathoms in the distribution range.	- September 1st to December 31st.	N	L	H	**N**
Gillnet	- Channel catfish - Carp - Lake sturgeon or Atlantic sturgeon - Walleye	- mesh of 19 cm to 20.3 cm; - 5 to 50 fathoms per net or in some cases, no maximum length; - maximum of 12,480 fathoms in the distribution range.	- April 1st to November 30th.	N-M	L	H	**N**
Gillnet	- Channel catfish - Carp	- mesh of 20.3 to 29.2 cm or in some cases 19 cm and over; - maximum net length 10 fathoms; - maximum of 4,872 fathoms in the distribution range.	- April 1st to July 15th.	L	N-L	H	**N**
Trammel-net	- several species	- mesh of 8.25 cm or 9 cm and over; - maximum net length 50 fathoms; - maximum of 250 fathoms in the distribution range.	- April 1st to June 14th and September 1st to November 30th.	N	M	L	**N**

Gear	Targeted species	Description of gear and authorized fishing effort*	Period	Catch probability		Risk of mortality	Impact on survival and recovery
				Time-space	Gear features		
Trotline	- American eel - Brown bullhead - Channel catfish	- maximum of 2,000 to 3,800 hooks per permit; - hook size 4/0 or less to 5/0.	- April 15th to September 30th.	L	L	H	**N**
Seine	- several species	- mesh of 5 cm or more; - maximum height may be restricted (6 m); - seine length 35 fathoms; - maximum of 306 fathoms in the distribution range.	- April 1st to June 15th and September 1st to November 30th.	N	L-M	N	**N**
Seine	- Rainbow smelt	- maximum of 7 gears for 230 fathoms in the distribution range.	- September 1st to December 31st.	N	L-M	N	**N**
Trap	-several species such as American eel	- mesh of 3.2 to 5.7 cm maximum for the netting leaders; - maximum of 51 gear for 8,686 fathoms of netting leaders in the current distribution range.	- April 1st to December 14th.	H	H	M	**M**
Fyke net	- several species	- maximum length of netting leader: 10 fathoms; - maximum length of wings: 4 fathoms; - maximum of 2,118 gears in the distribution range.	- April 1st to February 15th.	H	H	L	**L**
Various gear (bait trap, square net, dip net, nasse, seine)	- bait fish	- no detail.	- April 1st to March 31st.	N	L	N	**N**

* The fishing effort is the sum of authorized gear in the distribution range from the 2009-2010 MRNF fishery management plan.

Rationales for authorizing commercial fisheries targeted at freshwater and diadromous species

Based on the 2009-2010 MRNF fisheries management plan and comments from experts consulted, the following rationales were formulated for each type of fishing gear:

American eel traps:

- Catch probability: nil or almost nil, this fishing gear is specific to Lake St. François, a sector not occupied by striped bass because of upstream obstacles that are virtually impassable (except via the locks) and the gear's form is not favourable for capturing striped bass.
- Risk of mortality for striped bass captured accidentally: very low, because the fish are alive until the gear is lifted from the water.
- Impact on the survival and recovery of the striped bass population: nil or almost nil because striped bass does not occupy the sector where this gear is used and because the risk of mortality for striped bass captured accidentally is very low. In addition, this fishing gear is not currently used.

Drifting and fixed gillnets for American shad:

- Catch probability: low in terms of time-space, while probability related to the gear's features is moderate to high, because mesh-size of these nets can capture striped bass, particularly larger individuals. Upstream from Quebec, the fixed and drifting nets are primarily used between Gentilly and Lake St. Pierre, a sector occupied by striped bass, but seldom during the authorized fishing period. Most of the striped bass wintering upstream from Gentilly have usually returned downstream. Upstream from Quebec, only the fixed American shad nets are used, and this is at the limit of the striped bass distribution. Fixed nets are used in intertidal areas that may be occupied by striped bass, but it is unlikely that these habitats are occupied by striped bass during the authorized fishing period. However, a striped bass individual was captured in an American shad fixed net in the Kamouraska sector in 2008.
- Risk of mortality for striped bass captured accidentally: high by fixed gillnets because they are lifted after a long period and striped bass captured accidentally might be dead when the net is lifted. For drifting nets, the risk of mortality is low because the drifting nets are lifted after a short fishing period.
- Impact on the survival and recovery of the striped bass population: nil or almost nil for both types of nets, upstream from Quebec. This fishery is currently conducted over a short period (i.e. around 2 weeks), in a restricted sector and it is conducted only by a few fishermen. In addition, striped bass are unlikely to occupy this sector during the authorized fishing period. These fishermen are participants in the monitoring network.

Rainbow smelt gillnets:

- Catch probability: nil or almost nil in terms of time-space and low for gear features because the gear is only used in the Charlevoix region, a region that the species does not traditionally occupy. These nets have small mesh that would likely only catch small striped bass born during the summer.
- Risk of mortality for striped bass captured accidentally: high. Striped bass captured accidentally could be dead when the net is lifted.

- Impact on the survival and recovery of the striped bass population: nil or almost nil, the region where the gear is used is not very occupied by striped bass and this type of gear is selective for small size striped bass.

Gillnets for carp, channel catfish, lake and Atlantic sturgeon and walleye:

- Catch probability: nil or almost nil to moderate in terms of time-space according to the targeted species and low according to the fishing gear's features. The sector where the fisheries are conducted is occupied by striped bass, but in the estuary, these nets are installed primarily in deep waters and striped bass is a pelagic fish. Atlantic sturgeon commercial fishermen have been participating in the monitoring network since 2007 and there has been no reported striped bass capture so far. In addition, the authorized mesh-size (i.e. between 19 and 20.3 cm) would only allow for capturing larger individuals.
- Risk of mortality for striped bass captured accidentally: high. Striped bass captured accidentally may be dead when the nets are lifted.
- Impact on the survival and recovery of the striped bass population: nil or almost nil because of the mesh selectivity and the habitat where the fishing gear is used. Atlantic sturgeon fishermen are participants in the monitoring network.

Gillnets for carp and channel catfish:

- Catch probability: low in terms of time-space and nil or almost nil for the fishing gear's features. These nets are used in the spring upstream from Quebec primarily in shallow riparian grass bed areas (2-4 m), unlikely occupied by striped bass. In addition, the mesh-size of these nets (i.e. between 20.3 and 29.2 cm) only captures very large individuals.
- Risk of mortality for striped bass captured accidentally: high. Striped bass captured accidentally may be dead when the nets are lifted.
- Impact on the survival and recovery of the striped bass population: nil or almost nil because of the mesh selectivity and the habitat which is seldom used by striped bass.

Trammel-nets, several species:

- Catch probability: nil or almost nil in terms of time-space and moderate according to the fishing gear's features. This type of fishery is specific for Lake St. Louis in spring and fall, a sector very rarely occupied by striped bass. In addition, these nets are deployed in dense grass beds, which striped bass rarely occupy. However, this fishing gear could be effective if placed in a striped bass habitat.
- Risk of mortality for striped bass captured accidentally: low because nets are installed during a short period and captured fish stay alive.
- Impact on the survival and recovery of the striped bass population: nil or almost nil because this fishery is conducted in a sector rarely used by striped bass and the risk of mortality for striped bass captured accidentally is low. In addition, there is currently only one fisherman conducting this type of fishing.

Trotline for American eel and other species:

- Catch probability: low, this gear is only used in Lake St. Pierre and Lake St. François sectors. Based on available knowledge, larger striped bass individuals moved up the St. Lawrence River towards Lake St. Pierre in the fall, likely to winter there. Most striped bass left this area in the spring. Therefore, their potential for capturing striped bass in these waterways during the authorized fishing period is low. In addition, trotlines are dropped on the bottom in riparian grass beds in shallow areas that are not occupied by

striped pass. Even though striped bass are likely to take the hook, they are unlikely to come in contact with this fishing gear because of the habitat where the fishing gear is deployed.

- Risk of mortality for striped bass captured accidentally: high because the gear is usually lifted every 24 hours, striped bass captured accidentally may be dead by the time the lines are lifted.
- Impact on the survival and recovery of the striped bass population: nil or almost nil, this fishing gear is installed in a very limited area not often occupied by striped bass during the authorized fishing period. In addition, this gear is installed in habitats not occupied by striped bass.

Seine for several species:

- Catch probability: nil or almost nil in terms of time-space and low to moderate for the fishing gear's features. This fishery is mostly conducted in Lake St. Pierre and Montérégie in shallow riparian waters. It is also permitted in the Charlevoix region, a region that the species doesn't traditionally occupy. However, this type of gear could be effective for capturing striped bass and the beach seine was used to catch striped bass prior to it disappearance (Robitaille and Girard, 2002)[3].
- Risk of mortality for striped bass captured accidentally: nil or almost nil because this type of gear is not likely to cause striped bass mortality and individuals can easily be released.
- Impact on the survival and recovery of the striped bass population: nil or almost nil, even though this fishing gear is effective for capturing striped bass, the risk of mortality is low for striped bass captured accidentally. In addition, very few fishing gear are authorized in the striped bass distribution range.

Seine for rainbow smelt:

- Catch probability: nil or almost nil in terms of time-space and low to moderate for the fishing gear's features. This fishery is permitted in the Charlevoix region and it is not traditionally occupied by striped bass. However, this type of fishing gear could be effective for capturing striped bass and the beach seine was used for capturing striped bass prior to its disappearance (Robitaille and Girard, 2002).
- Risk of mortality for striped bass captured accidentally: nil or almost nil because this type of gear is not likely to cause striped bass mortality and individuals can easily be released.
- Impact on the survival and recovery of the striped bass population: nil or almost nil because this fishery is conducted in a sector not occupied by striped bass, the fishery is not intense (i.e. 7 authorized gears) and the risk of mortality of striped bass captured accidentally is low.

American eel trap:

- Catch probability: high because striped bass, between their juvenile and adult stages, are vulnerable to this type of gear. The netting leaders direct striped bass to the traps where they are captured. These traps are set up in a sector and habitat occupied by striped bass, in the intertidal area in the fall. Since 2004, over 400 striped bass

[3] According to Robitaille and Girard (2002), the beach seine was used to capture striped bass prior to it disappearance in the late 1960s. Fishermen used a shore seine of 60 cm by 2.5 cm and when mesh was stretched out measured 6 cm. The seine had to be weighted with a chain in order to avoid floating and to reach the bottom, when the depth exceeded the height of the fishing gear. The seine was released from a boat and then retrieved on the shore.

individuals captured with this type of gear were delivered to the MRNF within the framework of population monitoring.

- Risk of mortality for striped bass captured accidentally: moderate. Based on an ongoing study (MRNF), the risk of mortality for striped bass captured accidentally in traps is estimated at 50%. The risk is lower upstream from Quebec since the water level in traps remains high enough to allow for a safe release of striped bass captured accidentally. However, the risk of mortality is higher around the Kamouraska area. When the tide is low, some traps become waterless, which likely causes the death of striped bass captured accidentally.
- Impact on the survival and recovery of the striped bass population: moderate. Striped bass are vulnerable to the trap fishery and risk of mortality of striped bass captured accidentally is moderate. In the sector where juvenile striped bass were very vulnerable to this fishery prior to their disappearance (i.e. around Île d'Orléans and on the south shore, from St. Nicholas to Montmagny), the fishing effort exercised by this type of gear has considerably decreased during the 1960s and 1970s. In addition, in 2009, the number of authorized traps in the St. Lawrence River and Estuary dropped by 73%, from 190 to 51 (and only 35 are actually installed). Consequently, only 21 commercial trap fishermen still have active permits in the striped bass distribution range between St. Romuald and Rimouski, one fishermen near Quebec and the other 20 between Île d'Orléans and the mouth of the Saguenay River on the north shore and Rimouski on the south shore. Consequently, the sector where juvenile striped bass were very vulnerable prior to their disappearance is no longer a sector where the fishing effort is significant. Those commercial fishermen have been participants in the population monitoring network since 2004 and the information provided has helped produce a first portrait of the situation for this new population (Pelletier 2009). In 2009, a mitigation measure was added, living striped bass of more than 20 cm when the gear was lifted had to be released, and dead individuals of 20 cm and all striped bass captured dead or alive measuring less than 20 cm (i.e. those born during the current summer, age 0+) had to be delivered to MRNF biologists.

Fyke net:

- Catch probability: high, fyke nets are used upstream in the river in waters with little current, in a sector occupied by striped bass. In addition, this fishing gear is potentially very effective for capturing striped bass, netting leaders are used to guide the fish towards the fyke nets. A few striped bass have been reported in this type of fishing gear. In 2009, several commercial fishermen who were using this type of gear were solicited to participate in the monitoring network. It will henceforth be easier to assess accidental striped bass catch probabilities by fyke nets in upcoming years.
- Risk of mortality for striped bass captured accidentally: low, because almost all fish captured in fyke nets remain alive, if they are lifted regularly, which allows for the safe release of the captured striped bass.
- Impact on the survival and recovery of the striped bass population: low, even though this type of fishery is likely to capture a large number of striped bass, the risk of mortality for striped bass captured accidentally is low and individuals can be released alive. Since 2009, these fishermen have been participants in the monitoring network.

Various gear (bait trap, square net, dip net, nasse, seine) for bait fish:

- Catch probability: nil, this gear is used to capture small fish as bait fish. The gear is installed in shallow habitat areas, in a sector not very likely to be occupied by striped bass and thus represents a low risk level. Only very small striped bass could be captured by this type of gear.

- Risk of mortality for striped bass captured accidentally: nil or almost nil and striped bass can be released alive.
- Impact on the survival and recovery of the striped bass population: nil or almost nil, this fishery is unlikely to capture striped bass and the risk of mortality for striped bass captured accidentally is low.

Conclusion on commercial fisheries targeted at freshwater and diadromous species

This portrait of the commercial fisheries targeted at freshwater and diadromous species helps to conclude that overall, these commercial fishing activities are unlikely to have an impact on the survival and recovery of the reintroduced striped bass population in the St. Lawrence Estuary. Except for the American eel trap and the fyke net fisheries, all the other freshwater commercial fishing activities have a nil or almost nil impact. The number of authorized eel traps has significantly decreased, and thus the impact on the survival and recovery of the striped bass population is considered moderate. For fyke nets, the impact on the survival and recovery is considered low, because striped bass captured accidentally can usually be released alive.

These two groups of fishermen along with American shad and Atlantic sturgeon fishermen are participants in the monitoring network and they deliver captured striped bass to the MRNF. In 2009, the release of all live specimens of 20+ cm should further limit the impact of this fishery on the survival and recovery of the striped bass population in the estuary. In light of the information provided, the loss of a few individuals due to these commercial fishing activities on freshwater and diadromous species does not jeopardize the recovery and helps monitoring.

Since few striped bass will be captured accidentally in these fisheries and that the data collected is critical for monitoring the population, the harmful effects to the striped bass population in the estuary caused by these commercial fishing activities on freshwater and diadromous species does not jeopardize its survival and recovery. This advice on freshwater commercial fisheries is valid only for current fishery conditions.

Commercial fisheries for marine species

Fisheries for marine species in the St. Lawrence Estuary are managed by the Canadian government under the *Atlantic Fishery Regulations* of the *Fisheries Act*. Commercial activities involving striped bass concern Northwest Atlantic Fisheries Organization (NAFO) Unit Area 4Tp, which extends from Quebec to Ste. Flavie on the south shore and to Colombier on the north shore. This unit area represents the primary distribution range of striped bass in the marine environment according to the extirpated population and reintroduced population data as reported by the monitoring network.

Striped bass observations, reported between 1975 and 1994 on the Gaspé Peninsula's north shore, are likely attributable to migrating individuals belonging to the Miramichi River population (COSEWIC, 2004). Since the current impact assessment of commercial fisheries concerns the St. Lawrence Estuary population, extending this analysis to the coast of the Gaspé Peninsula was not necessary (NAFO Unit Areas 4Tq and 4To).

For commercial fisheries that could capture striped bass accidentally, details concerning the different types of fishing gear stem from the fishing plans specific to the targeted species, combined with comments from experts consulted and landing statistics for 2006-2008 seasons (Table 2). It should be noted that this analysis of commercial fisheries for marine species was

based on the procedures from the last fishing plans and that any change or new fishery should be reassessed considering the possible impacts on the striped bass population.

An initial assessment of commercial fishery activities in Unit Area 4Tp helped eliminate certain fisheries which striped bass catch probabilities were considered nil (e.g. whelk and snow crab fisheries using traps, Stimpson's surfclams and scallops with dredges, soft-shell clams with rakes and tongs, and diving for sea urchins).

Table 2. Impact assessment on the survival and recovery of the striped bass population in the St. Lawrence Estuary for the different types of commercial fisheries for marine species in Unit Area 4Tp. The values presented are generic and are from fishing plans or from permit conditions for the 2009-2010 season (for the features from each type of fishery, please refer to the fishing plan specific to each species). Risk level: N = nil or almost nil, L = low, M = moderate and H = high.

Gear	Targeted species	Description of gear* and fishing effort**	Period	Catch probability		Risk of mortality	Impact on survival and recovery
				Time-space	Gear features		
Gillnet	- Greenland halibut (turbot)	- maximum net length of 50 fathoms and minimum mesh of 152 mm; - 60 to 120 nets maximum for all fishermen in the estuary and Gulf; - Fishing effort between 2006 and 2008: Between 7 and 12 vessels for a total number of fishing days between 108 and 386 and a total number of nets installed between 1,704 and 9,553.	- between April and October depending on the year.	N	L	H	**N**
Gillnet	- Atlantic herring (bait fish)	- maximum 3 nets (per permit) and total length less than 50 fathoms; - maximum 2,000 lb. per day; - minimum mesh 57.1 mm; - Fishing effort between 2006 and 2008: no data.	- between April 1st and June 30th.	N	M	H	**N**
Gillnet	- Atlantic herring (spring stock)	- maximum 25 gillnets and total length less than 375 fathoms; - minimum mesh 57 mm; - maximum depth 100 mesh; - Fishing effort between 2006 and 2008: between 0 and 4 vessels for a number of fishing days between 0 and 25 (between 2 and 11 days per vessel).	- competitive fishery beginning when water is free of ice.	N	M	H	**N**

Gear	Targeted species	Description of gear* and fishing effort**	Period	Catch probability		Risk of mortality	Impact on survival and recovery
				Time-space	Gear features		
Gillnet	- Atlantic herring (fall stock)	- 150 fathoms and 125 mesh for a minimum mesh size of 63.5 mm; - per 24 hours maximum quantity of 351 ft³/ 20,000 lb or 439 ft³/25,000 lb; - Fishing effort between 2006 and 2008: no vessel.	- competitive fishery beginning July 1st.	N	M	H	**N**
Longline	- Atlantic halibut	- maximum between 500 and 3,000 hooks (8,000 in some cases) per permit with opening of ≥ 15.4 mm; - Fishing effort between 2006 and 2008: between 1 and 5 vessels for a total number of fishing days between 2 and 20.5 and a total number of hooks between 2,200 and 16,400.	- from May to September, a few days.	N	N	L-M	**N**
Longline	- Greenland halibut (turbot)	- maximum between 4,000 and 8,000 hooks per permit with opening of 12.6 mm; - Fishing effort between 2006 and 2008: only 1 vessel in 2006 for 1.33 fishing days and 8,000 hooks	- from May to September, a few days.	N	N	L-M	**N**
Trapnet (i.e. weir)	- Capelin and Atlantic herring	- only 1 trap per permit and only one permitted in the striped bass distribution range in 2009; - Fishing effort between 2006 and 2008: 1 to 2 fishermen, Ste. Irénée and Isle-aux-Coudres, total 88 and 25 fishing days in 2006 and 2007.	- capelin: May 2nd to August 31st. - Atlantic herring: January 1st to December 29th (mostly in spring).	N	H	N	**N**

* The number of authorized gear is usually applied for a wider area than that occupied by striped bass.
** Fishing effort is evaluated based on statistical data from landings from 2006-2008 in Area 4Tp.

Rationale for authorizing commercial fisheries targeted at marine species

Based on the DFO fishery management plans and comments from experts consulted, the following rationales were formulated for each type of fishing gear:

Gillnet for Greenland halibut (turbot):

- Catch probability: nil or almost nil in terms of time-space and low for the fishing gear's features. The turbot fishery with gillnets is carried out over a long period, only at the limits of the striped bass distribution range and usually in deep waters. Because striped bass is a pelagic fish, it is not very vulnerable to this type of fishery. In addition, the nets used have large mesh (i.e. minimum 152 mm), which would likely only capture very large size striped bass.
- Risk of mortality for striped bass captured accidentally: high. Striped bass captured accidentally would likely be dead when nets are lifted.
- Impact on the survival and recovery of the striped bass population: nil or almost nil because the gillnet fishery is carried out in deep waters in a sector not frequently occupied by striped bass and this gear is selective for large size individuals. Consequently, striped bass are not likely to be vulnerable to this gear type, but it would be important to monitor this fishery in sectors where the fishing effort is significant.

Gillnet for Atlantic herring (bait fish):

- Catch probability: nil or almost nil in terms of time-space and moderate for the fishing gear's features. The exploitation of herring with gillnets is only carried out at the limits of the identified striped bass distribution range. The gillnets used only have small mesh (i.e. minimum 57.1 to 66.7 mm), which would enable the capture of small size striped bass, individuals of around 1 year-old which are unlikely to occupy the sector when fishing is permitted.
- Risk of mortality for striped bass captured accidentally: high. Striped bass captured accidentally would likely be dead when nets are lifted.
- Impact on the survival and recovery of the striped bass population: nil or almost nil because this fishery is carried out at the limit of the striped bass distribution range and this fishing gear is selective for smaller individuals. In addition, traditionally, these individuals did not occupy this area.

Gillnet for Atlantic herring (spring stock):

- Catch probability: nil or almost nil in terms of time-space and moderate for the fishing gear's features. The exploitation of herring with gillnets is only carried out at the limits of the identified striped bass distribution range. In addition, the gillnets used only have small mesh (i.e. minimum 63.5 mm), which would enable the capture of small size striped bass, individuals of around 1 year-old which are unlikely to occupy the sector when fishing is permitted.
- Risk of mortality for striped bass captured accidentally: high. Striped bass captured accidentally would likely be dead when nets are lifted.
- Impact on the survival and recovery of the striped bass population: nil or almost nil because this fishery is carried out at the limit of the striped bass distribution range and this fishing gear is selective for smaller individuals. In addition, traditionally, these individuals did not occupy this area.

Gillnet for Atlantic herring (fall stock):

- Catch probability: nil or almost nil in terms of time-space and moderate for the fishing gear's features. The exploitation of herring with gillnets is only carried out at the limits of the identified striped bass distribution range. In addition, the gillnets used only have small mesh (i.e. minimum 63.5 mm), which would enable the capture of small size striped bass, individuals of around 1 year-old which are unlikely to occupy the sector when fishing is permitted.
- Risk of mortality for striped bass captured accidentally: high. Striped bass captured accidentally would likely be dead when nets are lifted.
- Impact on the survival and recovery of the striped bass population: currently nil or almost nil even though this fishery is carried out in a pelagic environment. In fact, this fishery is not carried out in the striped bass distribution range and there are no landings associated with this fishery in the 2006-2008 fishery statistics in Unit Area 4Tp. In the event of any change in fishing sectors, a reassessment of the impact on striped bass should be conducted.

Longline for Atlantic halibut:

- Catch probability: nil or almost nil. This fishery is carried out in deep waters (i.e. in channels) and at the limit of the striped bass distribution range and fishing is only permitted for a few days. In addition, the hooks used are circular and very large (i.e. 15.4 mm), thus unlikely to capture striped bass.
- Risk of mortality for striped bass captured accidentally: low to moderate according to the longline soak time.
- Impact on the survival and recovery of the striped bass population: nil or almost nil, because the fishery is carried out in deep water and the hooks used are not effective for capturing striped bass. In addition, fishing is only permitted for a few days.

Longline for Greenland halibut (turbot):

- Catch probability: nil or almost nil. This fishery is carried out in deep waters and at the limit of the striped bass distribution range. In addition, fishing is only permitted for a few days. The hooks used are circular and very large (i.e. 12.6 mm), thus unlikely to capture striped bass.
- Risk of mortality for striped bass captured accidentally: low to moderate according to the longline soak time.
- Impact on the survival and recovery of the striped bass population: nil or almost nil, because the fishery is carried out in deep water and the hooks used are not effective for capturing striped bass. In addition, the longline fishery targeted at Greenland halibut in the sector occupied by striped bass in the St. Lawrence Estuary is uncommon.

Trapnet (i.e. weir) for capelin or Atlantic herring:

- Catch probability: nil or almost nil in terms of time-space and high for the fishing gear's features. This fishery was carried out in the heart of the old population's marine distribution environment, for several weeks each year. Since 2009, only one fisherman uses this gear in the Ste. Irénée area and based on available data, the Ste. Irénée traps have never captured striped bass. Capelin and herring traps that were present at Isle-aux-Coudres are no longer permitted. This fishing gear is not very selective and could likely capture striped bass of all sizes.
- Risk of mortality for striped bass captured accidentally: nil or almost nil, almost all fish captured in trapnets at Ste. Irénée stay alive until nets are lifted because the water level

in the traps remains sufficiently high (except for high tides). This feature allows for the safe release of captured striped bass.

- Impact on the survival and recovery of the striped bass population: nil or almost nil. Currently this fishery is only carried out at Ste. Irénée in a sector not occupied by striped bass and the water level in the trap usually remains sufficiently high to allow for the safe release of captured striped bass.

Conclusion on commercial fisheries targeted at marine species

Based on available information, the risk of striped bass captures in marine species' commercial fishing gear is nil or almost nil. According to monitoring network data, these fisheries are carried out in a sector at the limit of the historic and recent striped bass distribution range. Knowledge acquisition in upcoming years will help assess the impact of marine species' commercial fishing activities and eventually adapt regulations and management measures required for decreasing the possible impacts on the striped bass population, if necessary.

Consequently, this portrait of commercial fisheries targeted at marine species helps to conclude that these fishing activities do not jeopardize the survival and recovery of the reintroduced striped bass population in the St. Lawrence Estuary. This advice on marine species' commercial fisheries is valid only for current fishery conditions.

Sport and Recreational Fisheries

In Quebec, sportfishing for freshwater and diadromous fish are managed by the Quebec government, and recreational fisheries for marine species are managed by the Canadian government.

In order to practice sportfishing in freshwater, fishermen must have a sportfishing permit and respect the *Quebec Fishery Regulations* under the *Fisheries Act*. According to these regulations, it is prohibited to keep striped bass captured during sportfishing and captured individuals must be released back into the water[4].

For marine species' fisheries, guidelines from the *Atlantic Fishery Regulations* under the *Fisheries Act* regulate recreational fishing for marine species and the species permitted (e.g. capelin, mackerel, some ground fish).

Description of sportfishing

The fishing effort by sport fishermen in the St. Lawrence River in 2005 was estimated at 627,688 fishing days, mostly located west of Île d'Orléans (68% of the effort) (DFO, 2007). The principal species captured are northern pike (*Esox lucius)*, muskellunge (*Esox masquinongy)*, yellow perch (*Perca flavescens)*, walleye (*Stizostedion vitreum*) and largemouth bass (*Micropterus sp.*). Fishermen carry out their activities either wading or from boats when the river is free of ice and most of them use a lightweight casting rod. Ice fishing is also quite popular on the river and is generally carried out from December to March, when the ice cover is thick

[4] For the 2009-2011 seasons, the publication *Sport Fishing in Quebec* states that *"...in order to contribute to the reintroduction of striped bass in the St. Lawrence River, all fishermen must release this species back into the water. Capturing striped bass is prohibited under the regulations and its release is therefore mandatory*".

enough. Enthusiasts mostly practice ice fishing on lakes St. Pierre, St. Louis and Deux-Montagnes, and the primary species targeted are walleye, yellow perch and northern pike as well as redfish, cod and turbot in the Saguenay Fjord (Environment Canada, 2009). The fishing gear used is the ripper and tip-up.

With a reputation for being combative and having delicate meat, striped bass were very popular among sport fishermen before their disappearance (Robitaille, 1999). This activity was carried out primarily between Quebec and Montmagny during summer, particularly from mid-July to late September. Since their reintroduction, sport fishermen have reported capturing some few dozen striped bass in the St. Lawrence, beginning in 2003, a year after the first stocking. Between 2003 and 2008, 4 striped bass that were captured by sport fishermen were delivered to MRNF biologists and in 2008, 40 striped bass were captured or spotted by sport fishermen and reported to the CDPNQ (Pelletier, 2009). Of these reported captures, only one was made during ice fishing activities in 2009, despite specifically monitoring this fishery on Lake St. Pierre in 2008 and 2009.

Rationale for authorizing sportfishing

Currently, under the *Quebec Fishery Regulations*, in the event a striped bass is captured, sport fishermen must immediately release the individual where it was captured, and make sure, it the fish is alive, to harm it as least as possible. In order to inform sport fishermen that striped bass have been reintroduced, a vast awareness raising campaign was carried out in 2005 by the Fédération québécoise des chasseurs et pêcheurs (Fédécp) (e.g. awareness posters, information sessions, interviews and articles in newspapers). This campaign was designed to inform sport fishermen about the mandatory release of captured striped bass and was aimed at promoting catch declarations to the CDPNQ in order to monitor the species' recovery. However, it is impossible to estimate the proportion of striped bass captured accidentally during sportfishing that are actually released and reported to the CDPNQ. Nevertheless, this analysis helps to conclude that due to the mandatory release and the awareness raising campaign carried out, the impact from sportfishing will not likely jeopardize striped bass recovery. However, it is important to continue monitoring sportfishing in order to reassess its impact on the striped bass population in upcoming years.

Sources of Uncertainty

This impact analysis of accidental captures of striped bass by commercial and recreational fisheries must take into consideration certain sources of uncertainty. The striped bass population is currently in reconstruction and should grow over the next few years (stocking and natural spawning). However, it is difficult to evaluate the population's reaction to changes in its habitat. In addition, very little data is available to quantitatively assess the species' vulnerability to accidental captures by different fishing gear. Only long term monitoring of the reintroduced population could bridge these gaps.

Below is a non comprehensive list of uncertainties:

- No assessment of the striped bass population in the St. Lawrence Estuary.
- Little knowledge of the habitats frequented annually (e.g. spawning, migration, feeding) and the population's structure. Only data on the extirpated population is available.

- Several biological parameters of this new population are currently unknown, such as growth and natural mortality rates for this population.

- Few data on accidental captures by recreational and sportfishing.

- The risk of striped bass accidental captures by commercial fisheries is currently based on a population in reconstruction, it is difficult to project this risk on a more significant population.

- Little information on the survival rate following accidental captures by various types of fishing gear.

Conclusion

Among the great variety of fishing gear used in the St. Lawrence River, two of them appear to be more likely to capture striped bass accidentally, eel traps and fyke nets. Eel traps are effective for capturing striped bass and based on an ongoing study, the mortality rate of striped bass captured accidentally is estimated at 50%. The impact on the populations' survival and recovery was thus considered moderate. Eel fishermen were the first to participate in the striped bass population monitoring network and their collaboration has helped monitor the species' recovery. In 2009, the authorized number of eel traps dropped sharply, from 190 to 51. Furthermore, a new mitigation measure was added in order to limit the number of striped bass losses delivered to MRNF biologists (i.e. all living striped bass of 20+ cm must be released into the water). Fyke nets on the other hand could become effective gear as the striped bass population grows. However, fish are usually kept alive in fyke nets, as long as they are lifted on a regular basis. The impact of fyke nets on the striped bass population recovery is considered low and since 2009, fishermen using this gear have been participating in the monitoring network.

Despite the little available data and the uncertainties listed above, this advice on the impact of fisheries helps to conclude 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. Current fishing activities are not likely to jeopardize the recovery objectives formulated by the St. Lawrence striped bass recovery team.

Recommendations:

Due to the little available information and the many uncertainties, five recommendations have been formulated to mitigate the impact of fisheries as source of mortality on the striped bass population in the St. Lawrence Estuary and to monitor this population.

1. **Mitigation measure:** It is important to introduce if possible mitigation measures to reduce the impact of commercial and recreational fisheries on the striped bass population and to subsume this mitigation measures according to the population's growth. Currently, the only mitigation measure identified is the mandatory release of striped bass captured alive or dead for all fishermen except for wildlife management permit holders who must release only live striped bass of 20+ cm. Fishermen must do their best to improve the survival of striped bass captured accidentally when releasing

them back into the water. Increased knowledge over the next few years will help develop other mitigation measures for limiting the number of accidental captures and losses of individuals resulting from these captures.

2. **Capture declarations:** For all commercial and recreational fishermen, it is important to report striped bass captures. Monitoring accidental captures of striped bass is necessary in order to acquire data in order to monitor the new population but also to better evaluate the impact of these fisheries and eventually to reassess the situation. Recording striped bass captures in commercial fishermen logbooks and declaring captures from recreational fishermen to the CDNPQ will help gather data in order to better assess the impact of accidental captures on the population's survival and recovery.

3. **Raising the awareness of fishermen:** Educating and raising the awareness of the fishermen is necessary in order for them to respect the first two recommendations; releasing captured individuals and declaring captures. Several recreational fishermen have been informed by the awareness raising campaign led by the Fédécp and several commercial freshwater and diadromous species fishermen have also been advised by the monitoring network. It is important to continue raising the awareness of fishermen and to include commercial marine species fishermen.

4. **Monitoring network:** It is important to make sure that all commercial fishermen participate in the monitoring network. The monitoring network must cover the species' entire distribution range and help collect specimens in order to characterize the new striped bass population (e.g. condition, growth, sexual maturity, fecundity). A first portrait was provided thanks to the monitoring network (Pelletier, 2009). However, it is important to adapt the procedures for the wildlife management permits annually according to the needs of the monitoring network in order to avoid losing striped bass unnecessarily that can be released back into the water (e.g. releasing live individuals of 20+ cm in 2009).

5. **Reviewing the analysis:** This advice on commercial and recreational fisheries is valid as long as the information on which the advice is based is up to date. Any change that alters the vulnerability of striped bass to commercial and recreational fisheries could require an update of the advice. In addition, because of the many uncertainties and possible change in terms of the striped bass population in the St. Lawrence Estuary, the assessment of allowable harm by the fishery will have to be reviewed after a five year period. This schedule should provide enough time to acquire new data on the reintroduction of striped bass and on the species' vulnerability to accidental captures by various types of fishing gear.

Contributors

Contribution	Name	Affiliation
Author and editor	J. Beauchamp	DFO, Species at Risk Management Branch
Author	M. Bérubé	DFO, Species at Risk Management Branch
Author	F. Grégoire	DFO, Fisheries and Aquaculture Science Branch
Author	M. Legault	MRNF, Service de la faune aquatique
Author	Y. Maillot	MRNF, Direction de l'expertise énergie, faune, forêts, mines et territoire de la Mauricie et du Centre-du-Québec
Author	C. Thiboutot	DFO, Resource Management and Aboriginal Fisheries Branch
Author	G. Trencia	MRNF, Direction de l'expertise énergie, faune, forêts, mines et territoire, Capitale-Nationale et Chaudière-Appalaches
Author	G. Verreault	MRNF, Direction de l'expertise énergie, faune, forêts, mines et territoire du Bas-Saint-Laurent
Examiner	G. Bourget	MRNF, Direction de l'expertise énergie, faune, forêts, mines et territoire du Bas-Saint-Laurent
Examiner	S. Coulombe	DFO, Fisheries and Aquaculture Science Regional Branch
Examiner	C. Cyr	DFO, Scientific Advice, Information and Support Branch
Examiner	R. Gosselin	DFO, Resource Management and Aboriginal Fisheries Branch
Examiner	J. Robitaille	Coopérative des conseillers en écologie appliquée de Québec
Examiner	Members	Équipe de rétablissement du bar rayé de l’estuaire du Saint-Laurent

Approved by

Serge Gosselin
Director, Scientific Advice, Information and Support Branch
Mont-Joli, Quebec
Date: December 11, 2009

Sources of Information

Bourget, G., G. Verreault, R. Tardif, M. Legault and D. Deschamps. 2008. Bilan de l'année 2008 du suivi de la réintroduction du bar rayé dans le Saint-Laurent. Ministère des Ressources naturelles et de la Faune. 1 pp.

Comité aviseur sur la réintroduction du bar rayé. 2001. Plan d'action pour la réintroduction du bar rayé (*Morone saxatilis*) dans l'estuaire du Saint-Laurent. Société de la faune et des parcs du Québec, Direction du développement de la faune, 41 pp.

COSEWIC. 2004. Assessment and status report on the striped bass (*Morone saxatilis)* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, viii + 51 pp.

Environment Canada. 2009. St. Lawrence Centre, St. Lawrence Info, Sportfishing in the St. Lawrence River [On line] Available at http://www.qc.ec.gc.ca/csl/inf/inf021_e.html (viewed August 26, 2009).

DFO (Fisheries and Oceans Canada). 2006. Recovery Assessment Report for the St. Lawrence Estuary, Southern Gulf of St. Lawrence and Bay of Fundy Striped Bass (*Morone saxatilis*) Populations. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/053. 23 pp.

DFO (Fisheries and Oceans Canada DFO). 2007. 2005 Survey of Recreational Fishing in Canada. Economic Analysis and Statistics, Policy Sector, 52p. Available at http://www.dfo-mpo.gc.ca/communic/statistics/recreational/canada/2005/index_e.htm.

MRNF (Ministère des Ressources naturelles de la Faune et des Parcs). 2009. Pêche sportive au Québec, saison 2009-2011. Available at http://www.mrnf.gouv.qc.ca/publications/enligne/faune/reglementation-peche/index.asp (Viewed July 15, 2009).

Pelletier, A.-M 2009. Premier portrait biologique de la nouvelle population de bar rayé (*Morone saxatilis*) qui colonise le fleuve Saint-Laurent suite aux ensemencements réalisés entre 2002 et 2008. Ministère des Ressources naturelles et de la Faune, Direction de l'expertise Faune-Forêts-Territoire du Bas-Saint-Laurent. 55 pp.

Robitaille, J. A. 1999. Rétablissement du bar rayé dans le Saint-Laurent : évaluation des possibilités et des contraintes. Bureau d'écologie appliquée, 67 pp.

Robitaille, J. A. 2001. Biologie et exploitation de la population disparue de bar rayé (*Morone saxatilis*) du Saint-Laurent. Bureau d'écologie appliqué, Fondation de la Faune du Québec, Société de la faune et des parcs du Québec, 80 pp.

Robitaille, J.A., and I. Girard. 2002. Observations sur le bar rayé (*Morone saxatilis*) du Saint-Laurent recueillies auprès de pêcheurs témoins de sa disparition. Québec, Fondation Héritage Faune, Bureau d'écologie appliquée, Société de la faune et des parcs du Québec. 43 pp.

Robitaille, J., M. Bérubé, A. Gosselin, M. Baril, J. Beauchamp, J. Boucher, M. Legault, Y. Mailhot, B. Ouellet, P. Sirois, G. Trencia and G. Verreault. 2009. Striped bass (*Morone saxatilis*) recovery strategy, St. Lawrence Estuary population, Canada [PRELIMINARY]. Recovery strategy series under the Species at Risk Act. Ottawa, Fisheries and Oceans Canada.

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Center for Science Advice (CSA)
Quebec Region
Fisheries and Oceans Canada
Maurice Lamontagne Institute
850, route de la mer,
Mont-Joli (Quebec)
G5H 3Z4

Telephone: (418) 775-0825
Fax: (418) 775-0679
E-mail: Bras@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas

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