Ministère des Forêts, de la Faune et des Parcs
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Forêts, Faune et Parcs
Québec

Update on the status of the American eel (*Anguilla rostrata*) in Québec *November 6, 2019 version, translated*

Summary

This scientific advice is an update on the knowledge and status of the American eel in Québec. Once considered one of the most common fish species in the province, its distribution range and abundance are showing the greatest decline ever observed. Despite recovery efforts over the past two decades, species recruitment is still declining and the stock shows no signs of recovery. There are multiple causes to this decline, many of them anthropogenic. The general decline in the species' range is such that some states, provinces and agencies have granted the American eel a conservation status to ensure its protection and others are in the process of doing so. The abundance of the eel stock in Québec is regarded as very concerning.

Distribution and status of the resource in Québec's regions

The American eel is established in all of the watersheds associated with the St. Lawrence River and the Gulf of St. Lawrence; most of the administrative regions of Québec are thus affected by the status of the species. The longest series of data available to estimate the relative abundance of eels in Québec come from monitoring juveniles during their upstream migration to rearing sites in the upper St. Lawrence River and from monitoring adults in the fluvial and upper estuary (commercial fishing) during their downstream migration to the spawning grounds. The status of eels in the tributaries of the Gulf of St. Lawrence and the baie des Chaleurs is more difficult to determine since the monitoring of recruitment and downstream migration covers only a short period of time. However, such recent monitoring suggests that the decline would be less sharp in eastern Québec than in the upper St. Lawrence system. Little information exists on the situation in the watersheds connected to the St. Lawrence River and the Gulf of St. Lawrence, where eels carry out part of their life cycle. This reality is an issue for many regions where the species' status is unknown locally despite the erection of new hydroelectric dams and the development of forest roads (culverts and roads).

Indicators of American eel abundance in Québec

The eel's status is raising concerns in Québec. Annual recruitment of juvenile eels upstream of the St. Lawrence River system, at the outlet of Lake Ontario, has been very low since the mid-1990s. In 2017, it was estimated at 0.8% of the average for the 1975-1985 period (Figure 1a). Yellow and silver eel landings based on voluntary declarations by commercial fishers have been in steady decline since the early 1990s. This decline in landings can be explained by the decline in eel abundance, combined with the various commercial gear buyback programs implemented during the 2002-2013 period. In 2016, reported commercial landings for the St. Lawrence River were the lowest ever recorded (33.3 t) and represent only 7.2% of the average for the 1975-1990 period (Figure 1b). Prior to the 1960s, more than 80% of the commercial landings recorded in Québec came from the upstream portion of the St. Lawrence River and its tributaries. In 2009, a fishing licence buyback program for the estuary's silver eel fisheries resulted in a 48% decrease in fishing effort, which translated into a decrease of the exploitation rate of more than 50% (21.5% in 1996-1997 and 9.2% in 2010-2011). The buyback programs for multispecies fishing licences in lac Saint-Pierre between 2001 and 2008 resulted in a reduction of eel landings of between 14% and 37%, taking into account the simultaneous decline in the abundance of the species. The buyback program in the Pont Laviolette-Île d'Orléans (PLIO) sector in 2013 would have had an impact of at most 5% on eel landings.

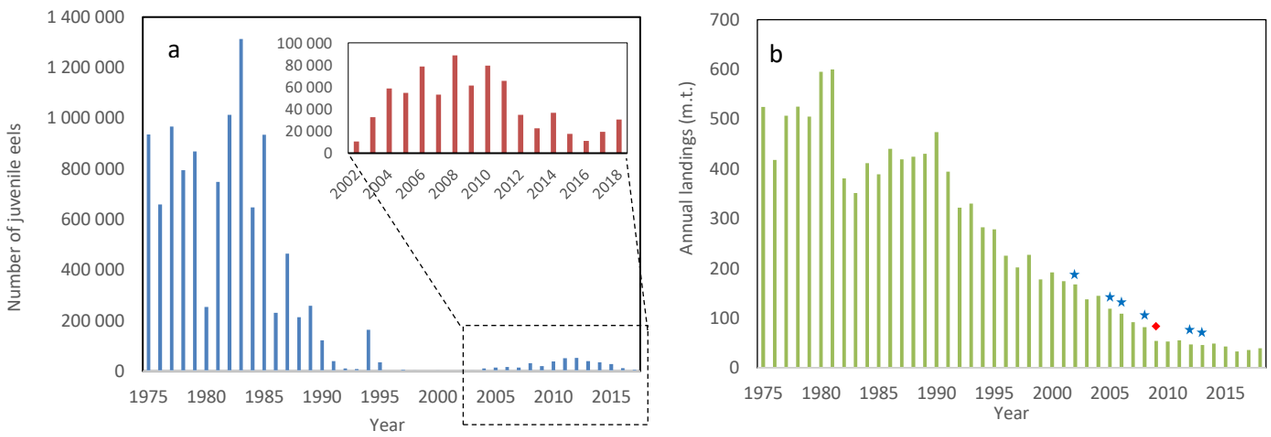


Figure 1. Population indicators monitoring. a) Number of juvenile eels passing through the eel ladders of the Moses-Saunders dam during their upstream migration. From 1975 to 2005, only one eel ladder was in operation on the Ontario side of the dam. A second eel ladder has been in place since 2006 on the New York side (source: Ontario Power Generation and New York Power Authority). The mean age of eels at this site varies from 4 to 7 years old. The box above shows the number of juvenile eels passing through the Beauharnois dam's eel ladders during their upstream migration. In 2002 and 2003, only one eel ladder was active on the west side of the dam. A second eel ladder has been in place since 2004 on the east side (source: Hydro-Québec). The mean age of eels at this site varies from 4 to 5 years old. b) Total commercial landings of yellow and silver eels in the St. Lawrence River (source: MAPAQ). The mean age of the silver eels varies from 12 to 17 years old. No recent biological information is available for yellow eels. The red diamond indicates the eel-specific licence and fishing gear buyback program, and the blue stars indicate the multispecies licence and gear buyback programs (Table 6).

Sources of uncertainty and limitations of population indicators

Although a significant decline in the recruitment of juveniles and the number of spawners (silver eels) has been observed, the assessment of the situation is based on a very limited number of indicators. Recruitment monitoring is limited to eel counts through the eel ladders of the Chambly dam (rivière Richelieu), the Beauharnois and the Moses-Saunders dams located on the main course of the St. Lawrence River. No other recruitment time series of this magnitude is available elsewhere in the province. The abundance indicator for the reproductive segment is derived from commercial silver eel landings on the south shore of the St. Lawrence estuary. With a harvest of less than 10,000 silver eels in 2017, commercial fishing in this sector reached historic low levels. Natural production in the St. Lawrence watershed upstream of the upper estuary that year was estimated at only 72,000 silver eels, or approximately 15% of the abundance estimated 20 years before. No recent abundance estimates are available for other Québec watersheds. Despite a decrease in fishing activities, as a result of the buyback programs introduced in the early 2000s, the downward trend in the harvest has continued. The harvest assessment varies from region to region and is often limited to a few sites, so no realistic range-wide estimate for Québec can be made. Although there are commercial and recreational fisheries in the Îles-de-la-Madeleine, there is a lack of data on the annual harvests for that area. Finally, although recreational fishing is allowed in several fishing areas, the activity seems marginal, but it cannot be quantified.

Threats

Table 1. Importance of threats and their impact on the American eel in Québec.

	Importance of threats				Impact on eels			
Type of threat	**1975-2000**	**2001-2017**	**2018**	**Justification**	**1975-2000**	**2001-2017**	**2018**	**Justification**
Habitat fragmentation	X	X	X	> 12,000 km² inaccessible, anthropogenic obstacles	↓	↓	↓	Nearly 3,200 dams in the eel's area of distribution in Québec, but only 10 eel ladders
Turbine mortality	X	X	X	Combined mortality > 40% for Beauharnois + Moses-Saunders	↓	↓	↓	No improvement for Beauharnois and Moses-Saunders, unknown for the other dams
Parasites / exotic species	?	?	?	*Anguillicoloides crassus* (*A. crassus*) detection in 2008 in rivers from which translocated glass eels where sourced for transfers	?	?	?	*A. crassus* present in naturally recruited eels in 2017 and 2018
Fishery	X	X	–	Harvesting rate < 10% in the estuary for silver eels	↓	↓	↓	Continuous decline of the two harvested phases
Contamination	X	X	?	No information	↓	–	?	No information on new contaminants
Climate change	?	?	?	Habitat alteration	?	?	?	Anticipated change in recruitment

Importance of threats: High intensity X Medium intensity X Low intensity – Unknown intensity ?

Impact on eels: Deleterious ↓ Stable – Unknown ?

Prior to 1975, episodes of silver eel mass mortality were regularly observed in the St. Lawrence estuary starting in the 1960s and it was estimated that they could exceed 100 tonnes (1972) annually during the 1960s and 1970s. The exact causes were never identified.

Reliability of the evaluation

The level of reliability of the available knowledge about the characteristics of the species and the different threats varies widely.

Table 2. Robustness and scope of the assessment of the eel status in Québec

Item	Robustness of the assessment	Scope of the assessment
Abundance	Robust but partial	Limited to the reproductive segment harvested in the estuary fishery. For annual recruitment, limited to the upper St. Lawrence River and the rivière Richelieu. Sporadic and partial monitoring was carried out on other tributaries of the St. Lawrence River and the Gulf of St. Lawrence.
Population dynamics	Not robust and partial	The population dynamics are unknown (except on the rivière du Sud-Ouest) and the definition of sensitive habitats is limited. It is difficult to assess the impact of our future actions.
Habitat fragmentation	Robust and quantitative	Available for the entire St. Lawrence basin. Limited to dams of 1 m or more. No assessment of the number and passability of the culverts.
Turbine mortality	Robust but partial	Limited to the Beauharnois-Les Cèdres (17.8%) and Moses-Saunders (26.4%) hydroelectric dams. For the other sites, the mortality rate is theoretical or unknown.
Parasites / exotic species	Robust but partial	Limited to *A. crassus* for silver eels caught in the St. Lawrence estuary commercial fishery and eels caught as part of recruitment monitoring at the Beauharnois and Chambly dams.
Fishery	Robust but partial	Reliable and complete harvest statistics for the estuary fishery. Partial and incomplete data for other sectors (St. Lawrence River and Îles-de-la-Madeleine).
Contamination	Not robust and unknown	Little data on contamination over the last 10 years. Impact of emerging contaminants not quantified. Impact on recovery potential unknown.
Climate change	Not robust and partial	No quantification regarding the impact of this threat on the St. Lawrence River stock.

Conservation status of the species

The American eel has varying conservation status throughout its distribution range. In Québec and Canada, **no legal protection status** is currently granted to the species. Six organizations or countries and provinces have listed the American eel on a list conferring varying levels of protection.

- International Union for Conservation of Nature (IUCN): endangered;
- Atlantic States Marine Fisheries Commission (United States of America): depleted;
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC): threatened;
- **Québec: included on the list of species likely to be designated as threatened or vulnerable;**
- Ontario: endangered;
- Newfoundland: vulnerable.

Importance of the upper St. Lawrence River for overall eel production

The panmictic nature of the species (a single population) and the spatial heterogeneity, on a North American scale, of the abundance of males and females indicates that the situation in Québec has a particular impact on the American eel population as a whole. This situation is explained by the fact that, naturally, only large fecund females (on average more than 12 million eggs per female) are produced in the upper St. Lawrence River. The production of spawners in watersheds located downstream of the upper estuary is not quantified, despite their large surface area and high growth habitat potential (e.g., contribution of Côte-Nord stocks).

Importance for Indigenous Peoples and heritage value

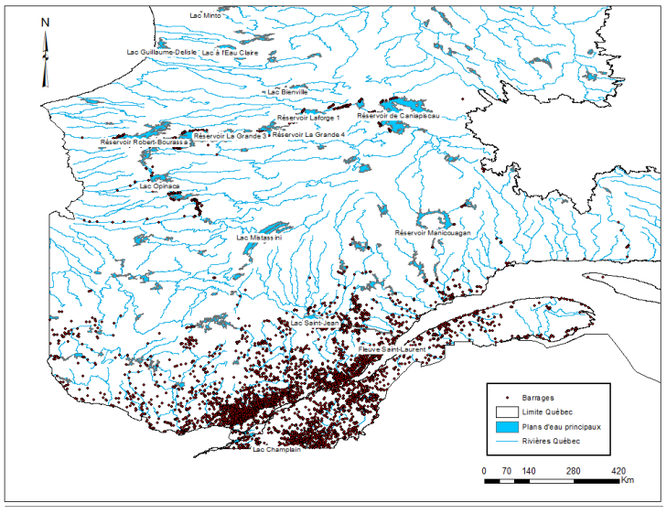
For First Nations, eel fishing was a seasonal activity of primary importance. In addition to being a first-rate food resource that enabled them to survive the winter dearth, eels were prized for their medicinal virtues and many parts of the fish were used to make basic necessities. It was, and still is, considered a sacred animal for many nations and several clans identify with the eel ("eel clan"). This fishery also allowed the first settlers to take advantage of the abundance of this energetic species to build up food reserves to survive the winter. In the 1940s to 1960s, as many as 600 commercial eel fishers were added to the many farmers who fished with fishing gear at the edge of their land.

Details on the main threats

The six main threats listed in Table 1 are presented to illustrate their magnitude and impact. The main bibliographical references can be found at the end of this document.

1- Habitat fragmentation

Out of 5,443 inventoried and analyzed dams, of which nearly 3,200 are in the historical range of the species, 94.4% are difficult or impossible for eels to pass through when moving upstream, especially for specimens larger than 20 cm. For downstream movements, 14% of the dams are difficult (significant delays incurred and significant mortality) or impossible (100% mortality) for eels to pass through, while all the others are partially passable but cause significant delays. Several of these dams are located downstream of the watersheds and therefore have an impact on access to all areas upstream of the site. No assessment of the number and crossability of bridges and culverts is available for the range. It is estimated that the reduction in free access to habitats upstream of the obstacles would have resulted in a **production loss of more than 1,000 tonnes or 835,000 reproductive eels** annually.



Barrages = Dams — Plans d'eau principaux = Main bodies of water

Limite Québec = Québec boundary — Rivières Québec = Québec rivers

Figure 2. Dams listed in the database of the Centre d'expertise hydrique du Québec in 2019

2- Turbine passage mortality

The only mortality estimate available in Québec's distribution range for American eels comes from the Beauharnois–Les Cèdres hydroelectric complex where mortality rates were at 23.9% for propeller turbines (n=10) and at 15.8% for Francis turbines (n=43) for a combined rate of 17.8%. It was estimated that 68,816 eels were killed while passing through the turbines of this complex in 1996. There are **more than 150 hydroelectric generating stations in Québec** within the eel's range and no mortality estimates are available for them.

3- Parasites and diseases

Although eels are recognized as a potential host for several parasites, no data is available for the St. Lawrence River. The presence of the nematode *A. crassus*, an exotic parasite found in the swim bladder of eels, was suspected in 2007 in glass eels samples from Nova Scotia and New Brunswick destined for transfer to Lake Ontario and the rivière Richelieu. Transfers stopped the following year in Québec, but continued in Ontario until 2010. Subsequently, the parasite's presence was confirmed in Ontario in 2010 and in Québec since 2015 in translocated eels. The frequency of parasitized individuals has been increasing since 2015 and the parasite is now found in naturally recruited eels. The impact is considered negative but has not been demonstrated.

Table 4. Occurrence of *A. crassus* in silver eels caught in the St. Lawrence estuary fishery

Year	Occurrence (%)	Comments
2015	0.3	Parasites in a translocated eel
2016	0.9	Parasites in three translocated eels
2017	3.6	Parasites in six eels (three translocated and three of natural origin)
2018	1.3	Parasites in four eels (three translocated and one of natural origin)

4- Commercial Fishing

Eel harvesting takes place mainly in the St. Lawrence River, in the estuary and marginally in the Îles-de-la-Madeleine. Aside from the annual volume of commercial landings, little information is available for the fishery upstream of the estuary. Silver eels in downstream migration are harvested in the upper estuary, while the fishery in lac Saint-Pierre and the fluvial estuary mainly targets yellow eels (growing residents). In this sector, six licence buyback programs were conducted. In lac Saint-Pierre, it is estimated that the impact of buybacks on the reduction of commercial landings would be on the order of 14% to 37%, depending on the indicator used. In the PLIO sector, the impact of the buyback on landings was more modest and would have reached at most 5%. The trend for landings in these two sectors is still declining. The estuary fishery is very well described both in terms of fishing parameters and the caught eels' biological characteristics. The average harvest rate, which was 21.5% in the late 1990s, fell to less than 10% after a voluntary buyback program in 2009 that reduced the number of licences granted from 67 to 21. Fewer than 15 fishers are active in this sector and the catch trend is downward for a stable fishing effort. In the Îles-de-la-Madeleine, the last harvest characterization dates back to the 2008 season. At that time, the total harvest was estimated at 8,100 eels. The current harvesting rate in this archipelago is not known.

5- Contamination

Eels have characteristics that make them sensitive to contamination. In the past, the consumption and export of eels for international markets was restricted due to high contamination of eel tissue, notably by mercury (1970-1971) and Mirex (1982-1983). By 1990, the levels of mercury and Mirex observed in eels had been halved compared to 1982. With respect to polychlorinated biphenyls (PCBs), from 1983 to 2012, eels from Lake Ontario exceeded Canadian consumption guidelines but no restrictions were enforced. In 2012, PCB concentrations were 10 times lower than in 1982. Although, as of 2012, tested eels no longer exceed Canadian standards for human consumption for PCBs, dichlorodiphenyltrichloroethane (DDT) and organochlorine pesticides, current contamination levels exceed the targets objectives set by the International Joint Commission for the protection of birds and animals that consume fish. Although the impact of contamination on eel recovery potential is unknown, the fact remains that this species is strongly affected by contaminants found in the aquatic environment.

6- Climate and ocean changes

Projected climate change and anticipated changes in ocean currents (e.g. Gulf Stream) could have an influence on the species' dynamics, notably by partially or totally preventing glass eels from having access to current rearing habitats and some fear negative impacts on the future abundance of eels in North America. Despite the great plasticity demonstrated by this ubiquitous species that exploits aquatic ecosystems from northern Venezuela to Greenland and Iceland, the speed at which climate change is likely to occur and the greater frequency of extreme events might have unpredictable effects on local stocks. The ministère des Forêts, de la Faune et des Parcs (MFFP) cannot directly address this threat. However, by acting on those threats whose impacts can be reduced or eliminated, the MFFP facilitates the American eel's adaptation to these changes.

Summary of past recovery actions

Since the first signs of deterioration in the status of the eel stock, several compensation and recovery actions have been taken. The results achieved for the latter are presented below. These actions were carried out by the MFFP and/or its partners.

Table 3. List of key eel recovery actions in Québec prior to 2019

Year	Action	Results	Organizations involved
1994 - 2001	Installation of an experimental eel trap at the Beauharnois dam (left bank/west bank).	This temporary structure demonstrated that eels use this site to cross the dam.	Hydro-Québec
1997	Installation of an experimental eel trap at the Chambly dam.	This temporary structure demonstrated that eels use this site to cross the dam. A total of 10,863 eels were counted in 1997.	Hydro-Québec
1998 to present	Installation of a fixed eel ladder at the Chambly dam.	The number of eels counted varies greatly from one year to the next, ranging from a minimum of 199 to a maximum of 9,875.	Hydro-Québec
1998	Installation of an eel ladder on rivière Rimouski and a fine screen to avoid turbine mortality.	Mitigation measure required by the MFFP to ensure free access to eels. Upstream and downstream passage is possible without eel mortality.	Private owner of the hydroelectric dam
1999	Experimental transfer to lac Morin (40,000 glass eels).	Demonstrate the feasibility of introducing glass eels to increase local eel production.	Association des pêcheurs d'anguilles du Québec MFFP
2001	Installation of an eel ladder at the Saint-Ours Dam (rivière Richelieu).	Eels use the eel ladder, but their numbers are not known.	Parks Canada
2002 to present	Installation of a permanent eel ladder at the Beauharnois dam (left/west banks).	As many as 87,942 eels have passed through the eel ladder annually, but the average number of eels passing through the eel ladder over the past five years is 22,983.	Hydro-Québec
2002 - 2008	Four fyke net buyback programs as part of the Yellow Perch Management Plans (lac Saint-Pierre).	The total number of fyke nets authorized in lac Saint-Pierre decreased by 86% during this period. Reduction in eel landings estimated at between 14% and 37%, depending on the estimation method. Reduction in the harvesting rate as a result of the buyback unknown and not assessed.	MAPAQ MFFP Héritage Faune
2004 to present	Installation of a permanent eel ladder at the Beauharnois Dam (right/east bank).	As many as 28,127 eels passed through the eel ladder per year, but eels mainly use the west eel ladder.	Hydro-Québec
2005 - 2010	Experimental glass eel transfer program.	Translocation of a total of 2.8 million glass eels to the rivière Richelieu to colonize lac Champlain (2005 to 2008) and 4.0 million glass eels to Lake Ontario (2006 to 2010). Program stopped because of the risk of spreading the *A. crassus* parasite. In 2017, one-third of the 9,933 eels caught by the commercial fishery in the estuary came from translocations.	Hydro-Québec, Ontario Power Generation, Association des pêcheurs d'anguilles du Québec, MFFP
2006	Installation of two eel ladders and a fine screen at the rivière Magpie dam.	Compensation measure required by the MFFP to ensure free access to eels. After the installation of two temporary eel ladders, the permanent installation of an eel ladder was completed in 2014 and allows eels to pass upstream. The fine screen allows part of the fish that come into the intake canal to be diverted from the dam's water intake.	Magpie Limited Partnership
2008 to present	Trap and transfer program of large, maturing eels from upstream of the Moses-Saunders and Beauharnois dams to the downstream side of the obstacles.	Helps avoid turbine mortality during migration to spawning sites. The number of adults transported varies from 1,000 to 2,200 annually. Considering the total turbine mortality rate of 40% (combining Moses-Saunders and Beauharnois), it made it possible to add 225 to 750 adults annually to the reproductive population, depending on the source of the eels caught. A historic high of 4,968 eels were transferred in 2017.	Ontario Power Generation MFFP
2009	Eel licence and trap buyback program (St. Lawrence estuary).	Helped reduce the harvesting rate by half, from 21.5% to 9.2% (2011).	Hydro-Québec MAPAQ MFFP
2012	Eel licence and fishing gear (fyke nets, eel traps and set lines) buyback program (upstream of lac Saint-Pierre, including rivière des Outaouais).	Elimination of fishing pressure upstream of lac Saint-Pierre, including the rivière des Outaouais, except in Lac Saint-François, where low eel landings are still reported. The reduction in the harvesting rate is not known.	Hydro-Québec MAPAQ MFFP
2012	Eel inventory by eel traps at the foot of Penman's dam on rivière Yamaska.	No catches. In the authorization for the rehabilitation work, an eel ladder and a dam management protocol to avoid mortality during down-river travel were required for 2024.	Ville de Saint-Hyacinthe
2013	Fishing gear buyback program (fyke nets and set lines), mainly in the Pont Laviolette-Île d'Orléans (PLIO) sector.	Reduction of 36% in the authorized fyke net fishing effort in the PLIO sector and 100% in the set lines fishing effort in lac Saint-Pierre. Reduction of 100% of the fishing effort authorized for Saint-Roch-des-Aulnaies and Gaspésie with the buyback of the fyke nets available in these sectors. Impact on the reduction of eel landings in the PLIO sector assessed at most 5%. Reduction in the harvesting rate as a result of the buyback unknown and not assessed.	Hydro-Québec MAPAQ Fondation de la faune MFFP
2013	Installation of eel ladders at the l'Épiphanie and Saint-Lin dams (rivière de l'Achigan).	Removable eel ladder to ensure the unobstructed passage of eels on rivière de l'Achigan. Eel-specific ladder that does not allow aquatic invasive species to cross the barriers. Eel ladder installed in 2013, 2015 and 2016. Cannot be installed during high spring flows. About ten eels have crossed the eel ladder.	Fondation de la faune, Ville de L'Assomption, Ville de l'Épiphanie Ville de Saint-Lin-Laurentides, Hydro-Québec, MFFP
2014-2019	Eel transfer to rivière des Outaouais.	Measure to ensure the presence of an eel population in the downstream section of rivière des Outaouais between the Carillon dam and the chutes des Chaudières dam (Gatineau).	MRNF-Ontario Hydro-Québec MFFP Ottawa Riverkeeper Canadian Wildlife Federation

Outlook

The particular biology of the American eel (semelparity, catadromy, panmixia, etc.), coupled with the large number of threats for which it is often impossible to act, limits the options for stopping and reversing the significant decline of the species. Knowledge acquisition on rivers and estuaries throughout their distribution range should be continued in order to better understand the biology of the species and its status. Among the threats described, the lack of free access to rearing habitats and turbine mortality remain priorities. No significant progress has been made in over 10 years, and turbines remain the largest source of mortality. A knowledge acquisition plan should also be put in place to assess other threats such as parasites, commercial fishing and contamination. The low recruitment observed upstream of the St. Lawrence system is extremely concerning, and actions to increase it in the short term should be thoroughly evaluated. The results of experimental translocation of more than 6,800,000 glass eels between 2005 and 2010 are globally positive and have generated tens of thousands of reproductive females annually for the past few years. By acting on threats that can be reduced or eliminated, the MFFP promotes the American eel's ability to cope with threats for which no direct action is possible.

The knowledge acquired and published over the past 15 years forms the basis of this advice. Because of the eel's unique biological characteristics and long migrations that extend well beyond Québec's territory, the MFFP has always worked closely with neighbouring provinces and states as well as its partners to ensure that the proposed actions remain realistic and adapted to the Québec context. The MFFP is working on developing an action plan aiming to optimize eel growth in Québec territory, limit the mortality of migrating eels and gain knowledge that will help guide recovery efforts for the conservation of this iconic species for Québec.

Information on data from the various partners

The data and information used to draw up this advice come from several sources. The table below summarizes the type of data used and their sources.

Table 4. List of partners and their expertise

Type of data/information	Source
Juvenile eel migration at the eel ladders of the Beauharnois–Les Cèdres hydroelectric complex and the Chambly dam	Hydro-Québec
Juvenile eel upstream migration at the Moses-Saunders dam	Ontario Power Generation, New York Power Authority and Ontario Ministry of Natural Resources and Forestry (OMNRF)
Commercial landings	Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec
Export (international trade) Knowledge acquisition of the marine environment and the Maritime Provinces	Fisheries and Oceans Canada
Indigenous traditional knowledge	Iroquois and Algonquin Nations of Québec - Abenakis, Innus, Malecites of Viger, - Algonquin, Atikamekw, Micmac, - Huron-Wendat, Mohawk.
Local actions and specific research projects	Association des pêcheurs d'anguilles et d'esturgeons noirs du Québec Association des pêcheurs commerciaux du lac Saint-Pierre et du secteur PLIO Non-profit organizations (NPOs) Watershed-based organizations (WBOs) Regional Environmental Councils (RECs)

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