Species at Risk Act
Management Plan Series

Management Plan for the Grass Pickerel (*Esox americanus vermiculatus*) in Canada

Grass Pickerel

2012

Fisheries and Oceans Canada
Pêches et Océans Canada
Canada

About the *Species at Risk Act* management plan Series

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

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003, and one of its purposes is "*to manage species of special concern to prevent them from becoming endangered or threatened*."

What is a species of special concern?

Under SARA, a species of special concern is a wildlife species that could become threatened or endangered because of a combination of biological characteristics and identified threats. Species of special concern are included in the SARA List of Wildlife Species at Risk.

What is a management plan?

Under SARA, a management plan is an action-oriented planning document that identifies the conservation activities and land use measures needed to ensure, at a minimum, that a species of special concern does not become threatened or endangered. For many species, the ultimate aim of the management plan will be to alleviate human threats and remove the species from the List of Wildlife Species at Risk. The plan sets goals and objectives, identifies threats, and indicates the main areas of activities to be undertaken to address those threats.

Management plan development is mandated under Sections 65-72 of SARA.

A management plan has to be developed within three years after the species is added to the List of Wildlife Species at Risk. A period of five years is allowed for those species that were initially listed when SARA came into force.

What's next?

The management plan sets out some of the recommended conservation measures and activities that jurisdictions, communities, land users, and conservationists can implement to help prevent further declines and encourage restorative benefits. Cost-effective measures to prevent the species from becoming further at risk should not be postponed for lack of full scientific certainty and may, in fact, result in significant cost savings in the future.

The series

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

To learn more

To learn more about the *Species at Risk Act* and conservation initiatives, please consult the SARA Public Registry.

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Additional copies:

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PREFACE

The Grass Pickerel is a freshwater fish and is under the responsibility of the federal government. The Minister of Fisheries and Oceans is a "competent minister" for aquatic species under the *Species at Risk Act* (SARA). Since Grass Pickerel is also located in Point Pelee National Park and St. Lawrence Islands National Park, both administered by the Parks Canada Agency, the Minister of the Environment is "competent minister" under SARA for individuals of this species that are located there. The Grass Pickerel was listed as a species of Special Concern under SARA in May 2006. SARA (Section 65) requires the competent minister(s) to prepare management plans for both species listed as Special Concern and their habitat. The development of this management plan was led by Fisheries and Oceans Canada – Central and Arctic region and Quebec region and Parks Canada Agency, in cooperation and consultation with many other individuals, organizations and government agencies including the provinces of Ontario and Quebec, the Ontario Freshwater Fish Recovery Team, and Quebec Cyprinidae and Small Percidae Recovery Team (see Appendix 1 for list of members). The plan meets SARA requirements in terms of content and process (SARA sections 65-68).

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this plan and will not be achieved by Fisheries and Oceans Canada and Parks Canada Agency or any other party alone. This plan provides advice to jurisdictions and organizations that may be involved or wish to become involved in activities to conserve this species. In the spirit of the Accord for the Protection of Species at Risk, the Ministers of Fisheries and Oceans and Environment Canada invite all partner jurisdictions and Canadians to join Fisheries and Oceans Canada and Parks Canada Agency in supporting and implementing this plan for the benefit of the Grass Pickerel and Canadian society as a whole. The competent Ministers will report on progress within five years.

AUTHORS

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ACKNOWLEDGMENTS

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STRATEGIC ENVIRONMENTAL ASSESSMENT

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally-sound decision making.

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

This management plan will clearly benefit the environment by promoting the conservation of the Grass Pickerel. The potential for the plan to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this plan will benefit the environment and will not entail any significant adverse effects. The reader should refer to the following sections of the management plan in particular: Description of the Species' Habitat and Biological Needs (Section 1.4.1), Ecological Role (Section 1.4.2); Limiting Factors (Section 1.4.3); Description of Threats (Section 1.5.2); Effects on Other Species (Section 2.4); and, Implementation Actions (Section 2.3).

EXECUTIVE SUMMARY

In 2005, the Grass Pickerel was designated a species of Special Concern in Canada by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and was listed on Schedule 1 of the *Species at Risk Act* (SARA) in 2006. The COSEWIC designation was based on the species' restricted distribution and declining population estimates in three of 10 known locations.

The Grass Pickerel is a sub-species of the Redfin Pickerel from the pike family Esocidae. It has the usual pike-like body (i.e., long, relatively shallow and cylindrical to sub-cylindrical body, large mouth with many teeth, forked tail and posterior dorsal and anal fins) and is generally less than 300 mm in total length with a maximum recorded total length of 381 mm. The global range of the Grass Pickerel is restricted to North America, and in Canada, its range is restricted to a small number of populations in Ontario and Quebec. However, in Quebec, the species' presence has not been confirmed for 20 years. This species is most commonly found in warm, slow-moving, heavily vegetated wetland-associated streams, ponds and shallow bays of larger lakes. They are typically ambush predators that feed predominately on fishes and, to a lesser extent, aquatic insects and crustaceans.

A principal concern for the future survival of Grass Pickerel populations in Canada is habitat destruction and degradation (including impacts from sediment and nutrient loading). Grass Pickerel appear to have specific habitat requirements and their long-term viability may be threatened by continued development and human encroachment at some locations. Of particular concern has been the loss of wetland habitat through rural land use practices including agricultural and other development activities. Additional potential threats identified for populations in Ontario and Quebec include drainage, damage/destruction of riparian or aquatic vegetation, contaminants input, exotic species, interspecific interactions, climate change, fishing pressure, water level fluctuations (beyond natural seasonal variability), disease, and barriers to movement.

The goal of this management plan is to ensure the long-term persistence of Grass Pickerel throughout their current and historical distribution in Canada. Management should be directed towards ensuring the conservation and restoration of habitat for known populations.

The following short-term management objectives (over the next 5 -10 years) have been identified to assist in meeting this goal:

i. To understand the health and extent of existing populations;
ii. To improve our knowledge of the species' biology, ecology and habitat requirements;
iii. To understand trends in populations and habitat;
iv. To maintain and improve existing populations;
v. To ensure the efficient use of resources in the management of this species; and,
vi. To improve awareness of the Grass Pickerel and engage the public in the conservation of this species.

Grass Pickerel has not been confirmed in Quebec for several years; therefore, it is necessary to establish the species' presence in Quebec, by conducting surveys of historical and potential new locations (Objective i), before further objectives can be met.

Approaches to reach the objectives listed above have been organized thematically into the following five categories, each of which is associated with key actions:

Surveys and monitoring

- Develop consistent protocols for surveying and monitoring Grass Pickerel populations, including the collection of genetic material should genetic analysis be required. See Portt *et al.* (2008) for the Ontario protocol to detect species at risk to determine appropriate gear types for sampling Grass Pickerel.
- Conduct background surveys to confirm current distribution at sites of known occurrence, including sites that have not been recently sampled.
- Conduct surveys in areas with suitable habitat but lacking Grass Pickerel records.
- Integrate the long-term monitoring requirements of Grass Pickerel with existing fish community survey efforts, where possible.
- Monitor the existence and potential arrival of exotic species in Grass Pickerel habitat. Where possible, this should be coordinated with relevant ecosystem-based programs.

Management and coordination

- Collaborate and share information with relevant groups, initiatives and recovery/management teams (e.g., drainage superintendents [Ontario], Priority Intervention Zone Committee (PIZ) [Quebec], Watershed committees [Quebec]), to address management actions of benefit to Grass Pickerel.
- Survey municipal drains proposed for maintenance activities before work occurs in locations suspected of supporting Grass Pickerel, but where records of such are lacking.
- Ensure that measures to mitigate potential impacts to Grass Pickerel are in place prior to and during in-water works (e.g., municipal drain maintenance, improvements, new drainage works). (See Appendix 1: Basic Principles to Minimize Impacts of Drainage Works on Grass Pickerel in Ontario.)
- Develop alternatives to drainage that will address land drainage needs while maintaining Grass Pickerel habitat.
- Create a central database, including habitat parameters, to facilitate Grass Pickerel data synthesis and transfer in Quebec (ongoing). A central database currently exists in Ontario.

Research

- Determine the seasonal habitat needs of the various life stages of Grass Pickerel.
- Gather information on the population dynamics of Grass Pickerel and fish community associations in Canada.
- Determine the quantity and quality of habitat required to ensure long-term conservation of Grass Pickerel and to support the long-term management goal.
- Conduct a threat assessment to evaluate threat factors that may be impacting the Grass Pickerel (e.g., exotic species, hybridization, interspecific competition with other esocids, water level management [e.g., in National Wildlife Areas]), which will be updated as new information becomes available.
- Determine the mechanisms by which drainage activities have caused Grass Pickerel populations to decline (e.g., through habitat loss or negative interspecific interactions). This will inform mitigation measures for drainage work.
- If justified, conduct a genetic assessment of the species across its range.

Stewardship, habitat protection and improvement, and threat mitigation

- Coordinate stewardship activities (e.g., federal/provincial funding programs) with existing groups and initiatives.
- Promote stewardship initiatives relating to Grass Pickerel conservation and ensure that information relating to funding opportunities for landowners is made available.

- Encourage the implementation of Best Management Practices relating to livestock management, the establishment of riparian buffers, nutrient and manure management, tile drainage etc.
- Promote retirement of fragile lands that provide Grass Pickerel habitat through Ecological Gift Programs, easements, and tax incentives (e.g., Conservation Land Tax Incentive Program [CLTIP] [Ontario]).

Outreach and communication

- Include the Grass Pickerel in existing and future communication and outreach programs for both ecosystem-based recovery as well as Endangered and Threatened aquatic species, to instil awareness of the need to protect freshwater fishes and ensure the health of freshwater ecosystems.
- Promote awareness with municipal planning offices, planning officials and drainage superintendents to develop and adopt land and stream management practices that minimize impacts on Grass Pickerel (e.g., see Appendix 1: Basic Principles to Minimize Impacts of Drainage Works on Grass Pickerel in Ontario)
- Develop and distribute educational materials to interested parties (e.g., local anglers, conservation biologists) that provide the key characteristics that distinguish the esocid species (particularly juveniles).
- Make landowners aware of various tax incentive programs for conservation lands (Ecological Gifts Program, easements, CLTIP [Ontario]) to protect Grass Pickerel habitat.

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1.1 Species assessment information from COSEWIC

Date of Assessment: May 2005
Common Name: Grass Pickerel
Scientific Name: *Esox americanus vermiculatus*
COSEWIC Status: Special Concern
Reason for Designation: A subspecies known from 10 locations between Lake St. Louis, Quebec and Lake Huron, Ontario. Its usual habitat is shallow water with abundance of aquatic vegetation. An overall decline of approximately 22% in the area of occupancy has been observed. This decline appears to be related to degradation and loss of habitat due to channelization and dredging operations in wetland habitats where this species occurs.
Canadian Occurrence: Ontario and Quebec
COSEWIC Status History: Designated Special Concern in May 2005. Assessment based on a new status report.

1.2 Description

The Grass Pickerel (*Esox americanus vermiculatus* Lesueur, 1846) (Figure 1), a subspecies of the Redfin Pickerel (*E. americanus*), is a relatively small member of the pike family (Esocidae). General characteristics of the pike family common to the Grass Pickerel include a long cylindrical to sub-cylindrical body, a large mouth with many teeth on a protracted snout, forked caudal fin and posterior dorsal and anal fins (Crossman and Holm 2005).

Figure 1. Grass Pickerel (*Esox americanus vermiculatus*). Copyright Joseph Tomelleri**.**

The Grass Pickerel can be morphologically distinguished from the Northern Pike (*E. lucius*) and Muskellunge (*E. masquinongy*) by its size, colouration, pattern and scaling. Grass Pickerel have a small adult size that is generally less than 300 mm total length (TL) (recorded maximum TL is 381 mm and maximum weight is 397 g) (Scott and Crossman 1998). Body colouration of the Grass Pickerel is variable but usually consists of a green to brownish background with 12 to 24 roughly vertical dark bars and black sub-, pre- and post-orbital bars, with juveniles displaying a pale lateral band that disappears as the fish matures (Crossman and Holm 2005). Grass Pickerel have fully scaled cheeks and opercula (Crossman and Holm 2005). The species can be distinguished from the Chain Pickerel (*E. niger*) and Redfin Pickerel by the number of

branchiostegal rays (bony rays that support the gill membrane); the Chain Pickerel has 14-17 rays, the Redfin Pickerel has 12-13 rays, while the Grass Pickerel has 11-12 rays (Scott and Crossman 1998). Additionally, the snout of the Redfin Pickerel is convex in profile and the lower fins are red to orange, while the Grass Pickerel has a concave snout in profile and dusky yellow-green lower fins (Scott and Crossman 1998).

Redfin Pickerel (*E. americanus*) was previously thought to be polyphyletic with one subspecies, Redfin Pickerel (*E. americanus americanus*), and monophyletic with Chain Pickerel; the other subspecies, Grass Pickerel, was found to be the sister group to Redfin Pickerel (*E. americanus*) and Chain Pickerel (Grande *et al*. 2004). However, it has subsequently been discovered that the apparent monophyletic relationship between Redfin Pickerel (*E. americanus*) and Chain Pickerel was a result of hybridization between the two species (N. Mandrak, Fisheries and Oceans Canada [DFO], pers. comm. 2009).

1.3 Populations and distribution

Distribution

Global Range: Natural populations of the Grass Pickerel are restricted largely to the west of the Appalachian Mountains, in the Great Lakes systems and Mississippi River basin (Figure 2). To the east, the species' range extends from the St. Lawrence River system, near Montreal, Quebec, to Texas, through northwestern New York State, western Pennsylvania, western Kentucky, the northwestern tip of Alabama, western Mississippi and Louisiana. To the west, it extends north from southeast Oklahoma to southern Ontario, through Arkansas and Missouri, eastern Iowa, southeast Minnesota, southwest Wisconsin, Illinois, Indiana and southern Michigan (Crossman and Holm 2005).

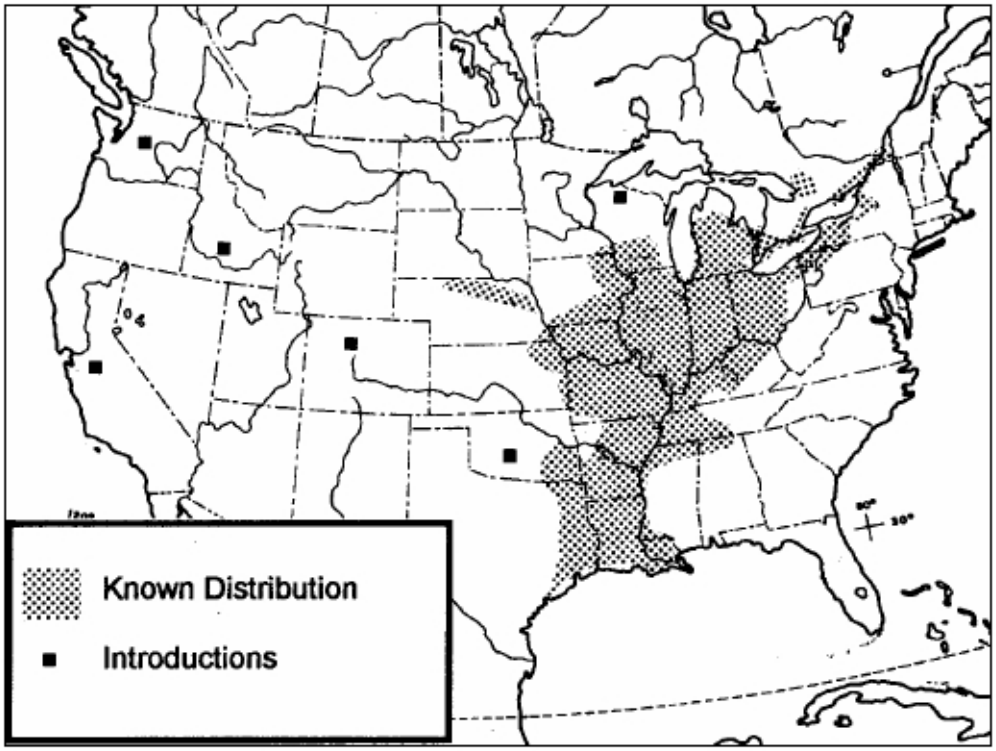

Figure 2. Global Grass Pickerel distribution (from Crossman and Holm 2005).

Canadian range: The Canadian range of the Grass Pickerel is disjunct and is represented by several populations in southern Ontario (Figure 3a-c and Table 1) and southwestern Quebec (Figure 4 and Table 2) (Crossman and Holm 2005).

Ontario - Grass Pickerel have been observed in the St. Lawrence River (including St. Lawrence Islands National Park) and its tributaries, the Lake St. Francis drainage (Cooper Marsh, Fraser Creek), in shallow bays and tributaries of eastern (Bay of Quinte region) and southwestern (Twenty Mile Creek) Lake Ontario, inland watercourses of the Niagara region (Niagara and Welland River tributaries) and Lake Erie (Grand River tributaries, Little Otter Creek) as well as the north shore of Lake Erie (West Townline Drain, Point Pelee National Park, Long Point region and Point Abino Drain). Populations occur in Lake St. Clair and some of its tributaries, in addition to several waterbodies in the Lake Huron watershed (Old Ausable Channel [OAC], Mud Creek, L Lake, Gartersnake River, South Kahshe River and Kahshe Lake) (Ausable Bayfield Conservation Authority [ABCA], unpubl. data, Crossman and Holm 2005, Royal Ontario Museum [ROM], unpubl. data).

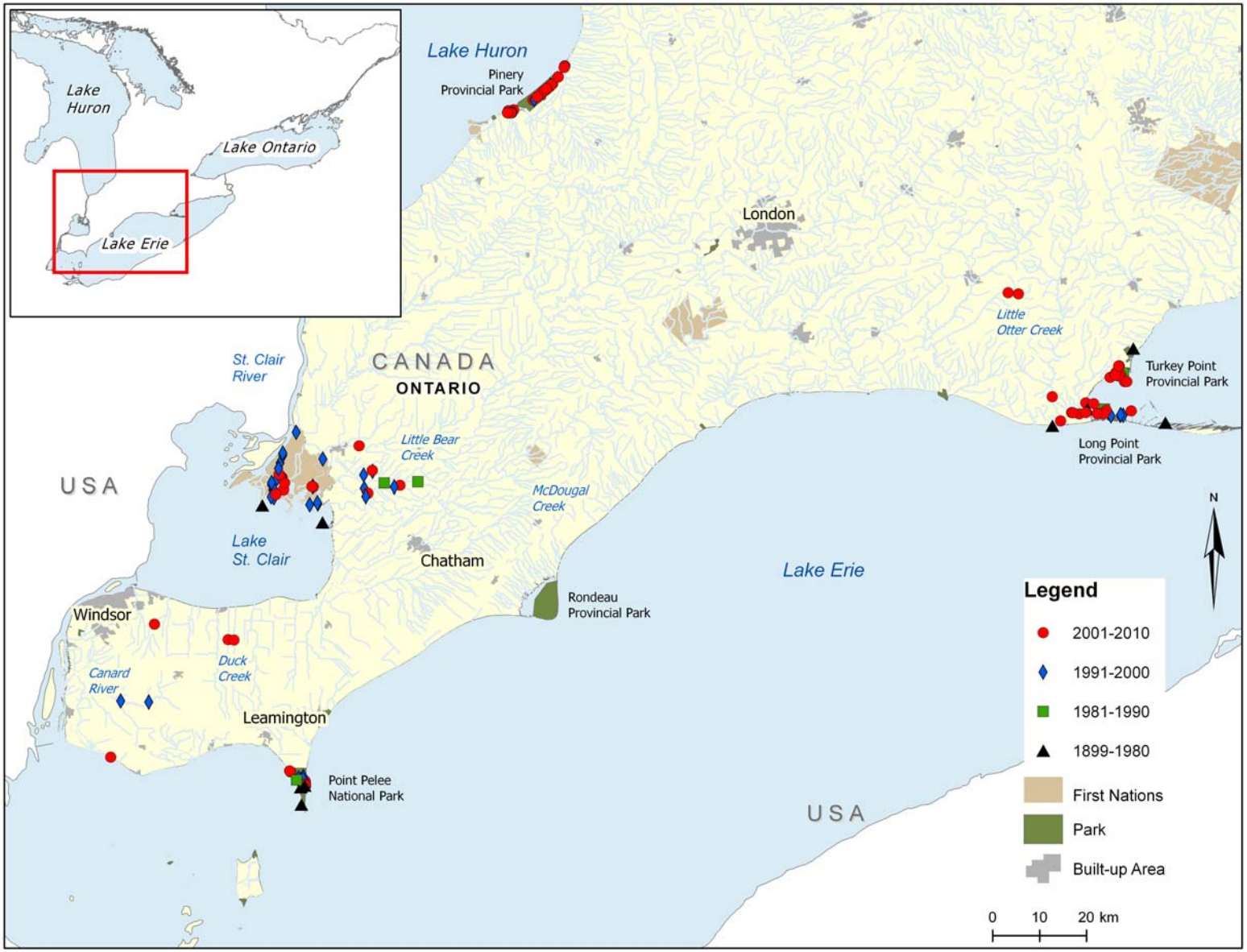

Figure 3(a). Distribution of the Grass Pickerel in southwestern Ontario.

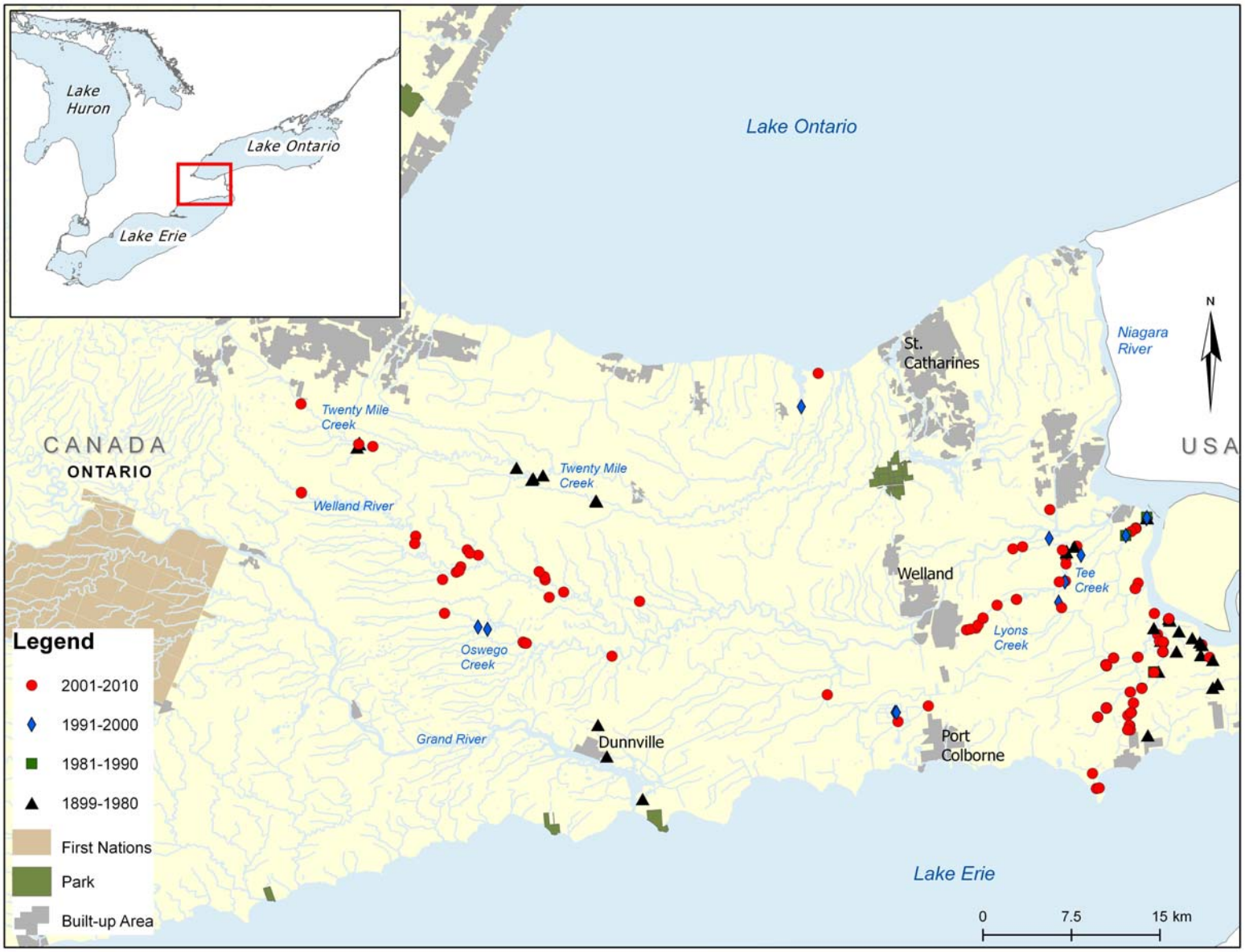

Figure 3(b). Distribution of the Grass Pickerel in southeastern Ontario (Niagara Region).

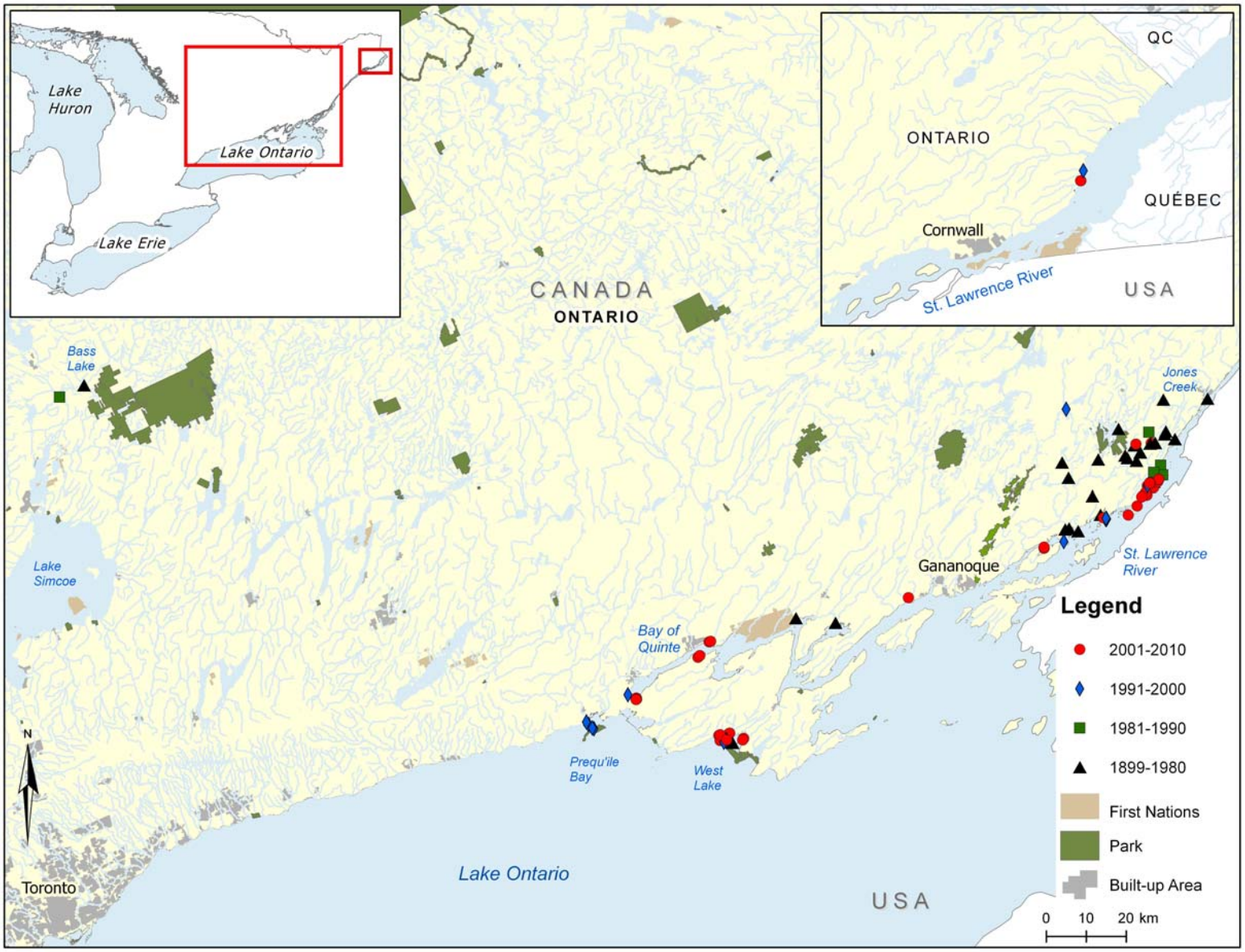

Figure 3(c). Distribution of the Grass Pickerel in southeastern Ontario.

Table 1. Grass Pickerel capture sites in Ontario and the most recent year the species was captured.

Location	Last Year of Observation
Lake Huron Tributaries:	
L Lake	2007
OAC	2009
Pond off of Mud Creek	2007
Lake St. Clair	2001
East Shore Tributaries of Lake St. Clair:	
Dyer Drain	2000
East Sydenham River	2003
Little Bear Creek	2003
Maxwell Creek	2003
Townline Drain	2000
South Shore Tributaries of Lake St. Clair:	
Duck Creek	2001
Moison Creek	2001
Pike Creek	2004
North Shore Tributaries of Lake Erie:	
Colchester Drains	2004
Long Point Creek	1899
Little Otter Creek	2003
Lower Grand River Tributaries	1959
Point Abino	2001
West Townline Drain	2004
Unknown Creek	1955
Point Pelee National Park	2003
Long Point Region:	
Big Creek	2005
Long Point Bay	2004
Turkey Point Marsh	2007
Niagara River and Tributaries:	
Baker Creek	2007
Beaver Creek	2003
Black Creek	2007
Boyers Creek	2004
Frenchmans Creek	1979
Hunters Drain	year unspecified
Miller Creek	2004
Upper Niagara River	2004
Usshers Creek	2005

Table 1 (con't). Grass Pickerel capture sites in Ontario and the most recent year the species was captured.

Location	Last Year of Observation
Welland River and Tributaries:	
Beaver Creek	2004
Coyle Creek	year unspecified
Elsie Creek	2007
Grassy Brook Creek	2003
Little Wolf Creek	2007
Lyons Creek	2004
Mill Creek	2007
Mill Race Creek	2004
Moores Creek	2007
Oswego Creek	2007
Tee Creek	2004
Welland River	2007
Wolf Creek	2007
Twenty Mile Creek	2009
Eastern Lake Ontario	2007
St. Lawrence River/Lake St. Francis and Tributaries:	
Cooper Marsh	1994
Fraser Creek	2009
Gananoque River	1937
Gananoque Lake	1975
Jones Creek	1987
Lake St. Francis	1994
Larue Creek	1981
Lower Beverly Lake	2008
Leeders Creek	1937
Lees Pond	1937
Michael Henry Creek	1960
St. Lawrence River	2006
Unknown Waterbody	1938
Severn River:	
Gartersnake River	1975
Kahshe Lake	1988
South Kahshe River	1987

Quebec – Three populations of Grass Pickerel are believed to occur in Quebec, along the St. Lawrence River, in an area covering approximately 150 km² (P. Dumont, Ministère des Ressources naturelles et de la faune du Québec [MRNF]), pers. comm. 2008, Crossman and Holm 2005). In the Lake St. François watershed, one observation dating back to 1941 (unconfirmed) exists for the Beaudette River. There have been no further captures despite several surveys; however, the species was observed on the Ontario side of the Cooper Marsh area in 1994. Grass Pickerel was recorded in the main channel of the St. Lawrence River near Coteau-du-Lac in 1970. The species was also recorded in Lake St. Louis down to Lachine and its tributaries (e.g., St. Jean Creek, Châteauguay River) between 1941 and 1988. These three sections of the St. Lawrence River are effectively separated by a series of natural obstacles (e.g., rapids) that restrict the movement of Grass Pickerel. Moreover, the section between Lake St. François and Lake St. Louis was isolated between 1912 and 1958 by a series of dams and weirs; however, it is

not known if these populations are reproductively isolated from each other or from those in Ontario (Crossman and Holm 2005). Note that, in the early 2000s, a consultant reported catching Grass Pickerel in the tailwaters of the Soulanges Canal hydroelectric power station next to Les Cèdres; however, these records have not been confirmed.

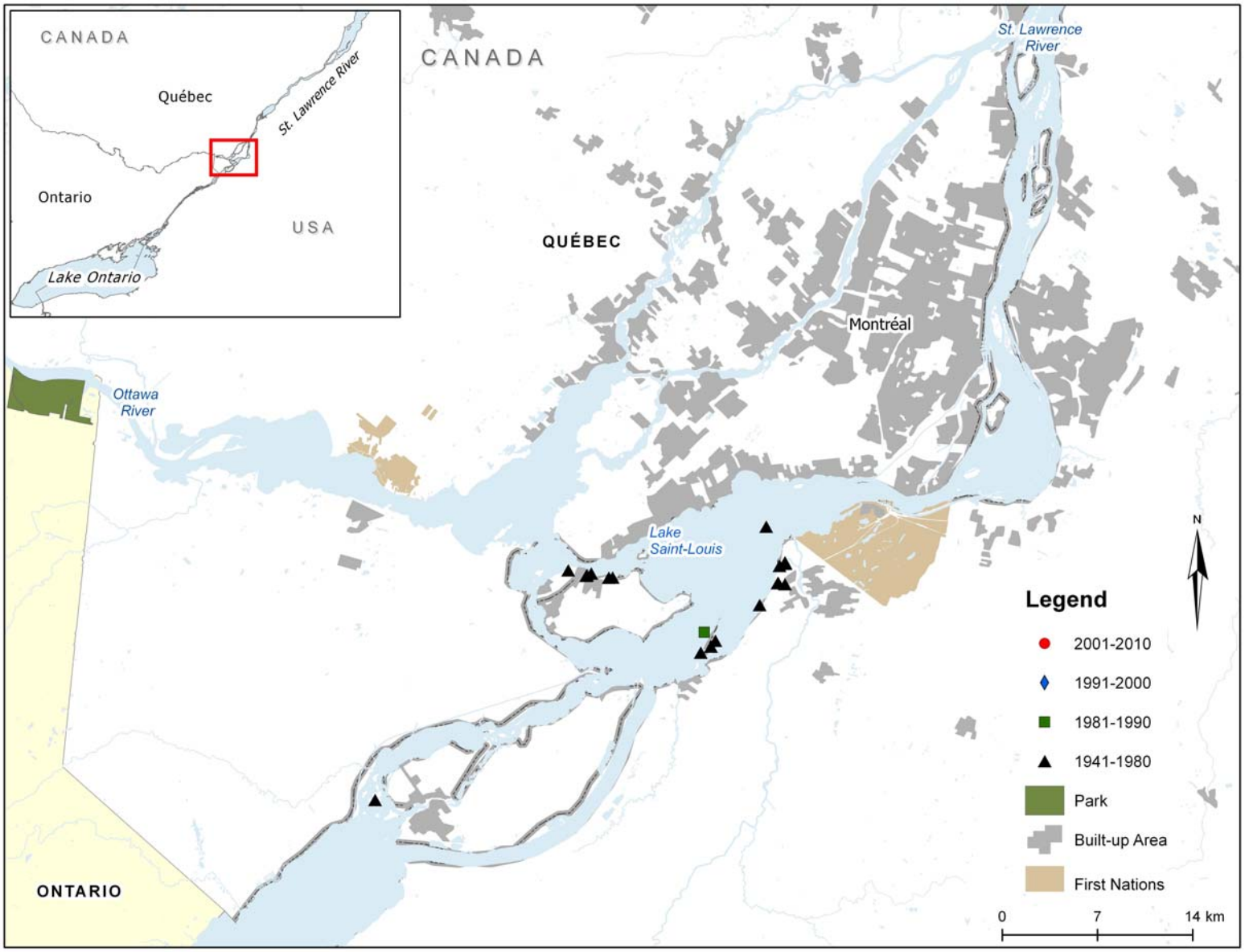

Figure 4. Distribution of Grass Pickerel in Quebec.

Table 2. Grass Pickerel capture sites in Quebec.

(Data provided by Ministère des Ressources naturelles et de la Faune du Québec.)

Location	Year of Observation (number of Grass Pickerel captured)
Lake St. François	
Beaudette River	1941 (?) *unconfirmed*
St. Lawrence River main channel	
Coteau-du-lac	1970 (1)
Lake St. Louis	
Perrot Island	1941 (52), 1942 (3), 1946 (3)
Maple Grove	1942 (18), 1965 (1), 1988 (1)
Léry	1969 (3), 1971 (1)
St. Jean Creek	1942 (2), 1971 (3), 1975 (2), 1978 (1)
Châteauguay River	1942 (3), 1973 (1)

Population size and status and trends

Global population size and status and trends:

Globally, both Redfin Pickerel and its subspecies, Grass Pickerel, are considered secure with a G5T5 status[1] (NatureServe 2009). State ranks are not presented here as there is confounding information presented by NatureServe regarding Redfin Pickerel and Grass Pickerel and the distribution and status of each.

Canadian population size and status and trends:

Population estimates for Grass Pickerel in Canada are not available. The national and sub-national conservation ranks of the Grass Pickerel as assessed by NatureServe are not presented here as there is confounding distribution information provided by NatureServe regarding the Redfin Pickerel and Grass Pickerel in Canada. Grass Pickerel was designated as Special Concern in 2005 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2005) and was listed on Schedule 1 of the federal *Species at Risk Act* (SARA) in 2006.

An extensive list of sampling effort for Grass Pickerel is catalogued in the COSEWIC report for this species (Crossman and Holm 2005).

[1] The conservation status of a species or community is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). The letter T refers to the intraspecific taxa (i.e., subspecies or varieties). The numbers have the following meaning: 1 = critically imperilled; 2 = imperilled; 3 = vulnerable to extirpation or extinction; 4 = apparently secure 5 = demonstrably widespread, abundant, and secure. (NatureServe).

Ontario

Refer to Table 1 for a summary of all known Grass Pickerel locations in Ontario.

OAC and L Lake (Lake Huron Drainage): Grass Pickerel populations are extant in the OAC and L Lake (an oxbow lake in the vicinity of the OAC). The species was captured in the OAC in 1997 (four specimens from four sites), 2002 (eight, seven), 2004 (30, 12) and 2005 (nine, seven) (Crossman and Holm 2005, DFO, unpubl. data). The population in the OAC is believed to be stable; however, given the lack of standardized long-term data this cannot be confirmed. In 2007, Grass Pickerel were detected for the first time in L Lake; sampling yielded eight Grass Pickerel from four sites (ABCA, unpubl. data). Additionally, in 2007, two specimens were captured in a small pond adjacent to Mud Creek near Port Franks; this is the first record of the species from this location. The status of these newly discovered populations is currently unknown.

Lake St. Clair/Walpole Island: In Lake St. Clair, the first recorded capture of Grass Pickerel occurred in 1929 and the species was subsequently captured in 1993 (unknown number of specimens caught from a single site), 1999 (80 specimens from 23 sites), 2001 (43, eight) and 2002 (five, two) (Crossman and Holm 2005, ROM, unpubl. data). Grass Pickerel populations are likely stable in Lake St. Clair given the species' presence in sampling events spanning more than 70 years.

South and East Shore Tributaries of Lake St. Clair: Sampling conducted by the Upper Thames River Conservation Authority along the east shore of Lake St. Clair in 2000 detected Grass Pickerel for the first time in Dyer Drain, Maxwell Creek and Townline Drain, and confirmed its presence in Little Bear Creek (first captured at this location in 1982). In 2003, the species was captured again from Maxwell Creek (three specimens from one site), Little Bear Creek (four specimens from two sites) and a new site, the East Sydenham River (one specimen), during targeted sampling for species at risk conducted by DFO (Mandrak *et al.* 2006a). The limited amount of targeted sampling that has occurred within the tributaries along the east shore of Lake St. Clair makes it difficult to determine trends in Grass Pickerel populations at this time.

Recent sampling (2001, 2004) along the south shore of Lake St. Clair, including tributaries, by the Essex Region Conservation Authority (ERCA) and a graduate student from the University of Guelph yielded Grass Pickerel from Moison Creek, Duck Creek (ERCA, unpubl. data) and Pike Creek (Stammler 2005), all of which are new locations for the species. It is not possible to determine population trends at these locations given the lack of standardized long-term data.

Canard River: An unknown number of Grass Pickerel were captured from two sites on the Canard River (a tributary of the Detroit River) in 2000 by ERCA (ERCA, unpubl. data). This is the first record of the species at this location and population trends are unknown.

North Shore Tributaries of Lake Erie: Grass Pickerel have been captured from several smaller tributaries on the north shore of Lake Erie. The species was detected for the first time in West Townline Drain (a tributary located between Cedar Creek and the Detroit River) in 2004, when a single specimen was captured by ERCA (Nelson 2004). Historic records exist for Long Point Creek (1899) and an unnamed creek near the town of Normandale (1955) (ROM, unpubl. data); however, these areas have not been sampled recently and the status of Grass Pickerel at these locations is unknown. In 2001, 31 specimens were captured from four sites at Point Abino Drain (Niagara region), and in 2003 Grass Pickerel were captured from two sites on Little Otter Creek. Given the lack of long-term data from these locations it is not possible to determine population status or trends.

Point Pelee National Park, Long Point Bay, Big Creek (including Big Creek National Wildlife Area [NWA]) and Turkey Point Marsh: Grass Pickerel were first captured in Point Pelee National Park in 1949 (21 specimens) and were subsequently captured in 1967, 1968, 1980, 1983, 1993/4, 1997, 2002 and 2003. Six Grass Pickerel were captured from five of 15 sites sampled in 1997, while nine specimens were captured from three of 117 sites in 2002 (Surette 2006). It is not clear if the lower frequency of capture in 2002 is a reflection of the different sampling techniques employed or represents an actual population decline (Crossman and Holm 2005).

In Long Point Bay, Grass Pickerel records exist for several years: 1950 and 1955 (unknown number of specimens), 1973 (58), 1985 (15 adults, unknown number of larvae and juveniles), 1994 (unknown) and 2001 (unknown) (Leslie and Timmins 1997, Crossman and Holm 2005, DFO, unpubl. data). More recently, Grass Pickerel were captured during sampling conducted by DFO in 2004 (five specimens from four sites) (Marson *et al.* 2007) and, in 2007, the Ontario Ministry of Natural Resources (OMNR) captured 25 Grass Pickerel (records unconfirmed) from seven of 32 sites throughout the bay during a nearshore fish community assessment (OMNR 2007). Although these records have not been verified there is no reason to believe they are not Grass Pickerel, as other confirmed records exist for the species in the bay.

The first recorded capture of Grass Pickerel in Turkey Point Marsh (located on the north side of Long Point Bay) occurred in 1984 and its presence was confirmed in 2007, when sampling conducted by DFO and ERCA yielded 24 Grass Pickerel from 10 of 35 sites sampled (Nelson and Staton, draft).

In 2002, the first record of Grass Pickerel in Big Creek (Long Point tributary) was obtained when a single individual was captured in the lower section of the creek by DFO. Sampling conducted by ERCA in 2004 yielded an unknown number of specimens from the upper portion of Big Creek, close to the town of Rowan Mills (ERCA, unpubl. data), and in 2005, a single specimen was captured by DFO within the northern cell of a diked impoundment in Big Creek NWA (Marson *et al.* 2007).

Although long-term standardized data are lacking for Grass Pickerel in the Long Point region, the species' continued presence in various surveys dating back to 1950 suggest that the population may be stable.

Lower Grand River Tributaries: Grass Pickerel records from 1949-1959 exist for tributaries of the lower Grand River near Dunnville; however, from 2001-2003, most drains in the Dunnville area that could be sampled were surveyed by the Grand River Conservation Authority (GRCA). Although juvenile Northern Pike were captured, no Grass Pickerel were detected, suggesting a decline in abundance (Crossman and Holm 2005). More recent OMNR sampling (1999-2009) of historic sites in lower Grand River tributaries did not produce any additional records of Grass Pickerel, confirming an apparent decline in abundance or possible extirpation (A. Yagi OMNR, unpubl. data).

Upper Niagara River and Tributaries, Welland River and Tributaries: Long-term standardized Grass Pickerel data are not available for the Niagara region. Only one comprehensive fish survey of upper Niagara River tributaries has been conducted, in 1979, which was then replicated to the extent possible in 2003 (Crossman and Holm 2005). Sampling conducted by the OMNR from 2003-2005 and 2007 yielded 284 Grass Pickerel from the Upper Niagara River and six of its tributaries (Baker, Black, Boyers, Miller, Usshers and Beaver creeks) (OMNR, unpubl. data). Grass Pickerel were not detected in another tributary with historic records (Frenchmans Creek) during a survey in 2003, and the habitat at this location no longer appeared suitable for Grass Pickerel (Crossman and Holm 2005, Yagi and Blott 2008).

Sampling effort for Grass Pickerel in the Welland River drainage has increased from 1999 to present. During six years of sampling (1999, 2000, 2003-2005, 2007), 125 Grass Pickerel were captured by the OMNR in the Welland River and 11 of its tributaries (OMNR, unpubl. data); the species was not detected in one tributary with historic records (Hunters Drain) and the habitat at this location may no longer be suitable for the species (Crossman and Holm 2005). In 2000 and 2004, four Grass Pickerel were captured (two specimens in 2000, two in 2004) from the Wainfleet Bog drains that empty into the Welland Canal (OMNR, unpubl. data).

In addition to sampling at historic Grass Pickerel sites, the OMNR has made additional effort in more recent years to sample smaller tributaries with isolated pools that are often difficult to access. Lower relative abundance has been observed in upper Niagara River tributaries and in watercourses that were sampled following channelization and dredging work for drainage purposes.

Twenty Mile Creek: Grass Pickerel were recorded from the upper reaches of Twenty Mile Creek (Lake Ontario drainage) in the 1990s; however, intensive sampling in 2003 detected far fewer specimens and habitat had been altered as a result of bridge construction (Crossman and Holm 2005). Sampling conducted by the OMNR in Twenty Mile Creek in 2008 detected Grass Pickerel in the uppermost reaches; however, there was a noted absence of any Grass Pickerel in samples within the historic mid-reach areas, suggesting a reduction in distribution (OMNR, unpubl. data). In 2008, a single site was sampled by DFO on Twenty Mile Creek, yielding three Grass Pickerel (DFO, unpubl. data) and in April 2009, the species was observed at another location exhibiting behaviour that was indicative of spawning; however, spawning was not confirmed (G. Coker, C. Portt and Associates, pers. comm. 2009).

Eastern Lake Ontario and Upper St. Lawrence River drainage: Grass Pickerel has been detected in various surveys spanning a period of almost 70 years (1939, 1949, 1979, 1994, 1998, 1999, 2002-2004 and 2007) in eastern Lake Ontario (including West Lake, Presquile Bay, Bay of Quinte and Wilton Creek) suggesting that populations are stable in this area.

Numerous Grass Pickerel have been captured in the St. Lawrence River and two of its tributaries, the Gananoque River and Jones Creek; the majority of records were collected before 1984 (Crossman and Holm 2005), which is likely a reflection of the intensive sampling conducted between 1934 and 1960.

In 2000, a single Grass Pickerel was captured in Lower Beverly Lake (located in the Gananoque River watershed), which represents a new location for the species. Further surveys of the lake in 2008 yielded close to 100 Grass Pickerel from approximately 25 sites (OMNR, unpubl. data).

In 2005, two Grass Pickerel were captured by DFO in the area of St. Lawrence Islands National Park (Mandrak *et al.* 2006b), and sampling conducted from 1989-1995 and 2005-2009 by the OMNR, Parks Canada Agency (PCA) and Muskies Canada (a survey of Muskellunge nursery habitat) yielded 23 Grass Pickerel in four of the years sampling took place (1989, 1994, 2005, 2006, 2008, 2009) (Lake 2005, J. VanWieren, PCA, pers. comm. 2010, OMNR, unpubl. data). A single Grass Pickerel was captured in Lake St. Francis at Cooper's Marsh in 1994; no other records exist for the species at this location. Sampling conducted in the lower reaches of Fraser Creek from 2007-2010 yielded a total of 35 Grass Pickerel, 10 of which were young-of-the-year (B. Jacobs, Raisin Region Conservation Authority, pers. comm. 2012). The Grass Pickerel population in the St. Lawrence River and its tributaries in Ontario is likely stable given the species presence in sampling events spanning many decades.

Severn River watershed (Kahshe Lake, South Kahshe River, Gartersnake River): Grass Pickerel was first recorded in the Severn River drainage in1960, when it was captured from the Gartersnake River (connecting Kahshe Lake and Bass Lake). It was subsequently captured at this location in 1975 (ROM, unpubl. data). In 1972, the species was reported from Hoaglands Marsh and Lake Couchiching;

however, these records cannot be verified (Crossman and Holm 2005). In the South Kahshe River and Kahshe Lake the OMNR captured 20 specimens (1987) and two specimens (1988), respectively (Crossman and Holm 2005, ROM, unpubl. data); however, Walleye (*Sander vitreus*) index-netting surveys conducted by the OMNR in 2001 in Kahshe Lake did not detect any Grass Pickerel (Crossman and Holm 2005). There are currently not enough data to determine the status of Grass Pickerel in the Severn River drainage.

Quebec

Refer to Table 2 for a summary of all known Grass Pickerel locations in Quebec.

The Grass Pickerel appears to be very rare and declining in Quebec (P. Dumont, pers. comm. 2008). Sampling from 1988 to 2005 in Lake St. Louis, around Perrot Island, the archipelago of the Îles de la Paix and Dowker Island, collected only one specimen, in 1988 (last known record for this region) (Table 2). However, between 1941 and 1988, more than 90 Grass Pickerel were captured in this region. During this time, the number of specimens captured declined from 52 in 1941 to one in 1988. Sampling in Lake St. François in 1968, 1996 and 2004 yielded no Grass Pickerel (La Violette *et al.* 2003, Crossman and Holm 2005, N. La Violette, unpubl. data). The only Grass Pickerel specimens captured in recent years were caught in the early 2000s in the tailrace of the Soulanges Canal hydroelectric power plant, near Les Cèdres; however, these records were not verified.

Since 1995, some surveys have been conducted as part of the Réseau de suivi ichtyologique du Saint-Laurent (RSI) of the MRNF. This network conducts systematic sampling of fish populations in six areas of the St. Lawrence River, located upstream of Quebec City (sampling is conducted annually as part of a five year sampling program). Other general surveys were conducted in potential sites in Quebec (e.g., in the Point Galipeault area between the Island of Montreal and Perrot Island [GENIVAR 2005], Canal Lachine [GENIVAR 2008], St. Jean Creek [M. Léveillé, MRNF, pers. comm. 2009] and St. Bernard Island in the Marguerite-D'Youville wildlife sanctuary [P. Brodeur, MRNF, pers. comm. 2009]). No Grass Pickerel were found despite the availability of suitable habitat for the species and the presence of other esocid species. There have been no recent targeted Grass Pickerel surveys and the methods used in general fish community surveys are not always adequate to detect this species. Lachance (2001) suggested that it is difficult to assess the abundance of the related Redfin Pickerel accurately because the species cannot be caught in several types of fishing gear used in general fish surveys, and shallow areas containing macrophyte beds are often by-passed in comprehensive surveys. Data on Grass Pickerel captures are available at the Centre de données sur le patrimoine naturel du Québec (Quebec Conservation Data Center).

1.4 Needs of the Grass Pickerel

1.4.1 Habitat and biological needs

Grass Pickerel habitat is typically characterized as shallow (< 2 m), heavily vegetated, slow moving, lowland streams and overflow ponds of large streams and stream expansions with mud or muck bottoms (organic soils) and clear- to tea-coloured water that is mildly alkaline to slightly acidic (Scott and Crossman 1998, Crossman and Holm 2005, Marson *et al.* 2007). Although Canadian Grass Pickerel populations are usually associated with mud substrates, they have been found in areas of gravel and rock (Crossman and Holm 2005). Some specific observed habitat features in Indiana streams include aquatic macrophytes, logs and woody structure and slow moving water (Cain *et al*. 2008). Grass Pickerel have also been associated with shallow vegetated areas in lakes and ponds (Kleinert and Mraz

1966, Foster 1979), dense beds of vegetation in headwaters of Oklahoma streams (Ming 1968), and with sheltered coastal wetlands with abundant vegetation in lakes Ontario and Erie (Brousseau *et al*. 2005). In Quebec, Grass Pickerel are most frequently associated with vegetated areas in large waterbodies.

Vegetation types that are typically associated with Grass Pickerel include pondweed (*Potamogeton* spp.), water lilies (*Nymphaea* and *Nuphar* sp.), muskgrass (*Chara* sp.) and coontail (*Ceratophyllum* sp.) (Crossman and Holm 2005). In Long Point Bay, Grass Pickerel were captured in habitats containing the following plant species: Common Reed Grass (*Phragmites australis*), cattail spp. (*Typha* spp.), bulrush (*Scirpus* sp.), wild rice (*Zizania* sp.), muskgrass (*Chara* sp.), Common Waterweed (*Elodea canadensis*), watermilfoil sp. (*Myriophyllum* spp.), Wild Celery (*Vallisneria americana*) and water lilies (*Nymphaea* and *Nuphar* sp.) (OMNR, unpubl. data).

Based upon a survey of 75 wetlands along the American shoreline of the Laurentian Great Lakes, Trebitz *et al*. (2007) determined that the Grass Pickerel was moderately turbidity-intolerant, which they defined as multiple occurrences at < 10 nephelometric turbidity units (NTU) and at most one occurrence at < 25 NTU.

In lakes, adult Grass Pickerel have been observed in shallow (< 5 m) water, with submergent and emergent vegetation, logs (Crossman 1962, Becker 1983) and fine grain-sized (clay/silt/sand) substrates (Lane *et al*. 1996a). In riverine habitats, juvenile Grass Pickerel have been associated with shallow water (< 60 cm) (Leslie and Gorrie 1984) and with silt/clay substrates and vegetation (Scott and Crossman 1998). Juveniles have also been found to be intolerant of turbidity (Trautman 1981) and to be most common in pools (Crossman 1962, Scott and Crossman 1998).

Grass Pickerel appear to be tolerant of a wide temperature regime (5^{o}C - 32^{o}C) (Ming 1968, Cain *et al*. 2008), although they are classified as a warmwater species with a preferred temperature of 26^{o}C (Wismer and Christie 1987) and upper avoidance of 29^{o}C (Scott and Crossman 1998). Additionally, the species is adapted to low dissolved oxygen environments (< 1.0 mg/l) (Scott and Crossman 1998, Cain *et al*. 2008); this allows them to survive in shallow, densely vegetated habitats that can become oxygen depleted during the night due to plant respiration. In Ohio, Grass Pickerel populations declined or were extirpated wherever ditching, dredging or other forms of channelization destroyed their habitat (White *et al.* 1975; cited *in* Cain *et al.* 2008, Trautman 1981). Leslie and Timmins (1997) observed the presence of Grass Pickerel in disturbed locations (e.g., drainage ditches) in Long Point Bay; however, it is possible that a sufficient length of time had elapsed since the streams were last disturbed to allow the regeneration of aquatic macrophytes that provide the necessary cover for Grass Pickerel.

Little knowledge exists with respect to the spawning habitat requirements of Grass Pickerel (Portt *et al*. 1999), but spring spawning does appear to be associated with flooded terrestrial vegetation at temperatures ranging from 4 to 12^{o}C (Keast 1977, Becker 1983, Lane *et al*. 1996b, Scott and Crossman 1998). Spawning in Ontario waters has been recorded from late March to early May with a period of approximately two weeks to egg hatch and a further two to five weeks to initiate feeding (Crossman 1962). In still-water habitats, Grass Pickerel spawning grounds appear to be in shallow (< 1 m) waters with emergent and partially or completely flooded terrestrial vegetation to which the eggs can adhere (Crossman 1962, Goodyear *et al*. 1982). Young-of-the-year are also associated with shallow (< 2 m) waters, submergent and emergent vegetation, and silt substrates (Goodyear *et al*. 1982, Dombeck *et al*. 1984). There is some evidence to suggest that Grass Pickerel may spawn more than once a year and late summer to winter spawning may occur (Crossman 1962, Kleinert and Mraz 1966). Eggs are broadcast over aquatic vegetation to which they then adhere; no parental care is given to the eggs or young of this species (Becker 1983). Egg diameters range from 1.5-2.5 mm with a hatching length of 5-6 mm (Carlander 1969, Scott and Crossman 1998). In Ontario, sexual maturity is reached during the second year, and estimated maximum longevity is approximately seven years (Crossman 1962).

This species likely only travels over short distances in search of food and cover (Crossman 1962), although spawning aggregations have been reported in lakes (Kleinert and Mraz 1966). In winter, the species may burrow in mats of fallen leaves (Etnier and Starnes 1993).

The Grass Pickerel is a solitary species that, along with other esocids, is typically an ambush predator (Foster 1979) with prey dominated by fishes and, to a lesser extent, aquatic insects and crayfishes (frogs and tadpoles were infrequently eaten in Ontario, despite being abundant) (Crossman and Holm 2005). When Grass Pickerel reach 50-150 mm TL, generally during their first year, they switch from consumption of aquatic insects to piscivory, after which fishes constitute 60-80% of their diet (Becker 1983, Keast 1985). Dietary studies of Grass Pickerel residing in Wisconsin lakes have observed a shift in food preference from zooplankton in individuals with a TL of 9.5-15 mm, to aquatic insects (15-40 mm TL) and finally to piscivory in maturity (Kleinert and Mraz 1966). Grass Pickerel residing in Indiana streams demonstrated a diet shift during their life-history from one dominated by fishes when they were 57-95 mm TL to fishes and crayfishes (96-150 mm TL) and finally to larger crayfishes (>150 mm TL) (Weinman and Lauer 2007). Grass Pickerel appear to be opportunistic feeders, which enables them to exist on a wide variety of prey within their area of occupancy (Weinman and Lauer 2007).

1.4.2 Ecological role

Many piscivorous fish species may act as keystone species (e.g., Carpenter and Kitchell 1993, Mittlebach *et al*. 1995, Carpenter *et al*. 2001). Grass Pickerel are predominantly piscivorous in nature and may be functioning as a keystone species in some systems. It is often the top predator in communities of which it is characteristic (Crossman and Holm 2005, Weinman and Lauer 2007) and may play a significant role in controlling populations of small fishes (Jenkins and Burkhead 1993). During the summer in the Niagara region, Grass Pickerel are typically found within remnant pool habitat of headwater streams, where they are often the top predator. Weinmann and Lauer (2007) speculated that if Grass Pickerel populations were to decline or disappear in the Indiana headwater streams they were studying, altered ecosystem dynamics may result. Yellow Perch (*Perca flavescens*), catfish spp. (Ictaluridae) and sunfish spp. (Centrarchidae) have been observed to prey on Grass Pickerel (Becker 1983) indicating that Grass Pickerel may be a significant food source for some species.

The Grass Pickerel can tolerate a wide range of water temperatures and water quality conditions (Cain *et al.* 2008), which may allow the species to utilize habitats that would be unsuitable for larger top predators (e.g., densely vegetated, shallow habitats).

1.4.3 Limiting factors

The Grass Pickerel is at the northern limit of its range in Canada and is limited by cooler water temperatures. This species has a specific habitat requirement for abundant aquatic vegetation, which may be limited in some areas. Since the Grass Pickerel is smaller than other esocid species (i.e., Muskellunge, Northern Pike), it may be particularly vulnerable to predation and/or competition from these species, which could result in the loss or decline of Grass Pickerel from habitats frequented by other esocids.

Hybridization between Grass Pickerel and other esocids, including Redfin Pickerel, Chain Pickerel and Northern Pike is known to occur in nature (McCarraher 1960, Crossman and Buss 1965, Serns and McKnight 1977). The probability of hybridization would likely be higher with species that are more closely related to the Grass Pickerel (i.e., Chain Pickerel and Redfin Pickerel). Offspring produced as a result of hybridization are sterile with the exception of Redfin Pickerel x Grass Pickerel offspring, which are fertile (Scott and Crossman 1998).

1.5 Threats

1.5.1 Threat classification

Current and anticipated threats to the Grass Pickerel are listed in Tables 3 and 4 for Ontario and Quebec, respectively. Threats were ranked based on their relative impact, spatial extent and expected severity. The threats have been prioritized starting with the greatest perceived threat to the survival of the species based on the strongest evidence. There may be some variability in the severity and level of concern for some threats for individual populations. Threat assessment, particularly where evidence is limited, is an ongoing process linked to both species assessment and, where applicable, management. The threat classification parameters are defined as follows:

Extent – spatial extent of the threat in the species range/waterbody (widespread/localized);
Occurrence – current status of the threat (e.g., current, imminent, anticipated);
Frequency – frequency with which the threat occurs in the species range/waterbody (seasonal/continuous);
Causal Certainty – level of certainty that it is a threat to the species (High – H, Medium – M, Low - L);
Severity – severity of the threat in the species range/waterbody (H/M/L); and,
Overall Level of Concern – composite level of concern regarding the threat to the species, taking into account the five parameters listed above (H/M/L).

Table 3. **Threat classification table for Grass Pickerel in Ontario.**

Threat	Extent (widespread/localized)	Occurrence (current, imminent, anticipated)	Frequency (seasonal/continuous)	Causal Certainty (high, medium, low)	Severity (high, medium, low)	Overall Level of Concern (high, medium, low)
Habitat Loss or Degradation						
Drainage	Widespread	Current	Continuous	High	High	High
Sediment Loading/Turbidity	Widespread	Current	Seasonal	High	High	High
*Damage/Destruction of Aquatic Vegetation**	Widespread	Current	Seasonal	High	High	High
Damage/Destruction of Riparian Vegetation	Widespread	Current	Continuous	High	Medium	Medium
Nutrient Loading	Widespread	Current	Continuous	Medium	High	Medium
Contaminant inputs	Widespread	Current	Seasonal	Medium	Medium	Medium
Exotic Species	Widespread	Unknown/ Anticipated	Continuous	Low	Medium	Medium
Climate Change	Widespread	Current/Anticipated	Continuous	Medium	Unknown	Medium
Interspecific Interactions	Localized	Current	Unknown	Low	Unknown	Low
Disease	Widespread	Current	Continuous	High	Unknown	Medium
Fishing Pressure	Localized	Unknown	Seasonal	Low	Unknown	Low
Barriers to Movement	Localized	Current	Unknown	Medium	Unknown	Low
Water level Fluctuations (beyond natural seasonal variability)	Widespread	Current	Continuous	Low	Low	Low

* The impacts of Damage/Destruction of Aquatic Vegetation are described under several other threats listed below due to the high degree of overlap that can occur between these threats.

Table 4. **Threat classification table for Grass Pickerel in Quebec.**

Threat	Extent (widespread/localized)	Occurrence (current, imminent, anticipated)	Frequency (seasonal/continuous)	Causal Certainty (high, medium, low)	Severity (high, medium, low)	Overall Level of Concern (high, medium, low)
Habitat Loss or Degradation						
Drainage	Widespread	Current	Continuous	High	High	High
Sediment Loading/Turbidity	Widespread	Current	Continuous	High	High	High
*Damage/Destruction of Aquatic Vegetation**	Widespread	Current	Seasonal	High	High	High
Damage/Destruction of Riparian Vegetation	Widespread	Current	Seasonal	High	High	High
Nutrient Loading	Widespread	Current	Continuous	High	High	High
Contaminant inputs	Widespread	Current	Continuous	Medium	Medium	Medium
Water Level Fluctuations (beyond natural seasonal variability)	Widespread	Current	Continuous	Medium	Medium	Medium
Barriers to Movement	Widespread	Current	Continuous	Medium	Medium	Medium
Exotic Species	Widespread	Imminent	Continuous	Medium	Medium	Medium
Climate Change	Widespread	Current/Anticipated	Continuous	Low	Unknown	Low
Interspecific Interactions	Localized	Anticipated	Seasonal	Low	Unknown	Low
Fishing Pressure	Localized	Unknown	Seasonal	Low	Low	Low
Disease	Unknown	Anticipated	Continuous	High	Unknown	Low

* The impacts of Damage/Destruction of Aquatic Vegetation are described under several other threats listed below due to the high degree of overlap that can occur between these threats.

1.5.2 Description of threats

The primary threat affecting this species appears to be the destruction and degradation of wetland habitat. Industrial, urban and agricultural developments have reduced the quality and quantity of habitat available to Grass Pickerel and pose a significant threat to their continued survival. For example, in the Niagara region, there may have been an 80% loss of suitable Grass Pickerel habitat since human settlement (Crossman and Holm 2005). As the Grass Pickerel is a visual ambush predator, activities that result in increased turbidity and the removal or destruction of aquatic and riparian vegetation (e.g., through channelization, dredging, ditching and clear-cutting) will likely have negative impacts on Grass Pickerel survivability.

Drainage: Local modification of natural hydrological regimes including the realignment of watercourses, excavation of channels and ditches, drainage measures, back-filling, diking of floodplains, maintenance, and any other local modification of the natural hydrological regime in Grass Pickerel habitat can be harmful to the species. In Ontario, municipal drainage activities are one of the primary threats to the Grass Pickerel; in the Niagara Region, surveys indicated that Grass Pickerel abundance immediately declined following drainage works in the Point Abino Drain (Crossman and Holm 2005, A. Yagi, pers. comm. 2008). Municipal drainage practices can alter flow characteristics, which results in reduced in-stream habitat complexity, reduced pool and wetland habitat, increased drainage rates (thereby leaving intermittent streams dry and inaccessible), reduced and/or eliminated riparian cover, and increased turbidity and sedimentation. Additionally, flow velocity and peak discharge increase in channelized watercourses during periods of heavy precipitation or snowmelt, subjecting the banks to greater erosion.

A decrease in water level can also influence recruitment and cause mortality by stranding young and adult fish (Kleinert and Mraz 1966). During low water periods in summer and winter, in areas that have been extensively drained, the groundwater reserves that feed streams are reduced, leading to lower water levels and unfavourable conditions for aquatic life. Some watercourses are completely dry during these low flow periods while others are intermittent. Fishes then become trapped in trenches where water temperature rises and dissolved oxygen is reduced, often resulting in mortalities (Société de la faune et des parcs du Québec [FAPAQ] 2002). If a watercourse is sufficiently deepened, or the substrate altered during channelization, the aquatic macrophyte community may not regenerate to its original quantity or quality. Additionally, activities resulting in low water levels and lowering of stream temperatures are also threats to Grass Pickerel (Crossman and Holm 2005). Water level reductions, particularly in nursery areas, may result in reduced Grass Pickerel recruitment (Kleinert and Mraz 1966). It should be noted that Grass Pickerel have demonstrated some ability to tolerate disturbed habitat if sufficient cover is present (Leslie and Timmins 1997).

Sediment loading/turbidity: Excessive sediment loading can affect aquatic habitats by decreasing water clarity, increasing siltation of substrates, and may have a role in the selective transport of pollutants, including phosphorous (Vachon 2003, Essex-Erie Recovery Team [EERT] 2008). Additionally, sediment loading may impact the entire food web (Vachon 2003). The impacts on aquatic organisms such as fishes may be direct (e.g., physiological disorders, behavioural modifications, physical injury) or indirect (e.g., destruction or degradation of habitat and of food resources) (Vachon 2003). This can result in stunted growth, population decline and problems associated with reproductive capability. The sensitivity of individuals to sedimentation and turbidity is different in the various stages of the life cycle; however, in most cases the indirect effects of sedimentation through the destruction of food resources, eggs and larvae and/or habitat degradation are clearly noticeable before the adult fish are directly affected (Vachon 2003).

The Grass Pickerel is moderately intolerant to turbidity (Trebitz *et al.* 2007); high levels of turbidity in the Dunnville Marsh (lower Grand River) have been implicated in the decline of aquatic macrophytes and may have contributed to the apparent decline of Grass Pickerel in the Grand River. Increasing turbidity reduces the depth to which sunlight can penetrate into the water, thereby limiting photosynthesis and the amount of aquatic vegetation that can establish. This can have detrimental impacts on species that rely on dense growths of aquatic vegetation, such as the Grass Pickerel. Trautman (1981) reported that the species declined or was locally extirpated wherever an increase in turbidity destroyed aquatic vegetation. Increased turbidity negatively impacted Grass Pickerel feeding in Long Point Bay (Crossman and Holm 2005).

Nutrient loading*:* Nutrients (nitrates and phosphates) enter waterbodies through a variety of pathways, including manure and fertilizer applications to farmland, manure spills, sewage treatment plant outputs and faulty domestic septic systems. Nutrient enrichment of waterways can negatively influence aquatic health through algal blooms and associated reduced dissolved oxygen concentrations. Although Grass Pickerel is apparently tolerant of low dissolved oxygen levels (Crossman and Holm 2005), it is possible that extended periods of low dissolved oxygen could negatively impact the species. Additionally, low dissolved oxygen levels may have an indirect affect on Grass Pickerel by negatively impacting prey abundance.

Damage/destruction of riparian vegetation: The removal of stream and riverbank vegetation as a result of forestry, agricultural, and urban development practices (e.g., through rock-fill, lawns, crops, shorewalls) reduces the quality and quantity of habitat available to Grass Pickerel. Riparian vegetation stabilizes water temperatures, and minimizes soil erosion and filters runoff from watershed lands that contain fertilizers, pesticides and sediments (FAPAQ 2002, Vachon 2003). As riparian vegetation is degraded or destroyed, waterbodies become vulnerable to direct sun exposure and impacts from other environmental elements. As a result, water temperatures increase and higher rates of overland runoff transporting sediment and nutrients into the water are experienced. Poor land management practices in agricultural areas have been a significant anthropogenic cause of siltation and increased turbidity in watercourses. Certain practices are especially destructive, for example, the trampling of banks and stream-beds by livestock can destroy riparian vegetation and damage aquatic habitat by re-suspending sediments (Crossman and Holm 2005). The ploughing of fields, the spreading of solid and liquid manure, and crop harvesting all contribute to increases in sediment input in streams, especially where riparian buffers are inadequate or non-existent. The presence of well vegetated, adequately wide riparian buffers promotes the maintenance of water quality in the waterbodies frequented by Grass Pickerel.

In Quebec, Grass Pickerel is very rare and likely endangered by the development of intensive agriculture and the resulting degradation of small rivers and streams (P. Dumont, pers. comm., 2008). In accordance with the *Règlement sur les exploitations agricoles* of the *Loi sur la qualité de l'environnement*, livestock access to watercourses is prohibited. Moreover, the protection of shoreline and stream and river banks is managed by municipal by-laws in Québec. These by-laws must conform to a provincial policy, The *Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains*:

> Section 2.1 of the *Environment Quality Act* (L.R.Q, c.Q-2) requires the Ministre du Développement durable, de l'Environnement et des Parcs to develop, implement and coordinate the application of a policy to protect rivers, littoral zones and floodplains. This obligation was fulfilled by the adoption of the *Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains* (Decree 468-2005). This Policy establishes a minimum level of protection for rivers, littoral zones and floodplains. Under the *An Act respecting land use planning and development*

(L.R.Q., c.A-19.1) the Ministre du Développement durable, de l'Environnement et des Parcs may request the amendment of a metropolitan plan or a regional county municipality's (RCMs) plan if the plan is not consistent with the *Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains*.

In areas around watercourses and lakes citizens can carry out private works, but those works must conform to municipal by-laws or by-laws of RCMs. Before commencing work, applicants must secure a permit, authorization or certificate in accordance with provincial legislation and applicable municipal by-laws, the requirements of which largely come from the *Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains*. Other laws, such as the *An Act Respecting the Conservation and Development of Wildlife* (L.R.Q., c.C-61.1) might also require authorizations for works near watercourses and lakes. Finally, according to s.104 of the *Municipal Powers Act* (L.R.Q. c.C-47.1), RCMs have the power to adopt by-laws regulating waterflow of watercourses.

In 2003, a survey conducted by Environment Quebec and the Department of Municipal Affairs, Sports and Recreation found that the level of conformity of municipal by-laws to this policy was very low (Sager 2004). It is doubtful whether the situation has changed since that time. Apart from the initiatives of a few municipalities and some reclamation projects, there has been a noticeable general deterioration of the quality of riparian zones in both urban and agricultural areas.

Contaminant inputs: The sources and types of contaminant inputs in Grass Pickerel habitat vary, as do their effects on the survival of the species. In general, the effects of contaminants on the Grass Pickerel are not well known, but several studies have shown that certain chemical compounds can have a lethal effects, others can disrupt the endocrine system of exposed organisms, cause deformities, and create problems in reproduction and growth in many fish species including the White Sucker (*Catostomus commersonii*), the Copper Redhorse (*Moxostoma hubbsi*) and the Spottail Shiner (*Notropis hudsonius*) (de Lafontaine *et al.* 2002, Jobling and Tyler 2003, Aravindakshan *et al.* 2004, Environment Canada [EC] 2009).

Pesticides and herbicides used in agriculture can impact Grass Pickerel habitat to the point where survival of the population is at risk. Herbicides that are commonly used can alter the composition and abundance of the aquatic vegetation, which is an essential component of Grass Pickerel habitat. For example, atrazine found in streams and rivers in agricultural areas is harmful to aquatic life and the entire ecosystem, causing reductions in zooplankton abundance, phytoplankton photosynthesis and aquatic plant growth (FAPAQ 2002).

Water level fluctuations (beyond natural seasonal variability): Natural water level fluctuations and flow regimes are necessary and beneficial to maintain pool habitat and wetland floodplain features that are important elements of Grass Pickerel habitat. Control structures (dams/weirs), channelization and drainage alters natural flow dynamics and degrades available habitat.

The fluctuations in water levels in the Great Lakes and St. Lawrence River are a result of the combined action of several natural factors (e.g., climate and climatic variations), but also of human activity. Water levels are affected by water-control structures that are used to prevent flooding in the spring, augment flows downstream during low flow conditions, facilitate commercial navigation, and produce hydroelectric power. Great Lakes and St. Lawrence River water flow is managed by the International Joint Commission (Canada and United States) whose goal is to provide wise management of lake and river systems along the border (International Joint Commission 2009).

Development of the St. Lawrence Seaway has also modified the river's flow regime (EC 1999). The dredging of the shipping channel and shallows has altered habitat and water levels, concentrating water flow in the main river channel and reducing current velocity in the shallower areas. Species, such as Grass Pickerel, that live in the shallower waters could be significantly affected by reductions in water levels in the Great Lakes and the St. Lawrence River. More specifically, some habitat areas may be temporarily drained leading to a deterioration of aquatic vegetation and precluding fish access to these areas, or these areas may be permanently dewatered, reducing available habitat for some Grass Pickerel populations.

Certain water level management activities may be beneficial to the long-term survival of Grass Pickerel. For example, in NWAs, water levels may be managed and some aquatic vegetation may be removed to maintain hemi-marsh conditions (50/50 emergent/open water habitat). Big Creek NWA has been diked and has had ongoing water level management (approximately once a decade) for the past 25 to 60 years (J. Robinson, Canadian Wildlife Service, pers. comm. 2008). This management appears to result in improved habitat conditions for Grass Pickerel in the long term; however, the impacts to the population and its viability are unknown and require investigation.

Disease: The introduction of pathogens can also constitute a threat for Grass Pickerel. For example, viral hemorrhagic septicaemia (VHS) is a contagious viral disease that affects, to varying degrees, more than 65 fish species (including Northern Pike and Muskellunge). First identified in the Great Lakes in 2005 and 2006, this potentially fatal disease has been linked to mass mortalities in several species of fish in the region, including Ontario. To date, no cases of VHS have been detected in Quebec. There is presently no treatment for this disease. The Canadian Food Inspection Agency (CFIA) implemented a biennial plan to monitor the presence of the VHS virus in Canadian wild fish in 2007 (CFIA 2009). Given the low population abundance of Grass Pickerel in Canada, mass mortalities associated with this disease could be highly detrimental to the conservation of the species.

Barriers to movement: Dams and other water-regulating structures (e.g., locks) can transform lotic (flowing water) habitat into lentic (still water) habitat and inhibit the movement of fishes, denying them access to different habitats, fragmenting their distribution, and isolating populations. Guenther and Spacie (2006) have shown that the fragmentation of lotic habitat causes important changes in the distribution and abundance of species, especially piscivorous species. For example, the Redfin Pickerel was less abundant in fragmented streams than in non-fragmented streams. Additionally, in the fragmented streams, the average size of captured fish was smaller (Guenther and Spacie 2006).

In Quebec, historic Grass Pickerel populations occurred in three disjunct areas that have no connection with each other or with the populations in Ontario. Two of the three populations of Grass Pickerel in Quebec were found in the St. Lawrence River on both sides of the Beauharnois locks and the Beauharnois-Les Cèdres hydroelectric station, and the third population was found in the original riverbed near Coteau-du-Lac. Though there is no evidence at the present time of any genetic or reproductive isolation (Crossman and Holm 2005), habitat fragmentation may be detrimental to the maintenance of genetic diversity and re-colonisation in the event that one of these populations becomes extirpated.

Exotic species: Dextrase and Mandrak (2006) suggested that while habitat loss and degradation is the predominant threat affecting aquatic species at risk, exotic species are the second most prevalent threat, affecting 26 of 41 federally-listed species across Canada. There are now at least 185 exotic species that have invaded the Great Lakes basin since 1840 and 88 in the St. Lawrence River (Y. de Lafontaine, Environment Canada-Centre Saint-Laurent,

pers. comm. 2009). Some of these species will likely impact the Grass Pickerel. Exotic species may affect the Grass Pickerel through several different pathways, including direct competition for space, habitat and food, and the restructuring of aquatic food webs.

Alteration of wetland habitat by species such as the Common Carp (*Cyprinus carpio*), Eurasian Watermilfoil (*Myriophyllum spicatum*) and Common Reed Grass may pose a threat to Grass Pickerel populations. Jolley and Willis (2008) have shown that increased Common Carp biomass in a Nebraska lake led to reductions in the quantity of aquatic vegetation and in the quality of Grass Pickerel habitat. Consequently, Grass Pickerel population density and individual growth rates were lower than in the other populations that were surveyed (Jolley and Willis 2008). Eurasian Watermilfoil, an aquatic plant that was first introduced to Ontario and Quebec in the 1960s (EC 2003), could have a negative effect on aquatic macrophyte beds available for or used by the Grass Pickerel. When Eurasian Watermilfoil invades a body of water it generally crowds out the other aquatic plants that are present. This plant creates changes in several physical and chemical parameters (e.g., pH, oxygen, temperature). These changes then impact on the different biological communities present in the waterbody, including aquatic insects and fishes (Auger 2006).

Climate change: Climate change is expected to have significant effects on aquatic communities of the Great Lakes basin through several mechanisms, including increases in water and air temperatures, lowering of water levels, shortening of the duration of ice cover, increases in the frequency of extreme weather events, emergence of diseases and shifts in predator-prey dynamics (Lemmen and Warren 2004). Additionally, warming trends, as a result of climate change, may favour the establishment of potentially harmful exotic species that may currently be limited by cooler water temperatures. Climate change may specifically affect Grass Pickerel through the alteration of water levels and vegetation communities. Mortsch *et al*. (2006) investigated potential impacts of climate change on Great Lakes coastal wetland communities, including areas where the Grass Pickerel is resident. The possibility exists for loss of diversity among aquatic vegetation communities resulting from modified hydrologic and thermal regimes. As the Grass Pickerel is highly associated with the presence of aquatic vegetation, factors altering aquatic communities may have profound impacts on Grass Pickerel populations. The Grass Pickerel was deemed a highly vulnerable species (ranked 26th most vulnerable of 99 species considered) under various climate change scenarios (Doka *et al*. 2006).

In southern Quebec, one of the major impacts of climate change would be a reduction in water flow in the St. Lawrence River. If concentrations of atmospheric carbon dioxide double over the course of the next century, the atmospheric general circulation models forecast a 3°C rise in temperature along the St. Lawrence River within 50 years and up to 50% reduction in water flow from Lake Ontario. The ensuing decrease in water levels in the western part of the St. Lawrence would entail increased dredging operations, deterioration of water quality, and a loss of wetlands (EC 1999).

Interspecific interactions: Hybridization between esocid species is a natural occurrence and cases have been reported from Canada (e.g., Crossman and Buss 1965, Serns and McKnight 1977); however, should the frequency of hybridization increase above natural rates, the genetic integrity of the Grass Pickerel could be at risk. Grass Pickerel is more likely to hybridize with Redfin Pickerel or Chain Pickerel as it is more closely related to these two species and is of a similar size and life-history (N. Mandrak, pers. comm. 2009).

In Canada, Chain Pickerel and Redfin Pickerel are found together with Grass Pickerel exclusively in Quebec, although the Chain Pickerel has recently been captured in the Bay of Quinte region (Lake Ontario). The Redfin Pickerel is rare, small in number, and limited to the area of the St. Lawrence River between the Contrecoeur Islands and the mouth of the Godefroy

River, and the river system of the Richelieu (including Lake Champlain), Godefroy (including Lake St. Paul), Yamaska and François rivers. Reports of Redfin Pickerel presence in the Contrecoeur Islands are relatively recent (1994) and it is the first time that this sub-species has been observed so far upstream from the mouth of the Richelieu River. Its distribution appears to be expanding westward, an expansion that may eventually be facilitated by various programs aimed at restoring and enhancing wetlands. Therefore, there is a risk that the ranges of both sub-species will overlap (Lachance 2001). The potential effects on Grass Pickerel (e.g., competition, predation) of an overlap in distribution with Redfin Pickerel are unknown, but the two sub-species could hybridize and Redfin Pickerel could eventually replace Grass Pickerel in Quebec (Crossman and Holm 2005).

It is not known if interactions with other esocid species may be negatively impacting the Grass Pickerel. In the Niagara region, preliminary results of recent surveys suggest that when Grass Pickerel are abundant, Northern Pike are present in low densities or absent (A. Yagi, pers. comm. 2008). Further research is required to determine the potential impacts on Grass Pickerel, if any, of interspecific competition with other esocid species.

Fishing pressure: The Essex-Erie recovery strategy identifies fishing pressure (incidental capture in commercial/recreational activities) as a speculative threat for Grass Pickerel in the Essex-Erie region (EERT 2008); however, further research is required to determine possible impacts this may have on the species. In Quebec, during two studies to determine the impact of baitfish fisheries on five species at risk, no Grass Pickerel were found in bait buckets or baitfish stores that were visited in autumn 2005 (Boucher *et al.* 2006) and summer 2007 (Garceau *et al.* 2008).

1.6 Actions already completed or underway

Ontario

Ecosystem Recovery Strategies[2]*:* An ecosystem-based recovery strategy for the Essex-Erie region addresses the Grass Pickerel and is currently being implemented by a recovery team (EERT 2008). The Essex-Erie region is defined as the tributaries and nearshore waters of Lake Erie (west of the mouth of the Grand River), the Detroit River and the south shore of Lake St. Clair (west of the mouth of Thames River). The goal of the recovery strategy is to "maintain or enhance existing population distributions and densities of Special Concern species in the Essex-Erie region, and improve the quality and quantity of their associated habitats through the implementation of ecosystem management approaches".

Other ecosystem-based recovery strategies that overlap with the known distribution of the Grass Pickerel include the Ausable River recovery strategy (Ausable River Recovery Team 2006), Sydenham River recovery strategy (Dextrase *et al*. 2003; published pre-SARA), Grand River recovery strategy (Portt *et al*. 2007), and the Walpole Island Ecosystem Recovery Strategy (Bowles 2005). The Grand River recovery strategy focuses primarily on the upper reaches of the river, where Grass Pickerel are not present and consequently may not provide as much benefit to the species; however, another initiative working within the Grand River watershed, called the Southern Grand River Ecosystem Rehabilitation Working Group, focuses on habitat improvement activities on the lower watershed (including the restoration of wetlands), which will likely have a positive impact on the species. Although the recovery strategies for the Sydenham

[2] The recovery strategies referenced in this section are not 'recovery strategies' as defined in SARA.

and Grand rivers, and Walpole Island, were developed prior to the listing of the Grass Pickerel by COSEWIC, their implementation is expected to benefit the species.

Baitfish Study: A graduate student from the University of Toronto is conducting a study (initiated in 2007) to examine the impacts of baitfish harvesting on species at risk and the distribution and spread of exotic species. The study is being conducted in cooperation with DFO, Great Lakes Laboratory for Fisheries and Aquatic Sciences.

Recent Surveys: Table 5 summarizes recent fish surveys conducted by various agencies within areas of known occurrence of the Grass Pickerel in Ontario.

Research project: DFO and University of Guelph are conducting a before-and-after impact (BACI) study on the effects of agricultural drain maintenance on Grass Pickerel populations in Beaver Creek. The study is examining the effect of drain maintenance on Grass Pickerel life history, movement, and habitat supply. A habitat model will be developed to determine how much of each of the different habitats is required to maintain a healthy population. After the baseline fish and habitat surveys and habitat modeling are completed, various drain maintenance scenarios will be evaluated by the study team, the selected scenario will be implemented, and the fish and habitat responses to maintenance will be monitored. The results of this study will be used to develop best management practices for Grass Pickerel in agricultural drains across Ontario through a science transfer workshop (N. Mandrak, pers. comm. 2011).

Table 5. Summary of recent fish surveys in areas of Grass Pickerel occurrence (further survey details are available in Crossman and Holm [2005]).

Waterbody/ General Area	Survey Description (years of survey effort)
Ausable River	• DFO targeted species at risk (SAR) sampling 2002, 2004, 2005[a,b,c,f] • ABCA targeted SAR sampling 2007, 2009[a, c]
Bay of Quinte area	• DFO fish community sampling 2000-2002[c]
Grand River watershed	• DFO fish community sampling 2002[b,c] • GRCA sampling 2003[a,b,c] • DFO/Trent University targeted SAR sampling in the lower Grand River 2008[a]
Long Point area	• DFO fish community sampling 2002-2005, 2008[a,c,f] • OMNR Index surveys of Long Point Bay (annually)[d] • ERCA/DFO targeted SAR sampling (Turkey Point) 2007[a,c,e]
Point Pelee National Park	• DFO/University of Guelph/PCA fish species composition study (Surette 2006) 2002-2003[c,f]
Rondeau Bay	• DFO/OMNR fish community sampling 2004, 2005[a, c, f]
Lake St. Clair watershed	• DFO fish community sampling2003[a,b] • OMNR nearshore fish community survey 2005, 2007[a] • Michigan Department of Natural Resources fish community survey 1996-2001[d] • ERCA/DFO targeted SAR sampling 2007[a,e] • OMNR young-of-the-year index seine survey annually [a] • OMNR fall trap net survey 1974-2007[e]
Tributaries of Little River and Lake Ontario, Essex Region	• ERCA fish community sampling 2004[b]
Tributaries of lakes Erie, Huron, St. Clair and the St. Clair River	• DFO/University of Guelph sampling of warmwater agricultural drains and reference watercourses 2004[a,b]
St. Lawrence River/St. Lawrence Islands National Park/Lake St. Francis and tributaries	• DFO/PCA fish community sampling 2005[a,c,f] • DFO fish assemblage survey 2004[c] • PCA/OMNR/Muskies Canada Muskellunge nursery site surveys/fish community sampling 2006-2011[a] • RRCA targeted SAR sampling (Fraser Creek, Charlottenburgh Marsh) 2007-2010[a,c, f]
Tributaries of Lake Erie – Niagara Region	• OMNR/Niagara Peninsula Conservation Authority (NPCA)/DFO fish community sampling 2001, 2006[a, b]
Tributaries of Upper Niagara River	• OMNR fish community sampling 2003-2005[a, b]
Tributaries of Welland Shipping Canal	• OMNR fish community sampling 2000, 2004[a, b]
Twenty Mile Creek, Niagara Region	• OMNR fish community sampling 1979, 2008[a,b,c] • NPCA fish community sampling 2004[a]
Welland River and Tributaries	• OMNR fish community sampling 2003-2005, 2007, 2008[a, b, c]

Gear type: a-seine net, b-backpack electrofishing unit, c-boat electrofishing unit, d-trawl, e-trap net, f-additional gear (minnow and Windermere traps, fyke and gill nets).

Quebec

On the south shore of Lake St. Louis, within the area in Quebec where most Grass Pickerel captures were reported, over 500 ha of marshland have been protected in the drainage basin of the St. Jean Creek, in St. Bernard Island and in the region of Lery and Maple Grove. These habitat restoration and protection projects are cooperative undertakings involving Heritage Saint-Bernard and the MRNF (Crossman and Holm 2005).

Recent Surveys: Several fish inventories have been conducted in Quebec throughout the potential distribution area of the Grass Pickerel (e.g., the Pont Galipeault area between l'île de Montréal and l'île Perrot [GENIVAR 2005], Canal Lachine [GENIVAR 2008], St. Jean Creek [M. Léveillé, pers. comm. 2009], St. Bernard Island in the Marguerite-D'Youville wildlife sanctuary [P. Brodeur, pers. comm. 2009]), but no Grass Pickerel were captured even though suitable habitat was found and other esocid species were caught. The RSI has never captured a Grass Pickerel. Since 1995, the RSI has been conducting a systematic survey of the fish communities present in six areas of the St. Lawrence River located upstream of Quebec City: Lake St. François, Lake St. Louis, the Montreal-Sorel reach, Lake St. Pierre and its archipelago, the Bécancour-Batiscan reach, and the Grondines-Donaconna reach (La Violette *et al.* 2003, N. La Violette, unpubl. data). However, no survey specifically targeting Grass Pickerel has been conducted for many years and general fish inventories do not always employ methods that are appropriate for the capture of smaller esocids, as Lachance (2001) has mentioned concerning Redfin Pickerel.

Database Project: In the winter of 2009, a project was initiated to create a central database that would include all the historical and current reports of the capture of Grass Pickerel and four other threatened fish species. This project should expand to include information about habitat parameters.

Baitfish Study: In autumn 2005 (Boucher *et al*. 2006) and summer 2007 (Garceau *et al.* 2008), studies were conducted to assess the impact of the fall commercial baitfish industry on five SARA-listed fishes (Bridle Shiner [*Notropis bifrenatus*], Channel Darter [*Percina copelandi*], Copper Redhorse, Eastern Sand Darter [*Ammocrypta pellucida*] and Grass Pickerel). No Grass Pickerel were detected during these studies. *Quebec Fisheries Regulations*, 1990, made under the *Fisheries Act,* prohibits the use of esocid species as bait.

1.7 Knowledge gaps

A considerable amount of the knowledge concerning the biology and life-history characteristics of the Grass Pickerel is taken from a few older publications (e.g., Crossman 1962), much of which is collated in a series of manuscript reports produced by DFO (e.g., Lane *et al*. 1996a,b,c, Portt *et al*. 1999, Coker *et al*. 2001). Since there has been little recent study on the Grass Pickerel, biological characteristics reliant on temperature regimes (e.g., time of spawning, time to hatch) may have changed over the decades. Many of these attributes were last quantified fifty years ago; therefore, a renewed effort to study the basic biological and habitat needs of the Grass Pickerel is desirable. More information is required regarding the interactions (e.g., competition, predation) between Grass Pickerel and other fishes using the same habitat, especially other esocids such as Northern Pike, to assess their effect on the survival of Grass Pickerel. Further surveys are required to determine the range and status of populations in Ontario and to determine if the species is extant in Quebec. In particular, sampling is required at historical sites that have not been visited recently as well as at new sites. In Ontario, these sites include the South Kahshe River, Kahshe Lake, Gartersnake River and Mud Creek (Port Franks area). In Quebec, the entire historical range needs to be re-sampled, including the Soulanges Canal to confirm reports from the early 2000s. Once there is a better understanding of the distribution and biology of Grass Pickerel, additional studies will be needed to understand and mitigate threats to the survival of the species (e.g., life history, movement, and habitat supply studies, as well as studies to assess the effectiveness of mitigation strategies to conserve Grass Pickerel populations).

1.8 Relevant Federal and Provincial fish habitat and fisheries management legislation

Canada – In addition to SARA, the *Fisheries Act* and its supporting regulations have direct or indirect applications to the management of the Grass Pickerel and its habitat. The *Fisheries Act* has provisions that (a) make fish passage mandatory and require the construction of fish-ways (when deemed appropriate by the Minister) (section 20); (b) prohibit the destruction of fish by means other than fishing, unless authorized (section 32); (c) prohibit the harmful alteration, disruption or destruction of fish habitat, unless authorized (section 35); and, (d) prohibit, subject to regulations, the deposit of deleterious substances into waters frequented by fish (section 36). The provisions of the *Fisheries Act* and supporting regulations are mostly administered by DFO. Environment Canada administers section 36 of this Act, which pertains to the release of deleterious substances into watercourses. The *Canadian Environmental Assessment Act* (CEAA) requires the assessment of the environmental effects of a proposed project. Environmental effects are, among other things, "any change that the project may cause in the environment, including any change it may cause to a listed wildlife species, its critical habitat or the residences of individuals of that species, as those terms are defined in subsection 2(1) of the *Species at Risk Act*." In addition, section 79 of SARA requires that, during the CEAA review of a project, all effects of the project on a listed species must be identified. If the project is carried out, measures must be taken that are consistent with applicable recovery strategies or action plans to avoid or lessen those effects (mitigation measures) and to monitor those effects. Grass Pickerel habitat located in Point Pelee National Park and St. Lawrence Islands National Park is subject to the *Canada National Parks Act*. According to that Act, when considering all aspects of management of national parks, maintenance or restoration of ecological integrity through the protection of natural resources and natural processes, is the first priority of the Minister responsible for PCA. Also, subject to certain exceptions, the Minister may not authorize any activity to be carried out in a wilderness area of a national park if, to do so, would be likely to impair the wilderness character of the area.

Quebec – Two pieces of Quebec's legislation are relevant to Grass Pickerel habitat protection. According to *An Act Respecting the Conservation and Development of Wildlife*, no person may carry on an activity in wildlife habitat that might alter any biological, physical or chemical component peculiar to the habitat of the animal or fish concerned. However, there are exceptions to this, including (but not limited to): activities exempted by regulation, activities carried on in accordance with standards or conditions of management prescribed by regulation, activities authorized by the Minister under the Act, and activities required to repair damage caused by a catastrophe or to prevent such damage.

Additionally, the *Environment Quality Act* (EQA) protects fish habitat by prohibiting the release or emission into the environment of any contaminant likely to be prejudicial to wildlife, beyond the quantity or concentration established by the regulations, whether on private or public lands. The EQA also regulates the development and implementation of the Politique de protection des rives, du littoral et des plaines inondables (Protection policy for lakeshores, riverbanks, littoral zones and floodplains) that aims to protect lakes and streams. This policy establishes minimum standards that must, under *An Act respecting land use planning and development*, be adapted in development plans of regional municipalities. Additionally, under the terms of the *Agricultural Operations Regulation* of the EQA, with the exception of fords, it is prohibited as of April 1st, 2005, to allow livestock free access to waterbodies and shorelines. Additional detail is provided in Section 1.5.2. (damage/destruction of riparian vegetation).

Ontario – In Ontario, subsection 3(5) of the *Planning Act* requires that decisions taken by various bodies "be consistent with" provincial policy statement issued under subsection 3(1) of that Act. Paragraph 2.1.3(a) of the *Provincial Policy Statement, 2005,* issued under s.3(1) of the *Planning Act* prohibits development and site alteration in the "significant habitat of [provincially-listed] endangered species and threatened species". The terms "development", "site alteration"

and “significant” have a precise definition in the Policy Statement. This will indirectly benefit species of Special Concern that co-habit with Endangered or Threatened species. Subsection 2.1.5 of the *Provincial Policy Statement, 2005* prohibits development and site alteration in fish habitat except in accordance with provincial and federal requirements, which provides some protection to Grass Pickerel habitat. Note that according to s.2.1.7, nothing in s.2.1. limits the ability of existing agricultural uses to continue. Stream-side development in Ontario is managed through floodplain regulations enforced by local Conservation Authorities. A majority of the land adjacent to the rivers inhabited by the Grass Pickerel is privately owned; however, the river-bottom is generally owned by the Crown. Subject to review by the relevant Conservation Authority, aquatic habitat for Grass Pickerel populations in Ontario is protected against wetland impacts (e.g., infilling) by several regulations concerning development, interference with wetlands, and alterations to shorelines and watercourses, which are administered by individual Conservation Authorities. Grass Pickerel habitat may also be indirectly protected under the *Environmental Assessment Act*, *Environmental Protection Act* and the *Water Resources Act*.

2. MANAGEMENT

The national management plan for Grass Pickerel must take into consideration the provincial differences in the status of the species. In Ontario, Grass Pickerel are distributed in several populations, while in Quebec there have been no confirmed occurrences since 1988, aside from the potential records in the Soulanges Canal. Therefore, the focus in Quebec is to confirm the presence of the species by conducting surveys at historic and potential sites. Until the status of the species is confirmed in Quebec, it is not possible to achieve established management goals, address identified objectives, or implement most of the proposed conservation measures.

The following management goals and objectives, and the actions required to achieve them, were developed from the COSEWIC assessment and status report on the Grass Pickerel (Crossman and Holm 2005), the Essex-Erie recovery strategy (EERT 2008) and recent Grass Pickerel survey and research efforts.

2.1 Goal

The long-term goal of this management plan is to ensure the long-term persistence of Grass Pickerel throughout their current and historic distribution in Canada. Management should be directed towards ensuring the conservation and restoration of habitat for known populations. More quantifiable objectives relating to individual populations will be developed once the necessary sampling/research has been completed.

2.2 Objectives

The following short-term objectives (over the next 5-10 years) have been identified to assist with meeting the long-term goal:

i. To understand the health and extent of existing populations;
ii. To improve our knowledge of the species’ biology, ecology and habitat requirements;
iii. To understand trends in populations and habitat;
iv. To maintain and improve existing populations;
v. To ensure the efficient use of resources in the management of this species; and,
vi. To improve awareness of the Grass Pickerel and engage the public in the conservation of this species.

Grass Pickerel must be confirmed extant in Quebec (Objective i) before the remaining objectives can be addressed. Although specific measures targeting the species are not currently possible,

other general measures can be implemented in the meantime (e.g., habitat restoration). Should Grass Pickerel populations remain unconfirmed in Quebec over the next five years, management of the species in Quebec will be restricted to the general improvement of fish habitat. In Ontario, all objectives should be addressed within the next five to ten years to ensure the protection of current populations.

2.3 Actions

In an effort to meet the goals and objectives of the management plan, five categories of actions will be addressed. These actions comprise the strategies required to protect, maintain and improve Grass Pickerel populations and habitat. Many of these actions can and should be performed in conjunction with other recovery and management teams dealing with individual species and ecosystem-based approaches. Ensuring that Grass Pickerel are considered where feasible in surveys, outreach and educational efforts targeted at Endangered and Threatened species, will result in more efficient and cost-effective conservation efforts.

Management priorities for the Grass Pickerel have been assigned five key categories as follows:

1. Surveys and Monitoring (Population and Habitat)
2. Management and Coordination
3. Research (Biology, Ecology, Threats)
4. Stewardship, Habitat Protection and Improvement, and Threat Mitigation
5. Outreach and Communication

2.3.1 Surveys and monitoring (populations and habitat)

A focused effort will be required to confirm the species' presence in Quebec and to determine the current distribution of the Grass Pickerel in Canada. In Ontario, this will require surveys of current and historical locations (e.g., South Kahshe River, Kahshe Lake, St. Lawrence River tributaries). In Quebec, all locations need to be re-sampled, including the Soulanges Canal where there were unconfirmed sightings from the early 2000s. Potential sites with suitable habitat but lacking Grass Pickerel records should be sampled in both provinces. Survey data will be added to existing distribution data and will establish baseline information upon which further management initiatives can be developed. A standardized index population and habitat monitoring program should be coordinated with existing monitoring programs where possible (e.g., OMNR/PCA/Muskies Canada surveys, surveys for Endangered/Threatened species as part of ecosystem-based recovery programs). A long-term monitoring program will enable assessments of changes/trends in range, population distribution and abundance, key demographic characters and changes/trends in habitat features, quality and extent.

Surveys for Grass Pickerel should include the use of standardized sampling techniques, a relevant assessment of habitat characteristics, as well as sampling methods proven effective at detecting Grass Pickerel (see Port *et al.* 2008). Every effort should be made to use appropriate sampling techniques that result in the least impact on individuals and habitat. Gear selection should also take into consideration site characteristics. A variety of sampling techniques using both active (e.g., boat and backpack electrofishing) and passive (e.g., gill and fyke nets) methods have been used recently for fish community surveys and some comparisons in efficiency of capture have been attempted (Edwards and Mandrak 2006, Mandrak *et al*. 2006a, b, c). For Grass Pickerel, catchability was calculated at equal rates using different capture methods or, in other cases, too few fish were captured to make reliable comparisons.

Actions:

1. Develop consistent protocols for surveying and monitoring Grass Pickerel populations, including the collection of genetic material should genetic analysis be required. See Portt

et al. (2008) for the Ontario protocol to detect species at risk to determine appropriate gear types for sampling Grass Pickerel.
2. Conduct background surveys to confirm current distribution at sites of known occurrence, including sites that have not been recently sampled.
3. Conduct surveys in areas with suitable habitat but lacking Grass Pickerel records.
4. Integrate the long-term monitoring requirements of Grass Pickerel with existing fish community survey efforts, where possible.
5. Monitor the existence and potential arrival of exotic species in Grass Pickerel habitat. Where possible, this should be coordinated with relevant ecosystem-based programs.

2.3.2 Management and coordination

Management efforts targeting Grass Pickerel should be coordinated with existing relevant management (e.g., Priority Intervention Zone Committee [PIZ] in Quebec) and recovery teams to facilitate resource and knowledge sharing and avoid duplication of effort as well as potential conflicts. Management efforts benefiting Grass Pickerel should be included in integrated management plans where possible (e.g., Essex-Erie recovery strategy).

Actions:

1. Collaborate and share information with relevant groups, First Nations, initiatives and recovery/management teams (e.g., drainage superintendents [Ontario], PIZ [Quebec], Watershed committees [Quebec]) to address management actions of benefit to Grass Pickerel.
2. Survey municipal drains proposed for maintenance activities before work occurs in locations suspected of supporting Grass Pickerel, but where records of such are lacking.
3. Ensure that measures to mitigate potential impacts to Grass Pickerel are in place prior to and during in-water works (e.g., municipal drain maintenance, improvements, new drainage works). (See Appendix 1: Basic Principles to Minimize Impacts of Drainage Works on Grass Pickerel in Ontario.)
4. Develop alternatives to drainage that will address land drainage needs while maintaining Grass Pickerel habitat.
5. Create a central database, including habitat parameters to facilitate Grass Pickerel data synthesis and transfer in Quebec (ongoing). A central database currently exists in Ontario.

2.3.3 Research

Considerable information concerning the biology and ecology of the Grass Pickerel in Canada is available through a small number of older publications. Validation of this knowledge in relation to a continually changing landscape and climate is desirable. Additionally, current knowledge regarding threats facing the species is limited. Protection of existing populations and their habitat is the principal foundation of this management plan. To enact viable and targeted protection measures, the development of a comprehensive threat assessment to quantify the impacts of possible threats will be required. It is important to ensure that threats are differentiated by geographic area where necessary.

Actions:

1. Determine the seasonal habitat needs of the various life stages of Grass Pickerel.
2. Gather information on the population dynamics of Grass Pickerel and fish community associations in Canada.
3. Determine the quantity and quality of habitat required to ensure long-term conservation of Grass Pickerel and to support the long-term management goal.

4. Conduct a threat assessment to evaluate threat factors that may be impacting the Grass Pickerel (e.g., exotic species, hybridization, interspecific competition with other esocids, water level management [e.g., in NWAs]), which will be updated as new information becomes available.
5. Determine the mechanisms by which drainage activities have caused Grass Pickerel populations to decline (e.g., through habitat loss or negative interspecific interactions). This will inform mitigation measures for drainage work.
6. If justified, conduct a genetic assessment of the species across its range.

2.3.4 Stewardship, habitat protection and improvement, threat mitigation

Active promotion of stewardship activities will raise community support and awareness of conservation issues regarding the Grass Pickerel and increase awareness of opportunities to improve aquatic habitats and land management practices that affect aquatic ecosystems. Habitat improvement activities should be coordinated with existing groups and initiatives (e.g., ecosystem-based recovery programs), and direction, technical expertise/contacts and information on financial incentives (i.e., existing funding opportunities for private landowners and First Nations) should be provided. Where possible, habitat improvement activities and Best Management Practices (BMPs) should be targeted at areas where there are identified threats to Grass Pickerel populations. Habitat protection and restoration measures specifically targeting Grass Pickerel in Quebec will not be implemented until the species has been confirmed to be extant. However, general fish habitat protection and restoration measures and stewardship projects targeting multiple species are encouraged and will prove beneficial to Grass Pickerel should their presence be confirmed in Quebec.

Actions:

1. Coordinate stewardship activities with existing groups, First Nations, and initiatives.
2. Promote stewardship initiatives (e.g., federal/provincial funding programs) relating to Grass Pickerel conservation and ensure that information relating to funding opportunities for landowners and First Nations is made available.
3. Encourage the implementation of BMPs relating to livestock management, the establishment of riparian buffers, nutrient and manure management, tile drainage etc.
4. Promote retirement of fragile lands that provide Grass Pickerel habitat through Ecological Gift Programs, easements, and tax incentives (e.g., Conservation Land Tax Incentive Program [CLTIP] [Ontario]).

2.3.5 Outreach and communication

Despite its listing under SARA, the Grass Pickerel is not widely known, and communication and education materials relating to Grass Pickerel are limited. Therefore, it is crucial to engage the cooperation of all appropriate landholders and First Nations in wetland habitat protection efforts and raise awareness regarding the Grass Pickerel. The Grass Pickerel should be included in existing communication and outreach programs for both ecosystem-based recovery as well as Endangered and Threatened aquatic species to ensure the efficient use of resources, and to instil awareness of the need to protect freshwater fishes and ensure the health of freshwater ecosystems.

In many areas of the Grass Pickerel range, other esocid species are present and Grass Pickerel is often mistaken for other *Esox* species (e.g., immature Northern Pike). Distinguishing features should be emphasized in outreach materials, and fishermen should be encouraged to release Grass Pickerel if caught.

Actions:

1. Include the Grass Pickerel in existing and future communication and outreach programs for both ecosystem-based recovery as well as Endangered and Threatened aquatic species (for more details, refer to Section 1.6 – *Ecosystem Recovery Strategies*).
2. Promote awareness with municipal planning offices, planning officials and drainage superintendents to develop and adopt land and water management practices that minimize impacts on Grass Pickerel (e.g., See Appendix 1: Basic Principles to Minimize Impacts of Drainage Works on Grass Pickerel in Ontario)
3. Develop and distribute educational materials to interested parties (e.g., local anglers, conservation biologists) that provide the key characteristics that distinguish the esocid species (particularly juveniles).
4. Advise landowners of various tax incentive programs for conservation lands (e.g., Ecological Gifts Program, easements, CLTIP [Ontario]) to protect Grass Pickerel habitat.

2.4 Effects on other species

It is possible that increased populations of Grass Pickerel could result in increased levels of predation on other co-occurring species, including species at risk (e.g., Pugnose Shiner [*Notropis anogenus*], Lake Chubsucker [*Erimyzon sucetta*]). However, the proposed management actions will benefit the environment in general, and wetland habitats that support Grass Pickerel specifically, and are expected to have a net positive affect on other sympatric native species. While there is potential for conflicts with other species at risk (aquatic and semi-aquatic) during implementation of management actions, this possibility will be minimized through strong coordination among the various recovery teams and groups/government agencies that may be working on species at risk and habitat management. Many of the stewardship and habitat improvement activities will be implemented through ecosystem-based recovery programs that have already taken into account the needs of other species at risk.

3. IMPLEMENTATION SCHEDULE

DFO and PCA encourage other agencies and organizations to participate in the conservation of the Grass Pickerel through implementation of this management plan. Table 6 summarizes those actions that are recommended to support the management goals and objectives. The activities implemented by DFO and PCA will be subject to the availability of funding and other required resources. Fisheries and Oceans Canada will collaborate with other agencies and organizations and lead research required to understand the seasonal habitat needs and fish community dynamics for Grass Pickerel, and the impacts to Grass Pickerel populations resulting from drain maintenance work in its habitat. From this research, DFO will develop and communicate best management practices to promote conservation of Grass Pickerel. Through various partnerships and programs, DFO and PCA will continue to promote awareness and stewardship of Grass Pickerel habitat. Where appropriate, partnerships with specific organizations and sectors will provide the necessary expertise and capacity to carry out the listed action, subject to their agency's priorities and budgetary constraints. (Note that the list of participating agencies is not meant to be an exhaustive list.)

Table 6. Implementation schedule.

Action	Objectives	Priority	Threats Addressed†	Participating Agencies ††		Approximate Timeframe[1]
				Quebec	Ontario	
2.3.1 Surveys and Monitoring (Populations and Habitat)						
1 Protocol development	i, ii, iii, iv	Necessary	All	DFO, MRNF, PIZ, WC	DFO, OMNR,PCA, EC, CA	2011-2016
2&3. Baseline surveys	i	Necessary	All	DFO, MRNF, PIZ, WC	DFO, OMNR,PCA, EC, CA	2011-2016
4. Long-term monitoring	i	Necessary	All	DFO, MRNF, PIZ, WC	DFO, OMNR,PCA, EC, CA	2011-2016
5. Exotics monitoring	i, iii	Beneficial	Exotics	DFO, MRNF, PIZ, WC	DFO, OMNR,PCA, CA	2011-2016
2.3.2 Management and Coordination						
1. Collaborate	iv	Necessary	All	DFO, MRNF, PIZ, WC,EC	DFO, OMNR, PCA, EC, CA	2013-2018
2. Survey drains (existing/proposed)	i, iii	Necessary	All	DFO, MRNF, PIZ, WC	DFO, OMNR,CA	2013-2018
3. Mitigation	ii, iii	Necessary	All	DFO, MRNF, PIZ, WC, EC	DFO, OMNR, PCA, EC, CA	2013-2018
4. Drainage alternatives	iv	Beneficial	Habitat Loss/Degradation	DFO, MRNF, PIZ, WC	DFO, OMNR,CA	2013-2018
5. Data management	v	Beneficial	All	DFO, MRNF, PIZ, WC	DFO, OMNR	2013-2018
2.3.3 Research						
1. Seasonal habitat needs	i, ii, iii	Necessary	All	DFO, MRNF, PIZ, WC, AI	DFO, OMNR, PCA, CA, AI	2011-2016
2. Fish community dynamics	i, ii, iii	Necessary	All	DFO, MRNF, PIZ, WC, AI	DFO, OMNR, PCA, CA, AI	2011-2016
3. Habitat quantity and quality	i, ii, iii	Necessary	All	DFO, MRNF, PIZ, WC, AI	DFO, OMNR, PCA, CA, AI	2011-2016
4. Threat evaluation	iii	Necessary	All	DFO, MRNF, PIZ, WC, AI	DFO, OMNR, CA, AI	2011-2016
5. Drainage evaluation	ii, iii	Necessary	Habitat Loss/ Degradation	DFO, MRNF, PIZ, WC, AI	DFO, OMNR, CA, AI	2011-2016
6. Genetics	i, iv, v	Beneficial	All	DFO, MRNF, PIZ, WC, AI	DFO, OMNR, PCA, CA, AI	2013-2018

Table 6 (Con't). Implementation schedule.

Action	Objectives	Priority	Threats Addressed†	Participating Agencies ††		Approximate Timeframe†††
				Quebec	Ontario	
2.3.4 Stewardship, Habitat Protection and Improvement, and Threat Mitigation						
1. Coordinate stewardship activities	ii, iii, iv, v	Necessary	All	DFO, MRNF, PIZ, WC	DFO, OMNR, PCA, CA	2011-2016
2. Promote stewardship	ii, iii, iv, v	Necessary	All	DFO, MRNF, PIZ, WC	DFO, OMNR, PCA, CA	2011-2016
3. BMP implementation	ii, iii	Necessary	All	DFO, MRNF, PIZ, WC	DFO, OMNR, PCA, CA	2011-2016
4. Land retirement incentives	iv, v, vi	Beneficial	All	DFO, MRNF, PIZ, WC	DFO, OMNR, PCA, CA	2011-2016
2.3.5 Outreach and Communication						
1. Existing/future communication and outreach programs	iii, iv, v	Necessary	All	DFO, MRNF, PIZ, WC	DFO, OMNR,PCA, CA	2011-2016
2. Promote awareness with planning offices, drainage superintendents etc.	ii, iii, iv, v	Necessary	All	DFO, MRNF, PIZ, WC	DFO, OMNR,PCA, CA	2011-2016
3. Educational materials for esocid species	ii, iii, iv, v	Beneficial	All	DFO, MRNF, PIZ, WC	DFO, OMNR,PCA, CA	2011-2016
4. Promote fragile land retirement	iv, v, vi	Beneficial	All	DFO, MRNF, PIZ, WC	DFO, OMNR,PCA, CA	2011-2016

† See Section: *1.5.2. Threat description*
†† See Section 7 for acronyms
†††Timeframes are subject to change in response to demands on resources.

4. ASSOCIATED PLANS

In Ontario, the Grass Pickerel is included in and/or will benefit from various existing ecosystem-based recovery strategies that encompass the species' range (see Section 1.6 for more detail). There are also numerous watershed-based management plans and initiatives that could benefit the Grass Pickerel, including Great Lakes Lakewide Management Plans, Great Lakes Areas of Concern Remedial Action Plans, Fish and Fish Habitat Management Plans, and Source Water Protection Planning.

In Quebec, several integrated resource and sustainable development management initiatives are currently underway within the range of the Grass Pickerel, most notably Watershed Committees and Priority Intervention Zone committees.

Additionally, there are a number of species at risk with ranges overlapping the Grass Pickerel in Quebec and Ontario (e.g., Channel Darter, Copper Redhorse, Eastern Sand Darter, Lake Chubsucker, Pugnose Shiner, Spotted Gar [*Lepisosteus oculatus*] and Warmouth [*Lepomis gulosus]*) that have single/multi-species recovery strategies/management plans in development or completed. Recovery initiatives within these strategies/plans may also provide some benefit for Grass Pickerel.

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6. CONTACTS

The following members of the Ontario Freshwater Fish Recovery Team and Quebec Cyprinidae and Small Percidae Recovery Team were involved in the development of the management plan for the Grass Pickerel:

Ontario freshwater fish recovery team

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Francis McDermot	Shabot Obaadjiwan Algonquin First Nations
Vicki M^{c}Kay	Parks Canada Agency
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Anne Yagi	Ontario Ministry of Natural Resources
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Quebec Cyprinidae and small Percidae recovery team

Jean-Philippe Detolle (Président)	Ministère des Ressources naturelles et de la faune du Québec
Geneviève Audet	Société de conservation et d'aménagement du bassin de la rivière Châteauguay (SCABRIC)
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Réjean Malo	Agence Parcs Canada
Marie-Pierre Maurice	Comité de concertation et de valorisation du bassin de la rivière Richelieu (COVABAR)

7. ACRONYMS

ABCA	Ausable Bayfield Conservation Authority
AI	Academic Institutions
BMP	Best Management Practices
CA	Conservation Authority
CFIA	Canadian Food Inspection Agency
CLTIP	Conservation Land Tax Incentive Program
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DFO	Fisheries and Oceans Canada
EC	Environment Canada
EERT	Essex-Erie Recovery Team
ERCA	Essex Region Conservation Authority
FAPAQ	Société de la faune et des parcs du Québec
GRCA	Grand River Conservation Authority
MRNF	Ministère des Ressources naturelles et de la faune du Québec
NWA	National Wildlife Area
NPCA	Niagara Peninsula Conservation Authority
NTU	Nephelometric Turbidity Units
OAC	Old Ausable Channel
OMNR	Ontario Ministry of Natural Resources
PCA	Parks Canada Agency
PIZ	Priority Intervention Zone Committee
RCM	Regional County Municipality
ROM	Royal Ontario Museum
RSI	Réseau de suivi ichtyologique du Saint-Laurent
SAR	Species at Risk
SARA	*Species at Risk Act*
SEA	Strategic Environmental Assessment
TL	Total Length
VHS	Viral Hemorrhagic Septicemia
WC	Watershed Committee

APPENDIX 1 - BASIC PRINCIPLES TO MINIMIZE IMPACTS OF DRAINAGE WORKS ON GRASS PICKEREL IN ONTARIO

The Grass Pickerel is typically found in clear to tea coloured water with very slow to no flow, generally shallower than 2 m, with abundant aquatic vegetation (both emergent and submergent). This species inhabits small, slow-moving, mud bottomed, heavily vegetated lowland streams and the small pond-like expansions of the streams, or overflow ponds of larger streams. It can also be found in quiet weedy bays of lakes.

In Ontario, Grass Pickerel spawn from late March to early May with a period of approximately two weeks to egg hatch and a further two to five weeks to initiation of feeding. Spawning appears to be associated with flooded terrestrial vegetation at temperatures ranging from 4^{o}C to 12^{o}C.

Municipal drainage activities (e.g., drainage maintenance, improvements and new drainage works) are a major threat to Grass Pickerel in Canada. Drainage typically involves channelization, which is the straightening and deepening of a channel, dredging, the removal of instream material (including most if not all structure/cover) and, often times, the destruction of riparian vegetation. In general, activities such as channelization, dredging etc. will have more of an impact than point-impact projects, such as road crossings etc.

The following interim guidance on drainage activities has been provided to minimize impacts to Grass Pickerel habitat. Where possible, design considerations should seek to:

- Ensure floodplain connection is maintained - flooded terrestrial vegetation must remain wet for ~7 weeks to support eggs and larvae within known or suspected Grass Pickerel spawning habitats. Projects should minimize impacts to the duration and extent to which floodplains are inundated
- Projects within Grass Pickerel habitat should be avoided during the spawning/hatching period (from mid-March to the end of May)
- Incorporate natural channel design principles to recreate habitat complexity
- Maintain pool habitats that act as overwintering and summer refugia
- Encourage ‘spot (localized) clean-outs’ to minimize maintenance footprint
- Control sedimentation before, during, and after work to maintain clear water conditions
- Where vegetation is impacted, reestablish or enhance vegetative buffers along the channel