PROPOSED

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Channel Darter (*Percina copelandi*) in Canada

Channel Darter

2012

Canada

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For copies of the recovery strategy, or for additional information on species at risk, including COSEWIC Status Reports, residence descriptions, action plans, and other related documents, see the Species at Risk Public Registry .

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PREFACE

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA) the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years.

The Minister of Fisheries and Oceans Canada is one of two competent ministers for the recovery of the Channel Darter. Due to the presence of Channel Darter in the Trent Severn Waterway, the Minister of the Environment, the minister responsible for Parks Canada Agency, is also a competent minister under SARA. Fisheries and Oceans Canada has prepared this strategy, as per section 37 of SARA in cooperation with many individuals, organizations and government agencies, including the provinces of Ontario and Quebec, Parks Canada Agency, the Ontario Freshwater Fish Recovery Team, and the Quebec Cyprinidae and Small Percidae Recovery Team (see Appendix C for list of members).

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Fisheries and Oceans Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Channel Darter and Canadian society as a whole.

Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations. This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Fisheries and Oceans Canada and other jurisdictions and/or organizations involved in the conservation of the species.

ACKNOWLEDGMENTS

Fisheries and Oceans Canada would like to acknowledge a number of individuals who have helped directly or indirectly in the development of this Strategy: Amy Boyko (DFO – Central and Arctic Region), Jacinthe Beauchamp (DFO – Quebec Region), Daniel Hardy (DFO – Quebec Region), the Ontario Freshwater Fish Recovery Team, the Quebec Cyprinidae and Small Percidae Recovery Team, Carolyn Bakelaar (DFO) helped in the preparation of the maps; Andréanne Demers (DFO) for her contribution to the harmonization of the English and French version of this document; Jean Dubé assisted with some of the research details. Recognition also goes to Erling Holm of the (Royal Ontario Museum) who has contributed his expertise to a number of studies that formed the basis of this recovery strategy, and the efforts of Ontario Ministry of Natural Resources staff, D. Jacobs, S.M. Reid and J. Brownlee, who contributed to earlier versions of the recovery strategy up to 2009.

EXECUTIVE SUMMARY

The Channel Darter is a small, benthic fish with a widespread but extremely disjunct distribution ranging west of the Appalachian Mountains from Louisiana north through 15 American states, and into Ontario and Quebec. In Ontario, the Channel Darter can be found along the shores of Lake Erie, and in the drainages of Lake St. Clair, the Ottawa River, and the Bay of Quinte. In Quebec, the species is found in the St. Lawrence River and also in tributaries of four hydrographic regions: Ottawa and Montreal, the southwest St. Lawrence, southeast St. Lawrence and the northwest St. Lawrence.

The Channel Darter has been designated as Threatened in Canada by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and is listed on Schedule 1 of the federal *Species at Risk Act*. In Canada, this species is threatened by habitat loss and degradation (e.g., shoreline modifications, altered flow regimes, barriers to movement, turbidity and sediment loading, contaminants and toxic substances), the introduction of exotic species, diseases and possibly, baitfish harvesting. In recent years, new populations have been discovered in Ontario and Quebec, but this is most likely attributable to increased sampling effort, rather than a range expansion. One population in Ontario and many populations in Quebec are presumed extirpated. Recent sampling suggests that populations in Lake Erie and Lake St. Clair are in decline.

The long-term recovery objective (> 20 years) for the Channel Darter is to maintain existing populations in Ontario and Quebec and restore self-sustaining populations to formerly occupied habitats, where feasible. In some locations, permanent changes in the fish community, as a result of the establishment of exotic species, may impact the feasibility of re-establishing Channel Darter populations.

The population and distribution objectives for the Channel Darter in Canada are to ensure the survival of self-sustaining population(s) at the following ten locations:

- Ontario: Lake Erie (Point Pelee area), Trent River, Moira River/Black River/Skootamatta River, Salmon River and Little Rideau Creek.
- Quebec: Gatineau River, L'Assomption River and its tributary the Ouareau River, Richelieu River, Saint-François River, and des Anglais River/aux Outardes River/Trout River (Châteauguay River watershed).

The recovery team has identified a variety of approaches to ensure that these objectives are met. These approaches have been broadly organized into five categories: 1) Research; 2) Monitoring; 3) Management and Coordination; 4) Protection, Restoration and Stewardship; and 5) Communication and Public Awareness. Some recovery activities that could be completed as part of such approaches include: additional research into the habitat requirements and life history of the species, the survey of historic Channel Darter locations or target surveys of extant of suspected populations, conduct flow needs assessments to determine impacts of water management on the species, restore existing Channel Darter habitat and improve communication with resource users to increase awareness of habitat use by Channel Darter.

Using the best available information, critical habitat has been identified in Ontario and Quebec at the following locations to date:

- Ontario: Little Rideau Creek/Ottawa River, Trent, Moira, Black, Skootamatta and Salmon rivers as well as the western basin of Lake Erie (Point Pelee area).
- Quebec: Gatineau River, L'Assomption River/Ouareau River, Richelieu River, Saint-François River, and Trout River/aux Outardes River/des Anglais River.

This recovery strategy addresses the needs of the Channel Darter throughout its Canadian range and also serves to facilitate cooperation and coordination of recovery efforts among those jurisdictions responsible for this species. A Quebec recovery plan for the Channel Darter was developed in 2001 (currently under revision) and many recovery actions for this species are already underway. Several ecosystem-based recovery planning documents already exist or are in development that include parts of the range of Channel Darter populations in southwestern Ontario and will likely promote the recovery of this species in those areas.

One or more action plans relating to this recovery strategy will be produced within five years of the final recovery strategy being posted on the public registry.

RECOVERY FEASIBILITY SUMMARY

The recovery of the Channel Darter is believed to be biologically and technically feasible. The following feasibility criteria have been met for the species:

1. Are individuals capable of reproduction currently available to improve the population growth rate or population abundance?

Yes. Phelps and Francis (2002) reported the presence of the Channel Darter at 55 sites in 23 waterbodies. Since this time, Channel Darter has been found in at least one additional waterbody. While spawning does require specific habitat conditions, the species' continued presence at these sites indicates that reproduction has occurred in recent years. Male and female Channel Darter in spawning condition, were observed in the Moira River in May 2001 (Reid et al. 2005) and Trent River in June 2003 (Reid 2004) and in the Gatineau River between May and June 1999 (Comtois et al. 2004), in July 2003 (J. Boucher, Ministère des Ressources naturelles et de la Faune du Québec, pers. comm. 2009) and July 2004 (Lemieux et al. 2005).

2. Is sufficient suitable habitat available to support the species or could it be made available through habitat management or restoration?

Yes. Sufficient suitable habitat is available for the Channel Darter in multiple locations (e.g., Trent River). Additionally, there is apparently suitable, but uninhabited, habitat available in the Quinte region (Reid et al. 2005). Improved water level management and water quality (e.g., through stewardship and Best Management Practices [BMPs] and Watershed Committees) could improve and expand the extent of suitable habitat.

3. Can significant threats to the species or its habitat be avoided or mitigated through recovery actions?

Yes. Many significant threats to Channel Darter habitat, such as dams and increased sedimentation and turbidity, can be addressed through recovery actions. Stewardship, implementation of BMPs and Watershed Committees, as well as improved water level management would mitigate these threats.

4. Do the necessary recovery techniques exist and are they demonstrated to be effective?

Yes. There are numerous techniques available to improve water quality in lakes and rivers. Watershed-based stewardship activities have been initiated in some areas of Ontario and Quebec.

Repatriation may be feasible through captive rearing or adult transfers. Although there are no published studies on the husbandry of Channel Darter, the species has been propagated successfully in captivity (Shute et al. 2000). Additionally, captive rearing and translocations have been used in the south-eastern United States in the recovery of other endangered darter species (Shute et al. 2005). For example, populations of imperilled species such as the Snail Darter (*Percina tanasi*) and Fringed Darter (*Etheostoma crossopterum*) have been established through adult transfers (Etnier and Starnes 1993, Poly 2003).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. COSEWIC SPECIES ASSESSMENT INFORMATION

Date of assessment: May 2002
Common name (population): Channel Darter
Scientific name: *Percina copelandi*
COSEWIC status: Threatened
COSEWIC reason for designation: This species exists in low numbers where found and its habitat is impacted by siltation and fluctuations in water temperature.
Canadian occurrence: Ontario, Quebec
COSEWIC status history: Designated Threatened in April 1993. Status re-examined and confirmed in May 2002.

Please note: The Status Summary above is as it appears on the COSEWIC website. The Recovery Team believes there was a typographical error and that the Reason for Designation should refer to habitat impacts from fluctuation in water levels. The COSEWIC Assessment and Update Status Report on Channel Darter completed by Phelps and Francis in 2002 also refers to habitat impacts from changes in both water temperature and flow.

2. SPECIES STATUS INFORMATION

Global Status - The Channel Darter (*Percina copelandi* Jordan, 1877) is globally secure (G4), but is extremely localized and sparingly distributed (Kuehne and Barbour 1983). Declines have been reported in the upper Ohio River system (Indiana, Ohio, Pennsylvania), the Ohio waters of Lake Erie and in the Tennessee River system in Kentucky (Goodchild 1994). Populations are apparently stable in the Licking River in Kentucky, and the Arkansas River drainage in Oklahoma and Arkansas (Kuehne and Barbour 1983, Goodchild 1994). The Channel Darter is ranked at risk (S1, S2 or S3) in 11 of the 15 American states where it occurs, as well as in Ontario and Quebec (Table 1) (NatureServe 2012).

Canadian Status - In Canada, the Channel Darter has a national ranking of N3, and is ranked S2 in Ontario and S2S3 in Quebec (NatureServe 2012). It was designated as Threatened in 1993 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and this status was reconfirmed in 2002 (COSEWIC 2002). Federally, the species is listed on Schedule 1 of the *Species at Risk Act* (SARA) and provincially, it is designated as Threatened in Ontario and is listed under Ontario's *Endangered Species Act, 2007* (OMNR 2009). Since March 2005 in Quebec, the Channel Darter has been designated as vulnerable under the *Loi sur les espèces menacées ou vulnérables*

Percent of Global Distribution and Abundance in Canada – Phelps and Francis (2002) estimated Channel Darter's extent of occurrence in Canada at 80 000 km^2, or 16% of the species global extent of occurrence. Phelps and Francis estimated that area of occurrence of this species, or the area actually occupied by this species, in Canada is 300 km^2.

Although there are no global or Canadian abundance estimates, Canada may represent about 5% of the global Channel Darter population (A. Dextrase, Ontario Ministry of Natural Resources [OMNR] pers. comm. 2006).

Table 1. Global, national and sub-national heritage status ranks[1] for the Channel Darter. (NatureServe 2012)

Rank	Jurisdiction rank
Global (G)	**G4** (24 Sept. 1996)
National (N) Canada U.S.	 **N3** **N4**
Sub-national (S) Canada U.S.	Ontario (**S2**), Quebec (**S2S3**) Arkansas (**S4**), Indiana (**S2**), Kansas (**S3**), Kentucky (**S4**), Louisiana (**S1S2**), Michigan (**S1S2**), Missouri (**S3**), New York (**S2)**, Ohio (**S2**), Oklahoma (**S4**), Pennsylvania (**S4**), Tennessee (**S2S3**), Vermont (**S1**), Virginia (**S2**), West Virginia (**S2S3**)

3. SPECIES INFORMATION

3.1 Species description

The following description has been adapted from Trautman (1981), Starnes et al. (1977) and Scott and Crossman (1998), unless otherwise noted. The Channel Darter (Figure 1) is a small, slender fish with an elongated body. Goodchild (1994) gives a range of 34 to 61 mm total length (TL) for Canadian specimens, although individuals up to 72 mm TL have been captured (Reid 2004). It is light sand or olive coloured, with brown speckles on its back and cross-shaped markings over its dorsal surface. A series of brown, oblong or round blotches often joined by a thin line can be found on its side. A dusky bar or spot may be present beneath the eye and extend forward on to the snout; fins are clear or only lightly speckled and the ventral half of the body is whitish. Breeding males may be noticeably darker (Goodchild 1994).

The Channel Darter resembles the Johnny Darter (*Etheostoma nigrum*), Tessellated Darter (*E. olmstedi*) and River Darter (*P. shumardi*) (Goodchild 1994), all of which have distributions that

[1] **G4/N4/S4** – **Apparently Secure**: Uncommon but not rare; some cause for long-term concern due to declines or other factors; **N3/S3** – **Vulnerable**: Vulnerable in the nation/state or province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation; **S2** – **Imperilled**: Imperilled in the state or province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the state or province; **S1** – **Critically Imperilled**: Critically imperilled in the state or province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state or province. For more information on ranking see NatureServe.

overlap that of the Channel Darter. An identification key for distinguishing the Channel Darter from other darters has been developed by Massé and Bilodeau (2003). However, juvenile identification is still problematic. Refer to Phelps and Francis (2002) for detailed information on how to distinguish the Channel Darter from other similar species.

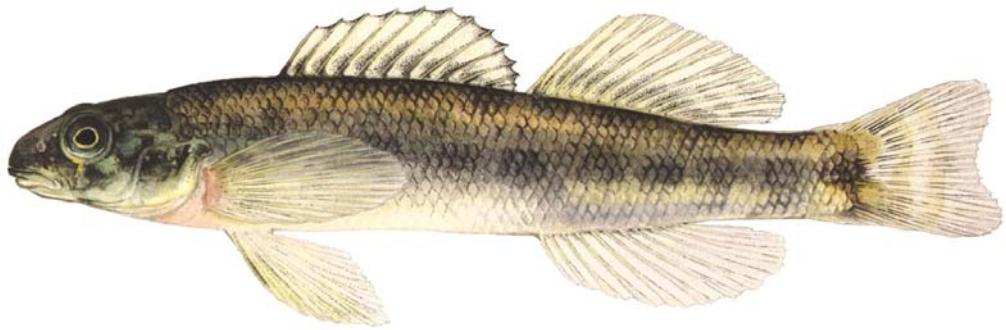

Figure 1. Channel Darter (*Percina copelandi*).

3.2 Population and distribution

Global range – The Channel Darter has a wide but disjunct distribution across central North America (Figure 2); occurring west of the Appalachian Mountains, in the Mississippi drainage (Tennessee, Ohio and Arkansas rivers) and southern Great Lakes basin (Lake Huron, Lake St. Clair, Lake Erie and the Lake Ontario and St. Lawrence River drainages) (Goodchild 1994). It is found in 15 U.S. states: Arkansas, Indiana, Kansas, Kentucky, Louisiana, Michigan, Missouri, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Vermont, Virginia and West Virginia. At the northern limit of its range, the Channel Darter is found in both Ontario and Quebec (NatureServe 2012). It may have had a greater North American pre-glacial distribution, as fossil records tentatively assigned to this species were found in South Dakota (Stauffer et al. 1982, Cavender 1986; both cited *in* Goodchild 1994).

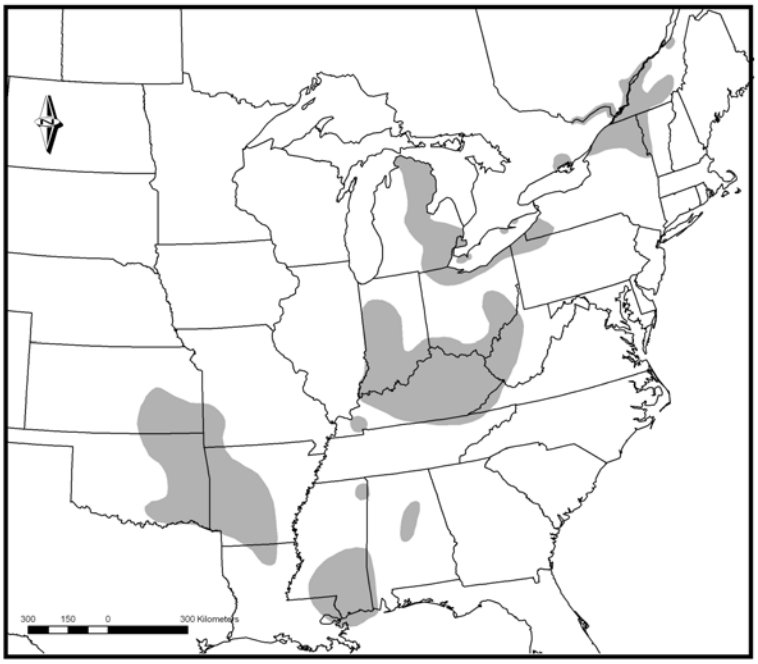

Figure 2. Global distribution of the Channel Darter.
(adapted from Page and Burr 1991).

Canadian range – Disjunct populations are found in Ontario and Quebec (Figure 3). Goodchild (1994) suggested that the Channel Darter has always been rare in Canada, as it is at the northern edge of its range.

Ontario: In Ontario (Figures 4 and 5), the Channel Darter is found in the lower Great Lakes basin. The species has been collected from the Detroit River, Lake St. Clair, the St. Clair River, Lake Erie and several tributaries to Lake Ontario, including the Trent River, Moira River and two of its tributaries (Skootamatta River and Black River), and Salmon River. It has also been found in Little Rideau Creek (a tributary of the Ottawa River) in eastern Ontario (Goodchild 1994, Phelps and Francis 2002).

Quebec: In Quebec, the species is at the northernmost limit of its global distribution. Its distribution is disjunct and populations are located in the tributaries of the upper St. Lawrence (Lapointe 1997, Scott and Crossman 1998) (Figure 6). In the St. Lawrence River, the species has been captured in Lake St. Louis and in Lake St. Pierre and its archipelago (N. La Violette, unpubl. data). The species has also been recorded in tributaries in four hydrographic regions: Ottawa and Montreal, the southwest St. Lawrence, southeast St. Lawrence and the northwest St. Lawrence (Figure 6). Since the preparation of the 2002 COSEWIC update status report (Phelps and Francis 2002) more recent surveys have yielded new Channel Darter records. See Appendix D and E for further details.

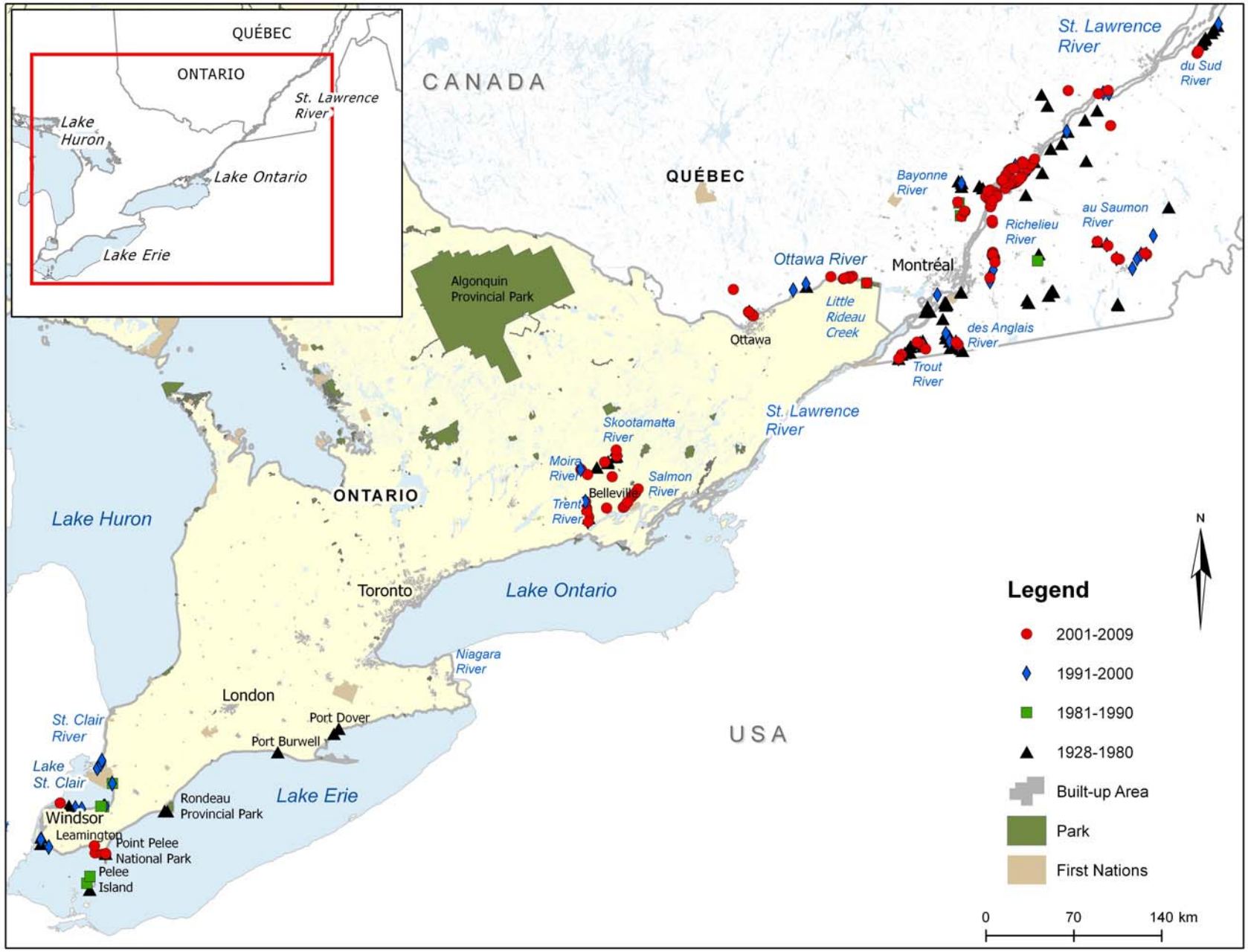

Figure 3. Channel Darter distribution in Canada.

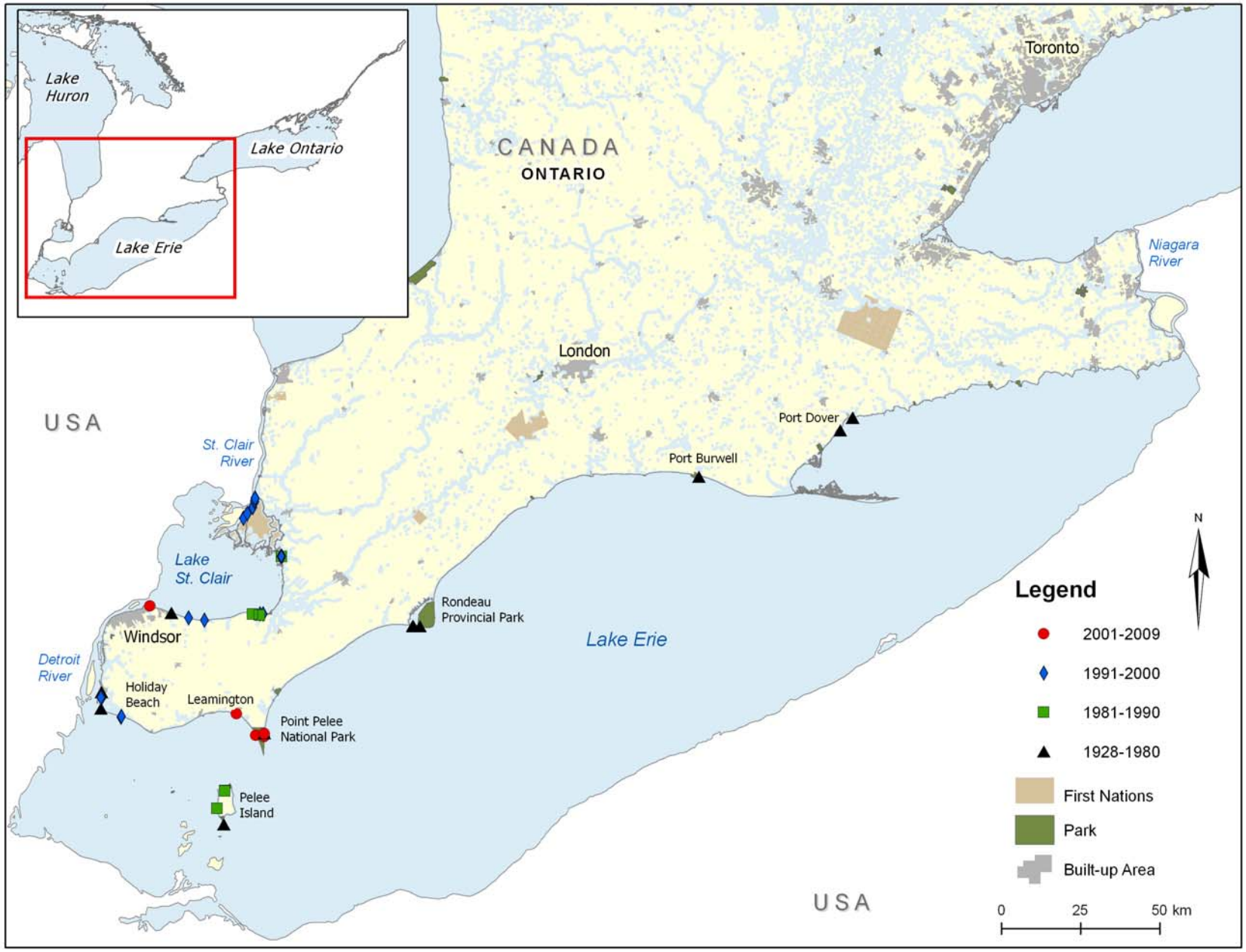

Figure 4. Channel Darter distribution in southwestern Ontario.

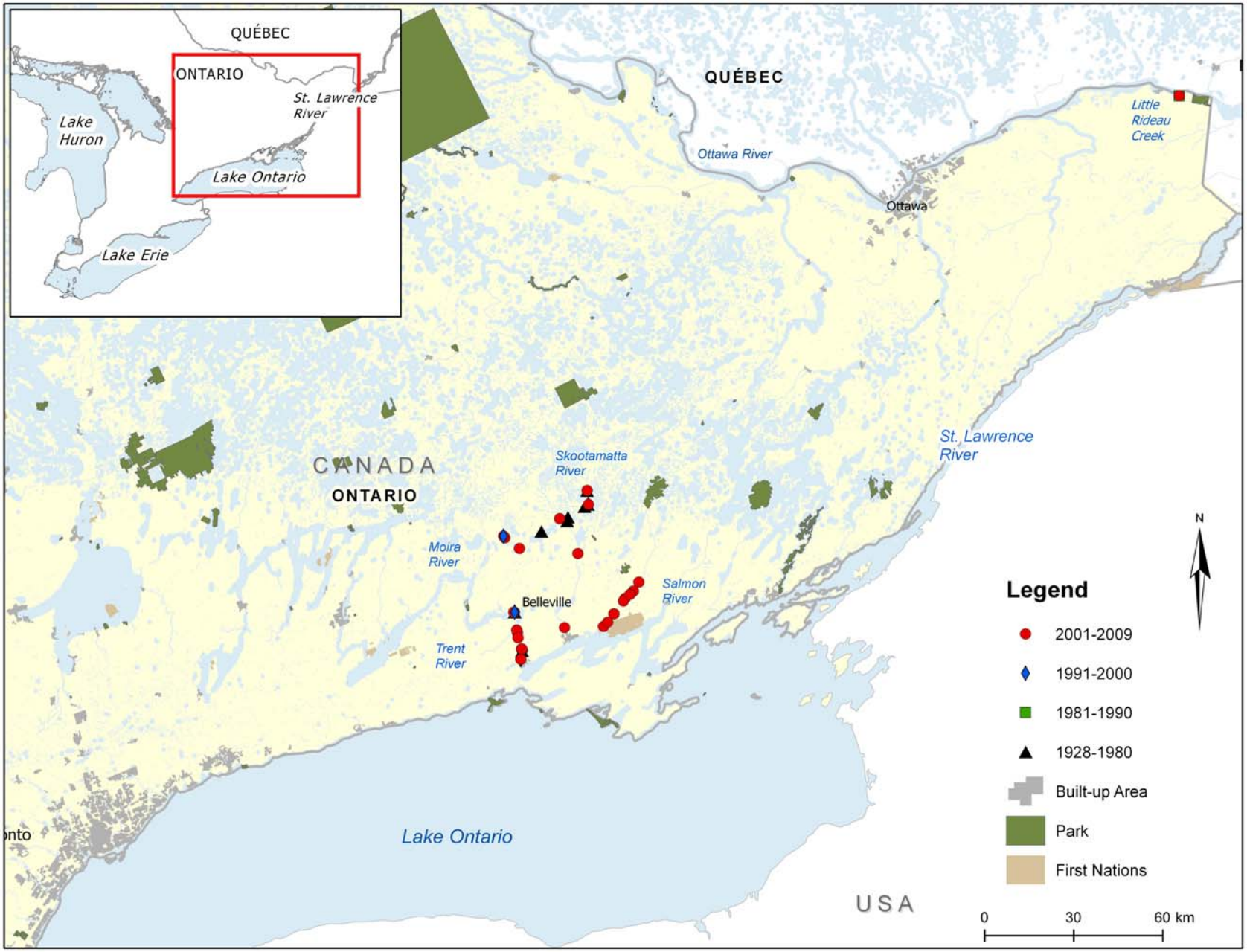

Figure 5. Channel Darter distribution in eastern Ontario.

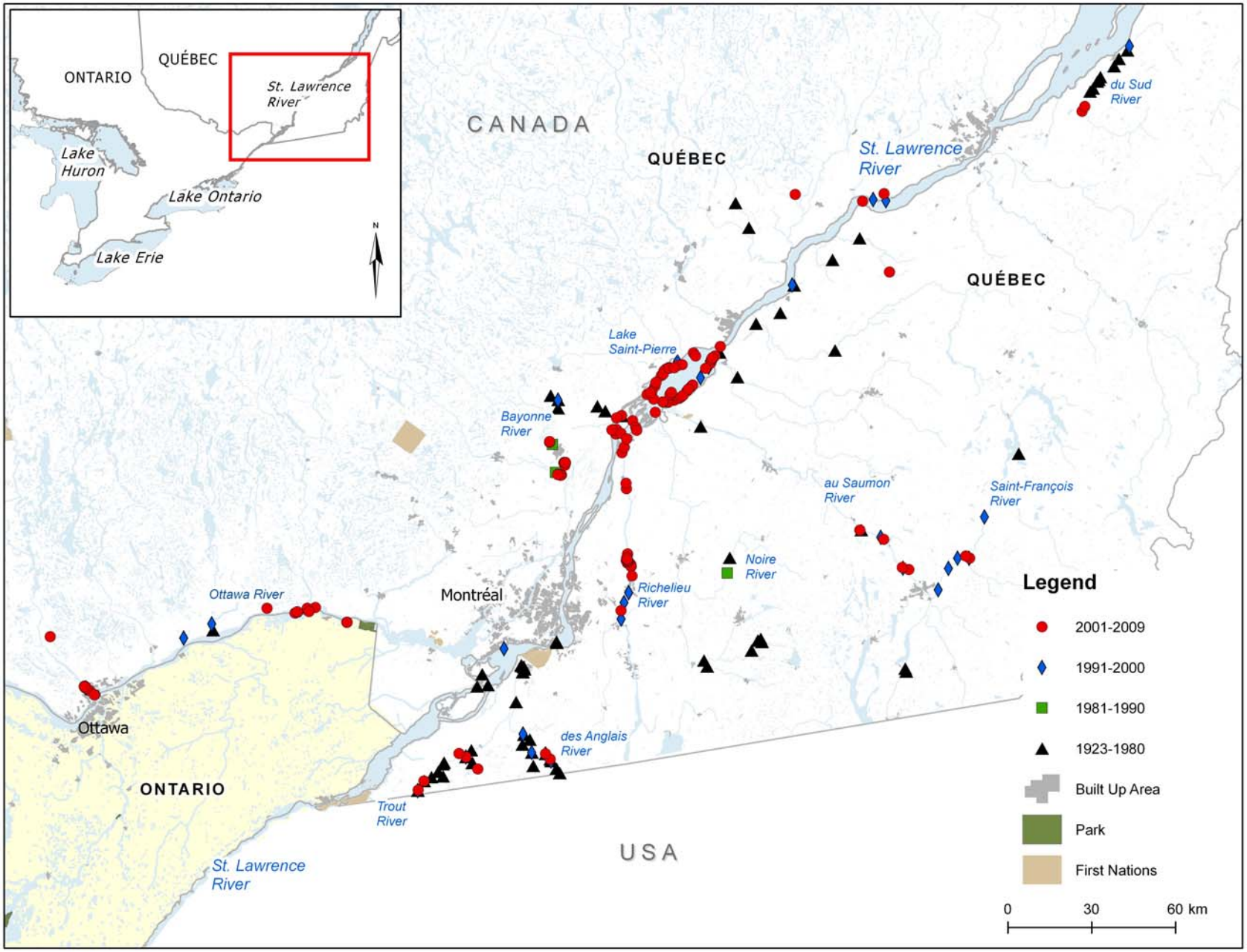

Figure 6. Channel Darter distribution in Quebec.

Canadian population size – Phelps and Francis (2002) reported that extant populations were sampled at 55 locations in 23 waterbodies. Additionally, seven historic sites are believed extirpated, one in Ontario, six in Quebec (Phelps and Francis 2002) (this number is now five as the species has recently been re-confirmed at a site in Quebec that was previously believed to be extirpated). New sites discovered are likely the result of increased sampling effort by OMNR, the Ministère des Ressources naturelles et de la Faune (MRNF) and partners (refer to Appendix E and F) rather than range expansion. Aside from the reported decline at a number of historical locations in Ontario and Quebec (Phelps and Francis 2002), there is no population abundance information, but it is likely that the loss of several Canadian populations is associated with a concomitant decline in abundance.

***Ontario*:** In Ontario, declines appear to be occurring in Lake Erie and Lake St. Clair. Channel Darter was detected at just one (shoreline bordering Point Pelee National Park) of six historic locations along the north shore of Lake Erie during intensive sampling conducted in the spring and fall of 2005 and 2006 (Reid and Mandrak 2008). This indicates that a more substantial range decline has occurred in Canada than reported in the 2002 COSEWIC assessment (Reid and Mandrak 2008). However, one Channel Darter was captured in Lake Erie at a depth of 10.8 m by the OMNR while conducting a bottom trawl in 2010, suggesting that the species may be present at greater depths (Bouvier and Mandrak 2010).

The most recent record of Channel Darter in the Lake Erie drainage comes from the Detroit River in 2009, where a single individual was captured at the mouth of the river where it connects to Lake St. Clair. This new record is located relatively far from previous Channel Darter records in the Detroit River, which were captured in the vicinity of the outlet into Lake Erie (Bouvier and Mandrak 2010).

The most recent records of Channel Darter in Lake St. Clair date back to 1996, when 65 individuals were captured near Walpole Island (Bouvier and Mandrak 2010). In 2005, surveys were conducted at historic sites along the south shore of Lake St. Clair by the OMNR; however, Channel Darter was not detected. Recent trawling (Thomas and Haas 2004) and 2005 OMNR seining surveys (M. Belore, OMNR, pers. comm. 2006) along the south shore of Lake St. Clair failed to collect any Channel Darter.

Recent sampling (2001, 2003) of historic sites in the Moira River (including two of its tributaries the Black and Skootamatta rivers) confirmed the persistence of these populations (Reid 2004, Reid et al. 2005). Two Channel Darter records (1989, 2004) exist for Little Rideau Creek near the confluence with the Ottawa River (Dextrase and Reid 2004). However, given the proximity of the records to the Ottawa River, further sampling is required at this location to determine if the records represent a resident population in Little Rideau Creek or a population in the Ottawa River.

Targeted sampling conducted on the lower Trent River from 2003 to 2008, yielded 831 Channel Darter (Reid 2005, Coker and Portt 2009), and sampling conducted in 2003 detected Channel Darter for the first time in the Salmon River (Reid et al. 2005). The species is believed to be extirpated from an un-named creek that flows into the Moira River (Phelps and Francis 2002). In the South Nation River, sites with unconfirmed Channel Darter records from OMNR stream inventories in the 1970's were re-sampled in May of 2005 but yielded no specimens (A. Dextrase, S. Reid, OMNR, pers. comm. 2009)

***Quebec*:** The status of the Channel Darter in Quebec is not well known as there have been few studies conducted. Nevertheless, the small amount of available abundance data could suggest

that the species' numbers have decreased (Lapointe 1997, Équipe de rétablissement du fouille-roche gris 2001, Phelps and Francis 2002, Fisheries and Oceans Canada [DFO] 2010). The Channel Darter appears to have disappeared from the Chicot, Niger, aux Bleuets and Maskinongé rivers as well as from the Port St. François area in the St. Lawrence River (Phelps and Francis 2002) and from the Lake St. Louis and Becancour-Batiscan area in the St. Lawrence River (data from the St. Lawrence Fish Monitoring Network [RSI]). The species was also believed to be extirpated from the du Sud River (Phelps and Francis 2002) until two specimens were detected in 2005 (P.Y. Collin, MRNF, pers. comm. 2005). Several areas with historic Channel Darter records have not been sampled recently; therefore, it is impossible to determine whether the species is extant at these locations.

Since the preparation of the 2002 COSEWIC status report (Phelps and Francis 2002), Channel Darter specimens have been captured in several waterways and in some cases in large numbers (e.g., 137 and 125 specimens in the Gatineau and Richelieu rivers, respectively, in 2003 [Boucher et al. 2009]; 58 specimens in the tributaries of the Ottawa River downstream from Gatineau in 2006 [Pariseau and Fournier 2007]) (Refer to Appendix D for more information). However, most of the targeted Channel Darter surveys were aimed at verifying the occurrence of the species and not the density. When one or more individuals were observed, sampling was halted to limit the impacts on the species and its habitat (S. Garceau, MRNF, pers. comm. 2009). These surveys revealed that several areas in Quebec appear to harbour significant Channel Darter populations, such as the Chambly Rapids on the Richelieu River, the Farmer Rapids on the Gatineau River, and Pointe-au-Chêne Creek and the Kinonge River, two tributaries of the Ottawa River. Potential new Channel Darter locations include the wider section of the Ottawa River between Fasset and Grenville (i.e., wide sand and gravel beaches washed over by waves) and the Saint-François River.

Canadian population assessment – The status of Channel Darter populations in Canada was assessed by Bouvier and Mandrak (2010) (Ontario) and Boucher and Garceau (2010) (Quebec) (Table 2). Populations were ranked with respect to abundance and trajectory (DFO 2010) (Table 2). Population abundance and trajectory were then combined to determine the population status. A certainty level was also assigned to the population status, which reflected the lowest level of certainty associated with either population abundance or trajectory. Refer to Bouvier and Mandrak (2010) and Boucher and Garceau (2010) for further details on the methodology.

Table 2. Population status and associated certainty of individual Channel Darter populations in Canada.
Certainty: 1 = quantitative analysis; 2 = Catch Per Unit Effort (CPUE) or standardized sampling; 3 = best guess. Table adapted from DFO (2010).

Population[2]	Population status	Certainty
ONTARIO		
Bay of Quinte Drainage		
Moira system: Moira, Skootamatta and Black rivers	Fair	2
Salmon River	Fair	2
Trent River	Fair	2
Lake Erie Drainage		
Detroit River	Unknown	3
Western basin: Pelee Island, Point Pelee, Holiday Beach	Poor	2
Central/Eastern basin: Port Dover, Port Burwell, Rondeau Bay	Extirpated	2
Lake St. Clair Drainage		
Lake St. Clair	Poor	2
Ottawa River Drainage		
Little Rideau Creek	Unknown	2
QUÉBEC		
Ottawa and Montreal		
Ottawa *River*	Good	2
Southwest St. Lawrence River		
Richelieu River	Good	2
Châteauguay River	Poor	2
Yamaska River	Poor	3
Saint-François River	Good	2
Nicolet River	Unknown	3
Northwest St. Lawrence River		
L'Assomption River	Fair	2
Bayonne River	Fair	2
Batiscan River	Unknown	3
Jacques-Cartier River	Unknown	3
Sainte-Anne River	Unknown	3
Southeast St. Lawrence River		
Bécancour River	Unknown	3
du Sud River	Poor	2
du Chêne River	Unknown	3
aux Ormes River	Unknown	3
Henri River	Unknown	3
Gentilly River	Unknown	3
aux Orignaux River	Unknown	3

[2] Note that, for lack of supporting data, a location was assumed to have a single population when population status was assessed by Bouvier and Mandrak (2010) and Boucher and Garceau (2010).

3.3 Needs of the Channel Darter

Habitat and biological needs

Spawn to Hatch: In the spring and early summer, Channel Darter migrate short distances to riffle or shoal habitats with moderate flows and clean coarse bed material to spawn (Winn 1953, Reid 2004, Lemieux et al. 2005, Garceau et al. 2007, Boucher et al. 2009). Winn (1958) described spawning in an inland Michigan lake to occur on gravely shoals, after which Channel Darter migrated to deeper waters. Moderate to fast flow rates may be essential to spawning success. For example, in the Trent River, a mean mid-column water velocity of 0.46 m/s was measured over a period when individuals in reproductive condition were collected (Reid 2004), and in the Richelieu River water velocities ranged from 0.24-0.60 m/s (Lemieux et al. 2005). Male Channel Darter establish and defend breeding territories around a rock located in the current. Females move between territories, spawning with successive males and laying 4-10 eggs in each nest; 350-700 eggs are laid in total. Water temperatures measured during spawning ranged from 14.5 to 25^{o}C (Winn 1953, Comtois et al. 2004, Reid 2004, Lemieux et al. 2005). No parental care is provided to the eggs/larvae. There is little information on generation time for this species, although eggs have been collected from 1-2 year old females (Page 1983).

Embryonic (yolk-sac) stage: Yolk-sac larvae have been collected in water 12 m deep in Lake Erie near Point Abino (Fish 1932; cited *in* Simon and Wallus 2006). In Quebec, eggs and larvae have been captured at depths of 0.3-0.4 m over substrates of cobble, gravel and sand (Lemieux et al. 2005). Nothing further is known regarding the habitat requirements of embryonic Channel Darter.

Young of the year (YOY): YOY are believed to associate with areas containing gravel and sand at depths of 0-5 m (Lane et al. 1996). Juveniles have been found in backwaters and pools with low flow and some have been captured adjacent to large rivers (Winn 1953). Little else is known regarding the specific habitat requirements of YOY Channel Darter.

Adult: The Channel Darter is a warm water benthic species that, in Canada, is found in three general habitats: gravel and coarse sand beaches of Lake Erie (Reid and Mandrak 2008); gravel/cobble shoals and riffles in large rivers (Reid 2005, Lemieux et al. 2005, Boucher et al. 2009); and riffles and pools of small- to medium-sized rivers (e.g., CARA 2002, Reid et al. 2005, Garceau et al. 2007). In Quebec, the species occurs primarily in rivers or small streams with undisturbed shorelines along forested or agricultural areas and with good water quality (Lapointe 1997, Garceau et al. 2007). Currents are slow to moderate, depths are usually less than 60 cm and substrates are composed of cobble along with other types of material (Desrochers et al. 1996, CARA 2002, Lemieux et al. 2005, Boucher 2006, Garceau et al. 2007, Boucher et al. 2009).

During the summer, Channel Darter continue to be associated with habitats containing riffles or shoals (Stauffer et al. 1996, Reid 2004) and adjacent sand-bottomed pools (Reid 2005). By late fall, few remain in riffle and shoal habitats and over-wintering occurs in pools with low current (Branson 1967, Etnier and Starnes 1993). Habitat requirements of lake populations are not as well documented as river populations. Along the north shore of Lake Erie, Channel Darter have been collected from wave-washed coarse sand and gravel beaches (Scott 1955, Reid and Mandrak 2008).

The Channel Darter is considered to be pollution intolerant. Good water quality, particularly low levels of turbidity, is important for this species (Lapointe 1997). The Channel Darter is sensitive

to high sedimentation levels (Goodchild 1994) and is not often found in areas with predominantly silt or clay substrates.

Limiting factors

The Channel Darter has specific habitat requirements relating to water temperature, flow and substrate that must be present for successful spawning. Water temperatures measured during spawning ranged from 14.5 to 25^{o}C (Winn 1953, Comtois et al. 2004, Reid 2004, Lemieux et al. 2005). Abrupt reductions in water flow during spawning can cause cessation of courtship activities and temporary use of the breeding area (Winn 1953). Spawning requires clean coarse bed material. Deposition of fine sediments over otherwise suitable spawning habitats has been suggested to preclude use (Winn 1953). Goodchild (1994) hypothesized that the conditions needed to create optimal spawning habitat may only occur at intervals, leading to a variation in reproductive success and thus changes in abundance from year to year. The communal spawning behaviour of the Channel Darter may limit the number of eggs deposited by females (Goodchild 1994). This implies that each female must spawn repeatedly with many males to lay all her eggs and this opportunity may not always exist (Goodchild 1994).

The Channel Darter is a small fish, with limited dispersal ability, that exists as a collection of disjunct populations. Therefore, rescue effect (the ability of a neighbouring population to halt the decline of another population through migration from one population to another) is low as extirpated populations have little opportunity to be re-colonized through natural movements. The ability to disperse might increase if we consider dispersal over more than one generation.

Goodchild (1994) suggested that the Channel Darter may be limited by competition from Johnny Darter or Logperch (*P. caprodes*) for spawning sites. Competition with Round Goby (*Neogobius melanostomus*) in areas where their ranges overlap may also occur (Janssen and Jude 2001).

4. THREATS

4.1 Threat assessment

Bouvier and Mandrak (2010) assessed threats to Channel Darter populations in Ontario while Boucher and Garceau (2010) assessed threats to the species in Quebec. Known and suspected threats were ranked with respect to threat likelihood and threat impact for each population (Tables 3a and 3b) (DFO 2010). The threat likelihood and threat impact were then combined to produce an overall threat status. A certainty level was also assigned to the overall threat status, which reflected the lowest level of certainty associated with either threat likelihood or threat impact. See Bouvier and Mandrak (2010) and Boucher and Garceau (2010) for further details. Additional information is provided in the subsequent threat summaries.

Table 3a. Threat status and certainty (), by population, for Channel Darter in Ontario by drainage.

Certainty: 1= causative studies; 2=correlative studies; and 3=expert opinion. Clear cells do not necessarily represent a lack of a relationship between a population and a threat; rather, they indicate that either the threat likelihood or the threat impact is unknown. Gray cells indicate that the threat is not applicable to the population due to the nature of the aquatic system where the population is located. Table adapted from DFO (2010).

	Lake Erie drainage			Lake St. Clair drainage
Threats	**Detroit River**	**Western basin**	**Central/ Eastern basin**	**Lake St. Clair system**
Shoreline modifications	Medium (3)	High (2)	High (2)	High (3)
Altered flow regimes	High (3)			Unknown (3)
Barriers to movement				
Turbidity and sediment loading	Medium (3)	Medium (3)	Medium (3)	Medium (3)
Nutrient loading	Medium (3)	Medium (3)	Medium (3)	Low (3)
Contaminants and toxic substances	Medium (3)	Unknown (3)	Unknown (3)	Low (3)
Exotic species and disease	High (2)	High (2)	High (2)	High (2)
Incidental harvest	Low (3)	Low (3)	Low (3)	Low (3)

	Bay of Quinte drainage			Ottawa River drainage
Threats	**Moira system**	**Salmon River**	**Trent River**	**Little Rideau Creek**
Shoreline modifications	Low (3)	Low (3)	Low (3)	Unknown (3)
Altered flow regimes	Low (3)	Low (3)	Medium (3)	Unknown (3)
Barriers to movement	Medium (2)	Low (2)	Medium (2)	Unknown (3)
Turbidity and sediment loading	Low (3)	Low (3)	Medium (3)	Low (3)
Nutrient loading	Low (3)	Low (3)	Low (3)	Unknown (3)
Contaminants and toxic substances	Low (3)	Low (3)	Low (3)	Unknown (3)
Exotic species and disease	High (2)	High (2)	High (2)	High (2)
Incidental harvest	Low (3)	Low (3)	Low (3)	Unknown (3)

Table 3b. Threat status and certainty (), by population, for Channel Darter in Quebec by hydrographic region and drainage.
Certainty: 1= causative studies; 2=correlative studies; and 3=expert opinion. Clear cells do not necessarily represent a lack of a relationship between a population and a threat; rather, they indicate that either the threat likelihood or the threat impact is unknown. Gray cells indicate that the threat is not applicable to the population due to the nature of the aquatic system where the population is located. Table adapted from DFO (2010).

	Ottawa – Montreal drainage	Southwest St. Lawrence River drainage		
Threats	**Ottawa River**	**Richelieu River**	**Châteauguay River**	**Yamaska River**
Shoreline modifications	Low (3)	Medium (2)	High (3)	Low (3)
Altered flow regimes	High (1)	Low (3)	Low (3)	Medium (3)
Barriers to movement	Medium (1)	Low (1)	Medium (1)	Low (1)
Turbidity and sediment loading	Low (2)	Medium (2)	Medium (2)	High (2)
Nutrient loading	Low (2)	Medium (1)	Medium (1)	High (1)
Contaminants and toxic substances	Low (2)	Medium (1)	Medium (1)	High (1)
Exotic species and disease	Unknown (3)	Unknown (2)	Unknown (2)	Unknown (2)
Incidental harvest	Low (1)	Low (1)	Low (1)	Low (1)

	Southwest St. Lawrence River drainage		Northwest St. Lawrence River drainage	
Threats	**Saint-François River**	**Nicolet River**	**L'Assomption River**	**Bayonne River**
Shoreline modifications	Low (2)	Medium (2)	Medium (2)	Medium (2)
Altered flow regimes	High (2)	Unknown (2)	Low (2)	Low (2)
Barriers to movement	High (2)	Low (2)	Low (2)	Low (2)
Turbidity and sediment loading	Medium (2)	Medium (2)	Medium (2)	Medium (2)
Nutrient loading	Low (2)	Medium (2)	Medium (2)	Medium (2)
Contaminants and toxic substances	Medium (2)	Medium (2)	Medium (2)	Medium (2)
Exotic species and disease	Unknown (3)	Unknown (3)	Unknown (3)	Unknown (3)
Incidental harvest	Low (1)	Low (1)	Low (1)	Low (1)

	Northwest St. Lawrence River drainage		
Threats	**Batiscan River**	**Jacques-Cartier River**	**Sainte-Anne River**
Shoreline modifications	Low (2)	Unknown (3)	Unknown (3)
Altered flow regimes	Unknown (2)	Unknown (3)	Unknown (3)
Barriers to movement	Unknown (2)	Unknown (2)	Unknown (2)
Turbidity and sediment loading	Low (2)	Low (2)	Low (2)
Nutrient loading	Low (2)	Low (2)	Low (2)
Contaminants and toxic substances	Low (2)	Low (2)	Low (2)
Exotic species and disease	Unknown (3)	Unknown (3)	Unknown (3)
Incidental harvest	Low (1)	Low (1)	Low (1)

Table 3b (cont'd). Threat status and certainty (), by population, for Channel Darter in Quebec.

Threats	Southeast St. Lawrence River drainage			
	Bécancour River	**du Sud River**	**du Chêne River**	**aux Ormes River**
Shoreline modifications	Medium (2)	Medium (3)	Unknown (3)	Unknown (3)
Altered flow regimes	Unknown (2)	Medium (2)	Low (2)	Unknown (3)
Barriers to movement	Unknown (2)	Unknown (2)	Low (2)	Unknown (3)
Turbidity and sediment loading	Medium (2)	Medium (3)	Unknown (3)	Unknown (3)
Nutrient loading	Medium (2)	Medium (3)	Unknown (3)	Unknown (3)
Contaminants and toxic substances	Medium (2)	Medium (3)	Unknown (3)	Unknown (3)
Exotic species and disease	Unknown (3)	Unknown (3)	Unknown (3)	Unknown (3)
Incidental harvest	Low (1)	Low (1)	Low (1)	Low (1)

Threats	Southeast St. Lawrence River drainage		
	Henri River	**Gentilly River**	**aux Orignaux River**
Shoreline modifications	Unknown (3)	Unknown (3)	Unknown (3)
Altered flow regimes	Unknown (3)	Unknown (2)	Unknown (2)
Barriers to movement	Unknown (3)	Unknown (2)	Unknown (2)
Turbidity and sediment loading	Unknown (3)	Unknown (3)	Unknown (3)
Nutrient loading	Unknown (3)	Unknown (3)	Unknown (3)
Contaminants and toxic substances	Unknown (3)	Unknown (3)	Unknown (3)
Exotic species and disease	Unknown (3)	Unknown (3)	Unknown (3)
Incidental harvest	Low (1)	Low (1)	Low (1)

4.2 Description of threats

Shoreline modifications

Natural coastal processes that occur near the shorelines along lakes and large rivers include sediment erosion and deposition zones that provide and maintain fish habitat. Much of the shoreline along Lake St. Clair and the Detroit River has been artificially hardened, filled, dredged or modified for human use (Essex-Erie Recovery Team [EERT] 2008). In addition, the Detroit and St. Lawrence rivers have been significantly altered through the creation of shipping lanes, which resulted in the deepening of the channels, the creation of artificially hardened shoreline walls, the creation of depositional zones where dredged materials are placed, and the modification of flow patterns in both rivers (Environment Canada 1999, EERT 2008). As a result, the natural processes of erosion and deposition along the St. Clair River-Detroit River corridor, and the St. Lawrence River have been altered. Similarly, the nearshore of Lake Erie has been extensively modified with groynes, jetties and breakwaters, thereby, reducing aquatic habitat diversity and altering nearshore sediment transport (Koonce et al. 1996). At Port Burwell and Port Dover, the construction of jetties has promoted sand deposition and changed the character of the sand beaches that previously supported the Channel Darter (Reid and Mandrak 2008). Reid and Mandrak (2008) also noted that the creation of a break-wall and armouring at another historic Channel Darter location had reduced the beach habitat present.

The presence of healthy riparian areas also plays an important role in the protection of water quality. These areas reduce soil erosion, filter runoff containing fertilizers, pesticides and sediment, regulate the water temperature and thus maintain good water quality for aquatic wildlife. The deforestation and loss of riparian strips to increase cropland and corn development, results in the increase of water temperature, but also increases the rate of runoff, sedimentation and nutrient enrichment in streams and rivers, which are likely to affect Channel Darter habitat (FAPAQ 2002, Vachon 2003). The regulations for protecting shorelines and littoral zones in Quebec, which were transferred to municipalities who must take the measures imposed by Quebec's policy on protection of banks, shorelines and floodplains (Politique de protection des rives, du littoral et des plaines inondables [PPRLPI]), were only marginally applied, if at all, in 2004 (Sager 2004). This situation has changed little in recent years. Aside from initiatives by a few municipalities or enhancement projects, in general, there was deterioration in the quality of riparian strips both in urban and agricultural areas (Boucher and Garceau 2010).

Altered flow regimes

Many Quebec and Ontario rivers that support Channel Darter are affected by dams (e.g., Gatineau River, Moira River, Ottawa River, Trent River, Yamaska River). Lacustrine conditions immediately upstream of dams are likely not suitable Channel Darter habitat. Flow regulation may also have a negative effect on downstream populations, especially during the spawning period. Abrupt decreases in flow during spawning can cause spawning to cease (Winn 1953). Altered flow can also result in physiological stress and mortality in individual fish. The Channel Darter is found downstream of dams along the Trent River where flow is primarily managed for navigation and flood control. Shoals used by the Channel Darter have been observed to be temporarily (1-2 hours) de-watered during the spawning period and consistently dry in fall (Reid 2005). In-stream flow needs assessments for species at risk are planned by Parks Canada Agency (PCA) for the Trent Severn Waterway in 2012. This, in addition to future hydro-electric projects proposed for the Trent River may provide the opportunity to confirm that the needs of the Channel Darter and other species at risk are taken into account during the design and operation of dam recapitalization projects and construction and operation of new or upgraded hydro-generating facilities.

Barriers to movement

Barriers to movement (e.g., dams, natural waterfalls, poorly installed culverts) can restrict access to important habitat areas as well as fragment fish populations and limit the potential for rescue effect from neighbouring populations (EERT 2008, NatureServe 2012). Conversely, barriers may afford protection for some species from competitors, predators or exotic species (EERT 2008). According to Phelps and Francis (2002), barriers can compromise the spawning success of the Channel Darter by blocking access to spawning areas, although they did not distinguish between man-made and natural barriers. Reid et al. (2005) found that natural barriers in the Bay of Quinte tributaries corresponded with the upper distribution limit of the Channel Darter in those systems. The Moira, Black, Skootamatta and Salmon rivers are all fragmented by man-made structures and although Channel Darter were found both upstream and downstream of the barriers, it is possible that the species had a wider historical distribution (Reid et al. 2005).

Turbidity and sediment loading

Elevated turbidity can negatively affect the ability of Channel Darter to find food and locate spawning sites. Most Canadian populations are found in relatively clear rivers or lakes. Similarly, high siltation rates can reduce the quality of spawning substrate, smother eggs or indirectly affect their benthic invertebrate food source (Goodchild 1994). When sediment loads

increase, the slow-to-moderate current habitat occupied by the Channel Darter may not be swift enough to prevent sediment deposition. In Quebec, the species populates areas where intensive agricultural activities and urbanization have caused a gradual degradation of its habitat as a result of sedimentation, which jeopardizes the species' survival (Lapointe 1997, DFO 2010). Biologists failed to detect any Channel Darter in five rivers where the habitat had been altered as a result of agricultural exploitation, urbanization and bank erosion from navigation (i.e., wave action from passing boats[3]) (Lapointe 1997, Phelps and Francis 2002).

Increased siltation and turbidity in Channel Darter habitats is most likely the result of agricultural activities and urban development, including watercourse and shoreline hardening, and channelization activities. The historic locations where the Channel Darter has been extirpated were all affected by such habitat changes (Phelps and Francis 2002).

Nutrient loading

Nutrients (nitrates and phosphorous) enter waterbodies through a variety of pathways including manure and fertilizer applications to farmland, manure spills, sewage treatment plants and faulty domestic septic systems. Nutrient enrichment of waterways can negatively influence aquatic health through algal blooms and associated reduced dissolved oxygen concentrations. From 1955 to 1980, Lake Erie was affected by extensive oxygen depletion and associated changes in the benthos that resulted from excessive nutrient loading (Koonce et al. 1996). Phosphorous loading in Lake Erie reached a high of 29 000 tonnes in 1968, resulting in whole-lake eutrophication (Mandrak and Holm 2001). From 1976 to 1999, phosphorous levels have showed a significant overall downward trend (Nicholls et al. 2001); however, data from 2000-2004 suggest a continued increasing trend in phosphorous since 1994, at a rate of approximately 1.4µg/L/year (U.S. Environmental Protection Agency 2007). Eutrophication, in addition to habitat degradation, overexploitation of the fisheries resource and introduction of exotic species, has altered Lake Erie over the past 70 years. Over this time frame, it appears that in addition to a decline in general species richness, the distribution of Channel Darter in Lake Erie has been reduced (Reid and Mandrak 2008).

Intensive livestock operations and sewage treatment plants are potential point sources of acute nutrient loading. Most Quebec and Ontario municipalities have sewage treatment systems that provide a preliminary treatment of wastewater. However, in the event of heavy precipitation or system breakdown, wastewater in some municipalities is evacuated into the natural environment without any treatment. Climate change could lead to more extreme weather conditions, which may increase the frequency of discharges from overflow structures. While it has not been researched specifically, the threat of point source pollution from intensive agriculture, specifically hog farms, appears to be more serious for Quebec populations relative to those in Ontario (A. Dextrase pers. comm. 2006).

In the Châteauguay River watershed, Garceau et al. (2007) found that the downstream portion of the watershed had only a few typical Channel Darter habitats due to the silting of the streams and the development of algae, including periphyton, caused by excessive nutrient loading due to agriculture and urbanization. Certain sections in the watershed where the Channel Darter had been reported historically (e.g., des Anglais River) no longer have any potential habitats as a result (Garceau et al. 2007).

[3]Wave action from passing boats that break on the shores of a river or stream can cause bank erosion. This erosion causes sediment re-suspension, which increases turbidity and silting of riverbeds. Therefore, high tonnage vessels that sail on the St. Lawrence River and pleasure boating in smaller rivers can cause the loss and degradation of Channel Darter habitats.

Contaminants and toxic substances

Compared to other darter species, the Channel Darter is considered to be pollution intolerant (Richard 1994; cited *in* Lapointe 1997). However, specific sensitivities to toxic chemicals and nutrient loading are largely unknown. Contaminants and toxic substances from various sources (e.g., wastewater treatment plant, agricultural and livestock production, industrial discharge) may have several types of significant effects at the population level, including impaired reproduction, disruption of behaviour, a decreased resistance to pathogens and disruption of embryonic development.

In Ontario, in locations such as the St. Clair and Detroit rivers, the fish community, including Channel Darter, is exposed to a variety of toxic compounds from point and non-point sources (Environment Canada 2010) associated with urbanization and intensive industrial development (including a large petrochemical complex). The specific impacts of toxic contaminants on the Channel Darter may not be direct; however, the cumulative impacts are a cause for concern (EERT 2008).

In Quebec, the water quality in some of the rivers occupied by the Channel Darter (e.g., Richelieu,Yamaska, Bayonne, L'Assomption, Châteauguay and des Anglais) is also of concern for aquatic species (Côté et al. 2006, Giroux 2007, DFO 2010) and could represent a threat for the Channel Darter with respect to contamination through various sources of contaminants and toxic substances (DFO 2010). The use of pesticides for corn crops intended for hog production is an example of very significant nonpoint source agricultural pollution that alters water quality in the southern part of the province (FAPAQ 2002) where Channel Darter populations are found.

Another substance that may indirectly impact Channel Darter is the insecticide *Bacillus thuringiensis israelensis* (BTI). To control Black Fly (Diptera; Simuliidae) populations, BTI bacteria based products are applied to rivers and streams where Black Fly larvae develop. BTI is a "digestive system inhibitor" for organisms that have a highly alkaline digestive canal and acts on certain species while remaining safe for fishes (Boisvert and Lacoursière 2004). Some studies have shown that BTI impacted non-targeted dipteral larvae, such as the Chironomid family (i.e., midges) (reviewed by Boisvert and Lacoursière [2004]), an important prey item for the Channel Darter. BTI spraying has been occurring for several years in Quebec in some lotic areas occupied by the Channel Darter for Black Fly control; however, the possible indirect impacts on Channel Darter have not been studied. BTI has not been applied to rivers occupied by Channel Darter in Ontario.

Exotic species and disease

The negative impacts of exotic fishes on native fishes in the Great Lakes basin have been well documented (e.g., French and Jude 2001, Thomas and Haas 2004). Exotic species may affect the Channel Darter through direct competition for space and habitat, food, spawning sites, through the restructuring of aquatic food webs and by the potential introductions of new parasites(e.g., Cestod *Valipora campylocristota* probably introduced by Tench [*Tinca tinca*] in the Richelieu River [Marcogliese et al. 2009]).

It has been suggested that the Round Goby may be a serious threat to the Channel Darter, competing for similar habitat and resources (Phelps and Francis 2002). The current ranges of the Channel Darter and the Round Goby overlap in the St. Clair River, Lake St. Clair, the Detroit River, Lake Erie, Lake Ontario in the Bay of Quinte area, as well as in the St. Lawrence River and at the mouth of some of it's tributaries (e.g., Richelieu River) (Reid 2005, A. Dextrase pers. comm. 2006, A. Gendron, Environment Canada [EC], pers. comm. 2011). Since its introduction, the Round Goby has been implicated in the declines of the following native benthic

fish species in the lower Great Lakes: 1) Logperch and Mottled Sculpin (*Cottus bairdii*) populations in the St. Clair River (French and Jude 2001); 2) Johnny Darter, Logperch, and Trout-Perch (*Percopsis omiscomaycus*) in Lake St. Clair (Thomas and Haas 2004); and, 3) Channel Darter, Fantail Darter (*E. flabellare*), Greenside Darter (*E. blennioides*), Johnny Darter and Logperch in the Bass Islands, western Lake Erie (Baker 2005). Round Goby are abundant and widespread in Lake Erie habitats currently and formerly occupied by the Channel Darter. The Round Goby was present at all sites sampled during a survey targeting the Channel Darter; however, Channel Darter catch-per-unit-effort was highest when Round Goby abundance was lowest (Reid and Mandrak 2008). In Quebec, ichthyologic surveys tend to show that the Round Goby has become more abundant since 2003 and that it disperses quickly. It is now present in most nearshore habitats in the St. Lawrence River (A. Gendron, pers. comm. 2011) and it seems less parasitized than native species such as Logperch, which could exacerbate the impact of the Round Goby on competing species (Gendron et al. 2011).

Potential impacts of the exotic dreissenid mussels (*Dreissena* spp.) on the Channel Darter are unknown; however, it is possible that they may negatively impact the Channel Darter by altering food web dynamics and surrounding water quality.

Introduced pathogens can also represent a threat for different fish species. For example, Viral Hemorrhagic Septicemia (VHS) is a contagious disease caused by a virus that affects more than 65 species of fish. First identified in the Great Lakes in 2005 and 2006, this disease has been linked to massive mortalities in several fish species from this region. There are currently no known cases of VHS occurring in the Channel Darter, and the impact of this disease on this species has not been studied. The virus has been confirmed in Lake Erie and Lake Ontario, and the freshwater portion of the St. Lawrence River, east of the Moses-Saunders Dam, is currently considered a high-risk watershed for infection. To date, there have been no reported VHS cases in Quebec (C. Brisson-Bonenfant, MRNF, pers. comm. 2009). The Canadian Food Inspection Agency (CFIA) has introduced a two-year plan to monitor the occurrence of VHS in wild fish species in Canada (CFIA 2009). Because of the Channel Darter's status in Canada, mortalities related to this disease could considerably impact the survival and recovery of this species.

Incidental harvest (baitfishing)

The Channel Darter is not a legal baitfish in Ontario (OMNR 2010) or Quebec (MRNF 2009). Baitfish harvesting is not documented in the literature as a threat to the Channel Darter; however, there is an overlap in the habitats used by the Channel Darter and those targeted by baitfish harvesters. In rivers, Channel Darter are easily captured by seine net from run and pool habitats downstream of riffles (Reid et al. 2005) and nearshore Lake Erie habitats (Scott 1955, Reid and Mandrak 2008). While not a legal bait species, it is occasionally captured incidentally. In rivers, the risk of by-catch would be greatest in areas where pools and runs occupied by the Channel Darter are located near bridges or other access points. Baitfish harvesting along the nearshore of the Great Lakes is believed to pose the greater potential threat to the Channel Darter populations as the targeted habitat is consistent with that preferred by Channel Darter, especially the nearshore areas of Lake Erie (Reid and Mandrak 2008). However, due to the rarity and limited distribution of the species, the probability of incidental capture is believed to be low (A. Drake, University of Toronto, pers. comm. 2009). No Channel Darter were collected in samples taken from baitfish dealers across southern Ontario in 2007 and 2008 during a study examining the impacts of baitfish harvesting on species at risk and the distribution and spread of exotic species (Drake 2011).

In Quebec, a study was conducted in the fall of 2005 (Boucher et al. 2006) and summer of 2007 (Garceau et al. in press) to assess the risk of catching fish species at risk (including the Channel Darter) by commercial bait harvesters. No Channel Darter specimens were reported in the samples from the commercial catches or in baitfish tanks.

Climate change

Climate change is expected to have significant effects on aquatic communities of the Great Lakes basin and the St. Lawrence River through several mechanisms, including increases in water and air temperatures; changes in water levels (i.e., lowering); 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). It is anticipated that the effects of climate change will be widespread and should be considered a contributing impact to species at risk and all habitats. Not all of the effects of climate change will negatively affect species at risk – those species that are limited in their range by cool water temperature may expand their distribution provided that dispersal corridors of suitable habitat are available. However, a suite of reactions related to changes in evaporation patterns, vegetation communities, lower lake levels, increased intensity and frequency of storms, and decreases in summer stream water levels may offset the direct benefits of increased temperatures. As the effects of climate change on Channel Darter are highly speculative, it is difficult to determine the impact that this will have on the populations and as such it was not included in the threats table.

5. POPULATION AND DISTRIBUTION OBJECTIVES

The long-term recovery objective (>20 years) for the Channel Darter is to maintain existing populations in Ontario and Quebec and restore self-sustaining populations to formerly occupied habitats, where feasible. In some locations, permanent changes in the fish community, as a result of the establishment of exotic species, may impact the feasibility of re-establishing Channel Darter populations.

According to recovery potential assessment (RPA) conducted on Canadian Channel Darter populations, at least ten discrete viable populations are required to reduce the species' risk of extinction in Canada to 1% over 250 years (DFO 2010). Modeling results from the RPA state that the estimated minimum viable population size (MVP) for Channel Darter is 31 000 adults, given a 10% chance of a catastrophic event occurring per generation (Venturelli et al. 2010).

The implementation of such a target is difficult without also having information on current population(s), population sizes and trends (e.g., recruitment rates, mortality rates, fecundity, longevity, sex ratio) and spatial distribution, as well as habitat quality; this information is mostly lacking for the majority of Channel Darter locations in Canada. Further research is required to obtain such information, validate the model results, and to verify if habitat deemed critical is sufficient to support the MVP. Acquiring such information should also be considered a goal for this species with an initial focus on populations named below but not excluding all locations throughout the species' Canadian distribution. As such, the MVP will be used as a guideline for recovery but not as an absolute target for recovery. More quantifiable objectives relating to MVP will be developed once abundance information can be obtained. This will also inform the refinement of the recovery objectives.

Another important factor to consider when determining population and distribution objectives is the number of populations that may be at a given location, as it is possible that a location may

contain more than one discrete population. In this context, location does not refer to the locality of the discrete population, but rather a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of this species present (COSEWIC 2010). The RPA states that ten discrete viable populations are required to reduce the risk of Channel Darter extinction in Canada. However, the number of populations present in waterbodies inhabited by Channel Darter is currently unknown. To be precautionary, where present, multiple populations at a single location should be maintained.

The population and distribution objectives for the Channel Darter in Canada are to ensure the survival of self-sustaining population(s) at the following locations:

Ontario: Lake Erie (Point Pelee area), Trent River, Moira River/Black River/Skootamatta River, Salmon River, and Little Rideau Creek.

Quebec: Gatineau River, L'Assomption River and its tributary the Ouareau River, Richelieu River, Saint-François River, and des Anglais River/aux Outardes River/Trout River (Châteauguay River watershed).

6. BROAD STRATEGIES AND GENERAL APPROACHES TO MEET OBJECTIVES

6.1 Recommended scale for recovery

The Channel Darter is best suited for a single-species recovery strategy. While other species at risk co-occur with Channel Darter (e.g., Eastern Sand Darter [*Ammocrypta pellucida*], River Redhorse [*Moxostoma carinatum*], Hickorynut [*Obovaria olivaria*]), its distribution does not closely coincide with other species at risk throughout the entirety of its Canadian range. Also, it is not restricted to a particular habitat type (e.g., stream, river or lake) or ecosystem that would make it a good candidate for an ecosystem-based strategy. Parts of the Channel Darter's Canadian range do overlap with other ecosystem-based recovery strategies (i.e., Walpole Island and the Essex-Erie region) and these recovery initiatives will complement the single-species focus for the Channel Darter.

6.2 Actions already completed or currently underway

Ontario:

- In 2002 and 2003, Channel Darter spawning timing and seasonal habitat use was investigated in the Trent River
- Investigation of the impact of Round Goby on the Trent River populations of Channel Darter has been underway since 2009
- Studies of the genetic structure of Ontario and Quebec populations are on-going since 2010
- The Essex-Erie region ecosystem-based recovery strategy covers 14 fishes at risk, including the Channel Darter. The long-term goal of this strategy is "to maintain and restore ecosystem quality and function in the Essex-Erie region to support viable populations of fish species at risk, across their current and former range" (EERT 2008).

– the plan will benefit Channel Darter populations in Lake St. Clair, Detroit River and Lake Erie

- The draft Walpole Island ecosystem-based recovery strategy includes several fishes at risk, including the Channel Darter. The recovery goal of the draft Walpole Island ecosystem recovery strategy is "to conserve and recover the ecosystems of the Walpole Island Territory in a way that is compliant with the Walpole Island First Nation Environmental Philosophy Statement, provides opportunities for cultural and economic development and provides protection and recovery for Canada's species at risk" (Bowles 2005)
- Remedial Action Plans have been implemented in the St. Clair River and Detroit River to address impairments to beneficial uses, such as "loss of fish and wildlife habitat"
- A baitfish primer (Cudmore and Mandrak 2011) has been developed that identifies the baitfish species of Ontario. This Primer has been made available to commercial bait harvesters, anglers and the general public via OMNR offices and ServiceOntario offices and the DFO website
- Changes to the Ontario Fishery Regulations (OFR 2007) were updated and became effective in January 2008. The list of fishes that legally could be used live as bait was refined from family taxon groupings to 48 species; fishes considered to be at risk (including the Channel Darter) or exotic were excluded from the list. Also, the OFR (2007) prohibit the possession, or use as bait, of exotic fishes (including Round Goby) or live fishes that are not a species of baitfish. Starting in 2007, some commercial bait harvesters were required to participate in mandatory training and complete a HACCP (Hazard Analysis and Critical Control Point) plan before being issued a licence (as of 2010, all must meet these requirements). Commercial bait dealers have been required to complete HACCP plans since 2007. The implementation of HACCP plans minimizes the risk of spreading exotic species and of selling non-target species
- A graduate student from the University of Toronto has conducted a study to examine the impacts of baitfish harvesting on species at risk and the distribution and spread of exotic species (Drake 2011). The study was conducted in cooperation with DFO
- See Appendix F for details on recent surveys that have been conducted by various agencies within areas of Channel Darter occurrence

Quebec:

- A provincial recovery strategy for the Channel Darter was developed by the province of Quebec in 2001 (Équipe de rétablissement du fouille-roche gris 2001) and is currently being revised
- A report was published in 2003 (Massé and Bilodeau 2003) on the verification of correct identification of percid specimen in the Faune Québec biological collection (captured between 1928 and 2002). This report presents the results of the new identifications and an update of the list of captures since the publication of the Channel Darter provincial recovery plan in 2001
- A guide on proper techniques of sampling to lower instances of injuries or death of Channel Darter, as well as to reduce habitat disturbance was produced (Letendre and Leclerc, MRNF, unpublished). A monitoring protocol has also been developed (Couillard et al. 2011)
- Numerous watershed committees have completed targeted Channel Darter sampling in various watercourses within their territories. They have also conducted awareness raising activities with riverside owners and farmers (e.g., guidance book for riverside

property owners, information booth, pamphlet). The Corporation de l'aménagement de la rivière l'Assomption (CARA), the Société de conservation et d'aménagement du bassin de la rivière Chateauguay (SCABRIC), the Comité de concertation et de valorisation de la rivière Richelieu (COVABAR) and Ambioterra have been notably involved in these activities

- Many surveys were conducted by biologists of the MRNF in different watercourse where the Channel Darter is found (e.g., Saint-François, Richelieu, Ottawa and St. Lawrence rivers), under the work of the Réseau de suivi Ichtyologique (RSI)
- A master thesis study was done to characterize summer habitat use of the Channel Darter in the Gatineau and Richelieu rivers (Boucher 2006)
- An awareness pamphlet was published by the MRNF on Channel Darter to provide information to the public on its precarious status and to propose means of action to insure its protection. In addition, an identification pamphlet was produced by DFO to help the public to recognize Channel Darter and to inform them that there is a legal obligation to release them alive if incidentally captured
- The Channel Darter's vulnerability to baitfish fisheries was assessed (Boucher et al. 2006, Garceau et al. in press)
- In 2009, the province of Quebec added the Channel Darter to the list of species prohibited for use as baitfish, and closed some areas to commercial baitfish harvesting where the probability of catching the species was high
- In 2011, DFO produced an educational flyer to inform the public on how to recognize the Channel Darter and of the legal obligation to release specimens alive if caught incidentally
- See appendices D and E for details on recent surveys that have been conducted by various agencies within areas of Channel Darter occurrence

6.3 Strategic direction for recovery

The overall approaches recommended to meet the population and distribution objectives have been organized into five categories: 1) Research; 2) Monitoring; 3) Management and Coordination; 4) Protection, Restoration and Stewardship; and, 5) Communication and Public Awareness. Each category is summarized in a table detailing strategies for recovery with a priority ranking (high, medium, low), a description of the threat addressed and the associated level of concern. A more detailed narrative is provided below in Section 6.4 (Narrative to support the recovery planning table) when further explanation is required. Implementation of the following approaches will be accomplished in coordination with relevant organizations in Ontario and Quebec. Priority will be given to highly ranked Research and Monitoring Activities (Tables 4 and 5), as the resulting data will be used to inform the approaches in Tables 6 to 8.

Table 4. Recovery planning table - research approaches.

Priority	Threat	Broad strategy to address threat	General description of research and management activities to meet objectives
High	All	1-1a.Research – Habitat Requirements	Determine the seasonal habitat requirements, including species movement and migration, of all life stages of the Channel Darter.
High	All	1-1b. Research – Habitat Requirements	Identify thresholds of tolerance to habitat modifications (e.g., flow) to determine what constitutes destruction of critical habitat for the Channel Darter.
High	All	1-2. Research – Life History	Determine the life history of the Channel Darter (e.g., population dynamics, feeding) and interactions with other species (e.g., predation, competition).
High	All	1-3.Research – Water Quality Parameters	Determine the physiological tolerance thresholds of the Channel Darter with respect to various water quality parameters (e.g., dissolved oxygen, nutrients, contaminants and toxic substances) and check against existing standards.
High	All	1-4.Research -Threat Evaluation	Investigate potential threats such as exotic species, baitfish harvesting and sources of contamination and toxic substances (e.g., discharge from wastewater treatment facilities). Consider the development of a map highlighting general habitat areas and major threats to allow analysis of cumulative effects.
High	All	1-5.Research – Re-establishment Methods/ Feasibility	Investigate the feasibility of various re-establishment approaches for the Channel Darter and identify appropriate source populations.
High	All	1-6.Re-Establishment – Evaluation of Potential Sites	Determine if there are extirpated or new sites that are suitable for threat mitigation or habitat restoration for potential re-establishment.
High	All	1-7.Release and Evaluation	Undertake an experimental re-establishment, monitor and evaluate its success.
High	All	1-8.Research - Genetics	Assess genetic variation across the global range and investigate population structure among/within Canadian populations.
Low	All	1-9. Habitat Model	Develop a predictive habitat model to identify potential Channel Darter sites and areas containing significant habitat.

Table 5. Recovery planning table - monitoring approaches.

Priority	Threat	Broad strategy to address threat	General description of research and management activities to meet objectives
High	All	2-1a. Background Surveys – Extant Occurrences	Complete targeted surveys of extant populations using gear types proven effective at detecting Channel Darter.
High	All	2-1b. Background Surveys – Little Rideau Creek/Ottawa River	Conduct extensive surveys on Little Rideau Creek and the Ottawa River (and tributaries) to determine whether a resident population exists in Little Rideau Creek. Surveys in the Ottawa River (and tributaries) to be informed through distribution of Channel Darter on Quebec side of the river.
High	All	2-2. Background Surveys – Historic Occurrences	Conduct targeted surveys at historic Channel Darter locations using gear types proven effective at detecting the species.
High	All	2-3. Background Surveys – Potential New Occurrences	Conduct targeted surveys for undetected populations in high probability areas with suitable habitat.
High	All	2-4. Monitoring – Populations and Habitat	Develop and implement a standardized index population and habitat monitoring program with a specific sampling and training protocol.
High	All	2-5. Spawning Habitat	Locate spawning locations and characterize habitat present.
Medium	All	2-6. Monitoring – Restored Sites	Monitor sites where threat mitigation and/or habitat restoration activities occurred to determine success of actions and to monitor Channel Darter populations.

Table 6. Recovery planning table - management and coordination approaches.

Priority	Threat	Broad strategy to address threat	General description of research and management activities to meet objectives
High	All	3-1. Coordination with Other Recovery Teams and Relevant Organizations	Work with relevant organizations (e.g., Conservation authorities, OMNR, MRNF, First Nations) and ecosystem/single species – based recovery teams to share knowledge, combine resources, implement recovery actions and ensure a coordinated approach to recovery.
High	Altered Flow Regimes	3-2.Resource Management - Flow-Needs Assessment	Conduct flow-needs assessments at hydroelectric dams and navigable waterways (e.g., seaway) and determine how water level management can be improved to mitigate impacts on the Channel Darter (e.g., adopt minimum low-flow level recommendations during sensitive life history stages such as spawning).
High	Barriers to Movement; Altered Flow Regimes; Shoreline Modifications	3-3.Resource Management – Planning, Permitting	Recommend consideration of the Channel Darter's needs when developing projects at the design stage (i.e., proponents) and when issuing permits (i.e., resource managers).
High	All	3-4. Survey Requirements	For medium- or high-risk projects in locations without Channel Darter records but with a high probability that the species is there (i.e., within the geographic range of the Channel Darter, and containing suitable habitat), ensure that proponents conduct appropriately timed, targeted surveys using gear types proven effective at detecting Channel Darter.
Medium	All	3-5.Communication - Data and Reporting	Develop a central provincial database for species records in Quebec and integrate recent and historic Channel Darter observation data.
Low	All	3-6. Communication-Cooperation/ Coordination With Adjacent U.S. States	Establish a co-operative relationship with neighbouring U.S. jurisdictions responsible for Channel Darter management.

Table 7. Recovery planning table - protection, restoration and stewardship approaches.

Priority	Threat	Broad strategy to address threat	General description of research and management activities to meet objectives
High	All	4-1.Stewardship-Watershed Efforts	Encourage stewardship efforts with waterpower industry, agricultural, urban and industrial sectors in watersheds with Channel Darter.
High	All	4-2.Best Management Practices	Encourage the implementation of Best Management Practices (BMPs) or similar practices within the agriculture and forestry industries (OMAFRA/MAPAQ and OMNR/MRNF), private forest management agencies, waterpower industry, other resource managers public and private landowners and First Nations.
High	All	4-3.Restoration and Threat Mitigation – Occupied Habitat	Identify extant habitat that would benefit from specific threat mitigation or other habitat improvement activities; undertake to the extent possible and monitor results.
Medium	All	4-4. Restoration and Threat Mitigation – Potential Habitat	Restore habitat and mitigate threats at potential Channel Darter re-establishment sites that have been evaluated and deemed suitable.
Medium	All	4-5. Waste-water Treatment	Ensure proper maintenance of wastewater treatment facilities upstream of areas inhabited by Channel Darter; establish a contingency plan in case of breakdown or intentional shutdown (e.g., for maintenance).
Medium	All	4-6.Habitat Protection	Investigate the potential for conservation easements or acquisitions to protect and recover Channel Darter.
Medium	All	4-7.Public Involvement	Involve local residents, partners, First Nations and appropriate agencies and groups in action planning, habitat improvement and threat mitigation activities.

Table 8. Recovery planning table - communication and public awareness approaches.

Priority	Threat	Broad strategy to address threat	General description of research and management activities to meet objectives
High	All	5-1.Communication – Communication Plan	Develop a communications plan that identifies partners, approaches, information products, educational and outreach opportunities, stewardship resources and specific BMPs that will assist with the recovery of this species. This may also include a public education plan to inform the public regarding the species, where it exists and how to identify it. This plan should include a focus on awareness of critical habitat and the SARA to help ensure compliance with the Act.
High	All	5-2.Municipal Planning – Involvement	Encourage municipalities to address the protection of habitat that is important to the Channel Darter in their official plans.
High	Exotic Species	5-3.Public Awareness – Exotic Species	Support exotic species awareness initiatives for the public.
Medium	Baitfish Harvesting	5-4.Public Awareness – Baitfish Harvesting	Develop an information campaign for bait fishermen (commercial harvesters, anglers and First Nations) in areas supporting Channel Darter.

6.4 Narrative to support the recovery planning table

Research approaches

1-1, 1-2 and 1-3: Further research on Channel Darter habitat requirements is required for improved descriptions and protection of this species' critical habitat. Such research is particularly needed for lacustrine habitats, deep riverine habitats, YOY Channel Darter and physiological thresholds for water quality parameters (e.g., contaminants and toxic substances). For all life stages, research should address the habitat's physical and chemical characteristics, seasonal patterns of use by the fish, migrations between habitats by this species, and landscape factors (e.g., surficial geology) influencing habitat characteristics. Landscape factors such as surficial geology and topography have been linked to habitat conditions and species distributions.

1-4: A variety of potential threats to Channel Darter populations (e.g., exotic species and baitfish harvesting) were identified in the COSEWIC report (Phelps and Francis 2002) and by the recovery team. The status and certainty of many of these threats were assessed based on a watershed approach in Section 4 (Threats) of this recovery strategy. This assessment and the cumulative effects of these threats should be confirmed throughout the species' distribution to ensure that appropriate and defensible recovery actions are undertaken.

1-5: The disjunct distribution of Canadian Channel Darter populations means that natural re-colonization of extirpated sites will likely not occur. Therefore, re-establishment efforts would be

required at sites where the Channel Darter has been extirpated if it is determined that source populations are robust enough to act as donors. Re-establishment efforts require research to determine appropriate source populations, identify the most effective method for re-establishment (e.g., translocation of individuals from other populations; or captive rearing and subsequent stocking) and the number of individuals required to create self-sustaining populations. Re-establishment should follow the American Fisheries Society Guidelines for Introductions of Threatened and Endangered Fishes or the National Code on Introductions and Transfers or Aquatic Organisms.

1-6: Before re-establishment or introductions, potential sites require an assessment of: 1) availability of access throughout the project duration; 2) whether the site has been previously inhabited (i.e., extirpated) and if habitat is suitable; and, 3) the extent to which the habitat could be improved and/or threats mitigated. Extirpated sites that can be made suitable for re-establishment should take precedence over introductions into new sites.

1-7: Whether or not this experimental re-establishment will occur depends on the outcome and recommendation of the feasibility analysis in 1-5 and identification of an appropriate pilot site in 1-6. If it is decided that the pilot re-establishment should proceed, then this action (release and evaluation) is high priority. The pilot project should not proceed if the follow-up monitoring and evaluation cannot be completed. If the feasibility analysis recommends against such a pilot project or it cannot be reasonably assured that these subsequent actions can be included in the pilot project, then this priority should drop to Low or Not Applicable and the pilot project should not proceed.

1-8: Re-establishment efforts need to identify the location of potential source populations and the number of individuals required to establish new, self-sustaining populations. Ideally, source populations possess a high level of genetic diversity and genetic composition developed under similar historic conditions as the re-establishment site. Therefore, an assessment of the genetic variation and relatedness of populations across its range and in Canada is required.

Monitoring approaches

2-1 to 2-3: Focused efforts are required to determine the current distribution of the Channel Darter at extant and historic locations, as well as to detect new populations in high probability locations. New Channel Darter sites have been recently discovered, suggesting that our knowledge on its distribution is incomplete. The selection of new sites for monitoring may be aided by reviewing historic studies of Channel Darter distribution as well as museum specimens, particularly in Ontario (Quebec already completed). Canadian agencies should work with U.S. partners to monitor known populations in U.S. waters of waterbodies shared with Canada. Sampling methods should be standardized at all sampling sites and include a relevant assessment of habitat features and should employ techniques proven effective at detecting the Channel Darter (see Portt et al. 2008 and Couillard et al. 2011 for effective species-specific sampling methods). Water depths can prevent the use of sampling gear that is effective at capturing Channel Darter in shallower habitats. Attempts to capture Channel Darter from deep waters adjacent to Trent River shoals using small mesh gill-nets, and minnow traps were unsuccessful (Reid 2005). Trawling is proving to be an effective method of capturing Channel Darter from deeper riverine habitats that are not accessible to seines or electrofishers. Recent sampling in the U.S. using an 8 ft mini-Missouri trawl was extremely effective at capturing Channel Darter from such habitat, and from river systems where the species was previously unreported (Herzog et al. 2009).

2-4: Monitoring populations and habitat will assist with identifying key habitat requirements needed to refine the identification of critical habitat, as well as the implementation of strategies to protect known currently occupied and historically occupied habitats. The monitoring program should be designed to allow for quantitative tracking of changes in population abundance and demographics, analyses of habitat use and availability, and changes in these parameters over time (with regard to known threats). It should also have the ability to detect the presence and abundance of exotic species in Channel Darter habitat. The fish monitoring protocol should have regard for the methodologies used in background survey work and provide guidance on the time of sampling and the types of biological samples that should be collected (e.g., scales, length, and weight). For populations in Quebec, refer to Couillard et al. (2011).

Tracking temporal changes in habitat condition at monitoring sites would assist in identifying incremental habitat changes and associated impacts to Channel Darter populations. When combined with population monitoring, it can help determine threshold levels for certain measurable habitat parameters (e.g., turbidity, nutrient content). As well, it would assist in identifying the need for habitat restoration or mitigation of stressors. Collecting habitat information would also assist in quantifying the amount of Channel Darter habitat available.

Management and coordination approaches

3-1: Many of the threats facing the Channel Darter are a result of habitat degradation that affects numerous aquatic species. Two ecosystem-based recovery strategies (i.e., recovery strategy for the Essex-Erie region and the draft Walpole Island recovery strategy) have incorporated the biological and ecological requirements of the Channel Darter into relevant watershed-based recovery approaches. A coordinated, cohesive approach between these teams and other relevant management teams that maximizes opportunities to share resources and information is recommended.

3-2: Abrupt reductions in water flow during spawning can cause cessation of courtship activities and Channel Darter to move from spawning locations to deeper areas (Winn 1953). Flow regulation can also result in the de-watering of shallow shoal habitats used by riverine Channel Darter populations during spring and summer months (Reid 2005). By considering the flow needs of the Channel Darter, flow regulation and water extraction activities can be undertaken in a manner that would minimize the disturbance; however, it is noted that water level management is a complex issue. PCA is planning to conduct flow needs assessments for species at risk fishes, including Channel Darter, at their dams on the Trent-Severn Waterway in 2012.

3-4: Environmental impact assessments of projects affecting Channel Darter waterways should consider effects on the Channel Darter and its habitat. Targeted Channel Darter inventories, within the range of the species and in areas with suitable habitat but lacking Channel Darter records, completed as required in support of impact assessments of proposed projects would assist recovery efforts by providing distribution and abundance information.

3-5: Distribution and abundance data from Quebec exist in several locations and formats. To monitor population abundance, species distribution and the success of recovery actions, the data must be compiled and shared among agencies. Associated data standards should also be identified.

3-6: Michigan, Ohio, Pennsylvania, New York and Vermont all support Channel Darter populations, encompassing a range of conservation ranks. In cases where there are shared Channel Darter-inhabited waterways, maintaining open communication and information sharing

about the species should benefit both recovery planning in Canada and state wildlife conservation planning in the U.S.

Protection, restoration and stewardship approaches

4-1 and 4-2: The Channel Darter is sensitive to siltation, turbidity and nutrient loading; all contributors to poor water quality. Supporting stewardship activities, such as planting (agriculture) or leaving riparian buffer strips (forestry), restricting livestock access to streams, preventing untreated or under-treated sewage or manure run-off into waterways and minimizing chemical and fertilizer applications to lands adjacent to waterways, would maintain or improve water quality in Channel Darter watercourses. BMPs are a good tool to provide clear direction for improved methods of operation for industries such as agriculture or forestry. To be effective, BMPs should be targeted to address primary threats affecting currently occupied/critical habitat.

4-3: Several populations have become extirpated in recent years. Threats and habitat degradation present at extant sites should be evaluated to determine if they pose immediate or long-term risks of extirpation. Where specific habitat restoration activities or threat mitigation options are available, they should be pursued and then monitored for success.

4-6: Methods of habitat protection also include acquisition, conservation easements and inclusion in conservation plans developed by various levels of government. While these methods are less utilized for aquatic species than for terrestrial species, they should be considered and pursued as opportunities arise to protect habitat in perpetuity.

4-7: Improvements to watershed water quality requires the involvement of local residents, businesses and organizations. The earlier into the recovery process that the community is involved, the greater the likelihood of sustained and growing support for recovery actions. Therefore, it is important to involve the public in the action planning and implementation of recovery.

Communication and public awareness approaches

5-1: The development of a communications plan will help to coordinate communications and outreach activities, ensure that necessary audiences are targeted with the most appropriate means, and that messages are consistent and accurate. This high priority action should occur prior to, or concurrent with, all subsequent communications and public outreach-type recovery activities, including any printed materials. Where appropriate, a multi-species communication approach will be applied to increase efficiency.

5-3 and 5-4: Various organizations have already undertaken public education efforts to prevent the further spread of exotic species. In the case of the Channel Darter, the Round Goby is of particular concern. Duplicating efforts or competing for funding benefits no one; instead the Channel Darter recovery team will support and encourage the continuance of these education efforts as they also support Channel Darter recovery. Developing communications for baitfish harvesters on the presence and identification of the Channel Darter and other fish species at risk would be beneficial, as it may increase reporting of these species and decrease incidental capture/use as a baitfish. A baitfish primer has already been developed for Ontario (see Cudmore and Mandrak 2011).

7. CRITICAL HABITAT

7.1 General identification of the Channel Darter's critical habitat

The identification of critical habitat for Threatened and Endangered species (on Schedule 1) is a requirement of SARA. Once identified, SARA includes provisions to prevent the destruction of critical habitat. Critical habitat is defined under section 2(1) of SARA as:

> "…*the habitat necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species*". [s. 2(1)]

SARA defines habitat for aquatic species at risk as:

> *"… spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced."* [s. 2(1)]

For the Channel Darter, critical habitat has been identified to the extent possible, using the best information currently available. The critical habitat identified in this recovery strategy describes the geospatial areas that contain the habitat necessary for the survival or recovery of the species. The current areas identified may be insufficient to achieve the population and distribution objectives for the species. As such, a schedule of studies has been included to further refine the description of critical habitat (in terms of its biophysical functions/features/attributes as well as its spatial extent) to support its protection.

7.1.1 Information and methods used to identify critical habitat

Using the best available information, critical habitat has been identified using a 'bounding box' approach for the locations in Ontario and Quebec where the species presently occurs within the ten rivers referenced in the current distribution objective. This approach requires the use of essential functions, features and attributes, where possible for each life stage of the Channel Darter to identify patches of critical habitat within the 'bounding box', which is defined by occupancy data for the species. Life stage habitat information was summarized in chart form using available data and studies referred to in Section 3.3 (Habitat and biological needs). The 'bounding box' approach was the most appropriate, given the limited information available for the species and the lack of detailed habitat mapping for these areas. Where habitat information was available, it was used to inform identification of critical habitat.

Site specific methods and data used to identify critical habitat are summarized below. The critical habitat description includes the entire 'bankfull' channel, which plays an essential role in maintaining channel flowing forms, for all cases in Ontario and Quebec except Lake Erie (Point Pelee).

Ontario

In Ontario, critical habitat was identified based on a 'bounding box' approach and further refined for riverine populations with an ecological classification system, the Aquatic Landscape Inventory System (ALIS). ALIS was developed by the OMNR to define stream segments based on a number of unique characteristics found only within those valley segments. Each valley segment is defined by a collection of landscape variables that are believed to have a controlling effect on the biotic and physical processes within the catchment (e.g., ecological landscape changes, barriers). Therefore, if a population has been found in one part of the ecological classification, there is no reason to believe that it would not be found in other spatially contiguous areas of the same valley segment. Critical habitat for the Channel Darter within riverine systems was therefore identified as the reach of river that includes all contiguous ALIS segments from the uppermost stream segment with the species present to the lowermost stream segment with the species present. Note that intermediate ALIS segments (between the upper and lower most occupied segments) with insufficient sampling to detect the presence of the species have been included within the critical habitat extent.

Critical habitat for Channel Darter has not been identified at this time in the Detroit River, St. Clair River or Lake St. Clair. No specimens were captured during intensive sampling of historic sites near the outlet of the Detroit River in 2005 and 2006. The most recent Channel Darter specimen (a single specimen) was captured in the Detroit River at the inlet of the river from Lake St. Clair in 2009 (Bouvier and Mandrak 2010). Additional areas of potential critical habitat in Lake St. Clair and the St. Clair River will be considered in collaboration with Walpole Island First Nation.

Specific methods and data used for locations within Ontario to identify critical habitat are summarized below.

Little Rideau Creek/Ottawa River: Two Channel Darter records (1989, 2004) exist for Little Rideau Creek near the confluence with the Ottawa River (Canadian Distribution Database 1989, Dextrase and Reid 2004). As these records are found near the end of the ALIS segment adjacent to the Ottawa River, the end of the segment was buffered using a minimum area for population viability (described later in this section) of 0.04 km^2. However, given the proximity of the records to the Ottawa River, further sampling is required at this location to determine if the records represent a resident population in Little Rideau Creek or a population in the Ottawa River.

Trent, Moira (Black and Skootamatta rivers) and Salmon rivers: Critical habitat was identified in the Trent River using data from the following datasets: Reid (2001, 2004, 2009), Portt and Associates (2004, 2008), Canadian Distribution Database (1976, 1997), and the Royal Ontario Museum database (1998, 1999). For the Salmon River, sampling data from Reid et al. (2005), Eco Tec Consultants (2007, 2008), and Reid (2009) were used. Sampling data from Reid (2004) and Reid et al. (2005) were used to identify critical habitat in the Moira River and two of its tributaries, the Black and Skootamatta rivers. The species is believed to be extirpated from an un-named creek that flows into the Moira River (Phelps and Francis 2002) and critical habitat was not identified at this location.

Lake Erie – Point Pelee (Ontario): Channel Darter records from 1928 to 2009 exist for this location; the data used to identify critical habitat came from the Canadian Distribution Database, Essex Region Conservation Authority, the OMNR Lake Erie Management Unit, and Reid (2005). As this is not a riverine population, critical habitat for the Channel Darter in Lake Erie at Point

Pelee was identified based on the 'bounding box' approach and refined using available habitat data (National Oceanic and Atmospheric Administration [NOAA] bathymetry, high water mark [HWM] and a shoreline classification system).

The HWM is the guideline elevation used by DFO to determine the minimum elevation that is considered as the (upshore) boundary for fish habitat and corresponds to the 80th percentile elevation for the month in which the highest annual water level occurs (i.e., 80% of the time the water level is at or below this elevation) (DFO 2005) and as such, has been used to define the upshore boundary of critical habitat in this area. The area below the HWM may or may not be inundated depending upon current water levels (i.e., seasonal and cyclical water fluctuations).

The shoreline of Lake Erie has been segmented into reaches and classified based on the geomorphic nature of the shoreline (categories included sandy beach/dunes, coarse beaches, clay banks, etc.), littoral areas (clay, sand, bedrock etc.), and the extent of shoreline protection (i.e., shoreline hardening) (Great Lakes Commission 2000). This system was used to refine the length of shoreline defined as critical habitat for Channel Darter by eliminating types of habitat not believed to be utilized by the species in lacustrine habitat. See Table 9a for a description of the features of critical habitat for this species.

The 2 m NOAA bathymetry contour was used to further define the lower extent of critical habitat for this species as targeted sampling for Channel Darter has occurred in waters 1.5 m or less (wadeable depth). The extent to which this species utilizes waters deeper than 2 m is not well documented. Future targeted sampling at depths greater than ~2 m may result in the refinement of this critical habitat extent.

Quebec

In Quebec, a broad scale landscape inventory system (similar to ALIS) was not available. Critical habitat identification in Quebec was also based on a 'bounding box' approach and has been limited to locations where habitat surveys have been conducted and where Channel Darter records have been verified within the last ten years, including sampling conducted in 2009. This approach was also justified by the fact that habitat characteristics may vary from one watershed to another (e.g., Gatineau and Richelieu rivers [Boucher et al. 2009]). The habitat characteristics related to specific locations within Quebec are presented in Section 7.1.3 (Identification of critical habitat: geospatial).

The most upstream and downstream of these stations where Channel Darter were captured have been used to set the limits of the watercourse segment in which critical habitat is found.

For the locations where Channel Darter has been confirmed but no habitat characterization has been conducted, further studies (see schedule of studies) will be required to better describe and understand the specific habitat characteristics associated with the presence of Channel Darter.

Ottawa and Montreal hydrographic region: Critical habitat in the Gatineau River was identified using data from Lemieux et al. (2005), Boucher (2006), and Boucher et al. (2009).

St. Lawrence northeast hydrographic region: Channel Darter have been sampled in L'Assomption River and its tributary, the Ouareau River, by the Corporation d'Aménagement de la Rivière L'Assomption in 2002 and 2009 (CARA 2002, Bourgeois 2010). These data were used in the identification of critical habitat.

St. Lawrence southwest hydrographic region: Sampling data used in the identification of critical habitat for Channel Darter in the Richelieu River were taken from studies completed by Boucher et al. (2009) and Vachon (2007), and information received directly from MRNF (N. Vachon, MRNF, pers. comm. 2010).

Channel Darter were captured in the Saint-François River between 1998 and 2003 while conducting an environmental study and in 2008 and 2009 by the MRNF during targeted sampling that also collected habitat data (S. Garceau, MRNF, pers. comm. 2010). Data from these surveys were used in the identification of critical habitat in the Saint-François River.

Studies completed by Garceau et al. (2007) and Ambioterra (2010) were used to help define critical habitat in the des Anglais, aux Outardes and Trout rivers.

7.1.2 Identification of critical habitat: biophysical functions, features and their attributes

There is limited information on the habitat needs for the various life stages of the Channel Darter. Tables 9a and 9b summarize available knowledge on the essential functions, features and attributes for each life stage within Ontario and Quebec, respectively (refer to Section 3.3 Habitat and biological needs for references). Areas identified as critical habitat must support one or more of these habitat functions. In Quebec, studies conducted demonstrated that habitat characteristics can vary from one watershed to another. Most studies were also limited to sampling adult fish and their habitat. Considering this variance and the fact that the Channel Darter is a small fish with limited dispersal, the habitat characteristics have been described for all life stages. It is important to note that a suitable habitat does not need to present all of these characteristics to be considered as critical habitat. Furthermore, values are given as indicators and may vary in time and space (e.g., current velocity and depth in spring flood vs. summer or fall drought).

Table 9a. Essential functions, features and attributes of critical habitat for each life stage of the Channel Darter for Ontario*.

Life stage	Habitat requirement (function)	Feature(s)	Attribute(s)
Spawn to Larvae	Migration Spawning Nursery (June and July)	Riffles, runs, shoals, backwater areas and pools in streams and rivers Shoals in lakes	• Moderate to fast current (e.g., 0.46 m/s) • Clean, coarse substrates (e.g., gravel and smooth rocks) • Shallow depths (e.g., 2 m) • Warm water temperatures (e.g., 14.5 to 25^{o}C) • Males establish spawning territory around a large rock in current
Juveniles** (Young of Year)	Rearing	Riffles, runs, shoals, backwater areas and pools in streams and rivers	• Slow current (e.g., 0.39 to 0.48 m/s) • Sand and gravel substrates • Shallow depths (e.g., <5 m)
Adult	Feeding	Riffles, runs, shoals, backwater areas and pools in streams and rivers Gravel and coarse sand beaches (Lake Erie)	• Slow to moderate current (e.g., 0.39 to 0.48 m/s) or gentle wave action • Cobble, gravel and sand substrates • Usually shallow depths (e.g., <0.60 m) • Minimal to sparse aquatic vegetation • Good water quality (i.e., low turbidity, sufficient dissolved oxygen, low pollution levels) • Availability of prey (benthic macroinvertebrates)

*Where known or supported by existing data
** There is little known about juvenile habitat requirements

Table 9b Essential functions, features and attributes of critical habitat for all life stages of the Channel Darter for Quebec*.

Life stage	Habitat requirements (function)	Features	Attributes
All	Spawning, Nursery, Rearing (juveniles), Feeding (adults), Migration	Riffles, shoals, nearshore areas, backwater and pools in streams and rivers	• Lotic (running) waters with current velocity (slow to moderate), varying on a 12 month basis • Depth up to 2 m • Coarse substrate (sand [1-2.9 mm], gravel [3-64.9 mm], cobble [65-255 mm]) • Minimal aquatic vegetation • Generally low turbidity • Availability of prey (benthic macroinvertebrates)

*Where known or supported by existing data

Studies to further refine knowledge on the essential functions, features and attributes for various life stages of the Channel Darter are described in Section 7.2 (Schedule of studies to identify critical habitat).

7.1.3 Identification of critical habitat: geospatial

Using the best available information, critical habitat has been identified in Ontario and Quebec for Channel Darter in the following areas:

- Ontario:
  - Little Rideau Creek/Ottawa River
  - Trent, Moira, Black, Skootamatta and Salmon rivers
  - The western basin of Lake Erie (Point Pelee)

- Quebec:
  - Gatineau River
  - L'Assomption River/Ouareau River
  - Richelieu River
  - Saint-François River
  - Trout River/aux Outardes River/des Anglais River

Areas of critical habitat identified at these locations may overlap with habitat known to support other species at risk; however, the specific habitat requirements within these areas may vary by species.

The areas delineated on the following maps (Figures 7-18) represent the area within which critical habitat is found at this time. Using the 'bounding box' approach, critical habitat is not comprised of all areas within the identified boundaries, but only those areas where the specified biophysical features/attributes occur (refer to Tables 9 a and 9b). Tables 10a and 10b below provide the geographic coordinates that situate the boundaries within which critical habitat is found for Channel Darter at the locations listed above; these points are indicated on Figures 7, and 9-18). *Note that permanent anthropogenic structures that may be present within the delineated areas (e.g., marinas, navigation channels) are specifically excluded; it is understood that maintenance or replacement of these features may be required at times.* Brief explanations for the areas identified as critical habitat are provided below.

Table 10a. Coordinates locating the boundaries within which critical habitat is found for the Channel Darter at seven locations within Ontario.

	Coordinates Locating Areas of Critical Habitat			
Location	**Point 1 (NW)**	**Point 2 (NE)**	**Point 3 (SE)**	**Point 4 (SW)**
Little Rideau Creek	45°34’20.827”N 74°31’49.498”W	45°35’11.088”N 74°31’11.190”W	45°35’14.582”N 74°31’02.069”W	45°35’11.011”N 74°30’52.823”W
Moira River*	44°29’55.273”N 77°36’46.551”W	44°09’35.584”N 77°23’02.505”W	n/a	n/a
Black River*	44°32’02.852”N 77°22’12.018”W	44°31’47.623”N 77°22’16.520”W	n/a	n/a
Trent River*	44°15’47.902’N 77°36’ 09.845”W	44°06’34.174”N 77°35’19.956”W	n/a	n/a
Skootamatta River*	44°37’02.412”N 77°13’59.405”W	44°31’09.305”N 77°20’24.210”W	n/a	n/a
Salmon River*	44°20’03.477”N 77°02’46.945”W	44°11’47.117”N 77°13’44.908”W	n/a	n/a
Point Pelee	42°01’53.445”N 82°37’25.255”W	41°59’14.773”N 82°29’52.422”W	n/a	n/a

* Riverine habitats are delineated to the midpoint of channel of the uppermost stream segment and lowermost stream segment (i.e., two points only)
† All coordinates obtained using map datum NAD 83

Table 10b. Coordinates locating the boundaries within which critical habitat is found for the Channel Darter at eight locations within Quebec.

	Coordinates locating areas of critical habitat	
Location	**Point 1 (NW)**	**Point 2 (NE)**
Gatineau River*	45°29’27.568”N 75°45’13.618”W	45°27’14.079”N 75°41’41.660”W
L’Assomption River*	45°59’01.680”N 73°25’01.560”W	46°04’02.640”N 73°28’11.280”W
Ouareau River*	45°57’30.420”N 73°27’20.040”W	45°57’19.080”N 73°26’20.400”W
Richelieu River*	45°26’54.128”N 73°15’52.827”W	46°02’56.714”N 73°07’13.676”W
Saint-François River*	45°28’25.968”N 71°38’49.992”W	45°37’39.134”N 72°06’53.038”W
Trout River*	45°07’01.129”N 74°05’21.474”W	45°00’41.880”N 74°18’10.852”W
Aux Outardes River*	45°03’05.537”N 74°00’52.603”W	45°06’14.832”N 74°03’54.719”W
Anglais River*	45°01’35.873”N 73°40’16.194”W	45°04’42.540”N 73°42’29.177”W

* Riverine habitats are delineated to the midpoint of channel of the uppermost stream segment and lowermost stream segment (i.e., two points only)
† All coordinates obtained using map datum NAD 83

Ontario

Little Rideau Creek/Ottawa River: Critical habitat in Little Rideau Creek is currently identified for the Channel Darter within a 2.3 km long reach of the creek extending from just south of Hwy 17 to the mouth of the Ottawa River. An additional area of 0.04 km^2 in the Ottawa River, at the confluence of Little Rideau Creek, has also been identified as an area within which critical habitat is found due to the proximity of the sampling data to the Ottawa River (Figure 7).

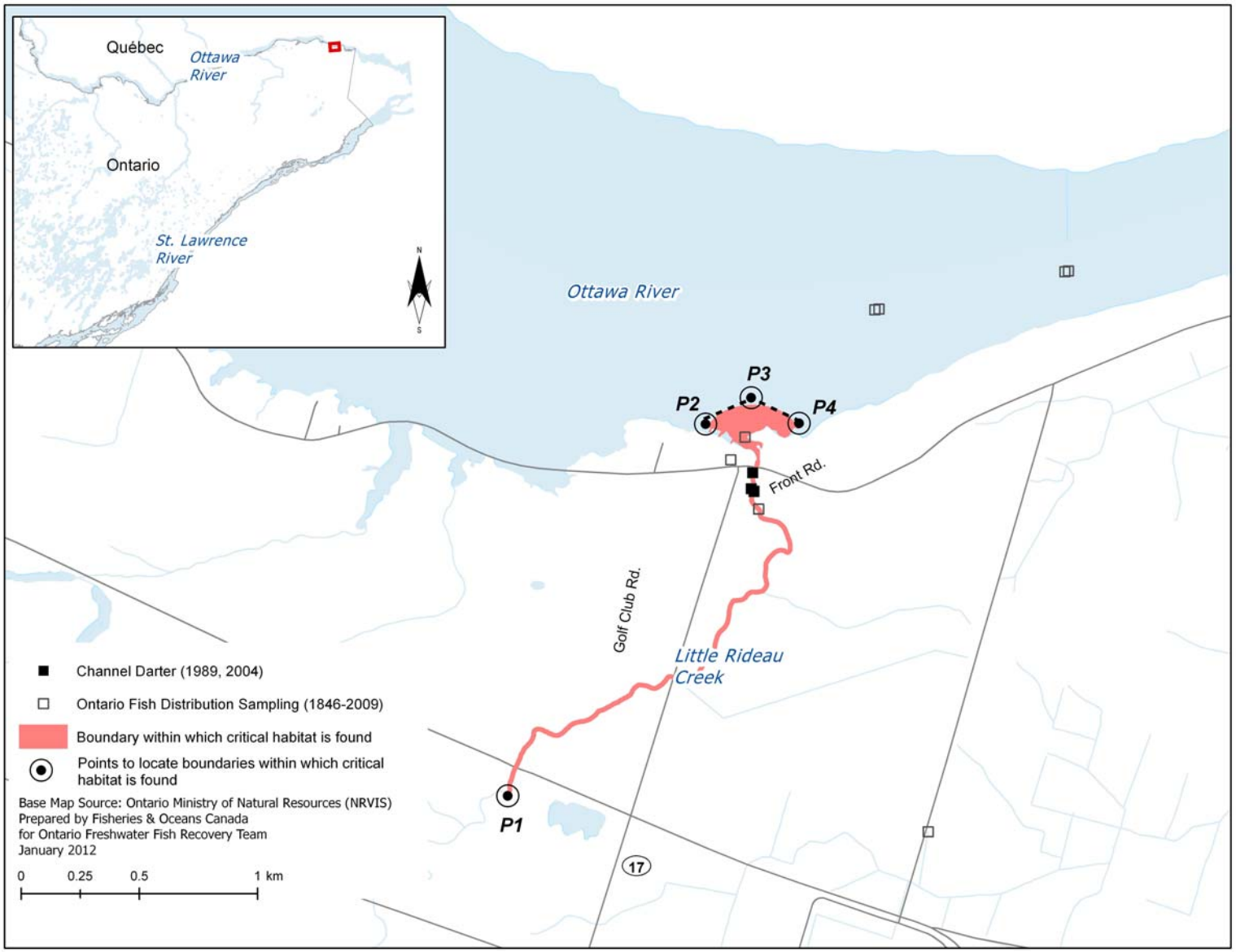

Figure 7. Boundaries of the area within which critical habitat of the Channel Darter is found within Little Rideau Creek/Ottawa River.

Trent, Moira (Black and Skootamatta rivers) and Salmon rivers: Critical habitat for the Channel Darter in the Trent River has been identified within a 22 km long stretch of river extending from the dam at Glen Ross downstream to Trenton. In the Moira River and its two tributaries, critical habitat is identified within a reach approximately 121 km long. In the Moira River, the area within which critical habitat is found extends from Hwy 7 near Deloro, downstream to Belleville. The stretch of river where critical habitat is found in the Skootamatta River extends from south of Flinton Road, downstream to the confluence with the Moira River. In the Black River, critical habitat is found in a reach that extends from just south of West Black River Road downstream to the confluence with the Moira River. In the Salmon River, critical habitat has been identified within a stretch of river 23 km long from Forest Hill (approximate) downstream to Shannonville (approximate). See Figures 8 to 12 below.

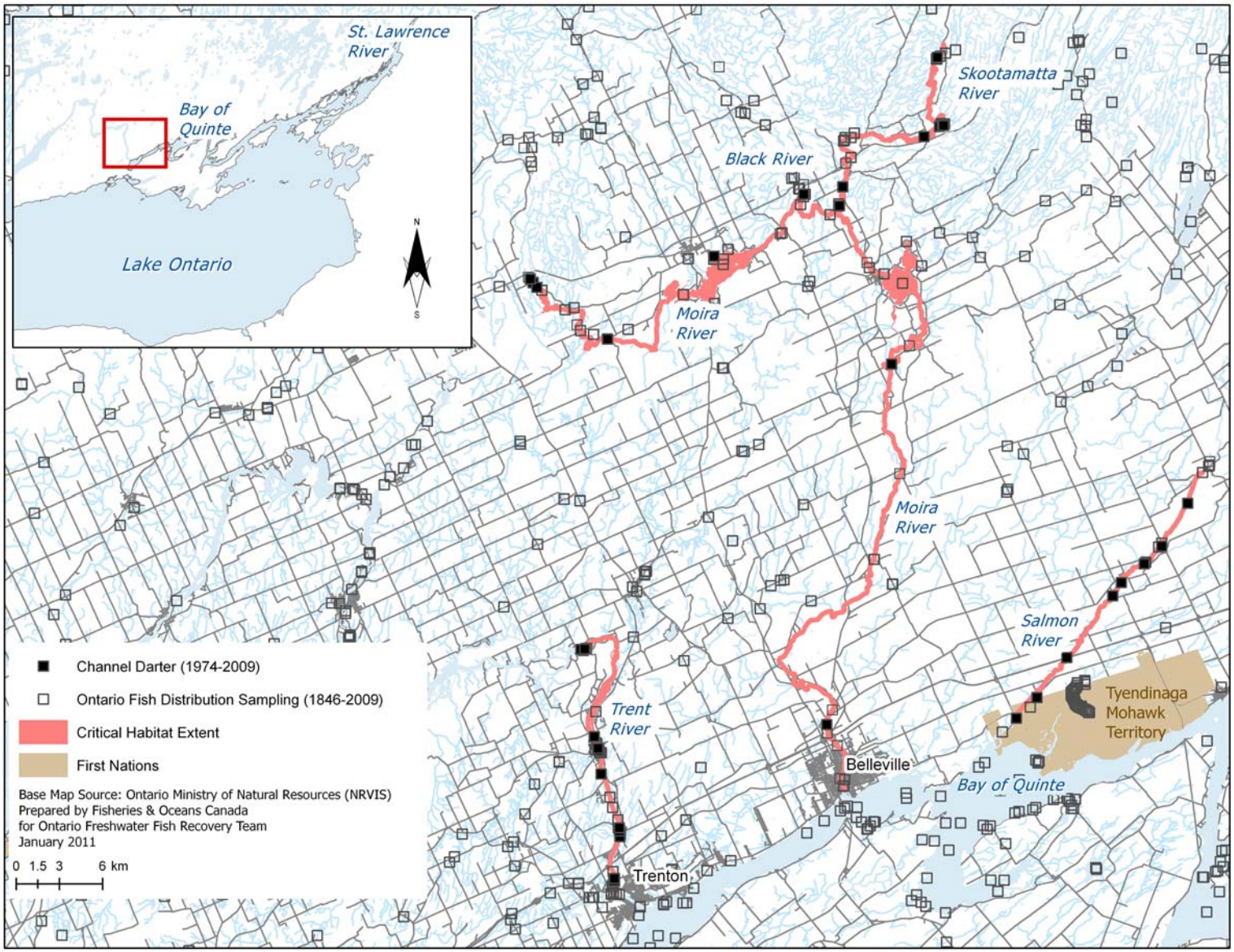

Figure 8. Boundaries of the area within which critical habitat of the Channel Darter is found in the Trent, Moira (Black and Skootamatta) and Salmon rivers.

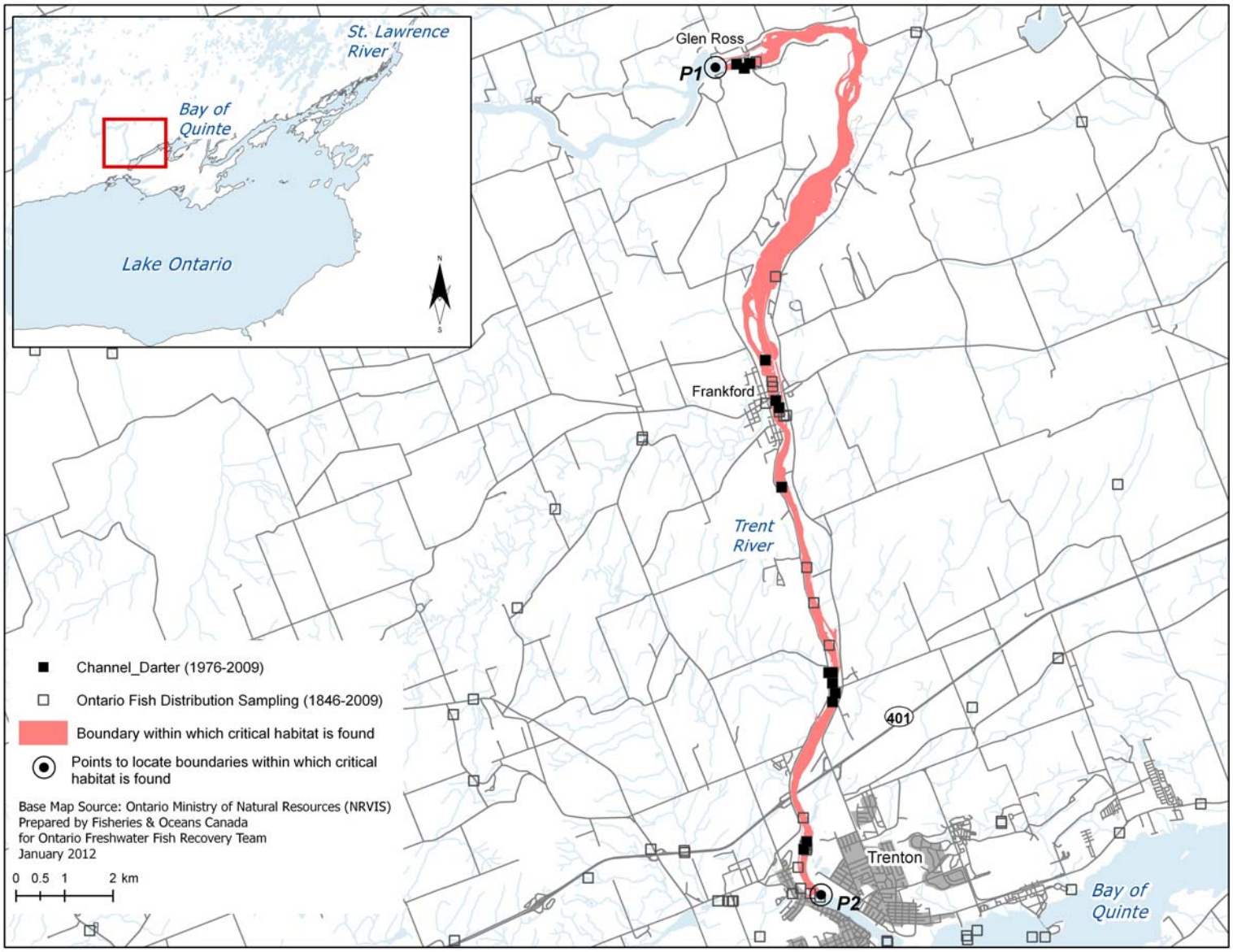

Figure 9. Boundaries of the area within which critical habitat of the Channel Darter is found in the Trent River.

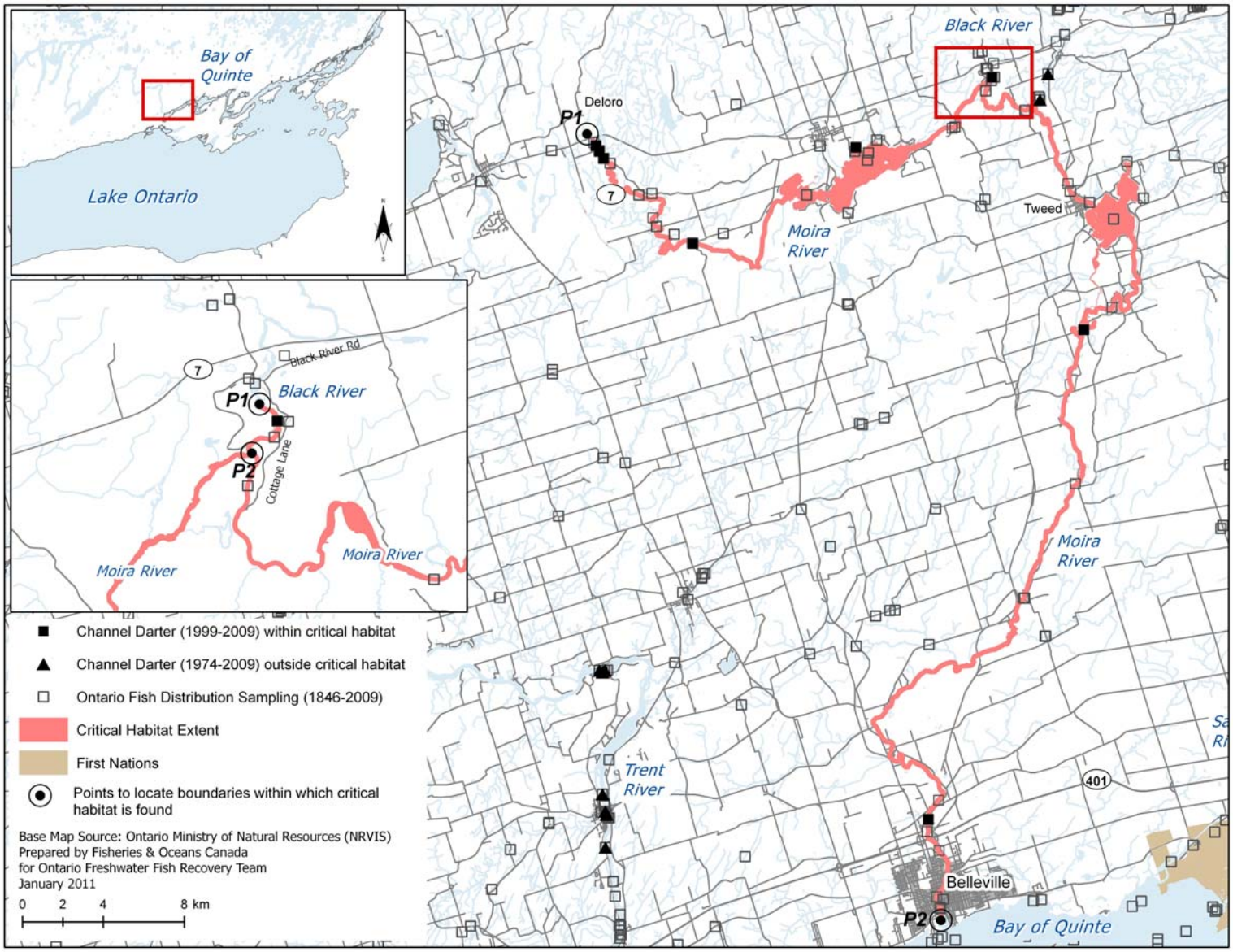

Figure 10. Boundaries of the area within which critical habitat of the Channel Darter is found in the Moira River and Black River.

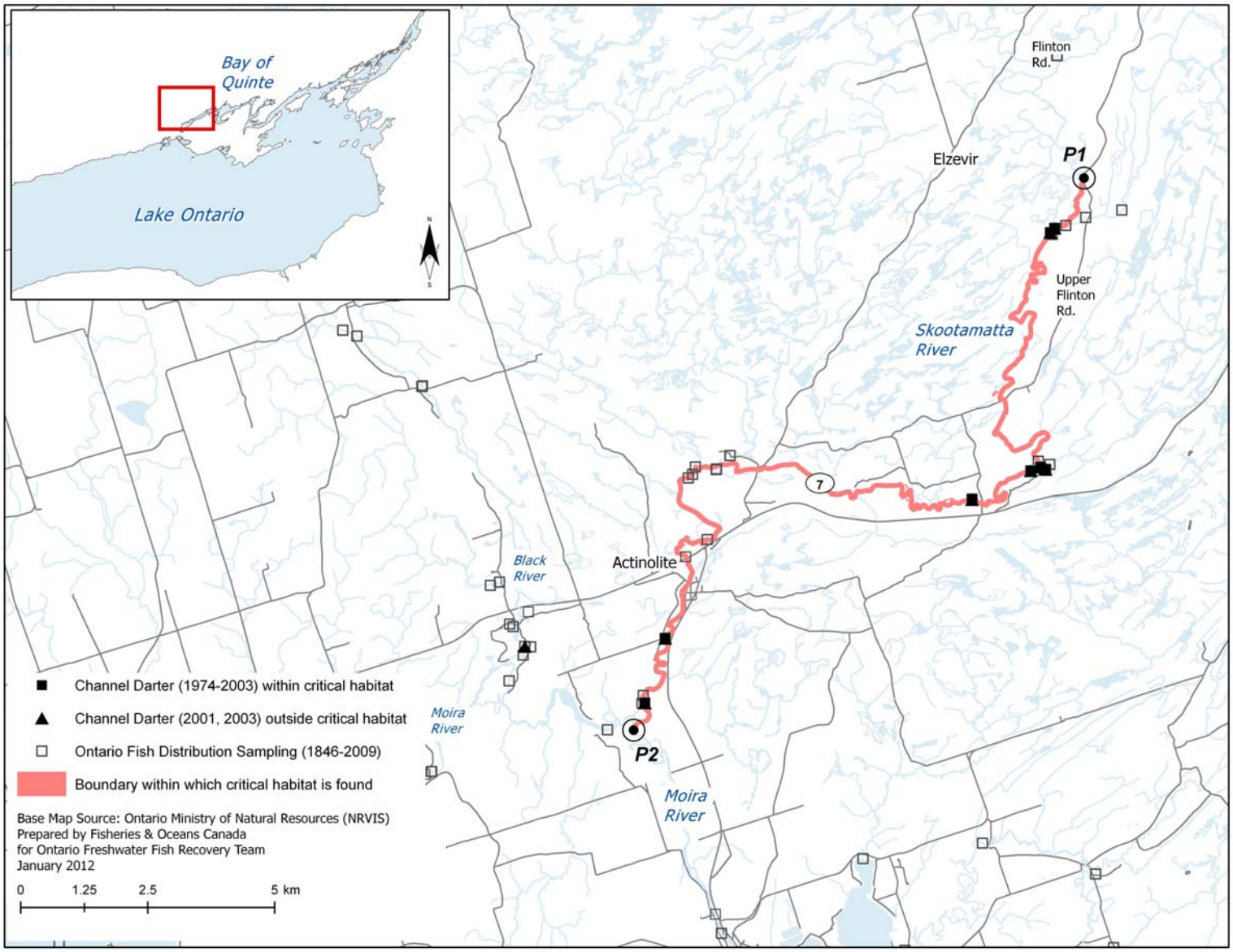

Figure 11. Boundaries of the area within which critical habitat of the Channel Darter is found in the Skootamatta River.

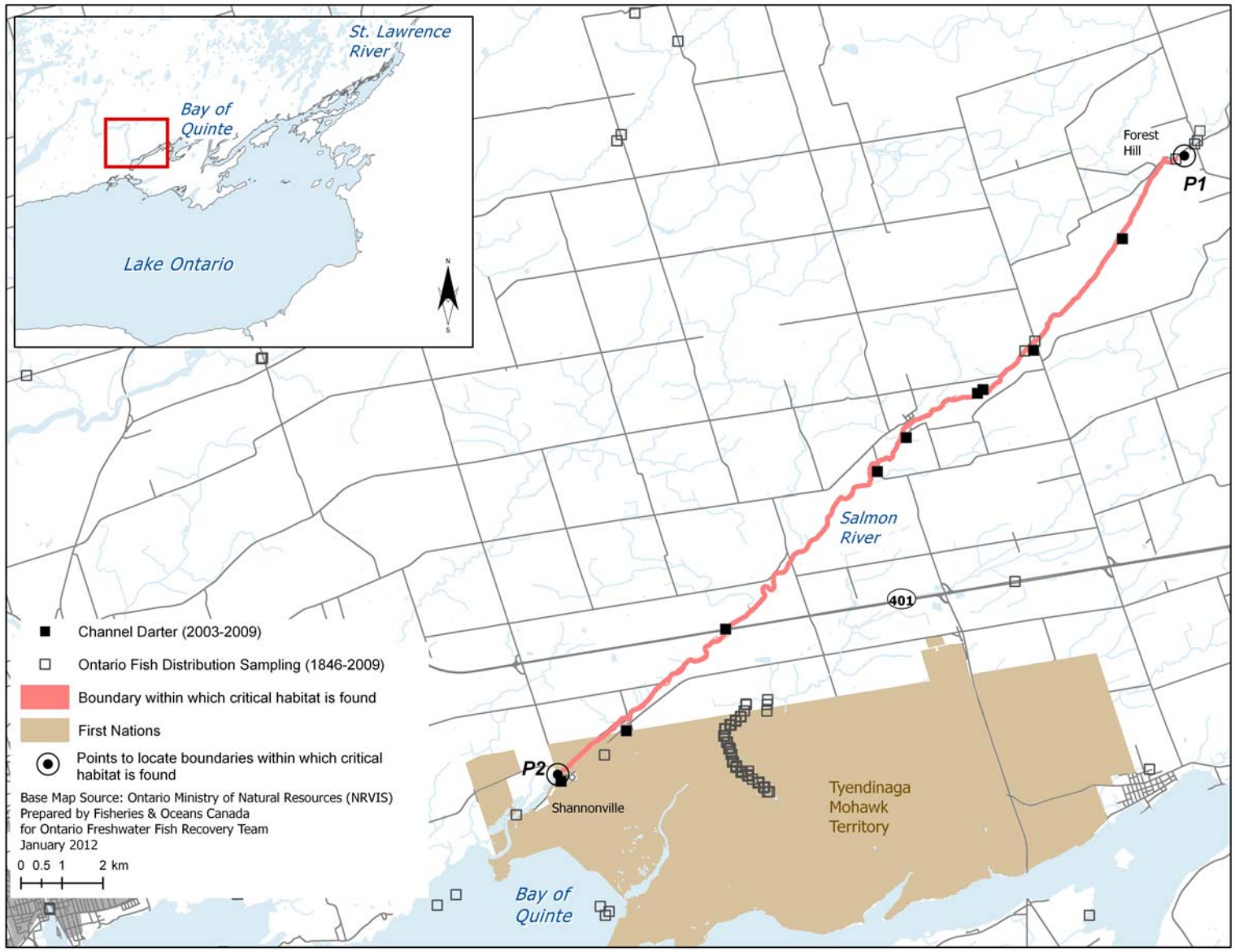

Figure 12. Boundaries of the area within which critical habitat of the Channel Darter is found in the Salmon River.

Lake Erie - Point Pelee: The area within which critical habitat is found for Channel Darter at Point Pelee is currently identified as the shoreline beginning at the northern boundary of Point Pelee National Park on the eastern side of the peninsula, extending south along the peninsula, encompassing all of the shoreline in the park, and continuing westerly along the shoreline to south of Fraser Road (Leamington) (approximate). Critical habitat boundaries extend down to the 2 m NOAA bathymetry contour and extend up to the HWM elevation for Lake Erie at 174.62 m above sea level (International Great Lakes Datum 1985). Refer to Figure 13.

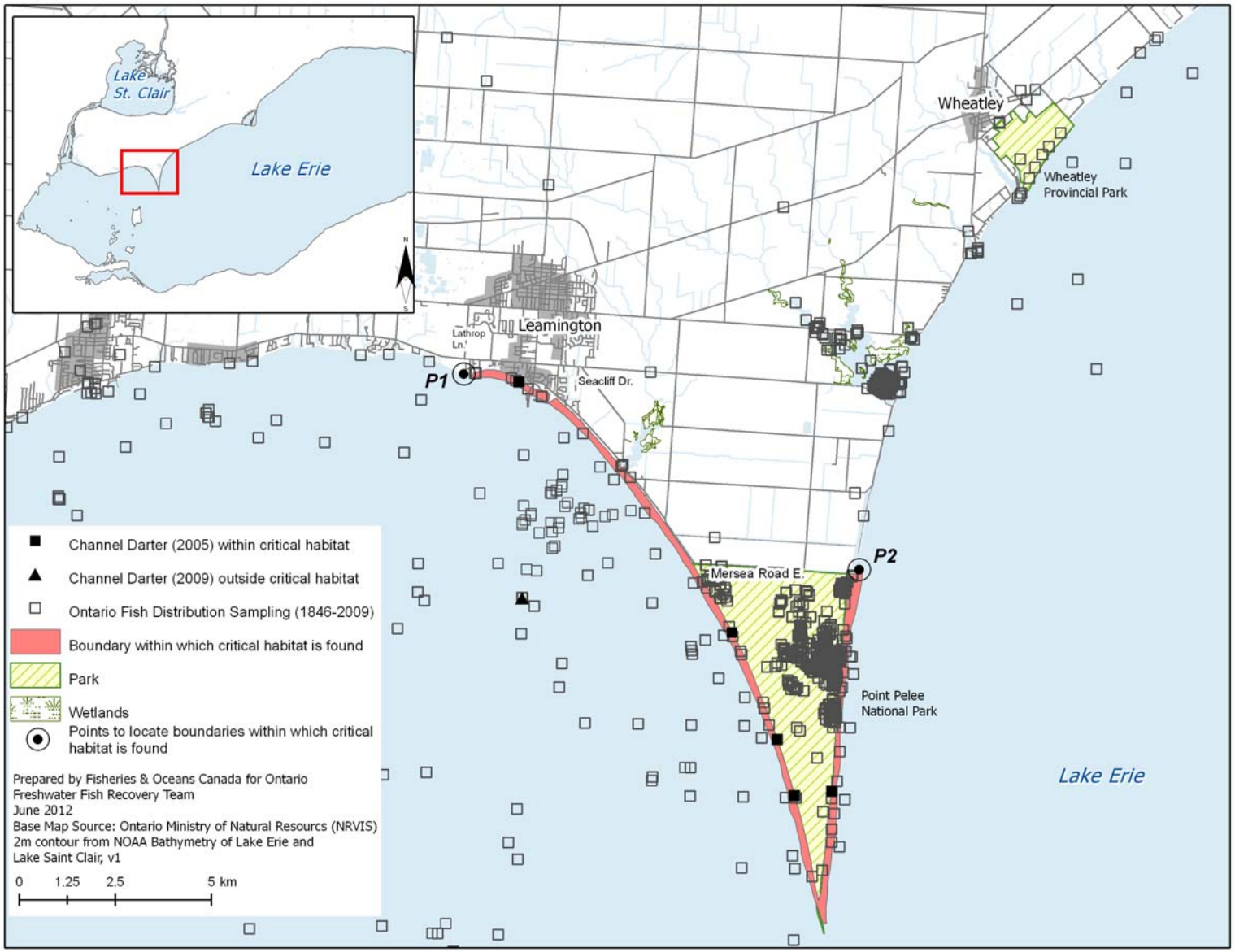

Figure 13. Boundaries of the area within which critical habitat of the Channel Darter is found in Lake Erie at Point Pelee.

Quebec

Ottawa and Montreal hydrographic region:

Gatineau River – The area within which critical habitat is identified in the Gatineau River begins at Farmer Rapids (midway between the Alonzo-Wright Bridge and the Centrale des Rapides-Farmer) and continues to the mouth of the river where it empties into the Ottawa River (Figure 14). This stretch of river is approximately 6.8 km long.

Boucher et al. (2009) found that Channel Darter was most often found in lotic habitats and that its presence was linked to two variables: current velocity (average of 41 cm/s); and, a light cover of periphyton on the substrate (less than 30% of total substrate area). All captures took place at depths less than 60 cm and spawning individuals were observed in July (Boucher 2006). Lemieux et al. (2005) have captured adults that seemed to be feeding in nearshore areas in June and July and have identified two spawning sites (presence of eggs) in July, upstream of the Alonzo-Wright bridge, at a water temperature of 21ºC, depth of 30 to 40 cm and current velocity of 0.24 to 0.60 m/s. The bed of the spawning areas was mainly composed of cobble with little amounts of sand and gravel. Comtois et al. (2004) have also captured spawning individuals downstream of the Alonzo-Wright Bridge, between May 20 and June 21, while water temperature was between 14 and 19 ºC.

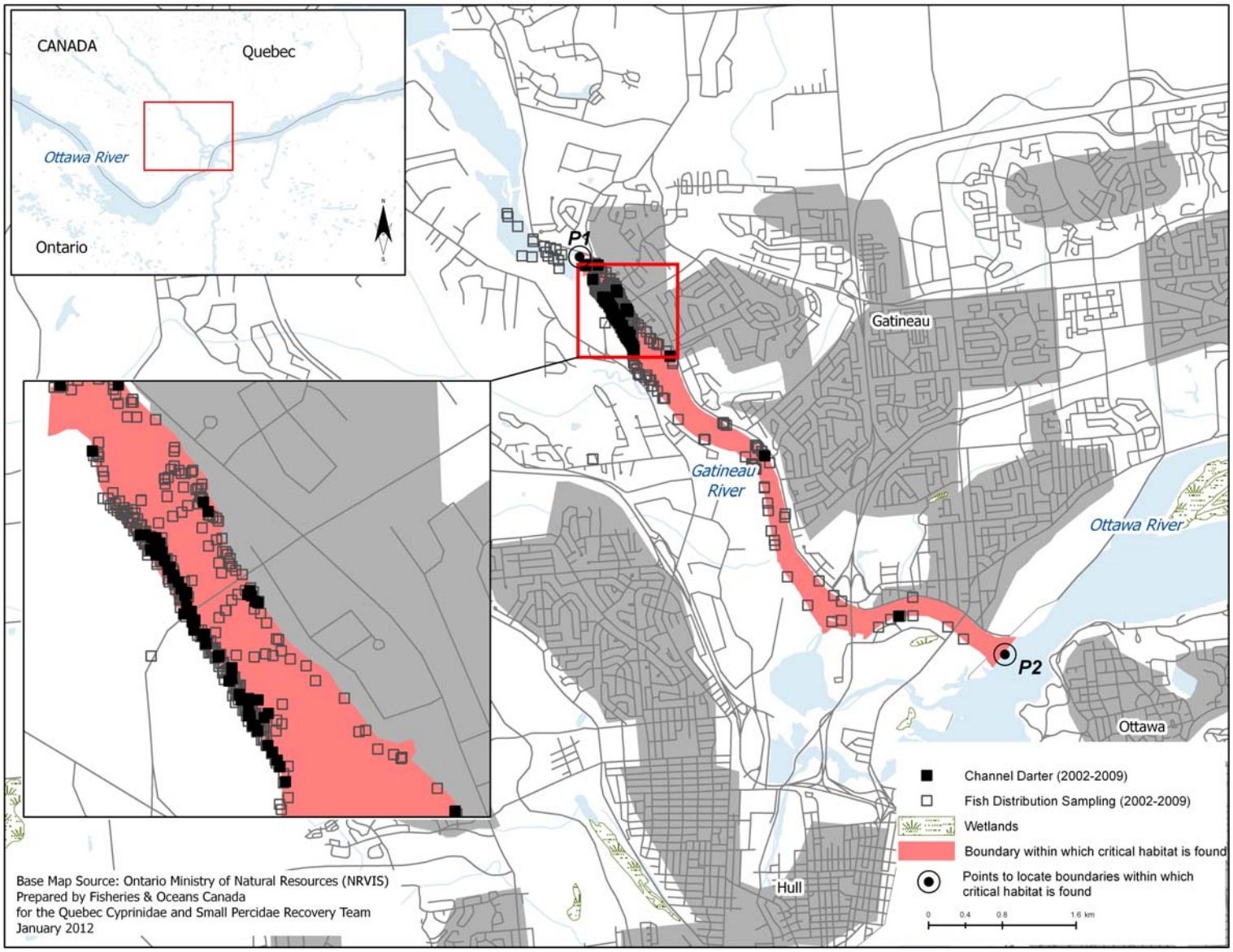

Figure 14. Boundaries of the area within which critical habitat of the Channel Darter is found in the Gatineau River.

St.-Lawrence northeast hydrographic region:

L'Assomption River and its tributary, the Ouareau River – Critical habitat identified in the L'Assomption River is found within a segment of the river near St. Paul, and a tributary, the Ouareau River, near Crabtree (Figure 15). These river segments have respective lengths of 23.2 km and 1.8 km. Further studies will be required to determine whether or not these two locations represent discrete populations.

In these two habitats, captures were made at depths of approximately 25 cm in clear water with an average temperature of 20.5 ºC, low to moderate current velocity, and a heterogeneous substrate mainly composed of rocks and sand but always with gravel as the next most abundant substrate (CARA 2002, Bourgeois et al. 2010).

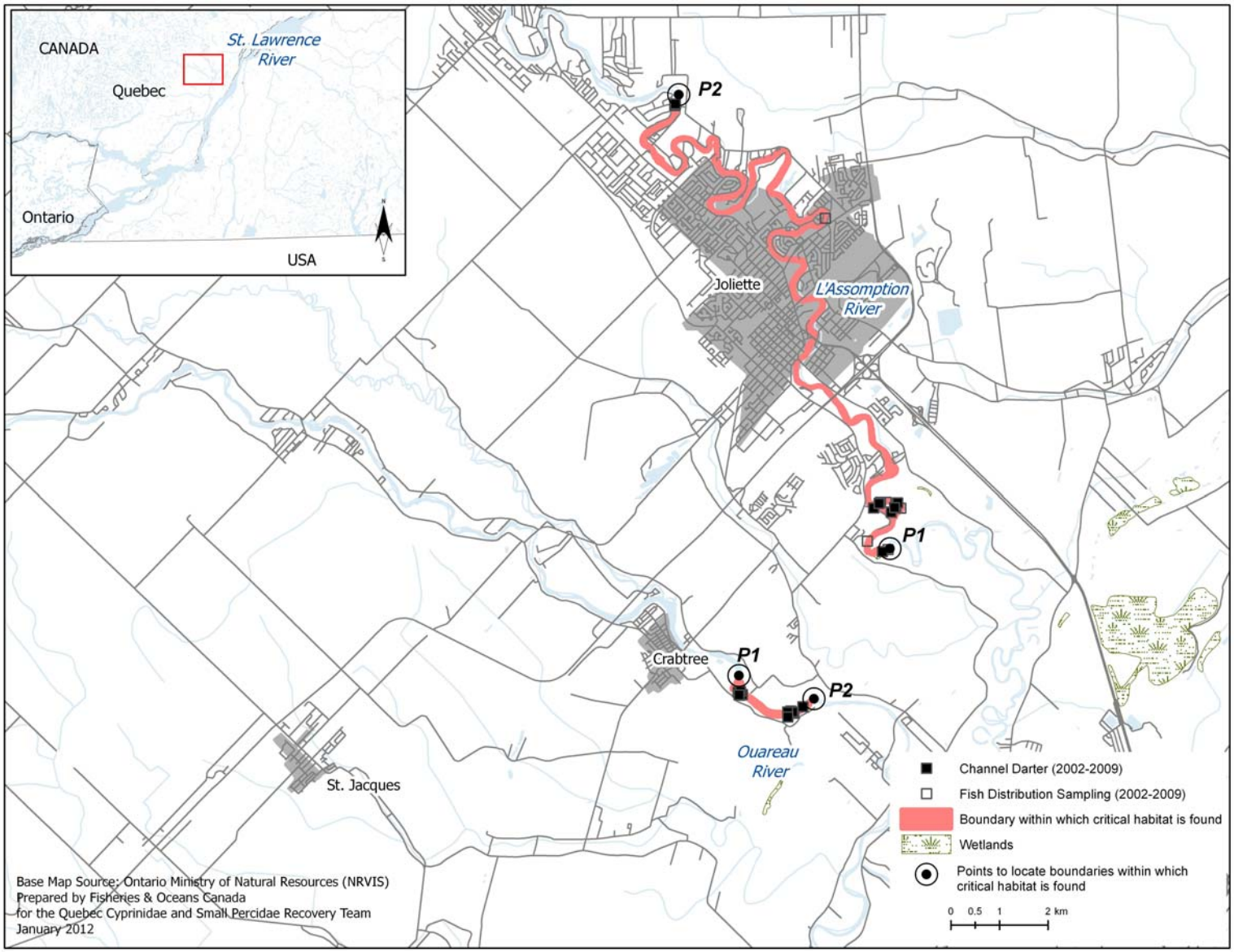

Figure 15. Boundaries of the area within which critical habitat of the Channel Darter is found in the L'Assomption River and its tributary, the Ouareau River.

St. Lawrence southwest hydrographic region:

Richelieu River – The area within which critical habitat is identified in the Richelieu River (Figure 16) extends from downstream of Chambly Dam to the mouth of the river where it empties into the St. Lawrence River. This river segment has a length of 72.7 km.

In the Richelieu River, Boucher et al. (2009) have conducted surveys in the Chambly Rapids and in the St. Marc-sur-Richelieu region. As on the Gatineau River, this study has demonstrated that Channel Darter is most often found in lotic waters. However, in the Richelieu River, its presence is linked to four habitat parameters: depth (average of 25 cm); current velocity (average of 44 cm/s); heterogeneous substrate (more than three classes); and, presence of woody debris. All captures occurred at depths of less than 60 cm. Channel Darter have also been captured between 1997 and 2009 in a follow-up study of the recruitment of the Copper Redhorse (*Moxostoma hubbsi*) in the Chambly Rapids, the St. Marc-sur-Richelieu region (Jeannotte and aux Cerfs islands), St. Ours region and at the mouth of the river (Vachon 2007, N. Vachon, MRNF, pers. comm. 2010). It is important to note that some captures were made on substrate dominated by clay, silt, sand, gravel or rocks and at depths of up to 5 m (S. Garceau, MRNF, pers. comm. 2010). Consequently the critical habitat in this river is characterized by depths of 0 to 5 m with substrate varying between clay (<0.1 mm) to rocks (65 to 255 mm).

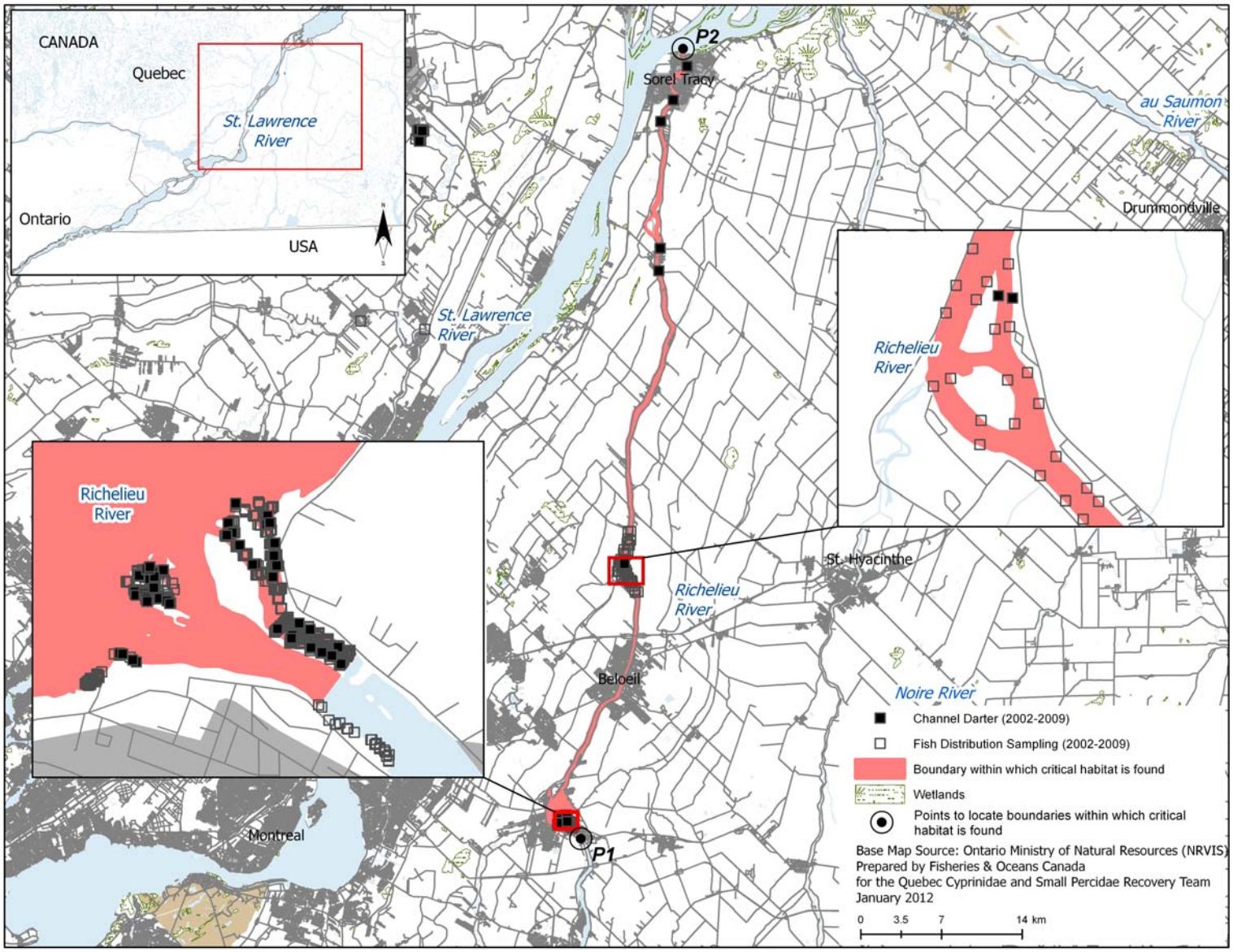

Figure 16. Boundaries of the area within which critical habitat of the Channel Darter is found in the Richelieu River.

Saint-François River – The area within which critical habitat is identified on the Saint-François River extends from East-Angus to Melbourne and includes the regions of Bromptonville and Windsor (Figure 17). This river segment has a length of 65.8 km.

In 1998 and 2003, Channel Darter were captured in the Saint-François River while conducting an environmental study on pulp and paper mill effluent, near Bromptonville and Windsor. Targeted inventories conducted by the MRNF have also reported captures of Channel Darter near East-Angus and downstream of Windsor and Bromptonville (downstream of Kruger's Dam), in 2008 and 2009. The sites of capture are characterized by a rocky substrate with gravel and a low quantity of sand. The captures were made in the nearshore area with low current velocity (S. Garceau, MRNF, pers. comm. 2010).

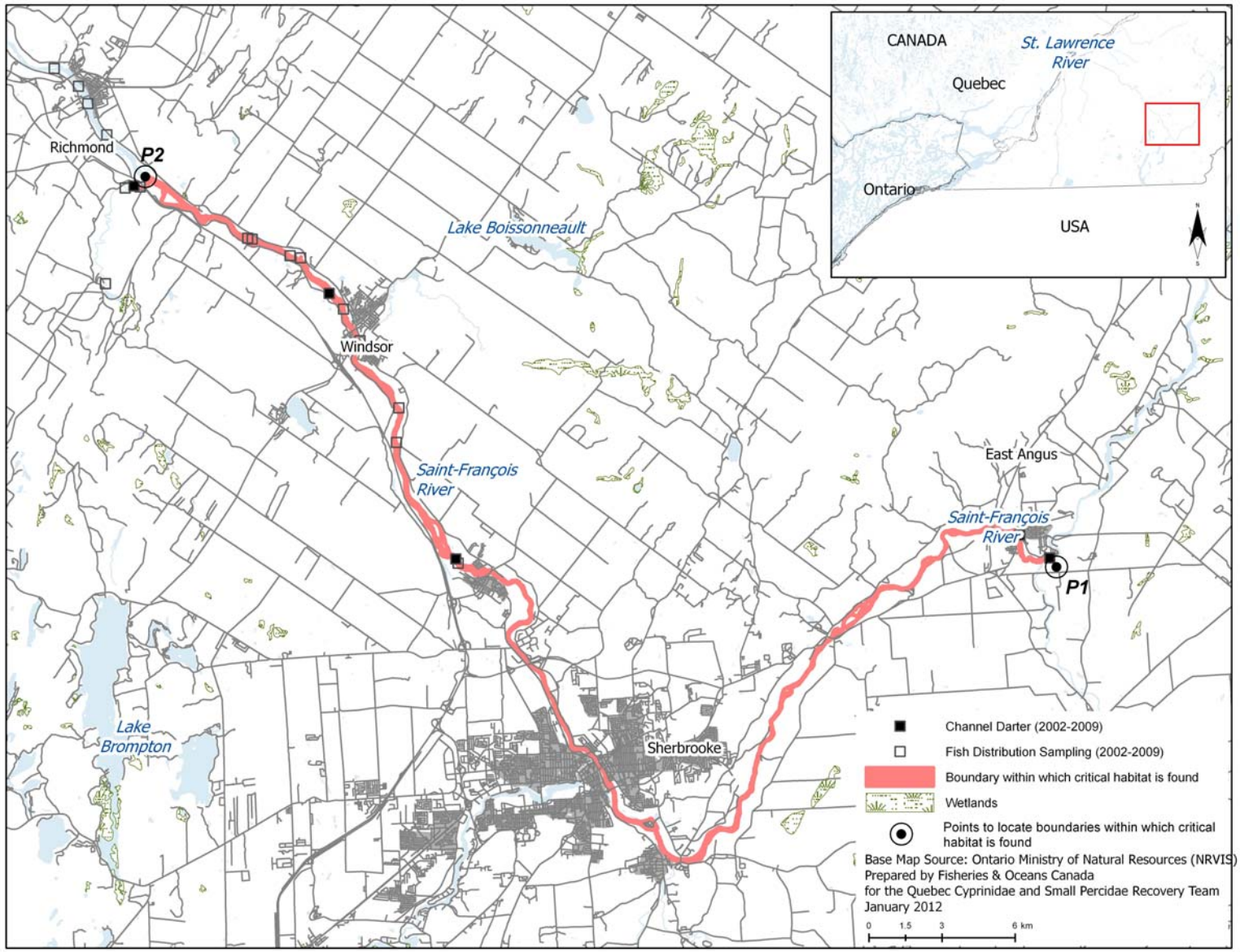

Figure 17. Boundaries of the area within which critical habitat of the Channel Darter is found in the Saint-François River.

Des Anglais, aux Outardes and Trout rivers (Châteauguay River watershed) – Channel Darter critical habitat in this watershed is found in the following rivers: des Anglais, aux Outardes and Trout (Figure 18). Critical habitat is located within a stretch of river approximately 9 km in length in the des Anglais River, 7.5 km in the aux Outardes River, and 25.7 km in the Trout River. Additional studies are required to confirm if the three locations correspond to three discrete populations or a single population.

Garceau et al. (2007) found that critical habitat in these three rivers is generally a segment of river where the bed is mainly composed of sand or gravel interspersed by rocks or boulders. The current velocity is generally low (around 30 cm/s) and Channel Darter were generally found in counter-current or current shelter areas. There was normally no aquatic vegetation present. The riparian band was of variable cover but generally with a minimum of 50% tree cover. At the stations where Channel Darter were captured, dissolved oxygen saturation was over 95%, pH between 6.9 and 9.4 and conductivity between 209 and 279 μS/cm. The water turbidity was low (below 2.5 UTN), which explains the low content of fines found on the substrate where Channel Darter were captured.

Channel Darter have also been captured in the des Anglais River by Ambioterra. Specimens were captured in locations of a minimum depth of 5 to 50 cm but not exceeding 150 cm, a variable substrate composed of consolidated clay or bedrock, a weak covering of aquatic vegetation and a riparian band composed of herbaceous plants, shrubs and trees and an average current velocity between 10 and 36 cm/s in August and between 4 and 21 cm/s in October (Ambioterra 2010).

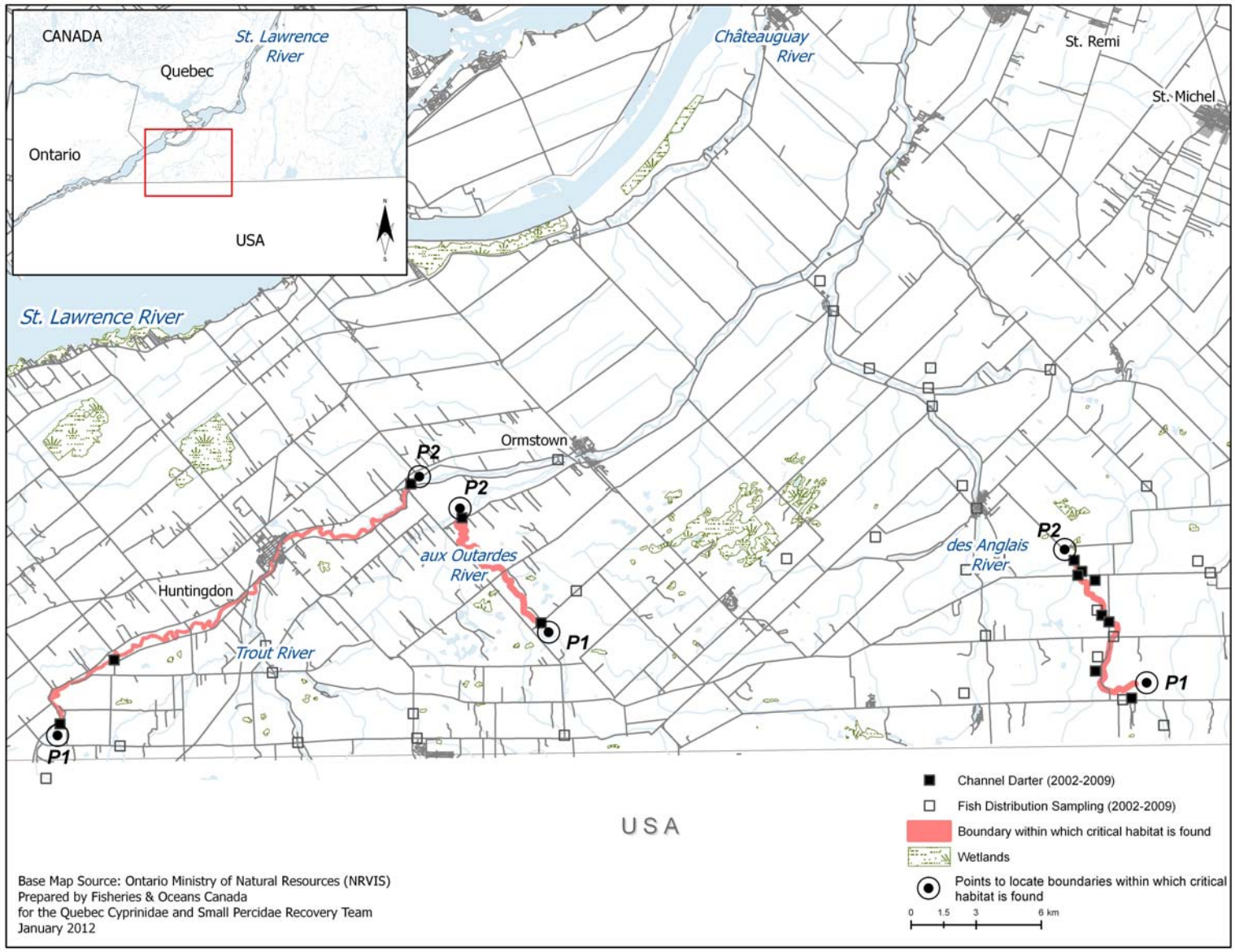

Figure 18. Boundaries of the area within which critical habitat of the Channel Darter is found in the Trout, aux Outardes and des Anglais rivers.

The identification of critical habitats within the described areas ensures that currently occupied habitat supporting Channel Darter is protected, until such time as critical habitat for the species is further refined according to the schedule of studies laid out in Table 12. The recovery team recommends to the Minister of Fisheries and Oceans and to the Minister of the Environment that these areas are necessary to achieve the identified survival and recovery objectives. The schedule of studies outlines activities necessary to refine the current critical habitat descriptions at confirmed extant locations, but will also apply to new locations should previously unknown populations be confirmed. Critical habitat descriptions will be refined as additional information becomes available to support the population and distribution objectives.

7.1.4 Population viability

The minimum area for population viability (MAPV) for each life stage of the Channel Darter was estimated for Canadian populations (Table 11a and 11b). The MAPV is defined as the amount of exclusive and suitable habitat required for a demographically sustainable recovery target based on the concept of a MVP (Vélez-Espino et al. 2009). The estimated MVP for YOY and adult Channel Darter is 2 712 363 and 31 000, respectively, given a 10% chance of a catastrophic event occurring per generation. The corresponding MAPV has been estimated to be 0.04 km^2 in rivers and 1.252 km^2 in lakes. For more information on the MVP and MAPV and associated methodology refer to Venturelli et al. (2010).

The MAPV is a quantitative metric of critical habitat that can assist with the recovery and management of species at risk (Vélez-Espino et al. 2009). MAPV values are somewhat precautionary in that they represent the sum of habitat needs calculated for all life history stages of the Channel Darter; these figures do not take into account the potential for overlap in the habitat of the various life history stages and may overestimate the area required to support an MVP. However, since many of these populations occur in areas of degraded habitat (MAPV assumes habitat quality is optimal), areas larger than the MAPV may be required to support an MVP. In addition, for many populations, it is likely that only a portion of the habitat within that identified as the critical habitat extent would meet the functional requirements of the species' various life stages.

Comparisons were made with the extent of critical habitat identified for each population relative to the estimated MAPV (refer to Table 11a and 11b). The critical habitats identified inside the segments are the areas that meet the functional habitat requirements outlined in Table 9a and 9b. Consequently, the area data provided are only cartographic estimations of the total watercourse segment and are not the actual area of available critical habitat. Further studies will be required to assess the area of critical habitat available on an annual basis, for each identified river segment. Future studies may also help quantify the amount and quality of available habitat within critical habitats for all populations; such information, along with the verification of the MAPV model, will allow greater certainty for the determination of population viability. As such, the results in Table 11a and 11b are preliminary and should be interpreted with caution.

Table 11a. Comparison of the area of river segments and lake areas in which critical habitat can be found (km^2) for each Channel Darter location in Ontario, relative to the estimated minimum area for population viability (MAPV)*.

Location[4]	Approximate area of critical habitat identified (km^2)	MAPV (km^2)	MAPV Achieved? (Y/N)
Trent River	4.85	0.04	Y
Moira River, Black River, Skootamatta River	5.94	0.04	Y
Salmon River	0.61	0.04	Y
Little Rideau Creek/Ottawa River	0.05	0.04	Y
Lake Erie – Point Pelee	7.01	1.25	Y

***** The MAPV estimation is based on modeling approaches described above.

Table 11b. Comparison of the area of river segments in which critical habitat can be found (km^2) for each Channel Darter location in Quebec, relative to the estimated minimum area for population viability (MAPV)*.

Location	Approximate area of critical habitat identified (km^2)	MAPV (km^2)	MAPV Achieved? (Y/N)
Gatineau River	1.40	0.04	To be confirmed
L'Assomption River/Ouareau River	0.97/0.14	0.04	To be confirmed
Richelieu River	9.32	0.04	To be confirmed
Saint-François River	7.00	0.04	To be confirmed
des Anglais/aux Outardes/Trout rivers	0.10/0.31/0.72	0.04	To be confirmed

***** The MAPV estimation is based on modeling approaches described above.

7.2 Schedule of studies to identify critical habitat

This recovery strategy includes an identification of critical habitat to the extent possible, based on the best available information. Further studies are required to refine critical habitat identified for the Channel Darter to support the population and distribution objectives for the species. The activities listed in Table 12 are not exhaustive and it is likely that the process of investigating these actions will lead to the discovery of further knowledge gaps that need to be addressed.

[4] Note that some locations may contain more than one population. In such cases, the MAPV would be applied to each discrete population.

Table 12. Schedule of studies to identify critical habitat.

Description of activity	Rationale	Approximate Timeline
Conduct studies to determine the habitat requirements for each life stage of the Channel Darter.	There is limited information available regarding the habitat requirements for juvenile Channel Darter. Determining the habitat requirements for each life stage will ensure that all necessary features and attributes of critical habitat for this species will be identified.	2012 - 2016
Survey and map habitat quality and quantity within historical and current sites, as well as sites adjacent to currently occupied habitat.	Strengthen confidence in data used to determine if sites meet the criteria for critical habitat; assist in refining the spatial boundaries of critical habitat.	2012 - 2016
Conduct additional species surveys to fill in distribution gaps, and to aid in determining population connectivity.	Additional populations and corresponding critical habitat may be required to meet the population and distribution objectives.	2012 - 2016
Create a population-habitat supply model for each life stage.	Will aid in developing recovery targets and determining the quantity of critical habitat required by each life stage to meet these targets.	2012 - 2016
Based on information gathered, review population and distribution goals. Determine amount and configuration of critical habitat required to achieve goal if adequate information exists. Validate model.	Revision of recovery targets may be required to ensure that they are achievable and defensible; will allow further refinement of critical habitat description (spatial and biophysical attributes).	2012 - 2016

Activities identified in this schedule of studies will be carried out through collaboration between DFO, PCA, and other relevant groups and land managers. Note that many of the individual recovery approaches will address some of the information requirements listed above.

The Trent-Severn Waterway is planning to conduct flow needs assessments for species at risk fishes, including Channel Darter, at some of PCA's dams on the Trent River during the spring of 2012. However, it should be noted that water level management on the Waterway is a complex issue and is subject to many other mandated considerations including public safety.

7.3 Examples of activities likely to result in the destruction of critical habitat

Activities that negatively alter flow regimes beyond the tolerance threshold of the species, and increase siltation, turbidity, and nutrient levels can negatively impact Channel Darter habitat. However, in areas where it is known that such activities do not negatively impact the species (determined by site-specific reviews and the determination of tolerance thresholds for individual populations) such activities described in the table may continue to occur.

Without appropriate mitigation, direct destruction of habitat may result from work or activities such as those identified in Table 13.

The activities described in this table are neither exhaustive nor exclusive and have been guided by the threats described in Section 4.2 (Description of threats). The absence of a specific human activity does not preclude, or fetter the department's ability to regulate it pursuant to SARA. Furthermore, the inclusion of an activity does not result in its automatic prohibition since it is destruction of critical habitat that is prohibited. Since habitat use is often temporal in nature, every activity is assessed on a case-by-case basis and site-specific mitigation is applied where it is reliable and available. In every case, where information is available, habitat thresholds and limits are associated with attributes to better inform management and regulatory decision-making. However, in many cases the knowledge of a species and its critical habitat may be lacking and in particular, information associated with a species' or habitat thresholds of tolerance to disturbance from human activities, is lacking and must be acquired.

Certain habitat management activities are recognized as being beneficial to the long-term survival and/or recovery of the species and may be allowed when required. Such activities may include water level and flow management (including dike maintenance) and habitat restoration activities. Stewardship, implementation of BMPs and Watershed Committees, as well as improved flow management could mitigate negative impacts to the species.

The critical habitat for Channel darters will be legally protected through the application of subsection 58(1) of SARA, which prohibits the destruction of any part of the critical habitat of aquatic species listed as Endangered or Threatened, and of any part of the critical habitat of aquatic species listed as Extirpated if a recovery strategy has recommended their reintroduction into the wild in Canada.

Table 13. Human activities likely to result in the destruction of critical habitat for Channel Darter. The affect pathway for each activity is provided as well as the potential links to the biophysical functions, features, and attributes of critical habitat.

Activity	Affect- pathway	Function affected	Feature affected	Attribute affected
Habitat modifications: Shoreline hardening Placement of material or structures in water (e.g., groynes, piers, infilling, partial infills, jetties) Dredging Grading Excavation	Changing shoreline morphology can result in altered flow patterns, change sediment depositional areas, cover preferred substrates, cause erosion and alter turbidity levels. These changes can impact water quality and cause changes to nutrient levels. Hardening of shorelines can impact organic inputs into the water and alter water temperatures, potentially affecting the availability of prey for this species. Placing material or structures in water reduces habitat availability (e.g., the footprint of the infill or structure is lost). Placing of fill can cover preferred substrates and change flow patterns. Changes in bathymetry and shoreline morphology caused by dredging and nearshore grading and excavation can remove (or cover) preferred substrates, change water depths, and/or change flow patterns, potentially affecting nutrient levels and water temperatures.	Spawning Nursery Rearing Feeding Migration	Riffles, runs, shoals, nearshore areas, backwater areas and pools in streams and rivers Gravel and coarse sand beaches	• Current and wave action • Clean, coarse substrates (e.g., cobble, gravel and sand) • Large rocks in current • Depth • Warm water temperatures • Good water quality • Minimal to sparse aquatic vegetation • Availability of prey
Habitat modifications: Significant changes in timing, duration and frequency of water flow to the extent that critical habitat becomes uninhabitable by any life stage of the Channel Darter Installation of barriers to movement (e.g., dams)	Rapid, repeated and prolonged changes in water flow (increases *or* decreases) can have a negative affect on Channel Darter habitat, especially spawning habitat. Large changes (rapid or prolonged) in water flow can cause significant sediment deposition (e.g., changing preferred substrates) or changes in prey abundance. Barriers can restrict access to important habitat areas and fragment fish populations affecting distribution of Channel Darter.	All or same as above	All or same as above	• All of the above

Table 13 (con't). Human activities likely to result in the destruction of critical habitat for Channel Darter. The affect pathway for each activity is provided as well as the potential links to the biophysical functions, features, and attributes of critical habitat.

Activity	Affect- pathway	Function affected	Feature affected	Attribute affected
Habitat modifications: Unfettered livestock access to waterbodies Grazing of livestock and ploughing to water's edge	Resulting damage to shorelines, banks and watercourse bottoms from unfettered access by livestock can cause increased erosion and sedimentation, affecting substrate, water quality and water temperatures. Such access can also increase organic nutrient inputs into the water causing nutrient loading and potentially promoting algal blooms and decreasing prey abundance.	All or same as above	All	• Clean, coarse substrates (e.g., cobble, gravel and sand) • Warm water temperatures • Good water quality • Minimal to sparse aquatic vegetation • Availability of prey
Introduction of exotic species	Exotic species, such as invasive plant species, may affect Channel Darter critical habitat by altering the nature of the habitat.	All or same as above	All or same as above	• Availability of prey
Contaminants and toxic substances: Over application or misuse of herbicides, insecticides and pesticides Release of urban and industrial pollution into habitat	Introduction of toxic compounds into habitat used by this species can change water quality affecting habitat availability or use and prey availability.	All or same as above	All or same as above	• Good water quality • Minimal to sparse aquatic vegetation • Availability of prey
Nutrient loadings: Over-application of fertilizer and improper nutrient management (e.g., organic debris management, wastewater management, animal waste, septic systems and municipal sewage)	Improper nutrient management can cause nutrient loading of nearby waterbodies. Elevated nutrient levels can cause increased aquatic plant growth changing water temperatures and slowly changing preferred flows and substrates. Dissolved oxygen levels can also be negatively affected. The availability of prey species can also be affected if prey are sensitive to organic pollution.	All	All or same as above	• Current and wave action • Clean, coarse substrates (e.g., cobble, gravel and sand) • Warm water temperatures • Good water quality • Minimal to sparse aquatic vegetation • Availability of prey

Table 13 (con't). Human activities likely to result in the destruction of critical habitat for Channel Darter. The affect pathway for each activity is provided as well as the potential links to the biophysical functions, features, and attributes of critical habitat.

Activity	Affect- pathway	Function affected	Feature affected	Attribute affected
Siltation and turbidity: Altered flow regimes causing erosion and changing sediment transport (e.g., tiling of agricultural drainage systems, removal of riparian zones) Work in or around water with improper sediment and erosion control (e.g., overland runoff from ploughed fields, use of industrial equipment, cleaning or maintenance of bridges or other structures)	Improper sediment and erosion control or mitigation can cause increased turbidity levels, changing preferred substrates, potentially reducing feeding success or prey availability, impacting the growth of aquatic vegetation and possibly excluding fish from habitat due to physiological impacts of sediment in the water (e.g., gill irritation). Also see: **Habitat Modifications:** Change in timing, duration and frequency of flow	All or same as above	All or same as above	• Current and wave action • Clean, coarse substrates (e.g., cobble, gravel and sand) • Warm water temperatures • Good water quality • Minimal to sparse aquatic vegetation • Availability of prey

Certain habitat management activities in Channel Darter habitat, such as flow management and habitat alteration, are occurring and will continue to occur. Since little is known about the species' tolerance thresholds in relation to these specific activities, additional study is required. In addition to the studies described in the schedule of studies (Table 12), efforts are planned for flow needs assessments and the determination of BMPs in areas where habitat management is subject to other mandated consideration such as public safety.

8. MEASURING PROGRESS

The overall success of implementing the recommended recovery approaches will be evaluated primarily through routine population (distribution and abundance) and habitat (quality and quantity) surveys and monitoring. During the next five years, focus will be placed on completing recovery actions identified as "high priority" for the Channel Darter. The recovery strategy will be reported on in five years to evaluate the progress made toward population and distribution objectives and will be reviewed within an adaptive management planning framework with input from ecosystem recovery teams. Performance measures to evaluate the recovery process in meeting recovery objectives over the next five years are outlined below.

Performance measures for evaluating the achievement of recovery objectives.

- Extant populations fully described by 2016
- Completion of activities outlined in the schedule of studies for the complete identification of critical habitat within the proposed timelines (by 2016).
- Monitoring program established by 2016
- Relative significance of threats evaluated by 2016
- Initiate implementation of remedial actions to address priority threats by 2017
- Feasibility of re-establishment and potential re-establishment methods determined by 2016
- Potential re-establishment sites identified by 2016
- Quantification of BMPs (e.g., number of Nutrient Management Plans and Environmental Management Plans completed; hectares of riparian zone established) implemented through ecosystem-based recovery teams and other relevant complementary groups/initiatives to address threats by 2016 (on-going)
- Document any changes in public perceptions and support for identified recovery actions through guidance identified in the communications strategy (by 2016)

9. ACTIVITIES PERMITTED BY THE RECOVERY STRATEGY

As set out in subsection 83(4) of SARA, a person can engage in an otherwise prohibited activity if the activity is permitted by a recovery strategy and the person is authorized under an Act of Parliament to engage in that activity. Section 83(4) can be used as an exemption to allow activities, which have been determined to not jeopardize the survival or recovery of the species.

Continuation of Limited Commercial and Sport Baitfish Harvesting:
Commercial baitfish harvesting is regulated by the provinces of Ontario and Quebec and the Channel Darter is not a legal baitfish. It is regulated under the *Fisheries Act* through the Ontario Fisheries Regulations and the Quebec Fishery Regulation. As outlined in Section 4.2 (Description of threats) under *Incidental Harvest*, commercial and sport baitfish harvesting activities are unlikely to affect Channel Darter populations and have been determined to be eligible for an exemption as per s.83(4). The management of Channel Darter recovery could include limited fishing mortality as the threat to Channel Darter by baitfish harvest is low. Consequently, under SARA s. 83.(4), this recovery strategy allows baitfish harvesters to engage

in the activities of commercial and sport fishing for baitfish that incidentally kill, harm, harass, capture or take Channel Darter, subject to the following two conditions:

1. The fishing activities are conducted under licenses issued under the Ontario Fishery Regulations 2007, or the Quebec Fishery Regulations 1990;
2. All Channel Darter caught are to be released immediately and returned to the waters from where taken in a manner that causes them the least harm.

10. STATEMENT ON ACTION PLANS

Action plans are documents that describe the implementation of recovery strategies. Under SARA, an action plan provides the detailed recovery planning that supports the strategic direction set out in the recovery strategy for the species. The plan outlines what needs to be done to achieve the population and distribution objectives identified in the recovery strategy, including the measures to be taken to address the threats and monitor the recovery of the species, as well as the measures to protect critical habitat. Action plans offer an opportunity to involve many interests in working together to find creative solutions to recovery challenges. As such, they may also include recommendations on individuals and groups that should be involved in carrying out the proposed activities.

One or more action plans relating to this recovery strategy will be produced within five years of the final recovery strategy being posted on the public registry.

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APPENDIX A: EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

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 strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

The recovery strategy will clearly benefit the environment by promoting the recovery of the Channel Darter. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant environmental effects.

APPENDIX B: RECORD OF COOPERATION AND CONSULTATION

The proposed recovery strategy for Channel Darter was prepared by Fisheries and Oceans Canada (DFO) with input from representatives of the Ministère des Ressources naturelles et de la Faune du Québec (MRNF), Société de conservation et d'aménagement du bassin de la rivière Châteauguay, Hydro-Québec, Ambioterra, Comité de concertation et de valorisation du bassin de la rivière Richelieu, Parks Canada Agency (PCA), Ontario Ministry of Natural Resources (OMNR), Lower Trent Conservation Authority, Port and Associates and the Quinte Conservation Authority. Members of the Bay of Quinte Remedial Action Plan, Royal Ontario Museum and Essex Region Conservation Authority were included on Recovery Team distribution lists

DFO has attempted to engage potentially affected Aboriginal communities in Ontario and Quebec during the development of this proposed recovery strategy. During the listing process in 2004 and 2005, information packages were sent to the Mohawks of the Bay of Quinte, Alderville First Nation, Mississaugas of the Credit, Six Nations of the Grand River, Curve Lake First Nation, Chippewas of the Thames First Nation, Walpole Island First Nation among others in Ontario, and Abénaquis d'Odonak et de Wôlinak and Mohawks of Kanesatake in Quebec. The following Aboriginal organizations also received information packages: Southern First Nation Secretariat, Ogemawahj Tribal Council, Toronto Metis Council, and Assembly of First Nations. Members of these communities may have travelled or harvested fishes from the waters where the Channel Darter was historically found. Follow-up telephone calls were made to many community offices to ensure that packages were received and to ask if they would like to schedule a meeting to learn more about species at risk in general and the proposed recovery strategy in particular.

In March 2011, DFO conducted community consultation sessions with Walpole Island First Nation (in coordination with Environment Canada and PCA) on several recovery documents, including the present recovery strategy. Feedback and written comments were received for consideration.

Although many Aboriginal and Métis communities already received a letter from DFO (in November 2007) regarding a recovery strategy for the Channel Darter, given the passage of time and the addition of critical habitat to the recovery strategy, a new letter will be sent to First Nations to invite their comments on the updated strategy. This letter will be sent in advance of the proposed recovery strategy being posted on the SARA Registry.

APPENDIX C: RECOVERY TEAM MEMBERS

Ontario's Freshwater Fish Recovery Team

The following members of the Ontario Freshwater Fish Recovery Team were involved in the development of the recovery strategy for the Channel Darter:

Tracy Allison	Fisheries and Oceans Canada
Jeff Borisko	Bay of Quinte Remedial Action Plan (distribution list only)
Amy Boyko	Fisheries and Oceans Canada
Beth Cockburn	Parks Canada Agency (Trent-Severn Waterway)
George Coker	Portt and Associates
Brian Craig	Parks Canada Agency (distribution list only)
Dr. Alan Dextrase	Ontario Ministry of Natural Resources
Melissa Laplante	Ontario Ministry of Natural Resources
Erling Holm	Royal Ontario Museum (distribution list only)
Dr. Nicholas E. Mandrak	Fisheries and Oceans Canada
Vicki M^{c}Kay	Parks Canada Agency (distribution list only)
Brad McNevin	Quinte Conservation Authority
Mike Nelson	Essex Region Conservation Authority (distribution list only)
Sharlene Polman	Lower Trent Conservation Authority
Dr. Scott Reid	Ontario Ministry of Natural Resources
Karen Soper	Ontario Ministry of Natural Resources
Shawn Staton	Fisheries and Oceans Canada

Quebec's Cyprinidae and Small Percidae Recovery Team

The following members of Quebec's Cyprinidae and Small Percidae Recovery Team were involved in the development of the recovery strategy for Channel Darter:

Jean-Philippe Détolle (President)	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)
Jacinthe Beauchamp	Fisheries and Oceans Canada
Marthe Bérubé	Fisheries and Oceans Canada
Julie Boucher	Ministère des Ressources naturelles et de la Faune du Québec
Jean Caumartin	Hydro-Québec – Division Environnement / Production
Chantal Côté	Ministère des Ressources naturelles et de la Faune du Québec
Priscilla Gareau	Ambioterra
Henri Fournier	Ministère des Ressources naturelles et de la Faune du Québec
Steve Garceau	Ministère des Ressources naturelles et de la Faune du Québec
Daniel Hardy	Fisheries and Oceans Canada
Réjean Malo	Parks Canada Agency
Marie-Pierre Maurice/ Marcel Cormiré	Comité de concertation et de valorisation du bassin de la rivière Richelieu (COVABAR)

APPENDIX D: CHANNEL DARTER SITES IN QUEBEC

Channel Darter observation sites in Quebec in the St. Lawrence River and in four hydrographic regions. X = occurrence; O = absent despite inventories directed on the species; (xxxx) = Year of capture; FMN = data from the St. Lawrence Fish Monitoring Network.

Waterway	Years when Channel Darter presence was confirmed			
	1930-1949	1950-1969	1970-1989	1990-2009
St. Lawrence River				
Lake St. François[FNM]				O (1996[FNM], 2004[FNM]) X (2009[FNM])
Pointe du Buisson	X (1942)			
Lake St. Louis[FNM]	X (1941)			O (1997[FNM], 2005[FNM]) X (1999)
Lachine Rapids	X (1941)			
Montréal-Sorel reach[FNM]				O (2001[FNM])
Lake St. Pierre[FNM]				X (1995[FNM], 2002[FNM], 2006, 2007[FNM])
Lake St. Pierre Archipelago[FNM]				O (1995[FNM]) X (2001, 2003[FNM])
Port St. François			X (1972)	O (1995)
Bécancour-Batiscan reach[FNM]				X (1996[FNM]) O (2001[FNM], 2008 [FNM])
Grondines-Donnacona reach[FNM]				X (1997[FNM]) X (2006[FNM])
Ottawa and Montreal				
Blanche River				X (1995, 2000)
Calumet Creek				X (2006)
Gatineau River				X (1999, 2002, 2003 2004)
la Petite Nation River		X (1964)		X (1995, 2000)
Ottawa River			X	X (2006)
de Pointe-au-Chêne Creek				X (2006, 2007)
Rouge River				X (1995, 2006)
Saumon River (or Kinonge River)				X (1995, 2007)
Northwest St. Lawrence				
Batiscan River			X (1973)	
Bayonne River			X (1971)	X (1996)
Chicot River	X (1941)		X (1971)	O (1996)
L'Assomption River			X (1981, 1987)	X (1991, 2002, 2009)
Jacques-Cartier River				X (2003)
Ouareau River			X (1981)	X (1990, 2002, 2009)

Waterway	Years when Channel Darter presence was confirmed			
	1930-1949	1950-1969	1970-1989	1990-2009
Sainte-Anne River				X (2002)
Southwest St. Lawrence				
Allen Creek			X (1976)	
aux Bleuets River			X (1977)	O (1992, 1996)
aux Saumons River (Richmond)	X (1932)			
Châteauguay River	X (1941, 1942, 1944)		X (1976, 1987)	X (2006)
des Anglais River			X (1976)	X (1996, 2006, 2009)
Lake Elgin discharge (or Maskinongé River)	X (1934)			O (1996)
Niger River	X (1931)			O (1996)
Noire River		X (1964)	X (1987)	X (1995)
aux Outardes Est River			X (1976)	X (1996, 2002, 2006)
Richelieu River				X (1991, 1993, 1994, 1997, 1999, 2001, 2003, 2006, 2009)
Saint-François River	X (1944)			X (1998, 2003, 2008, 2009)
Trout River (or Truite River)	X (1941)		X (1976)	X (1996, 2006)
Yamaska River		X (1969)	X (1971)	X (1995)
Southeast St. Lawrence				
Bécancour River		X (1964)		
aux Orignaux River			X (1975)	
aux Ormes River	X (1941)			
Bras St. Nicolas River			X (1975, 1980)	X (1997)
du Chêne River			X (1971)	X (2007)
du Sud River	X (1941)	X (1964)		O (1996) X (2005)
Gentilly River	X (1941)			
Henri River			X (1971)	
Nicolet River	X (1944)			

APPENDIX E: NEW CHANNEL DARTER SITES IN QUEBEC FOLLOWING THE PUBLICATION OF THE 2002 COSEWIC REPORT

Year	Site
1999	Gatineau River (Comtois et al. 2004); Richelieu (N. Vachon, pers. comm.)
2001	Richelieu River (Massé and Bilodeau 2003)
2002	L'Assomption and Oureau rivers (CARA 2002); aux Outardes Est River (M. Letendre, unpubl. data); Sainte-Anne River (M. Arvisais, pers. comm.); Lake St. Pierre (FMN)
2003	Saint-François River between Bromptonville and Windsor (M. Letendre, pers. comm.); Gatineau and Richelieu rivers (Boucher et al. 2009); Jacques-Cartier River (M. Arvisais, pers. comm.); Lake St. Pierre Archipelago (FMN)
2004:	Gatineau River in the Rapides-Farmer area (Lemieux et al. 2005)
2005:	Du Sud River downstream of the Arthurville powerplant at Saint-Raphaël (P.Y. Collin, pers. comm.)
2006	Châteauguay, aux Outardes Est, des Anglais and Trout rivers (Garceau et al. 2007); Ottawa and Rouge rivers, as well as de Pointe-au-Chêne and Calumet creeks (Pariseau and Fournier 2007); Grondines-Donnaconna (FNM)
2007	Saumon (Kinonge) rivers and de Pointe-au-Chêne Creek (H. Fournier, pers. comm.); Lake St. Pierre (FMN)
2008	Saint-François River near East-Angus, upstream and downstream of the former Worby Dam (S. Garceau, pers. comm.)
2009	L'Assomption and Ouareau rivers (Bourgeois et al. 2010); des Anglais River (Ambioterra 2010); Saint-François River between Bromptonville and Windsor (S. Garceau, pers. comm.); Lake St. François (FNM)

FMN = data from the St. Lawrence Fish Monitoring Network

APPENDIX F: RECENT FISH SURVEYS (SINCE 2000) IN AREAS OF CHANNEL DARTER OCCURRENCE (ONTARIO)

Waterbody/general area	Survey description (years of survey effort)
Moira (including the Black and Skootamatta rivers), Salmon and Napanee rivers	• Targeted Channel Darter survey, Trent University, OMNR (2001, 2003)[a,b]
Little Rideau Creek	• Sampling for Cutlip Minnow, OMNR (2004)[b]
Trent River	• Targeted Channel Darter sampling, Trent University/C. Portt and Associates (2002-2008)[b]
South Nation River	• Species at risk sampling, OMNR (2005)[b]
Lake Erie	• Targeted Channel Darter surveys, OMNR/DFO (2005, 2006)[a] • Lake Erie Biodiversity Project, OMNR (2007)[a,c]
Lake St. Clair	• Lake Erie Management Unit seining project, OMNR (2005, 2007)[a]
Long Point Bay (Lake Erie)	• 3 year assessment of Inner Long Point Bay, OMNR (2007-2009)[a,c]

a – seine net; b – backpack electrofishing; c – boat electrofishing