

# Recovery Strategy and Action Plan for the Channel Darter (*Percina copelandi*) in Canada (Lake Erie and Lake Ontario populations)

## Channel Darter



2025

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« Programme de rétablissement et plan d'action pour le fouille-roche gris (*Percina copelandi*) au Canada (populations du lac Érié et du lac Ontario) [version proposée] »

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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 the 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 a recovery strategy and action plan for species listed as extirpated, endangered, or threatened and are required to report on progress 5 years after the publication of the final document on the [Species at Risk Public Registry](#).

The Minister of Fisheries and Oceans and the Minister responsible for the Parks Canada Agency are the competent ministers under SARA for the Channel Darter (Lake Erie and Lake Ontario populations). Fisheries and Oceans Canada (DFO) prepared this recovery strategy and action plan in cooperation with Parks Canada (PC), as per sections 37 and 47 of SARA. In preparing this recovery strategy and action plan, the competent ministers have considered, as per section 38 of SARA, the commitment of the Government of Canada to conserving biological diversity and to the principle that, if there are threats of serious or irreversible damage to the listed species, cost-effective measures to prevent the reduction or loss of the species should not be postponed for a lack of full scientific certainty. To the extent possible, this recovery strategy and action plan has been prepared in cooperation with the Ontario Ministry of Natural Resources and Forestry, the Ministry of the Environment, Conservation and Parks, Environment and Climate Change Canada, and PC, as per sections 39(1) and 48(1) of SARA.

This document has been prepared to meet the requirements under SARA of both a recovery strategy and an action plan. As such, it provides both the strategic direction for the recovery of the species, including the population and distribution objectives for the species, as well as the more detailed recovery measures to support this strategic direction, outlining what is required to achieve the objectives. SARA requires that an action plan also include an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation. It is important to note that the setting of population and distribution objectives and the identification of critical habitat are science-based exercises and socio-economic factors were not considered in their development. The socio-economic evaluation only applies to the more detailed recovery measures. This recovery strategy and action plan is considered part of a series of documents that are linked and should be taken into consideration together, along with the COSEWIC Status Report and reports emanating from the Recovery Potential Assessment.

As stated in the preamble to SARA, 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 recovery strategy and action plan and will not be achieved by DFO and PC, or any other jurisdiction, alone. The cost of conserving species at risk is shared amongst different constituencies. All Canadians are invited to join in supporting and implementing this recovery strategy and action plan for the benefit of the Channel Darter (Lake Erie and Lake Ontario populations) and Canadian society as a whole.

This recovery strategy and action plan may be followed by further action plans that will provide additional information on recovery measures to be taken by DFO, PC, and other jurisdictions, and/or organizations involved in the conservation of the species. Implementation of this recovery strategy and action plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

## **Acknowledgments**

This recovery strategy and action plan was prepared by Joshua A. Stacey, Amy L. Boyko, and Peter L. Jarvis of DFO. To the extent possible, this recovery strategy and action plan has been prepared with inputs from the Ontario Ministry of Natural Resources and Forestry; the Ministry of the Environment, Conservation and Parks; Environment and Climate Change Canada; and Parks Canada.

## Executive summary

The Channel Darter was originally listed as threatened under the *Species at Risk Act* (SARA) in 2006. This recovery strategy and action plan is an update of the 2013 Channel Darter recovery strategy (DFO 2013). In 2016, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) separated the species into 3 designatable units (DUs): Lake Erie populations (DU 1); Lake Ontario populations (DU 2), both of which were assessed as endangered; and St. Lawrence populations (DU 3), which were assessed as special concern. The COSEWIC designation for DUs 1 and 2 was based on the species' restricted distribution and apparent extirpation from some historical locations, as well as past and continuing declines. Subsequently, the Channel Darter populations in Lake Erie and Lake Ontario were listed as endangered, and the St. Lawrence populations were listed as special concern under SARA in 2019. This recovery strategy and action plan is considered 1 in a series of documents for the Lake Erie and Lake Ontario populations (DUs 1 and 2) of this species that are linked and should be taken into consideration together, including the COSEWIC Status Report (2016) and the Recovery Potential Assessment (RPA) (DFO 2020). Recovery has been determined to be biologically and technically feasible. A separate management plan is being developed for the St. Lawrence populations (DU 3).

The Channel Darter is a small (typically in the range of 3 to 7 cm) percid (of the perch family, Percidae), which inhabits the benthic zone of lakes and rivers. The distribution of Channel Darter is widespread but extremely disjunct, 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 in the St. Clair River, along the shoreline of Lake St. Clair and Lake Erie, in the Detroit River, in the Trent, Salmon, and Moira River watersheds (tributaries of the Bay of Quinte, Lake Ontario), and in the Ottawa River. In Ontario, the Channel Darter inhabits large lakes and medium- to large-sized rivers with moderate currents. In Quebec, Channel Darter are in DU 3, which is not covered by this recovery strategy and action plan.

The main threats facing the species are described in section 5 and include invasive species and diseases; shoreline modifications; altered flow regimes; barriers to movement; nutrient loading; contaminants and toxic substances; turbidity and sediment loading; and incidental harvest. Climate change may also present a threat to Channel Darter populations in the future.

The population and distribution objectives (section 6) for the Channel Darter in DUs 1 and 2 are to ensure the survival of self-sustaining populations in:

- DU 1: St. Clair River, Lake St. Clair, Detroit River, and along the shorelines of Lake Erie (Western and Central basins); and
- DU 2: Trent and Salmon rivers, and the Moira River system, which includes the Black and Skootamatta rivers.

A description of the broad strategies to be taken to address threats to the species' survival and recovery, as well as research and management approaches needed to meet the population and distribution objectives, are included in section 7.

For the Channel Darter, critical habitat is identified to the extent possible, using the best available information, and provides the functions and features necessary to support the species' life-cycle processes and to achieve the species' population and distribution objectives (section 8). This recovery strategy and action plan identifies critical habitat for the Channel Darter in

DU 1 in the St. Clair River, the Detroit River, and the western (Point Pelee area) and central basins (Rondeau Bay) of Lake Erie. In DU 2, critical habitat has been identified in the Trent and Salmon rivers, and the Moira River system, which includes the Skootamatta and Black rivers. It is anticipated that the protection of the species' critical habitat will be accomplished through a SARA Critical Habitat Order made under subsections 58(4) and (5), which will invoke the prohibition in subsection 58(1) against the destruction of the identified critical habitat (section 8.3).

An evaluation of the socio-economic costs of this recovery strategy and action plan, and the benefits to be derived from its implementation, are provided in section 9.

## Recovery feasibility summary

The recovery of the Channel Darter is believed to be biologically and technically feasible. Recovery feasibility is determined according to 4 criteria outlined by the Government of Canada (2009):

1. Are individuals of the wildlife species that are capable of reproduction available now, or in the foreseeable future, to sustain the population or improve its abundance?

Yes. In Lake Erie designatable unit (DU 1), the Channel Darter is found at 6 locations. In Lake Ontario designatable unit (DU 2), the Channel Darter occurs at 3 locations. While spawning does require specific habitat conditions, the species' continued presence at these sites indicates that reproduction has occurred in recent years. Furthermore, Channel Darter in spawning condition have been observed in the Trent River in June 2003 (Reid et al. 2004).

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

Yes. DU 1: It is likely that suitable habitat is limited in availability due to human land use practices, including agricultural and urban development, and shoreline modifications, which have led to sedimentation and contamination in many areas where the Channel Darter occurs; however, regulatory and stewardship activities aimed at improving water quality and reducing the threats that have driven declines in Channel Darter are underway. Ideally, these measures should lead to increases in available habitat in the future, although there is little that can be done to reverse the impacts of established invasive species (for example, Round Goby).

DU 2: Sufficient suitable habitat is available for the Channel Darter in multiple locations (for example, 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 (for example, 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?

Yes. Many significant threats to the 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. One exception to be noted: there is little that can be done to reverse the impacts of established invasive species (for example, Round Goby).

4. Do recovery techniques exist to achieve the population and distribution objectives or can they be developed within a reasonable time frame?

Yes. Numerous techniques are available to improve water quality in lakes and rivers. Watershed-based stewardship activities have been initiated in some areas of Ontario that overlap with the Channel Darter.

Repatriation may be feasible through captive rearing or adult transfers. Although there are no published studies on the husbandry of the Channel Darter, the species has been propagated successfully in captivity (Shute et al. 2000). Additionally, captive rearing and translocations have

been used in the southeastern 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 tanas*) and Fringed Darter (*Etheostoma crossopterum*), have been established through adult transfers (Etnier and Starnes 1993; Poly, 2003).

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## 1. Introduction

The Channel Darter (*Percina copelandi*) was listed as threatened under the *Species at Risk Act* (SARA) in 2006. In 2016, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) separated the species into 3 designatable units (DUs): Lake Erie populations (DU 1); Lake Ontario populations (DU 2), both of which were assessed as endangered; and St. Lawrence populations (DU 3), which was assessed as special concern. The COSEWIC designation for DUs 1 and 2 was based on the species' restricted distribution and apparent extirpation from some historical locations, as well as past and continuing declines. Subsequently, DU 1 and DU 2 were listed as endangered under SARA in 2019, while the St. Lawrence populations were listed as special concern under SARA in the same year. This recovery strategy and action plan is considered 1 in a series of documents for DUs 1 and 2 that are linked and should be taken into consideration together, including the COSEWIC Status Report ([COSEWIC 2016](#)) and the recovery potential assessment (RPA) ([DFO 2020](#)). A separate management plan is being developed for St. Lawrence populations (DU 3).

The recovery strategy portion of the document identifies what needs to be done to arrest or reverse the decline of a species, in addition to providing background information on the species and its threats and critical habitat information. It sets objectives and identifies the main areas of activities to be undertaken, while the action plan portion provides the detailed recovery planning that supports the strategic direction set out in the recovery strategy portion. Action planning for species at risk recovery is an iterative process. The implementation schedule (tables 16 to 18) in this recovery strategy and action plan may be modified in the future, depending on the progression towards recovery.

The RPA is a process undertaken by Fisheries and Oceans Canada (DFO) to provide the information and scientific advice required to implement SARA, relying on the best available scientific information, data analyses and modeling, and expert opinions. The outcome of this process informs many sections of the recovery strategy and action plan. For more detailed information beyond what is presented in this recovery strategy and action plan, refer to the COSEWIC Status Report and the RPA Science Advisory Report.

## 2. COSEWIC species assessment information

**Date of assessment:** November 2016

**Species' common name (population):** Channel Darter - Lake Erie populations (DU 1)

**Scientific name:** *Percina copelandi*

**Status:** Endangered

**Reason(s) for designation:** This small-bodied species occupies nearshore lake and river habitats that are undergoing major shoreline modifications and the negative impact of the invasive Round Goby, having resulted in likely extirpation from large areas of Lake Erie and Lake St. Clair.

**Canadian occurrence:** Ontario

**Status history:** The species was considered a single unit and designated threatened in April 1993. Status re-examined and confirmed in May 2002. When the species was split into separate units in November 2016, the "Lake Erie populations" unit was designated endangered.

**Date of assessment:** November 2016

**Species' common name (population):** Channel Darter - Lake Ontario populations (DU 2)

**Scientific name:** *Percina copelandi*

**Status:** Endangered

**Reason(s) for designation:** This small-bodied species is limited to 3 small watersheds. The primary threat is the invasive Round Goby, which is now found throughout the Trent River and has resulted in declines in the abundance of this population. For the time being, populations along the Moira and Salmon rivers are largely unaffected by Round Goby. However, introductions upstream of dams via bait bucket transfers are considered likely.

**Canadian occurrence:** Ontario

**Status history:** The species was considered a single unit and designated threatened in April 1993. Status re-examined and confirmed in May 2002. When the species was split into separate units in November 2016, the "Lake Ontario populations" unit was designated endangered.

### 3. Species status information

**Table 1. Summary of existing protection or other status designations assigned to the Channel Darter Lake Erie (designatable unit [DU] 1) and Lake Ontario (DU 2) populations.**

Jurisdiction	Authority/organization	Year(s) assessed and/or listed	Status/description	Designation level
Ontario	COSSARO <sup>1</sup>	2017	Special concern	Population
Ontario	Ontario's <i>Endangered Species Act, 2007</i>	2018	Special concern	Population
Canada (Designatable Units [DUs] 1 & 2)	Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	2016	Endangered	Population
Canada (DU 3)	COSEWIC	2016	Special concern	Population
Canada (DUs 1 & 2)	<i>Species at Risk Act (SARA)</i>	2019	Endangered	Population
Canada (DU 3)	SARA	2019	Special concern	Population
Canada	NatureServe	2017	N3: vulnerable	Population
United States <sup>2</sup>	NatureServe	1996	N4: apparently secure	Population
International	NatureServe	2011	G4: apparently secure	Species
International	IUCN <sup>3</sup>	2012	Least concern	Species

Upon listing as an endangered species, the Lake Erie and Lake Ontario Channel Darter populations became protected wherever the species is found under section 32 of SARA:

“No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species.” [subsection 32(1)]

“No person shall possess, collect, buy, sell or trade an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species, or any part or derivative of such an individual.” [subsection 32(2)]

<sup>1</sup> COSSARO (Committee on the Status of Species at Risk in Ontario).

<sup>2</sup> Refer to NatureServe 2023 for state specific designations.

<sup>3</sup> IUCN (International Union for Conservation of Nature).

Under section 73 of SARA, the competent ministers may enter into an agreement or issue a permit authorizing a person to engage in an activity affecting a listed wildlife species, any part of its critical habitat, or its residences.

## 4. Species information

### 4.1 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. Reid (2019) recorded a range of 52 to 70 mm total length for 119 Channel Darter captured in the Trent River. The species 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 onto the snout; fins are clear or only lightly speckled and the ventral half of the body is whitish. Males in breeding conditions typically display a darker colouration, particularly around the head (Scott and Crossman 1973; Goodchild 1994).

Species identification can be challenging as there is an overlap in Channel Darter distribution with similar darters. The Channel Darter resembles the Johnny Darter (*Etheostoma nigrum*), Tessellated Darter (*Etheostoma olmstedti*), and River Darter (*Percina shumardi*) (Goodchild 1994), all of which have distributions that overlap with that of the Channel Darter in Canada. An identification key for distinguishing the Channel Darter from other darters has been developed by Massé and Bilodeau (2003). Briefly, all Ontario darters, with the exception of the Channel Darter, Johnny Darter, and Tessellated Darter, lack small M-, V-, W-, or X-shaped marks (Holm et al. 2009). The Channel Darter has 2 anal spines compared to only 1 for Johnny Darter and Tessellated Darter (Goodchild 1994). The Channel Darter has dark pigmentation at the base and side of the spiny dorsal fin, while the River Darter has a small anterior black spot and a large posterior black spot on the dorsal fin (Goodchild 1994). Species identification at the juvenile stage is more challenging.

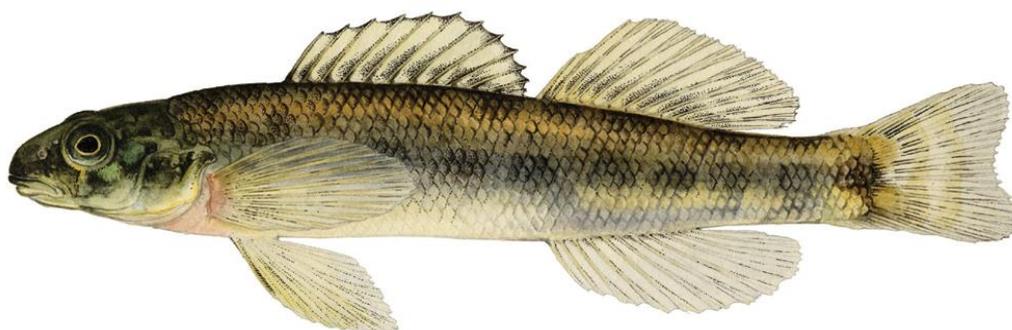


Figure 1. Channel Darter (*Percina copelandi*). Illustration: © Ellen Edmonson (New York State Department of Environmental Conservation).

### 4.2 Population abundance and distribution

**Global distribution (figure 2):** The Channel Darter has a wide but disjunct distribution across central North America; 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 states within the United States of America (U.S.): Arkansas, Indiana, Kansas, Kentucky, Louisiana, Michigan, Missouri, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Vermont, Virginia, and West Virginia. In Canada, the Channel Darter is found in both Ontario and Quebec.

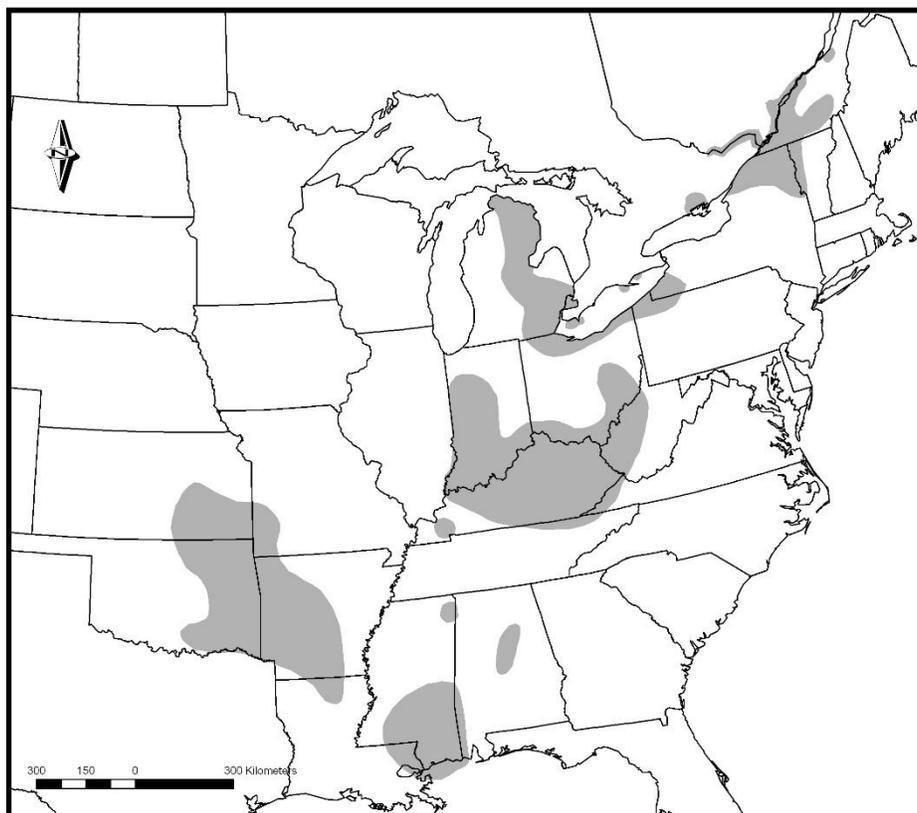


Figure 2. Global distribution of the Channel Darter (adapted from Page and Burr 1991).

**Canadian distribution:** In Canada, the Channel Darter has been subdivided into 3 DUs: Lake Erie populations (DU 1), Lake Ontario populations (DU 2), and St. Lawrence populations (DU 3) (see COSEWIC 2016). The separation of Canadian populations was based principally on their geographic isolation, and genetic factors. The contents of this recovery strategy and action plan are restricted to DU 1 and DU 2, both of which reside within Ontario, but exclude Ontario-based populations found within the Ottawa River watershed, which are part of DU 3.

**Ontario distribution and population abundance:** In Ontario, the species is found in Huron-Erie Corridor, including the St. Clair River, Lake St. Clair, and the Detroit River, as well as Lake Erie. All of these locations are grouped into DU 1. The Channel Darter also occurs in tributaries of Lake Ontario (DU 2). Recent search effort has been conducted in nearshore areas of Lake Huron; however, these surveys have not led to the detection of Channel Darter (LeBaron et al. in press). The species also occurs outside of DUs 1 and 2 in Little Rideau Creek (a tributary of the Ottawa River) in eastern Ontario (included in DU 3). Overall, the Channel Darter is believed to have always been rare in Canada, as it is at the northern edge of its range (Goodchild 1994).

Limited information is available concerning the size of Channel Darter populations in Ontario. Many of the studies that have detected Channel Darter were not targeting the species.

Furthermore, many studies that did focus on Channel Darter were not implemented with the rigor required to estimate population sizes but rather were aimed at determining the presence or absence of the species in a given location. Where quantitative data or catch per unit effort (CPUE) are available, comparison among populations is difficult due to a lack of consistency in gear types used during the surveys (see COSEWIC 2016).

## **DU 1 Lake Erie populations**

Within DU 1 the Channel Darter is currently known to occur in the St. Clair River, Lake St. Clair, the Detroit River, Lake Erie western basin (Point Pelee area), and Rondeau Bay, and Port Burwell in the central basin (figure 3). Refer to table 2 and figure 3 for more information on specific locations where the species has been detected and its overall distribution in DU 1. Furthermore, see COSEWIC (2016) and Andrews and Drake (2020) for further details on the sampling history in DU 1.

**Detroit River:** the Channel Darter was first collected from the Detroit River in 1940 (COSEWIC 2002) near the confluence with Lake Erie (Bar Point, Amhurstburg/Bois Blanc Island area). Between 2009 and 2013 the species has been detected at 4 other locations throughout the Detroit River (Pêche Island, Windsor/Belle Isle area, West Windsor area, and Fighting Island) (table 2, figure 3).

**St. Clair River:** The St. Clair River population has been poorly studied. The species was first collected from the St. Clair River in 1996 in the South Channel of Walpole Island; since then, the species has been captured in 2013, 2014, and 2019 including 1 location near Brander Park upstream of Walpole Island, and 3 locations near Sarnia (table 2, figure 3).

**Lake St. Clair:** the Channel Darter was detected in Lake St. Clair as early as 1980 along the south shore near the mouth of Pike Creek. Furthermore, the species was captured at several more locations along the south and east shores between 1990 and 1996 including the Belle and Puce rivers, Laforet Beach, and Mitchell's Bay. Targeted sampling during the 2000s (2004 to 2005 and 2007 to 2010) failed to detect the species; however, 1 individual was caught in 2012 at Stoney Point during surveys for Northern Madtom (*Noturus stigmosus*) (table 2, figure 3).

**Western Lake Erie:** Historically, the Channel Darter occurred at Holiday Beach, Pelee Island, and the Point Pelee area. The Channel Darter has not been detected at Holiday Beach or Pelee Island since 1997 and 1984, respectively, suggesting that these populations may be extirpated (COSEWIC 2016). The Channel Darter was last detected in the Point Pelee area in 2010 (COSEWIC 2016).

**Central Lake Erie:** Historical records of Channel Darter date back to the early 1950s where the species was captured just outside of Rondeau Bay at Erieau (Bouvier and Mandrak 2010). The species was thought to be extirpated from the area until 27 individuals were collected by the Ontario Ministry of Natural Resources and Forestry (OMNRF) in Rondeau Bay in the vicinity of Erieau in 2018, confirming that the species still occurs at this location (LeBaron et al. 2020). The Channel Darter was first collected in the Port Burwell area, near the mouth of Big Otter Creek, in 1950 and 1951. The species was not detected at this location again until 2017 when a single individual was caught in Big Otter Creek just upstream of the mouth.

**Eastern Lake Erie:** Historically the species was detected at Port Dover in 1946 and 1947. The species has not been detected at this location since the 1940s and is presumed extirpated (DFO 2020).

**Table 2. Locations and waterbodies where the Channel Darter has been detected in designatable unit 1 Lake Erie Populations, both historically and currently, the years the species was detected, and the number captured in that year when available.**

Waterbody description	Location description	Drainage/basin	Years detected (# captured)
St. Clair River	Sarnia/Point Edward area	Huron-Erie Corridor	2014 (1), and 2019 (7)
St. Clair River	Between Froomfield and Sarnia	Huron-Erie Corridor	2014 (8)
St. Clair River	Stag Island area	Huron-Erie Corridor	2013 (1), 2014 (1)
St. Clair River	Brander Park area	Huron-Erie Corridor	2013 (1)
St. Clair River	Walpole Island/South Channel	Huron-Erie Corridor	1996 (65)
Lake St. Clair	Mitchell's Bay	Huron-Erie Corridor	1990 (n/a), 1991 (n/a),
Lake St. Clair	Laforet Beach	Huron-Erie Corridor	1990 (n/a) and 1996 (n/a)
Lake St. Clair	Stoney Point	Huron-Erie Corridor	2012 (1)
Lake St. Clair	Belle River area	Huron-Erie Corridor	1991 (n/a)
Lake St. Clair	Puce River area	Huron-Erie Corridor	1991 (n/a)
Lake St. Clair	Pike Creek	Huron-Erie Corridor	1980 (n/a)
Detroit River	Peche Island area	Huron-Erie Corridor	2009 (1), 2010 (28), 2011 (13)
Detroit River	Windsor/Belle Isle area	Huron-Erie Corridor	2010 (2), 2011 (20), 2013 (2)
Detroit River	West Windsor area	Huron-Erie Corridor	2013 (7)
Detroit River	Fighting Island area	Huron-Erie Corridor	2011 (37), 2012 (2), 2013 (23)
Detroit River	Amhurstburg/Bois Blanc Island area	Huron-Erie Corridor	1940 (n/a), 1997 (n/a), 2011 (7)
Detroit River	Bar Point	Huron-Erie Corridor	1940 (n/a)
Lake Erie	Holiday Beach	Lake Erie Western Basin	1997 (n/a)
Lake Erie	Point Pelee	Lake Erie Western Basin	1953 (n/a), 2005/2006 (49) 2009 (1), 2010 (>50)
Lake Erie	Pelee Island	Lake Erie Western Basin	1928 (34), 1984 (n/a)
Lake Erie	Erieau – Lake Ontario coast	Lake Erie Central Basin	1951 (n/a), 1952 (n/a), 1953 (n/a)
Lake Erie	Rondeau Bay	Lake Erie Central Basin	2018 (27)
Lake Erie	Port Burwell/Big Otter Creek	Lake Erie Central Basin	1950 (n/a), 1951 (n/a) 2017 (1)
Lake Erie	Port Dover	Lake Erie Eastern Basin	1946 (n/a), 1947 (n/a)

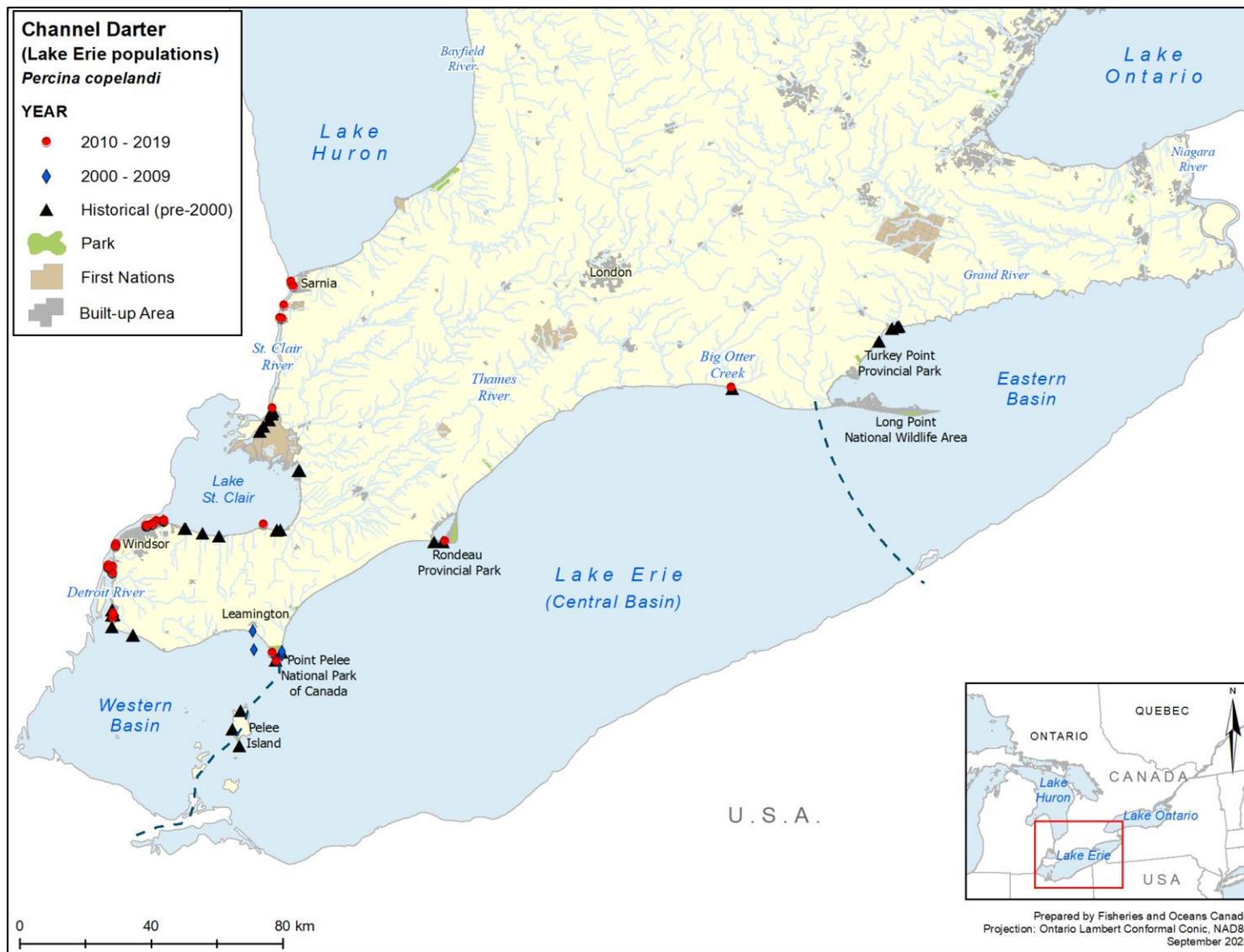


Figure 3. Distribution of the Channel Darter in designatable unit 1.

## DU 2 Lake Ontario Populations

The Channel Darter is currently known to occur in 3 watersheds in DU 2 including the Trent River (from Glen Ross to the town of Trenton), the Moira River system (including tributaries Skootamatta and Black rivers), and the Salmon River (from Kingsford to Shannonville) (figure 4). Based on COSEWIC criterion for determining the number of locations, and considering the threat of Round Goby only where it is currently distributed and not where it may spread in the future, there are a total of 4 locations: 1 in the Trent River; the Moira River and the Skootamatta and Black rivers represent 1 location; and the Salmon River represents 2 locations. The only known possible extirpation that has occurred within DU 2 is in an unnamed creek near Moira Lake (COSEWIC 2016). See COSEWIC (2016) and Andrews and Drake (2020) for further details on the sampling history in DU 2.

**Trent River:** The Channel Darter is known from the Trent River since 1976 when the species was detected downstream of the Sonoco Dam adjacent to the Glen Miller Generating Station, and in the Glen Ross Area. Since that time, the species has also been detected in the Trenton Area downstream of the Lock 1 Dam, Downstream of Lock 5 and the Frankfort Generating Station, and the Frankfort area downstream of Sills Island Generating Station (table 3, figure 4). The Ontario Ministry of Northern Development Mines Natural Resources and Forestry (NDMNRF) has regularly conducted targeted surveys throughout the Trent River since 2001, leading to numerous detections. For example, 1,280 Channel Darter were captured during electrofishing surveys targeting the species between 2001 and 2018 (LeBaron and Reid 2021).

**Salmon River:** The Channel Darter was discovered in the Salmon River in 2003 (Reid et al. 2005), at multiple locations throughout the watershed, including the Shannonville area, Milltown area, where the Macdonald Cartier Freeway (401) crosses the river, Lonsdale area, near Kingsford Conservation area, Kingsford, and in a stretch of river between Kingsford and Forest Mills (table 3, figure 4). Since that time, the species has been detected through surveys conducted in 2007, 2008, 2010, 2011, 2014, and 2021. The most recent sampling conducted in 2021 led to the detection of 35 Channel Darter at 5 sites.

**Moira River Watershed:** The Channel Darter was first detected in the Moira River system in 1948 in a small tributary that flows into Moira Lake; however, the species has never been detected in this tributary since that time (DFO 2020). In 1974, the species was detected at 3 locations on the Skootomatta River, a tributary to the Moira River. Between 1999 and 2019 the Channel Darter was captured at multiple areas throughout the watershed, including Bellville, Plainville, Chisholm Mills, Lost Channel, Tweed, Bronson Rapids, near the Highway 7 crossing, the Skootomatta River, and the Black River (tributary to the Moira River). The most recent sampling surveys were conducted in 2013 when 25 individuals were captured, and 2019 when 4 individuals were captured (table 3, figure 4).

**Table 3. Locations and waterbodies where the Channel Darter has been detected in designatable unit 2 Lake Ontario Populations, both historically and currently, the years the species was detected, and the number captured in that year when available.**

Waterbody description	Location description	Drainage/basin	Years detected (# captured)
Trent River	Downstream of Lock 1 Dam, Trenton area	Lake Ontario	1998 (n/a), 2001 (37), 2010 (2), 2011 (3), 2013 (5), 2014 (1), 2015 (6), 2016 (10), 2021 (2)
Trent River	Downstream of the Glen Miller Generating Station	Lake Ontario	1976 (n/a), 2001 (2), 2003 (27), 2008 (n/a), 2009 (144), 2010 (87), 2011 (46), 2012 (33), 2013 (60), 2014 (115), 2015 (8), 2016 (42), 2017 (56), 2021 (18)
Trent River	Downstream of Lock 5 and Frankfort Generating Station	Lake Ontario	2009 (28), 2010 (41), 2011 (15), 2012 (8), 2013 (88), 2014 (2), 2015 (21), 2016 (17), 2017 (2), 2021 (1)
Trent River	Frankfort area downstream of Sills Island Generating Station	Lake Ontario	2009 (37), 2010 (63), 2011 (7), 2012 (22), 2013 (48), 2014 (9), 2015 (32), 2016 (8), 2017 (9), 2021 (2)
Trent River	Glen Ross area	Lake Ontario	1976 (n/a), 1997 (n/a), 2001 (2), 2009 (18), 2010 (63), 2011 (95), 2012 (1), 2013 (63), 2014 (3), 2015 (29), 2016 (2), 2017 (12), 2021 (3)
Moira River	Bellville area	Lake Ontario	2003 (n/a), 2010 (n/a), 2011 (n/a), 2013 (7), 2019 (3)
Moira River	Plainfield	Lake Ontario	2011 (n/a)
Moira River	Chisholm Mills	Lake Ontario	2019 (1)
Moira River	Lost Channel	Lake Ontario	2003 (n/a) 2010 (n/a)
Moira River	Tweed	Lake Ontario	2011 (n/a), 2013 (4)
Moira River	Small stream flowing into Moira Lake	Lake Ontario	1948 (2)
Moira River	Bronson's Rapids	Lake Ontario	2003 (n/a)
Moira River	Downstream of Highway 7	Lake Ontario	1999 (n/a), 2001 (n/a), 2003 (n/a), 2010 (n/a), 2013 (14)
Skootamatta River (tributary of the Moira River)	Just upstream of confluence with the Moira River	Lake Ontario	1974 (n/a)
Skootamatta River (tributary of the Moira River)	Downstream of Actinolite	Lake Ontario	1974 (n/a)
Skootamatta River (tributary of the Moira River)	Downstream of confluence with Little Skootamatta River	Lake Ontario	1974 (n/a), 1997 (n/a), 2003 (n/a), 2010 (n/a)
Skootamatta River (tributary of the Moira River)	Flinton Creek confluence	Lake Ontario	1974 (n/a), 2003 (n/a)
Black River (tributary of the Moira River)	Just upstream of the confluence with the Moira River	Lake Ontario	2003 (n/a)
Salmon River	Shannonville area	Lake Ontario	2003 (n/a), 2011 (n/a)
Salmon River	Milltown area	Lake Ontario	2003 (n/a), 2010 (n/a), 2021 (21)

Waterbody description	Location description	Drainage/basin	Years detected (# captured)
Salmon River	Macdonald Cartier Freeway (401) crossing	Lake Ontario	2007 (1), 2008 (n/a)
Salmon River	Wyman Road crossing	Lake Ontario	2021 (1)
Salmon River	Lonsdale area	Lake Ontario	2003 (n/a), 2010 (n/a), 2014 (13), 2021 (6)
Salmon River	Near Kingsford Conservation Area	Lake Ontario	2003 (n/a), 2010 (n/a), 2014 (7), 2021 (7)
Salmon River	Kingsford	Lake Ontario	2003 (n/a), 2014 (10)
Salmon River	Between Kingsford and Forest Mills	Lake Ontario	2003 (n/a)

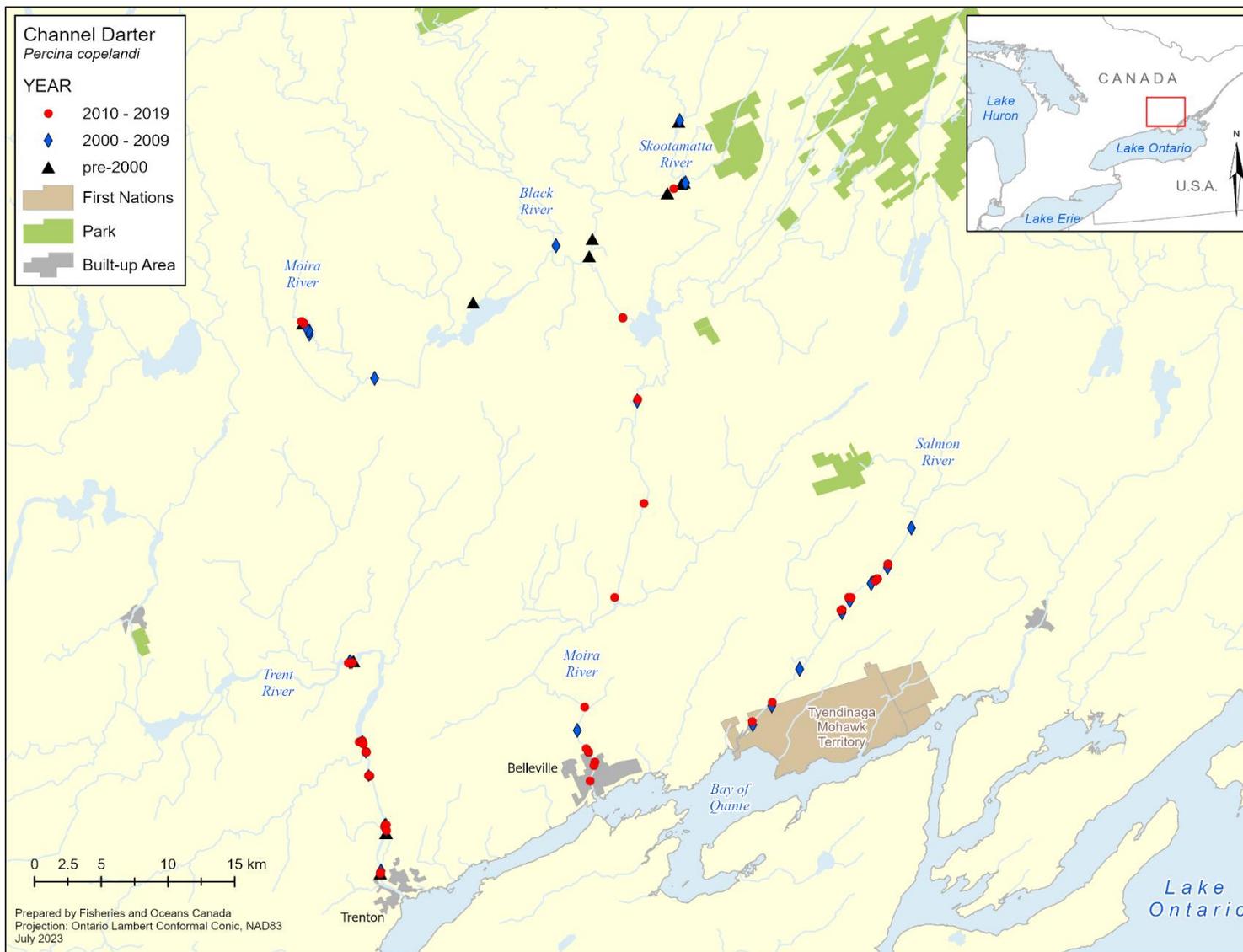


Figure 4. Distribution of the Channel Darter in designatable unit 2.

**Population assessment:** The status of DU 1 and DU 2 Channel Darter populations was assessed by Andrews and Drake (2020) (table 4). An important factor to consider when assessing population status (and population and distribution objectives described in section 6) is the number of populations that may be at a given site, as it is possible that a location may contain more than 1 discrete population. In this case, 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 2015). Populations were ranked with respect to abundance and trajectory and 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 abundance or trajectory. For more information on the following population assessment table, and description of the methodology used to undertake the assessment, refer to Andrews and Drake (2020).

**Table 4. Population status and associated certainty of Channel Darter Lake Erie Populations (designatable unit 1).**

Population	Population status	Certainty
St. Clair River	Poor	Expert Opinion
Lake St. Clair	Poor	Expert Opinion
Detroit River	Poor	Expert Opinion
Lake Erie western basin: Pelee Island, Point Pelee, Holiday Beach	Unknown	Expert Opinion
Lake Erie central/eastern basin: Rondeau Bay, Port Burwell, Port Dover	Poor	Expert Opinion

**Table 5. Population status and associated certainty of Channel Darter Lake Ontario Populations (designatable unit 2).**

Population	Population status	Certainty
Trent River	Fair	CPUE <sup>4</sup> or standardized sampling
Salmon River	Good	CPUE or standardized sampling
Moira system: Moira, Skootamatta and Black rivers	Good	CPUE or standardized sampling

### 4.3 Needs of the Channel Darter

Studies specific to the biological requirements of the Channel Darter are rare; hence, defining the needs of the species relies largely on surveys that have recorded both the Channel Darter and habitat characteristics at point of capture. Populations of the Channel Darter show differences in habitat use between DUs and between lentic and lotic environments. For example, populations within DU 1 are mostly found in lentic environments, primarily beach habitat along the shoreline of Lake Erie and Lake St. Clair; however, within this DU, the species also occurs in the lotic environments in the Huron-Erie Corridor (that is, St. Clair River and Detroit River). In DU 2 (Lake Ontario populations) the species is only known to occur in lotic habitats within tributaries of Eastern Lake Ontario that flow into the Bay of Quinte (Andrews and Drake 2020). Differences can be found in habitat features in lotic environments between DUs 1 and 2, which are described in more detail in table 20. The majority of the information about the Channel Darter habitat is based on the collection of adults during the summer months;

<sup>4</sup> CPUE (Catch Per Unit Effort)

therefore, juvenile habitat use and overwinter habitat use is poorly understood (COSEWIC 2016).

**Spawn to hatch:** In the spring and early summer (June in Ontario), Channel Darter migrate short distances to riffle (riverine) or shoal habitats (lacustrine) with moderate flows and clean coarse bed material such as cobble and gravel, and occasionally larger rocks to spawn (Winn 1953, Lane et al. 1996a, Reid 2004; Lemieux et al. 2005; Garceau et al. 2007; Boucher et al. 2009, Reid et al. 2016). Winn (1958) described spawning in an inland Michigan lake to occur on gravelly shoals, after which Channel Darter migrated to deeper waters. In riverine habitats sufficient flow rates may be essential to spawning success considering that spawning has been observed to cease after an interruption in water flow in a lotic environment (Winn 1953). 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 to 0.60 m/s (Lemieux et al. 2005). Sampling conducted in the Trent River during spawning shows an association with water depths from 0.1 to 0.4 m and water temperatures ranged from 19 to 27°C (Reid et al. 2016). Across Ontario and Quebec, water temperature during spawning has ranged from 14 to 26°C (Comtois et al. 2004, Reid 2004).

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 to 10 eggs in each nest; 350 to 700 eggs are laid in total. 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- to 2-year-old females (Page 1983).

**Juvenile stages:** Little information is available on the habitat needs of juvenile stage Channel Darter. Eggs and larvae have been captured over substrates of cobble, gravel, and sand (Lemieux et al. 2005). Young-of-the-year (YOY) are believed to associate with areas containing gravel and sand (Lane et al. 1996b), while juveniles have been found in backwaters and pools with low flow and some have been captured adjacent to large rivers (Winn 1953).

**Adult:** In Canada, adult Channel Darter are found in 3 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 (for example, CARA 2002, Reid et al. 2005, Garceau et al. 2007). Adult Channel Darter have been found in small to large rivers where the current is moderate, and over gravel or cobble shoals and riffles in large rivers (Reid 2006; Lemieux et al. 2005; Boucher et al. 2009; Reid et al. 2016); and from riffles, shallow runs with clean substrates, and the edges of pools of small- to medium-sized rivers (for example, CARA 2002; Reid et al. 2005; Garceau et al. 2007). 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 et al. 2005; Reid 2006). By late fall, few remain in riffle and shoal habitats and overwintering occurs in pools with low current (Branson 1967, Etnier and Starnes 1993). Habitat requirements of lake populations are not as well documented, but a seasonal shift in capture rate (Reid and Mandrak 2008) may suggest a seasonal shift in habitat use (COSEWIC 2016). 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. Lake Erie (DU 1) populations are primarily lacustrine, relying on nearshore beach habitat of Lake St. Clair and Lake Erie, but also occupy the flowing

waters of connecting channels. In contrast, Lake Ontario (DU 2) populations are riverine and confined to tributaries of eastern Lake Ontario.

### **Limiting factors**

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 neighboring population to halt the decline of another population through migration from 1 population to another) is low, as extirpated populations have little opportunity to be re-colonized through natural movements.

## **5. Threats**

### **5.1 Threat assessment**

An assessment and prioritization of threats to survival and recovery of the species was undertaken as a component of the RPA (DFO 2020). A 2-step process is used, which first characterizes threats at the population level and then at the wildlife species<sup>5</sup> level. For more details on the threat assessment process and the categories and associated rankings used for threat assessments, refer to the [Guidance on Assessing Threats, Ecological Risk and Ecological Impacts for Species at Risk](#) or tables provided in Appendix C. Tables 5 to 15 were modified from [Andrews and Drake \(2020\)](#). Assessment category definitions are provided in footnotes to the tables.

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<sup>5</sup> Also referred to as a designatable unit by COSEWIC.

**Table 6. Population-level threat assessment for Channel Darter in the St. Clair River (Lake Erie Populations designatable unit 1).**

Threats	Likelihood of occurrence <sup>6</sup>	Level of impact <sup>7</sup>	Causal certainty <sup>8</sup>	Population-level threat occurrence <sup>9</sup>	Population-level threat frequency <sup>10</sup>	Population-level threat extent <sup>11</sup>
Turbidity and sediment loading	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent and continuous	Extensive
Contaminant and toxic substances	Known to occur or very likely to occur	Unknown	Low	Historical and current	Recurrent and continuous	Extensive
Nutrient loading	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent and continuous	Extensive
Shoreline modifications	Known to occur or very likely to occur	Medium	Low	Historical	Recurrent	Broad
Altered flow regimes	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent and continuous	Broad
Exotic species and diseases	Known to occur or very likely to occur	High	Medium	Current	Continuous	Extensive
Incidental harvest	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent	Restricted

<sup>6</sup> Likelihood of occurrence: the probability of a specific threat occurring for a given population over 10 years or 3 generations, whichever is shorter.

<sup>7</sup> Level of impact: the magnitude of the impact caused by a given threat, and the level to which it affects the survival or recovery of the population.

<sup>8</sup> Causal certainty: the strength of evidence linking the threat to the survival and recovery of the population.

<sup>9</sup> Population-level threat occurrence: the timing of occurrence of the threat and describes whether a threat is historical, current, and/or anticipatory.

<sup>10</sup> Population-level threat frequency: the temporal extent of the threat over the next 10 years or 3 generations, whichever is shorter.

<sup>11</sup> Population-level threat extent: the extent of the population affected by the threat.

**Table 7. Population-level threat assessment for Channel Darter in the Lake St. Clair (Lake Erie Populations designatable unit 1)**

Threats	Likelihood of occurrence <sup>12</sup>	Level of impact <sup>13</sup>	Causal certainty <sup>14</sup>	Population-level threat occurrence <sup>15</sup>	Population-level threat frequency <sup>16</sup>	Population-level threat extent <sup>17</sup>
Turbidity and sediment loading	Known to occur or very likely to occur	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Contaminant and toxic substances	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent and continuous	Extensive
Nutrient loading	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent and continuous	Extensive
Shoreline modifications	Known to occur or very likely to occur	High	Low	Historical	Recurrent	Broad
Altered flow regimes	Unlikely	High	Low	Historical and current	Recurrent and continuous	Broad
Exotic species and diseases	Known to occur or very likely to occur	High	Medium	Current	Continuous	Extensive
Incidental harvest	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent	Restricted

<sup>12</sup> Likelihood of occurrence: the probability of a specific threat occurring for a given population over 10 years or 3 generations, whichever is shorter.

<sup>13</sup> Level of impact: the magnitude of the impact caused by a given threat, and the level to which it affects the survival or recovery of the population.

<sup>14</sup> Causal certainty: the strength of evidence linking the threat to the survival and recovery of the population.

<sup>15</sup> Population-level threat occurrence: the timing of occurrence of the threat and describes whether a threat is historical, current, and/or anticipatory.

<sup>16</sup> Population-level threat frequency: the temporal extent of the threat over the next 10 years or 3 generations, whichever is shorter.

<sup>17</sup> Population-level threat extent: the extent of the population affected by the threat.

**Table 8. Population-level threat assessment for Channel Darter in the Detroit River (Lake Erie Populations designatable unit 1)**

Threats	Likelihood of Occurrence <sup>18</sup>	Level of Impact <sup>19</sup>	Causal certainty <sup>20</sup>	Population-level threat occurrence <sup>21</sup>	Population-level threat frequency <sup>22</sup>	Population-level threat extent <sup>23</sup>
Turbidity and sediment loading	Likely to occur	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Contaminant and toxic substances	Known to occur or very likely to occur	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Nutrient loading	Likely to occur	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Shoreline modifications	Known to occur or very likely to occur	Medium	Low	Historical	Recurrent	Broad
Altered flow regimes	Known to occur or very likely to occur	High	Low	Historical and current	Recurrent and continuous	Broad
Exotic species and diseases	Known to occur or very likely to occur	High	Medium	Current	Continuous	Extensive
Incidental harvest	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent	Restricted

<sup>18</sup> Likelihood of occurrence: the probability of a specific threat occurring for a given population over 10 years or 3 generations, whichever is shorter.

<sup>19</sup> Level of impact: the magnitude of the impact caused by a given threat, and the level to which it affects the survival or recovery of the population.

<sup>20</sup> Causal certainty: the strength of evidence linking the threat to the survival and recovery of the population.

<sup>21</sup> Population-level threat occurrence: the timing of occurrence of the threat and describes whether a threat is historical, current, and/or anticipatory.

<sup>22</sup> Population-level threat frequency: the temporal extent of the threat over the next 10 years or 3 generations, whichever is shorter.

<sup>23</sup> Population-level threat extent: the extent of the population affected by the threat.

**Table 9. Population-level threat assessment for Channel Darter in the Lake Erie Western Basin (Point Pelee) (Lake Erie Populations designatable unit 1)**

Threats	Likelihood of occurrence <sup>24</sup>	Level of impact <sup>25</sup>	Causal certainty <sup>26</sup>	Population-level threat occurrence <sup>27</sup>	Population-level threat frequency <sup>28</sup>	Population-level threat extent <sup>29</sup>
Turbidity and sediment loading	Likely to occur	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Contaminant and toxic substances	Unlikely	Unknown	Low	Historical and current	Recurrent and continuous	Extensive
Nutrient loading	Likely to occur	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Shoreline modifications	Known to occur or very likely to occur	High	Medium	Historical	Recurrent	Broad
Exotic species and diseases	Known to occur or very likely to occur	High	Medium	Current	Continuous	Extensive
Incidental harvest	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent	Restricted

<sup>24</sup> Likelihood of occurrence: the probability of a specific threat occurring for a given population over 10 years or 3 generations, whichever is shorter.

<sup>25</sup> Level of impact: the magnitude of the impact caused by a given threat, and the level to which it affects the survival or recovery of the population.

<sup>26</sup> Causal certainty: the strength of evidence linking the threat to the survival and recovery of the population.

<sup>27</sup> Population-level threat occurrence: the timing of occurrence of the threat and describes whether a threat is historical, current, and/or anticipatory.

<sup>28</sup> Population-level threat frequency: the temporal extent of the threat over the next 10 years or 3 generations, whichever is shorter.

<sup>29</sup> Population-level threat extent: the extent of the population affected by the threat.

**Table 10. Population-level threat assessment for Channel Darter in the Lake Erie Central Basin (Rondeau Bay) (Lake Erie Populations designatable unit 1).**

Threats	Likelihood of occurrence <sup>30</sup>	Level of impact <sup>31</sup>	Causal certainty <sup>32</sup>	Population-level threat occurrence <sup>33</sup>	Population-level threat frequency <sup>34</sup>	Population-level threat extent <sup>35</sup>
Turbidity and sediment loading	Likely to occur	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Contaminant and toxic substances	Unlikely	Unknown	Low	Historical and current	Recurrent and continuous	Extensive
Nutrient loading	Likely to occur	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Shoreline modifications	Known to occur or very likely to occur	High	Medium	Historical	Recurrent	Broad
Exotic species and diseases	Known to occur or very likely to occur	High	Medium	Current	Continuous	Extensive
Incidental harvest	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent	Restricted

<sup>30</sup> Likelihood of occurrence: the probability of a specific threat occurring for a given population over 10 years or 3 generations, whichever is shorter.

<sup>31</sup> Level of impact: the magnitude of the impact caused by a given threat, and the level to which it affects the survival or recovery of the population.

<sup>32</sup> Causal certainty: the strength of evidence linking the threat to the survival and recovery of the population.

<sup>33</sup> Population-level threat occurrence: the timing of occurrence of the threat and describes whether a threat is historical, current, and/or anticipatory.

<sup>34</sup> Population-level threat frequency: the temporal extent of the threat over the next 10 years or 3 generations, whichever is shorter.

<sup>35</sup> Population-level threat extent: the extent of the population affected by the threat.

**Table 11. Population-level threat assessment for Lake Erie Central Basin (Port Burwell) (Lake Erie Populations designatable unit 1).**

Threats	Likelihood of occurrence <sup>36</sup>	Level of impact <sup>37</sup>	Causal certainty <sup>38</sup>	Population-level threat occurrence <sup>39</sup>	Population-level threat frequency <sup>40</sup>	Population-level threat extent <sup>41</sup>
Turbidity and sediment loading	Likely to occur	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Contaminant and toxic substances	Unlikely	Unknown	Low	Historical and current	Recurrent and continuous	Extensive
Nutrient loading	Likely to occur	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Shoreline modifications	Known to occur or very likely to occur	High	Medium	Historical	Recurrent	Broad
Exotic species and diseases	Known to occur or very likely to occur	High	Medium	Current	Continuous	Extensive
Incidental harvest	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent	Restricted

<sup>36</sup> Likelihood of occurrence: the probability of a specific threat occurring for a given population over 10 years or 3 generations, whichever is shorter.

<sup>37</sup> Level of impact: the magnitude of the impact caused by a given threat, and the level to which it affects the survival or recovery of the population.

<sup>38</sup> Causal certainty: the strength of evidence linking the threat to the survival and recovery of the population.

<sup>39</sup> Population-level threat occurrence: the timing of occurrence of the threat and describes whether a threat is historical, current, and/or anticipatory.

<sup>40</sup> Population-level threat frequency: the temporal extent of the threat over the next 10 years or 3 generations, whichever is shorter.

<sup>41</sup> Population-level threat extent: the extent of the population affected by the threat.

**Table 12. Population-level threat assessment for the Trent River (Lake Ontario Populations designatable unit 2).**

Threats	Likelihood of occurrence <sup>42</sup>	Level of impact <sup>43</sup>	Causal certainty <sup>44</sup>	Population-level threat occurrence <sup>45</sup>	Population-level threat frequency <sup>46</sup>	Population-level threat extent <sup>47</sup>
Turbidity and sediment loading	Unlikely	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Contaminant and toxic substances	Unlikely	Low	Low	Historical and current	Recurrent and continuous	Extensive
Nutrient loading	Unlikely	Low	Low	Historical and current	Recurrent and continuous	Extensive
Shoreline modifications	Likely to occur	Low	Low	Historical	Recurrent	Narrow
Altered flow regimes	Known to occur or very likely to occur	High	Low	Historical and current	Recurrent and continuous	Broad
Barriers to movement	Known to occur or very likely to occur	Medium	Medium	Historical and current	Continuous	Broad
Exotic species and diseases	Known to occur or very likely to occur	High	Medium	Current	Continuous	Extensive
Incidental harvest	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent	Restricted

<sup>42</sup> Likelihood of occurrence: the probability of a specific threat occurring for a given population over 10 years or 3 generations, whichever is shorter.

<sup>43</sup> Level of impact: the magnitude of the impact caused by a given threat, and the level to which it affects the survival or recovery of the population.

<sup>44</sup> Causal certainty: the strength of evidence linking the threat to the survival and recovery of the population.

<sup>45</sup> Population-level threat occurrence: the timing of occurrence of the threat and describes whether a threat is historical, current, and/or anticipatory.

<sup>46</sup> Population-level threat frequency: the temporal extent of the threat over the next 10 years or 3 generations, whichever is shorter.

<sup>47</sup> Population-level threat extent: the extent of the population affected by the threat.

**Table 13. Population-level threat assessment for Channel Darter in the Salmon River (Lake Ontario Populations designatable unit 2)**

Threats	Likelihood of occurrence <sup>48</sup>	Level of impact <sup>49</sup>	Causal certainty <sup>50</sup>	Population-level threat occurrence <sup>51</sup>	Population-level threat frequency <sup>52</sup>	Population-level threat extent <sup>53</sup>
Turbidity and sediment loading	Unlikely	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Contaminant and toxic substances	Unlikely	Low	Low	Historical and current	Recurrent and continuous	Extensive
Nutrient loading	Unlikely	Low	Low	Historical and current	Recurrent and continuous	Extensive
Shoreline modifications	Unlikely	Low	Low	Historical	Recurrent	Narrow
Altered flow regimes	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent and continuous	Restricted
Barriers to movement	Known to occur or very likely to occur	Low	Medium	Historical and current	Continuous	Restricted
Exotic species and diseases	Likely to occur	High	Medium	Anticipatory	Continuous	Extensive
Incidental harvest	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent	Restricted

<sup>48</sup> Likelihood of occurrence: the probability of a specific threat occurring for a given population over 10 years or 3 generations, whichever is shorter.

<sup>49</sup> Level of impact: the magnitude of the impact caused by a given threat, and the level to which it affects the survival or recovery of the population.

<sup>50</sup> Causal certainty: the strength of evidence linking the threat to the survival and recovery of the population.

<sup>51</sup> Population-level threat occurrence: the timing of occurrence of the threat and describes whether a threat is historical, current, and/or anticipatory.

<sup>52</sup> Population-level threat frequency: the temporal extent of the threat over the next 10 years or 3 generations, whichever is shorter.

<sup>53</sup> Population-level threat extent: the extent of the population affected by the threat.

**Table 14. Population-level threat assessment for Channel Darter in the Moira River (Lake Ontario Populations designatable unit 2)**

Threats	Likelihood of occurrence <sup>54</sup>	Level of impact <sup>55</sup>	Causal certainty <sup>56</sup>	Population-level threat occurrence <sup>57</sup>	Population-level threat frequency <sup>58</sup>	Population-level threat extent <sup>59</sup>
Turbidity and sediment loading	Unlikely	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Contaminant and toxic substances	Unlikely	Medium	Low	Historical and current	Recurrent and continuous	Extensive
Nutrient loading	Unlikely	Low	Low	Historical and current	Recurrent and continuous	Extensive
Shoreline modifications	Unlikely	Low	Low	Historical	Recurrent	Narrow
Altered flow regimes	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent and continuous	Broad
Barriers to movement	Known to occur or very likely to occur	Medium	Medium	Historical and current	Continuous	Narrow
Exotic species and diseases	Likely to occur	High	Medium	Anticipatory	Continuous	Extensive
Incidental harvest	Known to occur or very likely to occur	Low	Low	Historical and current	Recurrent	Restricted

<sup>54</sup> Likelihood of occurrence: the probability of a specific threat occurring for a given population over 10 years or 3 generations, whichever is shorter.

<sup>55</sup> Level of impact: the magnitude of the impact caused by a given threat, and the level to which it affects the survival or recovery of the population.

<sup>56</sup> Causal certainty: the strength of evidence linking the threat to the survival and recovery of the population.

<sup>57</sup> Population-level threat occurrence: the timing of occurrence of the threat and describes whether a threat is historical, current, and/or anticipatory.

<sup>58</sup> Population-level threat frequency: the temporal extent of the threat over the next 10 years or 3 generations, whichever is shorter.

<sup>59</sup> Population-level threat extent: the extent of the population affected by the threat.

**Table 15. Designated unit-level threat assessment for Channel Darter Lake Erie Populations (designatable unit 1).**

Threat	DU-level threat risk <sup>60</sup>	DU-level threat occurrence <sup>61</sup>	DU-level threat frequency <sup>62</sup>	DU-level threat extent <sup>63</sup>
Turbidity and sediment loading	Medium	Historical and current	Recurrent and continuous	Extensive
Contaminant and toxic substances	Medium	Historical and current	Recurrent and continuous	Extensive
Nutrient loading	Medium	Historical and current	Recurrent and continuous	Extensive
Shoreline modifications	High	Historical	Recurrent	Broad
Altered flow regimes	High	Historical and current	Recurrent and continuous	Broad
Exotic species and diseases	High	Current	Continuous	Extensive
Incidental harvest	Low	Historical and current	Recurrent	Restricted

<sup>60</sup> DU-level threat risk: the highest level of risk for a given population, based on the likelihood and level of impact of a population-level threat.

<sup>61</sup> DU-level threat occurrence: the timing of occurrence of the threat; may be any combination of historical, current, and/or anticipatory representing all categories that have been identified in the population-level assessment.

<sup>62</sup> DU-level threat frequency: the temporal extent of the threat representing all categories that have been identified in the population-level assessment.

<sup>63</sup> DU-level threat extent: the extent that the species is affected by the threat.

**Table 16. Designated unit-level threat assessment for Channel Darter Lake Ontario Populations (designatable unit 2).**

Threat	DU-level threat risk <sup>64</sup>	DU-level threat occurrence <sup>65</sup>	DU-level threat frequency <sup>66</sup>	DU-level threat extent <sup>67</sup>
Turbidity and sediment loading	Medium	Historical and current	Recurrent and continuous	Extensive
Contaminant and toxic substances	Medium	Historical and current	Recurrent and continuous	Extensive
Nutrient loading	Low	Historical and current	Recurrent and continuous	Extensive
Shoreline modifications	Low	Historical	Recurrent	Narrow
Altered flow regimes	High	Historical and current	Recurrent and continuous	Broad
Barriers to movement	Medium	Historical and current	Continuous	Narrow
Exotic species and diseases	High	Current	Continuous	Extensive
Incidental harvest	Low	Historical and current	Recurrent	Restricted

<sup>64</sup> DU-level threat risk: the highest level of risk for a given population, based on the likelihood and level of impact of a population-level threat.

<sup>65</sup> DU-level threat occurrence: the timing of occurrence of the threat; may be any combination of historical, current, and/or anticipatory representing all categories that have been identified in the population-level assessment.

<sup>66</sup> DU-level threat frequency: the temporal extent of the threat representing all categories that have been identified in the population-level assessment.

<sup>67</sup> DU-level threat extent: the extent that the species is affected by the threat.

## 5.2 Description of threats

Andrews and Drake (2020) identified habitat alteration and invasive species as the greatest threats to DUs 1 and 2 Channel Darter populations. Important threats that constitute habitat alteration include turbidity and sediment loading, nutrient loading, contaminants and toxic substances, barriers to movement, altered flow regimes and shoreline modifications (Andrews and Drake 2020). Significant distinctions of threats between the 2 DUs were noted. Altered flow regimes and barriers to movement are of greater prominence in DU 2, while invasive species, particularly Round Goby (*Neogobius melanostomus*), have greater prominence in DU 1.

**Turbidity and sediment loading:** The scope and impact of turbidity and sediment loading in DUs 1 and 2 are related to the form and intensity of human activities, and the interaction with substrate type and flow rates. Increased siltation and turbidity in Channel Darter habitats can result from agricultural activities, urban development, and the channelization of watercourses, as well as shoreline hardening as a result of human alteration to the riparian zone (for example, docks, jetties, breakwaters). Elevated turbidity can negatively affect the ability of Channel Darter to find food and locate spawning sites. Similarly, high siltation rates can reduce the quality of spawning substrate, smother eggs, reduce dissolved oxygen in the benthic zone, or affect the availability of benthic invertebrate food sources (Berkman and Rabeni 1987; Goodchild 1994; COSEWIC 2009). When sediment loads increase, the slow-to-moderate current habitat occupied by Channel Darter may not be swift enough to prevent sediment deposition. In the U.S., declines in riverine Channel Darter populations have been related to siltation associated with anthropogenic activities (Trautman 1981; Berkman and Rabeni 1987). In Canada, historical locations where Channel Darter has been extirpated were all affected by turbidity and sediment loading, which was driven by agricultural land practices and urban development (Phelps and Francis 2002).

**Contaminants and toxic substances:** The Channel Darter is thought to be sensitive to poor water quality (Phelps and Francis 2002) and intolerant to pollutants (Richard 1994; cited in Lapointe 1997); however, specific sensitivities to toxic chemicals are largely unknown. In the lower Ohio-upper Mississippi basin, extirpations have been attributed in part to the effects of pollution (Burr and Page 1986). Contaminants and toxic substances from various sources (for example, wastewater treatment plant, agricultural and livestock production, pesticide use, industrial discharge) may have several significant effects at the population level, including impaired reproduction, disruption of behaviour, a decreased resistance to pathogens, and disruption of embryonic development. The impact of toxic contaminants on the Channel Darter may also be indirect (for example, negatively impacting prey populations); ultimately, the combined and cumulative impacts are likely impacting Channel Darter populations.

Within DU 1, Channel Darter populations are found within the St. Clair and Detroit rivers, 2 Great Lakes Areas of Concern (AOC) where elevated toxicants are known to affect aquatic species (ECCC 2017). A variety of hydroxylated phenolic compounds (HPCs), suspected of having the ability to interfere with hormonal pathways, have been detected at elevated levels in fish from Great Lakes AOCs (Gilroy et al. 2017). Monitoring of the tissue concentrations of contaminants was conducted in 2002/2003 and later in 2014 within the St. Clair River at the heavily industrialized area of Stag Island, downstream at the St. Clair Delta (Walpole Island and Chenal Écarte), and at a reference site in Lake Huron (Muttray et al. 2020 and 2021) to examine changes over time. Concentrations of metals/metalloids (Muttray et al. 2021) and organic contaminants (Muttray et al. 2020) were examined in 3 fish species, including Shorthead Redhorse (*Moxostoma macrolepidotum*) – a species representative of the benthic niche, Yellow

Perch (*Perca flavescens*) – representative of piscivorous pelagic predators, and Emerald Shiner (*Notropis atherinoides*) – representative of pelagic planktivores. Muttray et al. (2020) found that concentrations of the majority of organic contaminants, including polychlorinated biphenyls (PCBs), and organochlorine pesticides and byproducts, decreased over the 12-year time period with no evidence that would indicate that these contaminants were affecting the growth or reproduction of the 3 aforementioned species. Furthermore, Muttray et al. (2020) found that dioxin-like PCBs tended to decline or remained consistent over the time period for Shorthead Redhorse and Yellow Perch collected from Stag Island and the St. Clair River Delta, and fish-derived calculated toxic equivalents (a measure of the toxicity of dioxins, furans and PCBs) indicated that current concentrations pose a low risk to the health of fish. Muttray et al. 2021 found that tissue concentrations of many of the metals/metalloids measured in 2002/2003 and 2014 decreased. Specifically, they observed that Mercury decreased in Shorthead Redhorse and Yellow Perch at both St. Clair River locations, Vanadium decreased in Shorthead Redhorse at Stag Island, while significant declines in concentrations of Barium, Magnesium, Manganese, Strontium, and Zinc were observed in the tissues of Shorthead Redhorse at Walpole Island (Muttray et al. 2021). Overall, they found that concentrations of metals/metalloids fell below thresholds projected to impact fish health, suggesting that the health and reproductive capacity of all 3 species is not likely being affected (Muttray et al. 2021). Taken together, these studies suggest that remedial activities conducted in the St. Clair River AOC may be driving improvements in water quality; however, further research is needed to better understand if, and to what degree, Channel Darter may be impacted by current levels of contaminants and toxicants at this location.

Within the Detroit River, other benthic fishes, including Brown Bullhead (*Ameiurus nebulosus*) and Common Carp (*Cyprinus carpio*), have been found to have more than twice the rate of damage to DNA in cells compared to fishes from healthier regions of the Great Lakes, possibly due to high levels of polycyclic aromatic hydrocarbons (PAHs) and PCBs found in sediments (Green et al. 2010). In addition, some portions of DU 2 populations are found within the Bay of Quinte AOC, where high PCB and dioxin loads have been observed in fishes near the outlet of the Trent and Moira rivers (Simmons et al. 2014).

The widespread use of road salt (sodium chloride) in winter months has also been documented to impact aquatic organisms. For example, larval freshwater mussels (Unionids) have been shown to be highly sensitive to sodium chloride (Gillis 2011). Fish species, conversely, appear to be far more resilient to chloride ions, with experimental studies indicating that extremely high concentrations (approximately ranging from 3,000 to 10,000 mg/L) were required before 50% mortality was reached for adults of some species, while others did not experience mortality at all despite high concentrations (Tiwari et al. 2018). Furthermore, impacts to freshwater fish eggs, embryos, and alevins were only evident in experimental settings for some species at elevated concentrations (approximately ranging from 900 to 6000 mg/L) (Tiwari and Rachlin 2018; Hintz and Relyea 2019). Currently, information regarding the potential impacts of road salt to benthic dwelling species such as Channel Darter, as well as the prey resources on which they rely, is not available. Furthermore, more information is needed to explore the impacts of chronically elevated chloride levels over longer time-scales to effectively evaluate this potential threat. The current federal water quality guidelines for the protection of aquatic life have been set at 120 mg/L for chronic exposure to chloride (CCME 2011). The upper range of chloride concentrations have been documented to exceed the aforementioned water quality guideline within the Sydenham and Thames rivers (Gillis 2011; Todd and Kaltenecker 2012), which are both tributaries to Lake St. Clair; therefore, these rivers are likely contributing to elevated chloride levels in Lake St. Clair and the Detroit River where Channel Darter occur. Further monitoring of chloride levels is needed throughout areas occupied by Channel Darter in DUs 1 and 2. In

addition, monitoring is needed to investigate the potential input of chloride from water softeners which are applied at wastewater treatment plants as well as septic systems.

**Nutrient loading:** Channel Darter populations within DUs 1 and 2 may be exposed to excess nutrients (nitrates and phosphorus) from agricultural (for example, manure and fertilizer run-off) and urban activities (for example, input from wastewater treatment facilities). Nutrient enrichment of waterways can negatively influence aquatic health through algal blooms and associated reduced dissolved oxygen concentrations. Nutrient loadings have been identified as a primary threat for fish species at risk in the Detroit River, Rondeau Bay, Point Pelee, and the south shore of Lake St. Clair (EERT 2008). 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 wholelake eutrophication (Mandrak and Holm 2001). Eutrophication of Lake Erie continues to be an ongoing concern, and has resulted in recent hypoxic events and harmful algal blooms (see Watson et al. 2016) that have caused large die-offs of fishes (for example, 2012 die-off) (Rao et al. 2014). Over this time frame, it appears that in addition to a decline in general species richness, the distribution of the Channel Darter in Lake Erie has been reduced (Reid and Mandrak 2008). Nutrient loading effects in DU 2 may be less intense considering the land surrounding watersheds where the Channel Darter is found are not as urbanized or as agriculturally intensive as those in DU 1.

**Shoreline modifications:** Within DU 1, 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. The effects of shoreline modifications can impact Channel Darter populations in both riverine and lacustrine habitats; the impacts to lacustrine populations may be more severe (COSEWIC 2016). The nearshore of Lake Erie has been extensively modified with shoreline protection structures, which have reduced aquatic habitat diversity and altered nearshore sediment transport (Koonce et al. 1996; Edsall and Charlton 1997). 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). Similarly, it has been postulated that shoreline modifications in the vicinity of Erieau alter the natural process of sediment transport that maintains Rondeau Bay's barrier beach, consequently affecting its configuration and position (Zuzek 2020). 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. Most of the shoreline along the Huron-Erie Corridor has been modified for human use (for example, removal of natural vegetation, shoreline stabilization and infilling). Along with channel modifications (for example, dredging for shipping lanes), these aforementioned activities have altered the natural process of erosion and deposition along the Huron-Erie Corridor (EERT 2008).

Populations in DU 2 may be impacted by the health of riparian areas, which plays an important role in the protection of water quality. Riparian areas reduce soil erosion, filter run-off containing fertilizers, pesticides, and sediment, and regulate water temperature. The loss of riparian vegetation may most critically affect siltation and water temperatures and, hence, the reproductive biology of the species.

**Altered flow regimes:** The rivers that support the Channel Darter within DU 2 (in particular the Trent River) are affected by dams, which have the capacity to modify flow regimes. Lacustrine conditions immediately upstream of dams are likely not suitable Channel Darter habitat, and flow regulation may 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), and 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, public safety, and flood control (for example, Reid et al. 2016). The shallow depth of habitats used during spawning makes them vulnerable to water level fluctuations. Historically, shoals used by the Channel Darter in the Trent River have been observed to be temporarily (1 to 2 hours) dewatered during the spawning period, and portions of the river where Channel Darter were captured in the summer appeared completely dry in the fall (Reid 2006); however, current water management practices aim to provide the flow conditions for Channel darter to spawn each spring (Power pers. comm. 2022). Extensive dewatering of tailwater habitats downstream of a dam on the Trent River has resulted in the stranding of several Channel Darter individuals (COSEWIC 2016; Reid 2016). In-stream flow needs assessments for the spawning period of Channel Darter in the Trent River have been initiated (Reid et al. 2016). Discharge-habitat models indicate that optimal river discharges differ between sites due to variation in stream morphology (Reid et al. 2016), suggesting that the regulation of flow will need to be tailored to each specific site on a case-by-case basis to optimize habitat conditions for Channel Darter.

Riverine populations in DU 1 are unaffected by dams, but the Detroit and St. Clair rivers have had significantly altered flow regimes from large-scale dredging and disposal of spoils; dredging operations still occur within both river systems. Impacts of these activities on Channel Darter populations within these systems remain to be explored.

**Barriers to movement:** Barriers to movement (for example, dams, poorly installed culverts) can have a 2-fold effect on fish populations: negatively, by restricting access to important habitat areas fragmenting fish populations and limiting the potential for rescue effect from neighbouring populations; and positively, since barriers may afford protection from competitors, predators, or invasive species (EERT 2008). Within DU 2, the Trent, Moira, Black, Skootamatta, and Salmon rivers are all fragmented by engineered structures (Reid et al. 2005), while no known barriers to movement are within the range of DU 1 Channel Darter populations. The barriers in DU 2 have the potential to impact the Channel Darter as individuals are thought to migrate seasonally to different habitats (Branson 1967; Cooper 1983). For example, dams appear to have fragmented populations of Channel Darter throughout the Trent River (Reid et al. 2016); although, in many instances, dams were constructed in the late 1800's at the locations of water drops (rapids/falls), which may have naturally limited Channel Darter movements (Angus 1988). The possibility that Channel Darter move through the adjacent lock system remains to be explored.

**Exotic species and diseases:** Invasive species may affect the Channel Darter through direct competition for habitat and food, and through the restructuring of aquatic food webs. The Round Goby was first collected in the St. Clair River in 1990 (Crossman 1991), and has since spread throughout the Great Lakes and many of their tributaries. The range of Round Goby and the Channel Darter overlap within DU 1, while this invasive species is currently only found in the Trent River within DU 2. The Round Goby has been implicated in the decline of a variety of native benthic fish species in the lower Great Lakes and their tributaries (for example, French and Jude 2001; Baker 2005; Poos et al. 2010), including the Channel Darter (Reid and Mandrak 2008; Burkett and Jude 2015). In their study on the status of the Channel Darter along the north shore of Lake Erie, Reid and Mandrak (2008) recorded the highest catch rates of Channel Darter when the Round Goby abundance was lowest. It is believed that Round Goby impacts other native species found in the benthic area through predation of eggs and larvae, competition for food resources, and aggressive behaviour/territoriality and spawning interference (Corkum et al. 2004, Reid and Mandrak 2008). Reid (2019) assessed summer habitat use and overlap

between Round Goby and native darter species in the Trent River and concluded that Round Goby are likely competing for physical habitat and food resources with the Channel Darter.

**Incidental harvest:** Although the Channel Darter is not a legal baitfish in Ontario (see [2019 Fishing Ontario: Recreational Fishing Regulations Summary](#)), there is concern with respect to accidental harvest of this species as 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). 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 the Channel Darter, especially the nearshore areas of Lake Erie (Reid and Mandrak 2008). However, Drake and Mandrak (2014a) estimated a low probability of incidental capture of Channel Darter as by-catch during the commercial baitfish harvest in nearshore areas of Lake Erie (240 harvest events would be necessary for a single event to capture Channel Darter as by-catch). Furthermore, no Channel Darter were collected in samples taken from baitfish dealers across southern Ontario during a study examining the impacts of baitfish harvesting on species at risk and the distribution and spread of invasive species (Drake and Mandrak 2014b). The potential for by-catch by anglers is unknown but is expected to be low (Andrews and Drake 2020).

**Climate change:** Climate change is expected to have significant effects on aquatic communities of the Great Lakes basin through several mechanisms, including increases in water and air temperatures, reductions in water levels, shortening of the duration of ice cover, increases in the frequency of extreme weather events, emergence of diseases, and shifts in predator-prey dynamics (Lemmen and Warren 2004).

The Channel Darter has been calculated to be both vulnerable (Brinker et al. 2018) and relatively insensitive to the anticipated effects of climate change (Doka et al. 2006), illustrating the current uncertainty of the threat. Potential outcomes of climate change to which the species may be particularly vulnerable include:

- lowered water levels and the possibility of habitat loss
- increased temperatures altering spawning cycles, and
- more extreme weather conditions, which may increase the frequency of discharges from overflow structures and the overland run-off of contaminants (for example, nutrients)

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. As the effects of climate change on the Channel Darter are highly speculative, it is difficult to determine the impact that this will have on the populations and, as such, it has an unknown threat level.

## 6. Population and distribution objectives

Population and distribution objectives establish, to the extent possible, the number of individuals and/or populations, and their geographic distribution, that are necessary for the recovery of the

species. The population and distribution objectives for the Channel Darter (DUs 1 and 2) are to ensure the survival of self-sustaining populations in:

- DU 1: Lake St. Clair, the St. Clair and Detroit rivers, and the western and central basins of Lake Erie, and
- DU 2: Trent and Salmon rivers, and the Moira River system, which includes the Black and Skootamatta rivers

The populations at these locations can be considered recovered when they have returned to historically estimated ranges and demonstrate active signs of reproduction and recruitment throughout their distribution. More quantifiable objectives will be developed once necessary surveys and studies have been completed (refer to section 8.2 Schedule of Studies to Identify Critical Habitat). The number of populations present in waterbodies inhabited by the Channel Darter is currently unknown. To be precautionary, where present, multiple populations at a single location should be maintained.

Population modelling conducted by Venturelli et al. (2010) estimated that the minimum viable population size (MVP) for the Channel Darter is 31,000 adults, given a 10% chance of a catastrophic event occurring per generation. However, the implementation of such a target is difficult without also having information on population demographics and spatial distribution, habitat quality, and a more complete understanding of the life history of the species. For example, life history characteristics, such as fecundity and clutch sizes, are unknown. Hence, more confident objectives relating to MVP can be developed, and further validation of model results can be obtained as understanding of this species is improved.

## **7. Broad strategies and general approaches to meet objectives**

### **7.1 Actions already completed or currently underway**

Single and multi-species recovery strategies and management plans have been drafted previously for a variety of fish species, the distributions of which partly overlap with that of the Channel Darter. Recovery teams for these species are currently engaged in the implementation of recovery actions within these watersheds that may indirectly benefit the Channel Darter and include, but are not limited to, Eastern Sand Darter (*Ammocrypta pellucida*), River Redhorse (*Moxostoma carinatum*), Northern Madtom (*Noturus stigmosus*), Pugnose Shiner (*N. anogenus*), and Silver Chub (*Macrhybopsis storeriana*).

Conservation authorities (for example, Essex, Lower Thames Valley, St. Clair, Long Point, Lower Trent, and Quinte Region) continue to play a vital role in stewardship and public education programs that have resulted in increased awareness of species at risk and improvements to habitat and water quality throughout the range of DUs 1 and 2 for the Channel Darter.

A baitfish primer that identifies the baitfish species of Ontario has been completed (Cudmore and Mandrak 2018). The [baitfish primer](#), which includes the Channel Darter, has been made available to commercial bait harvesters, anglers, and the general public via NDMNRF offices and ServiceOntario offices.

DFO has funded and/or participated in various research projects related to the conservation of the Channel Darter:

- Status of the Channel Darter in Lake Erie (Reid and Mandrak 2008)
- Determination of minimum flow levels for the Trent River during the spawning period of the Channel Darter (Reid et al. 2016)
- Electrofishing sampling effort in relation to detection probabilities of riverine fishes including the Channel Darter (Reid and Haxton 2017)
- Investigation of the impact of Round Goby on the Trent River populations of Channel Darter (Reid 2019)
- Impacts of baitfish harvesting on species at risk and the distribution and spread of invasive species (Drake and Mandrak 2014a,b)
- Studies of the genetic structure of Canadian Channel Darter populations

## 7.2 Strategic direction for recovery and implementation schedule

Successful recovery of this species is dependent on the actions of many different jurisdictions. It requires the commitment and cooperation of the constituencies that will be involved in implementing the directions and measures set out in this recovery strategy and action plan.

This recovery strategy and action plan provides a description of the measures that provide the best chance of achieving the population and distribution objectives for the Channel Darter, including measures to be taken to address threats to the species and to monitor its recovery, to guide not only activities to be undertaken by DFO, but those for which other jurisdictions, organizations, and individuals have a role to play. As new information becomes available, these measures and their level of priority may change. DFO strongly encourages all Canadians to participate in the conservation of the Channel Darter by undertaking measures outlined in this recovery strategy and action plan.

Four broad strategies were identified to address threats to the species and meet the management objectives: 1) inventory and monitoring; 2) research; 3) management and coordination; and 4) stewardship and outreach. Table 16 identifies the measures to be undertaken by DFO to support the recovery of the Channel Darter. Table 17 identifies the measures to be undertaken collaboratively between DFO and its partners, other agencies, organizations, or individuals. Implementation of these measures will be dependent on a collaborative approach, in which DFO is a partner in recovery efforts, but cannot implement the measures alone. As all Canadians are invited to join in supporting and implementing this recovery strategy and action plan, table 18 identifies the remaining measures that represent opportunities for other jurisdictions, organizations, or individuals to lead for the recovery of the species. If your organization is interested in participating in any of these measures, please contact the Species at Risk [Species at Risk Ontario and Prairies office](#).

Implementation of this recovery strategy and action plan is subject to the appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

**Table 17. Measures to be undertaken by Fisheries and Oceans Canada (DFO) for the Channel Darter (Lake Erie and Lake Ontario populations).**

#	Recovery measures	Broad strategy	Approach	Priority <sup>68</sup>	Threats or concern addressed	Status/ timeline
1	Implement a standardized index population and habitat monitoring program with a species-specific sampling and training protocol.	Inventory and monitoring	Population Assessment	High	Knowledge gaps	New
2	Work with ecosystem- and single species-based recovery teams to share knowledge, combine resources, implement recovery actions, and ensure a coordinated approach to recovery.	Management and coordination	Coordination of activities	High	All threats	Ongoing
3	Work with municipal planning authorities so that they consider the protection of critical habitat for the Channel Darter within official plans. Recommend consideration of the Channel Darter's needs when developing projects at the design stage and when issuing permits (for example, hydro retrofits).	Management and coordination	Coordination of activities	High	All threats	Ongoing

<sup>68</sup> "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

- "high" priority measures are considered likely to have an immediate and/or direct influence on the recovery of the species
- "medium" priority measures are important but considered to have an indirect or less immediate influence on the recovery of the species
- "low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

**Table 18. Measures to be undertaken collaboratively between Fisheries and Oceans Canada (DFO) and its partners for the Channel Darter (Lake Erie and Lake Ontario populations).**

#	Recovery measures	Broad strategy	Approach	Priority <sup>69</sup>	Threats or concern addressed	Status/timeline	Lead and partner(s) <sup>70</sup>
4	Conduct targeted surveys of extant populations using sampling techniques proven effective at detecting Channel Darter, especially at locations where the species has been recently detected (for example, Rondeau Bay and beach areas on the Lake Erie adjacent to Rondeau Bay).	Inventory and monitoring	Population assessment	High	Knowledge gaps	Underway/ 1 to 2 years	DFO, NDMNR, PC
5	Conduct targeted surveys (and/or target Channel Darter in pre-existing surveys) at historical Channel Darter locations (for example, Pelee Island, Holiday Beach, Erieau Beach, Port Burwell).	Inventory and monitoring	Population assessment	Medium	Knowledge gaps	Underway/ 1 to 2 years	DFO, NDMNR, PC
6	Conduct targeted surveys (and/or target Channel Darter in pre-existing surveys) for undetected populations in high probability areas with suitable habitat (for example,	Inventory and monitoring	Population assessment	Medium	Knowledge gaps	New/1 to 2 years	DFO, NDMNR, PC

<sup>69</sup> "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

- "high" priority measures are considered likely to have an immediate and/or direct influence on the recovery of the species
- "medium" priority measures are important but considered to have an indirect or less immediate influence on the recovery of the species
- "low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

<sup>70</sup> Fisheries and Oceans Canada (DFO); Ontario Ministry of Northern Development Mines Natural Resources and Forestry (NDMNR); Parks Canada (PC); Conservation Authorities (CAs); Ministry of the Environment, Conservation and Parks (MECP); Michigan Department of Natural Resources (DNR); United States Geological Survey (USGS). It is difficult to identify a lead agency given that many of these measures have not been started at this stage and in many cases collaborative efforts involve equal leadership among partners.

#	Recovery measures	Broad strategy	Approach	Priority <sup>69</sup>	Threats or concern addressed	Status/timeline	Lead and partner(s) <sup>70</sup>
	beach habitats along the north shore of Lake Erie).						
7	Determine the physiological tolerance thresholds of the Channel Darter with respect to various water quality parameters (for example, nutrients, contaminants) and check against existing standards.	Research	Threat evaluation	High	Turbidity and sediment loading, contaminants and toxic substances, nutrient loading	New/4 to 5 years	DFO, Academia
8	Identify thresholds of tolerance to habitat modifications (for example, sedimentation of spawning habitat, flow modifications) to determine what constitutes destruction of Channel Darter critical habitat.	Research	Threat evaluation	High	Turbidity and sediment loading, contaminants and toxic substances, nutrient loading, shoreline modifications, altered flow regimes, barriers to movement	New and ongoing/4 to 5 years	DFO, Academia, NDMNRF, PC

#	Recovery measures	Broad strategy	Approach	Priority <sup>69</sup>	Threats or concern addressed	Status/timeline	Lead and partner(s) <sup>70</sup>
9	Investigate the impact of invasive species interactions/competition with the Channel Darter (for example, Round Goby).	Research	Threat evaluation	High	Invasive species and diseases	New and ongoing/4 to 5 years	DFO, OMNRF, Academia
10	Determine the life history of the Channel Darter (for example, location of spawning and overwintering sites) and interactions with other species (for example, predation, competition).	Research	Life-history traits	Medium	Knowledge gaps	New/4 to 5 years	DFO, NDMNRF, Academia
11	Investigate the feasibility of various repatriation approaches for the Channel Darter and identify appropriate source populations.	Research	Population augmentation	Medium	Knowledge gaps	New/4 to 5 years	DFO, NDMNRF, Academia
12	Determine if there are historically occupied sites where Channel Darter is now extirpated that are suitable for threat mitigation or habitat restoration to prepare for potential repatriation.	Research	Stewardship assessment	Medium	Knowledge gaps	New/4 to 5 years	DFO, NDMNRF, Academia
13	Work with relevant organizations (for example, conservation authorities, NDMNRF, Indigenous groups) to share knowledge, combine resources, implement recovery actions, share intelligence information and enforce existing provincial and federal laws, regulations, policies, and prohibitions, and ensure a coordinated approach to recovery.	Management and coordination	Coordination of activities	High	All threats	Ongoing	DFO, NDMNRF, MECP, PC, CAs, Indigenous groups

#	Recovery measures	Broad strategy	Approach	Priority <sup>69</sup>	Threats or concern addressed	Status/timeline	Lead and partner(s) <sup>70</sup>
14	Establish a cooperative relationship with neighbouring United States jurisdictions responsible for Channel Darter management to allow for effective information sharing and, where possible, collaborative monitoring programs in the Huron-Erie Corridor.	Management and coordination	International cooperation	High	All threats and knowledge gaps	Ongoing	DFO, Michigan DNR, USGS
15	Conduct outreach sessions to engage the public and generate awareness of the needs of the Channel Darter and the prohibitions that protect this species (educational signage, pamphlets, school visitation, etc.)	Stewardship and Outreach	Awareness	High	All threats and knowledge gaps	Ongoing	DFO, NDMNRF, PC, CAs, Indigenous groups

**Table 19. Measures that represent opportunities for other jurisdictions, organizations, or individuals to lead for the Channel Darter (Lake Erie and Lake Ontario populations).**

#	Recovery measures	Broad strategy	Approach	Priority <sup>71</sup>	Threats or concern addressed	Potential jurisdictions or organizations <sup>72</sup>
16	Implement local stewardship programs to improve habitat conditions and reduce threats within critical habitat and other occupied habitats. Priorities and mitigation approaches to be informed through threat evaluation research.	Stewardship and outreach	Habitat improvement	High	All threats	PC, CAs
17	Promote stewardship among Indigenous groups and other land owners abutting aquatic habitats of the Channel Darter, and other local landowners with potential to have direct or indirect effects on the habitat of the Channel Darter.	Stewardship and outreach	Awareness: stewardship	High	All threats	CAs
18	Increase public awareness about potential impacts of invasive species on the ecosystem, including the Channel Darter. Discourage the emptying of bait buckets into waterbodies.	Stewardship and outreach	Awareness: invasive species	Medium	Invasive species and diseases	NDMNRF, PC, MECP, CAs

<sup>71</sup> "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

- "high" priority measures are considered likely to have an immediate and/or direct influence on the recovery of the species
- "medium" priority measures are important but considered to have an indirect or less immediate influence on the recovery of the species
- "low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

<sup>72</sup> Fisheries and Oceans Canada (DFO); Ontario Ministry of Northern Development Mines Natural Resources and Forestry (NDMNRF); Parks Canada Agency (PCA); Conservation Authorities (CAs); Ministry of the Environment, Conservation and Parks (MECP).

## 7.3 Narrative to support the recovery planning and implementation tables

### Inventory and monitoring

**Recovery measures 1 to 6 (population assessment)** : Of primary importance to effective recovery planning is the need to determine the current distribution and abundance of the Channel Darter within DUs 1 and 2. Sampling methods should be standardized at sampling sites as much as possible 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). Reid and Haxton (2017) investigated electrofishing sampling effort in relation to detection probabilities and site occupancy of riverine fishes, including the Channel Darter. Sampling of larger, non-wadeable rivers requires different sampling gear; attempts to capture Channel Darter from deep waters adjacent to Trent River shoals using small mesh gill-nets and minnow traps were unsuccessful (Reid 2006). Trawling is proving to be an effective method of capturing Channel Darter from deeper riverine and lake habitats that are not accessible to seines or electrofishers (Herzog et al. 2009; D et al. 2014).

Monitoring populations and habitat will assist with identifying key habitat requirements needed to refine the identification of critical habitat, as well as the implementing of strategies to protect 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 invasive species in Channel Darter habitat. The monitoring protocol should provide guidance on the time of sampling and the types of biological samples that should be collected (for example, scales, length, and weight). Where possible, standardized index population and habitat data should be collected through existing monitoring programs as appropriate/feasible. Furthermore, Canadian agencies should work with U.S. partners to monitor known populations in U.S. waters of waterbodies shared with Canada.

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 (for example, turbidity, nutrient content). In addition, tracking temporal changes 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.

Targeted surveys need to be conducted at historical locations within DU 1 to confirm if the Channel Darter is truly extirpated, including the east shore of Lake St. Clair (last detected in Mitchell's Bay in 1991 and 1992); the south shore of Lake St. Clair (near the mouths of the Pike Creek, Puce River, Bell River, Tremblay Creek, and Crystal Beach where the species was detected from 1980 to 1996); where the Detroit River flows into Lake Erie at Bar Point (last detected in 1940); in the Western Basin of Lake Erie at Holiday Beach (last detected in 1997) and Pelee Island (species last detected in 1984); the Central Basin of Lake Erie along the Lake Erie shoreline of Rondeau Bay Provincial Park and Erieau (species last detected in 1953), as well as Port Burwell where the species was detected in 2017 for the first time since 1950; and in

the Eastern Basin of Lake Erie in the Port Dover area (last detected in 1947). Several sites were sampled along Erieau Beach in 2018, which did not lead to the capture of any Channel Darter (LeBaron et al. 2020); however, given that the Channel Darter was captured at a nearby sample site within Rondeau Bay, more effort along the coastal shoreline of the Rondeau Bay Barrier, including Erieau, is warranted. Similarly, there are areas where Channel Darter was historically captured in DU 2 where targeted sampling should be undertaken, including sections of the Skootamatta River and a small tributary of Moira Lake where the Channel Darter was historically found.

Further sampling is also needed throughout extant locations to provide a better understanding of population trends and distribution patterns throughout both DUs 1 and 2. For example, sampling is warranted at new locations, including Rondeau Bay where the species was detected for the first time in 2018. Ideally, additional sampling within Rondeau Bay may help to refine the current configuration of critical habitat. Similarly, further sampling is needed within the St. Clair and Detroit rivers, especially between areas where the species has been detected.

Further exploratory sampling may also be warranted in order to discover potential undetected populations in high probability areas with suitable habitat. For example, beach seines were conducted in 2009 at locations with suitable features including 9 sites along the Lake Huron shoreline and 8 sites along the Lake Ontario shoreline (Bay of Quinte area) (LeBaron et al. 2020). Although these surveys did not detect Channel Darter, they are a good representation of effort to discover undetected populations. Further suitable locations may exist where undetected populations of Channel Darter occur that warrant similar targeted surveys.

## **Research**

A variety of potential threats to Channel Darter populations were identified in the COSEWIC Status Report (COSEWIC 2016) and during the RPA process (Andrews and Drake 2020) (tables 5 to 15). The status and certainty of many of these threats were assessed based on a watershed approach covered in section 5 (Threats) of this recovery strategy and action plan. Many of these threats can be classified as widespread and chronic and represent general ecosystem threats affecting myriad other aquatic species; efforts to remediate these threats will benefit many species in addition to the Channel Darter.

### **Measures 7 to 9 (threat evaluation):**

Further research is required that will investigate the physiological thresholds for various water quality parameters. For example, contaminants and toxic substances could potentially be impacting Channel Darter populations in locations such as the St. Clair and Detroit rivers, both of which are classified as Great Lakes Areas of Concern where elevated toxicants are known to affect aquatic species (ECCC 2017). Furthermore, turbidity and sediment loading, and nutrient loading resulting from agricultural activities, urban development, the channelization of watercourses, and shoreline alterations are occurring throughout both DUs; therefore, it is important to determine thresholds of tolerance to define destruction of critical habitat, adequately protect the species, and develop approaches to mitigation. Similarly, it is important to understand the flow requirements of the Channel Darter at various life-stages and how alterations to flow might impact habitat use and important life-cycle processes (for example, spawning, overwinter habitat). An assessment of the in-stream flow needs for the spawning period of the Channel Darter in the Trent River has been undertaken at 3 dams upstream of known spawning locations (Reid et al. 2016). Discharge-habitat models were developed, which

demonstrated that the regulation of flow will need to be tailored to each specific site to accommodate variation in stream morphology (Reid et al. 2016). Further assessments and modelling should be expanded from this study at other dam sites in the Trent River and other areas of DU 2 where Channel Darter critical habitat has been identified, to determine the minimum and maximum discharge rates in an effort to optimize stream flow.

The establishment of invasive species may be having adverse consequences on Channel Darter populations. Round Goby overlaps with the Channel Darter throughout the majority of its distribution in DUs 1 and 2 and it has been postulated that the decline of Channel Darter within coastal areas of Lake Erie is attributable to the proliferation of Round Goby (Reid and Mandrak 2008). Research has been initiated on the impacts of Round Goby on the Channel Darter in the Trent River that suggests Round Goby is likely having a negative impact on the Channel Darter (Reid 2019). Further examination of interactions between these 2 species should be undertaken in other areas where the 2 species co-occur.

**Measure 10 (life-history traits):** For all life stages, research should investigate seasonal patterns of habitat use and migrations between habitats. Specifically, research is needed to better characterize the life-history of the Channel Darter, particularly in regard to their habitat use in lacustrine and deep riverine habitats. Furthermore, a better understanding of the life-history traits (for example, fecundity, age of maturity, and life-span) of the Channel Darter throughout the species range, including both riverine and lacustrine habitats, would inform modelling efforts designed to quantify minimum viable population sizes and the habitat needed to support populations.

**Measure 11 (population augmentation):** The feasibility of Channel Darter repatriation is currently unknown. The disjunct distribution of Canadian Channel Darter populations means that natural re-colonization of extirpated sites is unlikely. Therefore, repatriation 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. Repatriation efforts require research to determine appropriate source populations, identify the most effective method for re-establishment (for example, translocation of individuals from other populations or captive rearing and subsequent stocking), and identify the number of individuals required to create self-sustaining populations. Repatriation should follow the [American Fisheries Society Guidelines for Introductions of Threatened and Endangered Fishes](#) or the [National Code on Introductions and Transfers of Aquatic Organisms](#). A feasibility analysis of Channel Darter repatriation within DUs 1 and 2 is required.

**Measure 12 (stewardship assessment):** 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 (that is, 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 reestablishment should take precedence over introductions into new sites.

## Management and coordination

**Measures 2, 3, 13 (coordination of activities):** Many of the threats facing the Channel Darter result from habitat degradation, which affects numerous aquatic species. Therefore, efforts to remediate threats should be carried out in close cooperation with other recovery teams and relevant groups in ways that maximize opportunities to share resources and information. Such cooperative practices may include the assessment of stressors to critical habitat and the

implementation of habitat improvement and restoration activities within waterbodies where the Channel Darter occurs. It is also important to coordinate the implementation of Channel Darter recovery measures with approaches for other aquatic species at risk where their distributions overlap (see section 7.1). Furthermore, experts and representatives should be engaged from other jurisdictions including the Ontario Ministry of the Environment, Conservation, and Parks (MECP), the NDMNRF, and Environment and Climate Change Canada (ECCC) to aid in undertaking research and monitoring measures that pertain to water quality parameters, including nutrients, heavy metals, industrial toxicants, and other contaminants on the Channel Darter. Currently, Multi-agency (PC, DFO, and NDMNRF) steering groups have been successful in providing direction for threat mitigation research in the Trent River (Reid et al. 2016), and such cooperation should continue in the future to address other aspects of Channel Darter research, monitoring, and protection. Furthermore, coordination is required among DFO, PC, OMNRF, and CAs to effectively enforce existing provincial and federal laws, regulations, policies, and prohibitions applicable to the Channel Darter and its habitat.

**Measure 14 (international cooperation):** As the Channel Darter is found in watercourses for which Canada shares jurisdiction with the U.S., strategic partnering with various entities in the U.S. is imperative. 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.

### **Stewardship and outreach**

**Measure 16 (habitat improvement):** The Channel Darter is sensitive to turbidity, sediment, 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 watercourses occupied by the Channel Darter. Best Management Practices (BMPs) are a good tool to provide clear direction for improved methods of operation for industries such as agriculture or forestry. In addition, it has been postulated that shoreline modifications in the vicinity of Eriean alter the natural process of sediment transport that maintains Rondeau Bay's barrier beach, consequently affecting its configuration and position (Zuzek 2020). Similar shoreline modifications in Western Lake Erie have disrupted sediment transport causing erosion in the Pelee Peninsula (Zuzek 2021). Therefore, mitigation projects focused on stabilizing the barrier beaches of Point Pelee and Rondeau Bay might be warranted in an effort to prevent further erosion where critical habitat has been identified, provided that such efforts are conducive to the habitat requirements of the Channel Darter. Ultimately, BMPs should be targeted to address primary threats affecting currently occupied/critical habitat throughout the range of the Channel Darter. Once threats have been evaluated for extant populations, the results will inform local stewardship programs for threat mitigation. Several populations of Channel Darter within DUs 1 and 2 appear to have become extirpated. 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. In addition, it is important to ensure that the flow needs of the Channel Darter are considered in the operation of generating stations location in areas of occupied habitat within DU2 (for example, Trent River).

**Measures 15 and 17 (awareness - stewardship):** Public participation in the recovery process for the Channel Darter is important, as significant threats to its populations result from diffuse

non-point source inputs relating to the general agricultural and urban activities within these watersheds. Recovery cannot occur without the full participation of local citizens and landowners, highlighting the need for an effective public awareness program. The Channel Darter should be considered in existing communication and outreach programs both for ecosystem-based recovery and for other aquatic species at risk, to instill the awareness of the needs to protect freshwater fishes and to ensure the health of aquatic freshwater ecosystems. Awareness can be generated by DFO, with cooperation from partner agencies, through a variety of mechanisms, including outreach sessions conducted by DFO Species at Risk biologists and Conservation and Protection officers, informative signage in areas of critical habitat, educational pamphlets, and interactions with the public during inspections and investigations. One important first step in achieving threat mitigation and habitat improvement is through an increase in awareness of stewardship activities and financial assistance that may be available to local landowners. Improvements to watershed water quality require the involvement of local residents, businesses, and organizations. For example, the participation of organizations such as Conservation Authorities should continue to help promote BMPs with applicable landowners, and Agriculture and Agri-Food Canada should conduct further stewardship and habitat improvement-related outreach to landowners through the Farm Stewardship Program. 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.

**Measure 18 (awareness – invasive species):** Various organizations have already undertaken public education efforts to prevent the further spread of invasive species. In the case of the Channel Darter, the Round Goby is of particular concern. Developing communications for baitfish harvesters about 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 2018).

## **8. Critical habitat**

### **8.1 Identification of Channel Darter critical habitat**

#### **8.1.1 General description of Channel Darter critical habitat**

Critical habitat is defined in SARA as “...the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species’ critical habitat in the recovery strategy or in an action plan for the species.” [subsection 2(1)]

Also, SARA defines habitat for aquatic species as “... spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced.” [subsection 2(1)]

For the Channel Darter, critical habitat is identified to the extent possible, using the best available information, and provides the functions and features necessary to support the species’ life-cycle processes, and to achieve the species’ population and distribution objectives.

This recovery strategy and action plan identifies critical habitat for the Channel Darter for Lake Erie populations (DU 1) in the St. Clair River, the Detroit River, an area adjacent to Point Pelee (western basin of Lake Erie), and Rondeau Bay (central basin of Lake Erie). Critical habitat has been identified for Lake Ontario populations (DU 2) in the Trent and Salmon rivers, and the Moira River system, which includes the Skootamatta and Black rivers. The habitat features required by Channel Darter differs between lentic and lotic environments and between locations found in DUs 1 and 2. Refer to table 20 for more information.

It is unknown if the critical habitat identified in this recovery strategy and action plan is sufficient to achieve the species' population and distribution objectives. The Schedule of Studies outlines the research required to acquire more detailed information about the critical habitat identified to achieve the species' population and distribution objectives.

### **8.1.2 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 aforementioned locations in DUs 1 and 2. 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 referenced in section 4.3 (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.

Critical habitat was identified based on a bounding box approach and further refined, where applicable, for riverine populations (in this case the rivers found in DU 2) with an ecological classification system, the Aquatic Landscape Inventory System (ALIS). ALIS was developed by the NDMNRF 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 (for example, ecological landscape changes, barriers). Therefore, if a population has been found in 1 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. Within all identified river segments (that is, valley segments), the width of the habitat zone is defined as the area from the mid-channel point to bankfull width on both the left and right banks. The critical habitat description includes the entire bankfull channel, which plays an essential role in maintaining channel-forming flows. 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 in keeping with the principles 7 and 8 of [SARA policies and guidelines](#) which emphasize the use of precaution where evidence is incomplete and protection should not be postponed for a lack of full scientific certainty.

In lake habitats, bathymetry and the high-water mark (HWM) were used to identify critical habitat. The HWM is the guideline elevation used by DFO to determine the minimum elevation

that is considered as the (up-shore) boundary for fish habitat and corresponds to the 80th percentile elevation for the month in which the highest annual water level occurs (that is, 80% of the time the water level is at or below this elevation) (DFO 2005) and, as such, has been used to define the up-shore boundary of critical habitat in this area. The area below the HWM may, or may not, be inundated, depending upon current water levels (that is, seasonal and cyclical water fluctuations). The bathymetry used was based on the watermark specified in the [IGLD 85](#)<sup>73</sup>.

Site-specific methods and data used to identify critical habitat are summarized below.

## DU 1

**St. Clair River:** The Channel Darter was detected in the upper portion of the St. Clair River in 2013 and 2014 (table 2). These records occur in several sections of the river, including an area just downstream of the Bluewater Bridge at Point Edward downstream to an area of the river adjacent to Sarnia Bay, in an area approximately 1.5 km upstream of Froomfield, and in the Stag Island area. The detections occurred during DFO and NDMNRF sampling events. Bathymetry data was used to identify critical habitat as areas < 6m in depth extending up to the HWM, which includes the range of 1.7 to 5.3 m specified as an attribute of critical habitat for the spawn to hatch and for adult life-stages of Channel Darter populations in DU1. The critical habitat was extended further downstream of the Channel Darter records using a precautionary approach to include areas where sampling has been fairly limited, and to include offshore areas of suitable depth (figure 5). Areas along the Sarnia Harbour and in Sarnia Bay, where anthropogenic structures are the predominant feature, were excluded from the bounding box.

**Detroit River:** The Channel Darter was historically captured in the Amhurstburg/Bois Blanc Island area and Bar Point in 1940. Between 1997 and 2013, the species has been captured at sites throughout the Detroit River, including the Peche Island area, the Windsor/Belle Isle area, the West Windsor area, the Fighting Island area, the Amhurstburg/Bois Blanc Island area, and Bar Point Area (table 2). These detections occurred during sampling conducted by DFO and United States Geological Survey (USGS). The same approach used to identify critical habitat in the St. Clair River was employed for the Detroit River (that is < 6 m depths extending up to the HWM). Given that recent records are found throughout the Detroit River, the bounding box is spread throughout the entire length of the river.

**Point Pelee:** The Channel Darter records from 1928 to 2010 exist for this location. The data used to identify critical habitat came from the Canadian Distribution Database, Essex Region Conservation Authority, the NDMNRF Lake Erie Management Unit, and Reid and Mandrak (2008). The bounding box approach was applied and refined using available habitat data (National Oceanic and Atmospheric Administration [NOAA] bathymetry, HWM and a shoreline classification system).

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 (that is, shoreline hardening) (Great Lakes Commission 2000). This system was used to refine

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<sup>73</sup> The National Oceanic and Atmospheric Administration states “the International Great Lakes Datum 1985 (IGLD 85) is a common reference system used to measure water level heights throughout the Great Lakes their connecting waterways, and the St. Lawrence River System. The IGLD is updated every 25-30 years” ([NOAA](#)).

the length of shoreline defined as critical habitat for the Channel Darter by eliminating types of habitat not believed to be utilized by the species in lacustrine habitat. See table 20 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 the 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.

**Rondeau Bay/Erieau shoreline:** The Channel Darter was historically captured along the Erieau shoreline outside of Rondeau Bay; however, no specimens have been captured in recent sampling, which focused on several sites along Erieau Beach. In 2018, 27 Channel Darter were captured by the NDMNRF within Rondeau Bay at 1 location on the North side of the barrier beach. No Channel Darter were captured at the other sampling locations within Rondeau Bay, which makes it difficult to determine the spatial extent of critical habitat at this location; however, the detection of 27 individuals suggests that a population likely occurs in this area; thus, the identification of critical habitat is warranted.

Given that no Channel Darter were detected at Erieau Beach, or many of the other locations along the shore of Rondeau Provincial Park, much of these areas were excluded from identification. Given the paucity of available information that characterizes the substrate type and degree of vegetation within Rondeau Bay, it was difficult to delineate a spatial area that best represents the attributes of critical habitat described for the Channel Darter for lacustrine populations in DU 1. For this reason, expert advice from DFO Biologists who have experience conducting sampling and habitat assessments in this area was used to delineate a bounding box that includes an area north of the barrier beach and along the southern shoreline of Rondeau Provincial Park, as well as the adjacent Lake Erie shoreline on the other side of the barrier each where sampling has not recently been conducted. Once more species sampling and habitat characterization is completed, the spatial extent of critical habitat at this location can be refined. The 2 m NOAA bathymetry contour was used to further define the lower extent of critical habitat for this species on the Lake Erie shoreline side of the barrier beach, similar to the approach used for Point Pelee.

## DU 2

**Trent, Moira (Black and Skootamatta rivers) and Salmon rivers:** Critical habitat was identified in the Trent River using data from sampling conducted by the NDMNRF, Portt and Associates, Canadian Distribution Database, and the Royal Ontario Museum database. For the Salmon River, records were obtained from sampling data provided by the OMNRF, and Eco Tec Consultants. Sampling data from the OMNRF (Reid 2004; and Reid et al. 2005) were used to identify critical habitat in the Moira River and 2 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.

### 8.1.3 Identification of critical habitat

#### Geographic information

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

- St. Clair River (figure 5)
- Detroit River (figure 6)
- Point Pelee (figure 7)
- Rondeau Bay (figure 8)
- Trent River (figures 9 and 10)
- Moira, Black rivers (figures 9 and 11)
- Skootamatta River (figures 9 and 12)
- Salmon River (figures 9 and 13)

Areas of critical habitat identified at these locations may overlap with critical habitat identified for other co-occurring species at risk (for example, Silver Chub); however, the specific habitat requirements within these areas may vary by species.

The areas delineated on the following maps (figures 5 to 13) 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 table 20). Table 19 provides 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 5 to 13. Note that permanent anthropogenic structures that may be present within the delineated areas (for example, marinas, navigation channels, marine dredgeate disposal areas) are specifically excluded; it is understood that maintenance or replacement of these features may be required at times. Brief explanations for the areas within which critical habitat is identified are provided for each of the waterbodies below.

**Table 20. Coordinates (Decimal Degrees) locating the boundaries within which critical habitat is found for the Channel Darter Lake Erie (DU 1) and Lake Ontario (DU 2) populations. All coordinates obtained using map datum NAD 83.**

Location	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
St. Clair River <sup>74</sup>	43.003106 -82.420066	43.010187 -82.407813	43.008323 -82.40209	42.973912 -82.406054	42.813641 -82.474345	42.815061 -82.480765
Detroit River <sup>74</sup>	42.353732 -82.914949	42.337122 -82.91313	42.268633 -83.093314	42.16861 -83.097415	42.054499 -83.116089	42.054585 -83.145202
Point Pelee (Lake Erie – western basin)	42.031512, -82.623682	41.987437, -82.497895	n/a	n/a	n/a	n/a
Rondeau Bay (Lake Erie – central basin)	42.257407, -81.907822	42.265147, -81.905398	42.265816, -81.892326	42.275137, -81.885956	42.274398, -81.880204	42.253713, -81.87854
Trent River <sup>74</sup>	44.263306, -77.602735	44.109493, -77.588877	n/a	n/a	n/a	n/a
Salmon River <sup>74</sup>	44.334299, -77.046374	44.207449, -77.209586	n/a	n/a	n/a	n/a
Moira River <sup>74</sup>	44.498687, -77.612931	44.159884, -77.384029	n/a	n/a	n/a	n/a
Skootomatta River <sup>74</sup>	44.617337, -77.233168	44.519251, -77.340058	n/a	n/a	n/a	n/a
Black River <sup>74</sup>	44.534126, -77.370005	44.529895, -77.371256	n/a	n/a	n/a	n/a

<sup>74</sup> Riverine habitats are delineated to the midpoint of channel of the uppermost stream segment and lowermost stream segment (that is, 2 points only).

**St. Clair River (figure 5):** The area within which critical habitat is found for the Channel Darter in the St. Clair River is currently identified as waters < 6 m in depth (IGLD 85) and extend up to the HWM from the border to the Canadian shoreline starting upstream in the Sarnia Long Beach area and the shoreline area of Canatara Beach and Park where the St. Clair River begins downstream to a point just below Mooretown (refer to table 20 for specific coordinates).

**Detroit River (figure 6):** The area within which critical habitat is found for the Channel Darter in the Detroit River is currently identified as waters < 6 m in depth and extend up to the HWM (IGLD 85) starting upstream of Peche Island from the border to the Canadian shoreline where the Detroit River begins downstream to the Bar Point area where the river ends and Lake Erie begins (refer to table 20 for specific coordinates).

**Lake Erie - Point Pelee (figure 7):** The area within which critical habitat is found for the 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 (IGLD 85) (refer to table 20 for specific coordinates).

**Rondeau Bay (figure 8):** The area within which critical habitat is found for the Channel Darter at Rondeau Bay is currently identified as the shoreline along the Lake Erie side of the barrier beach beginning at a point approximately 2 km east of the channel entrance to Rondeau Bay continuing west to the channel entrance to Rondeau Bay and extending down to the 2-m NOAA bathymetry contour and extending up to the HWM elevation for Lake Erie at 174.62 m above sea level (IGLD85). The bounding box then includes an area in the southeast corner of the bay on the north side of the barrier beach along the same 2 km stretch and extends northward approximately 2 km to include open-water sections of the bay and shoreline areas of Rondeau Bay Provincial Park (refer to table 20 for specific coordinates).

**Trent, Moira (Black and Skootamatta rivers), and Salmon rivers (figures 9 to 13):** 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 2 tributaries, critical habitat is identified within a reach approximately 121 km in length. In the Moira River, the area within which critical habitat is found extends from Highway 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 the 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 21-km-long stretch of river from approximately Forest Hill downstream to Milltown Rd. (refer to table 20 for specific coordinates).

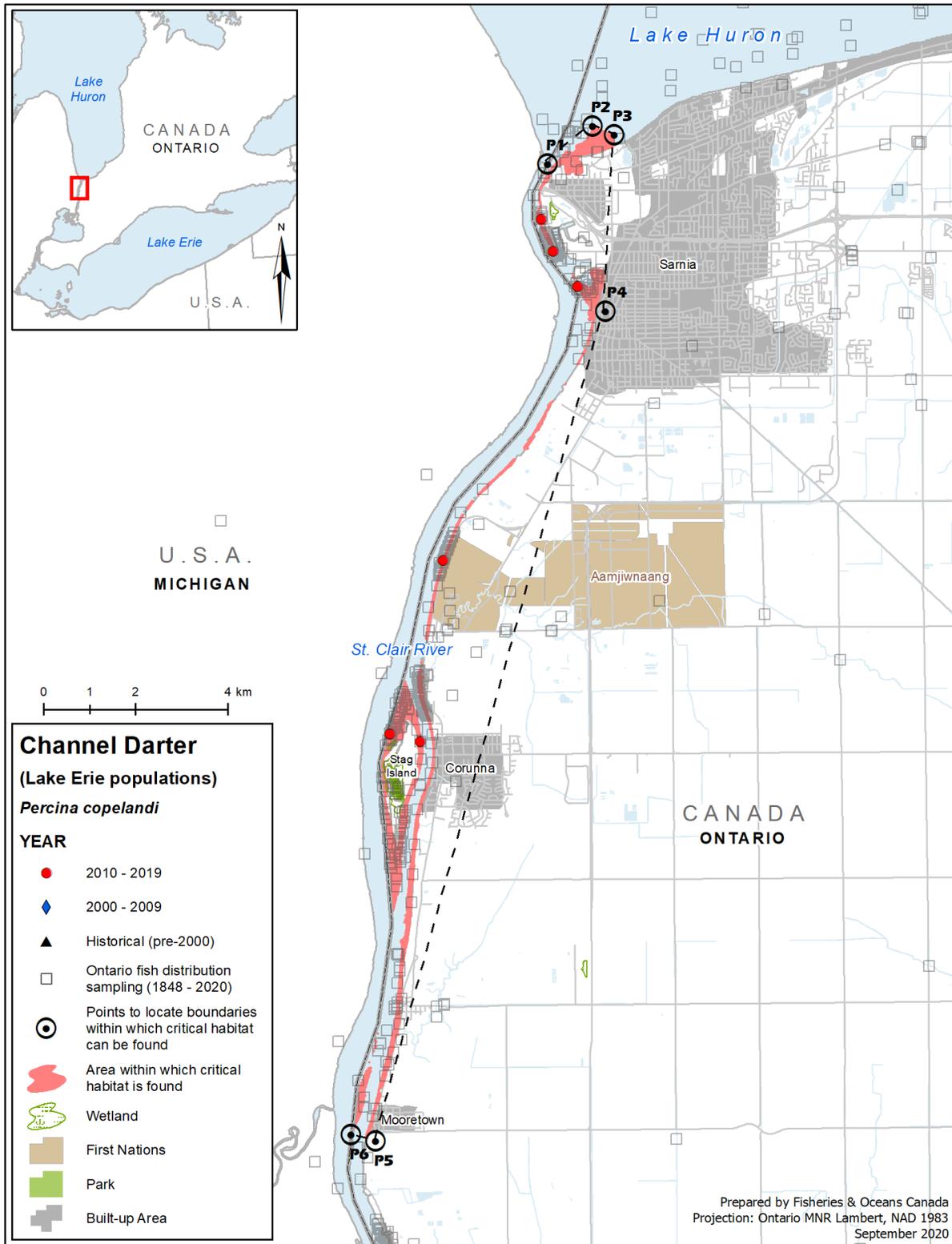


Figure 5. Boundaries of the area within which critical habitat of the Channel Darter is found in the St. Clair River.

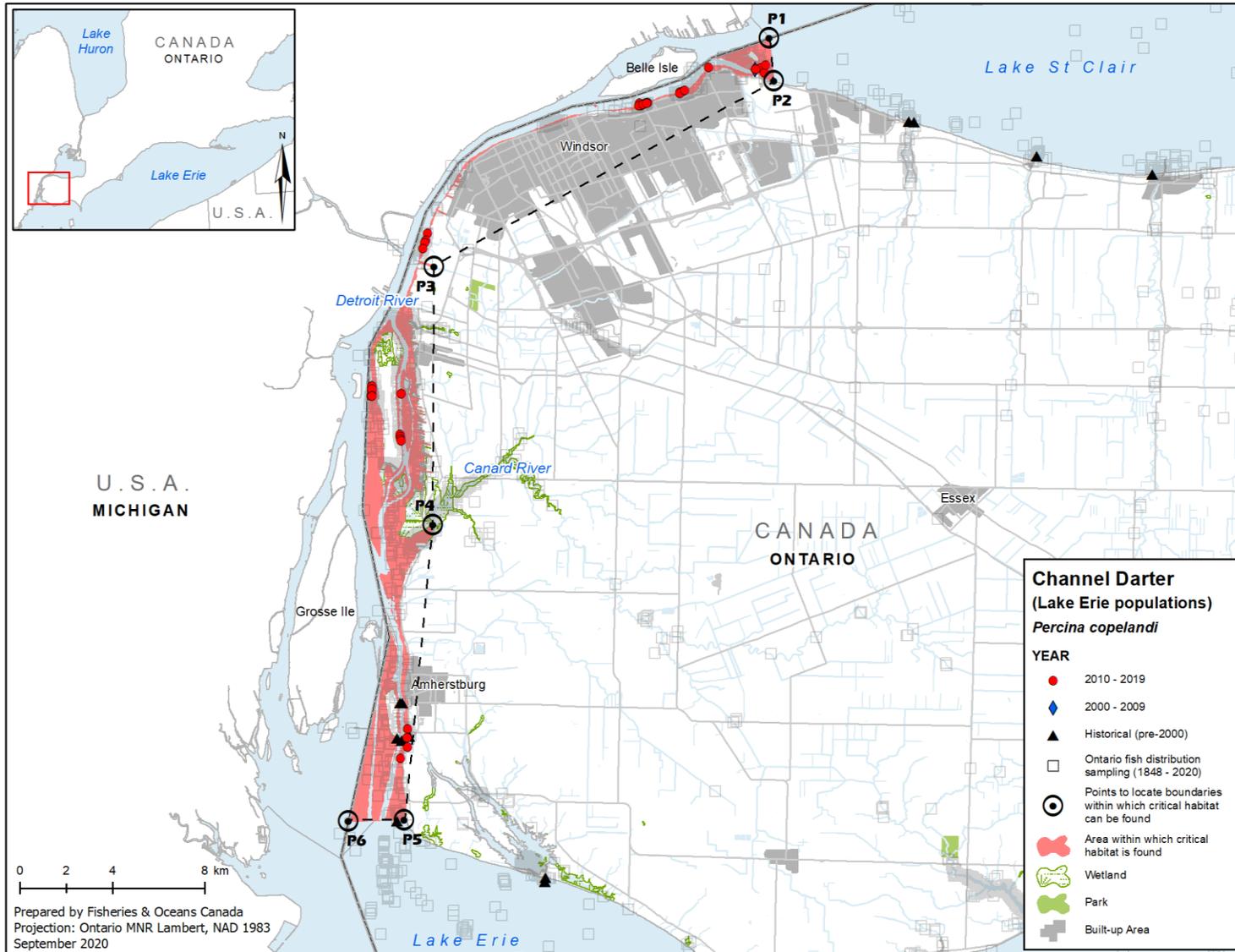


Figure 6. Boundaries of the area within which critical habitat of the Channel Darter is found in the Detroit River.

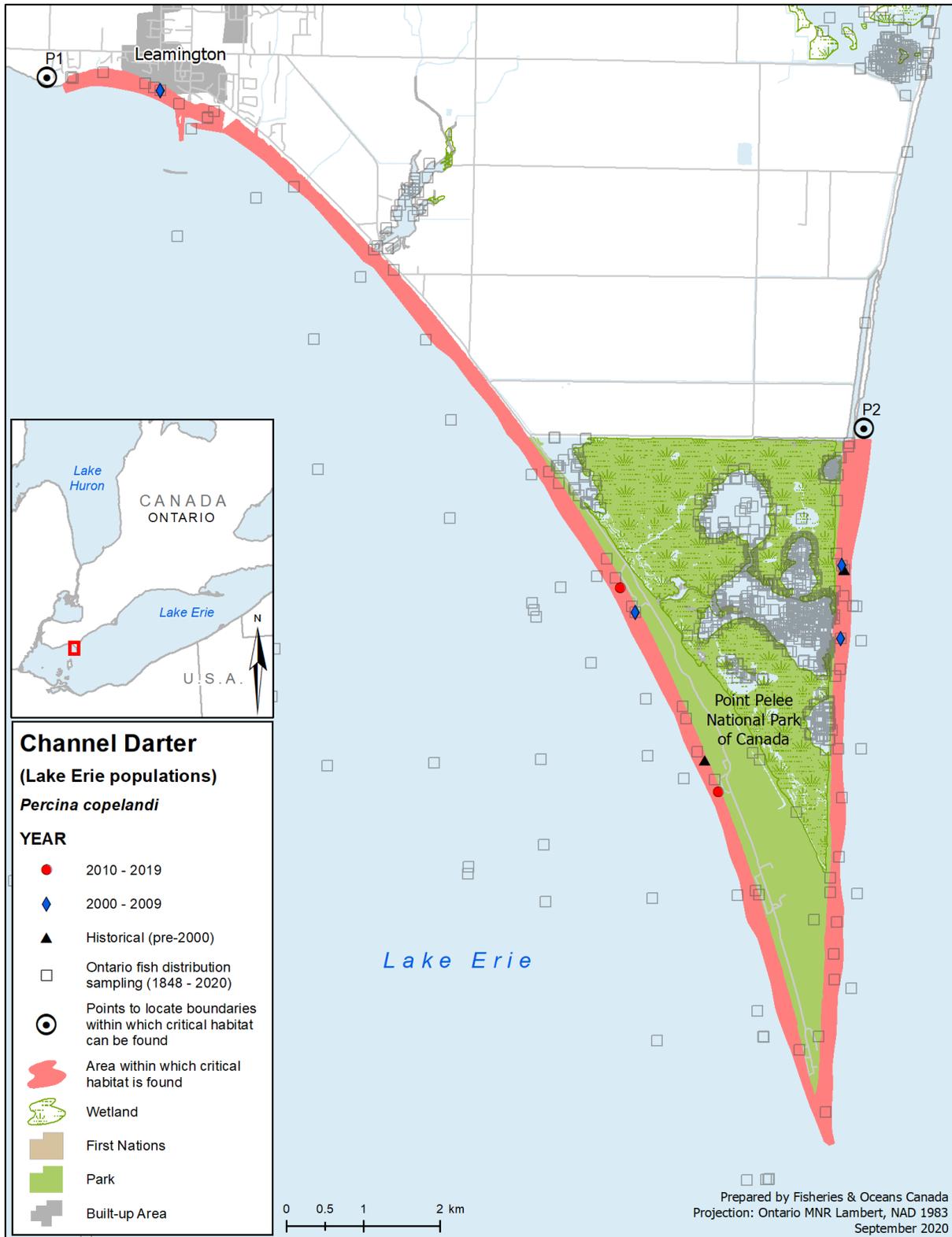


Figure 7. Boundaries of the area within which critical habitat of the Channel Darter is found in Lake Erie at Point Pelee.

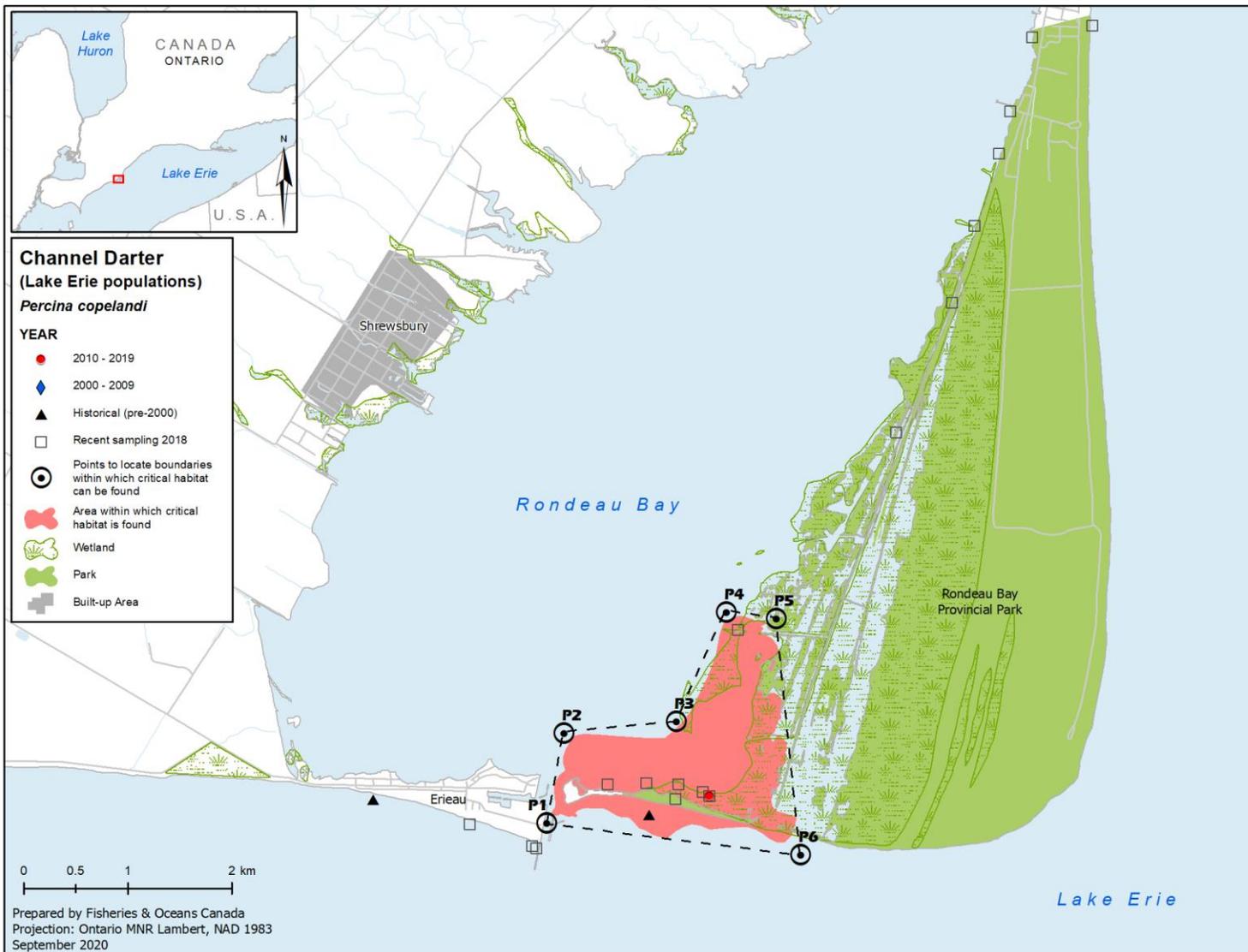


Figure 8. Boundaries of the area within which critical habitat of the Channel Darter is found in Rondeau Bay.

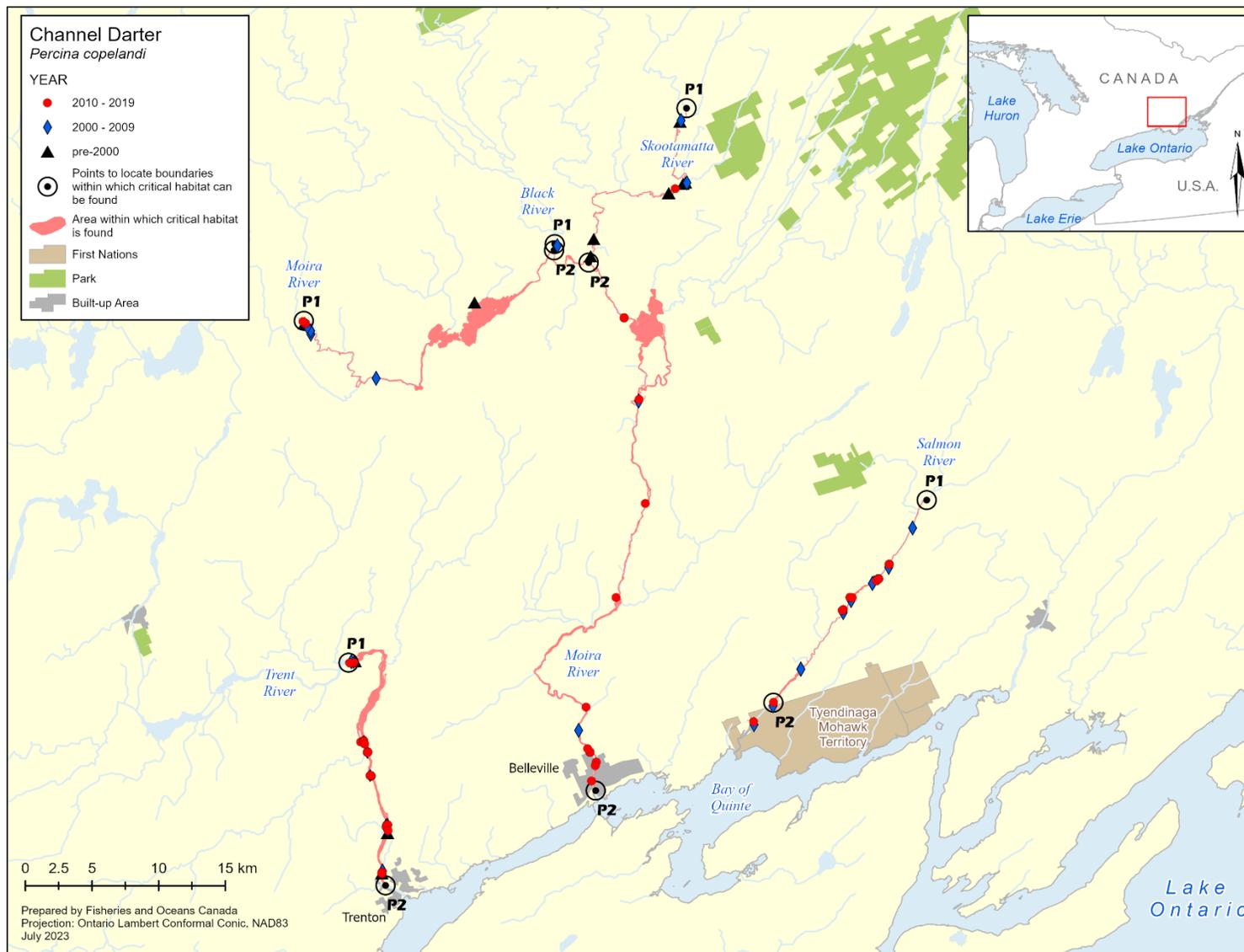


Figure 9. Boundaries of the area within which critical habitat of the Channel Darter is found in the Trent, Moira (Black and Skootamatta), and Salmon rivers.

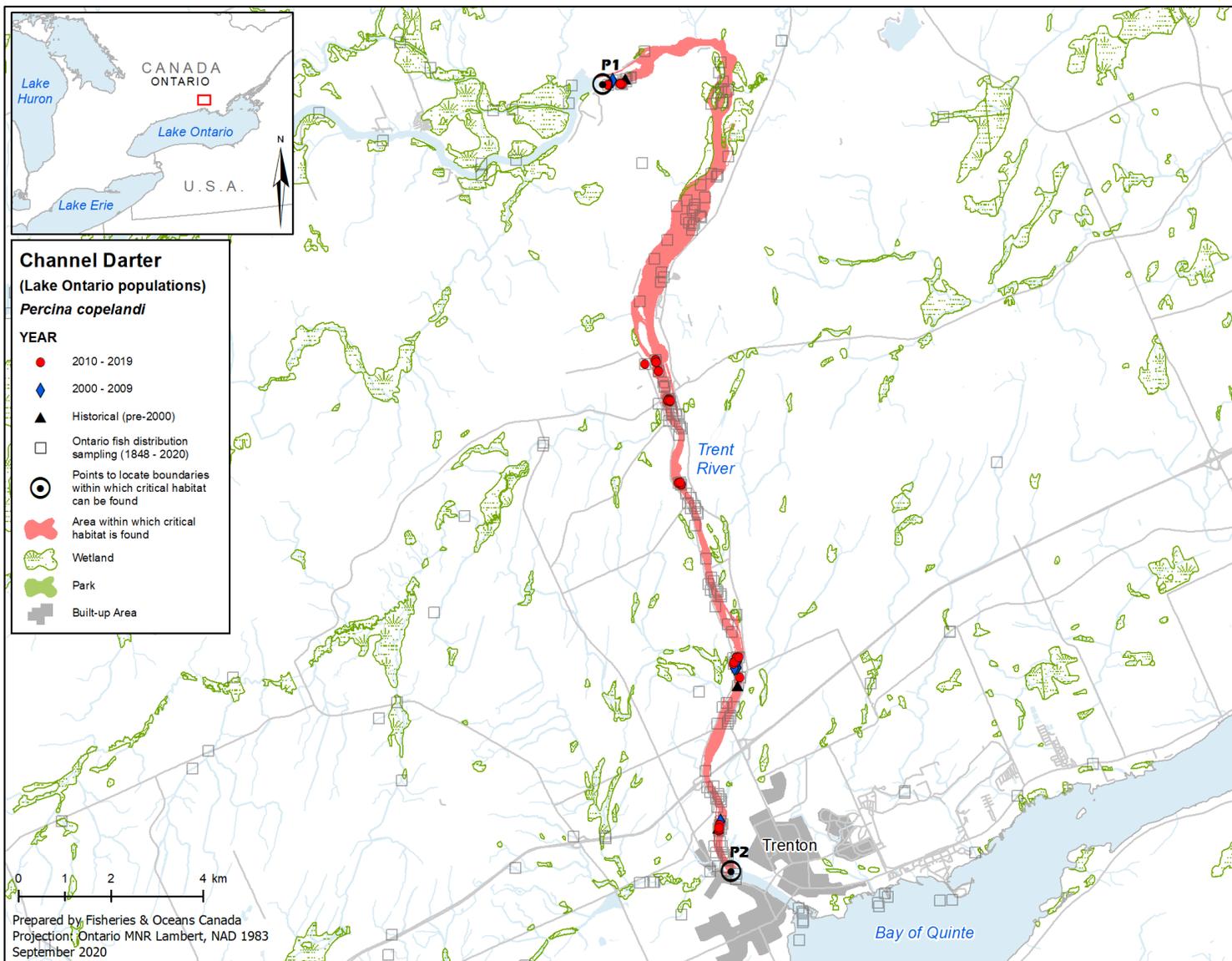


Figure 10. Boundaries of the area within which critical habitat of the Channel Darter is found in the Trent River.

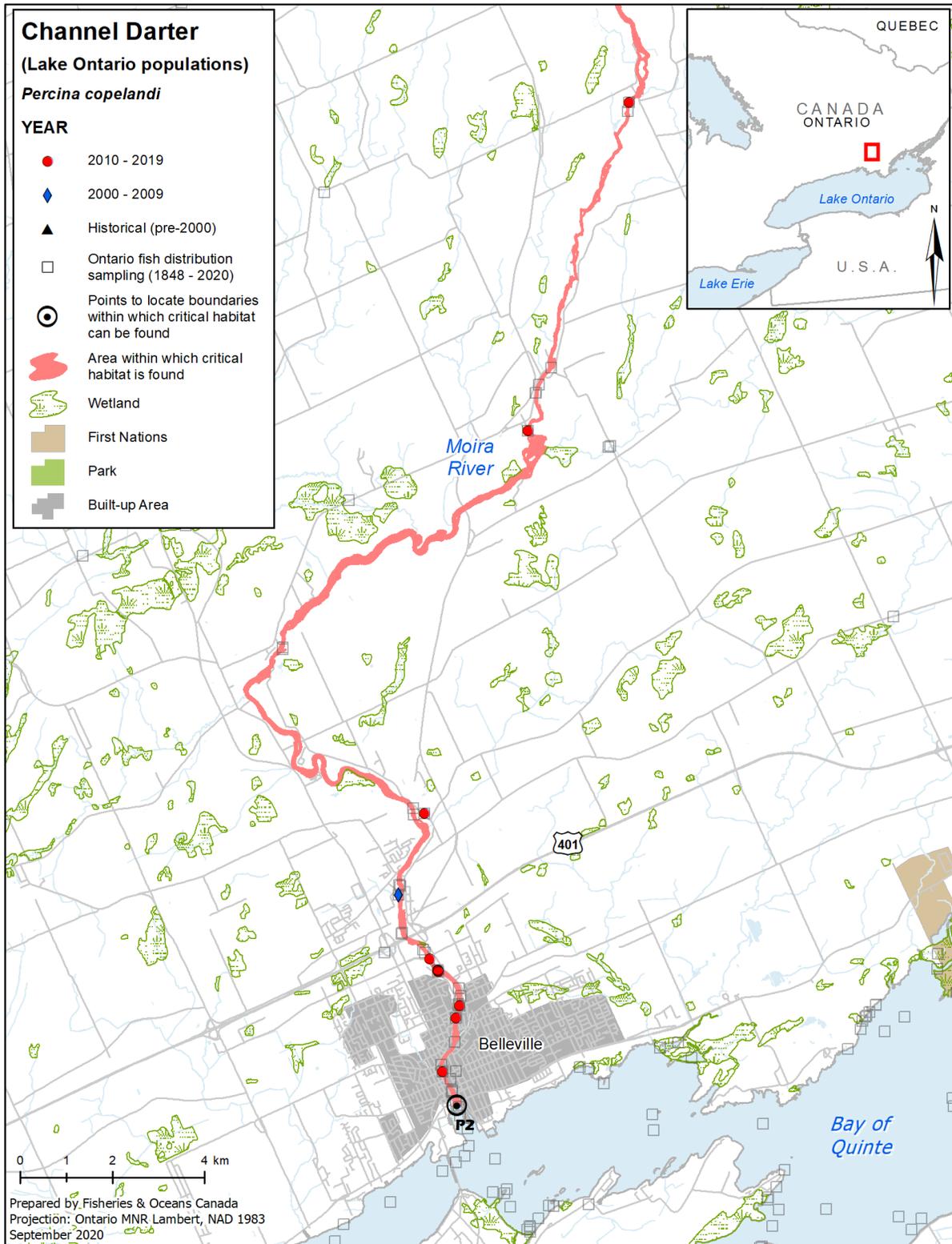


Figure 11. Boundaries of the area within which critical habitat of the Channel Darter is found in the lower Moira River.

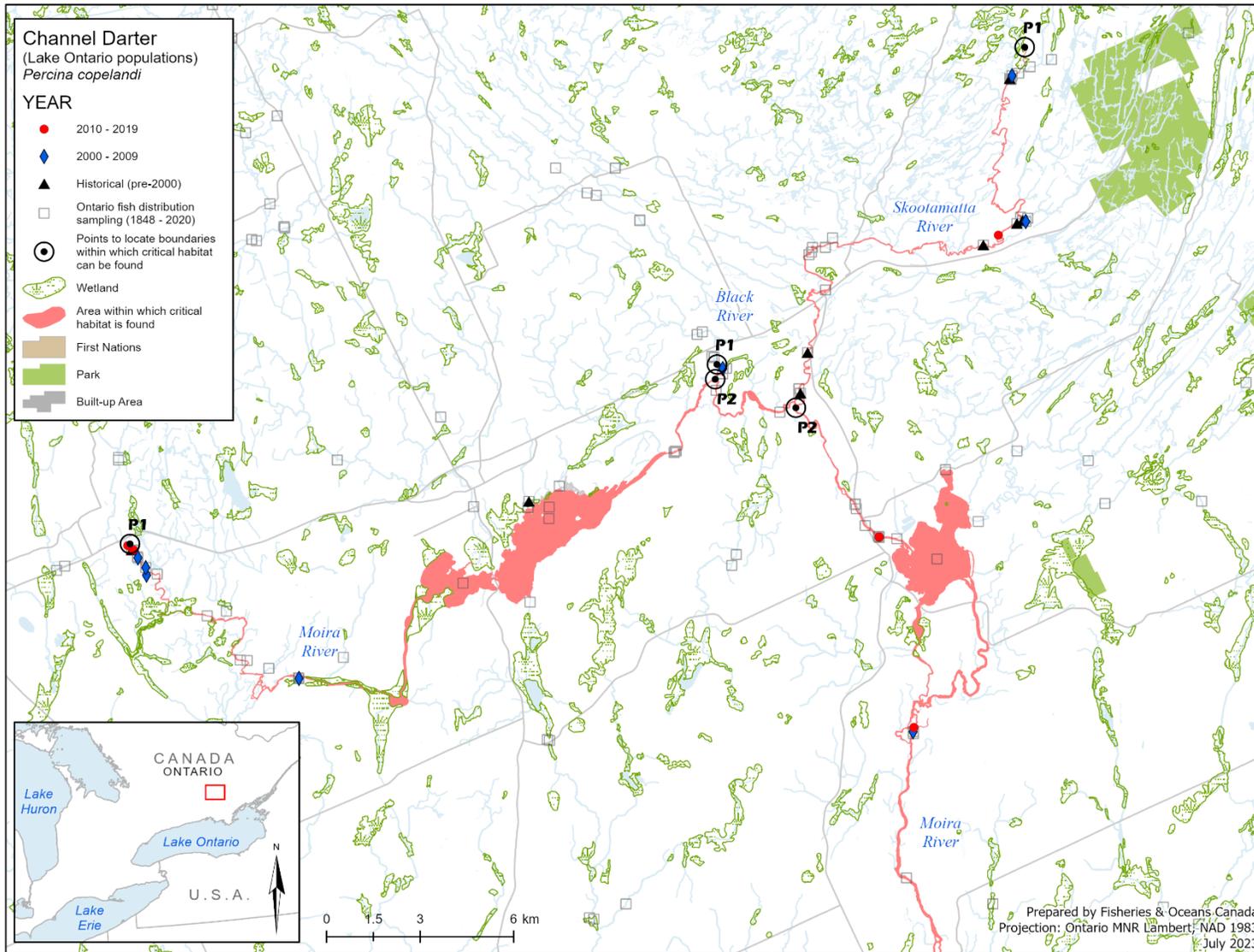


Figure 12. Boundaries of the area within which critical habitat of the Channel Darter is found in the upper Moira River and the Black and Skootamatta rivers.

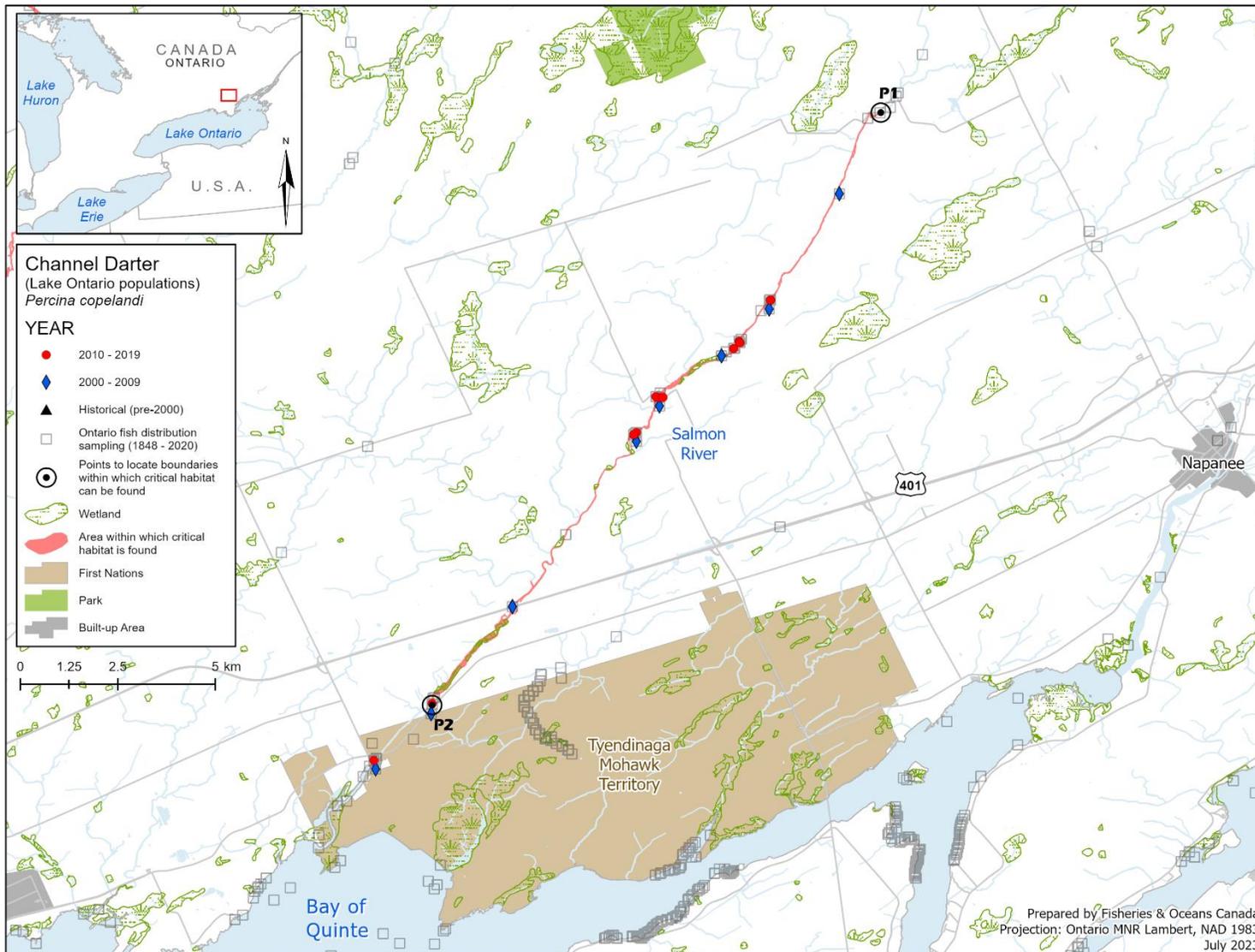


Figure 13. Boundaries of the area within which critical habitat of the Channel Darter is found in the Salmon River.

## Biophysical functions, features, and attributes

A relatively wide range of features and attributes have been reported for this species and it appears that habitat characteristics can vary from 1 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. Table 21 summarizes available knowledge on the essential functions, features and attributes for each life stage (refer to section 4.3 Needs of the Channel Darter, and Andrews and Drake [2020] for full references). Areas identified as critical habitat must support 1 or more of these habitat functions. 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 (for example, current velocity and depth in spring flood vs. summer or fall drought). Further information will be required to refine the description of critical habitat (for example, for most populations, it is unclear where spawning occurs).

**Table 21. General summary of the biophysical functions, features, attributes, and location of critical habitat necessary for the survival or recovery of Channel Darter Lake Erie (DU 1) and Lake Ontario (DU 2) populations.**

Life stage	Function <sup>75</sup>	Features <sup>76</sup>	Attributes <sup>77</sup>
Spawn to Hatch (usually May)	Spawning cover nursery	Riffle and shoal habitats	<p>For DU 1 lacustrine populations</p> <ul style="list-style-type: none"> <li>coarse sand – fine gravel beaches</li> </ul> <p>For DU 1 riverine populations</p> <ul style="list-style-type: none"> <li>water depths of 1.7 to 5.3 m</li> <li>mean water velocity of 0.21 m/s</li> </ul> <p>For DU 2</p> <ul style="list-style-type: none"> <li>riffles and shoals with moderate flow</li> <li>cobble and gravel substrates</li> <li>depths &lt;1 m</li> <li>flow velocity ~0.5 m/s</li> </ul>

<sup>75</sup> Function: A life-cycle process of the listed species taking place in critical habitat (for example, spawning, nursery, rearing, feeding, and migration). The function informs the rationale for its protection. The identification of critical habitat must describe how the functions support a life process necessary for the survival or recovery of species at risk.

<sup>76</sup> Feature: Every function is the result of a single or multiple feature(s), which are the structural components of the critical habitat. Features describe the essential structural component that provides the requisite function(s) to meet the species' needs. Features may change over time and are usually comprised of more than 1 part, or attribute. A change or disruption to the feature or any of its attributes may affect the function and its ability to meet the biological needs of the species.

<sup>77</sup> Attribute: Attributes are measurable properties or characteristics of a feature. Attributes describe how the identified features support the identified functions necessary for the species' life processes. Together, the attributes allow the feature to support the function. In essence, attributes provide the greatest level of information about a feature, the quality of the feature, and how the feature is able to support the life-cycle requirements of the species.

Life stage	Function <sup>75</sup>	Features <sup>76</sup>	Attributes <sup>77</sup>
YOY to Juvenile (age 1 until sexual maturity)	Feeding cover nursery	Riffles, shoals, pools	<p>For DU 1 lacustrine populations</p> <ul style="list-style-type: none"> <li>coarse sand – fine gravel beaches</li> </ul> <p>For DU 1 riverine populations</p> <ul style="list-style-type: none"> <li>slow to moderate (~0.5 m/s) sections of connecting channels with fine to coarse substrate</li> </ul> <p>For DU 2</p> <ul style="list-style-type: none"> <li>slow-moving riffles and pools with fine to coarse substrate.</li> </ul>
Adult	Feeding cover winter refugia	Riffles, shoals, coarse-sand beaches, pools	<p>For DU 1 lacustrine populations</p> <ul style="list-style-type: none"> <li>coarse sand – fine gravel beaches</li> </ul> <p>For DU 1 riverine populations</p> <ul style="list-style-type: none"> <li>water depths of 1.7 to 5.3 m</li> </ul> <p>For DU 2</p> <ul style="list-style-type: none"> <li>riffles and shoals with an average depth of 0.4 m and an average flow of 0.3 m/s</li> <li>coarse substrate of cobble and gravel</li> </ul> <p>Both DUs</p> <ul style="list-style-type: none"> <li>good water quality (that is, low turbidity, sufficient dissolved oxygen, low pollution levels)</li> <li>availability of prey (benthic macroinvertebrates)</li> </ul>

(Table adapted from Andrews and Drake 2020)

Studies to refine knowledge on the essential functions, features and attributes for various life stages of the Channel Darter are described in section 8.2 (Schedule of Studies to Identify Critical Habitat).

### Summary of critical habitat relative to population and distribution objectives

Locations identified as critical habitat are areas that, based on current best available information, the Minister of Fisheries and Oceans considers necessary to partially achieve the species' population and distribution objectives required for the survival/recovery of the species. Additional critical habitat may be identified in future updates to the recovery strategy and action plan.

### Population viability

The minimum area for population viability (MAPV) for each life stage of the Channel Darter was estimated for DUs 1 and 2 (table 21). 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). Therefore, 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). 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<sup>2</sup> in rivers and 1.252 km<sup>2</sup> in lakes. For more information on the MVP and MAPV and associated methodology, refer to Venturelli et al. (2010).

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 tables 22 and 23). The critical habitats identified inside the segments are the areas that meet the functional habitat requirements outlined in table 21. 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 that is actually comprised of the attributes described in table 21 that is 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 tables 22 and 23 are preliminary and should be interpreted with caution.

**Table 22. Comparison of area within which critical habitat is found for each Channel Darter Lake Erie Populations (designatable unit 1), relative to the estimated minimum area for population viability (MAPV).**

Population <sup>78</sup>	Area within which critical habitat is identified (km <sup>2</sup> )	Habitat type	MAPV area (km <sup>2</sup> )	MAPV achieved?
St. Clair River	3.05	Riverine	0.04	Yes
Detroit River	26.34	Riverine	0.04	Yes
Point Pelee	7.01	Lacustrine	1.25	Yes
Rondeau Bay	2.36	Lacustrine	1.25	Yes

<sup>78</sup> Note that some locations may contain more than 1 population (for example, some of the larger areas, such as Trent River). In such cases, the MAPV would be applied to each individual population.

**Table 23. Comparison of area within which critical habitat is found for each Channel Darter Lake Ontario Population (designatable unit 2), relative to the estimated minimum area for population viability (MAPV).**

Population <sup>79</sup>	Area within which critical habitat is identified (km <sup>2</sup> )	Habitat type	MAPV area (km <sup>2</sup> )	MAPV achieved?
Trent River	4.85	Riverine	0.04	Yes
Moira River, Black River, Skootamatta River	5.94	Riverine	0.04	Yes
Salmon River	0.94	Riverine	0.04	Yes

## 8.2 Schedule of studies to identify critical habitat

Further research is required to identify and protect critical habitat necessary to support the species' population and distribution objectives. The activities listed in table 24 are not exhaustive, and it is likely that conducting these scientific studies will lead to the discovery of further knowledge gaps that need to be addressed, as well as the potential discovery of critical habitat features for other species at risk.

**Table 24. Schedule of studies to identify critical habitat for Channel Darter Lake Erie (designatable unit [DU] 1) and Lake Ontario (DU 2) populations.**

Description of study	Rationale	Timeline
Conduct studies to determine the habitat requirements for each life stage of the Channel Darter.	Limited information is available regarding the habitat requirements for young-of-the-year and 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. In addition, not much is currently known about the home range size or the overwintering habitat requirements for the Channel Darter. It is believed that Channel Darter, in both lacustrine and riverine habitats, utilize areas in winter months with habitat features that differ from what is currently described in table 20: therefore, further research is recommended. Furthermore, very little information is currently available regarding the habitat use of Channel Darter in DU 1 lacustrine areas (for example, depth range).	5 years

<sup>79</sup> Note that some locations may contain more than 1 population (for example, some of the larger areas, such as Trent River). In such cases, the MAPV would be applied to each individual population.

Description of study	Rationale	Timeline
Survey and map habitat quality and quantity within historical and current sites, as well as sites adjacent to currently occupied habitat.	These surveys will strengthen the confidence in data used to determine if sites meet the criteria for critical habitat and assist in refining the spatial boundaries of critical habitat. Specifically, more information would be beneficial to refine the spatial extent of critical habitat in Rondeau Bay.	5 years
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.	5 years
Create a population-habitat supply model for each life stage.	Such modelling will aid in the development of recovery targets and the determination of the quantity of critical habitat required by each life stage to meet these targets.	5 years
Based on collected information, review population and distribution objectives. Determine amount, configuration and description of critical habitat required to achieve these objectives if adequate information exists. Validate model.	Refinement of recovery objectives and the critical habitat description to meet these objectives.	5 years

Activities identified in this schedule of studies will be carried out through collaboration between DFO, PC, and other relevant groups and land managers.

### 8.3 Activities likely to result in the destruction of critical habitat

Under SARA, critical habitat must be legally protected within 180 days of being identified in a final recovery strategy or action plan. For Channel Darter critical habitat, it is anticipated that this will be accomplished through a SARA Critical Habitat Order made under subsections 58(4) and (5), which will invoke the prohibition in subsection 58(1) against the destruction of any part of the identified critical habitat. Within DU1, these areas include the St. Clair River, the Detroit River, Point Pelee, and Rondeau Bay. Within DU 2, these areas include the Trent River, the Moira River, and the Salmon River. A portion of the critical habitat identified along Point Pelee occurs within the boundaries of Point Pelee National Park. As per subsection 58(2), the protection of this area of critical habitat will be accomplished via the publication of a Critical Habitat Description within 90 days of posting the final Recovery Strategy and Action Plan.

The following examples of activities likely to result in the destruction<sup>80</sup> of critical habitat (table 25) are based on known human activities that are likely to occur in, and around, critical habitat and may result in the destruction of critical habitat if unmitigated. The list of activities is neither exhaustive nor exclusive and has been guided by the threats described in section 5. The absence of a specific human activity from this table does not preclude or restrict the Department's ability to regulate that activity under the SARA. Furthermore, the inclusion of an

<sup>80</sup> Destruction occurs when there is a temporary or permanent loss of a function of critical habitat at a time when it is required by the species.

activity does not result in its automatic prohibition, and does not mean the activity will inevitably result in destruction of critical habitat. Every proposed activity must be assessed on a case-by-case basis and site-specific mitigation will be applied where it is reliable and available. Where information is available, thresholds and limits have been developed for critical habitat attributes to better inform management and regulatory decision-making. However, in many cases, knowledge of a species and its critical habitat's thresholds of tolerance to disturbance from human activities is lacking and must be acquired.

**Table 25. Activities likely to result in the destruction of critical habitat for Channel Darter Lake Erie (designatable unit [DU] 1) and Lake Ontario (DU 2) populations.**

Threat	Activity	Effect-pathway	Function affected	Feature affected	Attribute affected
Habitat modifications	<ul style="list-style-type: none"> <li>• Shoreline hardening</li> <li>• Placement of material or structures in water (for example, groynes, piers, infilling, partial infills, jetties)</li> <li>• Dredging</li> <li>• Grading</li> <li>• Excavation</li> </ul>	<p>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.</p> <p>Hardening of shorelines can impact organic inputs into the water and alter water temperatures, potentially affecting the availability of prey for this species.</p> <p>Placing material or structures in water reduces habitat availability (for example, 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.</p>	Spawning, Cover, Nursery, Feeding, Winter refugia	Riffles, shoals, coarse-sand beaches, pools	<p><b>Riverine locations:</b></p> <ul style="list-style-type: none"> <li>• depth</li> <li>• current</li> <li>• riffles and shoals with moderate flow</li> <li>• cobble and gravel substrates</li> <li>• slow to moderate sections of connecting channels with fine to coarse substrate</li> <li>• slow moving riffles and pools with fine to coarse substrate</li> <li>• coarse substrate of cobble and gravel</li> </ul> <p><b>Lacustrine locations:</b></p> <ul style="list-style-type: none"> <li>• coarse sand – fine gravel beaches</li> </ul>

Threat	Activity	Effect-pathway	Function affected	Feature affected	Attribute affected
Habitat modifications	<ul style="list-style-type: none"> <li>• 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</li> <li>• Installation of barriers to movement (for example, dams)</li> </ul>	<p>Rapid, repeated, and prolonged changes in water flow (increases or decreases) can have a negative effect on Channel Darter habitat, especially spawning habitat. Large changes (rapid or prolonged) in water flow can cause significant sediment deposition (for example, changing preferred substrates) or change in prey abundance.</p> <p>Barriers can restrict access to important habitat areas and fragment fish populations, affecting distribution of the Channel Darter.</p>	All	All	<p><b>Riverine locations:</b></p> <ul style="list-style-type: none"> <li>• depth</li> <li>• current</li> <li>• riffles and shoals with moderate flow</li> <li>• cobble and gravel substrates</li> <li>• slow to moderate sections of connecting channels with fine to coarse substrate</li> <li>• slow moving riffles and pools with fine to coarse substrate</li> <li>• coarse substrate of cobble and gravel</li> </ul>

Threat	Activity	Effect-pathway	Function affected	Feature affected	Attribute affected
Habitat modifications	<ul style="list-style-type: none"> <li>• Unfettered livestock access to waterbodies</li> <li>• Grazing of livestock and ploughing to water's edge</li> </ul>	<p>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.</p>	All	All	<p><b>Riverine locations:</b></p> <ul style="list-style-type: none"> <li>• cobble and gravel substrates</li> <li>• slow to moderate sections of connecting channels with fine to coarse substrate</li> <li>• slow moving riffles and pools with fine to coarse substrate</li> <li>• coarse substrate of cobble and gravel</li> </ul> <p><b>Lacustrine locations:</b> coarse sand – fine gravel beaches</p>
Exotic species and diseases	<ul style="list-style-type: none"> <li>• Introduction of invasive species (for example, from boats and baitfish releases)</li> </ul>	<p>The presence of Round Goby may exclude the Channel Darter from preferred habitat and cause increased competition for prey.</p>	All	All	<ul style="list-style-type: none"> <li>• Good water quality (that is, low turbidity, sufficient dissolved oxygen, low pollution levels)</li> <li>• Availability of prey</li> </ul>
Contaminants and toxic substances	<ul style="list-style-type: none"> <li>• Over application or misuse of herbicides, insecticides, and pesticides</li> <li>• Release of urban and industrial pollution into habitat</li> </ul>	<p>Introduction of toxic compounds into habitat used by this species can change water quality, affecting habitat availability or use and prey availability.</p>	All	All	<ul style="list-style-type: none"> <li>• Good water quality</li> <li>• Availability of prey</li> </ul>

Threat	Activity	Effect-pathway	Function affected	Feature affected	Attribute affected
Nutrient loading	<ul style="list-style-type: none"> <li>Over-application of fertilizer and improper nutrient management (for example, organic debris management, wastewater management, animal waste, septic systems, and municipal sewage)</li> </ul>	<p>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.</p>	All	All	<ul style="list-style-type: none"> <li>All substrate and flow attributes listed above</li> </ul>
Turbidity and sediment loading	<ul style="list-style-type: none"> <li>Altered flow regimes causing erosion and changing sediment transport (for example, tiling of agricultural drainage systems, removal of riparian zones)</li> <li>Work in, or around, water with improper sediment and erosion control (for example, overland run-off from ploughed fields, use of industrial equipment, and cleaning or maintenance of bridges or other structures)</li> </ul>	<p>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 (for example, gill irritation).</p> <p>Also see: Habitat modifications – Change in timing, duration, and frequency of flow.</p>	All	All	<ul style="list-style-type: none"> <li>All attributes listed above</li> </ul>

In the future, threshold values for some stressors may be informed through further research. For some of the above activities, BMPs may be enough to mitigate threats to the species and its habitat. However, in other cases, it is not known if BMPs are adequate to protect critical habitat, and further research is required.

## **9. Evaluation of socio-economic costs and benefits of the action plan**

SARA requires that the action plan component of the recovery document<sup>81</sup> include an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation (SARA 49(1)(e), 2003). This evaluation addresses only the incremental socio-economic costs of implementing this action plan from a national perspective, as well as the social and environmental benefits that would occur if the action plan were implemented in its entirety, recognizing that not all aspects of its implementation are under the jurisdiction of the federal government. It does not address cumulative costs of species recovery in general nor does it attempt a cost-benefit analysis. Its intent is to inform the public and to guide decision-making on implementation of the action plan by DFO and its partners.

This evaluation does not address any ‘underway’ measures (that is, measures that were initiated or implemented prior to the development of the action plan but have not yet been completed) as they are not considered as incremental costs to the government and other stakeholders (for example, research studies to identify critical habitat). In addition, the analysis does not address the costs associated with social and cultural loss of access to the species by Indigenous peoples and Canadians.

The protection and recovery of species at risk can result in both benefits and costs. The preamble to SARA recognizes that “wildlife, in all its forms, has value in and of itself and is valued by Canadians for aesthetic, cultural, spiritual, recreational, educational, historical, economic, medical, ecological and scientific reasons” (SARA 2003). Self-sustaining and healthy ecosystems with their various elements in place, including species at risk, contribute positively to the livelihoods and the quality of life of all Canadians. Actions taken to preserve a species, such as habitat protection and restoration, are also valued. An estimate of the costs and benefits associated with this action plan are described below.

This evaluation does not address the socio-economic impacts of protecting critical habitat for the Channel Darter. Under SARA, DFO must ensure that critical habitat identified in a recovery strategy or action plan is legally protected within 180 days of the final posting of the recovery document. Where an Order will be used for critical habitat protection, the development of the SARA Critical Habitat Order will follow a regulatory process in compliance with the Cabinet Directive on Regulation, including an analysis of any potential incremental impacts of the Order that will be included in the Regulatory Impact Analysis Statement. As a consequence, no additional analysis of the critical habitat protection has been undertaken for the assessment of costs and benefits of the action plan.

### **Policy Baseline**

The policy baseline consists of the protection under SARA for the Channel Darter (DU 1 and DU 2). The species was listed under the SARA as endangered in 2019. It is also listed as a species

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<sup>81</sup> The “action plan component of the recovery document” will simply be referred to as “action plan” from this point forward.

of special concern under Ontario's *Endangered Species Act (ESA), 2007*. Further protections may be afforded to Channel Darter and its habitat under other provincial legislation<sup>82</sup>.

### **Socio-economic costs**

The recovery measures in this plan are grouped under 4 broad strategies: management and coordination; inventory and monitoring; research; and stewardship and outreach. Costs would be incurred by the lead agencies to implement the measures listed in the recovery strategy and action plan, and by partners who choose to participate in the recovery measures. Some measures are ongoing, whereas others occur once or twice. The present value of the costs of implementing the recovery measures in this plan are anticipated to be approximately \$550K over a 5-year period<sup>83</sup>. Implementation of the actions is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations. Costs would be incurred by the federal government to implement the activities listed in the recovery strategy and action plan. In-kind costs, such as volunteer time and providing expertise and equipment, would be incurred as a result of implementing activities listed in the recovery strategy and action plan. Costs (including in-kind support) could be incurred by the province of Ontario and conservation authorities.

Long-term recovery activities will be developed through a cooperative approach following discussions among other agencies, levels of government, stewardship groups, and stakeholders allowing for consideration of costs and benefits during the process.

### **Socio-economic benefits**

Some of the benefits of recovery actions required to return/maintain self-sustaining populations of Channel Darter outlined in this recovery strategy and action plan are difficult to quantify but would generally be positive. If implemented, stewardship programs to improve habitat conditions and reduce threats within critical habitat could help to improve riverine habitat and lead to healthier watersheds through improved water quality.

Some unquantifiable non-market benefits would be enjoyed by the Canadian public as a result of implementing the recovery actions contained in the action plan. Research (Rudd et al. 2016) found that Canadian households had positive and significant willingness to pay values for recovery actions that led to improvements for little known species at risk in southwestern Ontario.

In the absence of information on biological outcomes of the measures identified in the action plan, it is not possible to estimate the incremental benefits that can be directly attributed to the implementation of the recovery measures.

### **Distributional Impacts**

Governments and conservation authorities will incur the majority of costs of implementing the action plan.

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<sup>82</sup> Examples of other provincial legislation that provide habitat protection include, but may not be limited to, considerations under section 2.1.7 of the Provincial Policy Statement (2020) under Ontario's *Planning Act*, which prohibits development and site alteration in habitat of endangered and threatened species, except in accordance with provincial and federal requirements, as well as protection under the *Lakes and Rivers Improvement Act* in Ontario.

<sup>83</sup> The present value of the total incremental costs of the action plan was estimated with a discount rate of 7% over the 5-year period.

The Canadian public will benefit from the implementation of the action plan through expected non-market benefits associated with recovery and protection of the species and its habitat. Recovery actions that improve riverine habitat will help lead to a healthier ecosystem, which has additional benefits to Canadians such as improvements to water quality.

## 10. Measuring progress

A report on the implementation of the recovery strategy and action plan (pursuant to sections 46 and 55 of SARA) will be produced through the evaluation of progress made in implementing the key strategies and measures proposed in section 7.2 (tables 16 to 18). Reporting on the implementation of the action plan requires an assessment of the ecological and socio-economic impacts (under section 55 of SARA). A report on the ecological impacts of the action plan will be produced by evaluating the results of the monitoring of the species' recovery and long-term viability and by evaluating the implementation of the action plan. Reporting on the socio-economic impacts of the action plan will be done by providing information on the costs incurred to implement the action plan. Assessing the benefits of the action plan would not be possible as information on specific ecological outcomes is difficult to attribute to specific recovery measures outlined in the action plan. However, if such information is available, effort would be made to analyze the socio-economic impacts (costs and benefits) to the extent possible.

## 11. Activities permitted by the recovery strategy and action plan

SARA states that “Subsections 32(1) and (2), section 33 and subsections 36(1), 58(1), 60(1) and 61(1) do not apply to a person who is engaging in activities that are permitted by a recovery strategy, an action plan or a management plan and who is also authorized under an Act of Parliament to engage in that activity, including a regulation made under section 53, 59 or 71.” As per subsection 83(4).

The following activity is permitted by this recovery strategy and action plan:

Activity 1: continuation of limited commercial and sport baitfish harvesting.

Commercial baitfish harvesting is regulated by the province of Ontario where the Channel Darter is not legal baitfish. Commercial baitfish harvesting is regulated under the *Fisheries Act* through the Ontario Fishery Regulations. As outlined in section 5.2 (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 section 83(4). The management of Channel Darter recovery could include limited fishing mortality, as the threat to the Channel Darter by baitfish harvest is low.

Under section 83(4) of SARA, this recovery strategy and action plan 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 2 conditions:

1. the fishing activities are conducted under licenses issued under the Ontario Fishery Regulations 2007

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

For activities not listed above that are likely to interact with the Channel Darter in a manner prohibited by SARA, section 73 permits may be sought by contacting the regional DFO office.

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## Appendix A: record of cooperation and consultation

Recovery strategies and action plans are to be prepared in cooperation and consultation with other jurisdictions, organizations, affected parties and others as outlined in *Species at Risk Act* (SARA) sections 39 and 48. Fisheries and Oceans (DFO) has utilized a process of species expert and subject matter expert review to seek input to the development of this recovery strategy and action plan. Information on participation is included below.

Member / attendee	Affiliation
<b>Fisheries and Oceans Canada</b>	
Andrew Drake	Andrew.Drake@dfo-mpo.gc.ca
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Scott Reid	Ontario Ministry of Natural Resources and Forestry
Kristen Diemer	Ministry of the Environment, Conservation and Parks
<b>Other government departments</b>	
Gerald Tetreault	Environment and Climate Change Canada
Tarra Degazio	Parks Canada
Tammy Dobbie	Parks Canada

In addition, consultation on the draft recovery strategy and action plan occurred through letters, and in some instances, meetings with Indigenous Groups. Additional stakeholder, Indigenous and public input will be sought through the publication of the proposed document on the Species at Risk Public Registry for a 60-day public comment period. Comments received will inform the final document.

## Appendix B: threat assessment categories

Likelihood of occurrence	Definition
Known or very likely to occur	There is 91 to 100% chance that this threat is or will be occurring
Likely to occur	There is 51 to 90% chance that this threat is or will be occurring
Unlikely	There is 11 to 50% chance that this threat is or will be occurring
Remote	There is 1 to 10% or less chance that this threat is or will be occurring
Unknown	There are no data or prior knowledge of this threat occurring now or in the future

Level of impact	Definition
Extreme	Severe population decline (71 to 100%) with the potential for extirpation
High	Substantial loss of population (31 to 70%) or threat would jeopardize the survival or recovery of the population
Medium	Moderate loss of population (11 to 30%) or threat is likely to jeopardize the survival or recovery of the population
Low	Little change in population (1 to 10%) or threat is unlikely to jeopardize the survival or recovery of the population
Unknown	No prior knowledge, literature, or data to guide the assessment of threat severity on population

Causal certainty	Definition
Very high	Very strong evidence that threat is occurring and the magnitude of the impact to the population can be quantified
High	Substantial evidence of a causal link between threat and population decline or jeopardy to survival or recovery
Medium	There is some evidence linking the threat to population decline or jeopardy to survival or recovery
Low	There is a theoretical link with limited evidence that threat is leading to a population decline or jeopardy to survival or recovery
Very low	There is a plausible link with no evidence that the threat is leading to a population decline or jeopardy to survival or recovery

Threat occurrence	Definition
Historical	A threat that is known to have occurred in the past and negatively impacted the population
Current	A threat that is ongoing, and is currently negatively impacting the population
Anticipatory	A threat that is anticipated to occur in the future, and will negatively impact the population

Threat frequency	Definition
Single	The threat occurs once
Recurrent	The threat occurs periodically, or repeatedly
Continuous	The threat occurs without interruption

Threat extent	Definition
Extensive	71 to 100% of the population is affected by the threat
Broad	31 to 70% of the population is affected by the threat
Narrow	11 to 30% of the population is affected by the threat
Restricted	1 to 10% of the population is affected by the threat