Species at Risk Act
Recovery Strategy Report Series

Report on the Progress of Recovery Strategy Implementation for the Channel Darter (*Percina copelandi*) in Canada for the Period 2013 to 2018

Channel Darter

2023

Canada

Recommended citation

Fisheries and Oceans Canada. 2023. Report on the Progress of Recovery Strategy Implementation for the Channel Darter (*Percina copelandi*) in Canada for the Period 2013 to 2018. *Species at Risk Act* Recovery Strategy Report Series. Fisheries and Oceans Canada, Ottawa. iv + 48 pp.

For copies of the progress report, or for additional information on species at risk, including Committee on the Status of Endangered Wildlife and Canada (COSEWIC) status reports and other related documents, please visit the Species at Risk Public Registry.

Cover illustrations: © 1996 Joseph R. Tomelleri.

Également disponible en français sous le titre : « Rapport sur les progrès de la mise en œuvre du programme de rétablissement du fouille-roche gris (*Percina copelandi*) au Canada pour la période 2013 à 2018 »

ISBN 978-0-660-40944-3
Catalogue no. En3-4/171-1-2023E-PDF

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 protection of species at risk throughout Canada. Under section 46 of the *Species at Risk Act* (S.C. 2002, c.29) (SARA) the competent ministers are responsible for reporting on the implementation of the recovery strategy for a species at risk, and on the progress towards meeting its objectives within 5 years of the date when the final recovery strategy was placed on the Species at Risk Public Registry, and in every subsequent 5-year period, until the recovery strategy is no longer required under SARA or the species' recovery is no longer feasible.

Reporting on the progress of recovery strategy implementation requires reporting on the collective efforts of the competent ministers, provincial organizations, and all other parties involved in conducting activities that contribute towards the species' recovery. Recovery strategies identify broad strategies and approaches that will provide the best chance of recovering species at risk. Some of the identified strategies and approaches are sequential to the progress or completion of others; not all may be undertaken or show significant progress during the time frame of a report on the progress of recovery strategy implementation (progress report).

The Minister of Fisheries and Oceans and the Minister responsible for Parks Canada are the competent ministers under SARA for the Channel Darter and have prepared this progress report.

As stated in the preamble to SARA, success in the recovery of species at risk depends on the commitment and cooperation of many different groups that will be involved in implementing the directions set out in the recovery strategy and will not be achieved by Fisheries and Oceans, Parks Canada, 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 the recovery strategy for the Channel Darter for the benefit of the species and Canadian society as a whole.

Acknowledgements

This progress report was prepared by Josh Stacey, Alain Kemp, Virginie Christopherson, Arianne Savoie, Marie-Pierre Veilleux and Catherine O'Leary. To the extent possible, this progress report has been prepared with input from the province of Ontario, Ontario Ministry of Natural Resources and Forestry, and from the province of Quebec, Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (MELCCFP; formerly Ministère des Forêts, de la Faune et des Parcs [MFFP] and Ministère de l'Environnement et de la Lutte contre les changements climatiques [MELCC]). The Department of Fisheries and Oceans would also like to express its appreciation to all individuals and organizations who have contributed to the recovery of the Channel Darter.

Executive summary

The Channel Darter (*Percina copelandi*) was listed as threatened under the *Species at Risk Act* (SARA) in 2006. The "Recovery Strategy for the Channel Darter (*Percina copelandi*) in Canada" was finalized and published on the Species at Risk Public Registry in 2013. Following the 2016 re-evaluation of Channel Darter by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), the species was separated into 3 designatable units (DUs). The Lake Erie populations (DU1) and Lake Ontario populations (DU2) units were assessed as endangered, while the St. Lawrence populations (DU3) unit was assessed as special concern. In August 2019, the new DUs, with their new statuses, were listed on Schedule 1 of SARA. As a result of the new status designation of special concern for DU3, critical habitat is no longer identified within the St. Lawrence River and associated watersheds. The updated recovery strategies for DU1 and DU2, and the management plan for DU3 have not been posted yet. Further progress reports will be based on these new documents and developed every subsequent 5-year period after their date of posting. This current progress report summarizes the progress made on the population and distribution objectives identified in the 2013 recovery strategy for the original Channel Darter population.

The main threats identified for the Channel Darter include habitat loss and degradation (for example, shoreline modifications, altered flow regimes, barriers to movement, turbidity and sediment loading, contaminants, and toxic substances), the introduction of invasive species and diseases, and possibly baitfish harvesting.

The population and distribution objectives for the Channel Darter are to maintain existing Canadian populations. The current Ontario distribution includes: the St. Clair River, Lake St. Clair, the Detroit River, Lake Erie (Point Pelee area), the Trent River, the Moira River watershed including the Black and Skootamatta rivers, the Salmon River, as well as Little Rideau Creek and the Ottawa River. The Quebec distribution includes the Gatineau River, the L'Assomption and Ouareau rivers, the Richelieu River, the Saint-François River, the des Anglais River, the aux Outardes Est River, and the Trout and Châteauguay rivers. Within the time period reported in this progress report, the following activities have been accomplished in support of the recovery objectives as stated in the recovery strategy:

- research investigating the life-history traits and requirements of Channel Darter has been conducted, including competitive interactions with other species, habitat use, and growth patterns and demographics among populations
- the potential effects of habitat modifications (for example, flow alterations) on Channel Darter have been investigated
- genetic variation among Canadian populations has been assessed and characterized leading to the splitting of the Canadian population into 3 DUs
- targeted surveys for Channel Darter have been conducted at extant locations, including the Detroit and Ottawa rivers
- stewardship projects aimed at habitat restoration and improvement have been implemented in both Ontario and Quebec by partner organizations through funding programs

Taken together, these ongoing and/or completed activities indicate that progress is being made toward the goal of recovering Channel Darter populations in Canada; however, there are still some areas where further information is required. Studies planned to better characterize critical habitat have been partially completed or have yet to be undertaken. For example, surveys still

need to be conducted to inventory suitable habitat for the Channel Darter and to map the quality and quantity of the habitat, which is information that can then be used to inform the development of a population habitat supply model for each life stage.

Table of contents

1 Introduction

This progress report outlines the progress made towards meeting the objectives listed in the recovery strategy for the Channel Darter (*Percina copelandi*) from 2013 to 2018 and should be considered as part of a series of documents for this species that are linked and should be taken into consideration together, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports (COSEWIC 2002, 2016), the "Recovery Potential Assessment of Channel Darter (*Percina copelandi*) in Canada" (Fisheries and Oceans Canada [DFO] 2010), and the "Recovery Strategy for the Channel Darter (*Percina copelandi*) in Canada" (recovery strategy) (DFO 2013).

Section 2 of the progress report summarizes key information on the threats to the species, population and distribution objectives for achieving its recovery, approaches to meeting these objectives, and performance indicators to measure the progress of recovery. For more details, readers should refer back to the recovery strategy. Section 3 reports the progress of activities identified in the recovery strategy to support achieving the population and distribution objectives. Section 4 summarizes the progress made and the outcome of the recovery effort.

2 Background

2.1 COSEWIC assessment summary

The listing of the Channel Darter as threatened in 2006 led to the development and publication of the recovery strategy for the species in 2013 (DFO 2013). The recovery strategy was mainly based on the information provided in the COSEWIC assessment and status report on the Channel Darter (COSEWIC 2002). This information has also been included in section 1.1 of the recovery strategy.

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

In 2016, COSEWIC re-examined the status of the Channel Darter (COSEWIC 2016). The Canadian populations were then split into 3 designatable units (DUs) including Lake Erie populations (DU1), Lake Ontario populations (DU2), and St. Lawrence populations (DU3). The new statuses assigned for each unit are presented below. In August 2019, the new DUs with their new statuses were listed on Schedule 1 of SARA.

Assessment summary: November 2016
Common name: Channel Darter, Lake Erie populations
Scientific name: *Percina copelandi*
Status: Endangered
Reason 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.
Occurrence: Ontario
Status history: The species was considered a single unit and designated threatened in April 1993. Its status was 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.

Assessment summary: November 2016
Common name: Channel Darter, Lake Ontario populations
Scientific name: *Percina copelandi*
Status: Endangered
Reason 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.
Occurrence: Ontario
Status history: The species was considered a single unit and designated threatened in April 1993. Its status was 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.

Assessment summary: November 2016
Common name: Channel Darter, St. Lawrence River populations
Scientific name: *Percina copelandi*
Status: Special concern
Reason for designation: This small-bodied species is broadly distributed, but there is evidence of extirpation at some localities within its range. The species is subjected to a variety of threats related to the impact of the invasive Round Goby and pollution. The species may become threatened if these threats are not effectively managed.
Occurrence: Ontario, Quebec
Status history: The species was considered a single unit and designated threatened in April 1993. Its status was re-examined and confirmed in May 2002. When the species was split into separate units in November 2016, the “St. Lawrence populations” unit was designated special concern.

2.2 Distribution

Between 2010 and 2018, Channel Darter has been detected in several new locations throughout its Canadian range (figures 1 to 4).

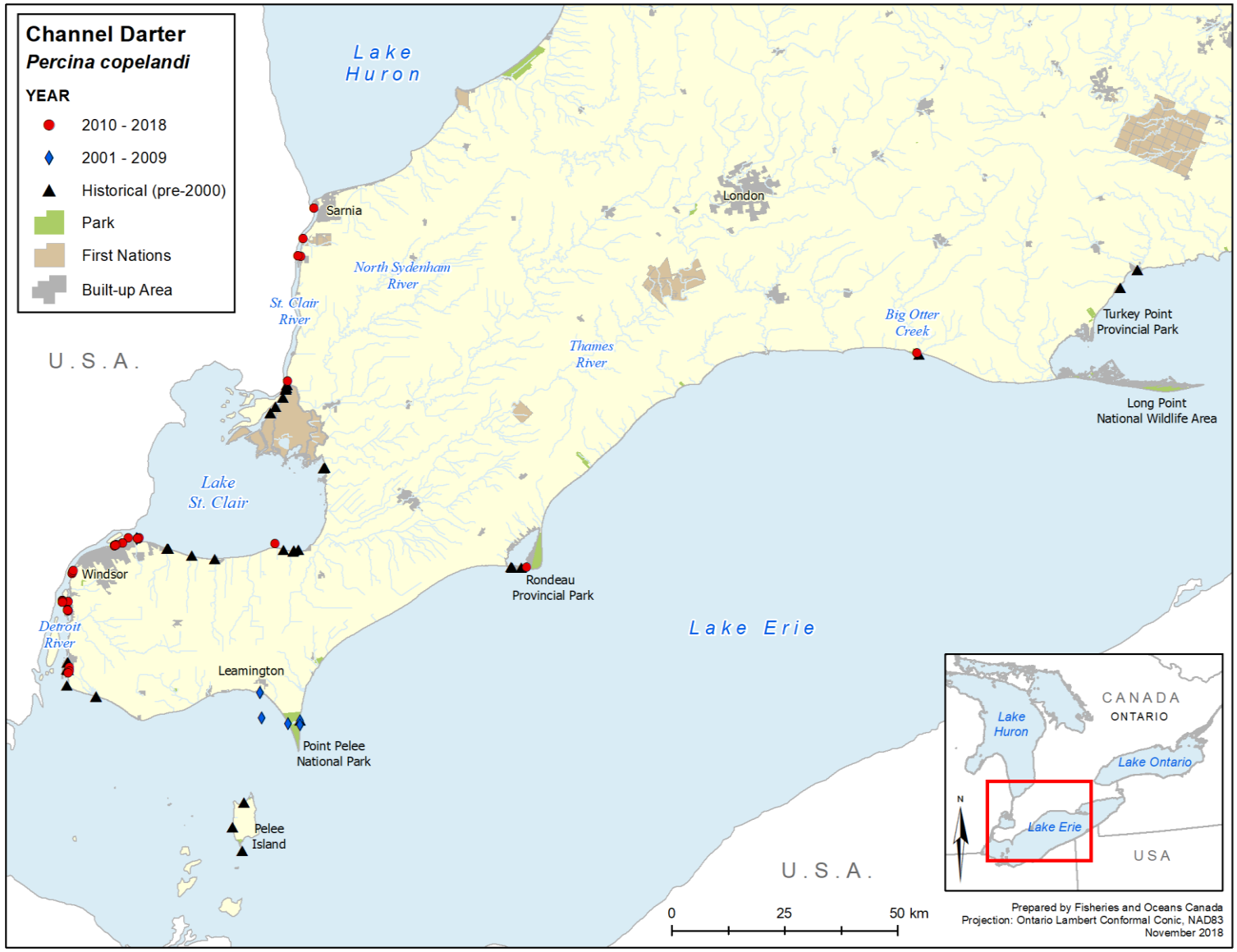

Figure 1. Historical distribution and recent detections of Channel Darter in southwestern Ontario.

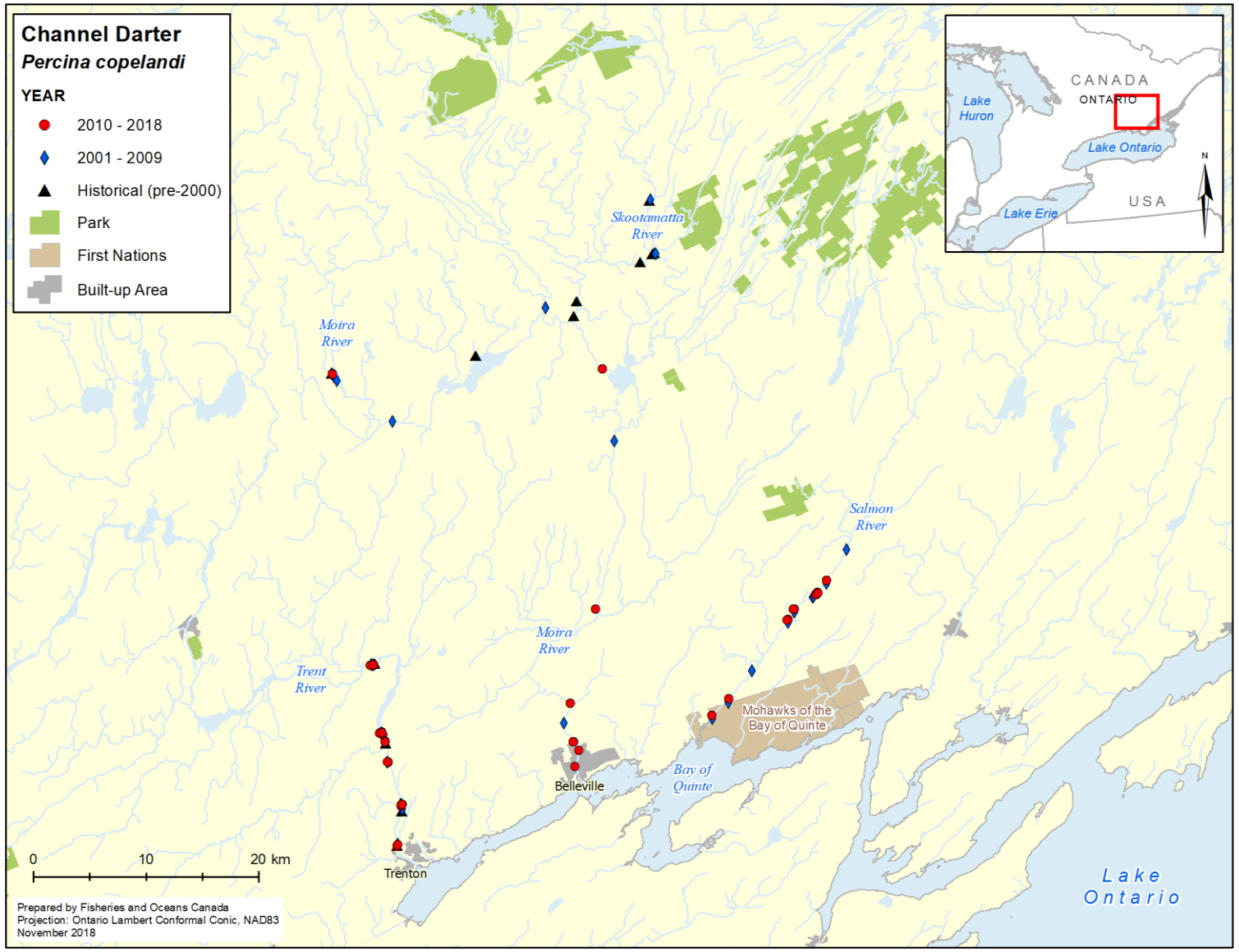

Figure 2. Historical distribution and recent detections of Channel Darter in eastern Ontario.

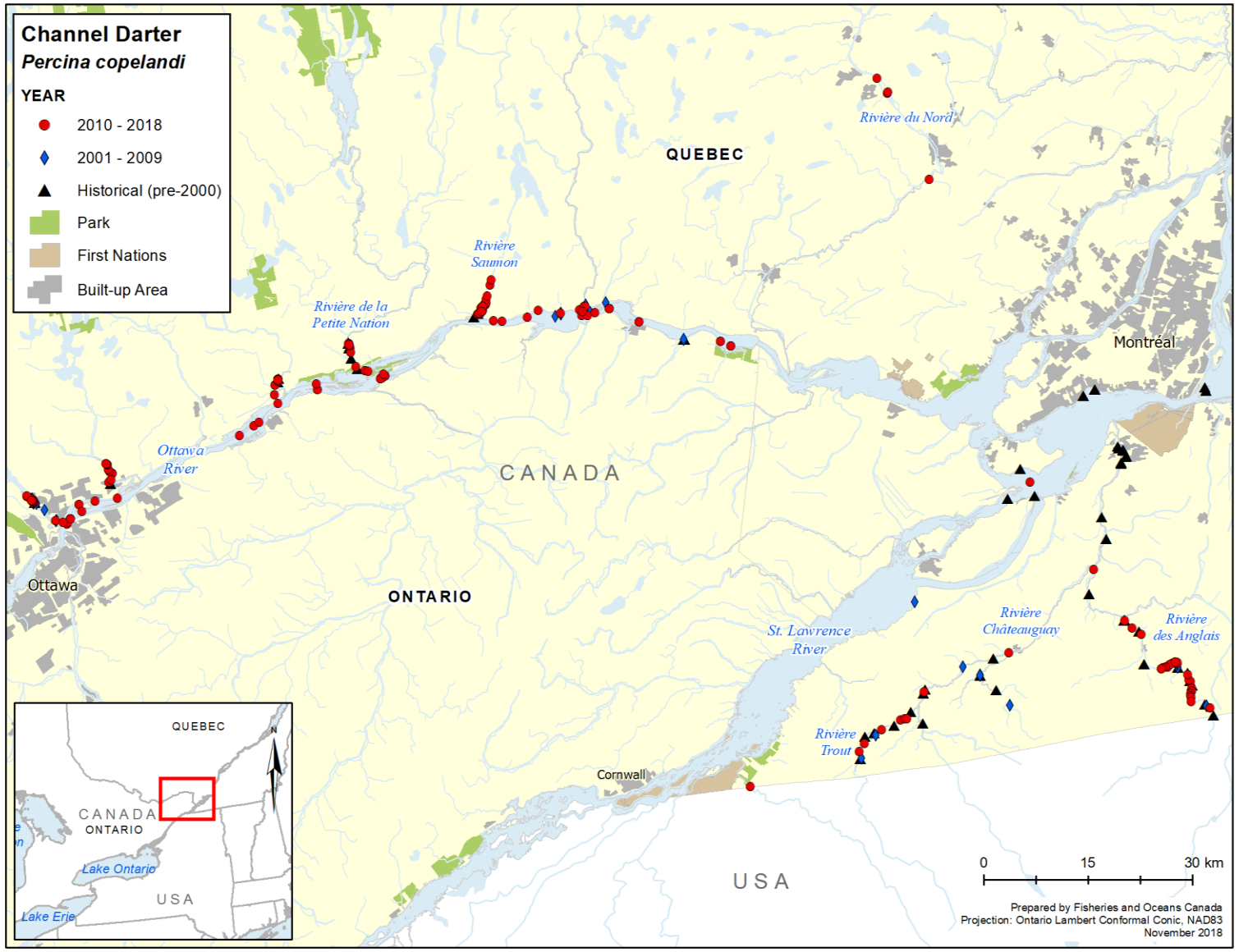

Figure 3. Historical distribution and recent detections of Channel Darter in the Ottawa River and southern Quebec.

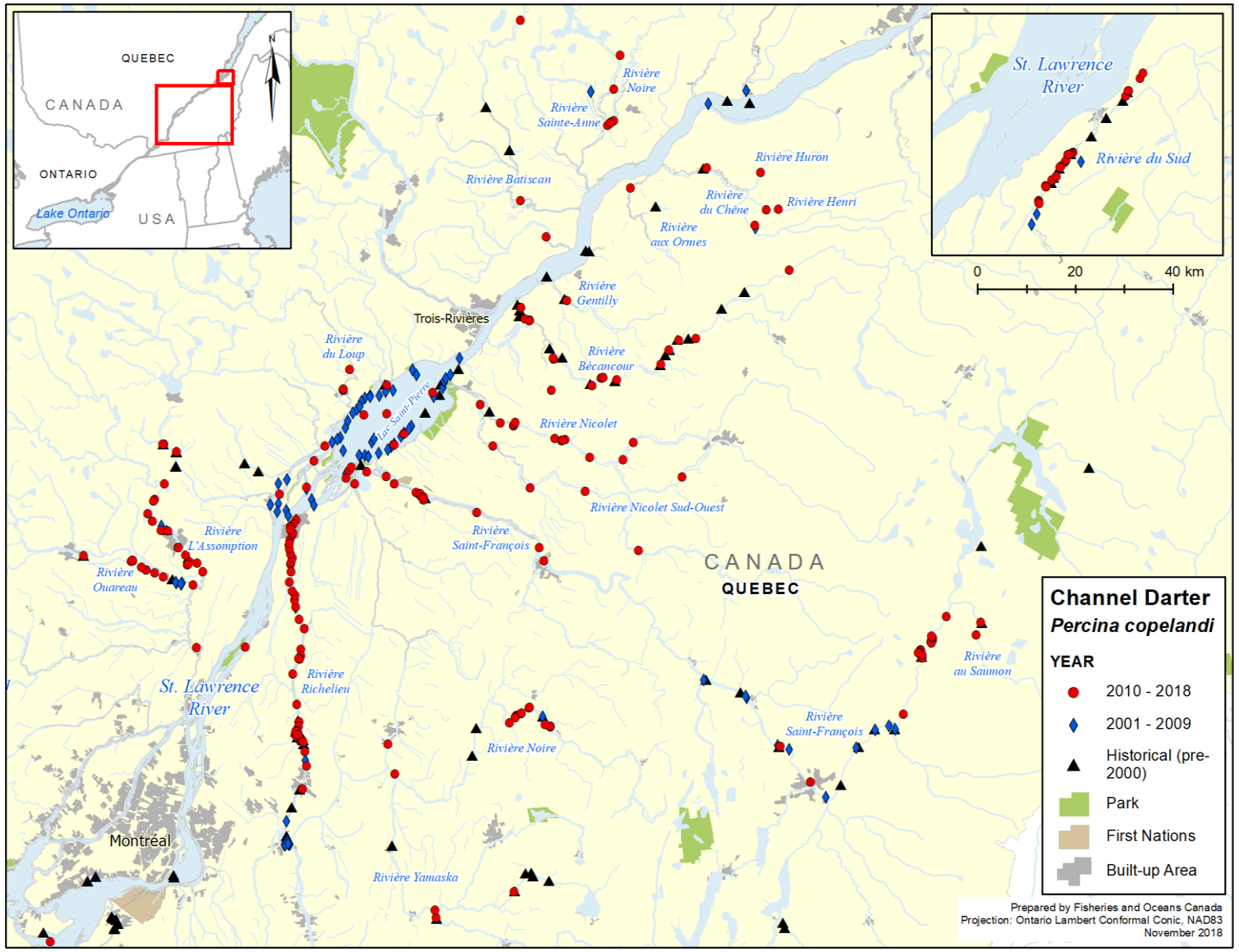

Figure 4. Historical distribution and recent detections of Channel Darter in the St. Lawrence River and northeastern Quebec.

2.3 Threats

This section summarizes the latest information on threats to survival and recovery of the Channel Darter, and threats to its critical habitat.

Population-level threats for Channel Darter, ranked by priority, were identified in the recovery potential assessment (DFO 2010) and included in the recovery strategy (DFO 2013). These include shoreline alterations, alteration of the flow regime, barriers to free passage, turbidity and excessive siltation, excessive nutrient loading, contaminants and toxic substances, aquatic invasive species, diseases, and bycatch. Readers are encouraged to refer to section 4.1 of the recovery strategy for more information on these threats and their significance across different watersheds. Since the release of the recovery strategy, COSEWIC has identified that the invasive Round Goby (*Neogobius melanostomus*) is a primary threat to Channel Darter populations in Lake Erie, Lake Ontario, and the St. Lawrence River (COSEWIC 2016).

Critical habitat has been identified for Channel Darter, to the extent possible, in section 7 of the recovery strategy, which also includes a description of threats to critical habitat, as well as examples of activities that may result in the destruction of critical habitat. For more details on threats and activities that may lead to the destruction of critical habitat, refer to the recovery strategy.

2.4 Recovery

This section summarizes the information found in the recovery strategy on the population and distribution objectives necessary for the recovery of the Channel Darter. This section also describes the performance indicators that provide a way to define and measure progress toward achieving the population and distribution objectives.

2.4.1 Population and distribution objectives

Section 5 of the recovery strategy identified the following objectives necessary for the recovery of the species:

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

- **Population and distribution objectives:** based on data available at the time this recovery strategy was developed (surveys conducted up to 2009), the population and distribution objectives for the Channel Darter in Canada are to ensure the survival of self-sustaining population(s) at the following locations:

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

    - Quebec: Gatineau River, L’Assomption/Ouareau River, Richelieu River, Saint-François River, and des Anglais River/aux Outardes Est River/Trout River/ Châteauguay River

2.4.2 Performance measures

Section 8 of the recovery strategy includes the following performance indicators to define and measure progress toward achieving the population and distribution objectives:

1. extant populations fully described by 2018

2. completion of activities outlined in the schedule of studies for the complete identification of critical habitat within the proposed timelines by 2018

3. monitoring program established by 2018

4. relative significance of threats evaluated by 2018 and initiation of the implementation of remedial actions to address priority threats by 2019

5. feasibility of re-establishment and potential re-establishment methods determined by 2018 and sites identified by 2018

6. quantification of best management practices (BMPs) (for example, number of Nutrient Management Plans and Environmental Management Plans completed, hectares of riparian zone established) implemented through ecosystem-based recovery teams and other relevant complementary groups/initiatives to address threats by 2018 (ongoing)

7. documentation of any changes in public perceptions and support for identified recovery actions through guidance identified in the communications strategy (by 2018)

3 Progress towards recovery

The recovery strategy for the Channel Darter divides the recovery effort into 5 broad strategies: 1) research; 2) monitoring; 3) management and coordination; 4) protection, restoration and stewardship; and 5) communication and public awareness. Progress in carrying out these broad strategies is reported in section 3.1. Section 3.2 reports on the activities identified in the schedule of studies to identify critical habitat. Section 3.3 reports on the progress on meeting the performance indicators and other commitments (for example, action plan and critical habitat order) identified in the recovery strategy and information obtained through its implementation.

3.1 Activities supporting recovery

Tables 1 to 5 provide information on the implementation of activities undertaken to address the broad strategies and approaches identified in the recovery planning table of the recovery strategy. Each activity has been assigned 1 of 4 statuses:

1) completed*:* the activity has been carried out and concluded
2) in progress*:* the planned activity is underway and has not concluded
3) not started: the activity has been planned but has yet to start
4) cancelled: the planned activity will not be started or completed

Table 1. Details of research activities supporting the recovery of the Channel Darter from 2013 to 2018. Approaches are identified in bold in the Activity column.

Activity	Descriptions and results	Progress	Participants
(1-1a) Life-history traits and requirements: determine the seasonal habitat requirements, including species movement and migration, of all life stages of Channel Darter.	A modelling study was conducted that characterized suitable spawning habitat at 3 locations within the Trent River, with regard to water depth and velocity (Reid et al. 2016). Surveys of historical Channel Darter locations in southern Quebec were conducted in 2013 and provided information necessary for the characterization of habitats in 9 rivers where the species occurs. These historical locations consisted mainly of lentic habitats (that is, channels or ponds) with oxygen saturation rates generally greater than 90%, and average pH levels, turbidity levels, flow rates, and depths of 7.5, 4.1 NTU[1], 0.13 m/s, and 1.2 m, respectively. Sand was the predominant substrate type in occupied habitats, although pebbles were also abundant. Coverage by aquatic vegetation within occupied habitats was low (3%) (WSP 2014). Levert et al. (2013) studied Channel Darter habitat and found that substrate type was the only fixed predictor of Channel Darter occupancy in 4 tributaries of the Ottawa River. In contrast, water velocities associated with the presence of the	In progress	Fisheries and Oceans Canada (DFO); Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (MELCCFP); Ontario Ministry of Natural Resources and Forestry (OMNRF); Ontario Power Generation

[1] Nephelometric Turbidity Units

Activity	Descriptions and results	Progress	Participants
	species varied among rivers. Environmental components associated with Channel Darter occurrence did not change among seasons, although migratory movement was evident, particularly in the Blanche River (Thurso) where a significant decline in the relative abundance of the species was observed from spring to fall. An analysis of fishery data collected in Quebec from 1930 to 2016 supports the habitat characterizations described in the literature for this species. In particular, it discusses the presence of dominant substrates, vegetation cover, stream velocity, and several other measured parameters. Although Channel Darter has been detected often in small rivers, they appear to frequent habitats at depths greater than 5 m. In addition, several occurrences of the species in highly disturbed rivers have been noted (Ricard et al. 2018).		(OPG); Parks Canada (PC)
(1-1b) Threat evaluation: identify thresholds of tolerance to habitat modifications (for example, flow) to determine what constitutes destruction of critical habitat for Channel Darter.	Research has been conducted that explores habitat used by Channel Darter for spawning within areas of the Trent River where hydro facilities are present (Reid et al. 2016). Although this study does not identify specific thresholds of tolerance to habitat modifications, it does characterize the habitat needs of the species during this critical life stage in terms of water velocity and depth at 3 locations within the Trent River. This information was then used to inform the setting of minimum flow levels to limit the impact of hydroelectric generating stations on Channel Darter within this specific watershed. In the summer of 2018, an experiment was conducted by DFO, OMNRF and the Trent Severn Waterway (PC) to investigate Channel Darter spawning success under varying levels of flow release. This research will inform the development of best management practices (BMPs) for water level management during Channel Darter spawning season in low-flow years. The	In progress	DFO, HydroNet, MELCCFP, OMNRF, PC

Activity	Descriptions and results	Progress	Participants
	data from these water release experiments are currently being analyzed (Reid, pers. comm. 2022). A study by HydroNet (2013) was undertaken to better understand the impact of hydroelectric facilities on fish and their habitat. Although Channel Darter was not specifically targeted by this study, the results show that peak flow storage dams had the lowest fish densities compared to gradual release storage dams and unregulated rivers. Inventory and monitoring projects were conducted by regional organizations, including MELCCFP and DFO, which allowed for the characterization of Channel Darter habitat at fine (capture site) and large (fishing station) scales, enhancing the knowledge of the habitat used by the species.		
(1-2) Life-history traits and requirements: determine the life history of Channel Darter (for example, population dynamics, feeding) and interactions with other species (for example, predation, competition).	Proulx (2014) has conducted research within 4 tributaries of the Ottawa River (au Saumon River; Petite-Nation River; Blanche River - Thurso; and Blanche River - Gatineau) to examine the demographics of Channel Darter through the characterization and comparison of the growth patterns of individuals, between males and females, and among populations. Channel Darter were found to have varying growth rates among the 4 populations, and between sexes, with males growing faster and attaining greater lengths than females. This study also explored the effects of interactions between Channel Darter and 5 other species: Logperch (*Percina caprodes*), Fantail Darter (*Etheostoma flabellare*), Tessellated Darter (*Etheostoma olmstedi*), Johnny Darter (*Etheostoma nigrum*), and Iowa Darter (*Etheostoma exile*). There was a highly positive correlation between the presence of Channel Darter and that of Fantail Darter and Logperch in all 4 rivers. More specifically, in terms of habitat use, all 3 of these species showed a preference for habitats consisting of medium to large	In progress	MELCCFP, University of Ottawa

Activity	Descriptions and results	Progress	Participants
	substrates (sand to boulder), high substrate heterogeneity, small bank slopes, and water velocities greater than 0.25 m/s. Furthermore, the highest indices of niche overlap[2] among species within this study were observed between Channel Darter, Fantail Darter, and Logperch. In contrast, the fact that these species were found in high densities within the same riffle areas suggests that either resources are not limited or that the habitat use of these 3 species (that is, water column position, feeding behavior, prey, etc.) may differ among them. However, variation in the growth rates of Channel Darter among the 4 rivers, which was not correlated with habitat variables, may have been driven by differences in the abundance of other darter species, suggesting inter-specific competition is having an effect on Channel Darter demographics. For example, the lowest growth rates occurred in the Blanche River (Gatineau) and the au Saumon River (Notre-Dame-de-Bonsecours), and these also had higher abundances of the other Darter species that were assessed in this study.		
(1-3) Threat evaluation: determine the physiological tolerance thresholds of Channel Darter with respect to various water quality parameters (for example, dissolved oxygen, nutrients, contaminants and toxic substances) and check against existing standards.	Experimental research was recently conducted that aimed to identify the tolerances of other species at risk (Pugnose Shiner [*Notropis anogenus*], Redside Dace [*Clinostomus elongatus*], and Eastern Sand Darter [*Ammocrypta pellucida*]) to dissolved oxygen and water temperature, including the interaction of these 2 parameters, in both laboratory and field settings. The same research objectives and experimental design may be expanded to other species including the Channel Darter if a suitable source stock is available (A. Drake pers. comm. 2022).	Not started	DFO, McGill University, OMNRF, University of Toronto
(1-4) Threat evaluation: investigate potential threats such as invasive species, baitfish harvesting, and	The OMNRF has been conducting fish community assessments within the Trent River from 2009 to 2018 to investigate the impacts of the invasive Round Goby on	In progress	DFO, McGill University, MELCCFP,

[2] Overlap of resource use between species.

Activity	Descriptions and results	Progress	Participants
sources of contamination and toxic substances (for example, discharge from wastewater treatment facilities). Consider the development of a map highlighting general habitat areas and major threats to facilitate analysis of cumulative effects.	Channel Darter. The data collected from these monitoring surveys have been analyzed to assess the degree of habitat overlap between native species, including Channel Darter and Logperch, and invasive Round Goby (Reid 2019). In Quebec, Round Goby was detected within areas occupied by Channel Darter at the mouth of the Yamaska River, the St. Lawrence River (near Contrecœur), the Richelieu and Saint-François rivers (Gareau et al. 2017a), the Châteauguay River, and the au Saumon River, which flows into Lake St. Francis (Groulx et al. 2018). Studies that investigate the potential impacts of Round Goby on native species suggest that they could be a fierce competitor for small percids such as Channel Darter (Garceau et al. 2016).		OMNRF, University of Toronto
(1-5) Re-establishment: investigate the feasibility of various re-establishment approaches for Channel Darter and identify appropriate source populations.	Research that investigates the feasibility of translocations and/or repatriations as a means of augmenting declines in Channel Darter within Ontario waters is planned for the future but is not currently underway. No repatriation plan has been developed at this stage.	Not started	University of Windsor
(1-6) Re-establishment: determine if there are extirpated or new sites that are suitable for threat mitigation or habitat restoration for potential re-establishment.	No progress has been made on this measure. This activity is dependent on the upcoming results of activity 1-5.	Not started	N/A
(1-7) Re-establishment: undertake an experimental re-establishment, monitor, and evaluate its success.	No progress has been made on this measure. This activity is dependent on the upcoming results of activities 1-5 and 1-6.	Not started	N/A
(1-8) Genetic characterization: assess genetic variation across the global range and investigate	Genetic variation has been assessed among Canadian populations of Channel Darter through comparisons of microsatellite DNA data, which indicated that the 3 geographically isolated populations (St. Clair and Erie	Completed	DFO, OMNRF

Activity	Descriptions and results	Progress	Participants
population structure among/within Canadian populations.	watershed; Bay of Quinte watershed; and Ottawa River and St. Lawrence River watersheds) are subdivided and exhibit population structure (Kidd et al. 2011; Reid et al. 2013). This finding led to the recommendation to segregate Channel Darter populations into 3 designatable units (DUs) (Lake Erie populations [DU1]; Lake Ontario populations [DU2]; St. Lawrence populations [DU3]) considering there is no possibility of dispersal among them, and consequently the potential for a rescue effect is not probable (Committee on the Status of Endangered Wildlife and Canada [COSEWIC] 2016). Kidd et al. (2011) also observed that significant genetic differences were apparent among watersheds within these DUs, suggesting that dispersal at finer spatial scales is also limited.		
(1-9) Habitat modelling: develop a predictive habitat model to identify potential Channel Darter sites and areas containing significant habitat.	No predictive habitat models have been created for Channel Darter to identify potential sites where the species may be undiscovered. Modelling has been conducted to identify associations with habitat features in specific rivers that could inform the development of a predictive habitat model, which could be used to identify potential locations where the species may occur. Dextrase et al. (2014) modelled occupancy for Channel Darter in the Detroit and Ottawa rivers; however, the model did not identify any clear variables that could be used to predict the presence of Channel Darter. Habitat modelling has been conducted to identify suitable spawning habitat, based on water velocity and depth, within 3 locations of the Trent River (Reid et al. 2016). This model was then combined with a 2-dimensional hydrodynamic model, which examined the impacts of river discharge as a function of upstream and downstream water management, to predict the	In progress	OMNRF, University of Ottawa

Activity	Descriptions and results	Progress	Participants
	impacts of flow alterations on the availability of suitable habitat, and to provide guidance for the operation of dam control gates. In addition, further research is underway to investigate the consistency and repeatability of the results reported in Reid et al. (2016) through further modelling of the relationship between spawning habitat use and the aforementioned habitat parameters. All of the data needed for this follow-up study has been gathered in 2017 and 2018 and is now being analyzed (Reid pers. comm. 2022). Proulx (2014) developed a predictive habitat model for Channel Darter within 4 tributaries of the Ottawa River (au Saumon River; Petite-Nation River; Blanche River - Thurso; and Blanche River - Gatineau). This study explored the relationship between the presence of Channel Darter and environmental variables including: water depth, dominant substrate size, substrate heterogeneity, vegetative cover, periphyton cover, presence of woody debris, water velocity, bank slope, distance to the confluence with the Ottawa River, and land use. Of these, 3 variables were significant in predicting the presence of Channel Darter, including substrate heterogeneity, bank slope, and area sampled, while water velocity (>0.25 m/s) was only a good predictor in 3 out of the 4 rivers. Levert (2013) also analyzed the habitat preferences of Channel Darter in the same 4 tributaries as Proulx (2014) and found that its presence was associated with environmental variables, including bank slope and substrate type. This study also found that Channel Darter was positively associated with water velocity at the river level.		

Table 2. Details of monitoring activities supporting the recovery of the Channel Darter from 2013 to 2018. Approaches are identified in bold in the Activity column.

Activity	Descriptions and results	Progress	Participants
(2-1a) Background surveys: complete targeted surveys of extant populations using gear types proven effective at detecting Channel Darter.	Targeted surveys were conducted by Fisheries and Oceans Canada (DFO) for Channel Darter in the Detroit River in 2011 leading to the detection of 13 individuals; and the Ottawa River, which led to the capture of 135 individuals. Both of these locations represent areas where the species was known to be extant. In Ontario, non-targeted surveys have been conducted by DFO in a number of locations where Channel Darter occur, including Lake St. Clair, Point Pelee, and the Trent River. These surveys led to the detection of the species in the St. Clair River and Lake St. Clair. In addition, the Ontario Ministry of Natural Resources and Forestry (OMNRF) has conducted targeted surveys for Channel Darter in the Trent, Moira, Skootamatta, and Salmon rivers leading to the capture of Channel Darter. Non-targeted surveys leading to the detection of Channel Darter have been conducted by organizations including: the United States Fish and Wildlife Service (USFWS) in the Detroit River, Quinte Conservation in the Moira River, and C. Portt and Associates in the Trent River. In summer 2015, the Indigenous community of Wôlinak conducted an inventory of Channel Darter abundance and habitat availability in the Bécancour River using a beach seine. A total of 5.3 ha of suitable habitat was delimitated up to a depth of 2 m. Channel Darter was present throughout the sampled area, with a total of 73 individuals captured (Richard 2016). In addition, in the summer of 2015, the Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (MELCCFP) conducted inventory surveys in the Richelieu, Saint-François and Yamaska rivers, as well as Lake Saint-Pierre using a bottom trawl designed to capture small benthic fish species. Within these locations, 129 Channel Darter were captured in the Richelieu River (where sampling efforts were	In progress	Ambioterra, Bureau environnement et terre de Wôlinak, CARA, DFO, MELCCFP, OMNRF, Organisme de bassin versant (OBV) Côte-du-Sud, Quinte Conservation, USFWS

Activity	Descriptions and results	Progress	Participants
	most extensive), 4 were captured in the Saint-François River, and 5 were captured in Lake Saint-Pierre (Garceau et al. 2016). Targeted surveys conducted in Pontbriand Lake (between 2 dams on Ouareau River) did not confirm the presence of Channel Darter; however, the potential occurrence of this species at this location remains plausible given the biophysical characteristics of the habitat (Corporation de l'Aménagement de la Rivière L'Assomption [CARA] 2013). Sampling took place in 17 tributaries of the Ottawa River in 2013, from the Red River to the Quyon River. No new populations of Channel Darter were found (Proulx et al. 2013). The environmental non-governmental organization Ambioterra has conducted surveys for Channel Darter in the des Anglais, Trout, and Châteauguay rivers between 2010 and 2018, which led to the discovery of more than 50 new Channel Darter occurrences in these rivers (Ambioterra 2013; Gareau and Groulx Tellier 2014, 2015; Gareau et al. 2016, 2017a and 2017b). Through these surveys, they evaluated the area of important habitat in the des Anglais, aux Outardes Est, and Trout rivers (Ambioterra 2013). These inventories resulted in the identification of these areas as critical habitat in the recovery strategy.		
(2-1b) Background surveys: conduct extensive surveys on Little Rideau Creek and the Ottawa River (and tributaries) to determine whether a resident population exists in Little Rideau Creek. Surveys in the Ottawa River (and tributaries) to be informed through distribution of	No surveys have been conducted within Little Rideau Creek. Sampling was conducted in the Ottawa and Gatineau rivers in 2011 by DFO and OMNRF, respectively. A total of 135 individuals were detected in the Ottawa River; however, Channel Darter was not captured in the Gatineau River. Proulx (2014) also sampled the au Saumon, Petite-Nation, Blanche (Thurso), and Blanche (Gatineau) rivers, which are tributaries of the Ottawa River, for Channel Darter in the spring, summer, and fall of 2011 and 2012. It is important to	In progress	DFO, MELCCFP, OMNRF

Activity	Descriptions and results	Progress	Participants
Channel Darter on Quebec side of the river.	note that physical barriers limit the distribution of Channel Darter relative to 4 other darter species studied (Proulx 2014). In summer 2016, a survey done by MELCCFP confirmed the presence of Channel Darter in the Ottawa River between Gatineau and Grenville-sur-la-Rouge. The species was detected throughout this reach of the river in deep water, and only at a few sites in shallow water. Consequently, the abundance was also greater in deep water (Gosselin 2016).		
(2-2) Background surveys: conduct targeted surveys at historical Channel Darter locations using gear types proven effective at detecting the species.	In Ontario, no targeted surveys have been conducted at the historic sites of Holiday Beach or Port Dover. DFO and OMNRF conducted sampling in 2017 and 2018 at several Lake Erie beach sites where Channel Darter was historically collected including Port Burwell, Normandale Pier, and Pebble Beach east of Nanticoke; however, no Channel Darter were detected. In contrast, non-targeted surveys (Asian carps Great Lakes monitoring program) detected Channel Darter in Big Otter Creek adjacent to Port Burwell. Furthermore, in 2018 the OMNRF detected Channel Darter in the Erieau beach area of Rondeau Bay where the species was previously considered to be extirpated. In Quebec, a concerted multi-stakeholder effort has sampled almost all historic sites in the province. Eight sites, where the presence of Channel Darter was uncertain in 2002, were successfully sampled validating the presence of the species. Overall, the continued occurrence of the species was confirmed at 22 sites; however, the presence of the species remains uncertain at Port-Saint-François and Pointe-du-Buisson. As a result of these surveys, the populations are still considered extirpated in the Bleuets, Niger, Maskinongé and Chicot rivers. However, the survey done by the OBV Côte-du-Sud has confirmed the presence of Channel Darter in du Sud River where the population was previously considered	In progress	Abenaki Council of Odanak, Ambioterra, CARA, Comité Zone d'intervention prioritaire (ZIP) du Lac St-Pierre, DFO, MELCCFP, OBV Côte-du-Sud, OMNRF, University of Ottawa, WSP

Activity	Descriptions and results	Progress	Participants
	extirpated. This river represents the northeastern limit of the distribution of the Channel Darter in North America (Paradis 2014).		
(2-3) Background surveys: conduct targeted surveys for undetected populations in high probability areas with suitable habitat.	In Ontario, no targeted surveys have been conducted in sites where undetected populations may exist; however, non-targeted sampling conducted by DFO in the St. Clair River led to the detection of 2 and 10 Channel Darter individuals in 2013 and 2014, respectively. In Quebec, numerous surveys conducted by various stakeholders have targeted Channel Darter in rivers where its presence was unknown. Seven new populations have recently been discovered in the Blanche River (Thurso), the Sainte-Anne River, the du Loup River, the Grande Yamachiche River, the Jacques-Cartier River, and the Calumet and Pointe-au-Chêne rivers (Boucher and Garceau 2010; Levert 2013; Comité ZIP du lac Saint-Pierre 2013; WSP 2014). The Abenaki community of Odanak conducted surveys in the lower sections of the Saint-François River in 2013 and 2016 to find undetected populations in high probability areas. Channel Darter was captured at 2 of 8 stations: the îles de Pierreville and the Bassin de Saint-Bonaventure (abundance estimate: 1,351 and 193 individuals, respectively) (Bureau environnement et terre d'Odanak 2017). They also identified several threats in this area including pollution and turbidity, which likely resulted from the absence of riparian vegetation and pesticide use. In 2013 to 2014, the OBV Côte-du-Sud conducted a survey to specify the distribution of Channel Darter and estimate their abundance in the Bras Saint-Nicolas River and other tributaries of the du Sud River. Channel Darter was captured at 2 new stations: the downstream Bellavance station and upstream Petit Cap station in Bras St-Nicolas River (Paradis 2014).	In progress	Abenaki Council of Odanak, Ambioterra, CARA, Comité ZIP du Lac St-Pierre, DFO, MELCCFP, OBV Côte-du-Sud, Stavibel, University of Ottawa, WSP

Activity	Descriptions and results	Progress	Participants
	In summer 2016, CARA conducted a targeted survey in Noire River and Noir Lake, as well as upstream tributaries of the L'Assomption River; however, no Channel Darter were detected in the upper part of the watershed (CARA 2017).		
(2-4) Monitoring of populations and habitat: develop and implement a standardized index population and habitat monitoring program with a specific sampling and training protocol.	A standardized index population and habitat monitoring program has not been developed yet; however, Dextrase et al. (2014) investigated the probability of detecting Channel Darter in the Ottawa and Detroit rivers through the use of various trawling protocols. These authors estimated moderate to high detection probabilities, which suggests that effort does not need to be exhaustive to determine if the species is present; however, they qualify that the sites they selected had a high likelihood of supporting Channel Darter and, consequently, may have led to under estimations of the level of effort required to detect the species at other locations. In addition, Reid and Haxton (2017) evaluated the effort required to both detect Channel Darter in shallow, wadeable habitats using backpack electrofishing and perceive changes in their distribution and occupancy. They concluded that 3 replicate sampling visits with a shocking effort of 750 to 1,000 seconds duration should be conducted to confidently sample for the presence of Channel Darter. Furthermore, using the 1,000 second duration, declines in population abundance greater than or equal to 70% can be detected.	In progress	DFO, MELCCFP, OMNRF
(2-5) Monitoring of populations and habitat: locate spawning locations and characterize habitat present.	A modelling study conducted by Reid et al. (2016) characterized the habitat use of Channel Darter at 3 sites within the Trent River during the spawning period. A study conducted by Levert et al. (2013) provided information on Channel Darter spawning habitat in 4 tributaries of the Ottawa river. They documented that spawning habitat consisted of shallow rapids with water velocities of 0.076 to 3.5 m/s, coarse substrates and water temperatures of 17.5°C to 23.9°C, which is comparable to	In progress	DFO, MELCCFP, OMNRF, Ontario Power Generation (OPG), Parks Canada (PC)

Activity	Descriptions and results	Progress	Participants
	observations made in the Trent River in Ontario by Reid et al. (2016).		
(2-6) Monitoring of populations and habitat: monitor sites where threat mitigation and/or habitat restoration activities occurred to determine success of actions and to monitor Channel Darter populations.	Proponents of development projects that obtained authorizations or permits from DFO and MELCCFP were required to provide follow-up reports, which documented the effectiveness of the mitigation measures. Many external organizations conducted inventories and characterized habitat to assess recovery activities that were implemented (for example, riparian buffer restoration) as part of the Habitat Stewardship Program (HSP), the Aboriginal Fund for Species at Risk (AFSAR) and the Interdepartmental Recovery Fund (IRF).	In progress	Abenaki Council of Odanak, Ambioterra, CARA, Comité ZIP du lac Saint-Pierre, Corridor appalachien, DFO, Fondation de la faune du Québec, MELCCFP, OBV Côte-du-sud

Table 3. Details of management and coordination activities supporting the recovery of the Channel Darter from 2013 to 2018. Approaches are identified in bold in the Activity column.

Activity	Descriptions and results	Progress	Participants
(3-1) Coordination with other recovery teams and relevant organizations: work with relevant organizations such as conservation authorities, Ontario Ministry of Natural Resources and Forestry (OMNRF), Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (MELCCFP), First Nations and ecosystem/single species-based recovery teams to share knowledge, combine resources, implement recovery actions, and ensure a coordinated approach to recovery.	In Ontario, Fisheries and Oceans Canada (DFO) organized meetings with staff from OMNRF, Parks Canada (PC), and Ontario Power Generation (OPG) to assess the flow needs of Channel Darter within the Trent River and develop guidelines to mitigate threats posed by hydro facilities. These meetings eventually led to the development of a Canadian Science Advisory Secretariat document (Reid et al. 2016), which provided flow recommendations for maintaining Channel Darter populations within the Trent River. The Cooperation Agreement for the Protection and Recovery of Species at Risk in Quebec (2012 to 2022), and the Canada-Ontario Agreement on Species at Risk (2011 to 2021) were created to coordinate interventions for species of common interest and their habitats. These agreements are also intended to foster the exchange of information and the improvement of knowledge about species at risk. Members of the Cyprinids and Small Percids Recovery Team meet at least twice a year to plan the recovery of the Channel Darter. The information is then disseminated to regional organizations via an e-newsletter.	In progress	Abenaki Council of Odanak; Abenaki Council of Wôlinak; Ambioterra; Bureau d'écologie appliquée; Comité de concertation et de valorisation du bassin de la rivière Richelieu (COVABAR); DFO; environmental non-governmental organizations (ENGOs); Hydro-Québec; MELCCFP; Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec; OMNRF; Ontario Ministry of the Environment, Conservation and Parks (MECP); OPG; PC; Société de conservation et d'aménagement des bassins

Activity	Descriptions and results	Progress	Participants
			versants de la Zone Châteauguay (SCABRIC); watershed organizations
(3-2) Coordination with other recovery teams and relevant organizations: conduct flow-needs assessments at hydroelectric dams and navigable waterways (for example, seaways) and determine how water level management can be improved to mitigate impacts on Channel Darter (for example, adopt minimum low-flow level recommendations during sensitive life-history stages such as spawning).	The flow needs of 3 Channel Darter populations along the Trent River during spawning were investigated by Reid et al. (2016). They modelled the habitat use of Channel Darter and combined these findings with a 2-dimensional hydrodynamic model to provide site-specific flow recommendations that would maintain suitable spawning habitat for Channel Darter.	In progress	DFO, OMNRF, OPG, PC
(3-3) Coordination with other recovery teams and relevant organizations: recommend consideration of the Channel Darter's needs when proponents are developing projects at the design stage and when resource managers issue permits.	The needs of Channel Darter are considered by DFO staff when assessing proposed projects at the design stage and upon the issue of *Species at Risk Act* (SARA) permit authorizations or letters of advice under the *Fisheries Act* and SARA. Similarly, the OMNRF, MELCCFP also consider the needs of Channel Darter when issuing permits (for example, *Endangered Species Act* permits in Ontario).	In progress	DFO, MECP, MELCCFP, OMNRF
(3-4) Coordination with other recovery teams and relevant organizations: for medium- or high-risk projects in locations without Channel Darter records but with a high probability that the species is there (for example, within the geographic range	DFO biologists conduct surveys for species at risk in high probability areas during the screening of in-water projects. A geomatics tool showing the range and critical habitat of species at risk is available to DFO biologists and the	In progress	DFO, MELCCFP

Activity	Descriptions and results	Progress	Participants
of Channel Darter, and containing suitable habitat), ensure that proponents conduct appropriately timed, targeted surveys using gear types proven effective at detecting Channel Darter.	general public to assess whether the proposed project is in an area frequented by a species at risk. Furthermore, DFO biologists have access to the most recent species distribution data. When necessary, surveys can verify the presence of Channel Darter and validate the quality of the habitat. In Quebec, MELCCFP biologists keep recent databases up-to-date, notably through the Centre de données sur le patrimoine naturel du Québec (Quebec Natural Heritage Data Center; CDPNQ), and invite proponents to complete the information with inventories when necessary.		
(3-5) Coordination with other recovery teams and relevant organizations: develop a central provincial database for species' records in Quebec and integrate recent and historical Channel Darter observation data.	A central database for 5 at-risk species in Quebec, including the Channel Darter, has been developed. The MELCCFP included these data in the CDPNQ. This database is updated annually to provide the most up-to-date distribution data. It is not accessible directly to the public or to external stakeholders, but targeted data are available on request.	In progress	DFO, MELCCFP
(3-6) Coordination with other recovery teams and relevant organizations: establish a co-operative relationship with neighbouring jurisdictions in the United States responsible for Channel Darter management.	No progress has been made on this measure.	Not started	N/A

Table 4. Details of protection, restoration and stewardship activities supporting the recovery of the Channel Darter from 2013 to 2018. Approaches are identified in bold in the Activity column.

Activity	Descriptions and results	Progress	Participants
(4-1) Habitat improvement: encourage stewardship efforts with waterpower industry, agricultural, urban, and industrial sectors in watersheds within the Channel Darter's range.	Various funds are available for species at risk. Environment and Climate Change Canada (ECCC) and Fisheries and Oceans Canada (DFO) collaborate to manage the Habitat Stewardship Program (HSP) and the Aboriginal Fund for Species at Risk (AFSAR), which provide funding to environmental non-governmental organizations (ENGOs) and First Nation organizations to implement species at risk recovery measures. The Ontario Waterpower Association (OWA) received funding through the HSP to develop a Best Management Practices (BMPs) Guide for Channel Darter and Waterpower Projects. The Species at Risk Stewardship Fund (SARSF) administered by Ontario Ministry of the Environment, Conservation and Parks (MECP) has also provided funding to the OWA, as well as other organizations to undertake BMPs and stewardship activities, respectively, which benefit the Channel Darter. In the Quebec region, the following organizations received funding for projects centred on the conservation or restoration of Channel Darter habitat: Ambioterra, Comité de concertation et de valorisation du bassin de la rivière Richelieu (COVABAR), Corporation de l'Aménagement de la Rivière L'Assomption (CARA), the Corridor appalachien, Nature Conservancy of Canada (NCC), Éco-Nature, Groupe ProConseil, Organisme de bassin versant (OBV) Côte-du-Sud; Organisme de concertation pour l'eau des bassins versants de la rivière Nicolet (COPERNIC); Société de conservation et d'aménagement (SCABRIC); and the Union of Agricultural Producers (UAP).	In progress	Ambioterra, CARA, COPERNIC, Corridor appalachien, COVABAR, Éco-Nature, Groupe ProConseil, MECP, NCC, OBV Côte-du-Sud, Ontario Ministry of Natural Resources and Forestry (OMNRF), OWA, SCABRIC, UAP, and others

Activity	Descriptions and results	Progress	Participants
(4-2) Habitat improvement: involve local residents, partners, First Nations and appropriate agencies and groups in action planning, habitat improvement, and threat mitigation activities.	The Essex Region Conservation Authority has conducted projects focused on riparian restoration through funding from the HSP within the Tremblay Creek, Belle River and Puce River watersheds (Channel Darter are known to occur at the mouths of these creeks/rivers). In total,14.5 ha of riparian habitat have been restored through these projects. A dozen regional organizations conducted projects funded by HSP and AFSAR that included habitat improvement and threat mitigation measures. For example, between 2012 and 2017, Ambioterra guided owners and stakeholders of the subwatersheds of the Châteauguay River, mainly the des Anglais and Trout rivers, toward practices that improve and protect the habitat and mitigate human impacts. Furthermore, many watershed organizations were involved and play an important role in the recovery of the Channel Darter in Quebec. For example, OBV Côte-du-Sud raised awareness among various stakeholders about the issue of Channel Darter from 2014 to 2017, and developed a species protection plan to ensure habitat sustainability and thereby support species recovery.	In progress	Ambioterra, DFO, Essex Region Conservation Authority, watershed organizations
(4-3) Best management practices: encourage the implementation of BMPs or similar practices within the agriculture and forestry industries (Ontario Ministry of Agriculture, Food and Rural Affairs / Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec and OMNRF / Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs [MELCCFP]), private forest management agencies, waterpower industry, other resource managers, public	As mentioned for measure 4-1, the OWA received funding through HSP and SARSF to develop a BMPs Guide for Channel Darter and Waterpower Projects.	In progress	MECP, MELCCFP, OBV Côte-du-Sud, OWA

Activity	Descriptions and results	Progress	Participants
and private landowners, and First Nations.			
(4-4) Habitat restoration and threat mitigation: identify extant habitat that would benefit from specific threat mitigation or other habitat improvement activities; undertake habitat restoration and threat mitigation activities to the extent possible and monitor results.	The CARA has conducted surveys that led to the identification of critical habitat within sections of the Ouareau and L'Assomption rivers based on the detection of Channel Darter, and building from this information, they have identified locations where habitat restoration activities should be implemented moving forward. Many regional organizations (Ambioterra, CARA, Comité Zone d'intervention prioritaire [ZIP] du Lac St-Pierre, Abenaki Council of Odanak, Corridor appalachien, OBV Côte-du-Sud) characterized and inventoried available habitat to determine where federally funded (for example, HSP, AFSAR, Interdepartmental Recovery Fund [IRF]) recovery activities (for example, riparian buffer restoration) should be conducted moving forward. Since 2010, Ambioterra has carried out the following recovery actions in the watersheds of the Trout, Châteauguay, and des Anglais rivers: • the development of 3 protection plans for habitat currently occupied by Channel Darter that could benefit from specific mitigation measures and/or other habitat improvement activities • the signing of 82 non-legally binding conservation agreements and the ongoing development of 3 legally binding conservation agreements (nature reserves) • the restoration of an area of 13,412 m^2, corresponding to 2,487 linear metres of shoreline, including the planting of 5,449 plants The OBV Côte-du-Sud characterized habitat in the Bras Saint-Nicolas River and created a map identifying areas where restoration activities that would benefit Channel Darter should be implemented. Three sites have been restored in this river to reduce sediment	Not started	Abenaki Council of Odanak, Ambioterra, CARA, Comité ZIP du lac Saint-Pierre, Corridor appalachien, ENGOs, Groupe ProConseil, OBV Côte-du-Sud, SCABRIC

Activity	Descriptions and results	Progress	Participants
	intake and 12 landowners have signed voluntary conservation agreements. Since 2003, SCABRIC has produced more than 185 booklets for landowners that promote and instruct the implementation of recovery actions for several at-risk species, including the Channel Darter. Follow-up surveys and site visits indicate that the majority of the landowners have put in place at least 1 recommendation listed in the notebook they received. As part of a bank erosion-reduction project conducted from 2013 to 2015, the ENGO Groupe ProConseil vegetated more than 5.2 km of shoreline by seeding and planting more than 10,500 shrubs.		
(4-5) Habitat restoration and threat mitigation: restore habitat and mitigate threats at potential Channel Darter re-establishment sites that have been evaluated and deemed suitable.	In the watershed of the Trout and des Anglais rivers, 13 non-legally binding conservation agreements have been signed and 3 legally binding conservation agreements are underway (nature reserves). An area of 8,993 m^2 corresponding to 1,619 linear metres of riparian shoreline has been protected. From 2014 to 2015, OBV Côte-du-Sud stabilized an erosion zone over a length of 67 m using the vegetation engineering technique, and redirected run-off from the watercourse to reduce severe erosion. From 2014 to 2016, Nature-Action Québec undertook a project focused on the protection and enhancement of species at risk habitats in Montérégie that provided benefits in terms of habitat improvement for Channel Darter, among other species at risk. From 2013 to 2016, Éco-Nature has carried out projects promoting the creation, conservation and restoration of important habitats for the benefit of aquatic fauna (including Channel Darter), that protect critical habitats through legal means (for example, wildlife refuges) and through agreements with private landowners.	In progress	Ambioterra, COVABAR, OBV Côte-du-Sud, Nature-Action Québec, Éco-Nature, Groupe ProConseil

Activity	Descriptions and results	Progress	Participants
	Several projects aimed at improving riparian strips were also carried out by the COVABAR in the Huron River watershed, including within the Richelieu River. The Groupe ProConseil undertook the revegetation of 12 km of shoreline to provide stabilization, which included the planting of 18,000 shrubs, the conservation of a 9-km riparian strip, and the establishment of a 1-km riparian agroforestry strip. These actions should help improve water quality and contribute to the improvement of habitats in the Richelieu River watershed.		
(4-6) Habitat restoration and threat mitigation: ensure proper maintenance of wastewater treatment facilities upstream of areas inhabited by Channel Darter; establish a contingency plan in case of breakdown or intentional shutdown (for example, for maintenance).	No progress has been made on this measure	Not started	N/A
(4-7) Habitat protection: investigate the potential for conservation easements or acquisitions to protect and recover Channel Darter.	No progress has been made on this measure	Not started	N/A

Table 5. Details of communication and public awareness activities supporting the recovery of the Channel Darter from 2013 to 2018. Approaches are identified in bold in the Activity column.

Activity	Descriptions and results	Progress	Participants
(5-1) Communication and coordination: develop and implement a communications plan that identifies partners, approaches, information products, educational and outreach opportunities, stewardship resources and specific best management practices (BMPs) that will assist with the recovery of this species. This may also include a public education plan to inform the public regarding the species, where it exists, and how to identify it. This plan should include a focus on awareness of critical habitat and the *Species at Risk Act* (SARA) to help ensure compliance with the Act.	No communication plans specific to the Channel Darter have been developed; however, information related to the recovery of Channel Darter is included in Fisheries and Oceans Canada (DFO) outreach sessions given to various stakeholders and partners. Information on the Channel Darter and the threats facing the species have also been presented or communicated as a component of projects that were funded through the Habitat Stewardship Program (HSP). The following are examples of projects undertaken in both Ontario and Quebec that provided benefit to the Channel Darter. The Great Lakes Program (Toronto Zoo), conducted from 2015 to 2017, involved presentations in both French and English to elementary and high school classes, internet outreach, informative brochures, broader public outreach events, and capacity building training. Carolinian Canada Coalition (CCC) implemented the Ecosystem Recovery for Species at Risk in Carolinian Canada program between 2012 and 2014, which involved posting BMPs that pertain to Channel Darter on their website as well as distributing outreach materials at public events. In 2012 to 2013, the Corporation de l'Aménagement de la Rivière L'Assomption (CARA) distributed booklets to river landowners providing advice regarding the conservation or restoration of a high-quality riparian strip. In 2016 to 2017, the Organisme de bassin versant (OBV) Côte-du-Sud provided landowners with booklets, as well as voluntary conservation agreements to encourage them to adopt more environmentally conscientious agricultural practices.	In progress	CARA, CCC, Centre de conservation de la nature du mont Saint-Hilaire, COPERNIC, DFO, environmental non-governmental organizations (ENGOs), OBV Côte-du-Sud, SCABRIC, Toronto Zoo

Activity	Descriptions and results	Progress	Participants
	In 2016 to 2018, in the Nicolet River, the Organisme de concertation pour l'eau des bassins versants de la rivière Nicolet (COPERNIC) distributed the landowner booklet, which contains a species protection plan and a conservation agreement. In 2014 to 2016, the Centre de conservation de la nature du mont St-Hilaire undertook a project aimed at carrying out activities centred on habitat acquisition, stewardship with landowners, recovery of endangered species populations, inventory and monitoring, and awareness among the general public. In 2014 to 2016, the Société de conservation et d'aménagement des bassins versants de la Zone Châteauguay (SCABRIC) undertook a project aimed at countering the threat of habitat degradation due to agricultural activities and private land development. SCABRIC met with 23 new owners in 2014 and visited their lands in order to provide customized recommendations for improving the quality of aquatic habitats. The Cooperation Agreement for the Protection and Recovery of Species at Risk in Quebec (2012 to 2022) and the Canada-Ontario Agreement on Species at Risk (2011 to 2021) were introduced to coordinate interventions for species of common interest and their habitats. DFO widely disseminated the recovery strategy for the Channel Darter, produced postcards, an Infoceans article, reprinted factsheets for shoreline landowners and baitfish fishers, and published articles in regional newsletters on various projects that were carried out between 2013 and 2018 that benefit this species. DFO continued to employ a coordinated information sharing approach for the management of species at risk throughout the reporting period.		

Activity	Descriptions and results	Progress	Participants
(5-2) Communication and coordination: encourage municipalities to address the protection of habitat that is important to Channel Darter in their official plans.	DFO species at risk guidance has been provided to Ontario municipalities that have aquatic (fish/mussel) species at risk within areas subject to municipal official plan updates. Initial contact has been made with municipalities that were actively updating their official plans. Species at risk guidance was updated in 2015 and additional contact/outreach to Ontario municipalities with species at risk in their areas is ongoing. In 2012 to 2013, the CARA invited municipal authorities and school groups to events that promoted awareness on the protection and conservation of the Channel Darter. Ambioterra (2012 to 2013) recommended less damaging practices for fish habitat, such as agro-environmental practices and integration into land planning tools, to the municipalities of the subwatersheds of the Châteauguay River. In 2016, OBV Côte-du-Sud undertook an initiative with the Montmagny Regional County Municipality to conserve Channel Darter habitat in their development plan. This initiative is still ongoing. Regional analysts from the Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (MELCCFP) advise municipalities to take wildlife issues into consideration in their projects, particularly with regard to species at risk such as the Channel Darter.	In progress	Ambioterra, CARA, DFO, MELCCFP, OBV Côte-du-Sud
(5-3) Threat awareness: support aquatic invasive species awareness initiatives for the public.	Aquatic invasive species information has been disseminated through the Watercraft Inspection Program and educational outreach material distributed by DFO (public postings and direct engagement), which provides information regarding species at risk as well as the aquatic invasive species that threaten them. Furthermore, licensed commercial baitfish harvesters in Ontario have completed Hazard	In progress	Ambioterra, CARA, Comité de concertation et de valorisation du bassin de

Activity	Descriptions and results	Progress	Participants
	Analysis and Critical Control Point training, which focuses on impacts and prevention of the spread of aquatic invasive species. In addition, research funded by DFO (Drake and Mandrak 2014a, 2014b) has quantified the risk of invasive species introductions throughout the province as a result of the bait industry. The Ontario Ministry of Natural Resources and Forestry (OMNRF), in partnership with Ontario Federation of Anglers and Hunters (OFAH), has developed the Early Detection and Distribution Mapping System that allows the general public and citizen scientists to share their information regarding the distribution of invasive species, including Common Reed, and provides guidance and direction on how to control invasive species. In Quebec, multiple regional organizations, which are listed in the description and results of activity 4-1 of table 4, have carried out Habitat Stewardship Program (HSP) and Aboriginal Fund for Species at Risk (AFSAR)-funded projects to raise public awareness of invasive species. The MELCCFP informs the public about species at risk and aquatic invasive species in several ways (brochures, social media, etc.).		la rivière Richelieu (COVABAR), COPERNIC, Corridor appalachien, DFO, ENGOs, Groupe ProConseil, MELCCFP, Nature Conservancy of Canada (NCC), OBV Côte-du-Sud, OFAH, OMNRF, SCABRIC, Union of Agricultural Producers (UAP)
(5-4) Threat awareness: develop an information campaign for bait fishermen (commercial harvesters, anglers, and First Nations) in areas supporting Channel Darter.	Within Quebec Region, a DFO fact sheet that provides information about the potential threat posed by bait fisheries was distributed by regional organizations to waterfront residents. Fishery officers distribute these cards during patrols or at information kiosks. In 2013, the Quebec government legislated the use of baitfishes, and in 2017, it prohibited the use of baitfishes in the summer period, regardless of whether they are alive or dead.	In progress	DFO, ENGOs, MELCCFP

3.2 Activities supporting the identification of critical habitat

Table 6 provides information on the implementation of the studies outlined in the schedule of studies to identify critical habitat from the recovery strategy. Each study has been assigned 1 of 4 statuses:

1) completed*:* the study has been carried out and concluded
2) in progress*:* the planned study is underway and has not concluded
3) not started: the study has been planned but has yet to start
4) cancelled: the planned study will not be started or completed

Table 6. Status and details of the implementation of the schedule of studies outlined in the recovery strategy for the Channel Darter for the period 2013 to 2018.

Study	Timeline	Status	Descriptions and results	Participants
Conduct studies to determine the habitat requirements for each life stage of Channel Darter.	2014 to 2018	In progress	A modelling study has been conducted that characterized spawning habitat suitability at 3 locations within the Trent River with regard to water depth and velocity (Reid et al. 2016). Levert (2013) wrote a thesis on the habitat use, distribution, and reproduction of Channel Darter throughout most of the year (spring, summer, fall) in 4 tributaries of the Ottawa River. Most Channel Darter surveys were routinely conducted at shallow depths (average 1.3 m) using portable electric fishing gear and shore seines. To address this bias, trawl inventories were conducted in 2015 and 2016 and several specimens were captured at depths of up to 5 m in the Richelieu, Saint-François, St. Lawrence, and Ottawa rivers (Gosselin 2016; Garceau et al. 2016). The results of these studies provide a better understanding of the habitat of Channel Darter and significantly expand our understanding of its potential habitat use/needs. In Quebec, the species' preferred habitat was characterized in the assessment of available information on 5 fish species at risk in Quebec and progress of recovery activities (Couillard et al. 2013). Furthermore, a second assessment was conducted that gathered additional data	Fisheries and Oceans Canada (DFO); Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (MELCCFP); Ontario Ministry of Natural Resources and Forestry (OMNRF); University of Ottawa

Study	Timeline	Status	Descriptions and results	Participants
			from inventories carried out between 2010 and 2016 (Ricard et al. 2018).	
Survey and map habitat quality and quantity within historical and current sites, as well as sites adjacent to currently occupied habitat.	2014 to 2018	In progress	DFO and MELCCFP conducted inventories and assessments of suitable habitat in the rivers identified as critical habitat in Quebec, including the L'Assomption, Ouareau, des Anglais, Trout, Richelieu, Gatineau, and Saint-François rivers. The minimum area for population viability, the amount of suitable habitat required for a demographically sustainable recovery target as established in the recovery strategy, has been achieved for all of these rivers (Levert et al. 2013; Corporation de l'Aménagement de la Rivière L'Assomption [CARA] 2013; Ambioterra 2013; Stavibel 2014a, 2014b). Regional organizations also inventoried and characterized the habitat in areas occupied by Channel Darter, as well as areas adjacent to occupied waters to target recovery activities under Habitat Stewardship Program (HSP), Interdepartmental Recovery Fund (IRF), and Aboriginal Fund for Species at Risk (ASFAR). MELCCFP is responsible for updates of the database (see table 3, activity 3-5), which includes data from research groups and consultants.	DFO, MELCCFP
Conduct additional species surveys to fill in distribution gaps, and to aid in determining population connectivity.	2014 to 2018	In progress	The targeted surveys conducted in Quebec rivers mentioned in table 1 have filled some information gaps in the distribution of Channel Darter. The species' distribution in Quebec seems relatively continuous along the St. Lawrence River and many watersheds with Channel Darter are connected; however, no studies were undertaken to examine the propensity for the dispersal of Channel Darter. The population connectivity within a river and between rivers remains to be determined.	DFO, MELCCFP
Create a population-habitat supply model for each life stage.	2014 to 2018	Not started	N/A	N/A

Study	Timeline	Status	Descriptions and results	Participants
Based on information gathered, review population and distribution goals. Determine amount and configuration of critical habitat required to achieve goal if adequate information exists. Validate model.	2014 to 2018	Not started	N/A	N/A

3.3 Summary of progress towards recovery

3.3.1 Status of performance indicators

Table 7 provides a summary of the progress made toward meeting the performance indicators outlined in table 2. Each indicator has been assigned 1 of 4 statuses:

1) not met: the performance indicator has not been met, and little to no progress has been made
2) not met, underway: the performance indicator has not been met, but there has been moderate to significant progress made
3) met: the performance indicator has been met and no further action is required
4) met, ongoing: the performance indicator has been met, but efforts will continue until such time the population is considered to be recovered (that is, the performance indicator will be reported against in the next progress report)

Table 7. Summary of progress made toward meeting the performance indicators outlined in the recovery strategy for the Channel Darter for the period 2013 to 2018.

Performance indicator	Status	Details
Extant populations fully described by 2018	Not met, underway	In Quebec, targeted surveys were conducted at all historical Channel Darter locations, as well as locations where populations may be undetected. Further inventories should be carried out in certain areas that have not yet been sampled on the south shore of the St. Lawrence River, between the Chêne and Sud rivers. The distribution within some rivers (Ottawa River, Richelieu River, Saint-François River, L'Assomption watershed, and Châteauguay watershed) is now better understood; however, quantitative estimates of abundance and population trends are still lacking. In Ontario, targeted surveys were conducted by DFO in the Detroit River in 2011 leading to the detection of 13 individuals, and in the Ottawa River, which led to the capture of 135 individuals. Non-targeted surveys have been conducted by DFO in a number of locations where Channel Darter occur, including Lake St. Clair, Point Pelee, and the Trent River. These surveys led to the detection of the species in the St. Clair River and Lake St. Clair. In addition, the Ontario Ministry of Natural Resources and Forestry (OMNRF) has conducted targeted surveys for Channel Darter in the Trent, Moira, Skootamatta, and Salmon rivers leading to the capture of Channel Darter.

Performance indicator	Status	Details
Completion of activities outlined in the schedule of studies for the complete identification of critical habitat within the proposed timelines (by 2018).	Not met, underway	Inventories and assessments of suitable habitat in the rivers identified as critical habitat have been undertaken in Quebec, primarily within the L'Assomption, Ouareau, des Anglais, Trout, Richelieu, Gatineau, and Saint-François rivers. Through these surveys, it was confirmed that the minimum area for population viability, the amount of suitable habitat required for a demographically sustainable recovery target as established in the recovery strategy, has been achieved for all of these rivers (Levert et al. 2013; Corporation de l'Aménagement de la Rivière L'Assomption [CARA] 2013; Ambioterra 2013; Stavibel 2014a, 2014b). Little to no progress has been made towards achieving a better understanding of the habitat requirements, the validation of habitat models, or the development of population-habitat supply models for each life stage. Considering that Channel Darter populations in Canada have been divided into 3 designatable units (DUs), which has consequently led to the down-listing of the St. Lawrence populations from a status of threatened to special concern, the identification of critical habitat is no longer required for this DU. Critical habitat still legally applies for the Lake Erie DU and Lake Ontario DU.
Monitoring program established by 2018.	Not met	Sampling for Channel Darter has occurred within various areas of the species' Canadian range; however, no monitoring program specific to this species has been established.
Relative significance of threats evaluated by 2018. Initiate implementation of remedial actions to address priority threats by 2019.	Not met, underway	Research has been conducted investigating the threat of hydroelectric generating stations on the habitat needs of Channel Darter, which led to the development of guidelines for the operation of such facilities to accommodate the life-history needs of the species (Reid pers. comm. 2022); however, the results of this study are specific to one watershed where the species is found. Therefore, similar research is needed to explore the flow needs of Channel Darter in other watersheds where the species occurs and may be affected by generating stations and dams. Research centered on exploring the potential impacts of invasive Round Goby, stream temperature and turbidity was completed in 2019 (Reid 2019).

Performance indicator	Status	Details
Feasibility of re-establishment and potential re-establishment methods determined by 2018. Potential re-establishment sites identified by 2018.	Not met, underway	Progress on this performance indicator has only been made for the Quebec portion of the DU. The recovery team in Quebec, which includes various stakeholders working towards the recovery of the species, has determined that reintroduction is not necessary for Quebec populations, as improved habitat quality should allow natural recolonization by the species. There is no information at this time regarding the feasibility or suitability of reintroductions for the Ontario portion of the DU.
Quantification of best management practices (BMPs) (for example, number of Nutrient Management Plans and Environmental Management Plans completed; hectares of riparian zone established) implemented through ecosystem-based recovery teams and other relevant complementary groups/initiatives to address threats by 2018 (ongoing).	Not met, underway	Projects focused on riparian restoration have been conducted within the Tremblay Creek, Belle River, and Puce River watersheds (Channel Darter are known to occur at the mouths of these creeks/rivers) by the Essex Region Conservation Authority through funding from the Habitat Stewardship Program (HSP). In total, 14.5 ha of riparian habitat in these watersheds has been restored through these projects. In 2014 to 2015, the Organisme de bassin versant (OBV) Côte-du-Sud stabilized an erosion zone over a length of 67 m using vegetation-engineering techniques, and redirected run-off from the watercourse to reduce severe erosion. In the watershed of the Trout and des Anglais rivers, 13 non-legally-binding conservation agreements have been signed and 3 legally-binding conservation agreements are underway (nature reserves). An area of 8,993 m^2 corresponding to 1,619 linear metres of riparian shoreline has been restored. Several projects aimed at improving riparian strips were also carried out by the Comité de concertation et de valorisation du bassin de la rivière Richelieu (COVABAR) in the Huron River watershed. Groupe ProConseil revegetated 12 km of shorelines, including the planting of 18,000 shrubs, the conservation of a 9-km riparian strip, and the establishment of a 1-km riparian agroforestry strip. These actions should help improve water quality in the targeted watersheds and contribute to the improvement of habitats in the Richelieu River.

Performance indicator	Status	Details
Document any changes in public perceptions and support for identified recovery actions through guidance identified in the communications strategy (by 2018).	Not met	No progress has been made.

3.3.2 Completion of action plans

An action plan has not been developed by DFO for the Channel Darter at the current time; however, a combined recovery strategy and action plan is being developed for the Lake Erie and Lake Ontario DUs, which have been listed under SARA as endangered. A multi-species action plan is currently being developed by PC for the Trent Severn Waterway that will prescribe implementation activities that will benefit the recovery of Channel Darter. An action plan is no longer required for the St. Lawrence River populations because this DU has been down-listed tospecial concern; however, DFO is currently developing a multi-species action plan for the Richelieu River that will aim to improve the water quality of the watershed to promote the recovery of several species, including the Channel Darter.

3.3.3 Critical habitat identification and protection

Using the best available information, critical habitat for Channel Darter was identified in the 2013 recovery strategy in the following areas:

Ontario:

1. Little Rideau Creek/Ottawa River
2. Trent, Moira/Black/Skootamatta rivers, and Salmon River
3. The western basin of Lake Erie (Point Pelee)

Quebec:

4. Gatineau River
5. L'Assomption River/Ouareau River
6. Richelieu River
7. Saint-François River
8. des Anglais River/aux Outardes Est River/Trout River/Châteauguay River

In August 2019, the listing on SARA Schedule 1 followed COSEWIC's recommendation to split Canadian populations of Channel Darter into 3 DUs. The St. Lawrence populations (DU3), which includes the Quebec and Little Rideau Creek/Ottawa River populations, was down-listed to special concern; therefore, critical habitat identification is no longer required for this DU.

Within Ontario, further critical habitat should be identified in the Detroit River when the recovery strategies for DUs 1 and 2 are developed, considering the substantial number of Channel Darter detected there since 2013. In addition, the detection of Channel Darter in the Erieau Beach area of Rondeau Bay may warrant further identification of critical habitat in that location; however, further sampling is needed to determine the extent of area within Rondeau Bay that is occupied by Channel Darter. Following the identification of critical habitat in an updated recovery strategy for the Lake Erie and Lake Ontario populations (DU1 and DU2, respectively), a critical habitat order will be made under SARA section 58(1) to protect the critical habitat from destruction.

3.3.4 Recovery feasibility

Currently, there is no need to review the recovery feasibility for this species, considering no new information has been gathered that would suggest that Channel Darter populations within Canadian waters no longer meet the feasibility criteria laid out in the recovery strategy. For example, there are still enough reproducing individuals and suitable habitat to support recovery

objectives, and threats to the species can be, or have been, addressed through restoration efforts and the promotion of BMPs.

4 Concluding statement

There has been some significant progress in the implementation of recovery activities for the Channel Darter with regard to specific measures prescribed in the strategy. For example, targeted sampling has been conducted by DFO and the Ontario Ministry of Natural Resources and Forestry (OMNRF) within 6 watersheds and the OMNRF has detected Channel Darter in Rondeau Bay in 2018 where the species was considered to be extirpated. In addition, non-target sampling conducted within the upper St. Clair River has led to the detection of Channel Darter where the species had not been previously detected, as well as within Big Otter Creek near Port Burwell, where the species was historically present.

In Quebec, a concerted effort between DFO, Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (MELCCFP), and non-governmental organizations has permitted the sampling of almost all historical locations, as well as areas of high potential for occupancy. This sampling has led to detections at a number of locations, including the discovery of 7 new populations, expanding the known distribution area for Channel Darter in the St. Lawrence River watershed. Populations in 4 rivers are still considered extirpated (aux Bleuets, Niger, Maskinongé, and Chicot rivers); however, the presence of Channel Darter has been confirmed in the du Sud River, where the population was previously considered extirpated. This river represents the northeast limit of the distribution of the Channel Darter.

In addition, research has been undertaken that examined the suitability of sampling approaches and the amount of effort needed to successfully detect Channel Darter, as well as potential declines in abundance, which is beneficial when developing a standardized sampling and monitoring program in the future. Modelling studies have also been completed that explored habitat use of the Channel Darter within the Trent River, as well as tributaries of the Ottawa River. Furthermore, modelling studies conducted in the Trent River led to the development of recommendations for generating stations regarding flows that should be maintained to ensure that the habitat needs for spawning are not compromised. Lastly, research has commenced that will investigate the feasibility of repatriations and translocations as a means of offsetting historical and/or ongoing declines in Channel Darter abundance at certain locations.

Progress has also been made with regard to outreach and awareness activities that have been conducted by DFO as well as external agencies through funding from the Habitat Stewardship Program (HSP). These activities are meant to inform the general public about the Channel Darter, its status, the threats that are affecting it, as well as BMPs that can be adopted to minimize impacts from human activities. In addition, some limited habitat improvement activities have been conducted by the Essex Region Conservation Authority within tributaries to the south shore of Lake St. Clair, which should help reduce the threat of sedimentation and improve water quality of downstream lakes where Channel Darter are present.

In Quebec, regional organizations have conducted projects, which were funded by HSP and the Aboriginal Fund for Species at Risk (AFSAR), to improve habitat and mitigate threats in areas such as the Châteauguay, Richelieu, du Sud, and L'Assomption watersheds. For example, guidance was provided to landowners and stakeholders within the Châteauguay River watershed regarding practices that improve and protect Channel Darter habitat and mitigate the impacts of anthropogenic land use practices. Awareness was also raised among various

stakeholders regarding Channel Darter recovery and the threats that affect the species. In addition, a species protection plan to ensure habitat sustainability and aid recovery was developed. Furthermore, habitat improvement projects centred on riparian restoration have been conducted since 2013.

A number of pertinent activities prescribed within the recovery strategy have not yet been implemented. Specifically, targeted surveys have not been undertaken in Ontario within areas where the species has not yet been discovered but where suitable habitat exists. Such surveys could both confirm Channel Darter occurrences within a given DU and allow for potential locations to be ruled out, which would advance the performance objective of fully describing extant populations. Research exploring the seasonal habitat needs of the Channel Darter is also pending, and would represent an important component in the development of predictive habitat models and habitat supply models. Further recovery implementation for the Channel Darter should focus on pending survey and monitoring, and research measures to fill knowledge gaps.

Following the 2016 re-evaluation of Channel Darter by COSEWIC, the species was separated into 3 DUs. The Lake Erie and Lake Ontario units were assessed as endangered, while the St. Lawrence River unit was assessed as special concern. In August 2019, the new DUs, with their new statuses, were listed on Schedule 1 of SARA. As a result of the new status designation of special concern within the latter DU, critical habitat is no longer identified within the St. Lawrence River and associated watersheds. The updated recovery strategy for the Lake Erie and Lake Ontario DUs, and the management plan for the St. Lawrence DU have not been posted yet. Further progress reports will be based on these new documents. When the recovery strategy and action plan for Lake Erie and Lake Ontario populations (DUs 1 and 2) is developed, further critical habitat should be identified within the St. Clair River, the Detroit River, and Rondeau Bay. In the interim, monitoring should be conducted within Rondeau Bay to determine the extent of Channel Darter occupancy and to better inform the identification of critical habitat at that location.

5 References

Ambioterra. 2013. Inventory and Characterization of Habitats Used by the Channel Darter and Assessment of the Area of Suitable Habitat for the Channel Darter (A6020). Report submitted to Fisheries and Oceans Canada. 41 pages and annexes.

Boucher, J. and S. Garceau. 2010. Information in support of a recovery potential assessment of Channel Darter (*Percina copelandi*) in Quebec. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/097. iii + 33 pp.

Bureau environnement et terre d'Odanak. 2017. Inventaire d'abondance et estimation de la superficie de l'habitat propice pour le fouille-roche gris dans la rivière Saint-François, secteur inférieur. 34 pages and annexes.

CARA (Corporation de l'Aménagement de la Rivière l'Assomption). 2013. Mise à jour du Rapport 2013. Corporation de l'Aménagement de la Rivière l'Assomption. Rapport final présenté à Pêches et Océans Canada. 69 pages and annexes.

CARA (Corporation de l'Aménagement de la Rivière l'Assomption). 2017. Inventaire de fouille-roche gris et de dard de sable dans la rivière Noire, bassin versant de la rivière L'Assomption – Numéro de contrat F3767-160008. Rapport préparé pour ministère des Pêches et Océans Canada. Joliette, Québec. 51 pp.

Comité (Zone d'Intervention Prioritaire) du lac Saint-Pierre. 2013. Projet d'inventaire et caractérisation des habitats utilisés par le fouille-roche gris et le dard de sable. Réf. A6019 et A6020. Rapporté présenté au Ministère des Pêches et Océans, Région du Québec. 27 pages and annexes.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002. COSEWIC assessment and update status on report on the channel darter *Percina copelandi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 21 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2016. COSEWIC assessment and status report on the Channel Darter *Percina copelandi*, Lake Erie populations, Lake Ontario populations and St. Lawrence populations, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xvi + 68 pp.

Couillard, M-A., J. Boucher and S. Garceau. 2011. Protocole d'échantillonnage du fouille-roche gris (*Percina copelandi*), du dard de sable (*Ammocrypta pellucida*) et du méné d'herbe (*Notropis bifrenatus*) au Québec. Ministère des Ressources naturelles et de la Faune du Québec, Faune Québec. 28 pages and 2 annexes.

Couillard, M. A., J. Boucher and S. Garceau. 2013. Bilan de l'information disponible sur cinq espèces de poissons à statut précaire au Québec et de l'état d'avancement des activités de rétablissement, ministère du Développement durable, de l'Environnement, de la Faune et des Parcs du Québec, Direction générale de l'expertise sur la faune et ses habitats. 58 pages + annexes.

DFO (Fisheries and Oceans Canada). 2010. Recovery Potential Assessment of Channel Darter (*Percina copelandi*) in Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/058.

DFO (Fisheries and Oceans Canada). 2013. Recovery Strategy for the Channel Darter (*Percina copelandi*) in Canada. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. viii + 82 pp.

Dextrase, A.J., N.E. Mandrak, J. Barnucz, L.D. Bouvier, R. Gaspardy, and S.M. Reid. 2014. Sampling Effort Required to Detect Fishes at Risk in Ontario. Canadian Manuscript Report of Fisheries and Aquatic Sciences. 3024: v + 50 p.

Drake, D.A.R. and N.E. Mandrak. 2014a. Bycatch, bait, anglers, and roads: quantifying vector activity and propagule introduction risk across lake ecosystems. The Ecological Society of America 24: 877-894.

Drake, D.A.R. and N.E. Mandrak. 2014b. Ecological risk of live bait fisheries: a new angle on selective fishing. American Fisheries Society 39: 201-211.

Garceau, S., N. Vachon and E. Drouin, 2016. Inventaires des habitats du fouille-roche gris et du dard de sable en eau profonde en Montérégie 2015, rapport final. Ministère des Forêts, de la Faune et des Parcs du Québec, Direction de la gestion de la faune de l'Estrie, de Montréal, de la Montérégie et de Laval, Secteur des opérations régionales, 44 pp.

Gareau, P. and E. Groulx Tellier. 2014. Rapport du projet «Écosystémique de protection du fouille-roche gris, du dard de sable et de la biodiversité», remis au ministère des Pêches et Océans Canada, permis N/Réf: DFO-MPO-SARA-LEP QC14-005. St-Chrysosotome (Qc) : le Groupe Ambioterra, 25 pp.

Gareau, P. and E. Groulx Tellier. 2015. Rapport du projet «Écosysté-mique de protection du fouille-roche gris, du dard de sable et de la biodiversité», remis à Pêches et Océans Canada, permis N/Réf: MPO-LPE-QC15-00716GP. St-Chrysosotome (Qc) : le Groupe Ambioterra, 26 pp.

Gareau, P., E. Groulx Tellier and K. Quirion-Poirier. 2016. Rapport des projets « du projet «Écosystémique de protection du fouille-roche gris, du dard de sable et de la biodiversité», re-mis au ministère Pêches et Océans Canada, permis N/Réf: MPO-LEP-QC-16-007.St-Chrysostome (Qc) : le Groupe Ambioterra, 31 pages and 2 annexes.

Gareau, P., E. Groulx-Tellier and K. Quirion-Poirier. 2017a. Inventaire ichtyologique et caractérisation de l'habitat du poisson dans la rivière Châteauguay. Rapport remis à la Fondation Héritage Faune. St-Chrysostome (Qc): le Groupe Ambioterra, vi + 42 pp. + 6 annexes.

Gareau, P., E. Groulx-Tellier et K. Quirion-Poirier. 2017b. Rapport d'acquisition de connaissances Rivière Châteauguay. Rapport remis à la Fondation de la Faune du Québec. St-Chrysostome (Qc): le Groupe Ambioterra, vi + 32 pp. + 3 annexes.

Gosselin, A.-M. 2016. Inventaire du fouille-roche gris dans la rivière des Outaouais. Rapport d'activité 2016. Ministère des Forêts, de la Faune et des Parcs. 43 pp.

Groulx Tellier, E., P. Juneau and P. Gareau. 2018. Rapport d'acquisition de connaissances : Protection du dard de sable - rivière aux Saumons. Rapport produit pour le compte de la Fondation de la Faune du Québec, St-Chrysostome (Qc): le Groupe Ambioterra, v + 53 pp.

HydroNet. 2013. Rivières échantillonnées au cours de l'été 2013, Province de Québec, présenté au ministère du Développement durable, de l'Environnement, de la Faune et des Parcs du Québec. 30 pp.

Kidd, A., S.M. Reid, and C.C. Wilson. 2011. Local and regional population genetic structure of the threatened Channel Darter in Ontario. Poster, Canadian Conference for Fisheries Research, Toronto, Ontario.

Levert, C. 2013. Étude de l'habitat d'une espèce en péril au Canada, le fouille-roche gris (Percidae : *Percina copelandi*), dans quatre tributaires de la rivière des Outaouais. Master of Science thesis, Biology Department, University of Ottawa, Ottawa (Canada).

Levert, C., C.L. Proulx, and F. Chapleau. 2013. Habitat essentiel du fouille-roche gris (*Percina copelandi*) dans la rivière Gatineau, Québec, Canada. Rapport soumis à :Julie Deschênes, biologiste. Direction régionale de l'Outaouais. Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs (MDDEFP). December 13, 2013.

OBV (Organisme des bassins versants) de la Côte-du-Sud. 2013. Projet d'inventaire et de caractérisation des habitats utilisés par la fouille-roche gris (*Percina copelandi*) dans le Bras-Saint-Nicolas. Rapport final présenté à Pêches et Océans Canada. 39 pages and annexes.

Paradis, V. 2014. Projet sur l'utilisation des tributaires de la rivière du Sud par le fouille-roche gris (*Percina copelandi*). Organisme de bassins versants de la Côte-du-Sud. 39 pp.

Proulx, C. 2014. A study of Darter (Percidae) assemblages in several tributaries of the Ottawa River, Quebec, Canada. Thesis, Department of Biology, Faculty of Science, University of Ottawa.

Proulx, C.L., C. Levert and F. Chapleau. 2013. Inventaire du fouille-roche gris (*Percina copelandi*) dans quelques tributaires de la rivière des Outaouais (Québec, Canada). Rapport soumis à Julie Deschênes, Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs, Secteur de la faune. December 13, 2013. 6 pp.

Reid, S.M. 2019. Summer microhabitat use and overlap by the invasive Round Goby (*Neogobius melanostomus*) and native darters in the Trent River (Ontario, Canada). Knowledge and Management of Aquatic Ecosystems, 420: article 23.

Reid, S.M., S. Brown, T. Haxton, J. Luce, and B. Metcalfe. 2016. Habitat modelling in support of the recovery of Channel darter (*Percina copelandi*) populations along the Trent River, Ontario. DFO, Canadian Science Advisory Research Document, 2016/043. V + 28 p.

Reid, S.M., and T.J. Haxton. 2017. Backpack electrofishing effort and imperfect detection: Influence on riverine fish inventories and monitoring. Journal of Applied Ichthyology, 33: 1083-1091.

Reid, S.M., A. Kidd, and C. Wilson. 2013. Genetic information in support of COSEWIC evaluation of Channel Darter (*Percina copelandi*) designatable units. Unpublished report prepared for COSEWIC Freshwater Fishes Subcommittee. 8 pp.

Ricard, M., M. A. Couillard and S. Garceau. 2018. État des connaissances sur quatre espèces de poissons à statut précaire au Québec : fouille-roche gris, dard de sable, méné d'herbe et brochet vermiculé, ministère des Forêts, de la Faune et des Parcs du Québec, Direction de l'expertise sur la faune aquatique, 61 p.

Richard, K. 2016. Inventaire d'abondance et estimation de la superficie d'habitat du dard de sable et du fouille-roche gris dans la rivière Bécancour. Bureau environnement et terre Wôlinak. 19 pages and annexes.

Stavibel. 2014a. Évaluation de la superficie d'habitats propices pour le fouille-roche gris et le dard de sable sur la rivière Richelieu. Rapport d'expertise. 41 pages and annexes.

Stavibel. 2014b. Évaluation de la superficie d'habitats propices pour le fouille-roche gris sur la rivière St-François. Rapport d'expertise. 26 pages and annexes.

WSP. 2014. Inventaire et caractérisation des habitats utilisés par le fouille-roche gris et le dard de sable dans 18 cours d'eau du Québec. Rapport de WSP à Pêches et Océans Canada. 39 pages and annexes.

APPENDIX A: ACRONYMS

AFSAR	Aboriginal Fund for Species at Risk
BMP	Best Management Practice
CARA	Corporation de l'Aménagement de la Rivière L'Assomption
CCC	Carolinian Canada Coalition
CDPNQ	Centre de données sur le patrimoine naturel du Québec
COPERNIC	Organisme de concertation pour l'eau des bassins versants de la rivière Nicolet
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
COVABAR	Comité de concertation et de valorisation du bassin de la rivière Richelieu
DFO	Fisheries and Oceans Canada
DU	Designatable Unit
ECCC	Environment and Climate Change Canada
ENGO	Environmental non-governmental organization
HSP	Habitat Stewardship Program
IRF	Interdepartmental Recovery Fund
MECP	Ontario Ministry of the Environment, Conservation and Parks
MELCC	Ministère de l'Environnement et de la Lutte contre les changements climatiques[3]
MELCCFP	Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs
MFFP	Ministère des Forêts, de la Faune et des Parcs[4]
NCC	Nature Conservancy of Canada
NTU	Nephelometric Turbidity Units
OBV	Organisme de bassin versant
OFAH	Ontario Federation of Anglers and Hunters
OMNRF	Ontario Ministry of Natural Resources and Forestry
OPG	Ontario Power Generation
OWA	Ontario Waterpower Association
PC	Parks Canada
SARA	*Species at Risk Act*
SARSF	Species at Risk Stewardship Fund
SCABRIC	Société de conservation et d'aménagement des bassins versants de la Zone Châteauguay
UAP	Union of Agricultural Producers
USFWS	United States Fish and Wildlife Service
ZIP	Zone d'intervention prioritaire

[3] MELCC was renamed Ministère de l'Environnement, de la Lutte aux changements climatiques, de la Faune et des Parcs (MELCCFP) in October 2022.

[4] Following the Quebec government's appointment of a new Cabinet in October 2022, the Forest Sector now reports to the Ministère des Ressources naturelles et des Forêts, while the Wildlife and Parks Sectors report to the Ministère de l'Environnement, de la Lutte aux changements climatiques, de la Faune et des Parcs (MELCCFP).