

Report on the Progress of Recovery Strategy Implementation for the Eastern Sand Darter (*Ammocrypta pellucida*) in Canada (Ontario Populations) for the Period 2017 to 2022

Eastern Sand Darter



2026

Recommended citation:

Fisheries and Oceans Canada. 2026. Report on the Progress of Recovery Strategy Implementation for the Eastern Sand Darter (*Ammocrypta pellucida*) in Canada (Ontario Populations) for the Period 2017 to 2022. *Species at Risk Act Recovery Strategy Report Series*. Fisheries and Oceans Canada, Ottawa. v + 40 pp.

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Cover illustration: Alan Dextrase, Ontario Ministry of Natural Resources

Également disponible en français sous le titre
« Rapport sur les progrès de la mise en œuvre du programme de rétablissement du dard de sable (*Ammocrypta pellucida*) au Canada, populations de l'Ontario pour la période 2017 à 2022 »

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ISBN 978-0-660-79422-8
Catalogue no. En3-4/122-1-2025E-PDF

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Preface

The *Species at Risk Act* (S.C. 2002, c.29) (SARA), requires reporting on the implementation of the recovery strategy for a species at risk (via a progress report), and 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 every subsequent 5 years, until the recovery strategy is no longer required under SARA or the species' recovery is no longer feasible. This reporting must be done by the competent Minister.

The Minister of Fisheries is the competent minister under SARA for the Eastern Sand Darter (Ontario populations) and has prepared this progress report.

Reporting on the progress of recovery strategy implementation requires reporting on the collective efforts of the competent minister(s), provincial and territorial governments, and all other parties involved in conducting activities that contribute to 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 and not all may be undertaken or show significant progress during the timeframe of a report on the progress of recovery strategy implementation (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 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 benefit of the Eastern Sand Darter (Ontario populations) and Canadian society as a whole.

Acknowledgments

This progress report was prepared by Fisheries and Oceans Canada (DFO). To the extent possible, this progress report has been prepared with inputs from Ontario Ministry of Natural Resources, Ontario Ministry of the Environment, Conservation and Parks and Environment and Climate Change Canada. DFO would like to express its appreciation to all individuals and organizations who have contributed to the recovery of the Eastern Sand Darter.

Executive summary

The Eastern Sand Darter (*Ammocrypta pellucida*) was listed as threatened under the *Species at Risk Act* (SARA) in 2003. The “Recovery Strategy for the Eastern Sand Darter (*Ammocrypta pellucida*) in Canada: Ontario Populations” was finalized and published on the [Species at Risk Public Registry](#) in 2012.

The threats identified for the Eastern Sand Darter (Ontario Populations) (hereafter referenced as Eastern Sand Darter) include the following:

- turbidity and sediment loading
- contaminants and toxic substances
- nutrient loading
- barriers to movement
- altered flow regimes
- shoreline modifications
- exotic species and disease
- incidental harvest

The long-term goal (greater than 20 years) for the Eastern Sand Darter is to maintain self-sustaining, extant populations and to restore self-sustaining populations to formerly occupied habitats where feasible. The population and distribution objective for the Eastern Sand Darter is to ensure the survival of self-sustaining population(s) at the 6 extant locations (Sydenham River, Thames River, Lake St. Clair, Big Creek, Grand River, Lake Erie [Long Point Bay]) and restore self-sustaining population(s) at the following locations: Ausable River, Lake Erie (Rondeau Bay and Pelee Island), Catfish Creek, and Big Otter Creek, where feasible.

The “Report on the Progress of Recovery Strategy Implementation for the Eastern Sand Darter in Canada (Ontario Populations) for the Period 2017 to 2022” (progress report) reports on the progress made by Fisheries and Oceans Canada (DFO) and its partners towards implementing the recovery strategy and achieving its objectives. During this time period, progress has been made including:

- extensive targeted sampling across key waterways, including significant findings such as the first recorded captures in Rondeau Bay since 2005 and the first ichthyoplankton data from the Sydenham River in Ontario, provided valuable insights into habitat use and species distribution
- research on genetic differentiation combined with the occurrence of Eastern Sand Darter in unique habitats, resulted in the Ontario populations to be split into 2 recognized designatable units
- advances in knowledge of translocation as a potential recovery approach such as habitat descriptions of potential translocation sites, potential impacts to source populations, and the development of a decision framework
- stewardship activities, such as habitat improvement projects (for example, riparian restoration, vegetation planting, and cattle fencing) which resulted in the rehabilitation of 142 ha and 27 km of shoreline in reaches of watersheds relevant to Eastern Sand Darter
- annual Eastern Sand Darter outreach activities which involved the public, conservation authorities, DFO, and other stakeholders

These ongoing and/or completed activities indicate that progress was made towards the population and distribution objective for the Eastern Sand Darter. However, a number of areas remain where further information is required. For example, a long-term monitoring

program that includes standardized sampling protocol needs to be developed and implemented to provide population estimates that would allow for the estimation of population trends over time. Moreover, the creation of a population-habitat supply model for each life stage will aid in developing recovery targets and determining the amount of critical habitat required by each life stage to meet these targets. A better understanding of threats to the species, including threat magnitude and mechanism of impact, will direct stewardship activities to alleviate their impacts.

Table of contents

Preface	ii
Acknowledgments.....	ii
Executive summary.....	iii
Table of contents	v
1 Introduction	1
2 Background.....	1
2.1 COSEWIC assessment summary and threats to the species and its critical habitat	1
2.2 Recovery	5
3 Progress towards recovery	6
3.1 Approaches supporting recovery.....	7
3.2 Activities supporting the identification of critical habitat	29
3.3 Summary of progress towards recovery	32
3.3.1 Status of performance indicators.....	32
3.3.2 Completion of action plan.....	36
3.3.3 Critical habitat identification and protection	36
3.3.4 Recovery feasibility	36
4 Concluding statement.....	36
5 References.....	38

1 Introduction

The “Report on the Progress of Recovery Strategy Implementation for the Eastern Sand Darter in Canada (Ontario Populations) for the Period 2017 to 2022” outlines the progress made towards meeting the recovery objectives listed in the “Recovery Strategy for the Eastern Sand Darter (*Ammocrypta pellucida*) in Canada: Ontario Populations” during the indicated time period and is 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 report ([COSEWIC 2022](#)), the science advisory report from the recovery potential assessment (RPA) ([DFO 2011](#)), a recovery strategy ([DFO 2012](#)), and a previous progress report ([DFO 2018](#)).

Section 2 of the progress report provides an overview of key information on the threats to the species, the population and distribution objective for achieving its recovery, and performance indicators to measure the progress of recovery. For more details, readers should refer to the recovery strategy. Section 3 reports on the progress made towards the broad strategies and approaches to meet the recovery objectives identified in the recovery strategy.

2 Background

2.1 COSEWIC assessment summary and threats to the species and its critical habitat

The listing of the Eastern Sand Darter under SARA in 2003 led to the development and publication of the “Recovery Strategy for the Eastern Sand Darter (*Ammocrypta pellucida*) in Canada: Ontario Populations” in 2012. The recovery strategy is consistent with the information provided in the third COSEWIC status report (COSEWIC 2009), and the COSEWIC summary information is included in section 1.1 of the recovery strategy. The listing and development of the recovery strategy were further informed by the “Recovery Potential Assessment of Eastern Sand Darter (*Ammocrypta pellucida*) in Canada” (Bouvier et al. 2010, DFO 2011).

Since the publication of the COSEWIC status report in 2009, a population of Eastern Sand Darter was found at West Lake, Ontario. Subsequently, the 2022 COSEWIC status report split the Ontario populations into 2 designatable units (DU): the Southwestern Ontario population and the West Lake population. These 2 DUs were examined in the latest COSEWIC status report in 2022, and both were confirmed as threatened (COSEWIC 2022). Detection records from 2017 to 2022 for Southern Ontario and West Lake are shown in figures 1 and 2, respectively.

The recovery strategy identifies the threats to survival and recovery of the Eastern Sand Darter and threats to its critical habitat. Section 1.5 of the recovery strategy provides information on the threats to the species’ survival and recovery. These threats include:

- turbidity and sediment loading
- contaminants and toxic substances
- nutrient loading
- barriers to movement
- altered flow regimes
- shoreline modifications
- exotic species and disease
- incidental harvest

Critical habitat for the Eastern Sand Darter has been identified, to the extent possible, in section 2.7 of the recovery strategy. The recovery strategy also provides examples of activities that are likely to result in the destruction of critical habitat (that is, threats to critical habitat). The list of activities provided in table 14 of the recovery strategy is neither exhaustive nor exclusive, and their inclusion has been guided by the relevant threats to habitat described in the recovery strategy. For more details on the activities likely to result in the destruction of critical habitat, consult the recovery strategy.

Section 8.2 of the recovery strategy includes a schedule of studies that outlines the research required to identify critical habitat to achieve the species' population and distribution objective. Progress in undertaking the schedule of studies is reported in section 3.2 of this document.

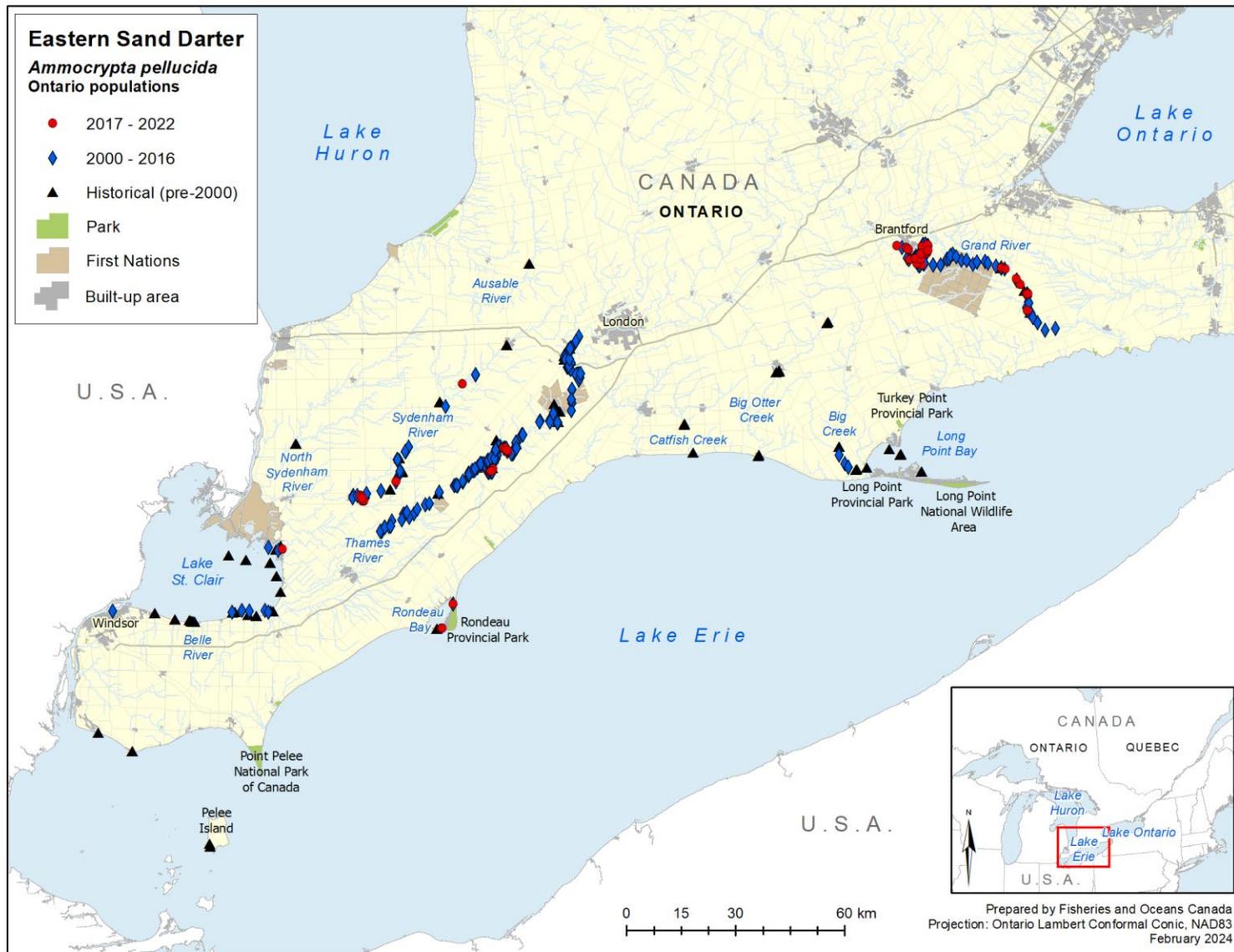


Figure 1: Detections of Eastern Sand Darter (Ontario populations) in southwestern Ontario.

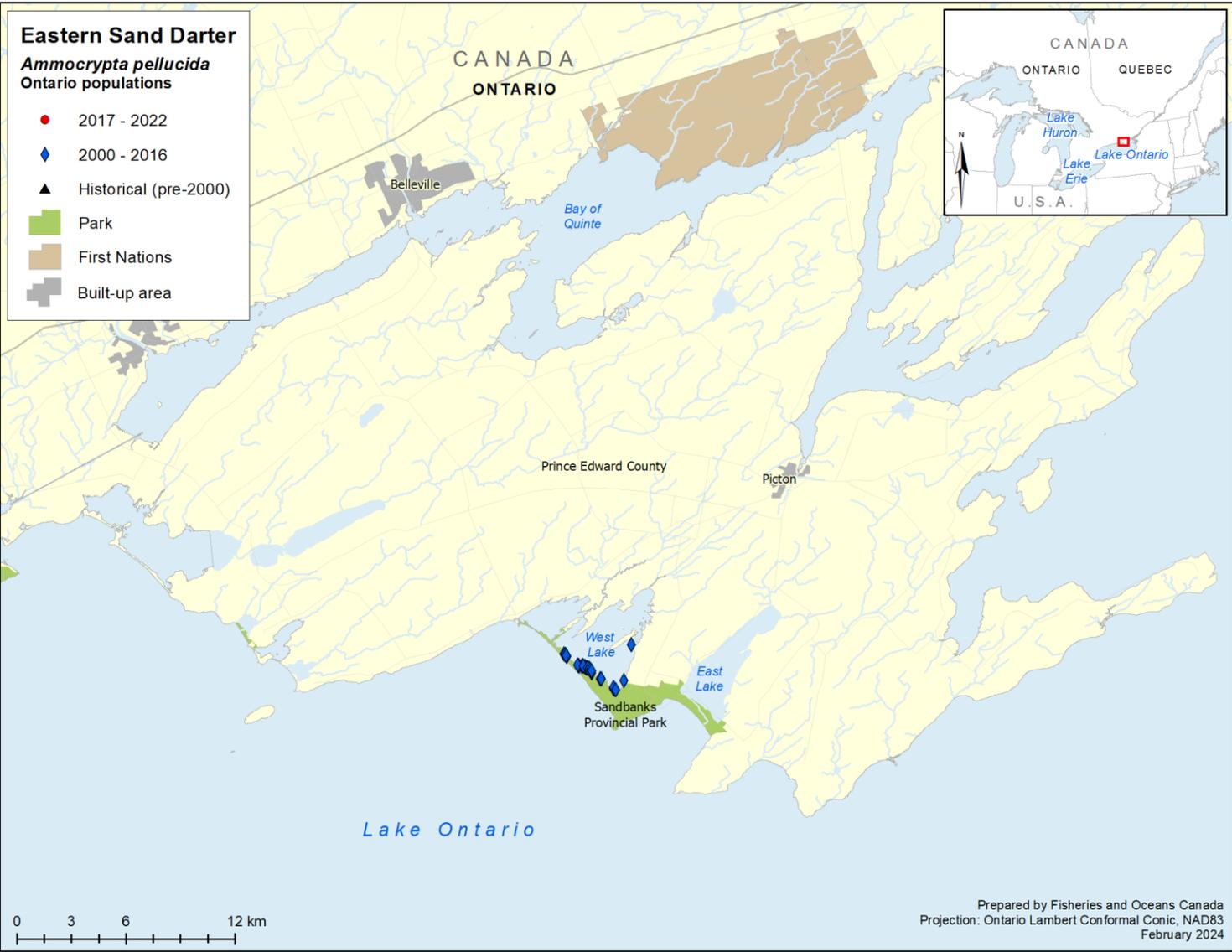


Figure 2: Detections of Eastern Sand Darter (Ontario populations) in West Lake, Ontario.

2.2 Recovery

This section summarizes the recovery objectives found in the recovery strategy to support the population and distribution objective that is necessary for the recovery of the Eastern Sand Darter, and the performance indicators to define and measure progress towards achieving the population and distribution objective.

Section 2.2 of the recovery strategy identified that the long-term goal (greater than 20 years) is to maintain self-sustaining, extant populations and to restore self-sustaining populations to formerly occupied habitats where feasible. Section 2.3 of the recovery strategy identified the following population and distribution objective necessary for the recovery of the species:

- to ensure the survival of self-sustaining population(s) at the 6 extant locations (Sydenham River, Thames River, Lake St. Clair, Big Creek, Grand River, and Lake Erie [Long Point Bay]) and to restore self-sustaining population(s) at the following locations: Ausable River, Lake Erie (Rondeau Bay and Pelee Island), Catfish Creek, and Big Otter Creek, where feasible

Section 2.4 of the recovery strategy identified the following recovery objectives to support the long-term goal:

- i. refine population and distribution objectives
- ii. ensure the protection of critical habitat
- iii. determine long-term population and habitat trends
- iv. evaluate and minimize threats to the species and its habitat
- v. investigate the feasibility of population supplementation or repatriation for populations that may be extirpated or reduced
- vi. enhance efficiency of recovery efforts through coordination with aquatic and terrestrial ecosystem recovery teams and other relevant or complementary groups/initiatives
- vii. improve overall awareness of the Eastern Sand Darter and the role of healthy aquatic ecosystems, and their importance to humans

Section 2.6 of the recovery strategy includes the following performance indicators to evaluate the achievement of recovery objectives:

- monitoring indicates that populations remain extant at known sites
- implementation of management measures in Table 7
- existing populations and historical sites and potential habitats have been sampled
- gained knowledge of currently occupied and potential of historical habitats.
- complete description of Eastern Sand Darter critical habitat
- monitoring program has been developed
- research has been conducted to clarify number, extent, and severity of threats to Eastern Sand Darter
- research has been conducted to evaluate feasibility of translocations, repatriations, and captive rearing
- outreach program developed and materials distributed
- formalized partnerships developed to increase awareness and formulate action plans towards recovery

However, some indicators may not have been measurable, or sufficient information/data for some indicators may have not been acquired within the timeframe covered in this progress

report. In such cases, the implementation of the recovery approaches and critical habitat studies will help report on the progress.

3 Progress towards recovery

The recovery strategy for the Eastern Sand Darter (DFO 2012) organized the recovery approaches into 3 categories: 1) Research and Monitoring, 2) Management and Habitat Protection, and 3) Stewardship, Outreach and Education. Within these categories, 19 broad strategies are identified; 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 in meeting the performance indicators and other commitments (for example, action plan and critical habitat order) identified in the recovery strategy and information obtained through implementing the recovery strategy.

3.1 Approaches supporting recovery

Table 2 provides information on the implementation of the approaches and broad strategies identified in the recovery planning table of the recovery strategy.

Table 2. Details of approaches supporting the recovery of the Eastern Sand Darter (Ontario populations) from 2017 to 2022.

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
<p>Refine knowledge of seasonal habitat requirements for all life stages, especially juvenile.</p>	<p>Research and Monitoring; R1. Habitat requirements</p>	<p>A diet and trophic niche study found that Eastern Sand Darter in the Thames River have a narrow trophic niche with a high probability of overlap with co-occurring benthic and benthopelagic feeders (Burbank et al. 2019). Specifically, niche overlap with Blackside Darter and Johnny Darter could mean potential competition with these species if prey were to become scarce.</p> <p>Occupancy models confirmed that sites with higher proportions of sandy and fine gravel substrates were more likely to be occupied (Lamothe et al. 2019). These same models showed that the probability of occupancy increased with water depth, clarity, and velocity.</p> <p>A study identifying early life stages of fishes in the Sydenham River found Eastern Sand Darter eggs and larvae at 2 sites (Gallage et al. 2023). This study was part of a multi-month larval fish sampling program implemented by</p>	<p>ii</p>	<p>All</p>	<p>Fisheries and Oceans Canada (DFO), University of Toronto, University of Waterloo</p>

¹ Lead participant(s) is/are listed on top and in bold; other participants are listed alphabetically. Not all activities have specific participants identified.

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<p>DFO to document the occurrence of eggs and larval fishes in the Sydenham River, including Eastern Sand Darter.</p> <p>Firth et al. (2021) assessed critical thermal maximum (CT_{max}) of individuals from the Grand and Thames rivers using stream-side field trials. For Grand River individuals, CT_{max} ranged from 27°C to 37°C, with mean stream temperature during the previous 24 hours being the most important determinant. The study also found that for Thames River individuals living in a turbid environment, turbidity did not affect CT_{max}.</p> <p>Metabolic rate and hypoxia tolerance of Eastern Sand Darter was investigated for Grand River individuals (Firth et al. 2023). The study found that water temperature was the most important predictor of these 2 physiological parameters; however, it was a weak predictor overall.</p>			
<p>Evaluate and map the distribution, quantity, and quality of habitat in the vicinity of known populations.</p>	<p>Research and Monitoring; R2. Habitat surveys and mapping</p>	<p>The St. Clair Region Conservation Authority (SCRCA) monitored water quality and sampled for benthic invertebrates in the Sydenham River watershed in 2017 and 2018 as part of their funding through the Habitat Stewardship Program (HSP) and the Species at Risk Stewardship Program (SARSP), and in 2021 and 2022 as part of their funding through the Canadian Nature Fund for Aquatic Species at Risk (CNFASAR). Family biotic index</p>	<p>i, ii</p>	<p>All</p>	<p>DFO, Ministry of Natural Resources (MNR), SCRCA, Ministry of the Environment, Conservation and Parks (MECP)</p>

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<p>scores, based on benthic invertebrates, showed that water quality ranged from good to poor, depending on the subwatershed.</p> <p>Aquatic habitat mapping using an acoustic doppler current profiler was conducted by DFO and MNR for occupied stretches of the Grand River in 2022, and by DFO for the Thames River in 2021. Results indicated that occupied sections of the Grand River contained enough depositional substrates that suitable habitat is likely not limiting for the species in the Grand River (DFO unpublished data; Illes et al. 2024).</p> <p>Occupied sites on the Grand River were sampled for dissolved oxygen, water surface temperature, and substrate in August 2022. Mean dissolved oxygen at the surface was 8.03 mg/l while substrate was dominated by medium gravel (>8 mm) or sand gravel (0.063 mm – 8 mm) (Firth pers. comm. 2024).</p>			
<p>Develop a long-term monitoring program that includes standardized sampling protocol to monitor for trends over time in distribution and</p>	<p>Research and Monitoring; R3. Background surveys and monitoring – extant, historical and potential new locations</p>	<p>Although a long-term standardized monitoring program has not been implemented, a variety of monitoring projects targeted towards Eastern Sand Darter have been conducted.</p> <p>DFO surveyed multiple rivers and tributaries in Southern Ontario since 2017. This includes the sampling of 2 historical watersheds, the Ausable River and Big Otter Creek, where the last confirmed records were from 1928 and</p>	<p>i, iii, v</p>	<p>All</p>	<p>DFO, Ausable Bayfield Conservation Authority (ABCA), Lower Thames Valley Conservation Authority</p>

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
<p>abundance for all life stages. Incorporate findings into a routine population monitoring program.</p>		<p>1955, respectively. In 2018, 9 sites were surveyed in the Ausable River while 52 sites were surveyed in Big Otter Creek (Barnucz et al. 2020). No Eastern Sand Darter were found during those targeted surveys.</p> <p>Targeted sampling in the Thames River occurred at 8 sites in 2020, with 59 Eastern Sand Darter captured (Barnucz et al. 2022a). This also included the collection of habitat data.</p> <p>In 2019, DFO conducted non-standardized sampling methods to target and catch Eastern Sand Darter in the Grand River for streamside physiology work. A total of 521 Eastern Sand Darter were captured near Cockshutt Bridge during 187 seine hauls and 61 benthic trawl tows (Gáspárdy and Drake 2021).</p> <p>In 2022, DFO conducted targeted sampling at 101 sites (303 seine hauls) in the Grand River from Brantford to Newport, and Caledonia to Cayuga where sand and fine gravel substrates were dominant. A total of 625 Eastern Sand Darter were captured across 36 sites, including 174 from a single site downstream of Cockshutt Bridge (Gáspárdy et al. 2025).</p> <p>LeBaron et al. (2020) conducted targeted surveys for Eastern Sand Darter in beach habitats of the Great Lakes. In total, 195 sites</p>			<p>(LTVCA), MNR, SCRCA, University of Toronto, University of Windsor, Upper Thames River Conservation Authority (UTRCA)</p>

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<p>were seined between 2009 and 2018. In 2018, 4 Eastern Sand Darter were caught at 3 of 18 sites in Rondeau Bay. This was the first confirmed record there since 2005.</p> <p>Sampling in Mitchell's Bay, Lake St. Clair in 2017 captured 2 individuals (MNR unpublished data).</p> <p>The LTVCA conducted environmental DNA (eDNA) sampling coupled with seining at 7 locations in the lower Thames River in 2022. Seining captured 6 young-of-the-year at 1 station and eDNA sampling detected Eastern Sand Darter at 4 stations. In 2021, eDNA sampling occurred at 12 sites, with Eastern Sand Darter detected at 2 sites only.</p> <p>The UTRCA conducted fish monitoring in the upper Thames River watershed as part of their HSP funding in 2021 and 2022. This sampling included both electrofishing and seining and no Eastern Sand Darter were captured.</p> <p>The SCRCA conducted 29 fish surveys in the Sydenham River watershed in 2019. In 2020, they conducted fish monitoring at 12 sites, capturing 1 Eastern Sand Darter. In an effort to detect trends over time, monitoring occurred at the same 10 index sites in both 2021 and 2022 but failed to detect the species.</p>			

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<p>The ABCA conducted fish sampling on the Ausable River at 3, 10, and 5 stations in 2019, 2020, and 2022, respectively. No Eastern Sand Darter were captured.</p> <p>The power to detect changes in occupancy and abundance of SARA-listed freshwater fishes was investigated in Lamothe et al. (2023b). This paper determined the relationship between the number of survey sites and statistical power to describe changes in occupancy and abundance over time.</p> <p>Reid and Dextrase (2017) compared the beach seine versus the bag seine in catching Eastern Sand Darter at lacustrine sites. They found that the beach seine is better at determining occupancy of sites and it is also better at detecting young-of-the-year of the species.</p> <p>Balasingham et al. (2018) developed a custom-designed group-specific primer to detect Eastern Sand Darter from eDNA samples. They successfully detected the species during their eDNA study on the Grand and Thames rivers.</p> <p>Detection probabilities between eDNA and seine-based sampling were compared at sites in West Lake (Reid and Haxton 2020). The authors found that while eDNA was successful</p>			

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<p>at detecting Eastern Sand Darter at known occupied sites, it was not better at determining occupancy than traditional methods.</p> <p>DNA barcoding was successfully used to identify Eastern Sand Darter eggs and larvae from multi-species batch samples in the Sydenham River (Gallage et al. 2023; DFO unpublished data) and DNA barcoding was successfully used to identify individual larval Eastern Sand Darter (DFO unpublished). Eastern Sand Darter larvae were detected at 3 locations: Alvinston, Oil Springs, and Florence; Eastern Sand Darter eggs were detected at Florence. This work was part of a multi-month egg and larval sampling program in the Sydenham River.</p>			
<p>Investigate and evaluate the significance of habitat threat factors that may be impacting extant populations. Take steps to mitigate immediate threats identified.</p>	<p>Research and Monitoring; R4. Threat clarification - habitat</p>	<p>As anthropogenic stressors are likely to increase water temperatures, Firth et al. (2021) assessed critical thermal maximum (CT_{max}) of individuals (See broad strategy R1 in this table for further details).</p> <p>Metabolic rate and hypoxia tolerance of Eastern Sand Darter was investigated for Grand River individuals (Firth et al. 2023). The study found that water temperature was the most important predictor of these 2 physiological parameters; however, it was a weak predictor overall. Mean dissolved oxygen levels ranged from 6.75 to 11.12 mg/L at occupied sites.</p>	<p>iv</p>	<p>All habitat-related threats (barriers to movement, altered flow regimes, shoreline modifications)</p>	<p>DFO, LTVCA, University of Waterloo</p>

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<p>The LTVCA produced an in-depth threat assessment report at the subwatershed level for all waters within their authority. This was produced from 2018 to 2022 through the HSP and CNFASAR programs. The report states that subwatersheds in the western region of the lower Thames River were exposed to more threats than other subwatersheds, which includes Big Creek, a historical location for Eastern Sand Darter, where tile drainage is extensive and water quality parameters are poor.</p>			
<p>Investigate the mechanisms of impact of Round Goby on Eastern Sand Darter. Monitor distribution of Round Goby in areas of Eastern Sand Darter populations.</p>	<p>Research and Monitoring; R5. Threat clarification – exotic species</p>	<p>In the Sydenham River, a study found that following invasion, a number of ecologically significant diet overlaps between Round Goby and benthic fishes were observed (Firth et al. 2020). This observation indicated that Round Goby may be leading to community-level changes in feeding strategy, in addition to diet overlap with Eastern Sand Darter. For this reason, the authors state that Eastern Sand Darter should be monitored for any potential habitat shifts in the future.</p> <p>A study on the impacts of Round Goby showed that the species is associated with reduced relative abundance of several darter species in Big Otter Creek and the Ausable River (McAllister et al. 2022).</p>	<p>iv</p>	<p>Exotic species</p>	<p>DFO, University of Waterloo</p>

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
<p>Where repatriations are deemed appropriate for restoring populations (historical or degraded), develop a repatriation plan.</p>	<p>Research and Monitoring; R6. Captive rearing and repatriations</p>	<p>In an effort to better understand Eastern Sand Darter co-occurrence patterns with other stream fishes, Lamothe et al. (2019) found that the species is negatively associated with Rosyface Shiner in the Grand River but positively associated with Northern Hogsucker, Silver Shiner, and Mimic Shiner.</p> <p>Lamothe et al. (2021) conducted a modelling exercise which showed that translocation of Eastern Sand Darter can be successful with minimal impacts to source populations. The models assumed that the source population was abundant and stable (generally greater than 20,000 individuals) and that suitable habitat was available.</p> <p>A recent habitat study was conducted in Big Otter Creek to determine the quality of habitat at historical and targeted sites for possible Eastern Sand Darter translocation (Barnucz et al. 2022b). The results of this work indicated high proportions of sand cover at both the targeted and historical survey sites.</p> <p>The ability of translocation to work as a species at risk recovery approach was assessed in a framework developed by Lamothe et al. (2023a).</p> <p>In 2022, The University of Windsor carried out a study on techniques for minimizing transport</p>	<p>v</p>	<p>All</p>	<p>DFO, University of Windsor</p>

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<p>stress of Eastern Sand Darter, which is important research for any future repatriations.</p> <p>See broad strategy R3 in this table for further details.</p>			
<p>Examine the degree of genetic variation and isolation within, and among, (that is, small populations and inbreeding concerns) populations across its North American range.</p>	<p>Research and Monitoring; R7. Conservation genetics</p>	<p>The genetic structure of northern populations was assessed by Walter et al. (2022). The study confirmed support for the existing 2 designatable units identified by COSEWIC in Ontario.</p>	<p>v</p>	<p>All</p>	<p>University of Toronto, University of Windsor</p>
<p>Develop a predictive habitat model to identify potential Eastern Sand Darter sites and significant habitat areas.</p>	<p>Research and Monitoring; R8. Habitat modelling</p>	<p>Using occupancy models, Lamothe et al. (2019) determined that the probability of occupancy was higher at sites with greater proportions of sand and fine gravel. The probability of occupancy also increased with water depth, clarity, and velocity.</p> <p>See broad strategies R1, R2, and R3 in this table for further details.</p>	<p>i</p>	<p>All</p>	<p>DFO</p>
<p>Work with relevant organizations (for example, conservation authorities, MNR), First Nations, and</p>	<p>Management and Habitat Protection; M1. Coordination with other recovery teams and</p>	<p>Through annual DFO species at risk (SAR) outreach, responsible agencies are informed about aquatic (fishes/mussels) SAR within their jurisdiction and are encouraged to incorporate SAR guidance into planning documents, including municipal official plans,</p>	<p>vi, vii</p>	<p>All</p>	<p>DFO</p>

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
<p>ecosystem/single species recovery teams to share knowledge and to implement recovery actions.</p>	<p>relevant organizations</p>	<p>with a goal of informing proponents early in the planning stage of any sensitive species in their project area.</p> <p>Stewardship and outreach projects with funding from HSP, CNFASAR, and the Aboriginal Fund for Species at Risk (AFSAR) target species at risk, including Eastern Sand Darter. DFO works with, and funds, relevant organizations through its Grants and Contributions programs to implement recovery actions.</p> <p>Compliance and enforcement efforts by DFO continue on an annual basis. Conservation and Protection officers within DFO continue to inspect all works or activities that impact species at risk. In 2017 an incidence of habitat destruction on the Thames River ultimately led to restoration of that habitat by the proponent via a <i>Fisheries Act</i> Corrective Measures Order.</p>			
<p>Ensure planning and management agencies, including local First Nations, recognize the importance of fluvial and long-shore processes and sources of sand bedload in the</p>	<p>Management and Habitat Protection; M2. Habitat management and policy</p>	<p>No progress has been made in this area from 2017 to 2022.</p>	<p>iii, iv</p>	<p>All habitat threats</p>	<p>Not applicable</p>

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
<p>maintenance of Eastern Sand Darter habitats. Ensure that flow requirements of the Eastern Sand Darter are considered in the management of water supply and flow regimes.</p>					
<p>In cooperation with relevant ecosystem recovery teams and First Nations, address watershed-scale stressors to populations and their habitat.</p>	<p>Management and Habitat Protection; M3. Assessment of watershed-scale stressors</p>	<p>A study by Smyth and and Drake (2021) modelled possible impacts of Bayluscide application, a lampricide used in the Great Lakes, to fishes and mussels. The study found that the application of granular Bayluscide over 100 years could significantly impact Eastern Sand Darter populations, but this was dependant on application cycle and population size. For example, depending on the density estimates used, a maximum modelled decline in abundance could be 13% or 90%, if Bayluscide applications occurred annually. These modelling results relied on several assumptions, including the inability of a species to recover following mortality. However, a relative risk assessment by Andrews et al. (2021) found that risk to Eastern Sand Darter from Bayluscide was relatively low in comparison to other fish species at risk. This risk was partly due to low overlap between past Bayluscide application</p>	<p>vi</p>	<p>All</p>	<p>DFO</p>

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<p>locations and the range of Eastern Sand Darter.</p> <p>Urban wastewater and industrial effluents are a pervasive threat to Eastern Sand Darter throughout its range. In the Grand River, metabolic and morphological impacts to darter species have been observed downstream of wastewater treatment plants (WWTP) (Mehdi et al. 2018, Hodgson et al. 2020). There have been major upgrades to several wastewater treatment plants on the Grand River in recent years. These upgrades include the Kitchener WWTP and Waterloo WWTP and has resulted in reduced pharmaceuticals, endocrine disruptors, and ammonia in the effluent. Following upgrades at the Kitchener WWTP, a study found that a major reduction in intersex in Rainbow Darters below the WWTP was associated with improved effluent quality (Hicks et al. 2017).</p>			
<p>Develop a management plan addressing potential risks and proposed actions in response to the arrival or establishment of exotic species.</p>	<p>Management and Habitat Protection; M4. Exotic species management plan</p>	<p>The action plan for the Ausable River in Canada: an ecosystem approach (DFO 2020) outlines best management practices (BMP) to address threats to species at risk in this ecosystem, including invasive species.</p> <p>Ontario launched the Early Detection and Distribution Mapping System (EDDMapS Ontario), an initiative that enhances monitoring and early detection of invasive species in the province (EDDMapS Ontario 2018)</p>	<p>vi, vii</p>	<p>Exotic species</p>	<p>DFO, MNR</p>

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
Encourage municipalities and First Nations to include the concerns about Eastern Sand Darter habitat conservation in the municipal planning documents.	Management and Habitat Protection; M5. Municipal planning	Municipal public works and planning departments have been included in aquatic species at risk outreach activities conducted by DFO's species at risk program staff. DFO has developed and distributed aquatic species at risk official plan guidance for municipalities (that is, Regional Planning Commissioners of Ontario) to incorporate into municipal official plan updates. This guidance includes providing a review on critical habitat orders to municipal planners and government agencies in 2018, as well as providing species at risk outreach to the Regional Planning Commissioners of Ontario in 2019. In 2021, species at risk outreach was provided to conservation authorities and their respective municipalities including the Essex Region Conservation Authority (ERCA), LTVCA, QCA (Quinte Conservation Authority), and SCRCA.	vi, vii	All habitat threats	DFO
Encourage and strengthen stewardship efforts with managers, stakeholders, First Nations, and citizens aimed at protecting Eastern Sand Darter habitats.	Stewardship, Outreach and Education; S1. Stewardship - awareness	Through HSP, a number of habitat restoration projects occurred from 2017 to 2022 that benefit Eastern Sand Darter, which includes the following: <ul style="list-style-type: none"> • Grand River Conservation Authority (GRCA) restored riparian areas along 19 km of shoreline on the Grand River and its tributaries through vegetation/tree plantings. The GRCA also carried out 3 stormwater management projects, which included the creation of a series of wetland cells and 2 water and sediment control 	v	All	DFO , ABCA, Catfish Creek Conservation Authority (CCCA), ERCA, GRCA, LTVCA, SCRCA, UTRCA

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<p>basins (WASCOBs) to minimize run-off. An outreach program was also initiated whereby the GRCA gave several webinars and presentations to inform the public on species at risk stewardship;</p> <ul style="list-style-type: none"> • ERCA restored 8.4 ha of habitat along Lake St. Clair while SCRCA restored 18.8 ha of riparian and aquatic habitat along the Sydenham River and its tributaries. Two landowners improved an additional 10 ha of wetland and shoreline through the installation of cattle fencing. Three erosion control programs were also implemented in the Sydenham River watershed and a total of 3.7 ha of wetland were created; • The Upper Thames River Conservation Authority created 1,700 m of riparian buffer habitat and eliminated an all-terrain vehicle (ATV) crossing on Wabuno Creek. This work was supported by the SARSP; • The LTVCA improved 31.4 ha of habitat in the Thames River watershed, and Rondeau Bay, which included plantings along riparian buffers and wetland habitat creation; • The ABCA restored 3 wetlands in the Ausable river watershed in 2018 and restored 250 m² of riparian buffer 			

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<p>habitat in 2021. This work was also supported, in part, by the SARSP;</p> <ul style="list-style-type: none"> • The Catfish Creek Conservation Authority restored 5 ha of riparian habitat and 525 m of shoreline in the Catfish Creek watershed through plantings. <p>The CNFASAR provided funding for a number of habitat restoration projects from 2017 to 2022 that benefit Eastern Sand Darter including the following:</p> <ul style="list-style-type: none"> • Approximately 29 hectares of habitat that were improved by the SCRCA through riparian plantings, wetland habitat creation, and cattle exclusion fencing in the Sydenham River watershed; • The LTVCA restored 14.7 hectares of habitat through riparian buffer plantings and wetland habitat creation. Also, stream habitat was protected through the installation of 1.2 km of cattle fencing; • 21.4 hectares of habitat were improved in the Ausable River watershed by the ABCA through riparian buffer plantings, and wetland habitat restoration. In addition to this, 5,710 m of riparian buffer was improved. The ABCA also worked with multiple landowners to create a total of 6 WASCObS in 2022. 			

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
<p>Work with landowners and First Nations to implement BMPs in areas that will provide the most benefit. Encourage the completion and implementation of Environmental Farm Plans and Nutrient Management Plans.</p>	<p>Stewardship, Outreach and Education; S2. Stewardship – implementation of BMP's</p>	<p>See broad strategies S1 and S6 for further details.</p>		<p>Turbidity and sediment loading, contaminants and toxic substances, nutrient loading, shoreline modifications</p>	<p>DFO, conservation authorities</p>
<p>Develop a communication and awareness-raising plan that identifies partners and target audiences. Raise the awareness and develop information products, educational and outreach opportunities, stewardship resources, and specific BMP's that will assist with the recovery of Eastern Sand Darter.</p>	<p>Stewardship, Outreach and Education; S3. Communication plan</p>	<p>An outreach strategy was developed for SAR in southwestern Ontario targeting the following audiences:</p> <ul style="list-style-type: none"> • local municipal staff – managers, planners, engineers, field staff, and consultants • urban developers – representatives of local development industries and/or their consultants • landowners – representatives of the local landowners, farmers, and cottagers, as well as recreational groups such as ATV/trail users • conservation/environmental/stewardship organizations – fish and game clubs, naturalist and environmental protection organizations, students, and stewardship councils 	<p>v, vi</p>	<p>All</p>	<p>DFO, ABCA, GRCA, LTVCA, SCRCA, Toronto Zoo</p>

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<p>In July 2020, TVOKids aired an episode of their Leo's FishHeads TV show that showcased Eastern Sand Darter through a partnership with DFO.</p> <p>DFO delivered outreach on SAR to partners, including indigenous groups, Conservation Authorities and the public on an annual basis. DFO provided outreach at 24 events that targeted species at risk, including Eastern Sand Darter, reaching a total of 4,025 people.</p> <p>From 2017 to 2022, a variety of species at risk outreach programs were delivered through HSP:</p> <ul style="list-style-type: none"> The LTVCA hosted 28 outreach events that reached 6,272 people, which included messaging about aquatic species at risk, including Eastern Sand Darter, threats to SAR, projects that can be undertaken to benefit these species, and agricultural best management practices. Flyer mail-outs were used to provide information on species at risk and stewardship opportunities to locals. LTVCA also started a social media campaign that aimed to increase public awareness and shift people's actions in relation to road salt use in winter; 			

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<ul style="list-style-type: none"> • The GRCA held several webinars and presentations to inform the public on species at risk stewardship; • The SCRCA conducted a large outreach program from 2018 to 2019 where SAR newsletters were sent out to more than 64,000 households and held several community events where SAR messaging reached approximately 900 people at schools and other venues. This work was also supported, in part, by the SARSP; • Outreach on species at risk was provided by the Toronto Zoo in 11 school boards, reaching 12,000 students in 2018 and 2019. This work was also supported by the SARSP. <p>From 2017 to 2022, a variety of species at risk outreach programs were delivered through CNFASAR:</p> <ul style="list-style-type: none"> • The SCRCA distributed 185,000 species at risk newsletters to homeowners on their lands. They also promoted BMPs at 6 agricultural events and reached thousands of kids through species at risk sessions presented at schools. Their social media outreach campaign reached approximately 310,000 individuals and 			

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<p>was aimed at species at risk stewardship;</p> <ul style="list-style-type: none"> • The LTVCA hosted 56 outreach events that reached almost 7,000 individuals. They distributed over 3,100 flyers to the public and worked with the Chippewas of the Thames First Nation to develop an agricultural management plan; • The ABCA mailed postcards to over 3,100 landowners to engage on stewardship incentives. They also developed 2 educational videos posted on YouTube which focused on fish, including species at risk. They conducted 4 social media outreach campaigns and provided 11 educational presentations on species at risk to 244 students. In 2020, they developed agricultural BMP guides for landowners in the Old Ausable Channel. In 2022, they held 5 targeted outreach sessions that focused on threats to species at risk and agricultural BMPs. 			
Collaborate with relevant groups, including First Nations groups and recovery teams to address recovery actions to benefit	Stewardship, Outreach and Education; S4. Coordination with other groups	See broad strategies M1, M5, S1, S3, S5 and S6 for further details.	v, vi	All	DFO

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
Eastern Sand Darter.					
Increase public awareness of the impacts of invasive species on the natural ecosystem, and encourage the use of the Ontario invasive species reporting system.	Stewardship, Outreach and Education; S5. Exotic species - awareness	DFO provided a SAR and invasive species outreach education session to Friends of Pinery Provincial Park in 2021.	v, vi	Exotic species and Disease	DFO
Facilitate access to funding sources for landowner and local community groups engaged in stewardship activities.	Stewardship, Outreach and Education; S6. Stewardship-financial assistance/ incentives	Federal funding was available through AFSAR, the HSP, and CNFASAR. HSP funding was provided by DFO through contribution agreements to support local stewardship initiatives led primarily by environmental non-government organizations, while AFSAR funding supported the development of Indigenous capacity to participate actively in the implementation of SARA. CNFASAR funding supported stewardship projects that help recover and protect aquatic species at risk. Collectively, the activities supported the implementation of measures, such as BMPs associated with water quality improvements, and reducing sedimentation. From 2017 to 2022, HSP and CNFASAR funding resulted in a number of habitat improvement projects in the Ausable River, Thames River, Sydenham River,	iv	All	DFO, Environment and Climate Change Canada (ECCC), MECP

Approach	Broad strategy and approach category	Descriptions and results	Recovery objectives	Threats addressed	Participants ¹
		<p>Rondeau Bay and its tributaries, and watersheds of the Grand River.</p> <p>Similarly, the Ontario Ministry of the Environment, Conservation and Parks administered the Species at Risk Stewardship Program, which provided money for similar stewardship activities to those described above for HSP. These activities included the Species at Risk Farm Incentive Program that provided funding to agricultural landowners interested in completing habitat creation, enhancement, and protection BMPs that supported species at risk.</p>			

3.2 Activities supporting the identification of critical habitat

Table 3 provides information on the implementation of the studies outlined in the schedule of studies to identify critical habitat found in the recovery strategy. Each study has been assigned 1 of 4 statuses:

- 1) completed: the study has been carried out and is 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 3. Status and details of the implementation of the schedule of studies outlined in the recovery strategy for the Eastern Sand Darter (Ontario populations).

Description of activity	Approximate timeline ²	Status	Descriptions and results	Participants ³
Conduct studies to determine the habitat requirements for all life stages.	2011 to 2014	In Progress	<p>Eastern Sand Darter eggs and larvae were identified from batch samples in the Sydenham River (Gallage et al. 2023). Eggs were detected during the month of June and larvae were present from June through August. The Florence site where the eggs were collected was dominated by sandy substrate.</p> <p>A population model indicated that the rate of population increase was most sensitive to 0+ survival rates, clutch size, and clutch number (Finch et al. 2017). For this reason, the authors stated that management actions should be focused on the stewardship of spawning and juvenile habitats.</p>	<p>Fisheries and Oceans Canada (DFO), Ministry of Natural Resources (MNR), University of Toronto, University of Waterloo</p>

² The approximate timeline refers to the timeline in the schedule of studies outlined in the recovery strategy for the Eastern Sand Darter (Ontario populations).

³ Lead participant(s) is/are listed on top and in bold; other participants are listed alphabetically. Not all activities have specific participants identified.

Description of activity	Approximate timeline ²	Status	Descriptions and results	Participants ³
			<p>For further details on studies that helped determine habitat requirements for different life stages, please see broad strategies R1 and R2 in Table 2 above.</p>	
<p>Survey and map habitat quality and quantity within historical and current sites, as well as sites adjacent to currently occupied habitat.</p>	<p>2011 to 2014</p>	<p>In Progress</p>	<p>DFO conducted targeted surveys for Eastern Sand Darter in the Ausable River, Thames River, Big Otter Creek, and Grand River from 2017 to 2022. During these surveys, DFO has also collected habitat data to further our understanding of Eastern Sand Darter distribution. During this same time period, the SCRCA have conducted water quality monitoring and benthic invertebrate sampling in the Sydenham River.</p> <p>Both National Wildlife Areas located at Long Point were surveyed for fishes during the period of this report. Parsons Inc., a contractor for Environment and Climate Change Canada, conducted fish community surveys at Big Creek National Wildlife Area from 2020 to 2022. Fyke nets with a mesh size of 6mm and seine nets with a mesh size of 3mm were used but no Eastern Sand Darter were captured (Dunn 2025). In 2017, fish sampling using seine and fyke nets occurred at the Long Point National Wildlife Area but no Eastern Sand Darter were captured (Montgomery 2019).</p> <p>For further details on habitat surveys, please see broad strategy R2 in Table 2 above.</p>	<p>DFO, Ministry of Natural Resources (MNR), St. Clair Region Conservation Authority (SCRCA),</p>
<p>Conduct additional species surveys to fill in distribution gaps, and to aid in determining population connectivity.</p>	<p>2011 to 2014</p>	<p>In Progress</p>	<p>Targeted surveys for Eastern Sand Darter were conducted in beaches of Lake Huron, Ausable River, Thames River, Rondeau Bay, Big Otter Creek, and Grand River. Northern Madtom surveys conducted by DFO in the Sydenham River (2019) and Thames River (2022) captured Eastern Sand Darter. These surveys contributed to our overall</p>	<p>DFO, Conservation Authorities (CAs), MNR, MECP</p>

Description of activity	Approximate timeline ²	Status	Descriptions and results	Participants ³
			<p>understanding of the known distribution of Eastern Sand Darter.</p> <p>In 2017, the ABCA surveyed under-sampled reaches in the Upper, Middle and Lower Ausable River for Eastern Sand Darter with funding from the Species at Risk Stewardship Program. No Eastern Sand Darter were captured (Desy 2025).</p>	
<p>Create a population-habitat supply model for each life stage.</p>	<p>2014 to 2016</p>	<p>In Progress</p>	<p>Although a population-habitat supply model has not been developed, several studies were necessary pre-cursors, which includes aquatic habitat mapping using an acoustic doppler current profiler for occupied stretches of the Grand River in 2022, and for the Thames River in 2021. Results indicated that occupied sections of the Grand River contained enough depositional substrates that suitable habitat is likely not limiting for the species in the Grand River (DFO unpublished data; Illes et al. 2024).</p> <p>An Ichthyoplankton study identifying early life stages of fishes in the Sydenham River found Eastern Sand Darter eggs and larvae at 2 sites (Gallage et al. 2023). This study was part of a multi-month larval fish sampling program implemented by DFO to document the occurrence of eggs and larval fishes in the Sydenham River, including Eastern Sand Darter.</p> <p>A study published in 2021 lists several technological and statistical methods for measuring habitat supply for Canadian freshwater fishes (Castañeda et al. 2021).</p>	<p>DFO, MNR</p>
<p>Based on information gathered, review</p>	<p>2014 to 2016</p>	<p>In Progress</p>	<p>In 2022, COSEWIC placed the Ontario populations of Eastern Sand Darter into 2 designatable units (DU) based on genetic differentiation and their occurrence in unique</p>	<p>DFO, Committee on the Status of</p>

Description of activity	Approximate timeline ²	Status	Descriptions and results	Participants ³
population and distribution goals. Determine amount and configuration of critical habitat required to achieve goal if adequate information exists. Validate model.			habitats (COSEWIC 2022). To date, no progress has been made on updating population and distribution goals. With respect to critical habitat, a population model by Lamothe et al. (2021) is an important outcome that will be useful for determining population viability and the amount and configuration of critical habitat required for Eastern Sand Darter.	Endangered Wildlife in Canada (COSEWIC)

3.3 Summary of progress towards recovery

3.3.1 Status of performance indicators

Table 4 provides a summary of the progress made towards meeting the performance indicators outlined in the recovery strategy. 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) partially met, underway: moderate to significant progress has been made towards meeting 1 or more elements of the performance indicator, and further work is ongoing or planned
- 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 as needed to achieve the objectives outlined in the species' recovery strategy

Table 4 Summary of progress made towards meeting the performance indicators outlined in the recovery strategy for the Eastern Sand Darter (Ontario populations).

Performance indicator	Status	Details
Monitoring indicates that populations remain extant at known sites.	Partially met, underway	Targeted sampling has occurred at beaches of Lake Huron, Ausable River, Thames River, Rondeau Bay, Big Otter Creek, and Grand River. During those sampling events, individuals were captured from the Thames River, Sydenham River, Lake St Clair, Rondeau Bay, and Grand River. No individuals were captured from Detroit River, Catfish Creek, Big Creek, West

Performance indicator	Status	Details
Implementation of management measures in table 7 of the Eastern Sand Darter Recovery Strategy.		Lake, or Long Point Bay during this same time period. However, no targeted surveys were conducted in these areas.
Existing populations and historical sites and potential habitats have been sampled.	Partially met, underway	Same as above. Historical sites such as Big Otter Creek and the Ausable River were surveyed for Eastern Sand Darter, suggesting these populations have been extirpated. Other historical areas such as Big Creek and Long Point Bay have not had targeted surveys for Eastern Sand Darter in over a decade, with the last specimens captured in 2008 and 1996, respectively.
Gained knowledge of currently occupied and potential of historical habitats.	Partially met, underway	A recent habitat study was conducted in Big Otter Creek where Eastern Sand Darter are believed to be extirpated. The goal of the study was to determine the quality of habitat at historical and targeted sites for possible Eastern Sand Darter translocation (Barnucz et al. 2022b).
Complete description of Eastern Sand Darter critical habitat.	Partially met, underway	Occupancy models confirmed that sites with higher proportions of sandy and fine gravel substrates were more likely to be occupied (Lamothe et al. 2019). These same models showed that the probability of occupancy increased with water depth, clarity, and velocity. A study identifying early life stages of fishes in the Sydenham River found Eastern Sand Darter eggs and larvae at both sites sampled, but a greater proportion were found at the site dominated by sand substrates compared to the site dominated by gravel (Gallage et al. 2023, Dunn pers. comm. 2024). Although these life stages are drifting, these habitat characteristics are consistent with known or suspected Eastern Sand Darter spawning and nursery habitat. Recent studies have also determined the sensitivity of Eastern Sand Darter to water temperature and dissolved oxygen levels (Firth et al. 2021; Firth et al. 2023). These studies will help inform the features, functions and attributes table of future recovery strategies, amendments to existing strategies, and/or action plans for this species.
Monitoring program has been developed.	Partially met, underway	The Eastern Sand Darter sampling conducted by Fisheries and Oceans Canada (DFO) in the Grand River in 2022 was a pilot monitoring program for the species. Much foundational research to inform monitoring program design has occurred. Examples include the progress made with respect to abiotic and biotic variables affecting site occupancy (Lamothe et al. 2019), and the effect of gear type on catch rates and life stage (Reid and Haxton 2017). A paper by Lamothe et al. (2023b) also investigated the power to detect changes in occupancy and abundance of rare freshwater fishes. Further progress has been made on the use of

Performance indicator	Status	Details
		environmental DNA as a sampling method through development of a custom-designed group-specific primer to detect Eastern Sand Darter (Balasingham et al. 2018).
Research has been conducted to clarify number, extent, and severity of threats to Eastern Sand Darter.	Partially met, underway	For the Thames River, the Lower Thames Valley Conservation Authority (LTVCA) produced an in-depth threat assessment report at the subwatershed level. In the Sydenham River, a study found that following invasion, a number of ecologically significant diet overlaps between Round Goby and benthic fishes were observed (Firth et al. 2020). This observation indicated that Round Goby may be leading to community-level changes in feeding strategy, in addition to diet overlap with Eastern Sand Darter. For this reason, the authors state that Eastern Sand Darter should be monitored for any potential habitat shifts in the future. More recently, 2 studies investigated the physiological response of Eastern Sand Darter to habitat stressors, including oxygen impairment and increasing water temperatures (Firth et al. 2021; Firth et al. 2023).
Research has been conducted to evaluate feasibility of translocations, repatriations, and captive rearing	Partially met, underway	A recent model showed that translocation of Eastern Sand Darter could occur with minimal impacts to source populations (Lamothe et al. 2021). A habitat study was conducted in Big Otter Creek to determine the quality of habitat at historical and targeted sites for possible Eastern Sand Darter translocation (Barnucz et al. 2022b). As a result of improved agricultural practices, silt-free, sand and fine gravel bars in Big Otter Creek have been restored over time (Lamothe et al. 2023a). A conservation translocation decision support framework was developed and used to assess if translocation could improve the recovery of the species in Big Otter Creek (Lamothe et al. 2023a).
Outreach program developed and materials distributed	Met, ongoing	Through DFO’s contributions programs, notably the Habitat Stewardship Program (HSP) and the Canada Nature Fund for Aquatic Species at Risk (CNFASAR), funding is provided for species at risk outreach. For this reporting period, a number of organizations received funding for species at risk outreach that includes Eastern Sand Darter. These organizations include the Ausable Bayfield Conservation Authority (ABCA), Grand River Conservation Authority (GRCA), LTVCA, St. Clair Region Conservation Authority (SCRCA), and the Toronto Zoo. Also, DFO’s Species at Risk Program delivers outreach to partners, including Indigenous groups, conservation authorities, and the public on an annual basis.
Formalized partnerships developed to increase awareness and	Met, ongoing	Conservation agreements under Section 11 of the <i>Species at Risk Act</i> provide a mechanism to identify and implement recovery and stewardship initiatives. DFO entered into 2 formal section 11 agreements in 2018 with the GRCA and LTVCA for the purposes of ensuring a coordinated approach to the implementation of conservation measures focused on aquatic species at risk in

Performance indicator	Status	Details
formulate action plans towards recovery		each conservation authority's watersheds. This approach includes identifying stewardship actions for, and communicating on, Eastern Sand Darter.

3.3.2 Completion of action plan

Eastern Sand Darter is included in 2 action plans published on the Species at Risk Public Registry. The “Action Plan for the Sydenham River in Canada: An Ecosystem Approach” was published in 2018 (DFO 2018), and the “Action plan for the Ausable River in Canada: An Ecosystem Approach” was published in 2020 (DFO 2020). These ecosystem/multispecies documents include several components that support recovery objectives for Eastern Sand Darter.

3.3.3 Critical habitat identification and protection

For Eastern Sand Darter, critical habitat was partially identified in the recovery strategy in the Sydenham River, Thames River, Grand River, Big Creek (Norfolk County), and Long Point Bay (Lake Erie). In 2017, a Critical Habitat Order made under subsections 58(4) and (5) of SARA was published in the Canada Gazette Part 2. The Order is intended to satisfy the obligation to legally protect critical habitat by triggering the prohibition in subsection 58(1) of SARA against the destruction of any part of the species’ critical habitat. Since the publication of the recovery strategy, research has been conducted that has potentially refined the functions, features, and attributes of critical habitat by confirming the importance of sites with higher proportions of sand and fine gravel substrates and by documenting that occupancy probability increases with water depth, clarity, and velocity. The habitat in which eggs and larvae were found in the Sydenham River will also help refine attributes of these life stages. These findings should be considered during the species’ next assessment and incorporated into the functions, features, and attributes table of future recovery strategies, amendments to existing strategies, and/or action plans for this species.

3.3.4 Recovery feasibility

Information available at this time suggests that the feasibility of recovery for Eastern Sand Darter has not changed since the publication of the recovery strategy.

4 Concluding statement

From 2017 to 2022, moderate progress has been made in recovering Eastern Sand Darter through the implementation of the approaches to meet recovery objectives identified in the “Recovery Strategy for Eastern Sand Darter (*Ammocrypta pellucida*) in Canada: Ontario Populations.” To summarize, extensive targeted sampling in the Ausable River, Thames River, Rondeau Bay, Big Otter Creek, Grand River, and the beaches of Lake Huron will help update the population status. The Rondeau Bay surveys captured the first individuals there since 2005. These targeted surveys and associated habitat data may inform future recovery strategy and action plan updates. In addition, ichthyoplankton surveys on the Sydenham River captured Eastern Sand Darter larvae and eggs at 2 sites, which provided valuable information on life history and habitat use.

Research efforts led to new information on genetic structure of populations in Canada. Genetic differentiation and the occurrence of Eastern Sand Darter in unique habitats prompted COSEWIC to identify a new DU structure for Ontario populations. The Ontario populations are now split into 2 DUs: the West Lake population, and Southwestern Ontario population.

Considerable work has been completed towards the repatriation of Eastern Sand Darter. DFO studied the habitat of potential translocation sites, modelled the impact to source populations as a result of translocation, and developed a translocation decision support framework. These contributions to Eastern Sand Darter research are necessary for the successful translocation of any individuals in the future. However, further research is required to minimize the potential negative consequences of translocation. For example, to determine if potential translocation sites in areas where the species has been extirpated are capable of supporting translocated individuals. Also, disease testing of individuals from source populations should be conducted prior to carrying out translocations.

Since 2017, habitat improvement projects, with funding from the Habitat Stewardship Program (HSP) and the Canada Nature Fund for Aquatic Species at Risk (CNFASAR), have been conducted in several watersheds where Eastern Sand Darter occurs or occurred historically. These projects included riparian restoration, vegetation planting, and cattle fencing. In total, approximately 142 ha of habitat have been rehabilitated, and over 27 km of shoreline have been improved.

Despite these habitat improvement projects, it is unknown if the overall habitat conditions for the species have improved in Ontario in comparison to the first progress report for the period of 2012 to 2017 (DFO 2018). Future work such as the creation of a population-habitat supply model will aid in developing recovery targets and determining the amount of critical habitat required by each life stage to meet these targets. Moreover, it's necessary to develop and implement a long-term standardized monitoring program to provide useful population estimates which can be used to estimate population trends over time.

DFO remains committed to recovering the Eastern Sand Darter. The work started and completed to date has built a strong foundation for continued research and management of this species over the next reporting period. Progress made to date would not have been achieved without the contribution from DFO's partners. DFO is looking forward to continuing this successful collaboration and welcomes the participation of additional partners.

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