Report on the Progress of Recovery Strategy Implementation for the Spotted Gar (*Lepisosteus oculatus*) in Canada for the Period 2017 to 2022

Spotted Gar

2024

Canada

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« Rapport sur les progrès de la mise en œuvre du programme de rétablissement du lépisosté tacheté (Lepisosteus oculatus) au Canada pour la période 2017 à 2022 »

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, 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 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 Ministers.

The Minister of Fisheries and Oceans and the Minister responsible for Parks Canada (PC) are the competent minister(s) under SARA for the Spotted Gar and have prepared this progress report.

Reporting on the progress of recovery strategy implementation requires reporting on the collective efforts of the competent minister(s), 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 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 constituencies that will be involved in implementing the directions described in the recovery strategy and will not be achieved by Fisheries and Oceans (DFO) and PC, or any other jurisdiction, alone. The cost of conserving species at risk is shared amongst different constituencies. All Canadians are invited to join in supporting and implementing the recovery strategy for the Spotted Gar for the benefit of the species and for Canadian society as a whole.

Acknowledgements

Executive summary

The Spotted Gar (*Lepisosteus oculatus*) was listed as threatened under the *Species at Risk Act* (SARA) in 2003. The "Recovery Strategy for the Spotted Gar (*Lepisosteus oculatus*) in Canada" was finalized and published on the Species at Risk Public Registry in 2012. In 2019, Spotted Gar was uplisted to endangered in Canada. As a result, an updated recovery strategy and action plan has been published on Canada's <u>Species at Risk Registry</u> (DFO 2024). The reporting period for the present report (2017 to 2022), covers the 5 years since the last progress report (DFO 2018).

The main threats identified for Spotted Gar include overall habitat loss due to dredging, filling and harbour improvements; aquatic vegetation removal; sediment and nutrient loading; invasive species; incidental harvest; and climate change.

The population and distribution objective for Spotted Gar is to ensure that extant populations are viable and are stable or increasing, and to maintain the distribution for these 3 extant populations (Point Pelee National Park, Rondeau Bay, and Long Point Bay area).

Individual Spotted Gar have been identified from 2 new locations (that is, Cedar Creek and Hillman Marsh), although no voucher specimens were collected, making it difficult to rule out the possibility that they were introduced Florida Gar (*L. platyrhincus*). If they are indeed Spotted Gar, then it remains unknown whether those single specimens were transient or if they represent new reproducing populations. It is unknown if detections of Spotted Gar at Muddy Creek, Hamilton Harbour, Frenchman's Bay, East Lake, Bay of Quinte, and the upper St. Lawrence River near Kingston in Lake Ontario represent reproducing populations.

During the time period reported by this progress report, progress has been made including:
- surveys of historical and potential new locations in the Lake Erie and Lake Ontario watersheds
- targeted surveys of extant populations of Spotted Gar in the Lake Erie watershed
- targeted sampling of larval Spotted Gar and their habitat use in Rondeau Bay
- recent species detections and information pertaining to habitat use warranted the identification of additional habitat in Girardin Pond of Point Pelee National Park, tributaries of Rondeau Bay, and in several new locations within the Long Point Bay area
- a review of the habitat needs of Spotted Gar through a science advisory meeting; advice was provided to update Best Management Practices (BMPs) for the removal of aquatic vegetation in Spotted Gar habitat; the guidelines were intended to identify habitat characteristics where vegetation removal should be avoided to minimize harm to Spotted Gar populations at various life stages
- increased knowledge of Spotted Gar ecology and conservation through academic research and publications on genetic diversity and habitat needs
- a threat inventory developed for species at risk, including Spotted Gar in Lower Thames Valley Conservation Authority (LTVCA) watersheds
- stewardship activities, including habitat improvement projects such as riparian restoration, in several watersheds where the Spotted Gar occurs
- Spotted Gar outreach activities involving Indigenous Peoples, the public, conservation authorities, DFO, and other stakeholders

Taken together, these ongoing and/or completed activities indicate that progress is being made towards the goal of recovering Spotted Gar populations in Canada. However, there are still a number of areas where further information is required. For example, a standardized monitoring program needs to be developed and implemented. The creation of a population-habitat supply model for each life stage would help benefit the conservation of the species. Lastly, the response of Spotted Gar to the management and removal of invasive non-native vegetation such as European Common Reed remains to be investigated.

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1. Introduction

The "Report on the Progress of Recovery Strategy Implementation for the Spotted Gar (*Lepisosteus oculatus*) in Canada for the Period 2017 to 2022" (progress report) outlines the progress made towards meeting the objectives listed in the "Recovery Strategy for the Spotted Gar (*Lepisosteus oculatus*) in Canada" (Staton et al. 2012) during the indicated time period and should be considered as part of a series of documents for this species that are linked and should be taken into consideration together. These documents include the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports (COSEWIC 2005; COSEWIC 2015), the recovery potential assessment (RPA) of Spotted Gar (DFO 2010), the initial recovery strategy (Staton et al. 2012), and the first progress report (DFO 2018). Also, as a result of being uplisted to endangered in 2019, an updated recovery strategy and action plan for Spotted Gar has been published on Canada's Species at Risk Registry (DFO 2024).

Section 2 of the progress report reproduces and summarizes key information on the threats that this species is facing, population and distribution objectives for achieving its recovery, approaches to meeting the objectives, 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 of activities identified in the recovery strategy to support achieving the population and distribution objectives. Section 4 provides a concluding statement about the progress of actions taken and outcomes of these recovery efforts.

2. Background

2.1 COSEWIC assessment summary

The listing of Spotted Gar under the *Species at Risk Act* (S.C. 2002, c.29) (SARA) in 2003 led to the development and publication of the recovery strategy for the Spotted Gar in 2012. The recovery strategy is consistent with the information provided in the COSEWIC status report (COSEWIC 2005). This information has also been included in section 1.1 of the recovery strategy.

Assessment Summary – May 2005
Common name: Spotted gar
Scientific name: *Lepisosteus oculatus*
Status: Threatened
Reason for designation: This species has a very limited range in Canada where it is known only from 3 coastal wetlands in Lake Erie. Although its distribution is likely limited by temperature, some of the shallow vegetated habitats that it requires for all life stages are subject to the impacts of siltation, dredging, filling, and aquatic vegetation removal and harbour improvements.
Occurrence: Ontario
Status history: Designated Special Concern in April 1983. Status re-examined and confirmed in April 1994. Status re-examined and designated threatened in November 2000, and in May 2005. Last assessment based on an updated status report.

In 2015, COSEWIC re-assessed the Spotted Gar as endangered (COSEWIC 2015); subsequently, the SARA status of the Spotted Gar was changed to endangered in 2019.

Assessment Summary – November 2015
Common name: Spotted gar
Scientific name: *Lepisosteus oculatus*
Status: Endangered
Reason for designation: This species has a very limited distribution in Canada and populations are known from only 3 coastal wetlands of Lake Erie. Shallow vegetated habitats that are required for all life stages continue to be degraded and are at risk from invasive aquatic vegetation, removal of native vegetation, filling, dredging, and siltation.
Occurrence: Ontario
Status history: Designated Special Concern in April 1983. Status re-examined and confirmed in April 1994. Status re-examined and designated threatened in November 2000 and in May 2005. Status re-examined and designated endangered in November 2015.

2.2 Distribution

Since the 2012 to 2017 time period reported in the previous progress report (DFO 2018), Spotted Gar continues to be detected throughout the Long Point Bay area, including Big Creek National Wildlife Area (NWA), inner Long Point Bay, Long Point NWA – Thoroughfare and Long Point Units, and Turkey Point; Rondeau Bay and its tributaries; and the wetlands of Point Pelee National Park (figures 1, 2, 3, and 4). In 2021, a record from Big Creek NWA was found in a new location called Broad Bend Pond (MacVeigh and Palombo 2023). Despite extensive surveys throughout the lower Great Lakes, no Spotted Gar have been detected in Hamilton Harbour (2013), East Lake (2007), Bay of Quinte (1985), Lake St Clair (1962), Thames River (2012), or Muddy Creek (2011) in recent years, areas where detections have occurred in the past (most recent detections in parentheses). Recently, Spotted Gar may have been found within the border of United States of America (U.S.) in the waters of eastern Lake Erie, as well as the Niagara River for the first time (MacGuigan et al. 2023). This possible range expansion may be influenced by climate change and should be investigated in the Canadian waters of eastern Lake Erie and the Niagara River.
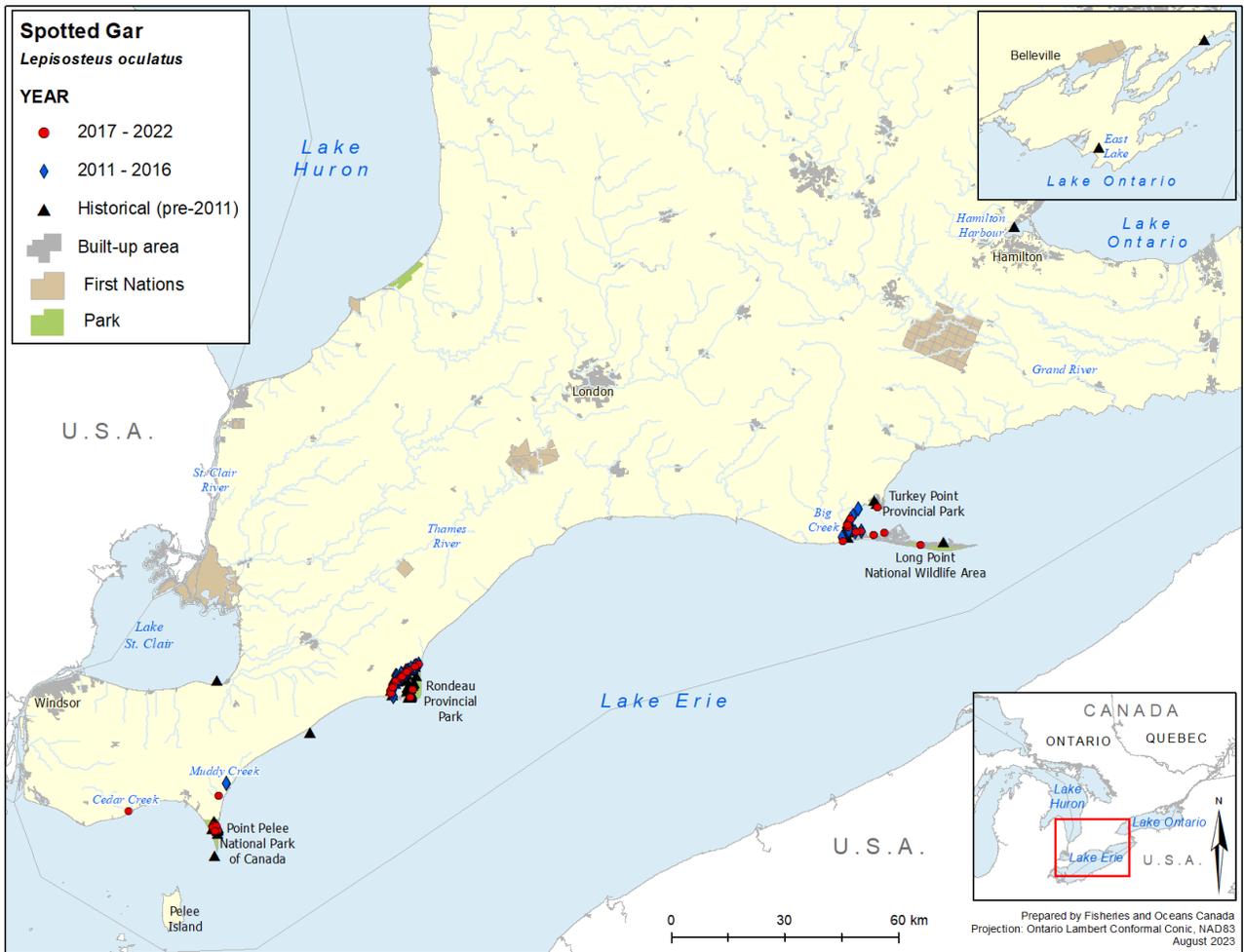
Figure 1[1]. Historical distribution and recent detections of Spotted Gar in Canada.

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[1] In 2023, a Spotted Gar individual was captured by DFO in the Grand River, just downstream of the Dunnville dam (Marson [DFO] pers. comm. 2023). This is the first confirmed record from the Grand River.

Figure 2. Distribution of Spotted Gar captured within Long Point Bay.

Figure 3. Distribution of Spotted Gar captured within Rondeau Bay.

Figure 4. Distribution of Spotted Gar captured within Point Pelee and surrounding areas.

2.3 Threats

For information regarding threats to Spotted Gar, as well as the species' critical habitat, refer to the recovery strategy (Staton et al. 2012) and the updated recovery strategy and action plan (DFO 2024).

2.4 Recovery

This section summarizes the information found in the recovery strategy (Staton et al. 2012) on the population and distribution objectives necessary for the recovery of the Spotted Gar. This section also describes the performance indicators that provide a way to define and measure progress towards achieving the population and distribution objectives.
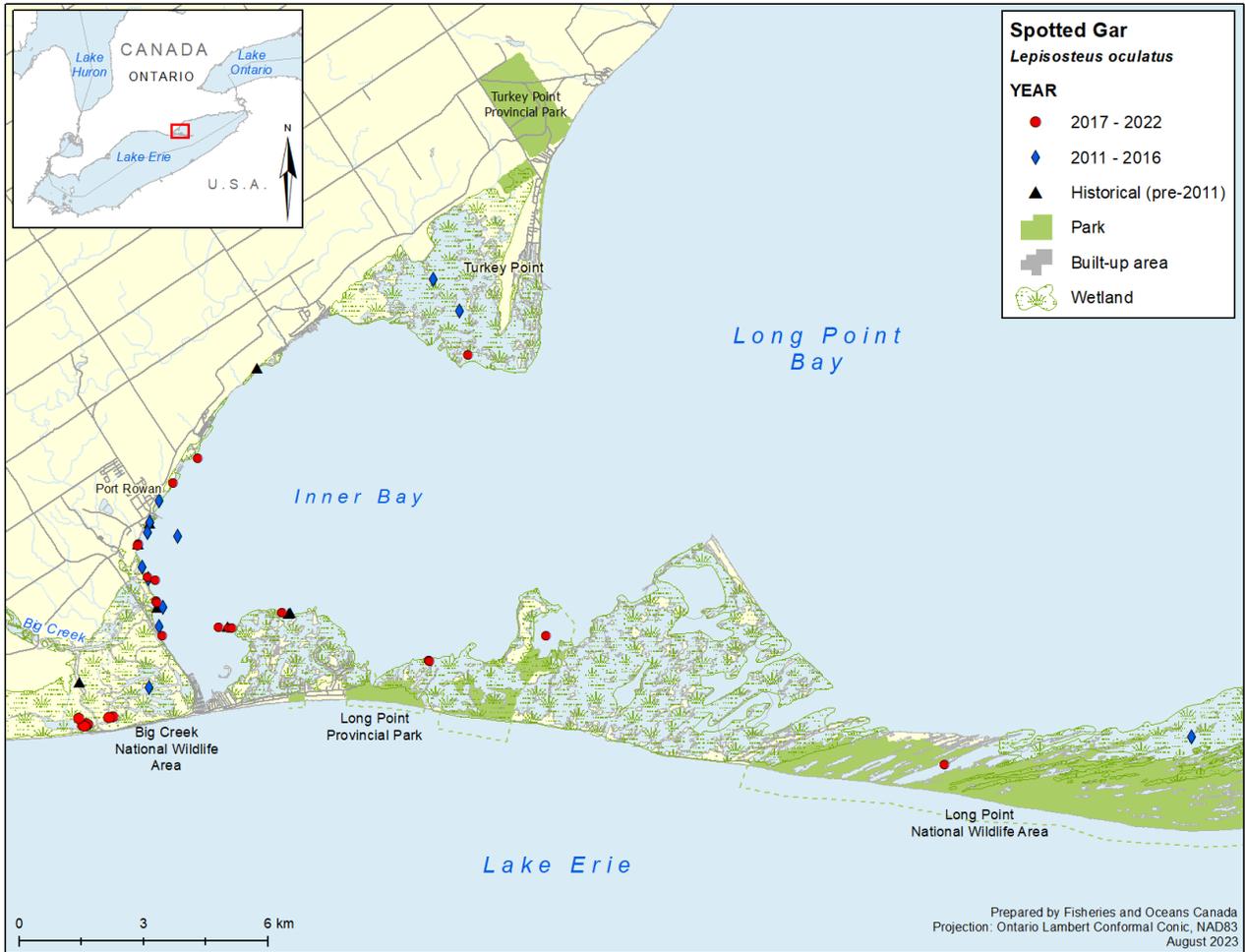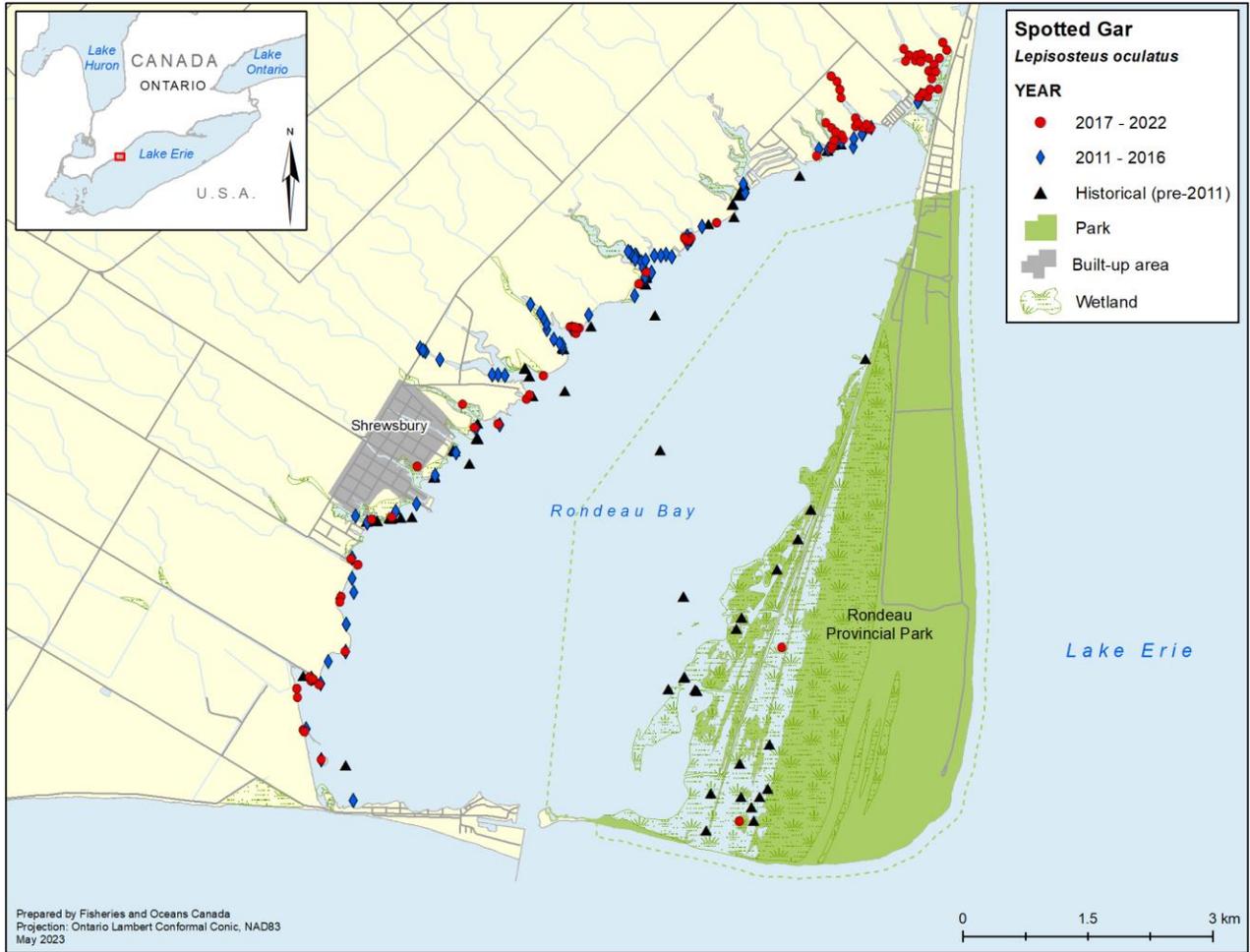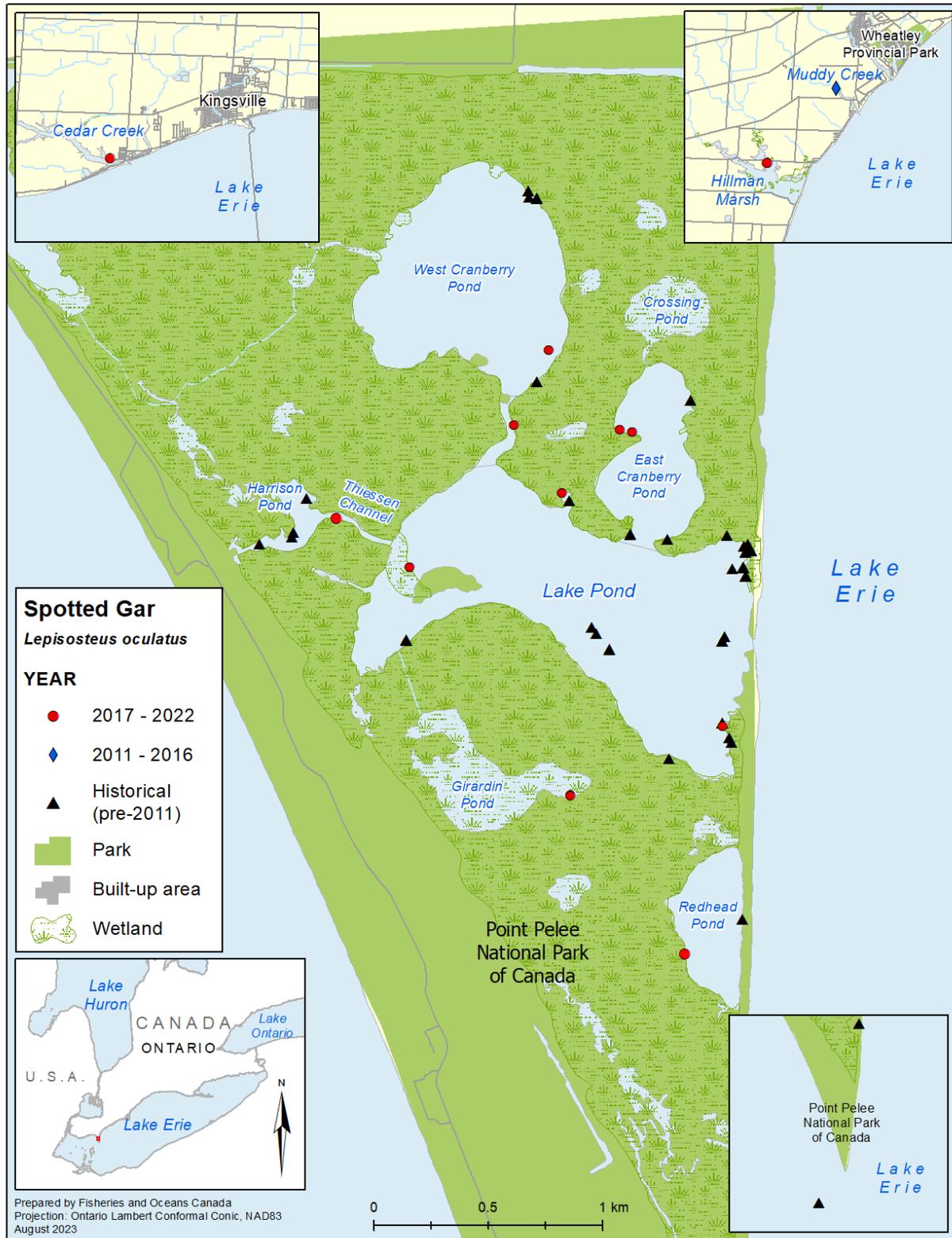
2.4.1 Population and distribution objectives and performance indicators

Section 2.3 of the recovery strategy (Staton et al. 2012) identified the following population and distribution objectives for the Spotted Gar:

- maintain current distribution and densities of extant populations of Spotted Gar in the 3 coastal wetlands of Lake Erie (Point Pelee National Park [PPNP], Rondeau Bay, and Long Point Bay/Big Creek National Wildlife Area)

Section 2.6 of the recovery strategy includes performance indicators to define and measure progress towards achieving the population and distribution objectives. These indicators are outlined in table 1. A successful recovery program will protect, enhance, and maintain viable Spotted Gar populations within the 3 coastal wetlands of Lake Erie where extant populations occur.

Table 1. Recovery objectives and corresponding performance indicators for Spotted Gar, found in the recovery strategy.

Recovery objectives	Performance measure
i. Refine population and distribution objectives.	Refined population and distribution objectives determined by 2015.
ii. Ensure adequate protection of critical habitat.	Completion of activities outlined in the schedule of studies for the complete identification of critical habitat within the proposed timelines. Critical habitat protected where identified.
iii. Determine long-term population and habitat trends.	Monitoring program established by 2015. Current distribution and density of Spotted Gar in 3 extant Great Lakes coastal wetland populations is maintained or enhanced.
iv. Identify threats, evaluate their relative impacts, and implement remedial actions to reduce their effects.	Relative significance of threats evaluated by 2014. Initiate implementation of remedial actions to address priority threats by 2015.
v. Enhance efficiency of recovery efforts.	Quantification of Best Management Practices (BMPs) (for example, number of Nutrient Management Plans [NMPs] and Environmental Farm Plan [EFPs] completed;

Recovery objectives	Performance measure
	hectares of riparian zone established) implemented by Essex-Erie Recovery Team (EERT) and other interest groups to address threats within the 3 occupied Lake Erie coastal wetlands by 2016 (ongoing).
vi. Enhance quality and extent of available habitat.	Report on habitat improvements as detected by the monitoring program 5 years after the initial baseline data collected (by 2020).
vii. Improve overall awareness and appreciation of Spotted Gar and the coastal wetland habitats that support it.	Document any changes in public perceptions and support for identified recovery actions through guidance identified in the communications strategy (by 2015).
viii. Engage landowners, communities, First Nations and organizations in stewardship actions that minimize/eliminate identified threats to Spotted Gar and its habitat.	Landowners engaged in stewardship actions from 2012 to 2016.

3. Progress towards recovery

The recovery strategy for the Spotted Gar divides the recovery effort into 3 broad strategies: 1) Research and monitoring; 2) Management and coordination; and 3) Stewardship, outreach and awareness (Staton et al. 2012). 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 implementing the recovery strategy.

3.1 Activities supporting recovery

Table 2 provides information on the implementation of activities undertaken to address the broad strategies and recovery actions identified in the recovery strategy.

Table 2. Details of activities supporting the recovery of the Spotted Gar since 2017.

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
Conduct targeted surveys of preferred habitats at Turkey Point, Tremblay Beach wetlands (mouth of the Thames River, Lake St. Clair) and Lake Ontario (Bay of Quinte, Hamilton Harbour, East Lake).	Research and Monitoring; R1. Background surveys – new/suspected and historical locations	While a single individual was confirmed from East Lake in 2007, subsequent surveys, including trawling by the Ontario Ministry of Natural Resources and Forestry (OMNRF) in 2021, failed to detect Spotted Gar. Therefore, a reproducing population is unlikely at this location. Additionally, no subsequent detections of Spotted Gar have occurred since the single capture in Lake St. Clair in 1962, a system where regular fish surveys occur, including surveys by DFO in 2018 and 2019. Also, annual non-targeted surveys in Jeanette's Creek and the Thames River from 2017 to 2021 did not capture any Spotted Gar. Spotted Gar have continued to be detected at Turkey Point, most recently in 2018, and the species was detected for the first time in Cedar Creek in 2019. Annual non-targeted surveys in Cedar Creek by DFO	i	DFO, Academic Institutions (AI), OMNRF, University of Windsor

[2] Fisheries and Oceans Canada (DFO), Ontario Ministry of Natural Resources and Forestry (OMNRF), Essex-Erie Recovery Team (EERT), Lower Thames Valley Conservation Authority (LTVCA), Essex Region Conservation Authority (ERCA), Long Point Region Conservation Authority (LPRCA), Walpole Island First Nation (WIFN), Academic Institutions (AI), Ontario Federation of Agriculture (OFA), Ontario Parks (OP), and Environment and Climate Change Canada (ECCC), Canadian Wildlife Service (CWS)

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		from 2017 to 2021 failed to detect any individuals. Further sampling is required to determine if there is a reproducing population in Cedar Creek, or if the individual was a migrant. The same situation exists at Muddy Creek and Hillman Marsh, where 1 Spotted Gar was captured at each location in 2011 and 2020, respectively. Surveys by the University of Windsor in 2017 at both Hillman Marsh and Muddy Creek did not detect the species. It is important to note that no voucher specimens were collected from Cedar Creek, Muddy Creek, and Hillman Marsh, making it difficult to rule out the possibility that they were introduced Florida Gar.

An unverified specimen was captured in Frenchman's Bay (coastal inlet of Lake Ontario) in 2018, which may have been the invasive Florida Gar. Annual non-targeted surveys by DFO in 2017 and from 2019 to 2021 in Frenchman's Bay did not capture any Spotted Gar, making it unlikely that an undetected reproducing population exists there.

Non-targeted surveys via mamou trawl were conducted in East Lake in 2021 by OMNRF. No Spotted Gar were detected (LeBaron and Reid 2023). | | |
| Complete targeted surveys of extant populations. | Research and Monitoring; R2. Background surveys – extant locations | In 2019 and 2021, DFO conducted fish community sampling in Point Pelee National Park to evaluate the composition of the fish community and to estimate population size of select SARA-listed species, including the Spotted Gar (Barnucz et al. 2021; | i, iii | DFO, Parks Canada, University of Toronto, Parsons |

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		Barnucz et al. in review). Sampling conducted in 2019 and 2021 detected Spotted Gar in West Cranberry Pond (2 specimens), East Cranberry Pond (3 specimens), Lake Pond (3 specimens), and in a new location, Girardin Pond (1 specimen). Passive integrated transponder (PIT) tags were inserted into 6 individuals in 2019. No recaptures of tagged individuals occurred and population size could not be estimated. Habitat sampling was conducted and included an assessment of macrophytes. Single detections occurred at Big Creek (2021) and Long Point (2017) National Wildlife Areas (NWA) as part of 2 separate surveys completed by external SARA permit holders. In 2018, DFO conducted targeted sampling at 356 sites in Rondeau Bay (and 2 tributary agricultural drains) for larval Spotted Gar (Gáspárdy et al. 2021). The sampling program involved the use of dip nets and quatrefoil light traps in 2 habitat types (tributary drains and coastal areas of the bay) and 2 sampling zones within each habitat type (nearshore and offshore/channel). A total of 37 larval Spotted Gar were captured in the dip net samples, while none were captured in light trap sets. Of the larval Spotted Gar detected, 95% were from the nearshore sampling zones (68% agricultural drains, 27% bay), while 5% were captured offshore in the agricultural drains. Habitat sampling was conducted and included an		Corporation, TRCA

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		assessment of the aquatic vegetation. Milfoil was the dominant vegetation at 60% of larval *Lepisosteus* sp. capture locations. Further analyses of this dataset showed that larval Spotted Gar strongly prefer shallow (0.5 to 1.0 m) nearshore habitat with submerged vegetation (McAllister et al. 2022). The dependence of young-of-the-year (YOY) on submerged vegetation decreased as fish increased in size (McAllister et al. 2022). In 2022, a 5 year study was initiated by the Toronto and Region Conservation Authority (TRCA) and the University of Toronto (U of T) and involved PIT-tagging and radio-tracking of adult Spotted Gar, and dip-netting for larval Spotted Gar in Rondeau Bay. The study will evaluate the effectiveness of habitat restoration activities on spawning habitat. 10 adults were tagged and tracked during the spring and summer while 16 larval Spotted Gar were captured from 4 drains in 2022 (McLean Drain, Bates-Bloomfield Drain, Holdaway Drain, and Branch 1 Drain).		
Establish and implement a standardized index population and habitat monitoring program for all extant locations.	Research and Monitoring; R3. Monitoring – populations and habitat	A standardized index population and habitat monitoring program has not been developed or implemented at this time, but evaluation of sampling gear continues. Richardson and Flinn (2019) investigated the effectiveness of gar capture (including Spotted Gar) with gill nets. They recorded a greater rate of capture	ii, iii	DFO, AI

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		with multifilament (versus monofilament) gill nets at temperatures above 15°C. Impact of net orientation and habitat type on rate of capture was also considered. Although sampling occurred in an area without Spotted Gar, Gardner Costa et al. (2020) evaluated the sampling efficacy of passive gear in *Phragmites* stands in the St. Clair River delta. Fyke nets (compared to large-mesh and small-mesh gill nets, and Windermere traps) were found to be most effective for sampling the fish assemblage in *Phragmites* stands. These results may be useful for future sampling for the species in *Phragmites*-dominated habitats.		
Determine the seasonal habitat needs of all life stages of the Spotted Gar. These investigations should determine the role that adjacent riparian and terrestrial/semi-aquatic habitat may play in the overall habitat needs of the species.	Research and Monitoring; R4. Research – habitat requirements	Based on a variety of previous research projects, DFO (2020) summarized the current understanding of Spotted Gar habitat needs. Briefly, adults prefer diverse patches of aquatic macrophytes, which may include invasive species (for example, *Myriophyllum spicatum*); adults show seasonal preferences for shallow (< 0.5 m) and deep (> 2.5 m) areas of available habitat; spawning occurs predominantly < 30 m from shore, but is associated with greater water depth; and plants of the genus *Potamogeton* are associated with spawning activity, though other species may also support egg development. Larval Spotted Gar are found primarily in the shoreline margins of tributaries (including agricultural drains) and lakefront areas, but secondarily may be found	ii	DFO, AI, OMNRF

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		offshore of these areas; larvae associate with sparse through heavy aquatic vegetation, and are commonly found in areas that include *Myriophylum* and/or *Ceratophylum* sp. Juveniles were associated with the shallowest depths available and moderate turbidity levels (50 to 149 NTU[3]).		
Confirm the significance of the threat factors that may be impacting extant populations. Identify the primary causes and take steps to mitigate immediate threats based on severity.	Research and Monitoring; R5. Threat evaluation and mitigation	Montgomery et al. (2020) investigated the extinction debt of fish in Lake Erie wetlands. Extinction debt is the time lag between habitat loss and local extinction. Seven wetlands containing Spotted Gar were identified as being in extinction debt for the species and, hence, are in need of restoration. The authors determined that 178 km^2 of additional wetland habitat across 29 wetlands are needed to reduce the risk of biodiversity loss, while an additional 29 km^2 of wetland habitat are required to maintain viable Spotted Gar populations. The authors of this study concluded that Rondeau Bay is in extinction debt and requires an additional 9.02 km^2 of wetland restored to support Spotted Gar (Montgomery et al. 2020). In light of climate change, understanding temperature impacts on Spotted Gar is valuable. Long et al. (2020) investigated the effect of temperature on the early development of the Spotted Gar (and Alligator Gar, *Atractosteus spatula*) in a laboratory setting using broodstock from Oklahoma. An inverse relationship between temperature (water temperature treatments	iv	DFO, AI, OMNRF, U.S. agencies

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[3] NTU= Nephelometric Turbidity Units

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		of 15.5, 20.0, 23.8, 27.5, and 32.2°C) and the timing of hatch and advancement to free-swimming fingerlings was observed for Spotted Gar, while hatching and development of Spotted Gar were optimal at 23.8°C. In contrast to what was observed for Alligator Gar, no developmental abnormalities were observed for Spotted Gar. Rodríguez et al. (2021) investigated the responses of vulnerable fishes to abiotic environmental stressors (that is, turbidity, water velocity, temperature, and dissolved oxygen) in the Canadian Great Lakes basin using a hierarchical joint species distribution model. Patterns of habitat use inferred by the model suggest the Spotted Gar have a tolerance for elevated turbidity, but are intolerant to low oxygen levels and higher water velocities, while no relationship to water temperature was detected. Updated guidelines for the removal of aquatic vegetation within Spotted Gar critical habitat have recently been drafted in the proposed recovery strategy and action plan (DFO 2020). The guidelines are designed to minimize harm to Spotted Gar in areas where vegetation removal occurs. The best management practices are based on knowledge accumulated on the importance of vegetation to Spotted Gar throughout their life history, and the availability of aquatic vegetation features throughout its critical habitat. The authors showed that small-		

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		scale vegetation removals, especially of diverse macrophyte beds, can jeopardize the species if undertaken in nearshore areas or in tributaries during spawning and nursery periods. There were also a few studies that helped to improve understanding of the threats impacting Spotted Gar but were more focused on life history. This includes studies by Snow et al. (2017) and Long and Snow (2018) that validated daily increment deposition of otoliths, which allows for estimates of daily age of juvenile Spotted Gar. Age estimates have the potential to allow for the back calculation of hatch dates, estimating early growth rates, and to correlate environmental factors with spawning success, which has the potential to improve understanding of the threats facing the species. Furthermore, Buckmeier et al. (2018) evaluated age estimates of Spotted Gar (and Longnose Gar, *L. osseus*) based on sagittal otoliths, pectoral fin rays, and branchiostegal rays. The authors found that ages derived from sagittal otoliths can be reliable through age 10, and that past age estimates from branchiostegal rays and pectoral fin rays should be considered suspect (also see King et al. 2018). A recently published stable isotope study was also useful for future research that could help in better understanding the threats to Spotted Gar. Stable isotope analysis (SIA) is a useful tool for investigating		

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		trophic ecology and energy fluxes through an ecosystem. Fredrickson et al. (2022) evaluated the feasibility of using fin tissue as a nonlethal alternative to using muscle tissue for SIA in Spotted and Alligator gars. Their results suggest that fin tissue can be used as a nonlethal surrogate for muscle tissue for SIA, for both gar species.		
Conduct radio-tracking studies to monitor habitat use and to determine home range size of individuals in the Lake Erie wetlands.	Research and Monitoring; R6. Research – home range and habitat use	A radiotelemetry study in Rondeau Bay and tributaries in 2017 identified spawning sites. Results indicated that preferred spawning sites occur close to shore (within < 10 m of shoreline preferred), typically contain pondweed species (*Potamogeton spp.*), occur over silt and detritus, and are of greater stream depth (0.8 to 1.6 m preferred) than surrounding areas (Drake pers. comm. 2023). Midwood et al. (2018) outlined a unique approach to surgically implanting electronic tags in the body cavity of gars, with a focus on the Longnose Gar. King and Stein (2020) investigated effective anesthetic dosage and recovery from specialized surgical methods in Shortnose Gar (*L. platostomus*). Low mortality and minimal postsurgery effects were observed, suggesting that the surgical technique can be applied to gar populations with minimal risk of harming the overall health of the population. Their findings will help researchers to safely utilize internal implantation of transmitters (for example, for long-term biotelemetry studies) in primitive fishes with ganoid scales, which includes the Spotted Gar.	ii	DFO, Parks Canada, AI

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		In 2019 and 2021, DFO conducted fish community sampling in Point Pelee National Park and a total of 9 Spotted Gar were captured (Barnucz et al. 2021; Barnucz et al. in review). Passive integrated transponder (PIT) tags were inserted into 6 individuals in 2019. No recaptures of tagged individuals occurred and population size could not be estimated.		
Identify point sources of nutrient and sediment inputs and their relative effects.	Research and Monitoring; R7. Point source contamination	Recent research has complemented previous studies on Great Lakes water quality, showing that agriculture and urbanization have had negative impacts on water quality in Great lakes coastal wetlands (Harrison et al. 2020). The authors recommend that best management practices be used to minimize nutrient application rates and run-off. Examples include the use of soil testing and riparian buffers.	ii	AI
Investigate the degree of connectivity between and within Spotted Gar populations (field surveys/research, genetic analysis), as well as population viability.	Research and Monitoring; R8. Threat evaluation and mitigation – investigate connectivity/ viability	David and Wright (2017) investigated genetic variation and biogeography of Spotted Gar. Similar to Glass et al. 2015, the authors found that genetic diversity was highest in the Mississippi River basin and lowest in the Great Lakes basin, the location of Canadian populations (their analysis included a specimen from Rondeau Bay). The authors speculate that the low genetic diversity of the northern Spotted Gar may make them highly susceptible to local extinction.	iv	DFO, University of Windsor
Evaluate the impacts of incidental harvest on Spotted Gar populations (for	Research and Monitoring; R9. Threat evaluation and	Research is underway to test commercial gear types in Long Point Bay. Initial sampling was conducted in 2018 to test gear types, which led to the capture of 4 Spotted Gar (OMNRF Unpub. 2019). Overall,	iv	OMNRF

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
example, surveys of fishermen).	mitigation – incidental harvest	commercial fisheries represent a minor threat to species at risk considering that the gear types used (fyke nets) have low mortality and any species at risk that are caught should be released (OMNRF Unpub. 2019).		
In cooperation with the EERT, assess watershed-scale stressors to occupied coastal wetlands.	Research and Monitoring; R10. Assessment of watershed-scale stressors	Water-quality monitoring has been conducted within the watersheds of Rondeau and Long Point bays. Additionally, habitat improvement activities, such as vegetation planting and riparian stabilization, have occurred within the watersheds of Rondeau and Long Point bays to reduce the input of nutrients and sediments. In 2018 to 2019, the LTVCA produced an aquatic species at risk threat assessment report that summarized environmental conditions and threats affecting aquatic species at risk at a subwatershed level.	iv, vi	DFO, EERT, LTVCA, ERCA, LPRCA, OMNRF
Measure sediment and nutrient loads (and possibly other contaminants) emitted from streams that are connected to wetlands occupied by Spotted Gar.	Research and Monitoring; R11. Water-quality monitoring	A threat assessment by the LTVCA in 2019 stated that the risk of pesticide contamination is low to very low in the Rondeau Bay subwatershed as no-till farming practices and other conservation measures have been in place since the 1980s. Water-quality monitoring was conducted in 2021 at Big Creek NWA by Environment and Climate Change Canada (ECCC). Parameters such as dissolved oxygen, pH, turbidity, and water temperature were measured (Grabas [ECCC] pers. comm. 2023). This	iv	DFO, EERT, LTVCA, ERCA, LPRCA, OMNRF, ECCC, Parks Canada

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		monitoring is part of the Protected Areas Wetland Monitoring Program (PAWMP) that is repeated every two years at Big Creek NWA and Long Point NWA. Parks Canada conducts their ecological integrity monitoring program on an annual basis at Point Pelee National Park. From 2017 to 2021, water quality index scores trended upwards while total phosphorus significantly declined (Windsor [Parks Canada] pers. comm.).		
Continue to monitor, investigate, and enforce penalties associated with illegal vegetation removal when it occurs in habitats occupied by Spotted Gar; to be accomplished in collaboration with the Rondeau Bay Aquatic Vegetation Issues Working Group.	Research and Monitoring; R12. Monitoring and enforcement	In 2018, following an investigation by fishery officers, 2 homeowners pleaded guilty in the Ontario Court of Justice to destroying critical habitat of Spotted Gar in Rondeau Bay. This case was the first SARA conviction for destroying critical habitat for an aquatic species in Canada. In 2019, DFO enforcement officers responded to infilling along the shoreline of critical habitat for Spotted Gar at Long Point as well as in Rondeau Bay. Rondeau Bay Aquatic Vegetation Issues Working Group has been dissolved but ultimately resulted in a more coordinated regulatory approach between responsible authorities.	iv	DFO, OMNRF
Investigate the response of Spotted Gar to wetland management practices (for example, Common Reed	Research and Monitoring; R13. Response of Spotted Gar	Wynia (2019) assessed whether fish and invertebrate communities differed in *Phragmites* stands versus native emergent vegetation communities (St. Clair River delta). No difference in the fish or invertebrate	iv	DFO, AI, OMNRF, OP, WIFN, ECCC, PC,

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
[*Phragmites australis*] control/management, water level management and other habitat alterations).	to wetland management practices	community was detected, implying that invasive *Phragmites* provides habitat as valuable for fish and invertebrates as other emergent vegetation types. Similarly, Krzton-Presson et al. (2018) found that fish diversity did not differ among sites (herbicide treated *Phragmites*, untreated *Phragmites*, and *Phragmites*-free), but individual species varied in distribution and abundance between the *Phragmites* sites and the *Phragmites*-free site (Clear Creek Wildlife Management Area, Kentucky). Croft-White et al. (2021) demonstrated an alteration in the wetland fish assemblage in relation to *Phragmites*, while fish species richness and catch-per-unit effort were unchanged among vegetation types (*Phragmites*, *Typha*, and *Schoenoplectus*). Impacts specific to Spotted Gar remain to be investigated, but the species relies on nearshore macrophyte-rich areas. As *Phragmites* spreads, the areas get reduced in size which decreases the amount of aquatic habitat available for the fish community. *Phragmites* control efforts are ongoing; for example, in Rondeau and Long Point provincial parks, MECP is actively engaged in invasive *Phragmites* management. OMNRF has created a monitoring plan as part of the invasive *Phragmites* control pilot project in wetland areas of Long Point Bay and Rondeau Provincial Park. Monitoring has included an assessment of the fate and impacts of glyphosate, a herbicide used for controlling *Phragmites*. Visual		Trent University, TRCA, U of T

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		monitoring of wetland fishes was also conducted before and after herbicide application at Long Point and Rondeau Provincial Park from 2016 to 2020 (Reid et al. 2023). No dead or distressed Spotted Gar were observed but the authors indicate that aerial glyphosate application adjacent to open-water could increase the risk of mortality (Reid et al. 2023). Impacts of herbicide application have been noted on macroinvertebrate communities (Robichaud et al. 2022). *Phragmites* is also controlled on federal lands in the Long Point Region through the application of herbicides and by rolling. As part of this control project, Environment and Climate Change Canada conducts monitoring which includes an assessment of the fate and effects of herbicide on wetland fishes. As of 2023, no dead or distressed Spotted Gar have been observed during visual surveys. Additionally, the Ontario Invasive Plant Council produced a best management practice (BMP) guide that aims to minimize the adverse impacts of *Phragmites* on species at risk (Nichols 2020). A baseline monitoring study on *Phragmites* removal was started by the University of Toronto and the St. Clair Region Conservation Authority (SCRCA) in Rondeau Bay in 2022 as part of a 5 year study on the effectiveness of habitat restoration in Spotted Gar habitat.		

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		Parks Canada conducted wetland restoration at Point Point Pelee National Park (PPNP) which included the mechanical removal of 0.14 Ha of invasive *Typha x glauca* in 2021-2022. A monitoring partnership between PPNP, Trent University and OMNRF showed that fish habitat connectivity increased, and a 15 % increase in submergent vegetation was observed as a result of this activity.		
Investigate the relationship between Longnose Gar and Spotted Gar in areas where they coexist.	Research and Monitoring; R14. Interspecific interactions	No known investigations into potential interactions between these 2 species in Ontario have been undertaken at this time. However, a recent study from Bohn et al. (2017) showed that Longnose Gar and Spotted Gar have been known to hybridize in areas of Texas where they coexist.	iv	AI
Conduct a risk assessment on the probability of Florida Gar becoming established in the Great Lakes basin (that is, within Spotted Gar habitats).	Research and Monitoring; R15. Florida Gar risk assessment	No known investigations regarding the likelihood of Florida Gar becoming established in the Great Lakes basin have been conducted at this time.	iv	
Investigate the impacts climate change is having, and will continue to have, on Spotted Gar and coastal wetland habitats.	Research and Monitoring; R16. Threat evaluation – climate change	Spotted Gar were scored as highly vulnerable in an assessment of climate change vulnerability in the Ontario Great Lakes Basin (Brinker et al. 2018). Based on their hydrological niche, this assessment concluded that they had greatly increased vulnerability to changing hydrological conditions that are expected	iv	DFO, ECCC, OMNRF

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		in the Great Lakes basin in the future due to climate change. In light of climate change, understanding temperature impacts on Spotted Gar is valuable. Long et al. (2020) investigated the effect of temperature on the early development of the Spotted Gar and Alligator Gar in a laboratory setting using broodstock from Oklahoma. The hatching and development of Spotted Gar were optimal at 23.8°C. In contrast to what was observed for Alligator Gar, no developmental abnormalities were observed for Spotted Gar. The authors showed that temperature clearly affects development rates of gar embryos and larvae, which indicates a need to better understand the impacts of climate change on Spotted Gar.		
Work with the EERT and other relevant groups to share knowledge and implement recovery actions.	Management and coordination; C1. Coordination with other recovery teams and relevant groups	Although EERT is no longer active, conservation authorities continue to implement stewardship programs, and receive advice from DFO as needed.	v	DFO, EERT, LTVCA, ERCA, LPRCA, OMNRF
Encourage municipalities to protect habitats that are important to Spotted Gar in	Management and coordination;	Municipal public works and planning departments have been included in aquatic species at risk outreach activities conducted by DFO staff. DFO has developed	vi, vii	DFO

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
their Official Plans and to ensure that planning and management agencies are aware of habitats important to the species.	C2. Municipal planning – involvement	and distributed aquatic species at risk official plan guidance for municipalities to incorporate into municipal official plan updates (via Regional Planning Commissioners of Ontario). 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 has been provided to conservation authorities and their respective municipalities, including the ERCA, LTVCA, QCA, and SCRCA.		
Establish good working relationships with drainage supervisors, engineers, and contractors to limit the effects of drainage activities on coastal wetland habitats.	Management and coordination; C3. Relationship building – drainage	Through partnerships with watershed-based conservation organizations (CAs in Ontario), DFO staff have promoted the implementation of BMPs via presentations, project reviews, and site meetings with the agricultural community, drainage engineers, and the Ontario Drainage Superintendents Association. In 2019, species at risk outreach was provided to members of the Drains Action Working Group by DFO. Furthermore, education on species at risk legislation is provided to Ontario Ministry of Transportation consultants in training on an annual basis.	vi, vii, viii	DFO
Ensure that existing guidelines on reducing, mitigating, and restoring areas of dredge, fill and vegetation removal impacts	Management and coordination; C4. Guidelines: dredge, fill and	Updated guidelines for the removal of aquatic vegetation within Spotted Gar critical habitat have recently been published (DFO 2020).	iv, vi	DFO, EERT, LTVCA, ERCA, LPRCA, OMNRF

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
take the needs of Spotted Gar into account.	vegetation removal	Updated guidelines for mitigating the impacts of watercourse modifications to Grass Pickerel were published in 2021 (Coker et al. 2021). Much of these BMPs are applicable to Spotted Gar habitat as both of these species share common threats, such as habitat modifications, turbidity and sediment loading, and nutrient loading. During project design and preparation, project proponents are directed to assess their projects in accordance with DFO's Fish and Fish Habitat Protection Program guidelines and mitigation, including pathways of effects, to minimize impacts on aquatic species, including species at risk.		
Encourage responsible agencies/jurisdictions to integrate recovery team recommendations into planning documents, including land management plans.	Management and coordination; C5. Information sharing-land use planning	Through annual DFO species at risk outreach, responsible agencies are informed about aquatic (fishes/mussels) species at risk within their jurisdiction, and encouraged to incorporate guidance into planning documents, including municipal official plans, with a goal of informing proponents early in the planning stage of any sensitive species in their project area. See Approaches C2 and C3 above for further details.	v, vii	DFO, EERT, LTVCA, ERCA, LPRCA, OMNRF
Collaborate with relevant groups, initiatives, and recovery teams to address recovery actions of benefit to Spotted Gar.	Stewardship, Outreach and Awareness; S1. Collaboration and information sharing	See Approaches C2, C3, and S2 in this table for further details.	v	DFO, OMNRF, ERCA, LPRCA, LTVCA

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
Promote stewardship among landowners, First Nations and other interested parties (for example, anglers) within watersheds of the occupied coastal wetlands, particularly Rondeau Bay.	Stewardship, Outreach and Awareness; S2. Stewardship and habitat initiatives	Through DFO's Habitat Stewardship Fund, a number of habitat restoration and outreach projects occurred since 2017 that benefit Spotted Gar. This includes: ○ in 2021 to 2022, the LTVCA restored 0.73 hectares of riparian habitat at Mill Creek, Rondeau Bay; ○ in 2021, ERCA restored 5.26 hectares of farmland adjacent to Mud Creek to decrease erosion and nutrient loading into Long Point Bay; ○ in 2020 to 2021, LTVCA developed and distributed 265 species at risk flyers to landowners in the Rondeau Bay watershed. They also distributed 1,010 combat erosion flyers in the Lower Thames Valley. LTVCA also provided outreach during 13 events that included 418 participants; ○ LTVCA improved 21.82 ha of wetland and riparian buffer habitat in 2020 to 2021; ○ Watersheds Canada restored and naturalized 1 waterfront property in East Lake in 2020 to 2021; ○ from 2019 to 2020, LTVCA conducted an extensive outreach campaign that included 24 events with a total of 3,457 participants, 19 social media posts, and the distribution of 142 flyers that targeted species at risk awareness in Rondeau Bay; ○ in 2018 to 2019, LTVCA restored 8.3 ha of riparian and wetland habitats in Rondeau Bay,		DFO, LTVCA, Watersheds Canada, ERCA

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
		while the ERCA restored 8.4 hectares of riparian and wetland features at Lake St. Clair Presentations were delivered to stakeholders and Indigenous communities, including the Métis Nation of Ontario regarding SARA, critical habitat, environmental issues and initiatives in Rondeau Bay (See Approach C2 for further details).		
Work with landowners to implement BMPs in areas where they will provide the most benefit. Encourage the completion and implementation of environmental farm plans (EFP) and nutrient management plans (NMPs).	Stewardship, Outreach and Awareness; S3. Stewardship - implementation of BMPs	See Approaches C2, C3, and S2 above for further details	iv, vii, viii	DFO, landowners, OMNRF
Develop and implement a communications strategy that identifies partners, target audiences, approaches, information products, educational and outreach opportunities, stewardship resources and specific BMPs that will assist with the recovery of this species. Should include a focus on awareness of	Stewardship, Outreach and Awareness; S4. Communi- cations strategy	An outreach strategy was developed for species at risk in southwestern Ontario targeting the following audiences: o local municipal staff – managers, planners, engineers, field staff, and consultants o development industries – representatives of local development industries and/or their consultants o landowners – representatives of the local landowners, farmers, and cottagers, as well as recreational groups such as ATV/trail users	vii, viii	DFO, LTVCA

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
SARA to help ensure compliance with the Act.		o conservation/environmental/stewardship organizations – fish and game clubs, naturalist and environmental protection organizations, students, and stewardship councils DFO's Species at Risk Program delivers outreach on species at risk to partners, including Indigenous Peoples, Conservation Authorities, and the public on an annual basis. In 2018, DFO conducted a specific outreach information session for Conservation Authorities (Essex, St. Clair Region, Lower Thames Valley, Grand River) that provided a review of the critical habitat order for Spotted Gar. In 2020 to 2021, the LTVCA hosted 13 outreach events that included messaging about aquatic species at risk, including Spotted Gar, threats to species at risk, projects that can be undertaken to benefit these species, and agricultural best management practices. They 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.		
Facilitate access to funding sources for landowner, First Nations, and local community groups engaged in stewardship activities.	Stewardship, Outreach and Awareness; S5. Stewardship – financial	Federal funding is available annually through the Aboriginal Fund for Species at Risk (AFSAR), the Habitat Stewardship Program (HSP), and the Canada Nature Fund for Aquatic Species at Risk (CNFASAR). HSP funding is provided by DFO through contribution agreements to support local stewardship initiatives led	viii	DFO, ECCC, MECP, OFA

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
	assistance/ incentives	primarily by environmental non-government organizations, while AFSAR funding supports the development of Indigenous capacity to participate actively in the implementation of SARA. CNFASAR is aimed at supporting stewardship projects that help recover and protect aquatic species at risk. Collectively, the activities supported facilitate the implementation of conservation measures, such as BMPs associated with water quality improvements, and sediment loading and reduction. HSP funding has resulted in a number of habitat improvement projects in Rondeau Bay and Long Point Bay. Similarly, the Ontario Ministry of the Environment, Conservation and Parks (MECP) administers the Species at Risk Stewardship Program, which provides money for similar stewardship activities to what is described above for HSP. This Program includes the Species at Risk Farm Incentive Program (SARFIP) that provides funding to agricultural landowners interested in completing habitat creation, and enhancement and protection BMPs that support species at risk.		
Provide a Spotted Gar information package to commercial and possibly recreational fishers. Request avoidance of occupied habitats, and the	Stewardship, Outreach and Awareness; S6. Awareness – incidental harvest	An information package has been developed and distributed to commercial fisherman who conduct operations in waters occupied by Spotted Gar in Lake Erie. Annual outreach activities by OMNRF include Boat Captain Days where commercial fishermen are provided information on species at risk that they are likely to encounter, handling techniques that they	vii	DFO, EERT, LTVCA, ERCA, LPRCA, OMNRF

Activity	Approach	Descriptions and results	Recovery objectives (from recovery strategy)	Participants[2]
release and reporting of any Spotted Gar captured.		should adopt to ensure the survivorship of these species, as well as other pertinent information.		

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 (Staton et al. 2012). 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 3. Status and details of the implementation of the schedule of studies outlined in the recovery strategy for the Spotted Gar.

Study	Timeline	Status	Descriptions and results	Participants[4]
Conduct studies to determine the habitat requirements for each life stage of the Spotted Gar (in particular the habitat requirements of yolk-sac stage, young-of-the-year [YOY] and juveniles).	2013 to 2015	In progress	Sampling was conducted for larval Spotted Gar in Rondeau Bay in 2018 (Gáspárdy et al. 2021). A total of 37 larval gar, confirmed through genetic analysis to determine species identity, were captured in early June (Gáspárdy et al. 2021). The results of this study demonstrated that larval gar were much more common in nearshore habitats (in many cases < 1 m from shore, but in almost all cases, < 5 m from shore) within tributaries and along the lakeshore when compared to more offshore locations. Specifically, 27% and 68% of the larval Spotted Gar were captured in nearshore tributary areas, respectively, while only 5% were captured in offshore lake and offshore tributary areas defined as areas in the centre channel of a tributary (Gáspárdy et al. 2021). Further analyses of this dataset showed that larval Spotted Gar strongly prefer shallow (0.5 to 1.0 m) nearshore habitat with submerged vegetation (McAllister et al. 2022). The dependence of YOY on submerged vegetation decreased as fish increased in size (McAllister et al. 2022).	DFO, OMNRF, University of Windsor
Survey and map habitat quality and quantity within historical and current sites, as well as sites adjacent to currently occupied habitat.	2013 to 2015	In progress	A fish community inventory of Point Pelee National Park in 2019 captured 8 Spotted Gar from 7 sites and also collected habitat data (Barnucz et al. 2021). At sites where Spotted Gar were present, water temperatures ranged from 18.5°C to 25.9°C (mean = 23.8 °C; summarized from Barnucz et al. 2021). This study captured adults at sites with a mean depth of 1.52 m with a mean dissolved oxygen at 7.53 mg/L and mean turbidity of 6.91 NTU. Median values of aquatic vegetation at sites with Spotted Gar adults were 30% emergent vegetation, 25% submerged vegetation, and 20% open water (summarized from Barnucz et al. 2021).	DFO, Parks Canada

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[4] Fisheries and Oceans Canada (DFO), Ministry of Natural Resources and Forestry (OMNRF).

Study	Timeline	Status	Descriptions and results	Participants[4]
			Overarching analysis to evaluate habitat quality and quantity among occupied locations has not been undertaken.	
Conduct additional species surveys to fill in distribution gaps, and to aid in determining population status.	2013 to 2015	Completed in some areas; in progress for others	Surveys for fishes occurred in areas where Spotted Gar detections have been reported but where evidence of reproducing populations is lacking. These surveys include the following locations with the number of sampling events in parentheses from 2017 to 2021: Cedar Creek (259), Frenchman's Bay (106), Jeanette's Creek (172), Thames River (Mouth of Thames River to Jeannette's Creek [141]), and Lake St. Clair (5).	DFO, OMNRF
Create a population to habitat supply model for each life stage.	2015 to 2017	Not started	Currently no known progress has been made in this area.	DFO
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.	2015 to 2017	In progress	Recent surveys for Spotted Gar in the coastal wetlands of Lake Erie, as well as research on their habitat use, has allowed DFO to update critical habitat for the species in the recovery strategy and action plan (RSAP) published as proposed in 2022 and finalized in 2024 (DFO 2024). The RSAP identified critical habitat for Spotted Gar as the coastal wetlands and connected quiet backwater areas, including interconnected flooded riparian areas and contributing channels of Point Pelee National Park; Long Point Bay (including Long Point NWA) Big Creek NWA, and Turkey Point; and Rondeau Bay. Population and distribution objectives were also revised in the RSAP for Spotted Gar in Canada (DFO 2024). The objectives are very similar but specifically include new areas in the vicinity of Long Point Bay. However, further refinement of the critical habitat description should be revisited in future studies.	DFO

3.3 Summary of progress towards recovery

3.3.1 Status of performance indicators

Table 4 provides a summary of the progress made toward meeting the performance indicators outlined in table 1. 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 indicator will be reported in the next 5-year progress report)

Table 4. Summary of progress made towards meeting the performance indicators for the Spotted Gar.

Performance indicators	Status	Details
Refined population and distribution objectives determined by 2015.	Met, ongoing	Population and distribution objectives were recently refined in the recovery strategy and action plan posted as proposed in 2022 and finalized in 2024 (DFO 2024); however, quantifiable objectives still need to be developed.
Completion of activities outlined in the schedule of studies for the complete identification of critical habitat within the proposed timelines. Critical habitat protected where identified.	Not met, underway	As a result of recent surveys and tracking of Spotted Gar, additional critical habitat has been drafted to include new areas in Point Pelee National Park, Rondeau Bay, and also at Long Point and Turkey Point. This recent scientific work has resulted in updated attributes of the biophysical features that comprise critical habitat. This critical habitat has been identified in the updated recovery strategy and action plan (DFO 2024).
Monitoring program established by 2015. Current distribution and density of Spotted Gar in 3 extant Great Lakes coastal wetland populations maintained or enhanced.	Not met, underway	A standardized monitoring program for Spotted Gar in Lake Erie has not been developed or implemented in all occupied locations. In 2019 and 2021, DFO conducted fish community sampling in Point Pelee National Park to evaluate the composition of the fish community and to estimate population size of select SARA-listed species, including the Spotted Gar (Barnucz et al. 2021). No

Performance indicators	Status	Details
		recaptures of tagged individuals occurred and population size could not be estimated. In 2018, DFO conducted targeted sampling at 356 sites in Rondeau Bay (and 2 tributary agricultural drains) for larval Spotted Gar (Gáspárdy et al. 2021). Of the larval Spotted Gar detected, 95% were from the nearshore sampling zones (68% agricultural drains, 27% bay), while 5% were captured offshore in the agricultural drains. A radiotelemetry study in Rondeau Bay and tributaries in 2017 identified spawning sites. Results indicated that preferred spawning sites occur close to shore (within < 10 m of shoreline preferred), typically contain pondweed species (*Potamogeton spp.*), occur over silt and detritus, and are of greater stream depth (0.8 to 1.6 m preferred) than surrounding areas (Drake pers. comm. 2023).
Relative significance of threats evaluated by 2014. Initiate implementation of remedial actions to address priority threats by 2015.	Not met, underway	Remedial actions to address threats are ongoing through water quality improvement programs and projects (for example, constructed wetlands, grassed waterways, and tree/shrub planting to reduce erosion and sedimentation, a significant threat to Spotted Gar). This effort includes actions funded through the Aboriginal Fund for Species at Risk (AFSAR), the Habitat Stewardship Program (HSP), and the Canada Nature Fund for Aquatic Species at Risk (CNFASAR). Remedial programs are offered through conservation authority stewardship programs that offer financial incentives to local landowners to protect and restore habitat, improve watershed quality, and reduce nutrient and sediment inputs into waterways and the Great Lakes, thereby addressing 2 threats of highest overall concern to Spotted Gar.

Performance indicators	Status	Details
		Updated guidelines for the removal of aquatic vegetation within Spotted Gar critical habitat have recently been published (DFO 2020). The guidelines are designed to minimize harm to Spotted Gar in areas where vegetation removal occurs. A threat assessment report affecting species at risk, including Spotted Gar in LTVCA watersheds, has been published.
Quantification of Best Management Practices (BMPs) (for example, number of Nutrient Management Plans [NMPs] and Environmental Farm Plan [EFPs] completed; hectares of riparian zone established) implemented by the Essex-Erie Recovery Team (EERT) and other interest groups to address threats within the 3 occupied Lake Erie coastal wetlands by 2016 (on-going).	Met ongoing	A number of habitat improvement activities representative of BMPs have been conducted through cooperation with conservation groups that benefit Spotted Gar within coastal wetlands of Lake Erie. The spatial extent of these activities has been quantified and is listed in the stewardship section of table 2.
Report on habitat improvements as detected by the monitoring program 5 years after the initial baseline data collected (by 2020).	Not met, underway	A comprehensive report on habitat improvements has not been prepared at this time; however, with support from species at risk funding programs (for example, HSP), habitat improvements within the distribution of Spotted Gar have been undertaken and reported individually. Parks Canada conducts their ecological integrity monitoring program on an annual basis at Point Pelee National Park. Their most recent report (2022) indicates that water quality index scores have trended upwards and total phosphorus significantly declined since 2017 (Windsor [Parks Canada] pers. comm.).
Document any changes in public perceptions and support for identified recovery actions through guidance identified in the communications strategy (by 2015).	Not met, underway	Through species at risk outreach programs conducted by DFO, OMNRF, and conservation authorities, public perception and understanding of the presence and significance of Spotted Gar has been raised; however, no known progress has been made to quantify and document this perception and understanding at this time.

Performance indicators	Status	Details
Landowners engaged in stewardship actions from 2012 to 2016.	Met ongoing	Stewardship activities that benefit Spotted Gar have been ongoing through the HSP, and the CNFASAR by working with groups such as NGOs, conservation authorities, and the Ontario Ministry of Natural Resources and Forestry (OMNRF).

3.3.2 Completion of action plans

An updated recovery strategy and action plan for Spotted Gar was posted to the Species at Risk Public Registry as proposed in 2022 and finalized in 2024 (DFO 2024). The "Multi-species Action Plan for Point Pelee National Park of Canada and Niagara National Historic Sites of Canada" (PCA 2016) also includes recovery actions that will benefit Spotted Gar found within Point Pelee National Park. An implementation report on the multi-species action plan has also been published by Parks Canada (PCA 2022).

3.3.3 Critical habitat identification and protection

Critical habitat for the Spotted Gar was identified to the extent possible in the 2012 recovery strategy (Staton et al. 2012). For those areas of critical habitat located within Point Pelee National Park and Big Creek NWA, a description of the critical habitat was published in the *Canada Gazette, Part I,* Vol. 150, No. 42 in 2016, pursuant to subsection 58(2). The subsection 58(1) prohibition against destroying any part of this critical habitat came into effect 90 days following this publication in the *Canada Gazette*. In 2017, a critical habitat order was made, which triggered the prohibition in subsection 58(1) against the destruction of any part of critical habitat found outside Point Pelee National Park and Big Creek NWA. Since the publication of the recovery strategy, a variety of surveys and research projects have resulted in the addition of critical habitat in the updated recovery strategy and action plan (posted as proposed in 2022 and finalized in 2024) (DFO 2024). The new areas of critical habitat include Point Pelee National Park, Long Point Bay, and Rondeau Bay.

Provincially, the Spotted Gar was listed as a threatened species under Ontario's *Endangered Species Act, 2007*; the species was reassessed as endangered in 2017. Under the Act, the species itself is currently protected, and the habitat of the Spotted Gar has been protected under general habitat protection provisions since June 20, 2013.

3.3.4 Recovery feasibility

Currently, a review of the recovery feasibility for this species is not necessary as Spotted Gar populations, within Canadian waters, likely meet the feasibility criteria laid out in the recovery strategy (Staton et al. 2012). For example, it is likely that there are enough reproducing individuals and suitable habitat to support recovery objectives, and threats to the species in many areas can be, or have been, addressed through restoration efforts and the promotion of Best Management Practices (BMPs).

4. Concluding statement

Continued sampling within the known range of the Spotted Gar has expanded the understanding of the species habitat utilization in Point Pelee National Park, Rondeau Bay, and the Long Point region. As a result, additional critical habitat at these locations was included in the updated recovery strategy and action plan posted on the Species at Risk Act Public Registry as proposed in 2022 and finalized in 2024 (DFO 2024).

Since the publication of the Report on the Progress of Recovery Strategy Implementation for the Spotted Gar (*Lepisosteus oculatus*) in Canada for the Period 2012 to 2017 (DFO 2018), there has been a substantial degree of progress in terms of activities that have been implemented as components of the broad strategies for recovery. For example, a number of surveys specifically

targeting larval Spotted Gar have been conducted in Rondeau Bay. This work has provided insight into habitat use of larval Spotted Gar, particularly the use of submerged vegetation. Sampling of both historical and potential new locations in the Lake Erie and Lake Ontario watersheds have also been undertaken with targeted surveys occurring at Point Pelee National Park. Non-targeted surveys conducted by DFO occurred at Frenchman's Bay, East Lake, Bay of Quinte (North Channel), Lake St Clair, Lake St. Clair NWA, Jeannette's Creek, and the Thames River. Despite these surveys, potential Spotted Gar reproducing populations at Frenchman's Bay, East Lake, and the Bay of Quinte remain unconfirmed. Similarly, confirmation of reproducing populations at Hamilton Harbour, Muddy Creek, and the upper St. Lawrence River near Kingston in Lake Ontario has not occurred. Putative specimens of Spotted Gar have been captured at 2 new locations (Cedar Creek, and Hillman Marsh); however, voucher specimens are needed to confirm they are Spotted Gar and not potential introductions of Florida Gar. Furthermore, it is unknown whether those single specimens were transient or represent new populations. More work is required in order to shed light on these occurrences.

The population and distribution objective defined in the recovery strategy is to maintain current distribution and densities of extant populations in 3 coastal wetland areas of Lake Erie (Staton et al. 2012). This objective may prove difficult, as a recent study provided evidence that an additional 29 km^2 of wetland habitat is required to maintain viable Spotted Gar populations. Since 2017, Spotted Gar have continued to be detected in these 3 coastal wetlands; however, the population study at Point Pelee failed to estimate the population size, as no tagged Spotted Gar were recaptured (Barnucz et al. 2021). Previously, there was some evidence that the Long Point Bay population may be a population sink but that evidence was based on the genetic make-up of 5 individuals (Glass et al. 2015). Since then, the species has been more widely detected throughout Long Point Bay. Therefore, Long Point Bay remains a part of the updated population and distribution objectives for the species. If new populations are confirmed through follow-up sampling, then this information will lead to additions to the current population and distribution objectives outlined in the updated recovery strategy and action plan (DFO 2024).

Threats to Spotted Gar and their habitat remain a serious concern but progress has been made by DFO and the academic community to better understand these threats, and how Spotted Gar respond to changing environments. This progress includes work on the response of Spotted Gar to abiotic environmental stressors, the effects of temperature on development, and the use of otoliths to get precise ages of juveniles, which will help relate developmental rates to environmental factors. Also, DFO has reviewed and summarized its current understanding of Spotted Gar habitat while providing BMPs on how to best remove aquatic vegetation in Spotted Gar habitats. These BMPs were intended to minimize harm to Spotted Gar in areas where vegetation removal occurs.

Stewardship and outreach projects with funding from the Aboriginal Fund for Species at Risk (AFSAR), the Habitat Stewardship Program (HSP), and the Canada Nature Fund for Aquatic Species at Risk (CNFASAR), continue on an annual basis, with projects targeting species at risk, including Spotted Gar. Since 2017, these efforts have included habitat improvement projects such as riparian restoration, and vegetation planting, which have been conducted in several watersheds where Spotted Gar occurs. Furthermore, outreach activities that benefit this species have been delivered to a number of audiences.

There are a number of recovery activities that still remain to be implemented and/or may take longer to be completed. For example, a standardized monitoring program is required to ensure that its extant distribution is maintained while ensuring that populations are stable and/or increasing. Habitat quantity and quality need to be formally evaluated. Such evaluation would

help to monitor habitat improvements as well as feed into a population-habitat supply model for each life stage that is important for the recovery of this species.

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