Species at Risk Act
Recovery Strategy Report Series

Report on the Progress of Recovery Strategy Implementation for the Spotted Gar (*Lepisosteus oculatus*) in Canada for the Period 2012 - 2017

Spotted Gar

2018

Canada

Recommended Citation:

Fisheries and Oceans Canada. 2018. Report on the Progress of Recovery Strategy Implementation for the Spotted Gar (*Lepisosteus oculatus*) in Canada for the Period 2012 – 2017. *Species at Risk Act* Recovery Strategy Report Series. Fisheries and Oceans Canada, Ottawa. iv + 23 pp.

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

Cover illustration: Joseph R. Tomelleri

Également disponible en français sous le titre
«Rapport sur les progrès de la mise en œuvre du programme de rétablissement du lépisosté tacheté (*Lepisosteus oculatus*) au Canada pour la période 2012-2017»

ISBN 978-0-660-24691-8
Catalogue no. En3-4/146-1-2018E-PDF

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under Section 46 of the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the competent ministers are responsible for reporting on the implementation of the recovery strategy for a species at risk, and on the progress towards meeting its objectives within five years of the date when the recovery strategy was placed on the Species at Risk Public Registry and in every subsequent five-year period, until its objectives have been achieved or the species' recovery is no longer feasible.

Reporting on the progress of recovery strategy implementation requires reporting on the collective efforts of the competent 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).

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

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

Acknowledgments

This Progress Report was prepared by P.L. Wong (DFO) and Joshua Stacey (DFO). To the extent possible, this Progress Report has been prepared with inputs from Ontario Ministry of Natural Resources and Forestry. The Department of Fisheries and Oceans would also like to express its appreciation to all individuals and organizations who have contributed to the recovery of the Spotted Gar.

Executive Summary

The Spotted Gar was listed as Threatened under the *Species at Risk Act* 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.

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

The population and distribution objective for Spotted Gar is to maintain current distributions and densities of extant populations in the three coastal wetlands of Lake Erie (Point Pelee National Park, Rondeau Bay and Long Point Bay/Big Creek National Wildlife Area). Spotted Gar has continued to be detected in these three coastal wetlands; however, the results of genetic analyses indicate that the Long Point Bay population appears to be a sink, suggesting this population will not be viable in the long-term. This should be taken into consideration in the future when population and distribution objectives are being re-evaluated.

A Spotted Gar individual has been confirmed at a new location (i.e., Muddy Creek), although it is unknown whether the single specimen was a transient or represents a new population. The presence of Spotted Gar populations at historical locations such as East Lake and the upper St. Lawrence River near Kingston in Lake Ontario remains unconfirmed. Additionally, the presence of a population in Hamilton Harbour remains unconfirmed despite the detection of an individual in 2010.

During the time period reported by this Progress Report, progress has been made including:

- Targeted 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;
- Research on Spotted Gar habitat use in Rondeau Bay and Long Point Bay that characterized spawning and juvenile rearing habitats, as well as habitat utilised by other life stages in Rondeau Bay;
- Research on Spotted Gar habitat use in Rondeau Bay that led to an extension of identified spawning areas to include tributaries up to the first permanent barrier to fish passage;
- Studies have been conducted that investigate the genetics of Spotted Gar in Ontario in relation to southern populations, as well as genetic differences present among the Ontario populations;
- Stewardship activities, including habitat improvement projects such as riparian restoration, vegetation planting, removal of invasive non-native vegetation, and other habitat improvement activities have been conducted in several watersheds where Spotted Gar occurs; and,
- Outreach activities involving presentations to landowners, cottagers, farmers, environmental students, Ontario Aboriginal Lands Association, and Ontario First Nations Economic Development Association to raise awareness about critical habitat, threats and protection measures, and recovery of Spotted Gar.

Taken together, these ongoing and/or completed activities indicate that progress is being made toward the goal of recovering Spotted Gar populations in Canada. However, there are

still a number of areas where further information is required. For example, sampling methods need to be refined and a habitat monitoring program still needs to be developed. Furthermore, sources of nutrients and sediments that threaten Spotted Gar have not been identified, and lastly, the response of Spotted Gar to the management and removal of invasive non-native vegetation remains to be investigated.

Table of Contents

1. Introduction

This Progress Report outlines the progress made from 2012 to 2017 towards meeting the objectives listed in the Recovery Strategy for the Spotted Gar and should be considered as one in 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 2015), the Recovery Potential Assessment (Fisheries and Oceans Canada [DFO] 2010), the Recovery Strategy (Staton et al. 2012), and, if available, one or more action plan(s).

Section 2 of the Progress Report reproduces or summarizes key information on the threats to the species, 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 back to the *Recovery Strategy for the Spotted Gar (*Lepisosteus oculatus*) in Canada*. Section 3 reports the progress of activities identified in the Recovery Strategy to support achieving the population and distribution objectives. Section 4 summarizes the progress toward achieving the objectives.

2. Background

2.1 COSEWIC Assessment Summary

The listing of Spotted Gar under the *Species at Risk Act* (SARA) in 2003, which led to the development and publication of the *Recovery Strategy for Spotted Gar (*Lepisosteus oculatus*) in Canada* in 2012, was based on the information provided in the COSEWIC Status Report (COSEWIC 2005). This information has also been included in Section 1.1 of the Recovery Strategy. In 2015, COSEWIC re-examined and changed the status of the Spotted Gar from Threatened to Endangered (COSEWIC 2015).

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 three 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

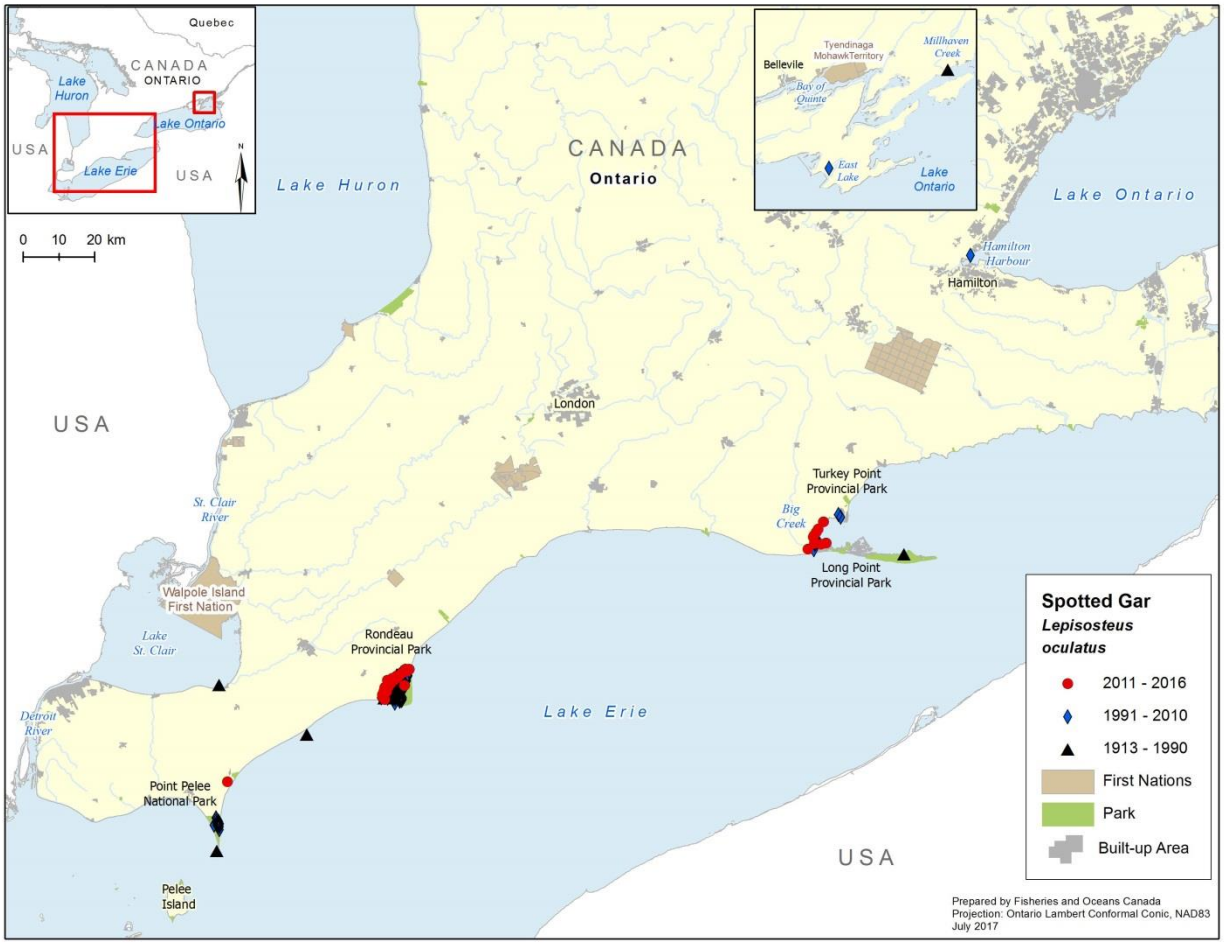

Figure 1. Historical distribution and recent detections of Spotted Gar in southwest Ontario.

2.3 Threats

For information regarding threats to Spotted Gar as well as the species' critical habitat refer to the Recovery Strategy section 1.5.

2.4 Recovery

This section summarizes the information, found in the Recovery Strategy (Staton et al. 2012), on the population and distribution objectives that are necessary for the recovery of Spotted Gar and on performance indicators that provide a way to define and measure progress toward achieving the population and distribution objectives.

2.4.1 Population and Distribution Objectives and Performance Indicators

Section 2.3 of the Recovery Strategy identified the following population and distribution objective necessary for the recovery of the species. The population and distribution objective is to maintain current distribution and densities of extant populations of Spotted Gar in the three

coastal wetlands of Lake Erie (Point Pelee National Park [PPNP], Rondeau Bay and Long Point Bay/Big Creek National Wildlife Area [NWA]).

In support of the long-term goal, short/medium-term recovery objectives that will be addressed over a 5-10 year period are listed in Table 1 along with the performance indicators:

Table 1. Recovery objectives and corresponding performance indicators[1] for Spotted Gar, found in the Recovery Strategy.

Recovery Objectives	Performance Measure
P1. Refine population and distribution objectives.	Refined population and distribution objectives determined by 2015.
P2. 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.
P3. Determine long-term population and habitat trends.	Monitoring program established by 2015. Current distribution and density of Spotted Gar in three extant Great Lakes coastal wetland populations is maintained or enhanced.
P4. 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.
P5. Enhance efficiency of recovery efforts.	Quantification of Best Management Practices (BMPs) (e.g., number of Nutrient Management Plans [NMPs] and Environmental Farm Plan [EFPs] completed; hectares of riparian zone established) implemented by Essex Erie Recovery Team (EERT) and other interest groups to address threats within the three occupied Lake Erie coastal wetlands by 2016 (on-going).
P6. Enhance quality and extent of available habitat.	Report on habitat improvements as detected by the monitoring program five years after the initial baseline data collected (by 2020).
P7. 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).
P8. 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 2012-2016.

[1] Some indicators may not be measurable within the timeframe covered in this Progress Report.

3. Progress Towards Recovery

The Recovery Strategy for the Spotted Gar divides the recovery effort into three broad strategies: 1) Research and Monitoring; 2) Management and Coordination; and, 3) Stewardship, Outreach and Awareness. Progress in carrying out these broad strategies is reported in Section 3.1. Section 3.2 reports on the activities identified in the Schedule of Studies to Identify Critical Habitat. Section 3.3 reports on the progress on meeting the performance indicators and other commitments (e.g., 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 approaches and broad strategies identified in the recovery planning table of the Recovery Strategy.

Table 2. Details of activities supporting the recovery of Spotted Gar from 2012 to 2017.

Activity	Approach	Descriptions and Results	Recovery Objectives *(from Recovery Strategy)*	Participants[2]
Broad Strategy 1: Research and Monitoring				
Conduct targeted surveys of preferred habitats at Turkey Point, Tremblay Beach wetlands (mouth of the Thames, Lake St. Clair) and Lake Ontario (Bay of Quinte, Hamilton Harbour, East Lake).	R1. Background surveys – new/suspected and historical locations	• Targeted surveys of historical and potential new locations were conducted in Lake Erie (Hillman Marsh, Flat, Georgie, Indian, Mill and Willow creeks, and McLeans and Wood drains), Lake Ontario (Coote's Paradise, East Lake and Hamilton Harbour) and Lake St. Clair (mouth of the Thames River, and Jeanette's, Baptiste and Big creeks). A total of 47 Spotted Gar were detected in five sites (Glass and Mandrak 2014). • There was a positive eDNA[3] detection in the vicinity of the mouth of Spencer Creek in Coote's Paradise but subsequent targeted sampling using conventional methods[4] resulted in no captures of Spotted Gar (Glass and Mandrak 2014). • Targeted surveys have not been conducted at Turkey Point, Tremblay Beach and Bay of Quinte. • External sampling conducted by University of Windsor researchers led to the detection of Spotted Gar in Muddy Creek, a tributary of Lake Erie located near Wheatley	i	DFO

[2] Fisheries and Oceans Canada (DFO), Ontario Ministry of Natural Resources (OMNRF), Essex-Erie Recovery Team (EERT), Lower Thames Valley Conservation Authority (LTVCA), Essex Region Conservation Authority (ERCA), Long Point Region Conservation Authority (LPRCA), Ontario Federation of Agriculture (OFA), and Environment and Climate Change Canada (ECCC).
[3] Environmental DNA refers to the detection of DNA material within the water column, originating from feces, mucus, gametes, sloughed cells, carcasses etc., which can be attributed to a given species.
[4] Conventional sampling refers to trapping or stunning fishes using methods such as fyke nets, trap nets, seine nets, electrofishing etc.

Activity	Approach	Descriptions and Results	Recovery Objectives *(from Recovery Strategy)*	Participants[2]
		Provincial Park. It is unknown whether the single specimen captured represents a new population or was a transient.		
Complete targeted surveys of extant populations.	R2. Background surveys – extant locations	• Targeted surveys of extant populations were completed in Lake Erie (Rondeau Bay and its tributaries, and Long Point Bay and PPNP). A total of 129 Spotted Gar were detected in Rondeau Bay and its tributaries while only three were captured in Long Point Bay. • An eDNA survey conducted in Rondeau Bay tributaries (Glass and Mandrak 2014) reported positive detections for Spotted Gar; however, conventional sampling was unable to detect the species at some sites where positive eDNA detections were found and eDNA failed to detect Spotted Gar at some sites where the species was captured through conventional methods. • A radio-tracking study of Spotted Gar tagged in Rondeau Bay tributaries during the 2015 spawning season found that 11 tagged individuals were presumed to have spawned in 2016. • Surveys were also conducted by the Canadian Wildlife Service (CWS) in the Long Point NWA to investigate the efficacy of Common Reed (*Phragmites australis*) management efforts; however, Spotted Gar was not detected. Additional research is underway within Long Point NWA to assess the relationship between freshwater fishes, including species at risk (SAR), and the area of wetland environments (Montgomery et al. 2017). Sampling information from this study is not yet available.	i, iii	DFO, CWS, U of Toronto, OMNRF
Establish and implement a standardized index population and habitat monitoring program for all extant locations.	R3. Monitoring – populations and habitat	• A standardized index population and habitat monitoring protocol has not been developed at this time.	ii, iii	
Determine the seasonal habitat	R4. Research –	• Glass and Mandrak (2014) conducted a study on spawning,	ii	DFO

Activity	Approach	Descriptions and Results	Recovery Objectives *(from Recovery Strategy)*	Participants[2]
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.	habitat requirements	juvenile and adult habitats within Rondeau and Long Point bays between 2013 and 2014 with the following results: ○ Spawning and juvenile rearing habitats in Rondeau Bay were characterized. ○ Juvenile Spotted Gar were all captured in shallow, nearshore areas with abundant vegetation (mean total coverage >70%) • Electivity indices showed that juvenile Spotted Gar preferred moderate turbidity levels, shallow depths (<0.5m), and water temperature >23.5˚C. Glass et al. (2012) observed that adult Spotted Gar used emergent and submerged aquatic macrophyte beds in both the nearshore and offshore areas of Rondeau Bay for feeding, cover, and spawning.		
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.	R5. Threat evaluation and mitigation	• A 2013 study extended the spawning areas in Rondeau Bay to include tributaries up to the first permanent barrier to fish passage. These tributaries are agricultural drains, potentially subject to drain maintenance that would remove vegetation and increase flow and turbidity (Glass and Mandrak 2014). • A research study (Gray et al. 2012) found Spotted Gar eggs had a 24% decreased hatching success in mildly turbid water compared with embryos held in clear water. This study illustrates that turbidity and sedimentation are threats to Spotted Gar in early life stages.	iv	DFO
Conduct radio-tracking studies to monitor habitat use and determine home range size of individuals in the Lake Erie wetlands.	R6. Research – home range and habitat use	• A radio-tracking study conducted in Rondeau Bay in spring and summer of 2007 to understand habitat utilization found Spotted Gar prefers specific depths and cover rather than shoreline features (Glass et al. 2012). It also found Spotted Gar moves nearshore to spawn in spring and in summer moves offshore and establishes a defined home range. • A follow-up study on tagged Spotted Gar showed 6 of 11 tagged individuals presumed to have spawned, returned to the same tributary where they were tagged the previous	ii	DFO

Activity	Approach	Descriptions and Results	Recovery Objectives *(from Recovery Strategy)*	Participants[2]
		year (Glass and Mandrak, *in review*).		
Identify point sources of nutrient and sediment inputs and their relative effects.	R7. Point source contamination	• Currently no known progress has been made in terms of identifying point sources of nutrient and sediment inputs.	ii	DFO, EERT, LTVCA, ERCA, LPRCA, OMNRF
Investigate the degree of connectivity between and within Spotted Gar populations (field surveys/research, genetic analysis) as well as population viability.	R8. Threat evaluation and mitigation – investigate connectivity/ viability	A study investigating genetic variance among Spotted Gar populations (Glass et al. 2015) found the following: • Across the species' range, significant genetic differentiation was found between northern (including Canada) and southern populations. Within the northern range, there are 7-9 distinct subpopulations; • Very low levels of genetic connectivity exist among populations of Spotted Gar in Ontario; • A population bottleneck is occurring in the PPNP location; • The physical isolation of PPNP appears to lead to distinct genetic isolation with individuals unable to disperse to other areas of Lake Erie except on occasions when the barrier beach is breached; • Long Point Bay appeared to be a sink population[5] indicating this population of Spotted Gar may not be viable in the long term; • There are five sympatric populations in Rondeau Bay with a high degree of differentiation among them; and, • All but one northern population (in Rondeau Bay) appear to have the number of breeding individuals below 500 that is required for long-term viability.	iv	DFO, University of Windsor
Evaluate the impacts of incidental	R9. Threat	• The Ontario Commercial Fisheries Association and OMNRF	iv	OMNRF

[5] Sink populations refer to populations that are not exhibiting adequate recruitment to ensure their long-term persistence. In the case of Spotted Gar in Long Point Bay, sink refers to the fact that this population has limited gene flow and will eventually experience inbreeding depression.

Activity	Approach	Descriptions and Results	Recovery Objectives *(from Recovery Strategy)*	Participants[2]
harvest on Spotted Gar populations (e.g., surveys of fishermen).	evaluation and mitigation – incidental harvest	have conducted a research study, funded through the Species at Risk Stewardship Fund, investigating the potential impacts of commercial hoopnet fisheries in Long Point Bay on aquatic SAR. Only one Spotted Gar was captured in this study and all SAR captured were released alive and in good condition, indicating that existing commercial fishing practices have little or no effect on aquatic SAR in Long Point Bay and current license conditions appear to provide adequate protection for the species (R. Dolson-Edge, OMNRF, pers. comm., 2017).		
In cooperation with the EERT, assess watershed-scale stressors to occupied coastal wetlands.	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.	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.	R11. Water quality monitoring	• The assessment of water quality parameters is underway in Rondeau Bay (Lake Erie) to gauge the efficacy of the Rondeau Bay Restoration Project.	iv	DFO, EERT, LTVCA, ERCA, LPRCA, OMNRF
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.	R12. Monitoring and enforcement	• The Rondeau Bay Aquatic Vegetation Issues Working Group continues to liaise with several agencies to ensure that aquatic vegetation removal projects do not negatively impact Spotted Gar and other SAR. • Several stewardship groups aimed at improving land use practices and aquatic habitat within the Rondeau Bay watershed are currently active.	Iv	DFO, OMNRF
Investigate the response of Spotted Gar to wetland management practices (e.g., Common Reed	R13. Response of Spotted Gar to wetland	• DFO Great Lakes Laboratory for Fisheries and Aquatic Sciences has been monitoring coastal wetlands and the response of aquatic SAR to wetland management projects.	iv	DFO, EERT, LTVCA, ERCA,

Activity	Approach	Descriptions and Results	Recovery Objectives *(from Recovery Strategy)*	Participants[2]
control/management, water level management and other habitat alterations).	management practices	• The Ontario Phragmites Working Group reported that aerial treatments in Rondeau Bay and Long Point started on September 6, 2016 and ended on October 31, 2016.		LPRCA, OMNRF
Investigate the relationship between Longnose Gar and Spotted Gar in areas where they coexist.	R14.Interspec-ific interactions	• No known investigations into potential interactions between these two species have been undertaken at this time.	iv	
Conduct a risk assessment on the probability of Florida Gar becoming established in the Great Lakes basin (i.e., within Spotted Gar habitats).	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.	R16. Threat evaluation – climate change	• One study conducted by Alexander (2012) has projected that climate change will lead to further declines in water levels, as well as an increase in extreme weather events. Furthermore, the increased effects of climate change will likely continue to promote the expansion of Common Reed along coastal Great Lakes shorelines (Alexander 2012). • Climate change scenarios were modelled in Great Lake coastal wetland communities including Long Point, Turkey Point and Rondeau Bay (Mortsch et al. 2006). Wetland community modelling indicates that lower water levels projected under most climate change scenarios will have an impact on the distribution and abundance of wetland habitat and wildlife communities. Lower water levels favour succession to drier vegetation types particularly along the upper margins of the wetland and reduced open water habitat, including submergent vegetation utilized by Spotted Gar, in most embayments. • Spotted Gar has been identified as highly vulnerable to	iv	DFO, ECCC, OMNRF

Activity	Approach	Descriptions and Results	Recovery Objectives *(from Recovery Strategy)*	Participants[2]
		future climate change within the Great Lakes by the Michigan Department of Natural Resources (Hoving et al. 2013).		
Broad Strategy 2: Management and Coordination				
Work with the EERT and other relevant groups to share knowledge and implement recovery actions.	C1. Coordination with other recovery teams and relevant groups	• The Essex-Erie Recovery Strategy identified three coastal wetlands in Lake Erie with extant populations as core areas for directing recovery efforts to benefit Spotted Gar and other high priority fishes. At PPNP, ongoing seasonal programs provide increased awareness of SAR issues.	iv	DFO, EERT, LTVCA, ERCA, LPRCA, OMNRF
Encourage municipalities to protect habitats that are important to Spotted Gar in their Official Plans and ensure that planning and management agencies are aware of habitats important to the species.	C2. Municipal planning – involvement	• In 2012-14, efforts were made to address the need for federal aquatic SAR protection in municipal planning documents (official plans) in Ontario. In conjunction with MNRF and the Ministry of Municipal Affairs and Housing, DFO developed additional guidelines that would apply to federal SAR for insertion into official planning documents. These guidelines were sent to 29 municipalities that were undergoing review of their official plans and that support species listed under SARA; only two municipalities have incorporated the guidelines thus far. This low uptake is due to delays in the reviews of the official plans caused by the impending revisions to the Provincial Policy Statement and the related National Heritage Reference Manual. • Critical habitat and species recovery presentations have been given to municipal planners in the watersheds where Spotted Gar is present.	vi, vii	DFO
Establish good working relationships with drainage supervisors, engineers and contractors to limit the effects of drainage activities on coastal	C3. Relationship building – drainage	• SARA legislation, critical habitat and recovery information were included in the Drainage Superintendent course in 2012. • Presentations regarding SAR critical habitat were given to drainage engineers.	vi, vii, viii	DFO

Activity	Approach	Descriptions and Results	Recovery Objectives *(from Recovery Strategy)*	Participants[2]
wetland habitats.				
Ensure that existing guidelines on reducing, mitigating and restoring areas of dredge, fill and vegetation removal impacts take the needs of Spotted Gar into account.	C4. Guidelines: dredge, fill and vegetation removal	• During project design and preparation, project proponents are directed to assess their projects in accordance with DFO's Fisheries Protection Program guidelines and mitigation, including pathways of effects, to minimize impacts on aquatic species, including SAR.	iv, vi	DFO, EERT, LTVCA, ERCA, LPRCA, OMNRF
Encourage responsible agencies/jurisdictions to integrate recovery team recommendations into planning documents, including land management plans.	C5. Information sharing-land use planning	• Through annual DFO SAR outreach, responsible agencies are informed about aquatic (fishes/mussels) SAR within their jurisdiction, and encouraged to incorporate SAR 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.	v, vii	DFO, EERT, LTVCA, ERCA, LPRCA, OMNRF
Broad Strategy 3: Stewardship, Outreach and Awareness				
Collaborate with relevant groups, initiatives and recovery teams to address recovery actions of benefit to Spotted Gar.	S1. Collaboration and information sharing	• The Essex-Erie Fish SAR Recovery Program is a collaboration between ERCA, LPRCA and LTVCA; projects have been conducted in Long Point Bay and Rondeau Bay.	v	DFO, OMNRF, ERCA, LPRCA, LTVCA
Promote stewardship among landowners, First Nations and other interested parties (e.g., anglers) within watersheds of the occupied coastal wetlands, particularly Rondeau Bay.	S2. Stewardship and habitat initiatives	• Presentations were delivered to landowners, cottagers and farmers regarding SARA, critical habitat, environmental issues and initiatives in Rondeau Bay. • Presentations were delivered to environmental students at Fleming College regarding SAR, threats, critical habitat and species recovery. • Presentations were delivered on aquatic SAR threats and protection measures to Ontario Aboriginal Lands Association and the Ontario First Nations Economic Development Association.	iv, vi, vii, viii	DFO
Work with landowners to	S3. Stewardship	• A number of habitat improvement activities have been	iv, vii, viii	DFO,

Activity	Approach	Descriptions and Results	Recovery Objectives *(from Recovery Strategy)*	Participants[2]
implement BMPs in areas where they will provide the most benefit. Encourage the completion and implementation of EFPs and NMPs.	-implementation of BMPs	conducted through cooperation with the EERT as well as other groups that benefit Spotted Gar within coastal wetlands of Lake Erie. For example, 0.81, 41.88 and 238.5 ha of vegetation planting have been undertaken in PPNP, Rondeau and Long Point bays, respectively. Furthermore, 12 and 2 ha of riparian zone has been restored, as well as 7.69 and 0.41 ha of other habitat improvement activities have been undertaken in Rondeau and Long Point bays, respectively. • Presentations have been provided to farmers and drainage engineers in southwestern Ontario. • BMPs are encouraged on rural properties. • Landowners in Rondeau Bay watershed have enhanced wetlands to reduce sedimentation and improve water quality. • Through the Species at Risk Stewardship Fund, the OMNRF has worked with drainage superintendents in the municipality of Chatham-Kent to improve riparian conditions within drains to improve the overall water quality found within these locations, as well as connected watersheds such as Lake St. Clair, the Thames River, and Rondeau Bay, where SAR are present (R. Dolson-Edge pers. comm., 2017).		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 SARA to help ensure compliance	S4.Communi-cations strategy	• An outreach strategy was developed for SAR in southwestern Ontario targeting the following audiences: ○ Local municipal staff – managers, planners, engineers, field staff and consultants; ○ Development industries – 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; and, ○ Conservation/Environmental/Stewardship Organizations – fish and game clubs, naturalist and	vii, viii	DFO

Activity	Approach	Descriptions and Results	Recovery Objectives *(from Recovery Strategy)*	Participants[2]
with the Act.		environmental protection organizations, students and stewardship councils.		
Facilitate access to funding sources for landowner, First Nations and local community groups engaged in stewardship activities.	S5. Stewardship –financial assistance/ incentives	• The DFO-funded Habitat Stewardship Program (HSP) provides support for local stewardship initiatives led by conservation authorities and Environmental Non-Governmental Organizations. HSP funding has resulted in a number of habitat improvement projects in Rondeau Bay and Long Point Bay. • Other stewardship related funding is available such as the Aboriginal Fund for Species at Risk (funded by DFO) and the Species at Risk Farm Initiative Program (funded by OFA).	viii	DFO, ECCC, OFA
Provide a Spotted Gar information package to commercial and possibly recreational fishers. Request avoidance of occupied habitats, and the release and reporting of any Spotted Gar captured.	S6. Awareness –incidental harvest	• An information package has been developed and distributed to commercial fishermen who conduct operations in waters occupied by Spotted Gar within Long Point Bay. Outreach activities conducted by the Ontario Commercial Fisheries Association and OMNRF focused on educating commercial fishermen who operate in Long Point Bay regarding SAR that they are likely to encounter, handling techniques that they should adopt to ensure the survivorship of these species, as well as other pertinent information (R. Dolson-Edge, pers. comm., 2017). • In PPNP, fish SAR information packages were distributed in 2008 and 2009 to day-use and seasonal sport fishers.	vii	DFO, EERT, LTVCA, ERCA, LPRCA, OMNRF

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 of the Recovery Strategy. Each study has been assigned one of four statuses:

Completed: The study has been carried out and concluded
In progress: The planned activity is underway and has not concluded
Not started: The activity has been planned but has yet to start
Cancelled: The planned activity will not be started or completed

Table 3. Status and details of the implementation of the Schedule of Studies outlined in the Recovery Strategy.

Study	Timeline	Status	Descriptions and Results	Participants[6]
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 and juveniles).	2013-2015	In progress	• Juvenile Spotted Gar were found at mean depths of 0.64 m, mean water temperatures of 22.4^{o}C, and mean secchi depths of 0.15 m. Sites had a mix of aquatic vegetation with mean coverage by emergent (30%), floating (9%) and submerged (32%) vegetation types. Strong selection was shown for habitats with moderate turbidity levels (50 – 149 NTU) (Glass and Mandrak 2014). • In spring, adult Spotted Gar showed a strong preference for nearshore, shallow (<0.5 m) and deep (>2.5 m) waters with pH values <8.5, likely for spawning activities. In summer, strong preference was shown for offshore areas with mixed macrophyte beds where they occupy defined home ranges (Glass et al. 2012). Spotted Gar was found to relate to specific depths and cover rather than to shoreline features in Rondeau Bay.	DFO, OMNRF, University of Windsor
Survey and map habitat quality and quantity within	2013-2015	Completed for Rondeau	• Glass and Mandrak (2014) reported spawning areas in Rondeau Bay in several tributaries up to the first permanent barrier to fish passage.	DFO

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

Table 3. Status and details of the implementation of the Schedule of Studies outlined in the Recovery Strategy.

Study	Timeline	Status	Descriptions and Results	Participants[6]
historical and current sites, as well as sites adjacent to currently occupied habitat.		Bay area; ongoing for additional populations		
Conduct additional species surveys to fill in distribution gaps, and to aid in determining population status.	2013-2015	Completed in some areas; in progress for others	• A single individual was captured in Hamilton Harbour in 2010; however, subsequent targeted conventional sampling did not yield any specimens, and the presence of a population at this location cannot be confirmed at this time. • A positive eDNA detection of Spotted Gar was found for one site in Coote's Paradise; however, conventional sampling in the same site did not yield any individuals. • Glass et al. (2012) reported the population of Spotted Gar in Rondeau Bay is large enough (8,121 individuals) and has sufficient suitable habitat (1,543-1884 ha) to be viable in the long term. On average, the size of each of the five populations in Rondeau Bay is approximately 1624 individuals, which is larger than the minimum viable population size of 712 adults (Glass et al. 2015). • Glass et al. (2015) concluded that Spotted Gar in Long Point Bay appear to be a sink population, indicating that this population may not be viable in the long term. • Spawning studies extended the species' distribution in Rondeau Bay to include several tributaries that are agricultural drains and potentially exposed to agricultural drain maintenance (Glass and Mandrak 2014).	DFO, OMNRF
Create a population-habitat	2015-2017	Not started	• Currently no known progress has been made in this area.	DFO

Table 3. Status and details of the implementation of the Schedule of Studies outlined in the Recovery Strategy.

Study	Timeline	Status	Descriptions and Results	Participants[6]
supply model for each life stage.				
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.	2015-2017	Not started	• Currently no known progress has been made in this area.	DFO

3.3 Summary of Progress Towards Recovery

3.3.1 Status of Performance Measures

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

Not met: The performance indicator has not been met, and little to no progress has been made
Not met, underway: The performance indicator has not been met, but there has been moderate to significant progress made
Met: The performance indicator has been met and no further action is required
Met, ongoing: The performance indicator has been met, but efforts will continue until such time the population is considered to be recovered (i.e., the indicator will be reported against in the next five-year progress report)

Table 4. Progress and details of the progress made toward meeting the performance indicators outlined in the Recovery Strategy.

Performance Measure	Status	Details
Refined population and distribution objectives determined by 2015.	Not met, underway	• Population sizes have been estimated within Rondeau Bay. • Long Point Bay is determined to be a sink population indicating its long-term viability is in doubt, while the population in PPNP appears to be physically, and, therefore, genetically isolated from other Lake Erie populations. • Spotted Gar populations in Hamilton Harbour and Muddy Creek have not been confirmed.
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	• A spawning habitat study was conducted in Rondeau Bay that extended the known distribution of the species; additional critical habitat may be identified at these locations in the future. • Juvenile and adult habitat requirements have been investigated in Rondeau Bay for the spring and summer seasons. • Critical habitat identified in the Recovery Strategy is protected via a Critical Habitat Order.
Monitoring program established by 2015. Current distribution and density of Spotted Gar in three extant Great Lakes coastal wetland populations is maintained or enhanced.	Not met, underway	• eDNA studies have been conducted that investigate this technique as a potential non-invasive method to monitor Spotted Gar populations and habitat use (Boothroyd et al. 2016). • Genetic analysis indicates Long Point Bay population will not likely be enhanced.
Relative significance of threats evaluated by 2014. Initiate implementation of remedial actions to address priority threats by 2015.	Not met, underway	• Relative significance of threats has not been reassessed. • Remedial actions to address threats are ongoing through water quality improvement programs and projects (e.g., constructed wetlands, grassed waterways, and tree/shrub planting to reduce erosion and sedimentation, a significant threat to Spotted Gar). • 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 two threats of highest overall concern to Spotted Gar.
Quantification of BMPs (e.g., number of NMPs	Met	• A number of habitat improvement activities representative of

Performance Measure	Status	Details
and EFPs completed; hectares of riparian zone established) implemented by EERT and other interest groups to address threats within the three occupied Lake Erie coastal wetlands by 2016 (on-going).	ongoing	BMPs have been conducted through cooperation with the EERT as well as other groups that benefit Spotted Gar within coastal wetlands of Lake Erie. The spatial extent of these activities have been quantified and are listed in the stewardship section of Table 2.
Report on habitat improvements as detected by the monitoring program five 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 SAR funding programs (e.g., HSP) habitat improvements within the distribution of Spotted Gar have been undertaken and reported on individually.
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 SAR outreach programs within 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 at this time.
Landowners engaged in stewardship actions from 2012-2016.	Met ongoing	• Stewardship activities that benefit Spotted Gar have been ongoing through the HSP by working with groups such as the EERT, conservation authorities and the OMNRF.

3.3.2 Completion of Action Plan

One or more action plans for the Spotted Gar were supposed to be developed with five years of the publication of the Recovery Strategy. Currently, the *Multi-species Action Plan for Point Pelee National Park of Canada and Niagara Natural Historic Sites of Canada* (2016), that includes Spotted Gar, has been published; however, a species-specific Action Plan for the Spotted Gar in Canada is currently being developed, and is expected to be completed in 2018.

3.3.3 Critical Habitat Identification and Protection

Critical habitat was identified within the Recovery Strategy in PPNP as well as Rondeau Bay and Big Creek NWA within Long Point Bay. Descriptions of critical habitat within Big Creek NWA (Long Point Bay) and PPNP were published in the *Canada Gazette* Part 1, to establish legal protection pursuant to subsection 58(2) of SARA. In 2017, a Critical Habitat Order made under subsections 58(4) and (5) of SARA was published in the *Canada Gazette* Part 2. The Descriptions and Order are 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. The Spotted Gar is listed as a Threatened species under Ontario's *Endangered Species Act,* 2007. Under the Act, the species itself is currently protected, and the habitat of the Spotted Gar has been protected under the general habitat protection provisions of the Act since June 20, 2013. Since the publication of the Recovery Strategy, research has been conducted that has potentially refined the functions, features and attributes of critical habitat in terms of habitat features and further documents the importance of tributaries to coastal wetlands as spawning areas. These new findings may be reflected through a revised version of the Recovery Strategy on the federal registry.

3.3.4 Recovery Feasibility

Currently, there is no need to review the recovery feasibility for this species as no new information has been gathered that would suggest that Spotted Gar populations, within Canadian waters, no longer meet the feasibility criteria laid out in the Recovery Strategy. For example, there are still enough reproducing individuals and suitable habitat to support recovery objectives and threats to the species in many areas can be or have been addressed through restoration efforts and the promotion of BMPs.

4 Concluding Statement

Since the publication of the Recovery Strategy for the Spotted Gar 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 Spotted Gar have been conducted in historical, potential new locations, as well as areas where the species was known to be extant. Of particular interest, a positive eDNA detection occurred in Spencer Creek, a tributary of Coote's Paradise, which could potentially represent the discovery of another population. This detection of Spotted Gar within Spencer Creek, combined with the detection in Hamilton Harbour in 2010 by the OMNRF, suggests that further sampling is required to confirm the presence of a population within this area and potentially identify further critical habitat. Similarly, the detection of Spotted Gar within Muddy Creek warrants further sampling within this watershed to determine whether a population exists there, as well as other suitable watersheds located between areas known to have populations of Spotted Gar. In

addition, radio telemetry studies conducted in Rondeau Bay have demonstrated the importance of tributaries to this coastal wetland as spawning grounds that are critical to the survival and growth of the Spotted Gar population found therein. Genetic analyses have been conducted that characterize the degree of population structure and gene flow among populations in Ontario. Threat assessments have also been undertaken within the watersheds of Rondeau and Long Point bays as components of the Essex-Erie Species at Risk Recovery Program and Restoring Rondeau Bay's Ecological Integrity Program.

The population and distribution objective for Spotted Gar is to maintain current distributions and densities of extant populations in the three coastal wetlands of Lake Erie (PPNP, Rondeau Bay and Long Point Bay/Big Creek NWA). Spotted Gar has continued to be detected in these three coastal wetlands; however, the results of genetic analyses indicate that the Long Point Bay population appears to be a sink, suggesting this population will not be viable in the long term. Although the population and distribution objectives were to be refined by 2015, as per the first performance measure, this new information pertaining to the Long Point Bay population should be taken into consideration in the future when population and distribution objectives are being re-evaluated. In addition, populations have yet to be confirmed in Hamilton Harbour and Muddy Creek. If these populations are confirmed through follow-up sampling, then this information will lead to additions to the population and distribution objectives. Furthermore, these findings have implications for the third performance measure, which states: the current distribution and density of Spotted Gar in three extant Great Lakes coastal wetland populations is maintained or enhanced. The potential lack of viability for the Long Point population may preclude the achievement of this measure.

Stewardship activities, including habitat improvement projects such as riparian restoration, vegetation planting, removal of invasive non-native vegetation have been conducted in several watersheds where Spotted Gar occurs, and outreach activities that benefit this species have been delivered to a number of audiences. More specifically, an information package has been developed and distributed to commercial fishers that may incidentally harvest in occupied wetlands in Long Point Bay.

There are a number of recovery activities that still remain to be implemented and/or may take longer to be completed. For example, targeted surveys have not been conducted at Turkey Point, Tremblay Beach and the Bay of Quinte. With regard to research, there are a number of measures that need to be implemented including: the response of Spotted Gar to wetland management practices (Common Reed control); the effects of climate change on coastal habitats occupied by Spotted Gar; potential interactions between Spotted Gar and Longnose Gar where they coexist; and, a number of coordination and management measures.

References

Alexander, K. 2012. *Phragmites australis* in coastal environments. Prepared by the Lake Huron Centre for Coastal Conservation. 57 p + Appendix.

Boothroyd, M., N.E. Mandrak, M. Fox, and C. Wilson. 2016. Environmental DNA (eDNA) detection and habitat occupancy of threatened Spotted Gar (*Lepisosteus oculatus*). Aquatic Conservation: Marine and Freshwater Ecosystems 26(6): 1107-1119.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2005. COSEWIC assessment and update status report on the Spotted Gar *Lepisosteus oculatus* in Canada. Committee on the Status of Endangered Wildlife in Canada: Ottawa. vi + 17 p.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2015. COSEWIC assessment and status report on the Spotted Gar *Lepisosteus oculatus* in Canada. Committee on the Status of Endangered Wildlife in Canada: Ottawa. xii + 40 p.

DFO. 2010. Recovery potential assessment of Spotted Gar (*Lepisosteus oculatus*) in Canada. DFO Canadian Science Advisory Secretariat Science Advisory Report 2010/047.

EERT (Essex-Erie Recovery Team). 2008. Recovery strategy for the fishes at risk of the Essex-Erie region: an ecosystem approach. July 2008. Draft. 110 p.

Glass, W.R. and N.E. Mandrak. *In review*. First evidence of spawning site fidelity in Spotted Gar (*Lepisosteus oculatus*). Submitted to Transactions of the American Fisheries Society.

Glass, W.R., L.D. Corkum, and N.E. Mandrak. 2012. Spring and summer distribution and habitat use by adult Threatened Spotted Gar in Rondeau Bay, Ontario, using radiotelemetry. Transactions of the American Fisheries Society 141: 1026-1035.

Glass, W.R. and N.E. Mandrak. 2014. Distribution of Spotted Gar (*Lepisosteus oculatus*) adults and juveniles in the Rondeau Bay, Long Point Bay and Hamilton Harbour watersheds. Canadian Manuscript Report of Fisheries and Aquatic Sciences 3048. 21 p.

Glass, W.R., R.P. Water, D.D. Heath, N.E. Mandrak, and L.D. Corkum. 2015. Genetic structure and diversity of Spotted Gar (*Lepisosteus oculatus*) at its northern range edge: implications for conservation. Conservation Genetics 16: 889-899.

Gray, S.M., L.J. Chapman, and N.E. Mandrak. 2012. Turbidity reduces hatching success in Threatened Spotted Gar (*Lepisosteus oculatus*). Environmental Biological Fisheries 94: 689-694.

Hoving, C.L., Y.M. Lee, P.J. Badra, and B.J. Klatt. 2013. Changing climate, changing wildlife. A vulnerability assessment of 400 species of greatest conservation need and game species in Michigan. Michigan Department of Natural Resources, Wildlife Division Report No. 3564.

Mortsch, L., J. Ingram, A. Hebb, and S. Doka (eds.). 2006. Great Lakes coastal wetland communities: vulnerability to climate change and response to adaptation strategies. Final report submitted to the Climate Change Impacts and Adaptation Program, Natural Resources Canada.

Environment Canada and the Department of Fisheries and Oceans, Toronto, Ontario. 251 p. + appendices.

Staton, S.K., A.L. Boyko, S.E. Dunn, and M. Burridge. 2012. Recovery strategy for the Spotted Gar (*Lepisosteus oculatus*) in Canada. *Species at Risk Act* Recovery Strategy Series. Fisheries and Oceans Canada. Ottawa. vii + 57 p.