

Report on the Progress of Recovery Strategy Implementation for the Pugnose Shiner (*Notropis anogenus*) in Canada for the Period 2012 to 2017

Pugnose Shiner



2022

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Preface

The federal, provincial, and territorial government signatories under the [Accord for the Protection of Species at Risk \(1996\)](#) agreed to establish complementary legislation and programs that provide for the protection of species at risk throughout Canada. Under 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 final 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 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 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 (PCA) are the competent minister(s) under SARA for the Pugnose Shiner 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 (DFO) and, PCA, 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 Pugnose Shiner for the benefit of the species and Canadian society as a whole.

Acknowledgments

This progress report was prepared by Fisheries and Oceans Canada. To the extent possible, this progress report has been prepared with inputs from PCA, the Ontario Ministry of Natural Resources and Forestry, the Canadian Wildlife Service as well as conservation authorities and academic institutions. Fisheries and Oceans Canada would also like to express its appreciations to all individuals and organizations who have contributed to the recovery of the Pugnose Shiner.

Executive summary

The Pugnose Shiner was listed as endangered under the *Species at Risk Act* (SARA) in 2003 and was reclassified as threatened in 2019. The “Recovery Strategy for the Pugnose Shiner (*Notropis anogenus*) in Canada” was finalized and published on the Species at Risk Public Registry in 2012.

The main threats identified for the Pugnose Shiner include habitat loss and degradation resulting from poor agricultural practices, leading to siltation and turbidity, increases in lakeshore development, and the removal of aquatic vegetation, as well as human-induced changes in water quality/quantity.

The population and distribution objectives for the Pugnose Shiner are to ensure the persistence of self-sustaining population(s) at the 12 extant locations (Teeswater River, Old Ausable Channel, Mouth Lake, Lake St. Clair and tributaries, St. Clair Unit of the St. Clair National Wildlife Area, Canard River, Long Point Bay/Big Creek, Wellers Bay, West Lake, East Lake, Waupoos Bay, and the St. Lawrence River [between Eastview and Mallorytown Landing, including the Thousand Islands National Park]) and restore self-sustaining population(s) in Rondeau Bay, Point Pelee National Park, and the Gananoque River, where feasible.

During the time period reported by this progress report, substantial progress has been made with regard to the implementation of survey and monitoring. For example, survey and monitoring projects, including both targeted and multi-species sampling, have been conducted throughout much of the species’ known distribution, as well as novel areas where the Pugnose Shiner was suspected to occur, leading to its detection at several new locations. These new locations include: the St. Clair River; West Otter Creek; the lower section of the Sydenham River; the south shore of Lake St. Clair; the inlet to the Detroit River; the Trent River; and, a number of locations in the St. Lawrence River. Furthermore, significant progress has been made in addressing research measures described in the recovery strategy. These projects include: the assessment of gear types and sampling approaches, which represents a step toward the development of a standardized sampling protocol; an investigation of the impacts of elevated turbidity levels on the behaviour and swimming performance of the Pugnose Shiner; the initiation of experiments that will explore the response of this species, in terms of metabolic rate and swimming performance, to elevated temperature regimes; threat assessment research that pertains to dissolved oxygen levels and winter kill events in the Old Ausable Channel, as well as the realized and/or projected impacts of invasive species such as the Common Reed and the Grass Carp; and, lastly, research that has been initiated that examines the feasibility of translocations or repatriations as a recovery tool.

Moving forward, it is important to fill remaining knowledge gaps and address measures that have not been completed, such as: characterizing the habitat needs of each life stage of Pugnose Shiner; finalizing a sampling protocol and monitoring program; and, the development of population-habitat supply models for each life stage in each location. Similarly, there are a number of locations where further targeted sampling should be conducted, including: the majority of locations where the species is extant; historical locations (Point Pelee National Park and Rondeau Bay); new locations where the species has recently been detected; and, suspected locations (for example, Lake St. Clair tributaries; locations within eastern Lake Ontario; the upper St. Lawrence River; and, the Gananoque River). Furthermore, threat management/mitigation measures should be conducted where feasible to reduce factors leading to the decline of Pugnose Shiner populations. Lastly, the discovery of the species within a

number of new locations also suggests that the population and distribution objectives for this species should be reevaluated to reflect new information that has been acquired.

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1. Introduction

The “Report on the Progress of Recovery Strategy Implementation for the Pugnose Shiner (*Notropis anogenus*) in Canada for the Period 2012 to 2017¹” (progress report) outlines the progress made towards meeting the objectives listed in the “Recovery Strategy for the Pugnose Shiner (*Notropis anogenus*) in Canada” (recovery strategy) 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 include the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports ([COSEWIC 2002](#); [COSEWIC 2013](#)), a recovery potential assessment ([DFO 2010](#)), and the recovery strategy ([DFO 2012](#)).

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 Pugnose Shiner (*Notropis anogenus*) in Canada” (DFO 2012). 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 the Pugnose Shiner 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 Pugnose Shiner in Canada. The recovery strategy is consistent with the information provided in the COSEWIC status report ([COSEWIC 2002](#)). This information has also been included in section 1.1 of the recovery strategy. The listing of the species under SARA and the development of the recovery strategy were further informed by the “Recovery potential assessment of Pugnose Shiner (*Notropis anogenus*) in Canada” ([DFO 2010](#)).

Assessment summary: November 2002

Common name: Pugnose Shiner

Scientific name: *Notropis anogenus*

Status: Endangered

Reason for designation: The Pugnose Shiner has a limited, fragmented Canadian distribution, being found only in Ontario where it is subject to declining habitat quality. The isolated nature of its preferred habitat may prevent connectivity of fragmented populations and may prevent gene flow between existing populations and inhibit re-colonization of other suitable habitats.

Occurrence: Ontario

Status history: Designated Special Concern in April 1985. Status re-examined and uplisted to Endangered in November 2002. Last assessment based on an update status report.

¹ This document primarily represents the 2012 to 2017 time period; however, any related progress that occurred in 2011 and 2012 is also reported.

In 2013, COSEWIC re-assessed the Pugnose Shiner as threatened ([COSEWIC 2013](#)); subsequently, the SARA status of the Pugnose Shiner was changed to threatened in 2019.

Assessment summary: May 2013

Common name: Pugnose Shiner

Scientific name: *Notropis anogenus*

Status: Threatened

Reason for designation: The species has a small area of occupancy and consists of numerous small populations, many of which may not be viable. At least two populations have been extirpated. Habitat degradation and loss continues to threaten populations, particularly in the western part of their distribution in the Lake Huron, Lake St. Clair and Lake Erie watersheds.

Occurrence: Ontario

Status history: Designated Special Concern in April 1985. Status re-examined and designated Endangered in November 2002. Status re-examined and designated Threatened in May 2013.

2.2 Distribution

Since 2011, the Pugnose Shiner has been detected in several new locations and reconfirmed in locations where the species was known to be extant throughout its Canadian range (figures 1 and 2).

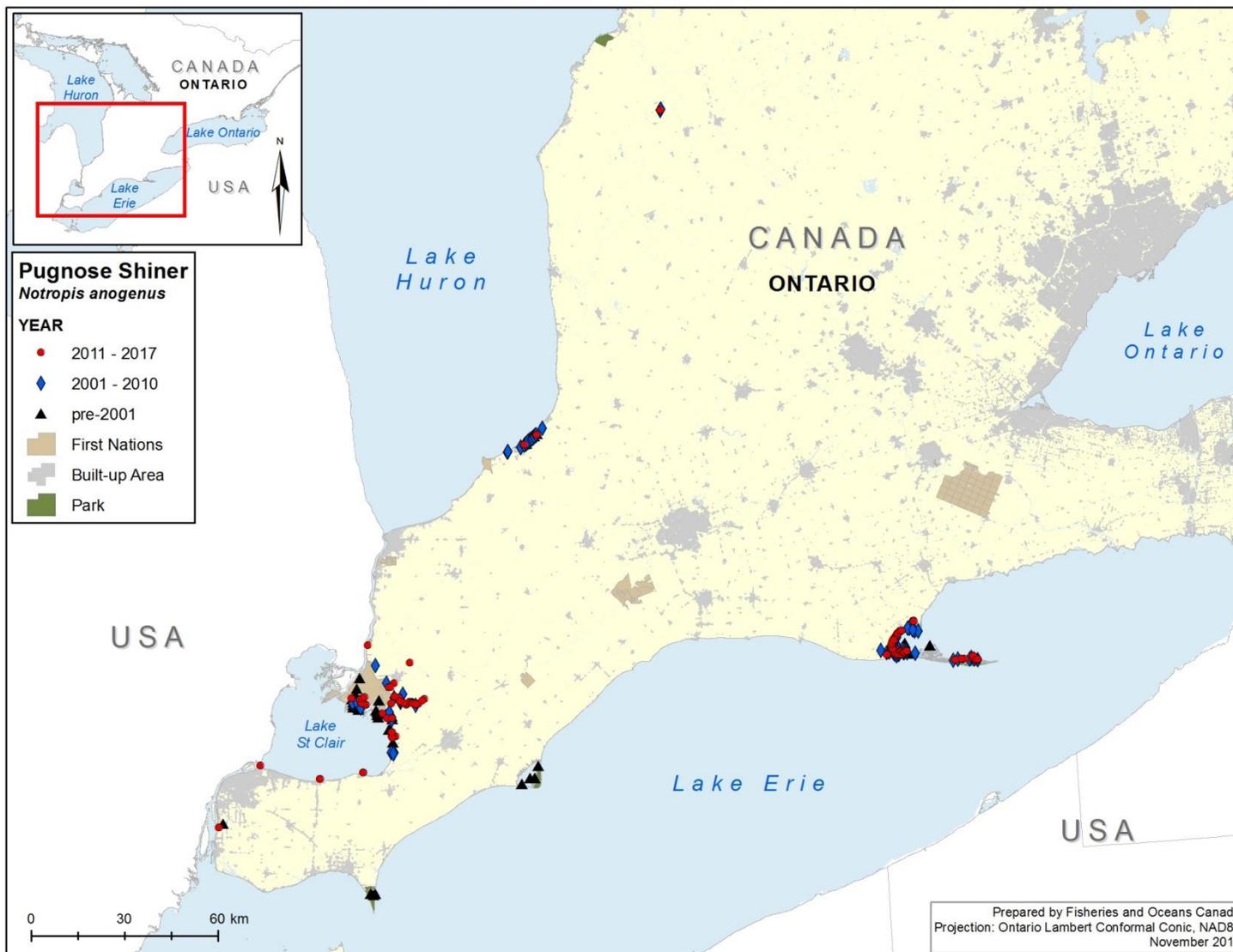


Figure 1. Historical distribution and recent detections of Pugnose Shiner in southwestern Ontario.

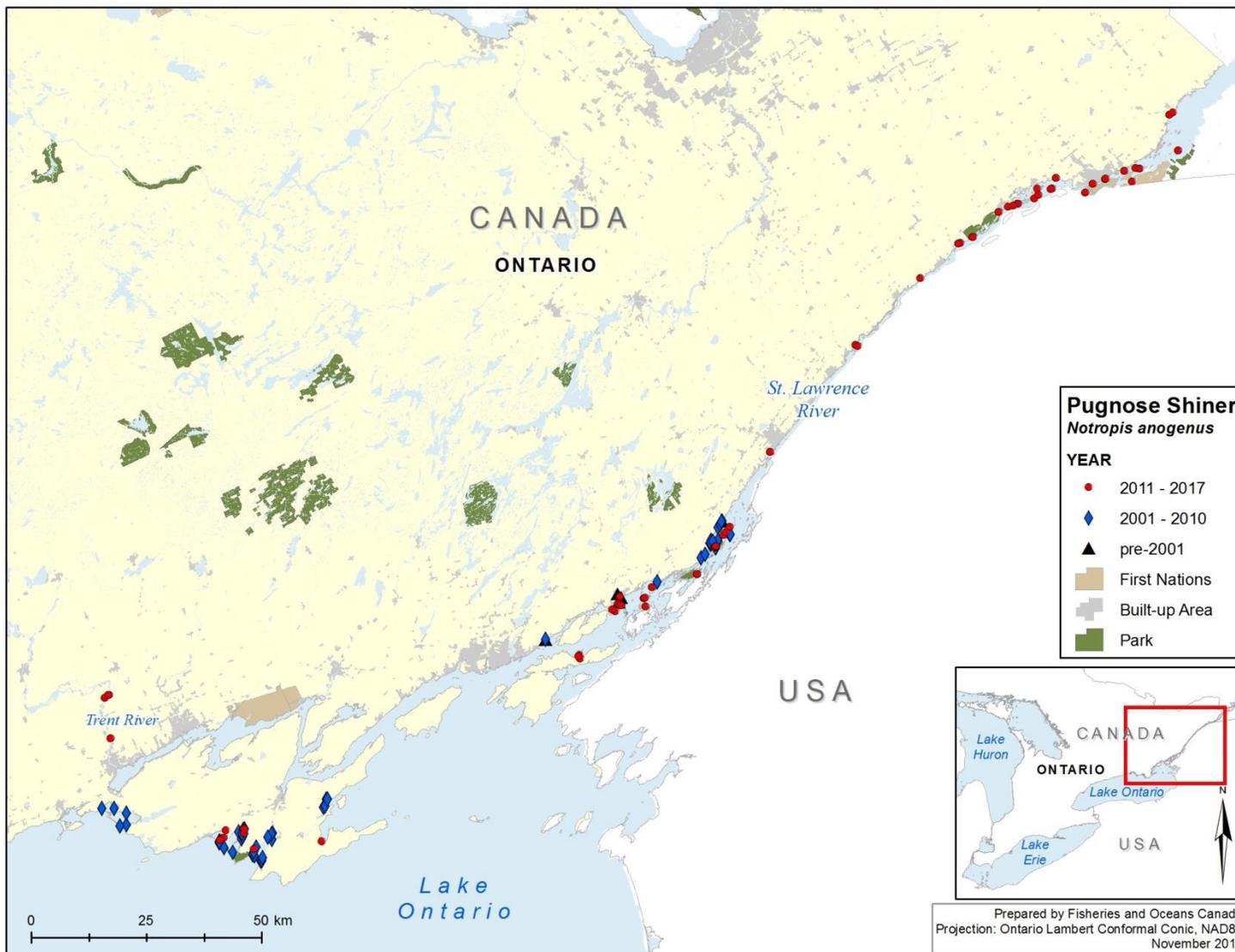


Figure 2. Historical distribution and recent detections of Pugnose Shiner in Lake Ontario and the Upper St. Lawrence River.

2.3 Threats to the species and its critical habitat

Section 1.5 of the recovery strategy provides information on threats to the survival and recovery of the Pugnose Shiner.

Population-level threats for the Pugnose Shiner, ranked by priority were initially identified in the recovery potential assessment (RPA) ([DFO 2010](#)); however, since that publication, the threats table was updated in the recovery strategy to include threats in Mouth Lake, where the species was discovered later that year. Since the publication of the recovery strategy and the RPA, research has been conducted or is underway that further investigates the potential impacts of: invasive species such as the Common Reed (*Phragmites australis australis*) and Asian carps, specifically the Grass Carp (*Ctenopharyngodon idella*); water quality issues that directly or indirectly affect the Pugnose Shiner including turbidity, higher water temperatures, reduced dissolved oxygen, as well as unnaturally/artificially high levels of nitrate and ammonia; and, anthropogenic activities, specifically drain maintenance.

2.4 Recovery

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

Recovery goal:

The long-term recovery goal (over the next 20 years) for the Pugnose Shiner is to maintain self-sustaining populations at existing locations and restore self-sustaining populations to historical locations, where feasible.

Population and distribution objective:

The population and distribution objective for the Pugnose Shiner is to ensure the persistence of self-sustaining population(s) at the 12 extant locations (Teeswater River, Old Ausable Channel [OAC], Mouth Lake, Lake St. Clair and tributaries, St. Clair Unit of the St. Clair National Wildlife Area [NWA], Canard River, Long Point Bay/Big Creek, Wellers Bay, West Lake, East Lake, Waupoos Bay, and the St. Lawrence River [between Eastview and Mallorytown Landing, including the Thousand Islands National Park]) and restore self-sustaining population(s) in Rondeau Bay, Point Pelee National Park, and the Gananoque River, where feasible.

Section 2.6 of the recovery strategy includes the following performance indicators to define and measure progress toward achieving the recovery objectives. These indicators are outlined in table 1.

Table 1. Recovery objectives and corresponding performance indicators for the Pugnose Shiner found in the recovery strategy.

Recovery objective	Performance indicator
i. Refine population and distribution objectives	<ul style="list-style-type: none"> Population monitoring protocol finalized Surveys of all extant, historical, and new and suspected locations completed Monitoring of at least two populations undertaken
ii. Refine and protect critical habitat	<ul style="list-style-type: none"> Completion of activities outlined in the schedule of studies (section 2.7.5 schedule of studies to identify critical habitat) for the complete determination of critical habitat within the proposed timelines
iii. Determine long-term population and habitat trends	<ul style="list-style-type: none"> Long-term population and habitat monitoring program established and baseline data collected for all populations
iv. Evaluate and minimize threats to the species and its habitat	<ul style="list-style-type: none"> Research conducted to evaluate changes in habitat conditions at extirpated and extant locations Quantification of best management practices (BMPs) (for example, number of nutrient management plans [NMPs]) implemented to address threats Habitat conservation tools to maintain enhance and restore habitat identified Communication strategy developed and implemented Collaboration with municipal planning committees to prevent development of land adjacent to established Pugnose Shiner habitat at 50% of locations Municipal waste- and storm-water facilities informed of impacts of facilities on Pugnose Shiner in areas where studies suggest impacts
v. Investigate the feasibility of population supplementation or repatriation for populations that may be extirpated or reduced	<ul style="list-style-type: none"> Research initiated into efficacy of repatriations for the Pugnose Shiner
vi. Enhance efficiency of recovery efforts through coordination with aquatic and terrestrial ecosystem recovery teams and other relevant or complementary groups/initiatives	<ul style="list-style-type: none"> Collaboration with all ecosystem recovery teams and other stakeholders
vii. Improve overall awareness of the Pugnose Shiner and the role of healthy aquatic ecosystems, and their importance to humans	<ul style="list-style-type: none"> Outreach programs developed and initiated to target recreation and park areas Communication strategy completed

3. Progress towards recovery

The recovery strategy (DFO 2012) divides the recovery effort into three broad strategies: 1) research and monitoring; 2) management and coordination; and, 3) stewardship, outreach and communication. 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

Tables 2 to 4 provide information on the implementation of activities undertaken to address the measures associated with each broad strategy identified in the recovery planning tables (tables 5 to 7) of the recovery strategy (DFO 2012). Each activity has been assigned one of four statuses:

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

Table 2. Status of activities undertaken from 2012 to 2017 to address the measures identified in table 5 of the recovery strategy (DFO 2012) under the broad strategy of research and monitoring for the Pugnose Shiner.

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
<p>1-1. Background surveys and monitoring (extant locations): Conduct targeted surveys in areas where the Pugnose Shiner is known to persist: un-sampled regions of the Old Ausable Channel (OAC), Long Point Bay, St. Lawrence River, Lake St. Clair, and Canard River.</p>	Urgent	In progress	<p>OAC</p> <p>Fisheries and Oceans Canada (DFO) conducted non-targeted sampling in the OAC in 2012 and detected five individuals. In addition, the Ausable Bayfield Conservation Authority (ABCA) detected one Pugnose Shiner in 2015 within the Pinery Provincial Park section of the OAC.</p> <p>Long Point Bay</p> <p>No surveys specifically targeting the Pugnose Shiner have been conducted at this time. Non-target surveys have been conducted within Long Point Bay from 2012 to 2017 and have resulted in 2,480</p>	i, ii	<p>DFO, ABCA, OMNRF, PCA, St. Lawrence River Institute, University of Windsor, University of Toronto</p>

² Lead participant(s) is/are listed on top and in bold; other participants are listed alphabetically. Not all activities have specific participants identified.

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<p>detections of Pugnose Shiner including 378 within Long Point National Wildlife Area (NWA) in 2016. Furthermore, external sampling conducted by the Ontario Ministry of Natural Resources and Forestry (OMNRF) in 2014, 2015, 2016, and 2017 detected 2, 67, 74 and 69 individuals, respectively. In addition, sampling conducted by researchers from the University of Toronto detected 20 Pugnose Shiner in 2016.</p> <p>St. Lawrence River</p> <p>Targeted surveys conducted by DFO for the Pugnose Shiner in 2011 were successful in detecting the species (66 individuals captured). In addition, from 2013 to 2017, 624 Pugnose Shiner were detected in the St. Lawrence River by external agencies including Parks Canada Agency (PCA) and the St. Lawrence River Institute.</p> <p>Lake St. Clair (general)</p> <p>No targeted surveys for the Pugnose Shiner have been implemented in Lake St. Clair since the publication of the recovery strategy. Non-targeted sampling has been conducted by DFO within the lake in 2012 and 2013 leading to the capture of nine individuals. Furthermore, sampling</p>		

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<p>conducted by DFO in partnership with the University of Toronto, within the coastal wetlands of Goose Lake and Snook’s Lake in 2016, led to the capture of 550 Pugnose Shiner. They also sampled Bush, Club and Walpole marshes but did not capture the Pugnose Shiner at these locations. Additional sampling has been conducted from 2011 to 2017 by external agencies including the OMNRF and the University of Windsor, which has led to the detection of a further 172 Pugnose Shiner.</p> <p>St. Clair National Wildlife Area</p> <p>No targeted sampling was conducted in the St. Clair NWA; however, DFO did undertake non-target sampling in 2016 in conjunction with the University of Toronto, which did not detect the Pugnose Shiner.</p> <p>Canard River</p> <p>No targeted sampling for the Pugnose Shiner has been conducted in the Canard River. Non-targeted sampling was conducted by DFO in this watershed from 2013 to 2017, which did not detect the species. Furthermore sampling has also been conducted by the OMNRF in 2012 and University of Toronto in 2017; however, no Pugnose Shiner were detected.</p>		

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
<p>1-2. Background surveys and monitoring (new and suspected locations): Conduct targeted surveys at new locations (where the species has only recently been discovered) and suspected locations: interior marshes of Turkey Point (Long Point Bay), Teeswater River (Saugeen watershed), Wellers Bay, West Lake, East Lake, Waupoos Bay, Big Creek (Haldimand, Norfolk County), south shore of Lake St. Clair, Lake St. Clair tributaries, and oxbow lakes near the OAC.</p>	<p>Urgent</p>	<p>In progress</p>	<p>Oxbow lakes near the OAC</p> <p>Mouth Lake: non-targeted surveys were conducted in 2012. The Pugnose Shiner was not detected.</p> <p>L Lake: non-targeted surveys were conducted in 2012. The Pugnose Shiner was not detected.</p> <p>Long Point Bay (Turkey Point)</p> <p>No targeted sampling has been conducted by DFO in Turkey Point; however, non-targeted sampling conducted by Long Point Region Conservation Authority (LPRCA) in 2011 detected two Pugnose Shiner.</p> <p>Big Creek (Haldimand-Norfolk County)</p> <p>DFO conducted non-targeted sampling of Big Creek NWA in 2016 but the Pugnose Shiner was not detected.</p> <p>Teeswater River (Saugeen watershed)</p> <p>DFO conducted targeted sampling in the Teeswater River in 2013, which resulted in the detection of one Pugnose Shiner.</p> <p>Trent River</p>	<p>i, ii</p>	<p>DFO, LPRCA, OMNRF, CLOCA</p>

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<p>The Pugnose Shiner was detected in the Trent River by the OMNRF in 2011 and 2012. A total of seven individuals were captured as a result of these sampling surveys.</p> <p>Bay of Quinte area</p> <p>No targeted sampling has been conducted by DFO in the Bay of Quinte area including Wellers Bay, East Lake, West Lake, or Waupoos Bay since 2010; however, targeted sampling has been conducted in:</p> <ul style="list-style-type: none"> • Consecon Lake: 2011, no detections • Lake on the Mountain: 2011, no detections • Presqu'ile Bay: 2011, no detections • North Beach: 2011, no detections <p>Other non-targeted surveys have been conducted by DFO as well as external agencies, which have led to detections in:</p> <ul style="list-style-type: none"> • South Bay: a non-targeted survey was conducted in 2014, leading to the detection of one Pugnose Shiner • East Lake: non-targeted 2013 surveys conducted by Central Lake Ontario Conservation Authority (CLOCA) detected nine individuals 		

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<ul style="list-style-type: none"> West Lake: OMNRF conducted non-targeted surveys in 2013, which detected 39 individuals. DFO conducted non-targeted surveys in 2015, which detected nine individuals <p>St. Clair River</p> <p>Non-targeted surveys were conducted in the St. Clair River from 2012 to 2014 and led to the detection of two Pugnose Shiner in 2012, the first detection of this species in this waterbody.</p> <p>Lake St. Clair (south shore)</p> <p>Targeted sampling for the Pugnose Shiner has not been implemented by DFO along the southern shore of Lake St. Clair; however, this area has been sampled by the OMNRF in 2011, leading to the detection of three Pugnose Shiner at two locations (near the mouth of the Belle River and adjacent to Stoney Point).</p> <p>Lake St. Clair (tributaries)</p> <p>Targeted sampling for the Pugnose Shiner has not been conducted in Lake St. Clair tributaries since 2010; however, non-targeted sampling has been conducted in a number of potential locations including:</p>		

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<ul style="list-style-type: none"> • Sydenham River: a total of nine Pugnose Shiner were caught where the stream meets the Johnston Channel during surveys conducted in 2015 to 2017, which suggests further sampling for this species should be conducted upstream • Otter Creek: non-targeted surveys conducted in 2013, no detections • East Otter Creek: non-targeted surveys conducted in 2013, no detections • West Otter Creek: non-targeted surveys conducted in 2013 led to the detection of one Pugnose Shiner • Little Bear Creek: non-targeted surveys conducted in 2013 to 2015 led to 236 Pugnose Shiner detected • Big Creek (tributary of Little Bear Creek): non-targeted surveys conducted in 2013, no detections • Maxwell Creek (tributary of Little Bear Creek): non-targeted surveys conducted in 2013, no detections; • Ruscom River: south shore tributary, non-targeted surveys conducted in 2013 to 2016, no detections • Pike Creek, south shore tributary: non-targeted surveys conducted in 2016, no detections 		

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<p>Detroit River</p> <p>One Pugnose Shiner was detected where Lake St. Clair outlets at the Detroit River during a DFO trawling survey in 2011; however, other non-targeted surveys conducted in 2011, and from 2013 to 2017, did not detect the species. Considering the Pugnose Shiner is also present in the Canard River, the species may occur in other locations within the Detroit River.</p>		
<p>1-3. Background surveys and monitoring (historical locations): Conduct targeted surveys at historical locations: Point Pelee National Park, Rondeau Bay, and the Gananoque River.</p>	<p>Urgent</p>	<p>Not started</p>	<p>Point Pelee National Park</p> <p>No targeted surveys have been conducted for the Pugnose Shiner. Some non-targeted sampling (Federal Contaminated Sites Action Plan and Asian carps monitoring) has occurred within this location; however, they did not detect the Pugnose Shiner. The species is likely extirpated from this location.</p> <p>Rondeau Bay</p> <p>No targeted sampling has occurred within this location; however, non-targeted surveys for other species were conducted from 2013 to 2017 using appropriate gear types: the Pugnose Shiner was not detected. The species is likely extirpated from this location.</p>	<p>i, ii</p>	<p>DFO</p>

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<p>Gananoque River</p> <p>No targeted sampling has been implemented at this location. Non-targeted sampling was conducted in 2013 and 2014; however, the Pugnose Shiner was not detected. Sampling that specifically targets the Pugnose Shiner is needed as the species may exist further upstream in this watershed, including Gananoque Lake.</p>		
<p>1-4. Monitoring (populations and habitat): Develop and implement standardized index population and habitat monitoring program with specific sampling and training protocol.</p>	<p>Urgent</p>	<p>In progress</p>	<p>Progress has been made in terms of investigating the best protocol to employ when searching for the Pugnose Shiner including optimal gear type and site selection. For example, research conducted by Dextrase et al. (2014) has identified that the Pugnose Shiner has the highest probability of being detected using active sampling approaches including electrofishing and seine netting. Furthermore, research conducted by McKenna et al. (2013) demonstrated that smaller mesh sizes (1/8”) lead to a greater detection of the Pugnose Shiner when using seine nets.</p> <p>Additional research, that commenced in 2018, aims to evaluate the co-occurrence of Pugnose Shiner with other members of the fish community, which may inform predictions of occupancy for this species (A. Drake, DFO, pers. comm. 2017).</p>	<p>i, ii, iii</p>	<p>DFO, OMNRF, U.S. Geological Survey (USGS), PCA</p>

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			DFO has not established a sampling program that would monitor changes in the abundance and population trajectory of the Pugnose Shiner throughout its Canadian range; however, PCA has conducted population monitoring within the Thousand Islands National Park.		
<p>1-5. Research habitat requirements: Determine seasonal habitat needs of all life stages of the Pugnose Shiner.</p>	Urgent	Not started	<p>No research has been conducted that further characterizes the seasonal habitat requirements of all life stages of the Pugnose Shiner; although the general habitat needs of the species were fairly evident from prior research at the time that the recovery strategy was published.</p> <p>Sampling of larval fishes was conducted in the Sydenham River in 2017, which may contain specimens of the Pugnose Shiner allowing for habitat associations to be made. However, the Pugnose Shiner has only been detected at the mouth of this river; therefore, it is unlikely that this sampling will yield any results for this species. Future sampling of this nature may be extended to other locations and habitat types where the Pugnose Shiner is present, depending on the success of this initial project as a means of capturing larval species at risk.</p>	ii, iii	<p>DFO, University of Toronto, PCA, USGS, and New York State Department of Environmental Conservation (NYSDEC)</p>
<p>1-6. Research water quality parameters: Determine the</p>	Urgent	In progress	Gray et al. (2014) examined the response of the Pugnose Shiner to turbidity in an experimental setting and observed that	ii, iv, v	<p>DFO, McGill University, Wildlife</p>

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
<p>physiological tolerance thresholds of the Pugnose Shiner with respect to various water quality parameters (for example, dissolved oxygen, nutrients) and check against existing standards.</p>			<p>even low levels of turbidity (<10 Nephelometric Turbidity Units [NTU]) altered the schooling behaviour of the Pugnose Shiner and led to reduced swimming speed. Furthermore, the results of this study indicate that turbidity levels should not exceed 7.0 NTU for the Pugnose Shiner. This finding should be incorporated into an updated table of the functions, features, and attributes of critical habitat for the Pugnose Shiner if/when the recovery strategy is updated.</p> <p>Research that began in 2017 at the Université du Québec à Trois-Rivières aims to explore variation in the impact of turbidity on the site occupancy of the Pugnose Shiner among different habitats throughout the species' Canadian range, which may result as a consequence of differences in habitat composition, as well as geographic variation in the traits of the species itself (N. Mandrak, University of Toronto, pers. comm., 2018). This will be achieved by modelling 15 years of historical Pugnose Shiner occupancy patterns and water chemistry data, which has been collected by DFO, and combining them with information on this species' vital rates such as growth, mortality, fecundity, and mobility, which has been acquired through meta-analysis of academic literature.</p>		<p>Conservation Society (Bronx, New York), Université du Québec à Trois-Rivières</p>

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<p>Experimental research is underway to investigate the acute and long-term impacts of elevated water temperatures on the aerobic performance (standard and maximum metabolic rates, maximum swim speed, metabolic range, and upper temperature limit) of the Pugnose Shiner (L. Chapman, McGill University, pers. comm., 2017). Two experiments have been initiated using six temperature regimes, which represent conditions observed within habitats where the Pugnose Shiner occurs. The first will measure the aforementioned responses of mature individuals to these varying temperature regimes, while the second will explore the effects of the same temperatures and resulting responses on the development of juvenile specimens.</p>		
<p>1-7. Research wastewater treatment plants, storm-water management facilities and septic systems: Identify potential areas of operation that might be contributing to siltation and nutrient loading downstream. Suggest improvements that may aid in reducing nutrient and suspended solid inputs from urban areas.</p>	<p>Urgent</p>	<p>Not started</p>	<p>No research has been conducted to address this measure. Nutrient impacts within the OAC (a more rural setting) are discussed in approaches 1 to 8. This measure is being re-evaluated and will likely be broken into several measures in an amended recovery strategy including:</p> <ol style="list-style-type: none"> engage experts and representatives from other jurisdictions such as Environment and Climate Change Canada (ECCC) and Ontario’s Ministry of the Environment, Conservation, and Parks (MECP) to address measures pertaining to 	<p>iv</p>	

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			water quality parameters and water treatment related infrastructure 2. determine if and where wastewater and/or storm management facilities exist that might threaten Pugnose Shiner populations 3. monitor nutrient levels and potentially other parameters (for example, pharmaceutical pollutants) in Pugnose Shiner occupied waters exposed to wastewater treatment plant emissions 4. conduct experiments exploring the impacts of elevated nutrient levels, as well as other pertinent pollutants emitted from treatment plants, on Pugnose Shiner		
<p>1-8a. Threat evaluation (changes in habitat conditions): Compare habitats of extant populations with formerly occupied sites (for example, Point Pelee National Park, Rondeau Bay). Investigate and evaluate the significance of threat factors that may be impacting extant populations. Take steps to mitigate immediate threats identified.</p>	<p>Urgent</p>	<p>In progress</p>	<p>No comparison of threats between historical sites and extant sites ; however, threat factors have been evaluated at locations where the Pugnose Shiner is present.</p> <p>One major threat that is likely impacting Pugnose Shiner abundance in the OAC is winter kill events caused by reduced dissolved oxygen concentrations. These events culminate when the effects of altered water flow, nutrient loading, siltation and turbidity, and the seasonal die off of dense colonies of algae and invasive macrophyte species, such as Eurasian Water-milfoil (<i>Myriophyllum spicatum</i>), are</p>	<p>iv</p>	<p>DFO, ABCA, Western University, University of Waterloo</p>

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<p>exacerbated by prolonged snow and ice cover leading to anoxic conditions. Dramatic winterkill events have led to the observed mortality of a number of species; however, shiners were not identified to the species level during these events precluding an inventory of affected Pugnose Shiner. Monitoring has been conducted to evaluate this threat since 2008 (Jean et al. 2015).</p> <p>Furthermore, research has been conducted that investigates nitrate sources in the OAC (Russell 2015), phosphorous and nitrate within groundwater originating from adjacent subdivisions (Robertson and Baer 2016), as well as the presence of aquatic macrophytes, including the invasive Eurasian Water-milfoil, in the OAC (Wiklund 2013).</p> <p>A habitat modelling project was conducted within a section of Little Bear Creek, where the Pugnose Shiner has been documented to be in high abundance in relation to the presence of aquatic macrophytes (Wiklund 2015), to assess the potential impacts of a proposed drain cleanout on this species (Montgomery et al. 2017). The results of this research indicate that the connectivity of habitat patches would be significantly impacted by the cleanout, and the area of remaining habitat suitable for the Pugnose</p>		

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			Shiner would fall below the minimum area required to support a viable population. This modelling project represents a step forward in the evaluation of drain maintenance activities as a threat factor that may impact extant Pugnose Shiner populations at specific locations.		
<p>1-8b. Threat mitigation: Investigate compensation measures to offset habitat loss</p>	N/A	Completed	<p>Modelling research was conducted using a Pugnose Shiner metapopulation in the upper St. Lawrence River to evaluate potential compensation approaches to offset habitat loss (McCusker et al. 2017). The results of this study indicate that the creation of habitat to offset habitat loss was the best method of compensation, which may or may not be applicable depending on the location in question. Secondly, they found that increasing vital rates, which would include the removal of predators and/or competitors to inflate recruitment, was the second most promising approach. In reality, this approach may prove controversial and would likely be costly and difficult to implement. Lastly, these authors note that increasing habitat connectivity and abundance showed limited effectiveness, which might suggest that the success of supplementation/translocation programs for this species would depend on niche availability, and consequently may not be a viable recovery option within locations where habitat is limited.</p>	iv	<p>University of Toronto, DFO</p>

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<p>Similarly, Montgomery et al. (2017) explored comparable options for offsetting the impacts of a drain maintenance project in Little Bear Creek. They found that increasing vital rates would be an unsuitable measure considering the potential predators and competitors were native species (controversial to remove in accordance with the <i>Fisheries Act</i>) that are in high abundance (logistically impractical to remove). Furthermore, they found that increasing connectivity between habitat patches would not be the most effective approach given the low dispersal potential of species at risk including the Pugnose Shiner. However, these authors suggest that increasing habitat availability, which consequently raises the carrying capacity, might be a better offsetting approach for maintaining or increasing the abundance of the Pugnose Shiner. In addition, they suggest that supplemental stocking may be another effective approach to compensate for losses in recruitment where habitat regeneration is slower than the generation time of this species.</p>		
<p>1-9. Threat evaluation (changes in trophic dynamics; invasive species): Use population and time comparisons of fish community data to</p>	Necessary	In progress	<p>Potential impacts of centrarchids: OAC fish community data from 1982, 1997, and 2004, was collected and examined to assess the potential effects of centrarchids and invasive species on the abundance of the Pugnose Shiner (A. Drake, DFO, pers.</p>	iv	DFO, OMNRF, University of Toronto, University of Notre Dame, McGill University,

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
<p>resolve uncertainty about negative effects of centrarchids on cyprinids, generally, and Pugnose Shiner, specifically. Evaluate the impacts of invasive species (including Common Carp, Eurasian Water-milfoil and Common Reed) on Pugnose Shiner and its habitat.</p>			<p>comm., 2017). Drake observed that increases in the abundance of centrarchid species, such as the Black Crappie (<i>Pomoxis nigromaculatus</i>), the Smallmouth Bass (<i>Micropterus dolomieu</i>), the Largemouth Bass (<i>M. salmoides</i>), and the Rock Bass (<i>Ambloplites rupestris</i>), appear to be correlated with declines in the abundance of the Pugnose Shiner, at least at downstream sites where centrarchids are most prolific. Furthermore, an additional project that will examine relationships of negative co-occurrence between the Pugnose Shiner and the fish community has undergone the planning stage and will commence in 2018 (A. Drake, DFO, pers. comm., 2017).</p> <p>Invasive species: The Common Reed: Research has been conducted exploring the impacts of the European Common Reed in coastal wetlands of Lake Erie where the Pugnose Shiner is present. In terms of mitigation approaches to this threat, the evaluation of habitat restoration activities for species at risk fishes within the Crown Marsh (Long Point Bay) involving the efficacy of wetland restoration (removal of the Common Reed), as a means of restoring species at risk habitat (for example, Pugnose Shiner spawning), has been conducted. Recommendations were made regarding</p>		<p>University of Alabama, University of Georgia, University of California Berkeley, USGS, ECCC</p>

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<p>the design of constructed wetlands to maximize suitability for species at risk, including the Pugnose Shiner. Guidance is provided that outlines potential threats, which can arise from these restoration activities (for example, low dissolved oxygen levels, stranding, genetic isolation) as well as design solutions that would prevent these threats from occurring (Rook et al. 2016).</p> <p>In addition, research has been conducted that investigates potential impact scenarios stemming from the combined effects of climate change and the increased expansion of the Common Reed within Long Point Bay. Although this study focused on impacts to the Warmouth (<i>Lepomis gulosus</i>), the findings are applicable for the Pugnose Shiner (McCusker 2017). A similar study was conducted within the reporting period to explore the same combined effects of climate change and the Common Reed on the Pugnose Shiner, although this document has not yet been published. The results of this modelling study indicate that the extinction risk of the Pugnose Shiner from climate change increased significantly after invasion from the Common Reed. The authors of this study conclude that uncertainty regarding the thermal tolerances of the Pugnose Shiner was a</p>		

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<p>factor that limited the predictive ability of this modelling approach, and as such should be elucidated through further experimental study of this species (A. Drake, DFO, pers. comm., 2018).</p> <p>DFO's Fish Habitat lab (Great Lakes Laboratory for Fisheries and Aquatic Sciences) began work during the reporting period in partnership with Trent University and Walpole Island First Nation within the St. Clair Delta to characterize fish community usage of native and non-native (that is, the Common Reed) emergent vegetation. The results of this study may elucidate knowledge gaps pertaining to the use of natural and invaded habitat by species at risk, including the Pugnose Shiner, which may inform on the potential impacts of the Common Reed on the life-history needs of this species (D. Reddick, DFO, pers. comm., 2018).</p> <p>Field studies that began during the reporting period are underway, in cooperation with McGill University, that investigate the potential for the Common Reed to contribute to anoxic conditions within the St. Clair NWA, with a specific focus on impacts to Pugnose Shiner found within this location (A. Drake, DFO, pers. comm., 2018).</p>		

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<p>Asian carps: A study conducted by American researchers has investigated the potential presence, colonization, and effects on aquatic biota of Asian carps, particularly the Grass Carp, within the Great Lakes (Wittmann et al. 2014). This study included:</p> <ul style="list-style-type: none"> • predictive species distribution modelling, which indicated that coastal wetlands with abundant macrophytes would be suitable for colonization within all Great Lakes with the exception of Lake Superior • meta-analyses regarding impacts on aquatic biota that indicated that Grass Carp directly reduces macrophyte abundance through its diet leading to indirect impacts on a number of fish species as well as other taxonomic groups <p>The Grass Carp has recently been detected within lakes Erie (Cudmore et al. 2016) and Ontario, including one location where the Pugnose Shiner occurs, the Bay of Quinte (DFO 2017). Furthermore, spawning Grass Carp have been confirmed within a tributary of Lake Erie in Ohio (Chapman et al. 2013; Embke et al. 2016) and a specimen capable of reproduction was detected within Jordan Harbour, a Canadian tributary of Lake Ontario (DFO 2017).</p>		

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<p>Predictive modelling of the potential effects of the Grass Carp on coastal habitats within the Great Lakes, at both the biotic and abiotic levels, suggests that this invasive species will likely have low-moderate impacts on coastal wetlands of Lake Erie where the Pugnose Shiner occurs, such as Rondeau and Long Point bays, depending on the projected density of the Grass Carp (Gertzen et al. 2016). In contrast, habitats within the upper St. Lawrence River are projected to be significantly impacted at both of the density scenarios used in the modelling (Gertzen et al. 2016). Based on this modelling, the Pugnose Shiner is predicted to experience significant impacts if colonization of the Grass Carp occurs within coastal wetlands where it is present due to the potential reduction of aquatic macrophytes, which are a critical component of its spawning, nursery and adult habitats (Gertzen et al. 2016).</p>		
<p>1-10. Water quality monitoring: Measure sediment and nutrient loads emitted from streams.</p>	<p>Necessary</p>	<p>In progress</p>	<p>Habitat monitoring has been ongoing in the OAC since 2008 as a component of the Ausable River Recovery Strategy Implementation Project. Through these monitoring surveys, water quality parameters such as phosphorus, nitrate, and un-ionized ammonia concentrations, as well as total suspended sediments, have been measured at a number of sites within</p>	<p>iv</p>	<p>ABCA, SCRCA, MECP</p>

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
			<p>the OAC. Nitrate and un-ionized ammonia concentrations did not exceed guidelines nor did levels of suspended sediment; however, phosphorus concentrations were found to exceed provincial water quality objectives (PWQO) at several sites throughout the study period (Jean et al. 2015).</p> <p>Similar habitat monitoring, including measurements of total phosphorus, has been conducted from 2012 to 2016 in the North and East Sydenham River branches, as well as Little Bear Creek, as a component of the Surface Water Monitoring Program (St. Clair Region Conservation Authority [SCRCA] 2017). The yearly average total phosphorus concentrations measured within these subwatersheds exceeded the PWQOs.</p> <p>Monitoring has also been conducted through the Provincial Water Quality Monitoring Network in a number of streams where the Pugnose Shiner is present, as well as those that are tributaries to locations where the Pugnose Shiner occurs including: Teeswater River, St. Clair River, Sydenham River, Bear Creek (North Sydenham River watershed), Canard River, Ruscom River, Big Creek (tributary to Long Point Bay), and the Trent River (MECP 2016).</p>		

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants ²
<p>1-11. Research population augmentation: Examine the feasibility of translocations and repatriations in areas of suitable habitat where the species has been extirpated. Develop a repatriation plan where appropriate (see section 2.1 Recovery feasibility for further detail).</p>	<p>Necessary</p>	<p>In progress</p>	<p>Research that investigates the feasibility of translocations and or repatriations as a means of augmenting declines in the Pugnose Shiner within Ontario waters is currently underway (T. Pitcher, University of Windsor, pers. comm., 2017). This is a multi-faceted study that aims to:</p> <ul style="list-style-type: none"> a. explore mating behaviours to inform captive rearing at later stages b. rear specimens in captivity for threat research and potential reintroductions c. conduct simulations and in-field translocations to explore potential genetic impacts of large-scale translocations <p>No repatriation plan has been developed at this stage.</p>	<p>v</p>	<p>University of Windsor, DFO</p>
<p>1-12. Monitoring invasive species: Monitor watersheds for invasive species of concern in cooperation with aquatic ecosystem recovery teams.</p>	<p>Beneficial</p>	<p>In progress</p>	<p>Monitoring for Asian carps has been conducted within Long Point Bay (2013 to 2016) and the Sydenham (2015 to 2016) and Canard rivers (2013 to 2016) by DFO; however, no Asian carps have been detected in these specific watersheds.</p> <p>Furthermore, PCA conducts monitoring for invasive species such as the Round Goby (<i>Neogobius melanostomus</i>), the Common Carp (<i>Cyprinus carpio</i>), and the Eurasian Water-milfoil in areas where the Pugnose Shiner occurs, such as the Thousand Island National Park.</p>	<p>iv</p>	<p>DFO, PCA</p>

Table 3. Status of activities undertaken from 2012 to 2017 to address the measures identified in table 6 of the recovery strategy (DFO 2012) under the broad strategy of management and coordination for the Pugnose Shiner.

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants
<p>2-1. Coordination with other recovery teams and relevant groups: Work with existing relevant ecosystem recovery teams, First Nations, and groups to share knowledge, implement recovery action plans, and to obtain incidental sightings.</p>	Urgent	In progress	In cooperation with relevant partners (for example, Essex Region Conservation Authority [ERCA]), the assessment of watershed-scale stressors to Pugnose Shiner critical habitat has been ongoing. This collaboration has also involved the implementation of habitat improvement and restoration activities within tributaries of Lake St. Clair and the Detroit River.	vi	Fisheries and Oceans Canada (DFO), ERCA
<p>2-2. Municipal planning involvement: Encourage municipal planning authorities and local First Nations to consider the recovery goal and associated objectives in Official Plans and the determination of land use designations. Support that future development does not degrade habitat of the Pugnose Shiner. Suggest improvements that may aid in reducing nutrient and suspended</p>	Urgent	In progress	DFO species at risk guidance was provided to Ontario municipalities that have aquatic (fish/mussel) species at risk within their areas to be used for Municipal Official Plan updates. Species at risk guidance was updated in 2015 and additional contact/outreach to these and all other Ontario municipalities with species at risk in their areas is ongoing. To date, the municipality of Chatham-Kent and the City of London have incorporated this guidance into their planning process.	iv, vii	DFO

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants
solid inputs from urban areas.					
<p>2-3. Evaluation of watershed-scale stressors: Address watershed-scale stressors to Pugnose Shiner populations and their habitat in cooperation with existing relevant aquatic ecosystem recovery teams.</p>	Urgent	In progress	<p>Substantial progress has been made in terms of evaluating watershed-scale stressors including:</p> <ul style="list-style-type: none"> the underlying causes of winter fish kills in the Old Ausable Channel (OAC), which include dissolved oxygen, nitrate, and phosphorous sources, and aquatic macrophyte composition the impacts of the Common Reed on species at risk in Long Point Bay 	iv, vi	<p>DFO, Ausable Bayfield Conservation Authority (ABCA), Western University, University of Waterloo, University of Toronto, Ontario Ministry of Natural Resources and Forestry (OMNRF)</p>
<p>2-4. Invasive species plan: Develop a plan that addresses potential risks, impacts, and proposed actions in response to existing invasive species and the arrival or establishment of new invasive species.</p>	Beneficial	Not started	<p>No federal plan has been developed; however, an action plan to address the potential arrival/establishment of high priority aquatic invasive species (AIS) will be developed by DFO's AIS Program. The focus of this program is to prevent the introduction of AIS, respond rapidly to the detection of new species, and manage the spread of already established AIS.</p>	iv	<p>DFO, OMNRF, OMAFRA, MECP, MTO</p>

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants
			<p>The OMNRF has developed an Invasive Species Strategic Plan (2012) in cooperation with the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), the Ministry of the Environment, Conservation and Parks (MECP), and the Ministry of Transportation (MTO). The objectives of this plan are to prevent new invasions, slow and/or reverse the spread of existing invasive species, and reduce the harmful impacts of existing invasive species (OMNRF 2012).</p> <p>Furthermore, the government of Ontario has legislated the <i>Invasive Species Act</i> (2015), which seeks to address the objectives of the aforementioned plan, primarily through prohibitions.</p>		
<p>2-5. Prohibitions (baitfishes): Evaluate the feasibility of prohibitions on the use of live baitfishes.</p>	Beneficial	Not started	<p>No progress has been made towards the completion of this measure. This measure will be re-evaluated and reworded to clarify that it is specific to the OAC. The use of baitfish is currently prohibited within the Pinery Provincial Park; however, use of</p>	iv	

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants
			baitfish is still legal within the northern portion of the OAC. In place of prohibitions, outreach materials (signs) might be used to encourage anglers not to use baitfish.		

Table 4. Status of activities undertaken from 2012 to 2017 to address the measures identified in table 7 of the recovery strategy (DFO 2012) under the broad strategy of stewardship, outreach and awareness for the Pugnose Shiner.

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants
3-1. Stewardship (promotion of habitat initiatives): Promote stewardship among landowners and First Nations abutting aquatic habitats of Pugnose Shiner, and other local landowners with potential to have direct or indirect effects on the habitat of the Pugnose Shiner.	Urgent	In progress	Fisheries and Oceans (DFO) outreach activities Since the publication of the recovery strategy, DFO has conducted outreach sessions to partner organizations about species at risk, including the Pugnose Shiner, their critical habitat, and implementation measures prescribed for their recovery. These presentations/training sessions were delivered to audiences including: Ontario Ministry of Natural Resources and Forestry (OMNRF), conservation authorities (CAs), Parks Canada Agency (PCA), and non-governmental organization staff in the Bay of Quinte area; Long Point Region	iv, vi, vii	DFO, Toronto Zoo, CCC, SCRCA, OFA

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants
			<p>Conservation Authority (LPRCA) staff in the Long Point area; Saugeen Valley Conservation Authority staff in the Saugeen River area; students at Fleming College; and, various partner agencies at the Latornell Conservation Symposium.</p> <p>External outreach activities From 2015 to 2017, through the Great Lakes Program, the Toronto Zoo conducted outreach to students, in both French and English, at both elementary and high school levels, which included information about the status and needs of the Pugnose Shiner. Furthermore, information regarding the Pugnose Shiner has been delivered through Great Lakes Program brochures.</p> <p>From 2011 to 2014, the Carolinian Canada Coalition (CCC) provided outreach materials that provide information on habitat loss and degradation, and invasive species as threats to aquatic species at risk, including the Pugnose Shiner. Furthermore, they conducted capacity building activities within areas that are applicable to</p>		

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants
			<p>species at risk in southwestern Ontario, including the Pugnose Shiner, which provide landowners and stewards with advice in terms of best management practices (BMPs) that will aid in the recovery of this species. Furthermore, the CCC provided outreach materials to First Nation groups concerning stewardship practices and ecological restoration activities. Although the Pugnose Shiner was not included in their information package, this species will benefit from the stewardship and habitat improvement activities that this project has promoted. Specifically, these outreach materials were communicated to Walpole Island First Nation, who's lands are within the distribution of the Pugnose Shiner.</p> <p>As part of an on-going watershed-based species at risk recovery program, the St. Clair Region Conservation Authority (SCRCA) has: a) delivered presentations centred on species at risk and BMPs to various groups at community events; b) maintained a species at risk information website; and, c) distributed approximately</p>		

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants
			<p>1,900 letters to landowners with property abutting reaches of the Sydenham River watershed, which flows into habitats where the Pugnose Shiner is present, to encourage the use of BMPs.</p> <p>The Ontario Federation of Agriculture (OFA) delivered information packages encouraging and instructing on the application of BMPs throughout the Lake Erie lowlands, which includes the Essex region where the Pugnose Shiner is found.</p>		
<p>3-2. Collaboration and information sharing: Collaborate with relevant groups, First Nations, initiatives and recovery teams to address recovery actions to benefit the Pugnose Shiner.</p>	Urgent	In progress	Collaboration has been ongoing with the Ausable River recovery team as well as directly with conservation authorities such as Essex Region Conservation Authority (ERCA), Ausable Bayfield Conservation Authority (ABCA), SCRCA, and the OMNRF.	vi, vii	ERCA, ABCA, SCRCA, OMNRF
<p>3-3. Stewardship (implementation of BMPs): Work with landowners, First Nations, and relevant interest groups to implement BMPs in areas where they will provide</p>	Urgent	In progress	Through the Habitat Stewardship Program (HSP), a number of habitat improvement projects have been conducted within watersheds where the Pugnose Shiner is either present or downstream. These projects include: vegetation planting (107.5 and 44.5 ha in Big	iv, vi, vii	DFO, ERCA, Lower Thames Valley Conservation Authority (LTVCA), LPRCA

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants
<p>the most benefit. Encourage the completion and implementation of Environmental Farm Management Plans and nutrient management plans.</p>			<p>Creek/Long Point Bay and the Canard River, respectively); riparian restoration (8.1, 16.26, 20.7 and 0.52 km in the Belle River, Canard River, Rondeau Bay and Tremblay Creek, respectively); as well as other habitat improvement activities (17.8 and 1 ha in Big Creek/Long Point Bay and Turkey Point, respectively).</p>		
<p>3-4. Communication strategy: Develop and implement a communications strategy that identifies partners, target audiences, approaches, information products, and educational and outreach opportunities, that will assist with the recovery of the species.</p>	Necessary	Completed	<p>An outreach strategy was developed for species at risk in southwestern Ontario targeting the following audiences: local municipal staff including managers, planners, engineers, field staff, and consultants.</p>	vii	DFO
<p>3-5. Stewardship (financial assistance or incentives): Facilitate access to federal and provincial funding sources for landowner and local community groups engaged in stewardship activities.</p>	Necessary	In progress	<p>HSP funding is provided by DFO through the conservation authorities to support local stewardship initiatives led primarily by environmental non-government organizations.</p> <p>The activities supported facilitate the implementation of recovery efforts, BMPs associated with</p>	vii	DFO

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants
			<p>water quality improvements, sediment loading and reduction, etc.</p> <p>Similarly, the OMNRF administers the Species at Risk Stewardship Fund (SARSF), which provides money for similar stewardship activities to those described above for HSP. Some of the projects funded through SARSF have been conducted in areas where the Pugnose Shiner occurs.</p>		
<p>3-6. Awareness to address landowner concerns: Provide clear communications addressing funding opportunities as well as landowner concerns for their responsibilities under the <i>Species at Risk Act</i> (SARA).</p>	Necessary	In progress	<p>Compensation opportunities, as well as landowner concerns and responsibilities have been communicated by conservation authorities to local groups, organizations, and landowners.</p>	vii	CAs
<p>3-7. Awareness of incidental harvest: Provide a Pugnose Shiner information package to bait harvesters. Request avoidance of occupied habitats, and the release</p>	Beneficial	Not started	<p>No information package specific to the Pugnose Shiner has been developed that addresses incidental harvest. However, Drake and Mandrak (2014a) released an academic publication documenting the potential for at risk fish species to be harvested as bycatch, which</p>	iv, vii	DFO, OMNRF

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants
and reporting of Pugnose Shiner captured.			<p>could inform a future information package targeted to bait fisheries.</p> <p>In addition, the updated baitfish primer (Cudmore and Mandrak 2018) produced by DFO, OMNRF, and the Ontario Federation of Anglers and Hunters (OFAH) during the reporting period is also a tool that bait fishers can use to differentiate species at risk from other more common species.</p>		
<p>3-8. Awareness of invasive species/baitfish introductions: Increase public awareness about potential impacts of invasive species on the ecosystem, including the Pugnose Shiner. Discourage the emptying of bait buckets.</p>	Beneficial	In progress	<p>Awareness materials regarding aquatic invasive species have been circulated through:</p> <ul style="list-style-type: none"> • the dissemination of aquatic invasive species (AIS) information through the Watercraft Inspection Program • the distribution of AIS educational information by DFO through public postings and direct engagement • the distribution of information through info cards (for example, ABCA's Old Ausable Channel [OAC] Fish Community card provides information regarding species at risk as well as invasive species that threaten them). 	iv, vii	DFO, ABCA

Activity	Priority	Status	Outcomes or deliverables	Objectives addressed	Participants
			<p>In addition, licensed commercial baitfish harvesters in Ontario have completed the OMNRF's Hazard Analysis and Critical Control Point plan and training, which discusses the impacts, and prevention of, the spread of AIS. Furthermore, Drake and Mandrak (2014a; 2014b) released an academic publication quantifying the risk of AIS introductions throughout the province.</p>		

3.2 Activities supporting the identification of critical habitat

Table 5 provides information on the implementation of the studies outlined in the schedule of studies to identify critical habitat in the recovery strategy. Each study has been assigned one of four statuses:

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

Table 5. Status and details of the implementation of the schedule of studies for the Pugnose Shiner outlined in the recovery strategy (DFO 2012) during the period of 2012 to 2017.

Study	Timeline	Status	Details	Participants
Conduct studies to determine the habitat requirements for all life stages (especially juvenile and young-of-the-year life stages).	2013 to 2015	Not started	No substantial progress has been made that adds to the life-history needs already characterized. A pilot study, aimed at investigating the habitat use of larval species at risk in the Sydenham River was conducted in 2017; however, given that the Pugnose Shiner has not been detected in this watershed, aside from recent detections near the mouth of the river, it is unlikely that the results of this research will contribute to the determination of habitat requirements for this species.	Fisheries and Oceans Canada (DFO)
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	Progress in this regard has been made within the St. Lawrence River, a location where the species currently occurs. Building from the known habitat requirements listed in the recovery strategy, McCusker et al. (2014a) developed a model based on variables including water depth, flow velocity, and the estimated density of submerged aquatic vegetation, which was used to inventory the distribution and availability of suitable habitat within the upper St. Lawrence River. Overall, the results of this study indicate that suitable habitat is readily available to the Pugnose Shiner in the upper St. Lawrence River that is more than ample to meet the estimated minimum area needed for population viability. A habitat model was developed for a section of Little Bear Creek to investigate the potential impacts of a proposed drain	DFO , University of Toronto, Parks Canada Agency , U.S. Geological Survey

Study	Timeline	Status	Details	Participants
			<p>maintenance project on Pugnose Shiner. This research identified 0.032 km² of suitable habitat for the Pugnose Shiner within a 0.22 km² section of the river (Montgomery et al. 2017). Although this may not represent the full extent of suitable or occupied habitat within this river, it does demonstrate a means of quantifying Pugnose Shiner habitat that could potentially be applied on larger scales in the future.</p>	
<p>Conduct additional species surveys to fill in distribution gaps, and to aid in determining population connectivity.</p>	<p>2013 to 2015</p>	<p>In progress</p>	<p>Surveys have been conducted in partnership with the University of Toronto and the Ontario Ministry of Natural Resources and Forestry in Lake St. Clair, St. Clair National Wildlife Area and the Canard River. Research has also been conducted that explores the population structure of the species. McCusker et al. (2014b) conducted a genetic assessment of Pugnose Shiner within the following Canadian locations: St. Lawrence East, St. Lawrence River at Mallorytown, East Lake, Wellers Bay, Mouth Lake, Old Ausable Channel (OAC), and Teeswater River. All of these locations, with the exception of three sites in the St. Lawrence River, exhibited high levels of population differentiation, which indicates that the Pugnose Shiner is likely limited in its dispersal behaviour. Furthermore, a genetic bottleneck is highly likely in Mouth Lake while potential bottlenecks may also be occurring in the OAC and East Lake.</p>	<p>DFO, University of Toronto</p>
<p>Create a population-habitat supply model for each life stage.</p>	<p>2016 to 2017</p>	<p>Not started</p>	<p>No habitat supply model has been developed specific to the life stages of the Pugnose Shiner. McCusker et al. (2014a) developed a population habitat supply model for Pugnose Shiner in the St. Lawrence River, which was not specific to life stage, and planning is underway to incorporate data that pertains to juvenile requirements into this modelling (A. Drake, DFO, pers. comm., 2017).</p>	
<p>Based on information gathered, review</p>	<p>2016 to 2017</p>	<p>Not started</p>	<p>No progress has been made in this area.</p>	

Study	Timeline	Status	Details	Participants
population and distribution goals. Determine amount and configuration of critical habitat required to achieve goal if adequate information exists. Validate model.				

3.3 Summary of progress towards recovery

3.3.1 Status of performance indicators

Table 6 provides a summary of the progress made toward meeting the performance indicators outlined in table 1 during the period of 2012 to 2017. Each indicator has been assigned one of five 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 against in the next five-year progress report)
5. cancelled: the performance indicator has been determined to be irrelevant

Table 6. Progress and details of the progress made toward meeting the performance indicators outlined in the recovery strategy (DFO 2012) for the Pugnose Shiner.

Performance indicator	Status	Details	Next steps
Population monitoring protocol finalized.	Met, ongoing	<p>Research conducted by McKenna et al. (2012) and Dextrase et al. (2014) have identified optimal gear types for the detection of Pugnose Shiner.</p> <p>Monitoring of Pugnose Shiner populations within the Thousand Islands National Park has been conducted by Parks Canada Agency (PCA).</p>	<p>Building off the work of Dextrase et al. (2014), further occupancy modelling could be conducted that is based on more robust catch data in order to yield more prescriptive sampling approaches for this species.</p> <p>Fisheries and Oceans Canada (DFO) will be developing a monitoring program to determine the abundance of Pugnose Shiner populations throughout the species' Canadian range and assess changes in the trajectories of these populations over time.</p>
Surveys of all extant, historical, and new and suspected locations completed.	Met, ongoing	Surveys have been conducted in four locations where the species is known to be extant (Teeswater River, St. Lawrence River, St. Clair Unit of the St. Clair National Wildlife Area [NWA], and Canard River), as well as four suspected	Extant locations: Ideally, targeted sampling of the ten remaining locations (Old Ausable Channel [OAC], Mouth Lake, Whitebread Drain/Grape Run Drain, Little Bear Creek, Long Point Bay/Big Creek, Wellers Bay, West Lake, East Lake, and Waupoos Bay) should be conducted to assess the status of these populations. At a minimum, locations that have not been sampled since

Performance indicator	Status	Details	Next steps
		<p>locations (Consecon Lake, Lake on the Mountain, Presqu'île Bay and North Beach). No targeted surveys have been conducted within historical locations (for example, Point Pelee National Park, Rondeau Bay).</p> <p>Overall, progress toward this measure, which includes only targeted surveys, can be described as follows:</p> <ul style="list-style-type: none"> • 2/14 extant locations (as listed in the recovery strategy) have been sampled • 0/3 historical locations have been sampled • the number of suspected locations remains unclear 	<p>2010 (for example, Mouth Lake, Waupoos Bay, Wellers Bay, Whitebread Drain/Grape Run) and locations where limited and/or unsuccessful non-targeted sampling has occurred (for example, Chenail Ecarte) should be given priority.</p> <p>Historical locations: Targeted sampling still needs to be conducted within Point Pelee National Park, Rondeau Bay, and the lower Gananoque River.</p> <p>Suspected and new locations: Targeted sampling should be conducted within tributaries of Lake St. Clair; the Detroit River; the Gananoque watershed; upper St. Lawrence River and eastern Lake Ontario (Eel Bay: western Wellesley Island; Flynn Bay: Grindstone Island, and various bays around Wolfe Island) based on McCusker et al. (2014a).</p>
Monitoring of at least two populations undertaken.	Met, ongoing	<p>DFO has not conducted monitoring to determine the population trends of Pugnose Shiner populations; however, targeted surveys for the Pugnose Shiner have been conducted in the St. Lawrence River in 2011 and the Teeswater River in 2013 .</p> <p>PCA has established a long-term population monitoring program for populations within the Thousand</p>	Where feasible, population monitoring should be conducted for the other populations mentioned above.

Performance indicator	Status	Details	Next steps
		Islands National Park, which has been ongoing since 2011. This program includes 19 monitoring sites, several of which have led to detection of the Pugnose Shiner. Analysis of long-term trends in the abundance of this species is ongoing.	
Completion of activities outlined in the schedule of studies (section 2.7.5 schedule of studies to identify critical habitat) for the complete determination of critical habitat within the proposed timelines	Not met	No substantial progress has been made that adds to the life-history needs.	Conduct larval sampling at locations where the Pugnose Shiner occurs and is likely to be detected. Determine what other life-stage specific information is pending.
Long-term population and habitat monitoring program established and baseline data collected for all populations	Met, ongoing	DFO has not established a long-term population and habitat monitoring program for the Pugnose Shiner at this time; however, PCA has established a long-term population and habitat monitoring program in the Thousand Islands National Park, which includes the assessment of habitat trends.	Once DFO has developed a protocol that will standardize sampling efforts for the Pugnose Shiner, as well as the collection of habitat variables, monitoring should be prioritized in locations where population status is listed as unknown in the recovery strategy (Teeswater River, Mouth Lake, St. Clair NWA, Canard River, Wellers Bay, West Lake, East Lake, and Waupoos Bay) and new locations where the population trajectory is also unknown.
Research conducted to evaluate changes in habitat conditions	Not met	No research has been conducted to compare threat factors among extant and historical sites; however, significant progress has	Conduct a threat comparison between historical and extant locations to elucidate what exactly led to the extirpation within historical sites such as Point Pelee National Park and Rondeau Bay in an effort to better

Performance indicator	Status	Details	Next steps
at extirpated and extant locations.		been made in terms of investigating and identifying threats within specific locations where the Pugnose Shiner is extant.	understand what the causal mechanisms are that are causing the species to decline. The original threat analysis tables composed for the recovery potential assessment (RPA) do not demonstrate a clear relationship between threat severity and species extirpation. For example, the threat severity levels assigned for Point Pelee National Park (where the species is extirpated) are all medium and low, while other locations where the species is still present have comparatively higher threat severity levels.
Quantification of best management practices (BMPs) (for example, number of nutrient management plans implemented to address threats). Habitat conservation tools to maintain enhance and restore habitat identified.	Not met	Within this document, habitat improvement activities listed within Habitat Stewardship Program (HSP) reports have been quantified; however, no substantial effort to quantify the scale, applicability and effectiveness of habitat improvement activities, as a means of recovering Pugnose Shiner populations has been conducted.	Develop funded relationships with external agencies: <ul style="list-style-type: none"> • provide resources for more targeted activities that specifically benefit target species and not just general ecosystem health • conduct monitoring of these projects to ensure that the results are consistent with what has been proposed • require detailed reporting that quantifies stewardship efforts and provides context regarding a project’s applicability to the threats of species at risk as well its spatial applicability in relation to species distribution
Communication strategy developed and implemented; Collaboration with municipal planning committees to prevent development of land adjacent to established Pugnose	Not met	No progress has been made at this time	Develop a closer working relationship with municipal planning committees to determine what the feasibility of this measure is.

Performance indicator	Status	Details	Next steps
Shiner habitat at 50% of locations.			
Municipal waste- and storm-water facilities informed of impacts of facilities on the Pugnose Shiner in areas where studies suggest impacts.	Not met	No research has been conducted at this point that identifies municipalities that would be applicable for such an information package.	Before this performance indicator can be completed, the activities described in research measures 1 to 7 (table 2) need to be undertaken.
Research initiated into efficacy of repatriations for the Pugnose Shiner.	Not met, underway	Research is currently underway to investigate the feasibility of repatriations.	Once it has been demonstrated that the Pugnose Shiner can be effectively reared within an aquaculture setting it will be important to explore potential genetic impacts that may arise from large-scale translocations.
Collaboration with all ecosystem recovery teams and other stakeholders.	Met	Refer to the recovery implementation tables for examples of stakeholder collaboration.	N/A
Outreach programs developed and initiated to target recreation and park areas.	Not met, underway	<p>DFO has conducted outreach sessions with PCA staff that discussed critical habitat for species at risk including the the Pugnose Shiner. Furthermore, Ausable Bayfield Conservation Authority has conducted outreach sessions and other projects, funded through HSP, which informed members of the public about aquatic species at risk in the OAC.</p> <p>PCA has implemented signage in designated critical habitat within Thousand Islands National Park</p>	Identify further target recreation and park areas.

Performance indicator	Status	Details	Next steps
		for the Pugnose Shiner, indicating site sensitivity and the suggested actions to reduce impacts from recreational activities.	

3.3.2 Completion of action plan

The “Action Plan for the Ausable River in Canada: an ecosystem approach” (DFO 2020) includes recovery activities for the Pugnose Shiner and has been published on the Species at Risk Public Registry. Although an ecosystem/multispecies document, this action plan includes several components that specifically implement recovery objectives for the Pugnose Shiner in the OAC as well as Mouth Lake. The “Multi-species Action Plan for the Thousand Islands National Park of Canada” (PCA 2016) also includes recovery actions that will benefit Pugnose Shiner found within the Thousand Islands National Park.

3.3.3 Critical habitat identification and protection

Critical habitat was partially identified in the recovery strategy at a number of locations. For more information, refer to the recovery strategy. The critical habitat of the Pugnose Shiner in the St. Clair Unit of the St. Clair NWA, Big Creek, and Long Point NWAs, as well as the habitat identified within PCA’s jurisdiction in Thousand Islands National Park, is already protected by the prohibition against destruction of critical habitat by the publication of a description of critical habitat in the Canada Gazette in 2016, pursuant to subsection 58(2) of SARA, which was required within 90 days of the description of critical habitat being identified in the recovery strategy. This prohibition provides additional protection to that already afforded and available under the *Canada Wildlife Act*, as well as the Wildlife Area Regulation associated with this statute. Since the publication of the recovery strategy, surveys have been conducted to identify further critical habitat in novel areas where suitable habitat is available. The Pugnose Shiner was detected at the following locations: St. Clair River; West Otter Creek; the lower section of the Sydenham River; the south shore of Lake St. Clair; the inlet to the Detroit River; and, a number of locations in the St. Lawrence River. Based on these detections, the identification of further critical habitat at new locations may be warranted when the recovery strategy is amended.

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 Pugnose Shiner populations, within Canadian waters, no longer meet the feasibility criteria laid out in the recovery strategy. For example, there are still enough reproducing individuals and suitable habitat to support recovery objectives, and threats to the species can be or have been addressed through restoration efforts and the promotion of best management practices. Furthermore, the aforementioned new locations where the species has been detected serve to reinforce this.

4. Concluding statement

A substantial amount of progress has been made in terms of the implementation of survey and monitoring measures prescribed in the recovery strategy (DFO 2012). For example, targeted sampling has been conducted in two areas where: the species is known to be extant (St. Lawrence River, Teeswater River) confirming its continued presence and providing data to derive abundance estimates; and, at locations where the species may occur (Consecon Lake, Lake on the Mountain, Presqu’île Bay, and North Beach). Furthermore, non-targeted sampling has led to the detection of the species in several new locations such as: the St. Clair River; West Otter Creek; the lower section of the Sydenham River; the south shore of Lake St. Clair;

the inlet to the Detroit River; the Trent River; as well as a number of new locations in the upper St. Lawrence River.

A number of research objectives have also been met in the last five years including: investigations into the effects of elevated turbidity levels on this species; assessments of mechanisms driving winter fish kills within the OAC, including investigations of low dissolved oxygen levels, invasive aquatic macrophytes, and ground water sources of nitrates and phosphorus; anthropogenic threats (drain maintenance) to Pugnose Shiner habitat and habitat connectivity in Little Bear Creek; modelling research pertaining to Pugnose Shiner habitat availability and distribution within the upper St. Lawrence River; modelling research that explores effectiveness of compensation approaches for offsetting habitat loss; and lastly, the characterization of the population structure of the Pugnose Shiner throughout its Canadian range.

In addition to these aforementioned projects, there are a number of unfinished research objectives that are currently underway for this species including: experiments that will explore the response of this species, in terms of metabolic rate and swimming performance, to elevated temperature regimes; and laboratory studies to examine the feasibility of supplementation/translocation approaches to species recovery.

Progress has also been made with regard to stewardship and outreach related activities. Stewardship activities, including vegetation planting and riparian restoration, as well as other habitat improvement activities have been conducted at several locations where the Pugnose Shiner is extant. Furthermore, substantial outreach activities have been conducted by DFO as well as a number of external agencies through Habitat Stewardship Program funding, which included information on the Pugnose Shiner and its habitat needs.

Despite this progress, there still remain a number of recovery activities that are yet to be implemented, which should be undertaken where/when feasible. These include, but are not limited to: more conclusive research to inform the development of a sampling protocol and inevitably a standardized index population and habitat monitoring program, the feasibility of which will likely be investigated in 2018; additional research centred on the habitat needs of each life stage of the Pugnose Shiner, building on the findings of Dextrase et al. (2014); and, the creation of a population-habitat supply model for each life stage. Similarly, there are a number of locations where further targeted sampling should be conducted including: the majority of locations where the species is extant; historical locations (Point Pelee National Park and Rondeau Bay); new locations where the species has recently been detected; and, suspected locations (for example, Lake St. Clair tributaries; locations within eastern Lake Ontario; the upper St. Lawrence River; and, the Gananoque River). Furthermore, threat management/mitigation measures should be conducted where feasible to reduce factors leading to the decline of Pugnose Shiner populations.

Lastly, the discovery of the species within a number of new locations also suggests that the population and distribution objectives for this species should be reevaluated to reflect new information that has been acquired.

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