Species at Risk Act
Recovery Strategy Report Series

Report on the Progress of Recovery Strategy Implementation for the Lake Chubsucker (*Erimyzon sucetta*) in Canada for the Period 2010 – 2015

Lake Chubsucker

2017

Canada

Recommended citation

Fisheries and Oceans Canada. 2017. Report on the Progress of Recovery Strategy Implementation for the Lake Chubsucker (*Erimyzon sucetta*) in Canada for the Period 2010 – 2015. In *Species at Risk Act* Recovery Strategy Report Series. Fisheries and Oceans Canada, Ottawa. iii+ 31 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 illustrations: Courtesy S. Staton, Fisheries and Oceans Canada

Également disponible en français sous le titre
« Rapport sur les progrès de la mise en œuvre du programme de rétablissement du sucet de lac (*Erimyzon sucetta*) au Canada pour la période allant de 2010 à 2015 »

ISBN: 978-0-660-08905-8
Catalogue no. En3-4/40-1-2017E-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 minister to report 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 organizations and all other parties involved in conducting activities that contribute towards the species' recovery. Recovery strategies identify broad strategies and approaches that will provide the best chance of recovering species at risk. Some of the identified strategies and approaches are sequential to the progress or completion of others; not all may be undertaken or show significant progress during the time frame of a Report on the Progress of Recovery Strategy Implementation (Progress Report).

The Minister of Fisheries and Oceans and the Minister for Parks Canada Agency are the competent ministers under SARA for the Lake Chubsucker 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 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 Lake Chubsucker for the benefit of the species and Canadian society as a whole.

Acknowledgments

This Progress Report was prepared by Josh Stacey (DFO) and Amy Boyko (DFO). To the extent possible, this Progress Report has been prepared with input from Parks Canada Agency and the province of Ontario. The Department of Fisheries and Oceans would also like to express its appreciation to the Ontario Freshwater Fish Recovery Team whose members have contributed to the recovery of the Lake Chubsucker.

Executive summary

The Lake Chubsucker was initially listed as Threatened in 2003 under the *Species at Risk Act* (SARA) and was reclassified to Endangered in 2011. The *Recovery Strategy for the Lake Chubsucker (Erimyzon sucetta) in Canada* was finalized and published on the Species at Risk Public Registry in 2010, before the species was uplisted in 2011. The main threats identified for the Lake Chubsucker include: wetland habitat loss; siltation and turbidity; and, nutrient loading. Additional contributing threats include: channelization/altered water flow; invasive species; incidental harvest; changes to trophic dynamics; barriers to movement; and, climate change.

The population and distribution objectives for the Lake Chubsucker are to maintain current distributions and densities of known extant populations in the Old Ausable Channel (OAC), L Lake, Lake St. Clair (Walpole Island, St. Clair National Wildlife Area [NWA]), Lake Erie (Point Pelee National Park, Rondeau Bay, Long Point Bay, Big Creek NWA), and the upper Niagara River (Lyons Creek). During the time period reported by this Progress Report, the following activities have been accomplished in support of the recovery objectives as stated in the Recovery Strategy:

- Targeted sampling for extant populations of Lake Chubsucker have been conducted in Long Point Bay (2013), Lyons Creek (2010), L (2010, 2012) and Mouth (2012) lakes, and the OAC (2012).

- Targeted surveys were also conducted in tributaries of the upper Niagara River including Grassy Brook, Big Forks Creek, and Tea Creek in 2012.

- Targeted surveys conducted in Lyons Creek, L Lake, and Long Point Bay included the examination of habitat use by Lake Chubsucker to further identify critical habitat features.

- Multiple wetland restoration projects (removal of Common Reed) have been conducted in marsh areas of Long Point, Turkey Point, and Big Creek.

- The efficacy of these wetland restoration projects, as a means of restoring species at risk habitat is under continued investigation through Fisheries and Oceans Canada monitoring programs conducted within the Crown Marsh in Long Point Bay.

- A permanent water-control structure was installed within the lower OAC to stabilize water levels and flow.

- The implementation of stewardship activities and the encouragement of best management practices within Rondeau Bay watersheds have led to water quality improvements, which will inevitably lead to better habitat quality within the bay.

Taken together, these ongoing and/or completed activities indicate that progress is being made toward the goal of recovering Lake Chubsucker populations in Canada; however, there are still a number of areas where further information is required. For example, it is difficult to establish viable population and distribution objectives in the absence of detailed population records; therefore, further monitoring and assessment should be conducted to refine the extent of the species' distribution and determine its prevalence within its current distribution. For this reason it may be beneficial to focus future recovery activities on filling these knowledge gaps.

Table of contents

1. Introduction

This Report details the progress toward meeting the objectives listed in the Recovery Strategy from 2010 to 2015 and should be considered as one in 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 report (COSEWIC 2008 assessment and update status report on the Lake Chubsucker *Erimyzon sucetta* in Canada) and the Recovery Strategy for the Lake Chubsucker (*Erimyzon sucetta*) in Canada (Staton et al. 2010).

Section 2 of the Progress Report reproduces or summarizes key information on the challenges the species is facing, population and distribution objectives for achieving its recovery, approaches to meeting the objectives, and performance indicators to measure the progress of recovery. For more details, readers should refer to the *Recovery Strategy for the Lake Chubsucker (Erimyzon sucetta) in Canada*. Section 3 reports on the progress of activities identified in the Recovery Strategy, to support achieving the population and distribution objectives. Section 4 summarizes the progress made and the outcome of the recovery effort.

2. Background

2.1. COSEWIC assessment summary

The reclassification of the Lake Chubsucker in 2011 to a higher risk category was based on the information provided in the COSEWIC status report (COSEWIC 2008). This information has also been included in Section 1.1 of the Recovery Strategy.

Common Name: Lake Chubsucker (Lacepède, 1803)
Scientific Name: *Erimyzon sucetta*
Current COSEWIC Status & Year of Designation: Endangered, 2008
Canadian Occurrence: Ontario
Reason for Designation: A species with a restricted geographic Canadian range with small extant populations having very specific and narrow habitat preferences, which are under continued stress. It is extremely susceptible to habitat change driven by urban, industrial and agricultural practices resulting in increased turbidity. Two populations have been lost, and of the 11 extant populations, 3 are in serious decline as a result of the continuing and increasing threats posed by agricultural, industrial and urban development that are expected to impact the remaining populations of Lakes Erie and St. Clair.
Status History: Designated Special Concern in April 1994. Status re-examined and designated Threatened in November 2001. Status re-examined and designated Endangered in November 2008. Last assessment based on an updated status report.

2.2. Threats

This section summarizes the information, found in the Recovery Strategy, on threats to survival and recovery of the Lake Chubsucker and threats to its critical habitat.

2.2.1 Threats to the Lake Chubsucker

Table 1 is an assessment of the threats to extant populations of the Lake Chubsucker in Ontario, as found in the previously published Recovery Strategy (Staton et al. 2010).

Table 1. Predominant threats to Lake Chubsucker populations in Ontario. Adapted from Staton et al. (2010).

Threat	Relative Impact	Spatial Extent	Evaluation of Threat
A Wetland Habitat Loss	Predominant	Widespread	Probable
B Siltation and Turbidity	Predominant	Widespread	Probable
C Nutrient Loading	Predominant	Widespread	Probable
D Channelization/Altered Water Flow	Contributing	Local	Speculative
E Invasive Species	Contributing	Widespread	Speculative
F Climate Change	Contributing	Widespread	Speculative
G Incidental Harvest (Commercial and Bait Fisheries)	Contributing	Local	Speculative
H Changes to Trophic Dynamics	Contributing	Local	Speculative
I Barriers to Movement	Contributing	Local	Speculative

The threats listed in Table 1 were identified in the Recovery Strategy (Staton et al. 2010); however, since that publication, a Recovery Potential Assessment of Lake Chubsucker in Canada (DFO 2011) has been published that identifies population level threats ranked by priority. Furthermore, research conducted over the last five years has led to new information regarding threats to Lake Chubsucker. For example, in addition to invasive species such as Common Carp (*Cyprinus carpio*) and Common Reed (*Phragmites australis australis*), the presence of Round Goby (*Neogobius melanostomus*) within Lake Erie habitats, such as Point Pelee, Long Point Bay and Rondeau Bay, may have a negative impact on the abundance of Lake Chubsucker. The Round Goby has been documented to affect multiple species including Channel Darter (*Percina copelandi*), Fantail Darter (*Etheostoma flabellare*), Greenside Darter (*E. blennioides*), Johnny Darter (*E. nigrum*), Logperch (*P. caprodes*) (Baker 2005), and Smallmouth Bass (*Micropterus dolomieu*) (Steinhart et al. 2004) in areas of western Lake Erie as well as Long Point Bay (Reid and Mandrak 2008). Potential causes include Round Goby predation on eggs and juveniles, competition for food and habitat, and interference competition for nests (French and Jude 2001; Janssen and Jude 2001).

The potential spread of Asian Carp species within Lake Erie may also pose a significant future threat to Lake Chubsucker in coastal wetland habitats. Grass Carp (*Ctenopharyngodon idella*)

has recently been detected within the Lake Erie basin, and spawning has been confirmed within a tributary of this watershed (Chapman et al. 2013; Embke et al. 2016). Furthermore, Grass Carp have been documented to directly reduce macrophyte abundance through consumption leading to indirect impacts on a number of freshwater game and cyprinid species (Wittmann et al. 2014). Therefore, should this invasive species become established within Lake Erie, habitat degradation for Lake Chubsucker within Rondeau and Long Point Bays would be expected.

Currently, it appears that invasive species are now likely a higher level threat for Lake Chubsucker than represented in Table 1 due to the increased expansion of the invasive species Common Reed that is causing habitat loss and degradation within the Lake Erie coastal wetlands. For instance, Gilbert and Locke (2007) documented that available wetted habitat within Rondeau Bay has been reduced as a consequence of the expansion of dense Common Reed stands. Similarly, the habitat within areas of Long Point Bay has also been greatly altered by the growth of dense stands of this invading plant species. For example, between 1999 and 2006, Common Reed stands expanded in surface area by 27.8, 12.9, 33.9, and 48% in the Crown Marsh, the Long Point Company Marsh, the tip of Long Point, and the Big Creek Marsh, respectively (Badzinski et al. 2008). More recently, modelling studies conducted in the Crown Marsh, Long Point Bay, have predicted that Phragmites will continue to expand its range out into the wetland, significantly decreasing open-water habitat, based on projected water-level reductions attributable to climate change (B. Glass, DFO, pers. comm. 2016).

It has been postulated that the increased expansion of Common Reed within coastal wetlands of Lake Erie has been expedited by water-level declines, increased air temperatures, and potentially both anthropogenic and natural disturbances (Wilcox et al. 2003). In addition, further declines in water-levels, paired with an increase in extreme weather events, are expected as a result of climate change and will likely continue to promote the expansion of Common Reed along coastal Great Lakes shorelines (Alexander 2012).

Another major threat that is impacting Lake Chubsucker abundance in the Old Ausable Channel (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 Watermilfoil (*Myriophyllum spicatum*), are exacerbated by prolonged snow and ice cover leading to anoxic conditions. Dramatic winterkill events have led to the observed mortality of >75, 25 and 10 Lake Chubsucker in the OAC in 2010, 2011, and 2014, respectively.

2.2.2 Threats to critical habitat

Critical habitat for the Lake Chubsucker has been identified, to the extent possible, in Section 2.7 of the Recovery Strategy (Staton et al. 2010). Examples of activities that are likely to result in destruction to critical habitat (i.e., threats to critical habitat) are listed below. The list of activities provided below is neither exhaustive nor exclusive, and their inclusion has been guided by the relevant threats to habitat described in the Recovery Strategy. For more details on the activities likely to result in the destruction of critical habitat, consult the Recovery Strategy.

Without appropriate mitigation, destruction of critical habitat may result from activities such as (from the Recovery Strategy):

- Dredging;
- Infilling along shorelines;

- Shoreline hardening;
- Installation of docks, groynes and piers (in some cases design choices [e.g., floating docks instead of crib docks] can allow for the mitigation of impacts);
- Instream/in-water work;
- Unfettered livestock access to waterways;
- Channelization and drainage works;
- Removal of riparian vegetation;
- Industrial, urban and/or rural chemical spills;
- Water-taking (this may include the prevention or interruption of clean water flow from the Welland Canal into Lyons Creek);
- Sewage treatment plants/septic system/manure spills;
- Construction of dams and impoundments; and,
- Deliberate introduction of invasive species.

2.3. Recovery

This section summarizes the information, found in the Recovery Strategy (Staton et al. 2010), on the population and distribution objectives that are necessary for the recovery of the Lake Chubsucker as well as performance indicators that provide a way to define and measure progress toward achieving the population and distribution objectives.

2.3.1 Recovery goal and population and distribution objectives

Recovery goal
The long-term recovery goal (>20 years) is to maintain current populations of the Lake Chubsucker and restore viable populations to formerly occupied wetland habitats.

Population and distribution objectives
The population and distribution objectives for the Lake Chubsucker are to maintain current distributions and densities of known extant populations in the OAC, L Lake, Lake St. Clair (Walpole Island, St. Clair National Wildlife Area [NWA]), Lake Erie (Point Pelee National Park, Rondeau Bay, Long Point Bay, Big Creek NWA), and the upper Niagara River (Lyons Creek).

Recovery objectives (short term: 5-years)
The short-term recovery goals as stated in the original Recovery Strategy for the Lake Chubsucker are:

i. Refine population and distribution objectives;
ii. Ensure adequate protection of critical habitat;
iii. Determine long-term population and habitat trends;
iv. Identify threats, evaluate their relative impacts, and implement remedial actions to reduce their effects, where feasible;
v. Determine the feasibility of repatriations for populations that may be extirpated or reduced;
vi. Enhance efficiency of recovery efforts through coordination of recovery efforts with aquatic and terrestrial ecosystem recovery teams and other relevant or complementary groups/initiatives; and,
vii. Improve overall awareness of the Lake Chubsucker and the role of healthy aquatic ecosystems, and their importance to humans.

2.3.2 Performance measures

Section 2.6 of the Recovery Strategy (Staton et al. 2010) includes the following performance indicators to define and measure progress toward achieving the recovery[1] objectives:

1. Extent of existing populations (including abundance and population demographics) fully determined through background surveys by 2011;
2. Completion of activities outlined in the Schedule of Studies for the complete determination of critical habitat within the proposed timelines;
3. Degree of protection/restoration achieved for known habitats of the Lake Chubsucker (e.g., number of habitat patches/populations enhanced);
4. Long-term population and habitat monitoring program established by 2013;
5. Quantification of stewardship effort (i.e., Best Management Practices [BMPs]) implemented through ecosystem-based recovery teams and other relevant or complementary groups/initiatives by (e.g., number of Environmental Farm Management Plans [EFMPs] and Nutrient Management Plans [NMPs] completed; hectares of riparian buffers established; number of livestock restricted from watercourses);
6. Number of high priority sites enhanced/protected by stewardship actions; and,
7. Documentation of public and agency participation/support for recovery actions identified in the Recovery Strategy (including in-kind and contributed financial resources).

Some indicators may not be measurable within the time frame covered in this Progress Report. In such cases, the implementation of the recovery approaches and critical habitat studies will help report on the progress towards achievement of the performance indicators.

3. Progress towards recovery

The Recovery Strategy for the Lake Chubsucker (Staton et al. 2010) 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.

The emphasis of the current progress review is on approaches that were deemed urgent and, where applicable, necessary, and beneficial in the original Recovery Strategy. The listing of results is meant to briefly touch on some of the more significant accomplishments and is not meant to be exhaustive.

[1] The Recovery Strategy (Staton et al. 2010) followed an older template that measured performance based on recovery objectives and not population and distribution objectives.

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. 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. Activities conducted/ongoing since the completion of the Lake Chubsucker Recovery Strategy.

Activity	Recovery Objectives Addressed	Status	Details	Participants[2]	Performance Indicators
Broad Strategy 1: Inventory and Monitoring					
(1-1) Conduct targeted surveys of preferred habitats in tributaries of Big Creek (Long Point region), Jeanette's Creek and Tea Creek to determine the status of these populations.	i, vi	In progress	• Currently, targeted sampling of Lake Chubsucker has only been conducted within one of these three locations - Tea Creek; however, no Lake Chubsucker were detected. • Projects targeting other species using suitable gear in similar habitat have been conducted in Jeanette's Creek but no Lake Chubsucker were detected as a result of these surveys. • Lake Chubsucker were detected in Big Creek by the Long Point Region Conservation Authority during the Long Point Wetland Restoration Project.	**DFO**, LPRCA	Extent of existing populations (including abundance and population demographics) fully determined through background surveys by 2011.
(1-2) Complete targeted surveys of extant populations.	i, vi	In progress	• Targeted sampling for Lake Chubsucker has been conducted in Long Point Bay (2013), L Lake (2010), and the OAC (2012).	**DFO**, OMNRF	

[2] Participant full names: Ausable Bayfield Conservation Authority (ABCA); Essex Region Conservation Authority (ERCA); Lower Thames Valley Conservation Authority (LTVCA); Long Point Region Conservation Authority (LPRCA); and, Ontario Ministry of Natural Resources and Forestry (OMNRF).

Table 2. Activities conducted/ongoing since the completion of the Lake Chubsucker Recovery Strategy.

Activity	Recovery Objectives Addressed	Status	Details	Participants[2]	Performance Indicators
			• Non-target surveys that represent potential effort for Lake Chubsucker have been conducted by DFO over the last five years in the OAC, Lake St. Clair and Walpole Island, Little Bear and Jeanette's creeks, and Rondeau and Long Point bays. Lake Chubsucker were captured in the OAC (2010), Little Bear Creek (2013) and Long Point Bay (2012-2015). • Non-target sampling conducted by partner agencies led to detections in Long Point Bay (LPRCA 2011, OMNRF 2015), Lyon's Creek (OMNRF 2013) and the OAC (ABCA 2015).		
(1-3) Conduct targeted surveys of undetected populations in high probability areas with suitable habitat. Areas to target would include tributaries of the upper Niagara River.	i, vi	In progress	• Targeted surveys were conducted in Grassy Brook, Big Forks Creek and Tea Creek (tributaries of the Niagara River) in 2012 - no Lake Chubsucker were detected.	**DFO**	
(1-4) Develop and implement a standardized index population and habitat monitoring program with a specific sampling and training protocol.	iii	In progress	• A standardized population and habitat monitoring program involving the establishment of a network of permanent monitoring stations throughout historical and current Lake Chubsucker habitat is currently in development. A DFO technical report was published in 2014 summarizing the optimal gear type and effort to detect species at risk fishes, including the Lake Chubsucker (Dextrase et al. 2014). • Little Bear Creek, Dover and Chatham Townships, Kent County Ontario Aquatic Vegetation and Fish Habitat	**DFO**, OMNRF, ABCA	Long-term population and habitat monitoring program established by 2013.

Table 2. Activities conducted/ongoing since the completion of the Lake Chubsucker Recovery Strategy.

Activity	Recovery Objectives Addressed	Status	Details	Participants[2]	Performance Indicators
			Survey 2014: macrophyte community surveys conducted that can be considered a first step toward the characterization of Lake Chubsucker habitat. Once habitat associations have been outlined for this species, the information can be used to develop a standardized index population and habitat monitoring program.		
(1-8) Monitor Lake Chubsucker watersheds for invasive species of concern in cooperation with aquatic ecosystem recovery teams.	iv	In progress	• Asian carp surveys have been conducted in Long Point Bay, Jeanette's Creek, and Rondeau Bay. • Monitoring is ongoing within the Old Ausable Channel to detect new colonies of Common Reed.	**DFO**, OMNRF, ABCA	
(1-10) Measure sediment and nutrient loads emitted from streams.	i, iv, vi	In progress	• **OAC**: Concentrations of total phosphorus, nitrate, un-ionized ammonia and total suspended solids were measured (Jean et al. 2015). • **Lake Erie, Rondeau Bay**: the assessment of water quality parameters is underway to gauge the efficacy of the Rondeau Bay Restoration Project.	ABCA, OMNRF	
Broad Strategy 2: Research					
(1-6) Evaluate the impacts of invasive species (including Common Carp and invasive plant species) on the Lake Chubsucker and its habitat.	iv	In progress	• The effects of Common Reed on Lake Chubsucker habitat is being investigated as a component of the Long Point, Crown Marsh Restoration Projects etc (Rook et al. 2016). • The presence/absence of Common Carp has been investigated by ABCA as a threat in the OAC.	**DFO**, OMNRF, ABCA	N/A – (nothing threat related in the performance indicators or schedule of studies)

Table 2. Activities conducted/ongoing since the completion of the Lake Chubsucker Recovery Strategy.

Activity	Recovery Objectives Addressed	Status	Details	Participants[2]	Performance Indicators
(1-7) Investigate and evaluate the significance of threat factors that may be impacting extant populations. Take steps to mitigate immediate threats identified.	iv	Completed /In progress	• Evaluation of habitat restoration activities for species at risk fishes within the Crown Marsh (Long Point Bay): the efficacy of wetland restoration (removal of Common Reed), as a means of restoring species at risk habitat (e.g., Lake Chubsucker spawning), has been explored within the Crown Marsh of Long Point Bay (Rook et al. 2016). Recommendations were made regarding the design of constructed wetlands to maximize suitability for species at risk fishes, including the Lake Chubsucker. Guidance is provided that outlines potential threats that can arise from these restoration activities (e.g. low dissolved oxygen levels, stranding, genetic isolation etc.) as well as design solutions that would prevent these threats from occurring. • Invasive Phragmites Best Management Practices 2011: guidelines and effective strategies for the control and removal of Common Reed are described for invasive species mitigation and wetland restoration projects (OMNRF 2011). • Assistance provided to stakeholders in controlling Common Reed to prevent establishment in wetland habitats (OAC, L Lake, Mouth Lake). • Evaluation of changes in habitat conditions for species at risk fishes in the OAC, L Lake and Mouth Lake:	**DFO**, ABCA, LPRCA, OMNRF, U of Toronto, Trent U	Degree of protection/restoration achieved for known habitats of the Lake Chubsucker (e.g., number of habitat patches/populations enhanced).

Table 2. Activities conducted/ongoing since the completion of the Lake Chubsucker Recovery Strategy.

Activity	Recovery Objectives Addressed	Status	Details	Participants[2]	Performance Indicators
			water levels, dissolved oxygen etc. • Investigation of Threats to Species at Risk Fishes in the Grand Bend – Port Franks Area 2013 (Jean et al. 2013). • Aquatic Macrophyte Survey of the Grand Bend – Port Franks Area in Support of: Investigation of Threats to Species-at-risk Fishes in the Grand Bend – Port Franks Area 2013 (Wiklund 2013). • Little Bear Creek, Dover and Chatham Townships, Kent County, Ontario: Aquatic Vegetation and Fish Habitat Survey 2014 (Wiklund 2015). • Impacts of an agricultural drain clean out on aquatic species at risk in Little Bear Creek: research is ongoing that explores the impacts of drain maintenance on Lake Chubsucker as well as potential mitigation measures (DFO 2015). • Nitrate Sources in the Old Ausable River Channel and Adjacent Aquifers in Pinery Provincial Park, Ontario Canada: research has been conducted that investigates nitrate inputs and routes of transmission into the OAC (Russell 2015).		
Broad Strategy 3: Management and Coordination					
(2-1) Work with relevant ecosystem- and single species-based recovery teams and other groups	vi	In progress	• Ontario Freshwater Fish Recovery Team (OFFRT), Essex-Erie Fish Species at Risk Recovery Team, and ongoing cooperation with existing	**DFO**, OMNRF, ABCA	Documentation of public and agency participation/support for recovery actions identified in the Recovery Strategy (including in-kind and

Table 2. Activities conducted/ongoing since the completion of the Lake Chubsucker Recovery Strategy.

Activity	Recovery Objectives Addressed	Status	Details	Participants[2]	Performance Indicators
to share knowledge, implement recovery actions and to obtain incidental sightings.			recovery teams (Ausable River Recovery Team): continued delivery of a seamless implementation of all recovery actions across jurisdictions.		contributed financial resources).
(2-2) Encourage municipalities to protect habitats that are important to the Lake Chubsucker in their official plans and ensure that planning and management agencies are aware of habitats important to the species.	vi, vii	In progress	• Presentations given to municipal planners from the Ausable Bayfield, St. Clair, Essex, and other regions providing information related to the protection of critical habitat and species recovery.	**DFO**, ABCA	Number of high priority sites enhanced/protected by stewardship actions.
(2-3) Establish good working relationships with drainage supervisors, engineers and contractors to limit the effects of drainage activities on this species.	vi, vii	In progress	• *Species at Risk Act* (SARA) legislation, critical habitat and recovery included in Drainage Superintendent course in 2011 and 2012. • Presentation regarding species at risk critical habitat given to drainage engineers.	**DFO**	N/A
(2-4) Evaluate watershed-scale stressors to populations and their habitat in cooperation with relevant ecosystem recovery teams.	iv, vi	In progress	• Aquatic Macrophyte Surveys of the Grand Bend – Port Franks Area (OAC) (Wiklund 2013), and Little Bear Creek (Wiklund 2015). • Monitoring of water quality parameters in Rondeau Bay (OMNRF). • Investigation of Threats to Species at Risk Fishes in the Grand Bend – Port Franks Area (OAC) (Jean et al. 2013). • OAC Species at Risk Fishes Habitat Monitoring.	**DFO**, OMNRF, ABCA	N/A – (nothing threat related in the performance indicators or schedule of studies)
(2-5) Development of a management plan that	iv, vi	Cancelled	N/A	N/A	N/A

Table 2. Activities conducted/ongoing since the completion of the Lake Chubsucker Recovery Strategy.

Activity	Recovery Objectives Addressed	Status	Details	Participants[2]	Performance Indicators
addresses potential risks, impacts, and proposes actions (including feasibility of control) in response to existing invasive species, and the arrival or establishment of new invasive species.					
(2-6) Evaluate the feasibility of prohibitions on the use of live baitfishes within the OAC (outside of the Pinery Provincial Park).	iv	In progress	• OMNRF is undertaking a comprehensive review of its provincial bait policies which includes aspects related to use, movement and harvest, and is considering options related to species at risk fishes	**DFO**, ABCA, OMNRF	N/A
Broad Strategy 4: Stewardship, Outreach and Awareness					
(3-1) Collaborate with relevant groups, initiatives and recovery teams to address recovery actions of benefit to the Lake Chubsucker.	vi	In progress	• The collaboration of existing ecosystem recovery teams to implement conservation measures has been ongoing and applies to Lake Chubsucker in the OAC and L Lake, the Essex-Erie Fish Species at Risk Recovery Program, the OFFRT etc.	**DFO**, ABCA, ERCA	Number of high priority sites enhanced/protected by stewardship actions; and, documentation of public and agency participation/support for recovery actions identified in the Recovery Strategy (including in-kind and contributed financial resources).
(3-2) Promote stewardship and awareness among landowners abutting aquatic habitats of Lake Chubsucker and other local residents.	vii	In progress	Raise Community Support: • Presentation given to landowners, cottagers and farmers regarding environmental issues and initiatives in Rondeau Bay, SARA and critical habitat. • Annual meeting of Stewardship and Outreach Recovery Implementation Group to coordinate efforts and foster partnerships.	**DFO**, ABCA,	Number of high priority sites enhanced/protected by stewardship actions; and, Documentation of public and agency participation/support for recovery actions identified in the Recovery Strategy (including in-kind and contributed financial resources).

Table 2. Activities conducted/ongoing since the completion of the Lake Chubsucker Recovery Strategy.

Activity	Recovery Objectives Addressed	Status	Details	Participants[2]	Performance Indicators
			• Presentations given to environmental students at Fleming College regarding species at risk, threats, critical habitat and species recovery. • Provided presentations on threats and protection measures to Ontario Aboriginal Lands Association (OALA) and Ontario First Nations Economic Development Association (OFNEDA) First Nation groups on species at risk (including Lake Chubsucker) found in their area. External Agency Outreach Programs: • Ausable River Recovery Strategy Implementation (ABCA) as well as the Restoring Rondeau Bay's Ecological Integrity and Rondeau Bay Watershed Restoration projects (OMNRF): media broadcasts, internet outreach, printed media, general public outreach, targeted outreach, stewardship training.		
			Habitat enhancement and protection programs: • Essex-Erie Fish Species at Risk Recovery Program, Rondeau Bay Watershed Restoration Project, Restoring Rondeau Bay's Ecological Integrity, and Ecosystem Restoration on a Watershed Basis: vegetation planting, riparian restoration, other habitat improvement activities.	**DFO**, ABCA, OMNRF	Number of high priority sites enhanced/protected by stewardship actions.
(3-3) Work with landowners to implement BMPs in areas that will	iv, vii	In progress	• Presentations given to farmers and drain engineers in southwestern Ontario by DFO staff.	**DFO**, OMNRF, ABCA	Number of high priority sites enhanced/protected by stewardship actions.

Table 2. Activities conducted/ongoing since the completion of the Lake Chubsucker Recovery Strategy.

Activity	Recovery Objectives Addressed	Status	Details	Participants[2]	Performance Indicators
provide the most benefit. Encourage the completion and implementation of EFMPs and NMPs.			• BMPs encouraged on rural properties, including livestock restrictions (fencing), milkhouse washwater system installations, riparian buffers, streambank stabilization, wetland creation or enhancement, well decommissioning, septic upgrades, and sediment control/trapping.		
(3-4) Develop a communications strategy that identifies partners and target audiences, approaches, information products, educational and outreach opportunities, stewardship resources and specific BMPs that will assist with the recovery of this species.	vii	In progress	• An outreach strategy was developed for species at risk 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 landowner, farmers and cottagers, as well as recreational groups such as ATV/trail users. **Conservation/Environmental/ Stewardship Organizations** – fish and game clubs, naturalist and environmental protection organizations, students and stewardship councils.	**DFO**, OMNRF	Degree of protection/restoration achieved for known habitats of the Lake Chubsucker (e.g., number of habitat patches/populations enhanced).
(3-5) Facilitate access to funding sources for landowner and local community groups engaged in stewardship activities.	vii	In progress	• Habitat Stewardship Program (HSP) funding is provided by DFO through the conservation authorities to support local stewardship initiatives led primarily by environmental non-government organizations. • The activities supported facilitate the implementation of recovery efforts, BMPs associated with water quality	**DFO**, OMNRF, ABCA	

Table 2. Activities conducted/ongoing since the completion of the Lake Chubsucker Recovery Strategy.

Activity	Recovery Objectives Addressed	Status	Details	Participants[2]	Performance Indicators
			improvements, sediment load and reduction, etc. (e.g., HSP funding has led to a number of habitat improvements in Lake Chubsucker habitat in Rondeau Bay, for example).		
(3-6) Provide clear communications addressing compensation opportunities and landowner concerns and responsibilities under SARA.	vii	In progress	• Compensation opportunities, as well as land owner concerns and responsibilities have been communicated by conservation authorities to local groups and organizations and landowners.	**DFO**, OMNRF, ABCA	N/A
(3-7) Provide a Lake Chubsucker information package to commercial fishers (including bait fishers). Request avoidance of occupied habitats, and the release and reporting of any Lake Chubsucker captured.	vi	In progress	• No information package specific to Lake Chubsucker has been developed at this time that addresses incidental harvest. • Drake and Mandrak (2014 b) released an academic publication documenting the potential for species at risk fish species to be harvested as bycatch, which could inform a future information package in regard to bait fisheries. • The baitfish primer (Cudmore and Mandrak 2011) produced by DFO is also a tool that bait fishers can use to differentiate species at risk from other more common species.	**DFO**, OMNRF	N/A
(3-8) Increase public awareness of the impacts of invasive species on the natural ecosystem and encourage the use of existing invasive species reporting systems. Discourage anglers from	vi	In progress	• Dissemination of aquatic invasive species information through the Watercraft Inspection Program. • Distribution of aquatic invasive species educational information by DFO through public postings and direct engagement.	**DFO**, OMNRF, OFAH, ABCA	Degree of protection/restoration achieved for known habitats of the Lake Chubsucker (e.g., number of habitat patches/populations enhanced).

Table 2. Activities conducted/ongoing since the completion of the Lake Chubsucker Recovery Strategy.

Activity	Recovery Objectives Addressed	Status	Details	Participants[2]	Performance Indicators
emptying the contents of bait buckets in areas where the bait was not captured.			• Distribution of information through info cards (e.g., ABCA's OAC Fish Community card provides information regarding species at risk as well as invasive species that threaten them). • Licensed commercial baitfish harvesters in Ontario have completed Hazard Analysis and Critical Control Point (HACCP) training, which focuses on impacts and prevention of the spread of aquatic invasive species. • Drake and Mandrak (2014a; 2014b) released an academic publication quantifying the risk of invasive species introductions throughout the province.		

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 from 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 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 3. Status of studies outlined in the Schedule of Studies to Identify Critical Habitat within the Lake Chubsucker Recovery Strategy.

Study	Timeline	Status	Details	Performance Indicators (if applicable)	Participants
Conduct studies to determine the habitat requirements for all life stages of the Lake Chubsucker.	2009-2011	In progress	• DFO monitoring surveys have been conducted within Long Point Bay, L Lake Little Bear and Lyons creeks and involved a habitat component to aid in the identification of the functions, features and attributes of critical habitat. • Specific research into the habitat needs of each life stage is still pending.	Completion of activities outlined in the Schedule of Studies for the complete determination of critical habitat within the proposed timelines.	DFO
Survey and map habitat quality and quantity within historical and current sites, as well as sites adjacent to currently occupied habitat.	2009-2011	In progress	• DFO monitoring surveys have been conducted within Long Point Bay, L Lake, Little Bear and Lyons creeks and involved the assessment of habitat	Long-term population and habitat monitoring program established by 2013.	DFO, OMNRF

Study	Timeline	Status	Details	Performance Indicators (if applicable)	Participants
			conditions.		
Conduct additional species surveys to fill in distribution gaps, and to aid in determining population connectivity.	2009-2011	In progress	• Targeted surveys of extant and potentially undetected populations were completed in Niagara and Lake Huron drainages to assess demographics and connectivity.	Extent of existing populations (including abundance and population demographics) fully determined through background surveys by 2011.	DFO
Create a population-habitat supply model for each life stage.	2012-2013	Not started	• Nothing to report.	Completion of activities outlined in the Schedule of Studies for the complete determination of critical habitat within the proposed timelines.	
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 population-habitat supply model and refine critical habitat descriptions as necessary.	2012-2013	Not started	• Nothing to report.	Completion of activities outlined in the Schedule of Studies for the complete determination of critical habitat within the proposed timelines; Degree of protection/restoration achieved for known habitats of the Lake Chubsucker (e.g., number of habitat patches/populations enhanced).	

3.3. Summary of progress towards recovery

3.3.1 Status of performance indicators

Table 4 provides a summary of the progress made toward meeting the performance indicators outlined in Section 2.3.1. Each indicator has been assigned one of four 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 (i.e., the indicator will be reported against in the next five-year progress report)

Table 4. Status of performance indicators listed in the Lake Chubsucker Recovery Strategy.

Performance indicator	Status	Details	Next Steps
Extent of existing populations (including abundance and population demographics) fully determined through background surveys by 2011.	*Not met, underway*	• Targeted surveys of extant and potentially undetected populations were completed in Lake Erie (Long Point Bay), as well as Niagara (Big Forks, Tea and Lyons creeks, Grassy Brook) and Lake Huron (OAC, L and Mouth lakes) drainages, to assess demographics and connectivity.	Targeted surveys should be conducted in: Jeanette's Creek (a tributary of the Thames River); the Big and Stoney Creek watersheds, which feed into Long Point (Lake Erie); the St. Clair River delta (Walpole Island First Nation land); and, tributaries that flow into Lake St. Clair, such as Little Bear Creek where the Lake Chubsucker was incidentally detected during Pugnose Minnow (*Opsopoeodus emiliae*) sampling. Point Pelee National Park should also be sampled considering the last survey was undertaken in 2003.
Completion of activities outlined in the Schedule of Studies for the complete determination of critical habitat within the proposed timelines.	*Not met, underway*	• DFO monitoring surveys have been conducted within Long Point Bay, L Lake and Lyons Creek and involved a habitat component to aid in the identification of the functions, features and attributes of critical habitat.	Research into habitat needs of each life stage of Lake Chubsucker should be conducted to adequately identify the functions, features and attributes that are required for the survival of the species.
Degree of protection/restoration achieved for known	*Met, ongoing*	• Water quality and habitat improvement through agricultural BMPs, and water regulation in the	Continued restoration activities and stewardship/promotion of BMPs in other areas of the species' range such as the Niagara drainages.

Table 4. Status of performance indicators listed in the Lake Chubsucker Recovery Strategy.

Performance indicator	Status	Details	Next Steps
habitats of the Lake Chubsucker (e.g., number of habitat patches/populations enhanced).		OAC. • Water quality improvements to the watershed that feeds Rondeau Bay. • Common Reed removal to restore wetted habitat has been conducted in Long Point Bay, Turkey Point, and the Big Creek wetland complex. • Currently 4/8 populations are found within NWAs and national parks, affording them additional protection.	
Long-term population and habitat monitoring program established by 2013.	*Met, ongoing*	• A standardized population and habitat monitoring program involving the establishment of a network of permanent monitoring stations throughout historical and present Lake Chubsucker habitat is currently in development. A DFO technical report was published (Dextrase et al. 2014) summarizing the optimal gear type and effort to detect species at risk, including the Lake Chubsucker.	Further research should be conducted to: a) Determine the spatial scale of suitable habitat that must be sampled; b) Confirm and strengthen the results of the sampling effort study; and, c) Investigate the applicability of a two-tiered sampling approach including both low effort and labour-intensive methods. The more labour-intensive measures, such as density estimates, could be applied to smaller spatial scales for research, such as habitat associations and species abundance. In contrast, less intensive presence/absence data could be collected over larger spatial scales to assess the distributional extent of populations within watersheds.
Quantification of stewardship effort (i.e., BMPs) implemented through ecosystem-based recovery teams and other relevant or complementary groups/initiatives (e.g., number of EFMPs and NMPs completed; hectares of riparian buffers established; number of	*Met, ongoing*	• A general inventory of stewardship activities performed through HSP funding has been undertaken within Rondeau and Long Point bays. These habitat improvement activities included: • 326 ha of vegetation planted • 142 ha of vegetation and invasive species removed (e.g. Common	Ecosystem-based recovery programs to implement on-the-ground stewardship efforts to reduce identified threats are ongoing [e.g. Ausable River Action Plan (DFO 2016)].

Table 4. Status of performance indicators listed in the Lake Chubsucker Recovery Strategy.

Performance indicator	Status	Details	Next Steps
livestock restricted from watercourses).		Reed) • 13 km of riparian shoreline restored.	
Number of high priority sites enhanced/protected by stewardship actions.	*Met, ongoing*	• A total of 97 sites were enhanced through stewardship activities over the five year time period; project funding for both habitat improvement and protection measures was provided through HSP within Rondeau and Long Point bay areas.	Recovery programs to implement on-the-ground stewardship efforts to reduce identified threats are ongoing.
Documentation of public and agency participation/support for recovery actions identified in the Recovery Strategy (including in-kind and contributed financial resources).	*Met, ongoing*	• The participation and support provided by partner organizations and agencies, funded through various programs is documented by DFO on an annual basis.	Documentation of recovery implementation is ongoing.

To summarize progress towards recovery, implementation of the short-term recovery objectives have been assessed as follows:

I. Refine population and distribution objectives.

- The known population and distribution of Lake Chubsucker has been updated since the Recovery Strategy based on targeted surveys conducted in sections of watersheds where this species was historically known to exist.
- High probability areas of suitable habitat were also surveyed in tributaries of the Niagara River and Lake Huron.

II. Ensure adequate protection of critical habitat.

- The Ausable River Action Plan (DFO 2017) prescribes the incorporation of protection for critical habitat features within the municipal planning process to ensure agencies recognize the importance of wetland habitats for Lake Chubsucker.
- DFO and the OMNRF are investigating the seasonal habitat needs of the Lake Chubsucker.

III. Determine long-term population and habitat trends.

- The current development of a standardized population and habitat monitoring program involving the establishment of a network of permanent monitoring stations throughout historical and current Lake Chubsucker habitat is an important step in the process of meeting this objective.

IV. Identify threats, evaluate their relative impacts, and implement remedial actions to reduce their effects, where feasible.

- Threats to Lake Chubsucker have been evaluated and ranked by priority at the population level through the Recovery Potential Assessment (DFO 2011). Further evaluation and assessment of threats has been accomplished as outlined in Table 2 (refer to sections 1-8, 1-10, 1-6, 1-7 and 2-4).
- The implementation of remedial actions to address threats are also summarized in Table 2 (refer to sections 3-2, 3-3 and 3-5) and are ongoing; for more detail refer to Table 5 (quantification of stewardship effort).

V. Determine the feasibility of repatriations for populations that may be extirpated or reduced.

- This objective has not been met at this point in time.

VI. Enhance efficiency of recovery efforts through coordination of recovery efforts with aquatic and terrestrial ecosystem recovery teams and other relevant or complementary groups/initiatives.

- Collaboration with existing recovery teams, such as the Ausable River Recovery Team, Essex-Erie Fish Species at Risk Recovery Team, and the OFFRT is ongoing to implement recovery actions as needed.

VII. Improve overall awareness of the Lake Chubsucker and the role of healthy aquatic ecosystems, and their importance to humans.

- Presentations have been delivered by DFO staff, as well as those of partner organizations, at multiple venues to a range of audiences.
- Signage has been installed adjacent to critical habitat in several locations such as the Lower Thames River and Rondeau Bay Provincial Park, Big Creek NWA, L Lake, Long Point Bay, OAC, and the St. Clair NWA.

3.3.2 Completion of action plans

The Ausable River Action Plan (DFO 2017) is currently in development and includes recovery activities for the Lake Chubsucker. Although an ecosystem/multispecies document, this Action Plan includes several components that specifically implement recovery objectives for the Lake Chubsucker within the Old Ausable Channel and L Lake.

3.3.3 Critical habitat identification and protection

Critical habitat was partially identified in the Recovery Strategy in the following locations: the OAC, L Lake, St. Clair NWA, Point Pelee National Park, Rondeau Bay, Long Point Bay, Big Creek NWA, and Lyons Creek. Since the publication of the Recovery Strategy, surveys have been conducted to identify further critical habitat in areas where this species was historically present as well as novel areas where suitable habitat is available; however, no Lake Chubsucker were detected as a result of these surveys.

Since 2010, the critical habitat of the Lake Chubsucker found within NWA's and National Parks (i.e., Big Creek NWA, Long Point NWA, St. Clair NWA and Point Pelee National Park) has been legally protected from destruction under subsection 58(1) of SARA.

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 Lake Chubsucker populations, within Canadian waters, no longer meet the feasibility criteria laid out in the Recovery Strategy. For example, there are still enough reproducing individuals and suitable habitat to support recovery objectives, and threats to the species can be or have been addressed through restoration efforts and the promotion of BMPs.

4. Concluding statement

Overall, recovery activities conducted over the last five years have helped to provide a clearer understanding of the range and extent of Lake Chubsucker in Canada, as well as the features, functions and attributes necessary for the survival of this species. Furthermore, investigations into the efficacy of gear types and sampling techniques for the detection of this species have

provided further insight regarding the development of a standardized, species-specific sampling protocol that will lead to a better assessment of distribution and abundance over time.

The recovery activities have also allowed for the evaluation of the effects of threats, specifically the invasive species Common Reed on Lake Chubsucker critical habitat and abundance, as well as the efficacy of related restoration projects. Studies exploring stressors to populations at the watershed and subwatershed level have also been conducted in areas such as the OAC, the results of which will help to refine the focus of future restoration efforts. Additionally, a number of restoration projects and the promotion of BMPs have led to reduced sedimentation and nutrient loading in locations such as Rondeau and Long Point bays. Lastly, awareness and outreach activities including info sessions focused on species at risk and their critical habitats have been provided to conservation authorities, drainage supervisors, contractors, consultants and municipal planners. Signage was also installed near sections of critical habitat to ensure increased awareness of at risk species within the area, as well as the activities that might negatively impact them.

Taken together, these ongoing and/or completed activities indicate that a substantial degree of progress has been made towards the goal of recovering Lake Chubsucker populations in Canada. There are still a number of areas where further information is required. For example, it is difficult to establish viable population and distribution objectives in the absence of detailed population records; therefore, further monitoring and assessment should be conducted to refine the extent of the species' distribution and determine its prevalence within its current distribution. For this reason, it may be beneficial to focus future recovery activities on filling these knowledge gaps. Furthermore, increased monitoring surveys, management and coordination, stewardship and outreach activities are needed within the lower Thames River and the St. Clair River delta, as well as other tributaries that flow into Lake St. Clair (i.e., Little Bear Creek) to fill in the major knowledge gaps that surround these populations.

References

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

Badzinski, S.S., S. Proracki S.A. Petrie, and D. Richards. 2008. Changes in the distribution and abundance of common reed (*Phragmites australis*) between 1999 and 2006 in marsh complexes at Long Point - Lake Erie. Prepared for the Ontario Ministry of Natural Resources. Accessed: 20 November 2014.

Baker, K. 2005. Nine year study of the invasion of western Lake Erie by the Round Goby (*Neogobius melanostomus*): changes in goby and darter abundance. Ohio Journal of Science 105: A-31.

Chapman, D.C., J.J. Davis, J.A. Jenkins, P.M. Kocovsky, J.G. Miner, J. Farver and P.R. Jackson. 2013. First evidence of grass carp recruitment in the Great Lakes Basin. Journal of Great Lakes Research (2013).

Cudmore, B. and N.E. Mandrak. 2011. The baitfish primer: a guide to protecting Ontario's baitfishes. Published by Communications Branch Fisheries and Oceans Canada 2011.

Dextrase, A.J., N.E. Mandrak, J. Barnucz, L.D. Bouvier, R. Gaspardy, and S.M. Reid, 2014. Sampling effort required to detect fishes at risk in Ontario. Canadian Manuscript Report of Fisheries Aquatic Sciences. 3024: v + 50 p.

DFO (Fisheries and Oceans Canada). 2011. Recovery Potential Assessment of Lake Chubsucker (*Erimyzon sucetta*) in Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/033.

DFO (Fisheries and Oceans Canada). 2015. Fish exclusion options for aquatic species at risk for drainage activities in Little Bear Creek, Ontario. Canadian Science Advisory Secretariat Science Response 2015/36.

DFO (Fisheries and Oceans Canada). 2017. Action Plan for the Ausable River in Canada: An Ecosystem Approach [Draft]. *Species at Risk Act* Action Plan Series. Fisheries and Oceans Canada, Ottawa. XX + XX p.

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

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

Embke, H.S., P.M. Kocovsky, C.A. Richter, J.J. Pritt, C.M. Mayer, S.S. Qian. 2016. First direct confirmation of grass carp spawning in a Great Lakes tributary. Journal of Great Lakes Research, 42: 899-903.

French, J.R.P. and D.J. Jude. 2001. Diets and diet overlap of nonindigenous gobies and small benthic native fishes co-inhabiting the St. Clair River, Michigan. Journal of Great Lakes Research 27: 300-311.

Gilbert, J.M. and B. Locke. 2007. Restoring Rondeau Bay's ecological integrity. A report funded by: The Lake Erie Management Unit, OMNR, the Canada/Ontario Agreement and the Lake Erie Habitat Restoration Section, Environment Canada. 40 pp.

Janssen, J. and D.J. Jude. 2001. Recruitment failure of mottled sculpin *Cottus bairdi* in Calumet Harbour, southern Lake Michigan, induced by the newly introduced Round Goby *Neogobius melanostomus*. Journal of Great Lakes Research 27:319-328.

Jean, K., M. Veliz, H. Brock, and B. Upsdell Wright. 2013. Investigation of threats to species at risk fishes in the Grand Bend – Port Franks area. Ausable Bayfield Conservation Authority. Exeter, Ontario.

Jean, K., M. Veliz, B. Upsdell Wright, T. Skinner, and M. Lowenstine. 2015. Old Ausable Channel species at risk fishes habitat monitoring. Ausable Bayfield Conservation Authority. Exeter, Ontario.

OMNRF (Ontario Ministry of Natural Resources and Forestry). 2011. Invasive *Phragmites* – best management practices. Ontario Ministry of Natural Resources, Peterborough, Ontario. Version 2011. 17 p.

Reid, S.M. and N.E. Mandrak. 2008. Historical changes in the distribution of Threatened Channel Darter (*Percina copelandi*) in Lake Erie with general observations on the beach fish assemblage. Journal of Great Lakes Research 34: 324-33.

Rook, N.A., N.E. Mandrak, and S.M. Reid. 2016. Evaluation of habitat restoration on fish species at risk within Crown Marsh, Long Point Bay, Lake Erie, Ontario. Canadian Science Advisory Secretariat. Research Document 2016/059.

Russell, S.D.J. 2015. Nitrate sources in the Old Ausable River Channel and adjacent aquifers. Ph.D. Dissertation. Accessed: Dec. 2015.

Staton, S.K., K.L. Vlasman, and A.L. Edwards. 2010. Recovery Strategy for the Lake Chubsucker (*Erimyzon sucetta*) in Canada. In *Species at Risk Act* Recovery Strategy Series, Fisheries and Oceans Canada, Ottawa. vi + 49 p.

Steinhart, G.B., E.A. Marschall, and R.A. Stein. 2004. Round Goby predation on Smallmouth Bass offspring in nests during simulated catch-and-release angling. Transactions of the American Fisheries Society 133:121-131. DOI: 10.1577/T03-020.

Wiklund, J. 2013. Aquatic macrophyte survey of the Grand Bend – Port Franks area in support of: investigation of threats to species at risk fishes in the Grand Bend – Port Franks area.

Wiklund, J.A. 2015. Little Bear Creek, Dover & Chatham Townships, Kent County Ontario aquatic vegetation and fish habitat survey 2014. Report prepared for Nicholas E. Mandrak, Fisheries and Oceans Canada, Great Lakes Laboratory for Fisheries and Aquatic Science.

Wilcox, K.L., S.A. Petrie, L.A. Maynard, and S.W. Meyer. 2003. Historical distribution and abundance of *Phragmites australis* at Long Point, Lake Erie, Ontario. Journal of Great Lakes Research 29: 664–680.

Wittmann, M.E., C.L. Jerde, J.G. Howeth, S.P. Maher, A.M. Deines, J.A. Jenkins, G.W. Whitledge, S.R. Burbank, W.L. Chadderton, A.R. Mahon, J.T. Tyson, C.A. Gantz, R.P. Keller, J.M. Drake, and D. M. Lodge. 2014. Grass carp in the Great Lakes Region: establishment potential, expert perceptions, and re-evaluation of experimental evidence of ecological impact. Canadian journal of Fisheries and Aquatic Science, 71: 992-999.

Acronyms

ABCA	Ausable Bayfield Conservation Authority
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DFO	Fisheries and Oceans Canada
ERCA	Essex Region Conservation Authority
HACCP	Hazard Analysis and Critical Control Point
HSP	Habitat Stewardship Program
LPRCA	Long Point Region Conservation Authority
LTVCA	Lower Thames Valley Conservation Area
NWA	National Wildlife Area
OAC	Old Ausable Channel
OALA	Ontario Aboriginal Lands Association
OFAH	Ontario Federation of Anglers and Hunters
OFNEDA	Ontario First Nations Economic Development Association
OMNRF	Ontario Ministry of Natural Resources and Forestry
SAR	Species at Risk
SARFIP-F	Species at Risk Farm Incentive Program -F