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 2016 to 2021

Lake Chubsucker

2023

Canada

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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 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 5 years of the date when the recovery strategy was placed on the Species at Risk Public Registry and in every subsequent 5-year period, until its objectives have been achieved or the species' recovery is no longer feasible.

Reporting on the progress of recovery strategy implementation requires reporting on the collective efforts of the competent minister(s), provincial and territorial governments and all other parties involved in conducting activities that contribute to the species' recovery. Recovery strategies identify broad strategies and approaches that will provide the best chance of recovering species at risk. Some of the identified strategies and approaches are sequential to the progress or completion of others and not all may be undertaken or show significant progress during the timeframe of a Report on the Progress of Recovery Strategy Implementation (progress report).

The Minister of Fisheries and Oceans Canada and the Minister responsible for Parks Canada Agency are the competent minister(s) 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 groups that will be involved in implementing the directions set out in the recovery strategy and will not be achieved by Fisheries and Oceans Canada and Parks Canada, or any other jurisdiction alone. The cost of conserving species at risk is shared amongst different groups. 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.

Acknowledgments

This progress report was prepared by Zummara Tanwir, Department of Fisheries and Oceans Canada (DFO) and Joshua Stacey (DFO). To the extent possible, this progress report has been prepared with input from the Ontario Ministry of Natural Resources (OMNRF), Walpole Island First Nation, Environment and Climate Change Canada (ECCC), and Parks Canada (PC). DFO would also like to express its appreciation to all individuals and organizations who have contributed to the recovery of the Lake Chubsucker.

Executive summary

The Lake Chubsucker (*Erimyzon sucetta*) 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. The main threats identified for the Lake Chubsucker include natural system modification (via agriculture, shoreline development and hardening, and dredging), pollution (via agriculture, industrial activity, and urbanization), climate change, and invasive and other problematic species and genes.

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 (St. Clair River Delta, St. Clair National Wildlife Area [NWA]), Lake Erie (Point Pelee National Park [PPNP], Rondeau Bay, Long Point Bay, Big Creek NWA), and the upper Niagara River (Lyons Creek). During the period reported by the Report on the Progress of Recovery Strategy Implementation for the Lake Chubsucker (*Erimyzon sucetta*) in Canada for the Period 2016 to 2021, 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 L Lake (2018 and 2021) to determine population size, distribution, habitat preferences, and species interactions
- fish community surveys/inventories and fish habitat assessments conducted in extant Lake Chubsucker population locations, using appropriate gear for Lake Chubsucker, resulted in the detection of individuals in OAC, St. Clair NWA, PPNP, Big Creek NWA, Long Point Bay (inner bay), Long Point Bay (Long Point NWA), and Lyons Creek
- fish community surveys/inventories, which led to the detection of Lake Chubsucker, were conducted in the St. Clair River Delta, in partnership with Walpole Island First Nation, that examined fish species richness, abundance, size distribution, and biomass among 3 different types of emergent vegetation stands
- non-target sampling led to detections of Lake Chubsucker in all extant populations' locations, as well as new locations where Lake Chubsucker have not previously been recorded, including the Maxwell Cell and East Cell of St. Clair NWA, 2 drains located east of Lake St. Clair (Albert and Collop drains), and Big Creek NWA’s Hahn Unit, and an upper section of Big Creek which was historically occupied and Lake Chubsucker were considered extirpated
- funding provided through the Habitat Stewardship Program (HSP) and Canada Nature Fund for Aquatic Species at Risk (CNFASAR) allowed for Conservation Authorities to carry out monitoring, stewardship, and outreach projects that monitored and improved Lake Chubsucker habitat quality, increased awareness for aquatic species at risk (SAR), and engaged local landowners in applying best management practices in the OAC and Rondeau Bay
- a total of approximately 31 hectares of riparian habitat enhancement was completed by the Ausable Bayfield Conservation Authority (ABCA), Essex Region Conservation Authority (ERCA) and Lower Thames Valley Conservation Authority (LTVCA) from 2016 to 2020, benefiting Lake Chubsucker habitat in the OAC, Rondeau Bay, and Long Point Bay
- the impact of the spread and control of invasive species such as European Common Reed, and the threat posed by the potential invasion by Grass Carp, on Lake Chubsucker and its habitat have been investigated

- the threat of environmental stressors, such as poor water quality, climate change, and anthropogenic activities on Lake Chubsucker and its habitat were investigated through monitoring of habitat quality parameters and utilizing models
- the impact of water-control structure maintenance in the St. Clair NWA and St. Clair tributaries on Lake Chubsucker habitat was investigated, and alternative management scenarios were presented

Substantial progress has been made towards the recovery of Lake Chubsucker populations in Canada. Moving forward, it is important to fill remaining knowledge gaps and to address measures that have not been completed, such as characterizing the habitat needs of each life stage of Lake Chubsucker; undertaking studies that investigate population size, structure, and condition of extant Lake Chubsucker populations; finalizing a sampling protocol and monitoring program; developing population-habitat supply models for each life stage in each location; conducting targeted sampling in locations where populations are extant and have historically occurred (for example, Jeanette's Creek), and at new locations where the species has recently been detected, such as Big Creek NWA's Hahn Unit. Threat management/mitigation measures should be conducted, where feasible, to reduce factors leading to the decline of Lake Chubsucker.

Table of contents

1. Introduction

The Report on the Progress of Recovery Strategy Implementation for the Lake Chubsucker (*Erimyzon sucetta*) in Canada for the Period 2016 to 2021 outlines the progress made towards meeting the objectives and measures listed in the recovery strategy for the Lake Chubsucker from 2016 to 2021 and should be considered as 1 in a series of documents for this species that are linked and should be taken into consideration together. These documents include the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report (COSEWIC 2021), the "Recovery Strategy for the Lake Chubsucker (*Erimyzon sucetta*) in Canada" (Staton et al. 2010), and the "Information in Support of an Updated Recovery Potential Assessment of Lake Chubsucker (*Erimyzon sucetta*) in Canada, 2011–2020" (Colm and Drake 2023).

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 measures to measure the progress of recovery. For more detail, readers should refer to the recovery strategy (Staton et al. 2010). 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 towards achieving objectives and the outcome of the recovery effort.

2. Background

2.1 COSEWIC assessment summary

The reassessment of the Lake Chubsucker in 2011 from a threatened to endangered risk category was based on the information provided in the COSEWIC status report (COSEWIC 2008). In 2021, COSEWIC re-examined and confirmed the status of the Lake Chubsucker as endangered (COSEWIC 2021). This information has also been included in the COSEWIC Assessment Summary (COSEWIC 2021).

Date of assessment: May 2021
Common name: Lake Chubsucker
Scientific name: *Erimyzon sucetta*
Status: Endangered
Reason for designation:
This small sucker species is restricted in Canada to wetlands in southwestern Ontario. It has very specific and narrow habitat preferences, making it extremely susceptible to habitat changes driven by invasive species, climate change, and agricultural practices. These interacting threats result in increased turbidity and ongoing fragmentation and loss of habitat. In particular, it is suspected that, unless managed effectively, the invasive European Common Reed will rapidly expand and substantially reduce the species' habitat in a short period of time. A total of 3 historical subpopulations have been lost and, of the remaining 10, the relative population status is poor for 9 and fair for 1. If the threats to these extant subpopulations are not managed effectively, loss of individuals and subpopulations will continue.
Occurrence: Ontario
Status history:
This species was designated special concern in April 1994. The status was re-examined and designated threatened in November 2001. The status was re-examined and designated endangered in November 2008. Status was re-examined and confirmed in May 2021.

2.2 Distribution

Since 2015, Lake Chubsucker has been detected in several new localities and reconfirmed in areas where the species was known to be extant throughout its Canadian range (figures 1 to 5).

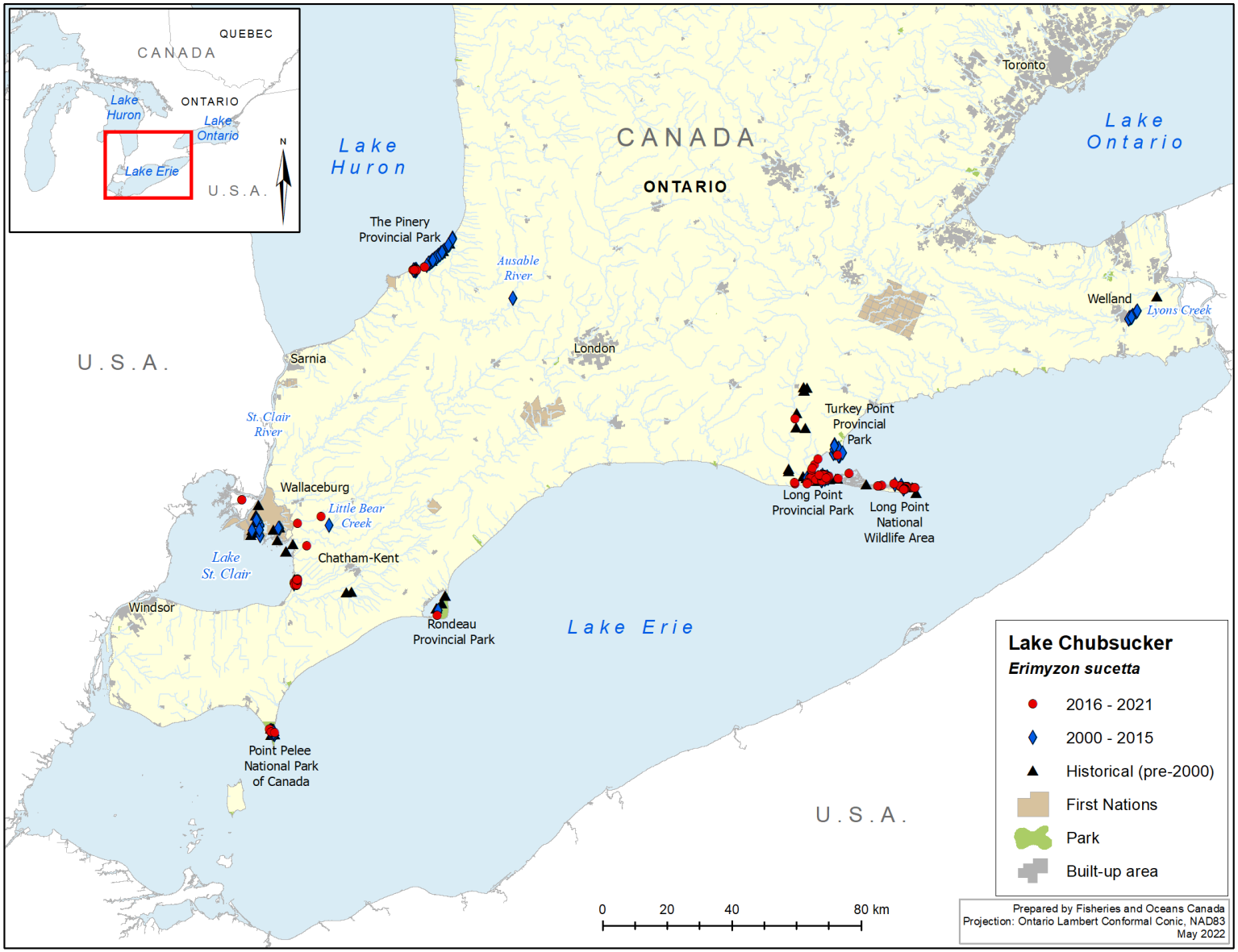

Figure 1. Historical distribution and recent detections of Lake Chubsucker throughout its range in southern Ontario.

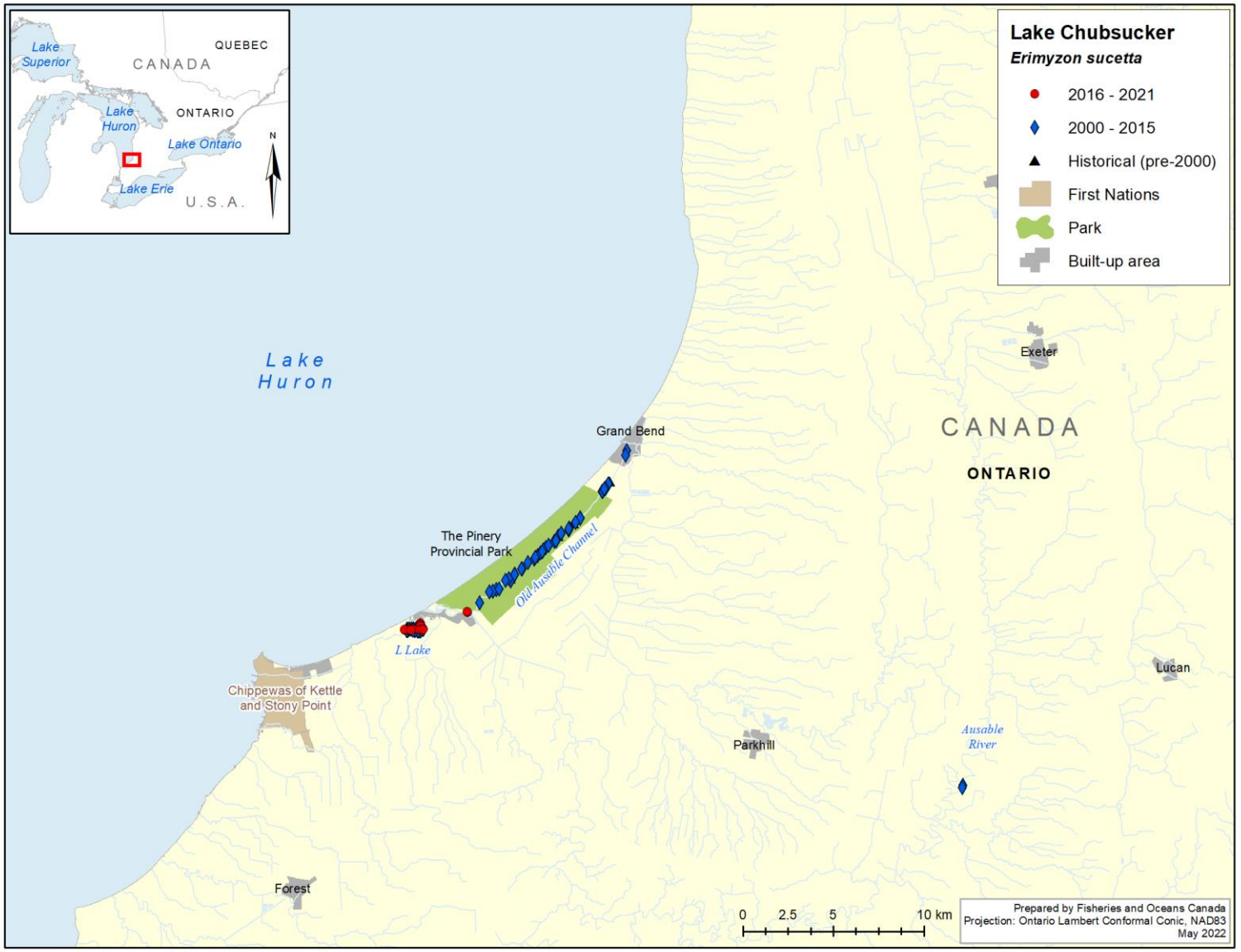

Figure 2. Historical distribution and recent detections of Lake Chubsucker in L Lake and Old Ausable Channel (OAC).

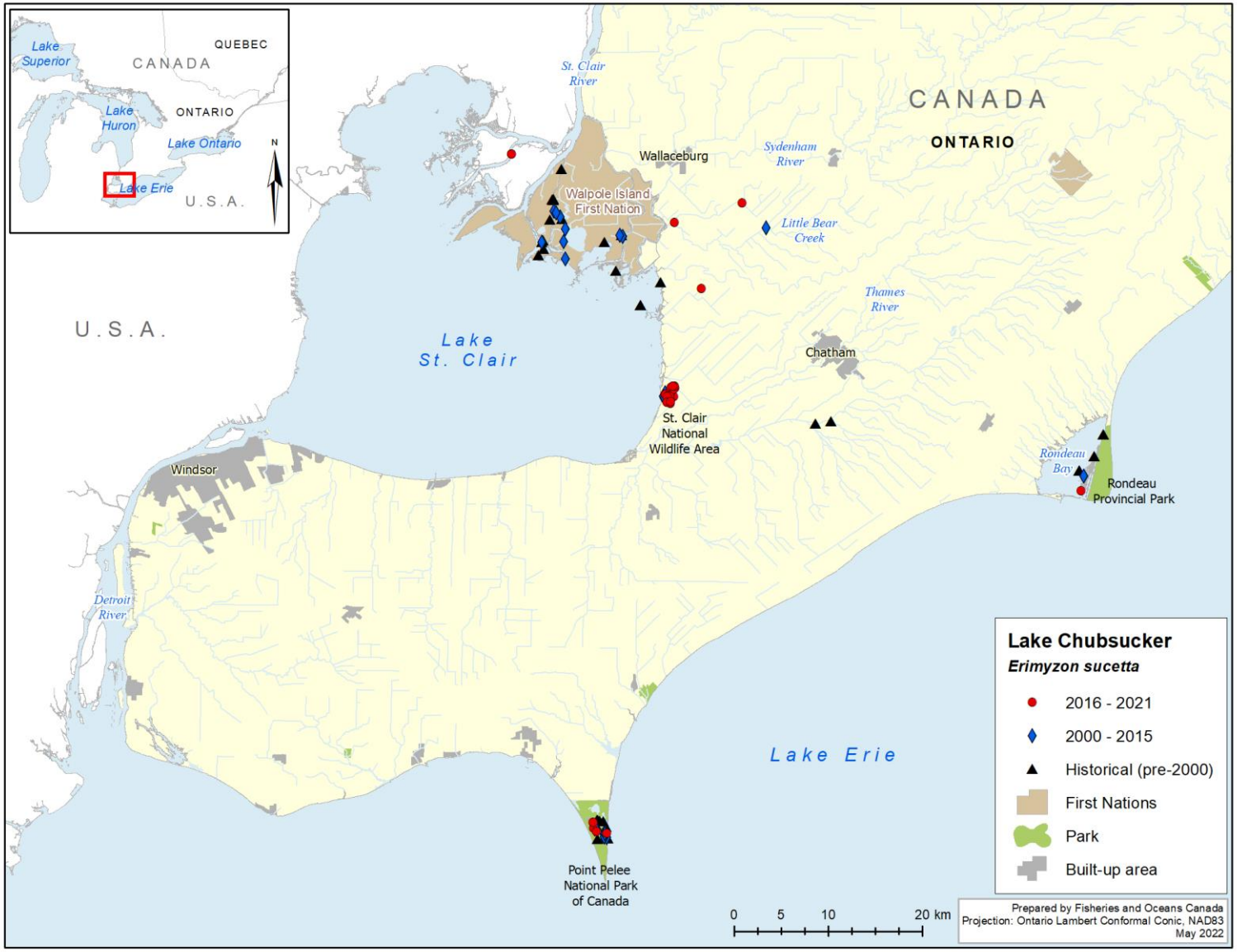

Figure 3. Historical distribution and recent detections of Lake Chubsucker in the St. Clair River Delta, Lake St. Clair, St. Clair National Wildlife Area (NWA), Point Pelee National Park, and Rondeau Provincial Park.

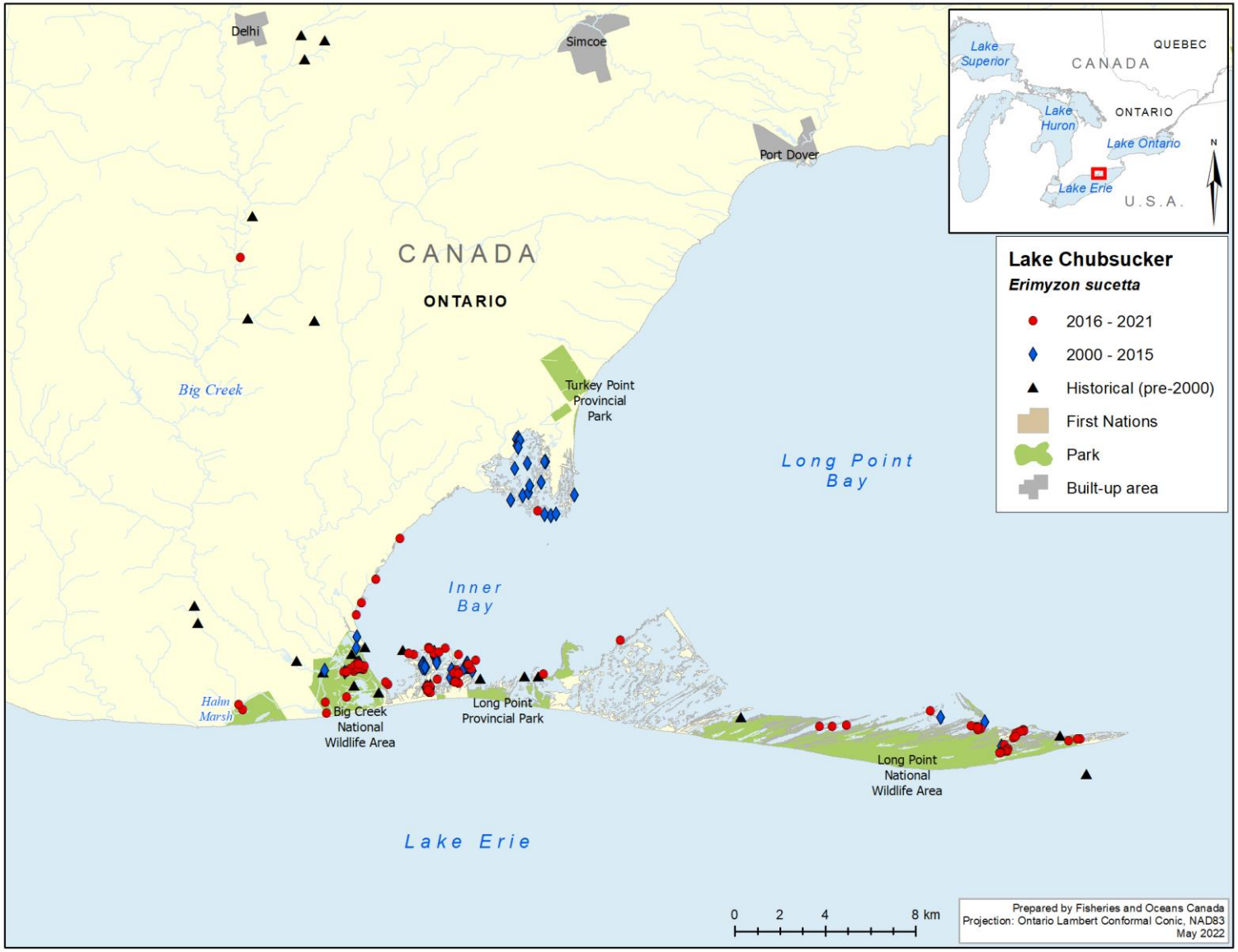

Figure 4. Historical and recent detections of Lake Chubsucker in Big Creek (Norfolk County), Big Creek NWA, Long Point Bay (Inner Bay), Long Point NWA. And Turkey Point.

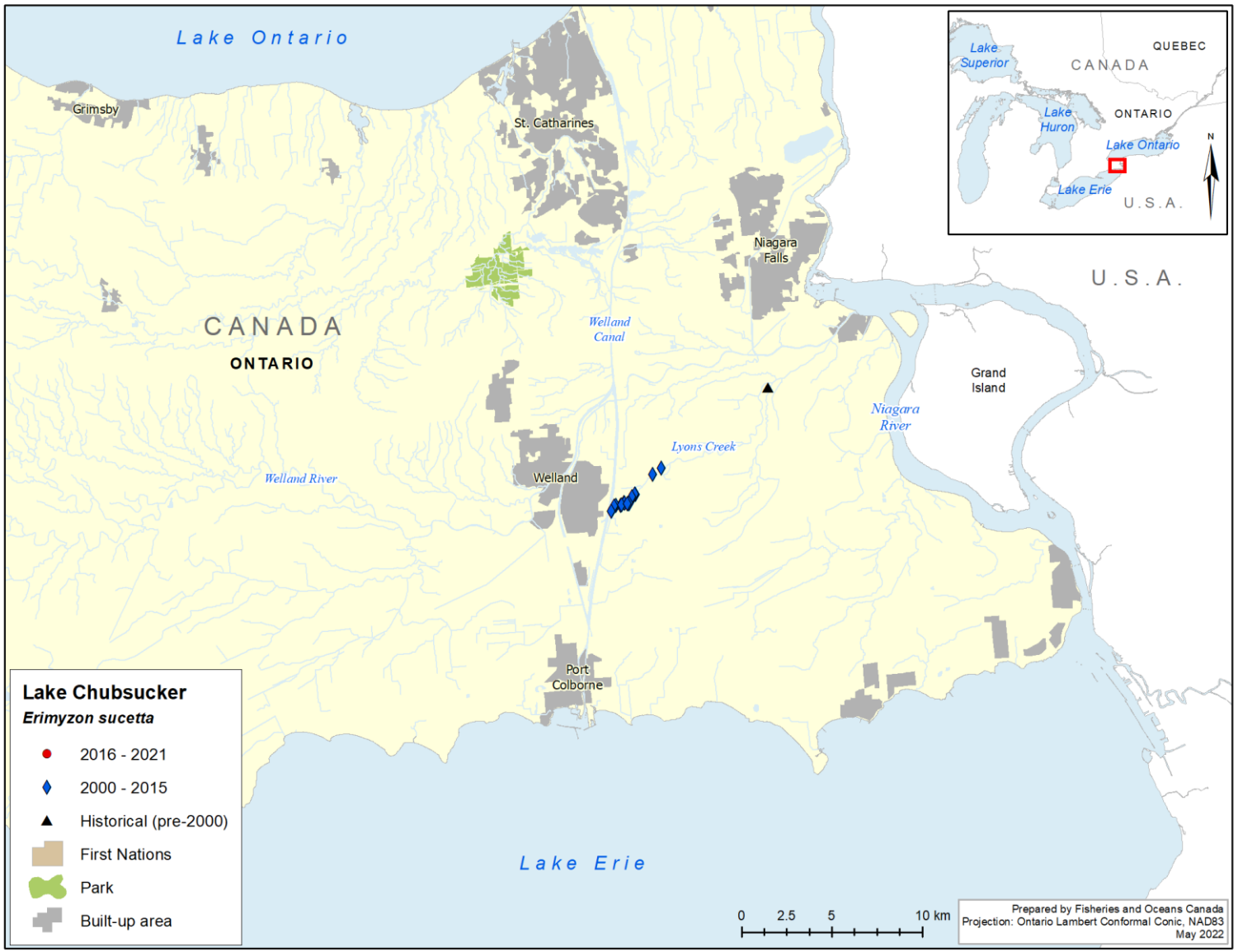

Figure 5. Historical detections of Lake Chubsucker in Lyons Creek, Ontario.

2.3 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.

2.3.1 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 have since been reassessed at an updated recovery potential assessment (RPA) meeting for Lake Chubsucker, which took place in 2021 (DFO 2023) (table 2). The updated threat level assessment of Lake Chubsucker populations in Canada (table 2), included an analysis of both the threat likelihood and threat impact. The number in brackets refers to the causal certainty associated with the threat impact (1 = Very High; 2 = High; 3 = Medium (Med); 4 = Low; 5 = Very Low). For more information, refer to the "Information in Support of an Updated Recovery Potential Assessment of Lake Chubsucker (*Erimyzon sucetta*) in Canada, 2011 to 2020" (Colm and Drake 2023).

Table 2. Population-level threat assessment for Lake Chubsucker in Canada (taken from Colm and Drake 2023).

Threat	Old Ausable Channel	L Lake	Lake St. Clair	Dyked Marshes within Lake St. Clair	St. Clair NWA[1]	PPNP[2]	Rondeau Bay	Long Point Bay	Long Point NWA	Big Creek NWA	Lyons Creek
Natural systems modification: Agriculture	Low	Low	High	Med	Med	High	High	High	Med	Med	High
Natural systems modification : Shoreline development and hardening	Med	Med	High	Low	Low	Low	Med	High	Low	Low	Med
Natural systems modification: Dredging	Low	Low	High	Low	High	Med	High	High	Low	High	Med
Natural systems modification: Drawdown of dyked wetlands and other water level manipulations	High	Med	Low	High	High	Low	Low	Low	Low	High	High

[1] National Wildlife Area.

[2] Point Pelee National Park.

Threat	Old Ausable Channel	L Lake	Lake St. Clair	Dyked Marshes within Lake St. Clair	St. Clair NWA[1]	PPNP[2]	Rondeau Bay	Long Point Bay	Long Point NWA	Big Creek NWA	Lyons Creek
Natural systems modification: Aquatic invasive species	High	High	High	High	High	High	High	High	High	High	Med
Pollution: Agriculture	Low	Low	High	Med	Med	High	High	High	Med	Med	High
Pollution: Industrial activity	Low	Low	Med	Med	Low	Med	Med	Med	Med	Med	Med
Pollution: Urbanization	Med	Med	Med	Low	Low	Med	Med	High	Med	Low	Med
Climate Change	High	High	Med	High	High	High	Med	Med	High	High	Med
Invasive and other problematic species and genes: Competition/ predation	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Invasive and other problematic species and genes: Illegal stocking	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low

Since the publication of the previous progress report, research has been conducted that further investigates the potential impacts of invasive species such as European Common Reed (*Phragmites australis ssp. australis*) and Asian carps, specifically the Grass Carp (*Ctenopharyngodon idella*); water quality issues that directly or indirectly affect Lake Chubsucker, including turbidity, higher water temperatures, and reduced dissolved oxygen; climate change; and anthropogenic activities, specifically drain maintenance. Invasive species are now likely a greater threat for Lake Chubsucker than represented in table 1, due to the increased expansion of European Common Reed which has resulted in habitat loss and degradation within the Lake Erie coastal wetlands. In response to this threat, government and non-government groups have implemented an integrated pest management strategy to control the spread of this invasive species and to improve habitat conditions for wetland species, such as Lake Chubsucker. A Before-after Control Impact (BACI) monitoring program in the managed areas revealed no evidence of elevated mortality risk from aerial herbicide applications used to control Common Reed (Reid et al. 2021). Continued monitoring of Lake Chubsucker in the managed areas is required to understand the impact of control efforts. Similarly, the threat of invasive Grass Carp on coastal habitats in the Great Lakes was investigated via predictive modelling, which suggested that all life stages of Lake Chubsucker are predicted to experience significant impacts if colonization of this species occurs in locations where populations are extant (Gertzen et al. 2017). Another major threat that is impacting Lake Chubsucker abundance in the OAC is reduced dissolved oxygen concentrations, which led to at least 1 winterkill event in 2010. The Ausable Bayfield Conservation Authority (ABCA) has monitored water quality in the OAC annually, revealing hypoxic conditions during the winter and summer months, as well as overall degraded aquatic habitat conditions in the northern portion of the channel (Ziegler et al. 2021). Continued monitoring of water quality and habitat conditions, as well as the implementation of stewardship efforts to improve riparian buffers in this area, are needed.

2.3.2 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). Table 2 provides examples of activities that are likely to result in destruction to critical habitat (that is, threats to critical habitat). The list of activities provided in this table 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 (Staton et al. 2010) and the updated RPA (Colm and Drake 2023).

Without appropriate mitigation, destruction of critical habitat may result from activities such as:

- dredging
- agriculture
- infilling along shorelines
- shoreline development and hardening
- drawdown of dyked wetlands and other water level manipulations
- installation of docks, groynes, and piers (in some cases, design choices [for example, floating docks instead of crib docks] can allow for the mitigation of impacts)
- instream/in-water work
- aquatic invasive species (habitat-related impacts)
- unfettered livestock access to waterways
- channelization and drainage works
- removal of riparian vegetation

- pollution (industrial, urban, and/or agricultural)
- climate change
- water-taking (this may include the prevention or interruption of clean water flow from the Welland Canal into Lyons Creek)
- sewage treatment plant/septic system/manure spills
- construction of dams and impoundments
- deliberate or accidental introduction of exotic species

2.4 Recovery

This section summarizes the information found in the recovery strategy (Staton et al. 2010) on the population and distribution objectives for the recovery of the Lake Chubsucker and on performance measures that provide a way to define and measure progress towards achieving the population and distribution objectives.

2.4.1 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 (St. Clair River Delta and St. Clair NWA), Lake Erie (PPNP, 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 repatriation for populations that may be extirpated or reduced
vi. enhance efficiency of recovery efforts through coordination with aquatic and terrestrial ecosystem recovery teams and other relevant or complementary groups/initiatives
vii. improve overall awareness of the Lake Chubsucker and the role of healthy aquatic ecosystems, and their importance to humans

2.4.2 Performance measures

- extent of existing populations (including abundance and population demographics) fully determined through background surveys by 2011
- 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 (for example, number of habitat patches/populations enhanced)
- long-term population and habitat monitoring program established by 2013
- quantification of stewardship effort (that is, best management practices [BMPs]) implemented through ecosystem-based recovery teams and other relevant or complementary groups/initiatives (for example, number of environmental farm plans [EFPs] and nutrient management plans [NMPs] completed; hectares of riparian buffers established; number of livestock restricted from watercourses)
- number of high priority sites enhanced/protected by stewardship actions
- 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 timeframe covered in this progress report. In such cases, the implementation of the recovery approaches and critical habitat studies will help report on the progress towards achievement of the performance measures.

3. Progress towards recovery

The recovery strategy for the Lake Chubsucker (Staton et al. 2010) divides the recovery effort into 3 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 towards meeting the performance measures and other commitments (for example, 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 report is on actions identified in the original recovery strategy that were deemed urgent, and in some cases, necessary. The list of results is meant to briefly touch on some of the more significant accomplishments and is not meant to be exhaustive.

3.1 Activities supporting recovery

Tables 3 to 5 provide information on the implementation of activities undertaken to address the approaches and broad strategies identified in the recovery planning table of the recovery strategy.

Table 3. Implementation of research and monitoring activities undertaken to address the measures identified in the recovery planning table of the recovery strategy for the Lake Chubsucker.

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
1-1 Background surveys: Conduct targeted surveys of preferred habitats in tributaries of Big Creek (Long Point region/Norfolk County), Jeanette's Creek and Tea Creek, to determine the status of these populations.	A single Lake Chubsucker was detected in an upper section of Big Creek (Norfolk County) through research conducted by the Sea Lamprey Control Program (SLCP) of Fisheries and Oceans Canada (DFO) in 2021 (SLCP, 2022). Projects targeting other species using sampling methods that are effective for detecting Lake Chubsucker in suitable habitat have been conducted in Jeanette's Creek; however, no Lake Chubsucker were detected. No surveys targeting Lake Chubsucker have been conducted at Tea Creek from 2016 to 2021. Lake Chubsucker are thought to be extirpated in Tea Creek, with only a single historic record of this species in 1958 (COSEWIC, 2021).	I, VI	**DFO**
1-2 Background surveys (extant occurrences): Complete targeted surveys of extant populations.	**Old Ausable Channel (OAC)** The Ausable Bayfield Conservation Authority (ABCA) conducted sampling in the OAC in the fall of 2021 and captured a total of 46 Lake Chubsucker (Jean pers. comm. 2022).	I, VI	**DFO**; McGill University; OMNRF; ABCA; Parsons Inc.; USGS; U of T;

[3] Lead participant(s) is/are listed on top and in bold; other participants are listed alphabetically (not all studies have specific lead participants identified).

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	L Lake In 2018, DFO conducted a mark-recapture sampling study for Lake Chubsucker and Grass Pickerel in L Lake, with the goal of estimating population size, determining distribution and characterizing habitat features used by these species (Barnucz & Drake, 2021a). Sampling was conducted twice (August and September) at 43 sites around the perimeter of L Lake through the deployment of bag seines within straight seines. A total of 39 Lake Chubsucker were captured, representing multiple age classes, and 21 individuals were tagged. No tagged individuals were re-captured during the second sampling period. Powell and Reemeyer (2021) sampled L Lake for Lake Chubsucker with fyke nets in 2021 and captured 20 individuals (16 adults and 4 juveniles). **St. Clair River Delta** From 2013 to 2019, researchers from the United States Geological Survey (USGS) Great Lake Science Center conducted annual shoreline seine surveys in the St. Clair River-Detroit River System and collected 9 and 25 Lake Chubsucker 2017 and 2019, respectively, in United States (U.S.) waters adjacent to Walpole Island First Nation lands (WIFN) in the St. Clair River Delta (Hilling et al. 2021). Fish community surveys were conducted by DFO in collaboration with the University of Toronto, Scarborough (U OF T), throughout Southern Ontario wetlands in 2016, leading to the detection of a total of 68 Lake Chubsucker in areas of the St. Clair River Delta (WIFN) (DFO, unpublished data).		Walpole Island Heritage Centre

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	In 2017, DFO and WIFN partnered in a fish community assemblage study to compare fish species richness, abundance, size distribution, and biomass among 3 different types of emergent vegetation stands (non-native *Phragmites*, *Typha* spp. and Schoenoplectus spp.) in the waters surrounding Walpole Island, and to determine the optimal gear for effectively sampling fish community assemblages in non-native *Phragmites australis* (Gardner Costa et al. 2020). A total of 31 Lake Chubsucker were captured (Gardner Costa et al. 2020). Non-target surveys that represent potential effort for Lake Chubsucker have been conducted by DFO's Asian Carp's Great Lakes Monitoring Program, leading to detection of 1 individual in the lower St. Clair River in 2020 (Aguiar et al. 2021). Non-target fish community surveys by DFO in the St. Clair-Detroit River System were conducted to determine indices of biotic integrity (IBI) of the system. This resulted in the detection of 49 Lake Chubsucker in the Snye (St. Clair River Delta) in 2019 (Midwood et al. 2020). **St. Clair National Wildlife Area (NWA)** In 2016, a fish inventory of the St. Clair Unit of St. Clair NWA was completed (Biotactic, 2016). Specifically within the East Cell of the Unit, this comprehensive survey was conducted utilizing multiple gear types, including minnow traps, fyke nets, cast nets, seine nets, dip nets, and angling, resulting in the detection of 22 Lake Chubsucker. In response to these detections, DFO conducted a fish community inventory of the dyked wetlands in this NWA (Barnucz et al. 2021b). They first re-sampled the East Cell		

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	in 2018 with mini-fyke nets, yielding 6 individuals. Additional sampling was conducted in 2019 of both the East and West Cells to describe the composition of the fish community in both cells via fyke nets, yielding 9 individuals in the East Cell and 5 in the West Cell. Fish community surveys conducted by DFO and U OF T throughout Southern Ontario wetlands in 2016, led to the detection of a total of 19 Lake Chubsucker in SCNWA marsh's West and Maxwell cells (DFO, unpublished data). **Point Pelee National Park (PPNP)** In 2016, DFO detected 1 Lake Chubsucker in Girardin Pond within PPNP (Colm and Drake 2023). In 2019, DFO conducted fish community sampling in PPNP within the open waters of Lake Pond, East Cranberry Pond, and West Cranberry Pond using mini-fyke nets over 2, 3-week periods in the summer months (Barnucz et al. 2021c). The aim of the study was to evaluate fish community composition, estimate population abundance of species at risk (SAR) fishes, including Lake Chubsucker, and evaluate site fidelity, movement, and habitat associations of SAR. A single Lake Chubsucker was captured in Lake Pond. DFO conducted a PPNP wetland fish community survey in 2021, leading to detection of 2 individuals from Girardin and Redhead Pond (Barnucz et al. 2022). **Long Point (Inner Bay)** Non-target surveys that represent potential effort for Lake Chubsucker have been conducted by DFO's Asian Carp's		

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	Great Lakes Monitoring Program in Long Point Bay, leading to detection of a total of 20 individuals from 2016 to 2021 (Marson et al. 2018; Colm et al. 2018; Colm et al. 2019a; Colm et al. 2019b; Colm and Marson, 2020; Aguiar et al. 2021; DFO unpublished data). The Ontario Ministry of Natural Resources and Forestry (OMNRF) conducted sampling in Long Point Bay (Inner Bay) to investigate habitat use by wetland fishes at risk in newly open-water habitats, following their creation after Common Reed control efforts (Reid pers. comm. 2022). This led to the detection of a total of 25 Lake Chubsucker from 2016 to 2021 (OMNRF, unpublished data). **Long Point Bay (Long Point National Wildlife Area [NWA])** Fish community surveys conducted by DFO and University of Toronto (U of T) throughout Southern Ontario wetlands in 2016, led to the detection of a total of 14 Lake Chubsucker in Long Point NWA (DFO, unpublished data). In the second year of this field study in 2017, a total of 54 individuals were observed in Long Point NWA (DFO, unpublished data). **Big Creek NWA** Fish community surveys conducted by DFO and U of T throughout Southern Ontario wetlands in 2016, led to the detection of a total of 165 Lake Chubsucker in Big Creek NWA's North and South dyked cells (DFO, unpublished data). In 2021, the consulting company, Parsons Inc. conducted an inventory of fish in the Big Creek NWA (DFO, unpublished data). The Big Creek Unit and Hahn Unit of the		

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	NWA were sampled primarily using fine mesh fyke nets, supplemented with seining where feasible. This survey resulted in the capture of a total of 4 Lake Chubsucker in the NWA, with 2 individuals caught in each Unit (2 adults and 2 juveniles in each). This is the first time Lake Chubsucker has been caught in Hahn Unit. **Rondeau Bay** Non-target surveys that represent potential effort for Lake Chubsucker have been conducted by DFO's Asian Carp's Great Lakes Monitoring Program in Rondeau Bay from 2016 to 2021. A single Lake Chubsucker was detected in 2020 (Aguiar et al. 2021). **Lyons Creek** No surveys have been conducted in this location during the 2016 to 2021 time period.		
1-3 Background surveys (new occurrences): Conduct targeted surveys of undetected populations in high probability areas with suitable habitat. Areas to target would include tributaries of the upper Niagara River.	Non-targeted surveys allowed for the observation of Lake Chubsucker in new locations, including the Ausable River (2020 and 2021), the St. Clair NWA East Cell (St. Clair Unit) (2016), the Maxwell Cell (Bear Creek Unit) (2016), Big Creek National Wildlife Area's Hahn Unit (2021), an upper section of Big Creek in Norfolk County (2021), Prince Albert Drain (2017), and Collop Drain (2018).	I, VI	**DFO**; Parsons Inc.; Stantec Inc.; St. Clair Region Conservation Authority (SCRCA)
1-4 Monitoring - populations and habitat: Develop and implement a standardized index population and habitat monitoring program with a specific sampling and training protocol.	A standardized habitat monitoring program has been carried out in the OAC by ABCA from 2016 to 2021 (supported by Habitat Stewardship Program [HSP] and Canada Nature Fund for Aquatic Species at Risk [CNFASAR] funding), to evaluate the status of SAR fish habitat by assessing dissolved oxygen concentrations via dissolved oxygen (DO) loggers and Yellow Springs	III	ABCA; DFO; OMNRF; U of T Walpole Island First Nation

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	Instruments (YSI) metre point samples along the 7 segments of the OAC watercourse (Ziegler et al. 2021). A study conducted by DFO and WIFN evaluated the optimal gear type to detect SAR fishes, including Lake Chubsucker, within non-native Phragmites stands in the St. Clair River Delta (Gardner Costa et al. 2020). Fyke nets were comparable in catch-per-unit effort to Windermere traps, with both capturing a significantly greater number and diversity of fish than either small- or large-mesh gill nets. The study recommended the use of Fyke nets when sampling sites with non-native *Phragmites* (Gardner Costa et al. 2020). A recent study carried out by OMNRF and U of T, utilized SAR fish sampling data collected by DFO and OMNRF, to provide guidance on seining effort (that is, quantifying the number of sampling sites and level of sampling intensity) required to describe wetland fish communities (Samarasin et al. 2017). Data was collected using a repeat-sampling strategy with a seine in 7 coastal wetlands, including 3 Lake Chubsucker locations (L Lake, Long Point Bay [Inner Bay], and Lyons Creek). The results of this study indicated that generally, the amount of sampling effort increases as the proportional target for species richness increases. They found that to detect 90% of species in a wetland, half the number of sites were required when 3 sein hauls per site were done compared with 1 haul (Samarasin et al. 2017). While findings were not calibrated to Lake Chubsucker, this sampling protocol is suitable for this SAR and can be applied in future sampling efforts.		
1-5 Research - habitat: requirements: Determine the seasonal habitat needs	**L Lake** The habitat requirements of Lake Chubsucker at each life	II	**DFO**; U of T

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
of all life stages of the Lake Chubsucker.	stage were investigated in L Lake by DFO and the U of T, through targeted sampling in 2018 and 2021, respectively (Barnucz et al. 2021a; Powell & Reemeyer, 2021). Studies sought to estimate population size, to examine the distribution, habitat preferences, presence, and abundance of Lake Chubsucker, as well as its interactions with other species. Habitat variables (air and water temperature, DO, turbidity, conductivity, water depth, macrophyte coverage, and most dominant macrophyte present) were collected at each site. At most sampling sites, water clarity was high and dense submerged vegetation cover was prominent. The dominant, submerged macrophyte within sampling sites across both sampling period was *Chara spp*. Similarly, Powell and Reemeyer (2021) sampled L Lake for Lake Chubsucker to study the presence, abundance, habitat preferences, and species interactions of the Lake Chubsucker. **St. Clair River Delta** Hilling et al. (2021) identified habitat attributes at the sites (substrates and shoreline vegetation) overlapping with Lake Chubsucker habitat. Sites where Lake Chubsucker were observed were characterized by slower flow velocities and marsh habitat, and provided habitat for several at-risk fishes not collected elsewhere in the study. **Saint Clair NWA** Barnucz et al. (2021b) carried out a fish community inventory of the dyked wetlands in this NWA, including aquatic habitat sampling in all fish sampling sites (that is, air and water temperature, conductivity, DO, turbidity, depth, and aquatic vegetation type and coverage), to		

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	determine suitable habitat for Lake Chubsucker in this location. **PPNP** In 2019, Barnucz et al. (2021c) conducted fish community sampling in PPNP, which included a habitat assessment where SAR fishes were captured through the visual determination of dominant aquatic macrophyte class, and the collection of water depth measurements, surface water temperature, conductivity, turbidity, and DO.		
1-6 Threat evaluation - exotic species: Evaluate the impacts of exotic species (including Common Carp and exotic plant species) on the Lake Chubsucker and its habitat.	**European Common Reed** The invasive European Common Reed (*Phragmties australis ssp australis*) has been rapidly spreading and degrading Great Lakes coastal wetlands upon which Lake Chubsucker rely since its introduction in the mid 1800s (Reid et al. 2021; Croft-White et al. 2021). Research has been conducted exploring the impacts of European Common Reed (*Phragmites australis spp australis*) in coastal wetlands of Lake Erie where Lake Chubsucker is present. In the summer of 2018, Croft-White et al. (2021) investigated the potential impacts of European Common Reed expansion on fish and fish habitat in coastal wetlands of the Laurentian Great Lakes by comparing fish catch and community composition, diversity, and abundance among stands of flooded European Common Reed, invasive cattail (*Typha angustifolia* L), and native species of the genus *Schoenoplectus* at 16 sites across 4 regions of the Laurentian Great Lakes: Lake Erie, Walpole Island Delta, Lake Ontario, and Georgian Bay. Locations sampled that are occupied by Lake Chubsucker include Walpole Island, Rondeau Bay, and Long Point Bay, and gear appropriate for the capture of Lake Chubsucker (fyke nets) was utilized. Croft-White et al. (2021) found minimal evidence of fish	IV	Canadian Wildlife Service (CWS); DFO; Great Lakes Fishery Commission; Michigan Department of Natural Resources; MECP; Ohio Department of Natural Resources; **OMNRF**

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	community differences between European Common Reed and Narrowleaf Cattail, concluding that fish are using both invasive, colony-forming occupied areas similarly in the summer. *Schoenoplectus*, however, did support a slightly different fish community dominated by Cyprinids rather than Centrarchids, which Croft-White et al. (2021) attribute to differences in habitat conditions within these stands. Overall, this study's results suggests that the expansion of European Common Reed and Narrowleaf Cattail at the expense of *Schoenoplectus* may alter wetland fish assemblages; however, flooded European Common Reed habitat may provide habitat for some fishes during the summer in the study wetlands (Croft-White et al. 2021). Studies investigating whether European Common Reed expansion contributes to the loss of habitat for Lake Chubsucker across seasons is needed. In response to control efforts to manage the establishment of European Common Reed in Lake Erie's coastal wetlands (that is, Rondeau Bay Provincial Park, Long Point Crown Marsh, Big Creek NWA, and Long Point NWA), OMNRF, with support from the Ministry of the Environment, Conservation and Parks (MECP), and the Canadian Wildlife Service, carried out a long-term monitoring project to evaluate the effects of the herbicide application and to evaluate the benefits of invasive species removal to fish SAR (Reid et al. 2021). Visual-based surveys of fish were completed before and after herbicide application at Long Point and Rondeau Provincial Park from 2016 to 2020, and a Before-after Control Impact (BACI) monitoring program was initiated in 2020 for Big Creek Unit of Big Creek NWA and Thoroughfare Unit of Long Point NWA, recording the number of distressed or dead fish between treatment and		

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	control sites. Researchers found no evidence of elevated mortality risk from aerial herbicide application in Big Creek NWA and Rondeau Provincial Park. The level of fish mortality varied among ponds in the Crown Marsh treatment areas, with smaller and more isolated ponds displaying higher mortality than others (Reid et al. 2021). **Grass Carp** Predictive modelling of the potential effects of 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 to moderate impacts on coastal wetlands of Lake Erie where Lake Chubsucker occurs, such as Rondeau and Long Point bays, depending on the projected density of Grass Carp (Gertzen et al. 2017). All life stages of Lake Chubsucker are predicted to experience significant impacts if colonization of 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. 2017). A study monitoring the movement of Grass Carp released throughout Lake Erie with implanted acoustic transmitters, found that there is evidence that Grass Carp is moving throughout the western basin of Lake Erie and, in some cases, through the Huron-Erie corridor (Harris et al. 2021). Similarly, a study utilizing otolith stable oxygen isotope data to infer dispersal of Grass Carp from natal rivers and estimate ages, found that there is dispersal of individuals between the Great Lakes, with majority of wild fish caught in the Lake Erie Basin (Whitledge et al. 2021). Moreover, age estimates indicated multiple year classes of Grass		

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	Carp in Lake Erie, suggesting successful recruitment to adulthood (Whitledge et al. 2021). The knowledge gained from these studies regarding the potential routes of travel into the Great Lakes and its habitat preferences should be used to perform control measures to prevent the spread and establishment of Grass Carp in Lake Chubsucker critical habitat. Herbst et al. (2021) developed and implemented a multi-jurisdictional response strategy for Grass Carp in Lake Erie as an early response effort to control the spread of this invasive species. Collaborative response efforts resulted in the capture and removal of 184 Grass Carp since 2014, and efforts are ongoing. This 5-year strategy highlights the importance of an adaptive management approach to invasive species control responses (Herbst et al. 2021).		
1-7 Threat evaluation: Investigate and evaluate the significance of threat factors that may be impacting extant populations. Take steps to mitigate immediate threats identified.	**Poor water quality/hypoxia** Long-term monitoring of water quality parameters (for example, water quality, water level, and DO) and SAR fishes' habitat has been conducted in the OAC by ABCA, funded through HSP and CNF, to investigate threats of poor water quality (that is, nutrient levels) and low DO leading to winter fish kills. This research has demonstrated the occurrence of hypoxic conditions throughout the OAC, where DO concentrations reach 0 milligrams per litre (mg/l) during winter conditions when ice is present and have reached levels close to 0 mg/l during the summer months. Although winter fish kills have been documented, populations appear to be persisting, suggesting that fish find refugia in low DO conditions, possibly in the Pinery Dam and Southcott Pines segments where zones of higher DO were observed in the summer months of 2017 and 2018. Continued and expanded monitoring of water quality	IV	ABCA; DFO; OMNRF, Université du Québec à Trois-Rivières, U of T

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	in the OAC and its impacts on Lake Chubsucker is necessary to inform management in this important ecosystem. Temperature-induced hypoxia is a prevalent threat in fragmented river systems with reduced flows such as the OAC, which experiences summer and winter hypoxia (Ziegler et al. 2021). However, it is unclear if increases in water temperature always predict hypoxic stress for aquatic species. Primary production and respiration, both affected by flow rates and air temperatures, are the most important internal processes controlling concentrations of DO in rivers. As higher temperatures lead to higher rates of respiration in aquatic species compared to gross primary production, the net ecosystem production (NEP) and net oxygen cycling can decrease. Ziegler et al. (2021) developed ecosystem metabolism models to define the effect of water temperature on NEP of oxygen at 12 sites across the OAC, with the aim of predicting hypoxia in fragmented river systems. They found that water temperature and precipitation events at 75% of the sites were significantly, and negatively, correlated to NEP estimates. Therefore, temperature-induced reductions in NEP at these sites likely contribute to hypoxic conditions threatening aquatic SAR, such as Lake Chubsucker. These findings can help to understand the drivers of hypoxic stress in fragmented watercourses and to support the implementation of management actions aimed at reducing water temperatures at sites in the OAC that experience seasonal hypoxia.		

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	Climate change Research was conducted to assess the relative vulnerability of species found within Ontario's Great Lakes Basin to climate change using NatureServe's Climate Change Vulnerability Index (CCVI) (Brinker et al. 2018). The index assessed the vulnerability of a species based on its exposure to climate change and its sensitivity/adaptive capacity. Projected changes in temperature and moisture from both recent historical (1960 to1990) records and near-future projections (2041 to 2071) were used, and assessed against factors such as natural barriers preventing migration, the amount of land use change, and the physiological thermal niche occupied by the species, etc. Lake Chubsucker (Lake Huron, Lake Erie, and Lake Ontario populations) had a CCVI score of moderately vulnerable, meaning that the abundance and/or range extent within the assessed geographical area will likely decrease by the year 2050. **Extinction debt** Montgomery et al. (2020) evaluated extinction debt for 8 SAR fishes in Lake Erie coastal wetlands, including Lake Chubsucker. Despite these habitats being significantly lost and/or degraded due to agricultural land-use practices, they display high species richness and several at-risk fishes persist, leading to the hypothesis that Great Lakes wetland fishes are in extinction debt. In the summers of 2016 and 2017, researchers sampled the current species richness of wetland-specialist fishes in protected and unprotected wetlands of Lake Erie and those surrounding Lake St. Clair. Using parameter estimates from the species-area curve relationship of the current species richness of wetland-specialist fishes in protected wetlands, they predicted what		

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	species richness should be in unprotected wetlands. Extinction debt was indicated when the observed species richness was greater than the predicted species richness, which was the case in multiple unprotected wetlands. Using this information, researchers identified 17 wetlands of high priority for restoration and determined that the restoration of 178 square kilometres (km^2) of wetland habitat is needed to reduce the risk of future biodiversity loss. By combining extinction-debt assessments with minimum-area requirements for Lake Chubsucker, they determined that an additional 0.14km^2 of wetland habitat, beyond that required for all other wetland species, would be required to support viable Lake Chubsucker populations and to reduce the magnitude of its extinction debt in the Great Lakes (Montgomery et al. 2020).		
1-8 Exotics - monitoring: Monitor Lake Chubsucker watersheds for exotics of concern in cooperation with aquatic ecosystem recovery teams.	**Asian Carp** DFO has conducted an annual Asian Carp early detection field surveillance program throughout the Great Lakes basin since 2013 (Marson et al. 2018; Colm et al. 2018; Colm et al. 2019a; Colm et al. 2019b; Colm and Marson 2020; Aguiar et al. 2021; DFO unpublished data). These efforts, which target Asian Carps, have led to the incidental capture of SAR, including Lake Chubsucker. Surveys are performed in multiple locations where Lake Chubsucker historically or currently occur, including the Ausable River, Big Creek (Essex County), Jeannette's Creek, Rondeau Bay, and Long Point Bay, and any Lake Chubsucker captured during sampling are recorded. A total of 32 Lake Chubsucker have been captured via this monitoring from 2015 to 2021, with the majority of detections in Long Point Bay.	IV	**DFO**

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
1-9 Research - controlled water levels and wetland dynamics: Investigate impacts of regulated water levels (that is, dyked wetlands) vs. natural wetlands (undyked or with natural barriers) on habitat conditions for Lake Chubsucker. Investigate the degree to which populations within dyked wetlands are connected to adjacent waters.	**St. Clair NWA** DFO investigated the potential impact water-level drawdown in the East cell of the St. Clair Unit would have on Lake Chubsucker (DFO, 2021). They investigated the relationship between drawdown increment and available refuge habitat for Lake Chubsucker in the East cell; the relationship between habitat availability and Lake Chubsucker abundance; and the potential for deep water habitat creation in advance of drawdown to increase available refuge. It was concluded that a reduction in the wetted area and volume of the cell would decrease habitat availability for both young of the year and adults, thus imposing density-dependent effects. Greater drawdowns would lead to greater reductions in deep water habitat used for refuge. The drawdown would also likely create patches of disconnected habitat, insufficient in depth to provide suitable refuge habitat and possibly leading to young of the year being stranded due to the use of shallower habitats. DFO suggested the creation of deep-water habitat prior to drawdown to counter the loss during this process, through channels connecting isolated deep water habitat patches, thereby allowing fish to access a larger amount of habitat in the cell and reducing density-dependent and independent effects. Research is ongoing to assess the feasibility of creating deep-water habitat patches, as well as other mitigation measures to minimize the impact of water-level drawdowns, and to compare potential outcomes of these options to scenarios where no water-level management activities are undertaken (K. Diemer and S. Ghafouri, ECCC, pers. comm. 2023).	II, IV	**DFO**

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	St. Clair Lake tributaries - Little Bear Creek Building on the previous 2010 to 2015 Lake Chubsucker progress report's mention of a study investigating the potential impact of Little Bear Creek drain maintenance on aquatic SAR (Fisheries and Oceans Canada, 2017), an additional study was conducted to investigate this issue. To better understand the seasonal variations and distribution and abundance of fishes in Little Bear Creek, Montgomery et al. (2017) conducted fish, macrophyte, bathymetry, and fluvial geomorphology surveys in the summer of 2015. They modelled the distribution and habitat requirements of fish SAR in Little Bear Creek and predicted the impacts to suitable habitat under different drain maintenance scenarios. The study provided alternative maintenance scenarios and determined the impact they may have on fish SAR, offered mitigation measures to minimize the impacts of maintenance on fish SAR, and specified offsetting options for each alternative drain maintenance scenario that would potentially benefit many SAR fishes including Lake Chubsucker.		
1-10 Water quality monitoring: Measure sediment and nutrient loads emitted from streams.	**OAC** ABCA has monitored water quality in the OAC from 2016 to 2021 (supported by HSP and CNFASAR funding) to evaluate the status of SAR fish habitat through nutrient and DO concentrations. Concentrations of total phosphorus, nitrate, unionized ammonia, and total suspended solids were determined with water samples obtained from randomly selected sites along the watercourse, and handheld YSI units collected DO and temperature data. This monitoring has determined that all studied areas of the OAC experience a period of time where DO concentrations reached 0 mg/L, particularly in the winter months. Overall,	I, IV, VI	**ABCA**

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	aquatic habitat conditions were most degraded in the northern portion of the channel and improve within the Pinery Provincial Park. Continued long-term monitoring of water quality in the OAC is needed to track changes and aid in SAR recovery and habitat management decisions.		
Weight and length standard equations (not prescribed in recovery strategy)	Although not prescribed in the recovery strategy for Lake Chubsucker as a recommended approach to meet recovery objectives, researchers developed standard weight equations for Lake Chubsucker through the evaluation of weight-length relationships for over 19,000 individuals from 129 populations that were collected from 1977 to 2020 (Bonvechio & Bonvechio, 2021). The development on this equation and standard-length categories will aid biologists in assessing condition and size structure of Lake Chubsucker populations (Bonvechio & Bonvechio, 2021).	N/A	Georgia Department of Natural Resources; Florida Fish and Wildlife Conservation Commission
Reintroduction feasibility assessment (not prescribed in recovery strategy)	Although not prescribed in the recovery strategy for Lake Chubsucker as a recommended approach to meet recovery objectives, an evaluation has been conducted that summarizes existing knowledge and reintroduction progress for all *Species at Risk Act* (SARA)-listed fishes in Canada that are candidates for reintroduction efforts, including Lake Chubsucker (Lamothe et al. 2019). This study states that the probable causes of Lake Chubsucker extirpation from Jeanette's Creek, Tea Creek, lower Ausable River, and tributaries of Big Creek (Norfolk County), and the Niagara River were agricultural practices, which caused increased siltation and turbidity in these watercourses, and the spread of invasive species, such as Common Carp and European Common Reed. The authors highlight that several uncertainties may delay the implementation of reintroduction efforts for Lake Chubsucker, including the lack of knowledge of habitat	N/A	**DFO**; Quebec Ministry of Forests, Wildlife and Parks; University of Alberta; U of T; University of Windsor; OMNRF

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	associations among all life stages, the extent of genetic diversity among local populations, and the potential impact of removals on source populations during translocation efforts. To support this potential conservation measure, more detailed studies investigating population size, structure, and condition to understand the robustness of source populations for potential translocations are recommended (Lamothe et al. 2019). Lamothe et al. (2019) suggest that the populations on which to focus for these studies include those inhabiting L Lake and the OAC, and that an adaptive management framework is necessary.		
Genetic assessment (not prescribed in recovery strategy)	Although not prescribed in the recovery strategy for Lake Chubsucker as a recommended approach to meet recovery objectives, there has been progress in the evaluation of the genetic structure of this species, as well as the phylogeny of Chubsuckers through mitochondrial and nuclear DNA analyses. From 2010 to 2016, researchers conducted a genetic survey of Lake Chubsucker from 7 localities where the species occurs in the Lakes Huron, Erie, St. Clair, and Niagara River basins (Hauser et al. 2019). Through mitochondrial barcoding of 71 individuals, they identified a genetically distinct population in Lyons Creek, Ontario. Lyons Creek may be a reservoir of unique genetic diversity; though further investigation is required to determine whether this population should be considered a separate designatable unit for conservation purposes under SARA (Hauser et al. 2019). More extensive sampling of Lyons Creek individuals is warranted to confirm that there are no shared haplotypes with the other populations.	N/A	U of T; Texas A&M University; Virginia Institute of Marine Science; Southeastern Louisiana University

Activity	Outcomes or deliverables	Objectives addressed	Participants[3]
	In another study conducted in the U.S., researchers investigated the phylogenetic relationships among all 4 members of the genus *Erimyzon*, including Lake Chubsucker, using mitochondrial and nuclear gene sequence data, as well as morphological data (Hunt et al. 2021). The results of this study indicate that there are 5 evolutionarily independent groups within the genus *Erimyzon*, rather than 4, with observed genetic distinction between 2 clades Lake Chubsucker. Further examination of the morphology of specimens throughout the Lake Chubsucker range is necessary before revising the taxonomy of the genus (Hunt et al. 2021).		

Table 4. Implementation of management and coordination activities undertaken to address the measures identified in the recovery planning table of the recovery strategy for the Lake Chubsucker.

Activity	Outcomes or deliverables	Objectives addressed	Participants[4]
2-1 Coordination with other recovery teams and relevant agencies: Work with relevant ecosystem- and single-species-based recovery teams and other groups to share knowledge, implement recovery actions and to obtain incidental sightings.	Fisheries and Oceans Canada (DFO) collaborated with representatives from Conservation Authorities, including Ausable Bayfield Conservation Authority (ABCA); St. Clair Region Conservation Authority (SCRCA); and Lower Thames Valley Conservation Authority (LTVCA) to determine areas for potential species at risk (SAR) outreach collaboration on a local level.	VI	**DFO**; ABCA; LTVCA; STRCA
2-2 Municipal planning/habitat management - involvement: 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.	Presentations were delivered by DFO to municipal planners, drainage consultants, and developers who work in, or near, water in Central Ontario to increase awareness of SAR, inform participants about Lake Chubsucker critical habitat protection and restrictions, promote aquatic SAR guidance available for municipal official plans, and provide general information regarding the *Species at Risk Act* (SARA) and SAR protection and recovery.	VI, VII	**DFO**
2-3 Relationship building - drainage: Establish good working relationships with drainage supervisors, engineers, and contractors to limit the effects of drainage activities on this species.	DFO provides ongoing guidance regarding SARA, specifically regarding critical habitat protection and recovery planning and implementation for municipal planning information sessions to municipal and infrastructure departments, drainage contractors, and stakeholders, through long-term outreach program. In 2021, LTVCA identified and contacted 24 farm drainage contractors in the Lower Thames watershed to explain the benefits of erosion control and to promote funding available to mitigate erosion issues. Contractors were encouraged to	VI, VII	**DFO**; LTVCA

[4] Lead participant(s) is/are listed on top and in bold; other participants are listed alphabetically. Not all studies have specific lead participants identified.

Activity	Outcomes or deliverables	Objectives addressed	Participants[4]
	share information with their clients, the general public, and any landowners they knew of that showed interest.		
2-4 Evaluation of watershed-scale stressors: In cooperation with relevant ecosystem recovery teams, evaluate watershed-scale stressors to populations and their habitat.	Long-term monitoring of water quality parameters (for example, water quality, water level, and dissolved oxygen) and SAR fishes' habitat was conducted in the Old Ausable Channel (OAC) by ABCA via both DFO (Habitat Stewardship Program [HSP] and Canadian Nature Fund for Aquatic Species at Risk [CNFASAR]) and Environment and Climate Change Canada (ECCC) HSP funding support.	IV, VI	**ABCA**
2-5 Exotic species management plan: Development of a management plan that addresses potential risks, and impacts, and proposes actions (including feasibility of control) in response to existing exotic species and to the arrival or establishment of new exotics.	The management, monitoring and control of exotic species is undertaken by DFO.	IV, VI	DFO
2-6 Prohibitions - baitfishes: Evaluate the feasibility of prohibitions on the use of live baitfishes within the OAC (outside of the Pinery Provincial Park).	No progress has been made since the previous progress report when Ontario Ministry of Natural Resources and Forestry (OMNRF) was undertaking a review of its provincial bait policies, which includes aspects related to use, movement, and harvest, and was considering options related to SAR fishes.	IV	OMNRF

Table 5. Implementation of stewardship, outreach and awareness activities undertaken to address the measures identified in the recovery planning table of the recovery strategy for the Lake Chubsucker.

Activity	Outcomes or deliverables	Objectives addressed	Participants[5]
3-1 Collaboration and information sharing: Collaborate with relevant groups, initiatives, and recovery teams to address recovery actions of benefit to the Lake Chubsucker.	Through the Habitat Stewardship Program (HSP) and the Canadian Nature Fund for Species at Risk (CNFASAR), Fisheries and Ocean Canada (DFO) collaborated with Conservation Authorities to carry out stewardship, monitoring, and outreach-related projects benefiting Lake Chubsucker and their habitats in the Old Ausable Channel (OAC), Rondeau Bay, and Long Point Bay. Funding recipients report on project results to DFO on an annual basis. DFO has an outreach program conducted annually to deliver presentations to municipal planners, drainage consultants, and developers who do work in, or near, water in Central Ontario. These sessions aim to increase awareness of species at risk (SAR), inform participants about Lake Chubsucker critical habitat protection and restrictions, promote aquatic SAR guidance available for municipal official plans, and provide general information regarding the *Species at Risk Act* (SARA) and SAR protection and recovery.	VI	**DFO**; ABCA; ERCA; LTVCA
3-2 Stewardship and habitat initiatives: Promote stewardship among landowners abutting aquatic habitats of Lake Chubsucker, and other local residents.	**OAC** The Ausable Bayfield Conservation Authority (ABCA) conducted public outreach events to educate the general public and youth about aquatic SAR (including Lake Chubsucker) and stewardship possibilities in the Ausable	IV, VII	ABCA; LTVCA; UTRCA

[5] Lead participant(s) is/are listed on top and in bold; other participants are listed alphabetically (Not all studies have specific lead participants identified).

Activity	Outcomes or deliverables	Objectives addressed	Participants[5]
	River watershed via: **2017:** - 4 information sessions provided (Grand Bend, Port Franks, Ailsa Craig, Exeter) for watershed residents, to provide education about Ausable River SAR and stewardship possibilities to alleviate threats - 9 presentations delivered to 197 students and 13 adults about aquatic SAR **2018:** - Students taught about aquatic SAR at more than 10 in-school programs and at conservation areas - 3 events held for adults in the Ausable watershed regarding aquatic SAR **2019:** - 2 presentations (60 attendees) provided and 3 information booths (1560 attendees) arranged - 17 programs delivered to 10 local schools (total of 388 students) about the aquatic SAR found within their communities **2020:** - Video posted online to educate general public and landowners about species at risk and Ausable River recovery **Rondeau Bay** **2019:** - The Lower Thames Valley Conservation Authority (LTVCA) conducted a SAR fish awareness campaign called "Fish Fridays" through their Facebook page,		

Activity	Outcomes or deliverables	Objectives addressed	Participants[5]
	which included an informational graphic focused on Lake Chubsucker that described the species SARA status, threats, and best management practices (BMPs) to improve its habitat - LTVCA developed and delivered 142 "Save Rondeau Bay's Aquatic Species at Risk/Funding Available for Land Stewardship" flyers to rural household mailboxes within 1 kilometre (km) of the bay to increase awareness of Rondeau Bay's aquatic SAR, including Lake Chubsucker - LTVCA developed Rondeau Bay Fish SAR Banners in partnership with the UTRCA to allow for targeted communications in the Rondeau Bay watershed **2020:** - LTVCA hosted a "Lower Thames Aquatic Species at Risk" presentation at Delaware Nation Heritage Circle at Moraviantown to increase community awareness on aquatic SAR in the Lower Thames River, including Lake Chubsucker and their greatest threats (approximately 50 community members of the Delaware Nation at Moraviantown attended) **2021:** - LTVCA delivered 265 "Save Rondeau Bay's Aquatic Species at Risk" flyers to rural landowners - LTVCA identified and contacted 24 farm drainage contractors in the Lower Thames River Watershed to explain the benefits of erosion control and to promote funding available to mitigate erosion issues		
3-3 Stewardship and habitat initiatives: conduct habitat improvement activities to mitigate	Parks Canada has conducted Marsh restoration work at Point Pelee National Park as part of their Multi-species Action Plan for Point Pelee National Park of Canada and		

Activity	Outcomes or deliverables	Objectives addressed	Participants[5]
threats to Lake Chubsucker (not prescribed in recovery strategy)	Niagara National Historic Sites of Canada (PC 2016). These activities have been focused on reducing the area of invasive Common Reed (*Phragmites australis spp australis*) and Cattail (*Typha spp.*) in the marsh, restoring habitat for Lake Chubsucker and other species at risk, and helping to conserve wildlife diversity in the marsh (PC 2022).		
3-4 Stewardship - implementation of BMPs: Work with landowners to implement BMPs in areas that will provide the most benefit. Encourage the completion and implementation of Environmental Farm Management Plans (EFPs) and Nutrient Management Plans (NMPs).	BMPs encouraged on rural properties in the OAC and Rondeau Bay by ABCA and LTVCA, respectively, through the provision of incentives to complete stewardship projects such as the creation of riparian buffers, streambank stabilization and erosion control, and through the provision of technical support and guidance. In 2018, DFO collaborated with Ontario Soil and Crop Improvement Association by providing revised aquatic SAR text for updating Environmental Farm Plan training material, which increases awareness of landowners to carry out BMPs benefitting aquatic SAR.	IV, VII	ABCA; DFO; ECCC; LTVCA
3-5 Communications strategy: 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.	**OAC** **2015 to 2020:** ABCA implemented a communications strategy (for example, postcards, flyers, press releases, posters, and outreach events) each year they received HSP or CNFASAR funding support, that they used to inform landowners about SAR and watershed health, as well as the funding opportunities available for stewardship projects. **2020:** - ABCA produced 2 landowner recommendation guides for best practices to be used to protect and restore the	VII	ABCA; DFO; ECCC; LTVCA

Activity	Outcomes or deliverables	Objectives addressed	Participants[5]
	northern portion of the OAC and Mud Creek Oxbow Wetlands, which included a list of habitat preferences and threats to the Lake Chubsucker and a summary of recommendations regarding monitoring, management, and outreach to improve the OAC for species at risk. **Rondeau Bay** **2020 to 2021:** Through a project funded by DFO's CNFASAR, LTVCA developed an outreach program that educated the local community and landowners about aquatic SAR in the Lower Thames Watershed and promoted the importance of BMPs to landowners and the availability of funds for stewardship projects. This program included: - promoting funding opportunities through social media outlets including updating the LTVCA website's Species at Risk webpage to include information on the number of fish and mussel species and SAR in Rondeau Bay - providing links to download Aquatic Species at Risk Fish Guidebooks, which included a page on Lake Chubsucker identification, distribution, habitat, and other interesting facts - hosting webinars to promote the availability of funds for stewardship projects to landowners in the watershed and the benefits of undertaking these efforts - distributing flyers with information about aquatic SAR in Rondeau Bay and the availability of funds for stewardship projects to improve aquatic habitat quality		
3-6 Stewardship - financial assistance/incentives: Facilitate access to funding sources for	**OAC** The following actions were completed by ABCA to promote the availability of funding support for landowners-led stewardship projects via Environment and Climate Change	VI	ABCA; DFO; ECCC; LTVCA

Activity	Outcomes or deliverables	Objectives addressed	Participants[5]
landowner and local community groups engaged in stewardship activities.	Canada (ECCC) HSP, DFO HSP, and DFO CNFASAR funding from 2016 to 2019, 2019 to 2020, and 2020 to 2021, respectively. The aim was to encourage local landowners to engage in voluntary stewardship activities that will help reduce nutrient and sediment entering the Ausable River and its tributaries, with support from ABCA staff: - release of 4 newspaper articles (Farm Progress ; Exeter Lakeshore Times Advance; Clinton News Record) - 2 media releases (in 2017 and 2018) - delivery of postcards to 500 landowners in 2016 and 800 landowners in 2018 - 2 outreach events in 2017 and 2018 to educate targeted landowners and to promote stewardship - distribution of 1,172 stewardship postcards in 2020 to inform landowners about CNF funding incentive to perform stewardship projects in OAC **Rondeau Bay** **2019:** LTVCA promoted the availability of funds for stewardship programs to rural landowners by distributing 142 "Save Rondeau Bay's Aquatic Species at Risk/Funding Available for Land Stewardship" flyers to rural households within 1 km of the bay. The "Funding Available for Land Stewardship" side of the flyer outlined the purpose of the funding, the types of projects that are eligible, landowner responsibilities, and funders. **2020:** LTVCA hosted a "Greening the Landscape: Urban and		

Activity	Outcomes or deliverables	Objectives addressed	Participants[5]
	Rural Environmental Stewardship" Webinar to inform and engage landowners in the watershed regarding program qualifications, incentives, and project examples applicable for funding available in Elgin, Middlesex, Chatham-Kent (includes Rondeau Bay), and Lambton (includes St. Clair River Delta). The online seminar had 10 people in attendance. **2021:** LTVCA distributed 265 "Save Rondeau Bay's Aquatic Species at Risk/Funding Available for Land Stewardship" flyers informing how landowners can positively impact the species through improvements in water quality, along with information regarding funding available to landowners and the types of projects eligible. LTVCA posted a flyer on their social media accounts promoting the availability of funding for farmers and landowners to complete 2021 stewardship programs falling under the categories of habitat restoration, erosion control, and agricultural BMP's. The posts engaged 63, 16, and 14 people via likes, comments, and shares on Facebook, Twitter, and Instagram, respectively. LTVCA's website was updated to include new information on grants available to landowners for erosion control projects and information on aquatic SAR.		
3-7 Awareness - addressing landowner concerns: Provide clear communications addressing compensation opportunities and landowner concerns and	**Rondeau Bay** **2019:** LTVCA promoted the availability of funds for stewardship programs to rural landowners by distributing 142 "Save Rondeau Bay's Aquatic Species at Risk/Funding Available	VII	DFO; LTVCA

Activity	Outcomes or deliverables	Objectives addressed	Participants[5]
responsibilities under the Species at Risk Act (SARA).	for Land Stewardship" flyers to rural households within 1 km of the bay. The "Funding Available for Land Stewardship" side of the flyer outlined the purpose of the funding, the types of projects that are eligible, landowner responsibilities, and funders. **2020:** LTVCA hosted a "Greening the Landscape: Urban and Rural Environmental Stewardship" Webinar to inform and engage landowners in the watershed regarding program qualifications, incentives, and project examples applicable for funding available in Elgin, Middlesex, Chatham-Kent (includes Rondeau Bay), and Lambton (includes St. Clair River Delta). The online seminar had 10 people in attendance. **2021:** LTVCA distributed 265 "Save Rondeau Bay's Aquatic Species at Risk/Funding Available for Land Stewardship" flyers informing how landowners can positively impact the species through improvements in water quality, along with information regarding funding available to landowners and the types of projects eligible.		
3-8 Awareness - incidental harvest: 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.	No information package specific to Lake Chubsucker has been developed at this time that addresses incidental harvest.	VII	-
3-9 Exotic species/baitfish introductions: Increase public	Distribution of aquatic invasive species educational information by DFO through public postings and direct	VII	**DFO**;

Activity	Outcomes or deliverables	Objectives addressed	Participants[5]
awareness of the impacts of exotic species on the natural ecosystem, and encourage the use of existing exotic species reporting systems. Discourage anglers from emptying the contents of bait buckets in areas where the bait was not captured.	engagement. Distribution of information regarding invasive species such as European Common Reed by Conservation Authorities, through "Invasive Species Awareness Week", social media posts, and other engagement events to educate the public about invasive species that affect aquatic species such as Lake Chubsucker. The OMNRF published guidance for invasive species assessments under the *Invasive Species Act* to describe the risk assessment process which Ontario will use to inform decisions to consider and recommend species to be listed under this legislation (OMNRF, 2016). The action plan for the Ausable River in Canada: an ecosystem approach (DFO, 2020) outlines BMPs to address threats to species at risk in this ecosystem, including invasive species.		ABCA; ERCA; LTVCA; MNRF

3.2 Activities supporting the Identification of Critical Habitat

Table 6 provides information on the implementation of the studies outlined in the schedule of studies to identify critical habitat of the recovery strategy. Each study has been assigned 1 of 4 statuses:

1) Completed: the study has been carried out and concluded
2) In progress: the planned study is underway and has not concluded
3) Not started: the study has been planned but has yet to start
4) Cancelled: the planned study will not be started or completed

Table 6. Status and details of the implementation of the schedule of studies outlined in the recovery strategy for the Lake Chubsucker.

Study	Status	Descriptions and results	Participants[6]
Conduct studies to determine the habitat requirements for all life stages of the Lake Chubsucker.	In progress	Fisheries and Oceans Canada (DFO) monitoring surveys have been conducted in the majority of Lake Chubsucker population locations that involved a habitat component to aid in the identification of the functions, features, and attributes of critical habitat. A total of 2 targeted surveys in L Lake identified habitat preferences of Lake Chubsucker; however, additional sampling effort is required to draw conclusions on habitat preferences of each life stage. An updated recovery potential assessment for Lake Chubsucker was conducted in 2021 that included an updated description of the attributes of critical habitat (Colm and Drake 2023).	**DFO**; University of Toronto (U of T)
Survey and map habitat quality and quantity within historical and current sites, as well as sites adjacent to currently occupied habitat.	In progress	DFO monitoring surveys have been conducted within L Lake, Big Creek National Wildlife Area (NWA), Long Point NWA, Point Pelee National Park (PPNP), Saint Clair NWA, and the St. Clair River Delta/tributaries of Lake St. Clair, leading to the detection of Lake Chubsucker. All studies included an assessment of habitat conditions to allow for a better understanding of Lake Chubsucker habitat needs.	**DFO**; Ausable Bayfield Conservation Authority (ABCA); McGill University; Ontario Ministry

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

Study	Status	Descriptions and results	Participants[6]
			of Natural Resources (OMNRF); Parsons Inc.; U of T; United States Geological Survey (USGS); Walpole Island Heritage Centre (WIFN)
Conduct additional species surveys to fill in distribution gaps, and to aid in determining population connectivity.	In progress	Fish community surveys were conducted by DFO, in collaboration with U of T, across southern Ontario's wetlands in 2016 and 2017, adding to knowledge of Lake Chubsucker distribution throughout its range in Ontario. An inventory of fish in the Big Creek NWA was conducted, resulting in the first detection of Lake Chubsucker in the Hahn Unit, expanding the known distribution of the species at this location, which could lead to the identification of further critical habitat in the future. A fish community assemblage and fish habitat assessment study was conducted in the St. Clair River Delta by USGS to determine fish species richness, abundance, and distribution among different habitat conditions, and the overall utilization of this habitat by species at risk (SAR) fishes (Hilling et al. 2021). This survey allowed for the capture of 34 Lake Chubsucker and for the assessment of Lake Chubsucker distribution and habitat associations in this system. A fish inventory within the dyked wetlands of the St. Clair Unit of Saint Clair NWA was completed, along with habitat assessments in all fish sampling sites, which resulted in the capture of 6 Lake Chubsucker in 2018 and 14 individuals in 2019 within the east and	**DFO**; OMNRF U of T; Walpole Island Heritage Centre; USGS; Parsons Inc.

Study	Status	Descriptions and results	Participants[6]
		west cells of this NWA, allowing for a better understanding of its current distribution and its utilization of habitat in this location (Barnucz et al. 2021b).	
Create a population-habitat supply model for each life stage.	Not started	Nothing to report.	-
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.	In progress	Updated recovery potential modelling of Lake Chubsucker was undertaken in 2021 (Fung and Koops 2023) which estimated the minimum viable population size (MVP) for Lake Chubsucker populations to be sustainable. These model estimates varied depending on the life stage in question, the frequency of catastrophes (events that could cause a population decline greater than 50%) that might impact populations, and the desired probability of persistence. For example, using the most conservative rate of catastrophe (15% per generation), population sustainability can be achieved with an adult female population size of approximately 8,500 individuals. Fung and Koops (2023) then extrapolate from this MVP estimate to determine the minimum area for population viability (MAPV). They estimate that a population of approximately 8,500 adult females would require 2.63 square kilometres of habitat.	DFO

3.3 Summary of progress towards recovery

3.3.1 Status of performance measures

Table 7 provides a summary of the progress made towards meeting the performance measures outlined in section 3.3.1. Each measure has been assigned 1 of 4 statuses:

1) Not met: The performance measure has not been met, and little to no progress has been made
2) Not met, underway: The performance measure has not been met, but there has been moderate to significant progress made
3) Met: The performance measure has been met and no further action is required
4) Met, ongoing: The performance measure has been met, but efforts will continue until such time that the population is considered to be recovered (that is, the measure will be reported in the next 5-year progress report)

Table 7. Details of the progress made towards meeting the performance measures outlined in the recovery strategy for the Lake Chubsucker.

Performance measure	Status	Details	Next steps
Extent of existing populations (including abundance and population demographics) fully determined through background surveys by 2011.	Not met, underway	A total of 2 targeted surveys of the extant population in L Lake were completed to assess population size, distribution, and habitat features of Lake Chubsucker. Non-target surveys were conducted within locations where Lake Chubsucker is extant and in areas with potentially undetected populations which, in some cases, led to the capture of Lake Chubsucker. These surveys were conducted in the Old Ausable Channel (OAC), Ausable River, St. Clair River Delta, Lake St. Clair tributaries (Little Bear Creek), Point Pelee National Park (PPNP), Rondeau Bay, Long Point and Big Creek National Wildlife Areas (NWA), and Long Point Bay.	Targeted surveys should be conducted in: Jeanette's Creek (a tributary of the Thames River); an upper section of Big Creek (Norfolk County), which drains into Long Point (Lake Erie); the tributaries of the Niagara River; and Lyons Creek to determine the state of these Lake Chubsucker populations.
Completion of activities outlined in	Not met, underway	Fisheries and Oceans Canada (DFO) monitoring surveys have been conducted within L Lake, Big	Further research into habitat needs of each life stage of Lake Chubsucker should

Performance measure	Status	Details	Next steps
the schedule of studies for the complete determination of critical habitat within the proposed timelines.		Creek NWA, Long Point NWA, PPNP, St. Clair River Delta, Saint Clair NWA, and the St. Clair River Delta/tributaries of Lake St. Clair. The surveys involved a habitat component to aid in the identification of the functions, features, and attributes of critical habitat.	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 habitats of the Lake Chubsucker (for example, number of habitat patches/populations enhanced).	Met, ongoing	Water quality and habitat improvements have been undertaken through agricultural best management practices (BMP) and water regulation in the OAC. Water quality and habitat improvements have been undertaken in the watersheds that drain Rondeau Bay and Long Point Bay. From 2016 to 2021, European Common Reed removal to restore wetted habitat has been conducted in PPNP, Rondeau Bay, Long Point Bay (Inner Bay), Long Point NWA, and Big Creek NWAs. Similarly, Parks Canada (PC) has been creating open water channels in areas dominated by invasive Blue Cattail (*Typha x glauca*) and Narrow-leaf Cattail (*Typha angustifolia*) to enhance Lake Chubsucker habitat. Alternative scenarios have been formulated for the maintenance of dyked wetlands in St. Clair NWA (DFO 2021) and Little Bear Creek drain (DFO 2017) to reduce harm to Lake Chubsucker. Currently 5 of 11 populations are found within NWAs and national parks, affording them additional protection.	Continued restoration activities and stewardship/promotion of BMPs in the OAC, Rondeau Bay, and Long Point Bay, as well as other areas of the species' range such as the Niagara drainages.

Performance measure	Status	Details	Next steps
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 standardized habitat monitoring program has been carried out in the OAC by the Ausable Bayfield Conservation Authority (ABCA) from 2015 to 2021 to evaluate the status of species at risk (SAR) fish habitat. A study by DFO and Walpole Island First Nation evaluated the optimal gear type to detect species at risk fishes, including Lake Chubsucker, within non-native *Phragmites* stands in the St. Clair River Delta (Gardner Costa et al. 2020).	Further research should be conducted to determine the spatial scale of suitable habitat that must be sampled, particularly in locations where there have been new Lake Chubsucker detections (for example, tributaries of Big Creek in Norfolk County).
Quantification of stewardship effort (that is, BMPs) implemented through ecosystem-based recovery teams and other relevant or complementary groups/initiatives (for example, number of environmental farm plans [EFMP] and nutrient management plans [NMP] completed; hectares of riparian buffers established; number	Met, ongoing	**OAC** ABCA (with Canada Nature Fund for Aquatic Species at Risk [CNFASAR] funding), completed a streambank restoration project in 2020 with Ontario Streams and Southcott Pines Park Association (SPPA), to reduce the slope of 36 metres of riverbank in the OAC. This stewardship effort will allow further vegetation to take root and provide a buffer zone to slow run-off, reduce erosion, and provide habitat for Lake Chubsucker. The lower Thames Valley Conservation Authority (LTVCA) (with CNFASAR funding) and the Essex Region Conservation Authority (ERCA) (with Habitat Stewardship Program [HSP] funding), in partnership with Long Point Region Conservation Authority (LPRCA), completed riparian habitat enhancement	Ecosystem-based recovery programs to implement on-the-ground stewardship efforts to reduce identified threats are ongoing.

Performance measure	Status	Details	Next steps
of livestock restricted from watercourses).		projects, through vegetation planting and other habitat improvement activities. These projects would improve water filtration and reduce overall sediment and nutrient loadings to Rondeau Bay, thereby improving habitat for Lake Chubsucker. Below are the stewardship efforts implemented by these groups: **Rondeau Bay** **2016 to 2016:** ERCA, in partnership with LTVCA, completed 24.72 hectares (ha) of habitat improvement through vegetation planting projects in the Rondeau Bay Watershed, upstream from Lake Chubsucker habitat in Rondeau Bay. **2017 to 2018:** ERCA, in partnership with LTVCA, completed 16.6 ha of riparian habitat improvement in the Rondeau Bay Watershed, upstream from Lake Chubsucker habitat in Rondeau Bay. **2018 to 2019:** ERCA, in partnership with LTVCA, completed 5.7 ha of riparian habitat improvement in the Rondeau Bay Watershed, upstream from Lake Chubsucker habitat in Rondeau Bay. **2020 to 2021:** LTVCA created 0.6 ha of prairie riparian buffer in McGregor Creek subwatershed, upstream from Lake Chubsucker habitat in Rondeau Bay.	

Performance measure	Status	Details	Next steps
		Long Point Bay **2016:** Under the same HSP project listed above, ERCA, in partnership with LPRCA, restored 0.81 ha of wetland and associated riparian habitat in Dedrick Creek Watershed, upstream from Lake Chubsucker habitat in Long Point Bay. **2018:** Same as above, ERCA, in partnership with LPRCA, completed 1.21 ha of vegetation planting in Black Creek Watershed, upstream from Lake Chubsucker habitat in Long Point Bay.	
Number of high priority sites enhanced/protected by stewardship actions.	Met, ongoing	From 2016 to 2021, 20 sites were enhanced through stewardship activities that benefit Lake Chubsucker habitat. Project funding for habitat improvement measures was provided through HSP and CNFASAR within the OAC (1 site), Rondeau Bay (17 sites) and Long Point Bay (2 sites).	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.

3.3.2 Completion of action plan

"The Action Plan for the Ausable River in Canada: An Ecosystem Approach" (DFO, 2020) was posted on Canada's species at risk public registry on March 3, 2020. Although an ecosystem/multispecies document, this action plan includes several components that specifically address the implementation recovery actions for Lake Chubsucker in the OAC and L Lake. The "Multi-species Action Plan for Point Pelee National Park of Canada and Niagara National Historic Sites of Canada" (PC 2016) also includes recovery actions that will benefit Lake Chubsucker found within Point Pelee National Park, specifically measures directed at addressing major threats to marsh habitat, such as declining water quality and invasive species. For more information on the progress of these measures, refer to the "Implementation Report: Multi-species Action Plan for Point Pelee National Park of Canada and Niagara National Historic Sites of Canada (2016-2021)" (PC 2022).

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, PPNP, Rondeau Bay, Long Point Bay, Big Creek NWA, and Lyons Creek. From 2016 to 2021 time period, non-target surveys have led to the detection of Lake Chubsucker in Callop Drain and Prince Albert Drain (Lake St. Clair Drainage), and an upper section of Big Creek (Norfolk County), which may lead to the identification of additional critical habitat, if there is sufficient evidence that Lake Chubsucker occurs at these locations. There have been very few captures in these locations; therefore, additional surveys are needed.

Since 2010, the critical habitat of the Lake Chubsucker found within NWAs and National Parks (that is, 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 within Canadian waters no longer meet the recovery feasibility criteria laid out in the recovery strategy. Reproducing populations of Lake Chubsucker still exist, as well as suitable habitat to support recovery objectives. The completion of restoration efforts and promotion of best management practices will further support the recovery of this species via threat mitigation.

4. Concluding statement

A substantial amount of progress has been made in terms of the implementation and monitoring measures prescribed in the recovery strategy (2010). Targeted sampling was conducted in St. Clair NWA, L Lake, Point Pelee National Park, and in several Southern Ontario wetlands, through multiple independent studies by DFO and external researchers. These studies, along with non-targeted studies over the last 6 years, have allowed for a better 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. Specifically, non-targeted sampling led to the detection of Lake Chubsucker in Rondeau Bay, where the species was previously thought to be extirpated, and to the detection of the species in several new locations, such as Big Creek National Wildlife Area's (NWA) Hahn Unit, an upper section of Big Creek, and 2 drains located east of Lake St. Clair. Future efforts should focus on completing more targeted surveys in Big

Creek NWA's Hahn and Big Creek Units for Lake Chubsucker, due to the recent detections of adults and juveniles. Surveys should aim to determine this population's status and if reproduction is occurring.

Monitoring of habitat quality parameters as part of these surveys has allowed for a better understanding of the overall habitat health and environmental stressors impacting Lake Chubsucker. Long-term water quality monitoring in the OAC has provided a better understanding of how hypoxic water conditions in the winter months contribute to winter fish kills. This threat warrants continued investigation into the impact, frequency, and magnitude of winter kills of Lake Chubsucker in the OAC. This effort should also aim to locate the presence of refugia that may be used by this population. Stewardship efforts to improve water quality in this ecosystem should be prioritized.

Several research objectives have also been undertaken in the last 6 years including an investigation of the habitat requirements of Lake Chubsucker in L Lake; an examination of the potential impacts of dyked wetland and drain maintenance in St. Clair NWA and Lake St. Clair tributaries; and comparison of the efficacy of different sampling gear in various vegetation types, including European Common Reed, to determine the optimal gear to detect SAR. Research not prescribed by the recovery strategy was also completed, including investigating the feasibility of Lake Chubsucker reintroduction into extirpated locations; conducting genetic assessments of the genus *Erimyzon,* including Lake Chubsucker, which led to the identification of a genetically distinct population in Lyons Creek; and developing a standard weight equation for this species to aid biologists in assessing the condition and size structure of Lake Chubsucker populations. More detailed studies investigating population size, structure, and condition is needed to support the conservation measure of reintroduction, and additional genetic analyses are needed to confirm the presence of a unique haplotype in Lyons Creek and the possibility of genetic distinctiveness between 2 clades of Lake Chubsucker.

Recovery activities have also allowed for the evaluation of the effects of threats on Lake Chubsucker critical habitat and abundance. Specifically, there were studies investigating the impact of the invasive species European Common Reed on Lake Chubsucker abundance and habitat usage, and the effects of control programs in Long Point and Big Creek NWAs, Long Point Crown Marsh, and Rondeau Bay. Similarly, there were multiple studies investigating the potential impact that Grass Carp could have on Lake Chubsucker critical habitat, should populations become established. Future projects should focus on the implementation of control efforts to prevent the spread of Grass Carp in the Great Lakes that would result in the loss of Lake Chubsucker critical habitat.

Finally, there have been several restoration projects and the promotion of BMPs that have led to reduced sedimentation, erosion, and nutrient loading in locations such as the OAC, Rondeau Bay, and Long Point Bay. In addition, marsh restoration work at Point Pelee National Park has focused on reducing the area of invasive Common Reed and Cattail in the marsh, restoring habitat for Lake Chubsucker and other species at risk, and helping to conserve wildlife diversity in the marsh. Awareness and outreach activities included information sessions focused on promoting awareness of aquatic SAR, including Lake Chubsucker, and the availability of funds to support stewardship projects in areas around the OAC and Rondeau Bay to improve habitat quality for SAR. DFO also provided information sessions to Conservation Authorities, drainage supervisors, contractors, consultants, and municipal planners to raise awareness of SAR and their critical habitat and to ensure the mitigation or prevention of 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 in Canada. Several areas remain where further information is required, namely the need for further research into the habitat needs of each life stage of Lake Chubsucker; and monitoring in underrepresented locations like Little Bear Creek, Long Point Bay (including Long Point NWA dyked and undyked marshes and Turkey Point), and Big Creek NWA (dyked and undyked marshes), Lyons Creek, as well as in the new locations where Lake Chubsucker have been observed, that is, the Lower Ausable River, the St. Clair NWA – Maxwell Cell, the 2 drains located east of Lake St. Clair, and an upper section of Big Creek in Norfolk County), to determine population size and range in these locations so that habitat can be better protected through the further identification of critical habitat for future recovery strategy amendments. Further research is also necessary regarding increased stewardship in coastal wetlands and in areas with decreased water quality, such as the OAC, to improve quality and quantity of Lake Chubsucker critical habitat.

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Appendix

Table 8. Summary of number of Lake Chubsucker detections.

Location	2016	2017	2018	2019	2020	2021	Total
Old Ausable Channel					2	1	**3**
L Lake			39			20	**59**
St. Clair River Delta	68	40		74	1		**183**
Prince Albert Drain (tributary to Maxwell Creek)		3					**3**
Collop Drain (tributary to Lake St. Clair)			1				**1**
St. Clair National Wildlife Area (NWA)	41		6	14			**61**
Point Pelee National Park	1			1		2	**4**
Rondeau Provincial Park					1		**1**
Lyons Creek							**0**
Big Creek Norfolk County						1	**1**
Big Creek NWA	165					4*	**169**
Long Point Bay (Inner Bay)	7	10	18	7	2	1	**45**
Long Point NWA	14	54					**68**
Lake Erie	1	2				13	**16**
Total # of detections	297	109	64	96	6	42	**614**

Table 9. Summary of DFO monitoring and external research sources leading to Lake Chubsucker detections from 2016 to 2021.

Year	Location	Number of LCS detected	Source(s)
2016	Long Point Bay (Inner Bay)	4	DFO Biodiversity Science (Asian Carp Early Detection Field Surveillance Program)
	Long Point Bay (Inner Bay)	3	Ministry of Northern Development, Mines, Natural Resources, and Forestry (OMNRF)
	Long Point NWA (Anderson's Pond)	13	DFO Biodiversity Science
	Long Point NWA (Bluff Pond)	1	DFO Biodiversity Science
	Lake Erie (Otter Pond)	1	Environment and Climate Change Canada
	St. Clair NWA (West Cell)	18	DFO Biodiversity Science
	St. Clair NWA (East Cell)	22	Biotactic Inc.
	St. Clair NWA (Maxwell Cell)	1	DFO Biodiversity Science
	Big Creek NWA (South Cell)	94	DFO Biodiversity Science
	Big Creek NWA (North Cell)	71	DFO Biodiversity Science
	St. Clair River Delta	68	DFO Biodiversity Science
	Point Pelee National Park	1	DFO Biodiversity Science (Bortoluzzi unpubl. data 2017)
			2016 Total: 297
2017	Long Point Bay (Inner Bay)	4	DFO Biodiversity Science (Asian Carp Early Detection Field Surveillance Program)
	Long Point Bay (Inner Bay)	6	OMNRF
	Long Point NWA (Long Pond)	3	University of Toronto Scarborough
	Long Point NWA (Duncan's Pond)	22	University of Toronto Scarborough
	Long Point NWA (Otter Ridge Pond)	23	University of Toronto Scarborough
	Long Point NWA (Buock Pond)	6	University of Toronto Scarborough

Year	Location	Number of LCS detected	Source(s)
	Lake Erie (Inland Pond)	2	Environment and Climate Change Canada
	St. Clair River Delta	31	DFO and Walpole Island First Nation (Gardner Costa et al. 2020)
	St. Clair River Delta	9	U.S. Geological Survey Great Lakes Science Center (Hilling et al. 2021)
	Prince Albert Drain (tributary to Maxwell Creek)	3	Stantec (via SARA permit # 16-HCAA-01491)
			2016 Total: 109
2018	Long Point Bay (Inner Bay)	5	DFO Biodiversity Science (Asian Carp Early Detection Field Surveillance Program)
	Long Point Bay (Inner Bay)	13	OMNRF
	L Lake	39	DFO Biodiversity Science (Barnucz & Drake, 2021a)
	St. Clair NWA marsh (East Cell)	6	DFO Biodiversity Science
	Collop Drain (tributary to Lake St. Clair)	1	St. Clair Region Conservation Authority (via SARA permit #18-PCAA-00005)
			2018 Total: 64
2019	Long Point Bay (Inner Bay)	5	DFO Biodiversity Science (Asian Carp Early Detection Field Surveillance Program)
	Long Point Bay (Inner Bay)	2	OMNRF
	Point Pelee National Park (Lake Pond)	1	DFO Biodiversity Science (Barnucz et al. 2021b)

Year	Location	Number of LCS detected	Source(s)
	St. Clair NWA marsh (West Cell)	5	DFO Biodiversity Science (Barnucz et al. 2021a)
	St. Clair NWA marsh (East Cell)	9	DFO Biodiversity Science (Barnucz et al. 2021a)
	St. Clair River Delta	25	U.S. Geological Survey Great Lakes Science Center (Hilling et al. 2021)
	Snye River Wetland	49	DFO Biodiversity Science (Midwood et al. 2020)
			2019 Total: 96
2020	Long Point Bay (Inner Bay)	2	DFO Biodiversity Science (Asian Carp Early Detection Field Surveillance Program)
	Old Ausable Channel	2	DFO Biodiversity Science (Asian Carp Early Detection Field Surveillance Program)
	St. Clair River Delta	1	DFO Biodiversity Science (Asian Carp Early Detection Field Surveillance Program)
	Rondeau Bay	1	DFO Biodiversity Science (Asian Carp Early Detection Field Surveillance Program)
			2020 Total: 6
2021	Point Pelee National Park (Redhead Pond)	1	DFO Biodiversity Science
	Point Pelee National Park (Girardin Pond)	1	DFO Biodiversity Science
	Old Ausable Channel	1	DFO Biodiversity Science (Asian Carp Early Detection Field Surveillance Program)

Year	Location	Number of LCS detected	Source(s)
	Long Point Bay (Inner Bay)	1	OMNRF
	Lake Erie	13	OMNRF
	Big Creek (Norfolk County)	1	DFO Biodiversity Science (Sea Lamprey Control Program monitoring via SARA Permit #21-PCAA-00036)
	L Lake	20	University of Toronto Scarborough (Powell & Reemeyer, 2021)
	Big Creek National Wildlife Area (Hahn Unit)	2	Parsons Inc. (via SARA permit #21-PCAA-00046)
	Big Creek National Wildlife Area (Big Creek Unit)	2	Parsons Inc. (via SARA permit #21-PCAA-00046)
2021 Total: 42			
2016 to 2021 Total: 614			

Table 10. Summary of targeted sampling efforts for Lake Chubsucker from 2015 to 2021.

Year	Project and/or organization name	Number of detections
2016	The balance between reservoir drawdown and the impact on species at risk, Lake Chubsucker in the St. Clair National Wildlife Area. (Biotactic Inc. unpublished report)	22
2016	Southern Ontario Wetlands Inventory	266
2017	University of Toronto Scarborough (continuation of Southern Ontario Wetlands Inventory)	54
2018	Mark-Recapture Sampling for Lake Chubsucker and Grass Pickerel in L Lake	39
2018	St. Clair NWA Pre-Drawdown - Lake Chubsucker Assessment	6
2019	Point Pelee National Park Wetland Fish Community Survey	1
2019	St. Clair NWA Drawdown - Community Assessment	14
2021	University of Toronto Scarborough, McGill University (via DFO issued SARA permit)	20
	Point Pelee National Park Wetland Fish Community Survey	2

Table 11. Summary of non-targeted sampling effort leading to Lake Chubsucker detections from 2015 to 2021.

Year	Project and/or organization name	Number of detections
2016	Asian Carps Great Lakes Monitoring of Long Point Bay	4
2016	Environment and Climate Change Canada (unpubl. data)	1
2016	Ministry of Natural Resources and Forestry (unpubl. data)	3
2016	DFO (Bortoluzzi unpubl. data 2017)	1
2017	Asian Carps Great Lakes Monitoring of Long Point Bay	4
2017	Environment and Climate Change Canada (unpubl. data)	2
2017	Ministry of Natural Resources and Forestry (unpubl. data)	5
2017	Nearshore Fish Species Richness and Species–Habitat Associations in the St. Clair–Detroit River System (research by USGS)	9
2017	Sampling efficacy of passive gear in the non-native emergent *Phragmites australis subsp. Australis* (research by DFO and Walpole Island First Nation)	31

Year	Project and/or organization name	Number of detections
2017	Stantec (via DFO issued SARA permit)	3
2018	Asian Carps Great Lakes Monitoring of Long Point Bay	5
2018	Ministry of Natural Resources and Forestry (unpubl. data)	13
2018	St. Clair Region Conservation Authority (via DFO issued SARA permit)	1
2019	Asian Carps Great Lakes Monitoring of Long Point Bay	5
2019	Ministry of Natural Resources and Forestry (unpubl. data)	2
2019	DFO (Midwood et al. 2020)	49
2019	Nearshore Fish Species Richness and Species–Habitat Associations in the St. Clair–Detroit River System (research by USGS)	25
2020	Asian Carps Great Lakes Monitoring of Ausable River	2
2020	Asian Carps Great Lakes Monitoring of Long Point Bay	2
2020	Asian Carps Great Lakes Monitoring of Rondeau Bay	1
2020	Asian Carps Great Lakes Monitoring of St. Clair River	1
2021	Asian Carps Great Lakes Monitoring of Ausable River	1
2021	Big Creek National Wildlife Area Fisheries Inventory	4
2021	Sea Lamprey Control Program (via DFO issued SARA permit)	1
2021	Ministry of Natural Resources and Forestry (unpubli. data)	14