COSEWIC
Assessment and Status Report

on the

Lake Chubsucker
Erimyzon sucetta

in Canada

ENDANGERED
2021

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Previous report(s):

COSEWIC. 2008. COSEWIC assessment and update status report on the Lake Chubsucker *Erimyzon sucetta* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 29 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

COSEWIC. 2001. COSEWIC status report on the Lake Chubsucker *Erimyzon sucetta* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 12 pp.

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COSEWIC
Assessment Summary

Assessment Summary – April 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. Three historical subpopulations have been lost and, of the remaining 10, the relative population status is poor for nine and fair for one. 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 re-examined and confirmed in May 2021.

COSEWIC
Executive Summary

Lake Chubsucker
Erimyzon sucetta

Wildlife Species Description and Significance

Lake Chubsucker (*Erimyzon sucetta*) is a member of the sucker family (Catostomidae), with an average total length of 200 mm in Canada. The species is one of 13 sucker species known from the Great Lakes basin and the only member of the *Erimyzon* genus in Canada. There is a single Lake Chubsucker designatable unit in Canada.

Distribution

Lake Chubsucker exhibits a widespread distribution in North America, from eastern Texas to Florida, and north to Ontario, Wisconsin, and Michigan. The only Canadian specimens are recorded from the southern Great Lakes basin. In Canada, the species has been recorded from lakes Huron, St. Clair, and Erie, as well as a tributary of the Niagara River. The Canadian distribution of Lake Chubsucker is limited to 10 extant localities and three localities are thought to be extirpated.

Habitat

Lake Chubsucker inhabits clear, warm, well-vegetated wetlands. Several wetland types are occupied in Canada, including dyked wetland cells, small lakes, oxbow river channels, slow-moving sections of tributary streams, agricultural drains, and coastal wetlands. Habitat requirements include the environmental conditions that promote the growth of native aquatic macrophytes. Water clarity to support photosynthesis and substrates to support root development of submergent and emergent plant species are important habitat features. Differences in habitat features that support larval, juvenile, and adult Lake Chubsucker are not well understood. The loss of Lake Chubsucker habitat is occurring due the release of agricultural effluent (e.g., nutrient loading, siltation) as well as the establishment of invasive plant and fish species. Both threats reduce the availability of native macrophyte species that Lake Chubsucker requires to carry out its life history.

Biology

Lake Chubsucker is a bottom feeder, and its diet mostly consists of small crustaceans, mollusks, aquatic insects, filamentous algae, and plant material. The maximum age of Lake Chubsucker reported is 8 years, while results of recent age interpretations indicate a maximum age of 6 years. Age of maturity has been reported at 3 years. Lake Chubsucker has been described as a warmwater species, and has been detected in water ranging from 13.8 to 33.7 °C.

Population Sizes and Trends

Lake Chubsucker is found at low abundances throughout most of its range and abundances have remained stable or are declining throughout its Canadian range. Areas where Lake Chubsucker is thought to be most abundant include L Lake, the Old Ausable Channel, Walpole Island dyked marshes, and Lyons Creek. Very few Lake Chubsucker have been captured from Rondeau Bay, with the last known record recorded in 2005. As the inner marshes of Rondeau Bay have been sampled on numerous occasions with the appropriate gear type since 2005, Lake Chubsucker is likely extirpated from this system. Lake Chubsucker has been detected from all other previously known localities since the last status report and from two new localities (Prince Albert Drain and Collop Drain).

Threats and Limiting Factors

Threats to Lake Chubsucker in Canada include: natural system modification (by invasive species such European Common Reed and Common Carp), shoreline development and hardening, dredging, and the drawdown of dyked wetlands and other water-level manipulations); pollution (agricultural effects such as the release of nutrients, sediment, and other pollutants; urban effects such as the release of effluent associated with housing subdivisions; and industrial effects such as contamination with PCBs); and invasive and other problematic species and genes. Climate change has also been implicated in the decline of Lake Chubsucker, but its effects on the species are poorly understood. Due to the small geographic area occupied by Lake Chubsucker and the presence of multiple threats within most localities, cumulative threat effects are anticipated. The availability of clear, well-vegetated wetlands free from anthropogenic impairment is the only significant limiting factor of Lake Chubsucker in Canada.

Protection, Status and Ranks

Lake Chubsucker was listed on Schedule 1 of the *Species at Risk Act* when the Act was proclaimed in June 2003 and is currently listed as Endangered on Schedule 1. Lake Chubsucker is listed as Threatened under the Ontario *Endangered Species Act, 2007*. Lake Chubsucker found in Point Pelee National Park are protected under the *Canada National Parks Act*, while those found in Long Point, Pinery, and Rondeau provincial parks are protected under the *Provincial Parks and Conservation Reserves Act, 2006*. On August 28, 2010, a description of Lake Chubsucker critical habitat in the Big Creek National Wildlife Area, the Long Point National Wildlife Area, the St. Clair National Wildlife Area, and Point Pelee National Park was published in the Canada Gazette. On December 16, 2017, a Lake Chubsucker Critical Habitat Order was registered in Canada Gazette.

TECHNICAL SUMMARY

Erimyzon sucetta

Lake Chubsucker

Sucet de lac

Range of occurrence in Canada (province/territory/ocean): Ontario

Demographic Information

Generation time	4-5.5 years Based on average age of parents.
Is there an inferred continuing decline in number of mature individuals?	Yes, inferred. Based on declining habitat quality and threats calculator.
Estimated percent of continuing decline in total number of mature individuals within 5 years	Unknown
Percent reduction in total number of mature individuals over the last 10 years?	Unknown
Percent reduction in total number of mature individuals over the next 10 years.	Unknown
Percent reduction in total number of mature individuals over any 10 years period, over a time period including both the past and the future.	Unknown
Are the causes of the decline (a) clearly reversible, (b) understood, and (c) ceased?	a. No b. Partially c. No
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	23,478 km²
Index of area of occupancy (IAO) 2x2 grid value	164 km²

Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse? **Notes:** Minimum Area for Population Viability (MAPV) = 1 km^2 (Young and Koops 2011) Populations bolded below are smaller than what would be required to support a viable population: Old Ausable Channel **L Lake – 0.11 km^2** Lake St. Clair Walpole Island (dyked) St. Clair NWA Long Point Inner Bay Long Point NWA **Big Creek NWA (dyked) – 0.92 km^2** Point Pelee **Lyons Creek - 2 km x 20 m wide=0.4 km^2**	(a) No (b) Yes
Number of locations* Current: 1. Old Ausable Channel, L Lake 2. Lake St. Clair, Walpole Island (dyked), St. Clair NWA 3. Long Point Inner Bay, Long Point NWA, Big Creek NWA (dyked) 4. Point Pelee 5. Lyons Creek	3-5 The most plausible threat is the rapid spread of aquatic invasive species having habitat-related effects (European Common Reed; Eurasian Watermilfoil; Grass Carp).
Is there an inferred continuing decline in extent of occurrence? Recent: 2009-2018 EOO= 23,478 km^2 Recent historical: 1999-2008 EOO = 23,181 km^2 All historical records: 1949-2008 EOO = 24,133 km^2	No Fluctuations in EOO are attributed to variable sampling effort over time resulting in a slight increase (1.3% or +297 km^2) in EOO compared to recent historical EOO.
Is there an inferred continuing decline in index of area of occupancy? Recent: 2009-2018 IAO = 164 km^2 Recent historical: 1999-2008 IAO = 152 km^2 All historical records: 1949-2008 IAO = 232 km^2	No Fluctuations in IAO are attributed to variable sampling effort over time resulting in a slight increase in IAO (7.9% or +14 km^2) compared to recent historical IAO.
Is there a continuing decline in number of populations?	Yes Rondeau population has been extirpated since previous report.
Is there an observed continuing decline in number of locations?	Not calculated. Locations not identified in previous report.

* See Definitions and Abbreviations on COSEWIC web site and IUCN (Feb 2014) for more information on this term

Is there an observed continuing decline in area, extent, and quality of habitat?	Yes Inferred decline in area and quality of habitat at localities with the introduction, establishment, and spread of the European Common Reed. Declines in the area and quality of habitat due to agricultural, industrial, and urban effluent have also been observed.
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of "locations"?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Populations (give plausible ranges)	**N Mature Individuals**
	Unknown for all populations except where the species is thought to be extirpated.
Total	

Quantitative Analysis

Probability of extinction in the wild is at least 20% within 20 years or 5 generations or 10% within 100 years.	Unknown

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

7. Natural system modification (very high-high impact)
9. Pollution (medium impact)
11. Climate change (medium-low impact)
8. Invasive and other problematic species (low impact)

Was a threats calculator completed for this species? Yes. Overall score from Threat Calculator was Very High-High.

What additional limiting factors are relevant?

The availability of warm, clear, well-vegetated wetlands free of anthropogenic disturbance is the primary limiting factor of Lake Chubsucker in Canada.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	United States: states adjacent to lakes Erie, Huron and Ontario (MI–S2; NY–SH; OH–S2; PA-SX)
Is immigration known or possible?	Unknown
Would immigrants be adapted to survive in Canada?	Likely

Is there sufficient habitat for immigrants in Canada?	Unknown
Are conditions deteriorating in Canada?	Yes
Are conditions for the source (i.e., outside) population deteriorating?	Yes Based on status in adjacent jurisdictions.
Is the Canadian population considered to be a sink?	Unknown
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC 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 re-examined and confirmed in May 2021.

Status and Reasons for Designation:

Status: Endangered	**Alpha-numeric codes:** A3bce+4bce; B2ab(ii,iii,iv,v)

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. Three historical subpopulations have been lost and, of the remaining 10, the relative population status is poor for nine and fair for one. If the threats to these extant subpopulations are not managed effectively, loss of individuals and subpopulations will continue.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Endangered, A3bce+4bce. Observed, estimated, inferred, and suspected reduction of >50% in total number of mature individuals based on: continuing decline in relative population status and in number of populations; continuing decline in index of area of occupancy and quality of habitat; rapid expansion of invasive Phragmites; and threats calculator overall impact of Very High (50-100% population loss) – High (22-70%).
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered, B2ab(ii,iii,iv,v). Small (164 km²) IAO, <5 locations, and a continuing observed and projected decline in: index of area of occupancy; area and quality of habitat; and number of populations and mature individuals.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. No information available. Population estimate is unknown.
Criterion D (Very Small or Restricted Population): Does not apply. Population estimate is unknown.
Criterion E (Quantitative Analysis): Not applicable. Analysis not completed.

PREFACE

Lake Chubsucker was first assessed by COSEWIC in April 1994 and designated as a species of Special Concern. Subsequently, in November 2001, the species was reassessed as Threatened and, most recently, reassessed as Endangered in November 2008. In June 2003, Lake Chubsucker was listed on Schedule 1 of the *Species at Risk Act*. The federal listing has provided increased opportunities for research on Lake Chubsucker, including targeted sampling, and new information on the genetic structure of Canadian populations. Genetic analysis shows evidence of genetic distinctiveness; however, there is insufficient evidence to suggest the species meets the criteria to demonstrate evolutionary significance; therefore, a single designatable unit is proposed for the species in Canada. Lake Chubsucker requires clear, warm, well-vegetated wetlands, which continue to be threatened by: establishment of invasive macrophyte and fish species; agricultural, industrial, and urban habitat modifications; and the habitat-related effects of climate change. Due to the restricted area occupied by Lake Chubsucker and the incidence of multiple threats in these localities, cumulative threats are expected to contribute to future declines of the species in Canada.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2021)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service

Environnement et Changement climatique Canada
Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Kingdom: Animalia
Phylum: Chordata
Class Actinopterygii
Order: Cypriniformes
Family: Catostomidae
Species: *Erimyzon sucetta* (Lacepède, 1803)
Common English Name: Lake Chubsucker (Page *et al.* 2013)
Common French Name: sucet de lac (Page *et al.* 2013)

Morphological Description

Lake Chubsucker (*Erimyzon sucetta*) is a member of the sucker family (Catostomidae), characterized by a deep body, a thick caudal peduncle, and a wide head with a blunt snout ending in a small, slightly inferior mouth (Scott and Crossman 1973; Holm *et al.* 2009). Colouration can vary with the back and upper sides of the fish ranging from deep olive-green to bronze; however, a cross-hatching pattern is generally always evident in adults resulting from scales having a dark edge (Holm *et al.* 2009). The colouration of the lower sides ranges from gold to silver, while the belly can appear greenish-yellow to whitish-yellow (Holm *et al.* 2009). Juvenile Lake Chubsucker exhibit a prominent dark stripe along the front edge of the dorsal fin and a dark lateral stripe that runs from the snout ending in a black spot at the base of the tail (Holm *et al.* 2009). The lateral dark stripe often becomes less prominent in adult Lake Chubsucker, appearing broken or sometimes absent. Lake Chubsucker can also be distinguished from other sucker species in Canada by the lack of a lateral line. Breeding males often have three or four large tubercles on each side of their snout (Boschung and Mayden 2004).

A total of 13 sucker species are known from the Great Lakes basin (Holm *et al.* 2009). Lake Chubsucker is easily distinguishable from members of the genera *Carpiodes, Cycleptus*, and *Ictiobus* by the presence of a dorsal fin with a short base lacking a rounded or pointed anterior lobe (COSEWIC 2008). Lake Chubsucker more closely resembles Creek Chubsucker (*E. oblongus*), which is known to occupy American tributaries of lakes Ontario and Erie (COSEWIC 2008) but this species has not been reported from Canadian waters and can be differentiated from Lake Chubsucker in having a larger eye diameter, lower lateral-line scale count, higher dorsal-ray count, and a stouter body form (COSEWIC 2008).

Population Spatial Structure and Variability

A recent study focused on mtDNA barcoding (cytochrome oxidase 1 (COI) sequencing) described the genetic structure of Lake Chubsucker throughout its range in Ontario (Hauser *et al.* 2019). A total of 71 genetic samples were taken from the seven localities: Lake Huron (Old Ausable Channel, L Lake), Lake Erie (Big Creek, Long Point), Lake St. Clair (Walpole Marsh, St. Clair National Wildlife Area), and the Niagara River (Lyons Creek). In addition to these samples, COI sequences from four additional individuals from Long Point Bay were obtained from Genbank. Also obtained from Genbank, and used as outgroups in the study, were Lake Chubsucker from South Carolina, as well as Sharpfin Chubsucker (*E. tenuis*) and Creek Chubsucker (*E. oblongus*). Phylogenetic analysis and tree visualization were performed on the dataset to implement maximum likelihood estimation. The resulting phylogenetic tree includes samples of all Canadian and South Carolina Lake Chubsucker, and Sharpfin and Creek chubsuckers, and indicates that the majority of Lake Chubsucker individuals (84%) share the same haplotype, which occurs at all localities with the exception of Lyons Creek (Figure 1). Furthermore, individuals from Lyons Creek had three unique haplotypes not found at any other locality examined in this study. The authors concluded that Lyons Creek represents a genetically distinct population in Canada, which resulted from a large geographic distance between Lyons Creek and all other Lake Chubsucker localities in Canada.

Designatable Units

All Canadian Lake Chubsucker populations are located within the Great Lakes-Upper St. Lawrence biogeographic zone of the freshwater biogeographic zone classification adopted by COSEWIC. To determine the number of designatable units, both discreteness and significance need to be considered. Within the range of Lake Chubsucker in Canada, and following the criteria described for discreteness, Lake Chubsucker shows evidence of genetic distinctiveness (Hauser *et al.* 2019). Individuals sampled from Lyons Creek had three unique haplotypes not found in any other site. In addition to genetic distinctiveness, the Lyons Creek population is located at a distance of greater than 160 km from the closest known record of Lake Chubsucker in Long Point Bay. These two populations are separated a great distance and unsuitable habitat and unfavourable hydrological conditions, including the Niagara River, resulting in a low likelihood of exchange between these populations.

However, to satisfy the requirements for the designation of multiple designatable units (COSEWIC 2021), a population must also show evolutionary significance by either demonstrating relatively deep intraspecific phylogenetic divergence, persistence of the discrete population in a unique ecological setting, representation as the only surviving natural occurrence of a species, or evidence that the loss of the population would induce extensive disjunction in the range of the species. There is currently no evidence to suggest that Lake Chubsucker fully meets one or more of the above criteria to demonstrate evolutionary significance; therefore, a single designatable unit is proposed for Lake Chubsucker in Canada.

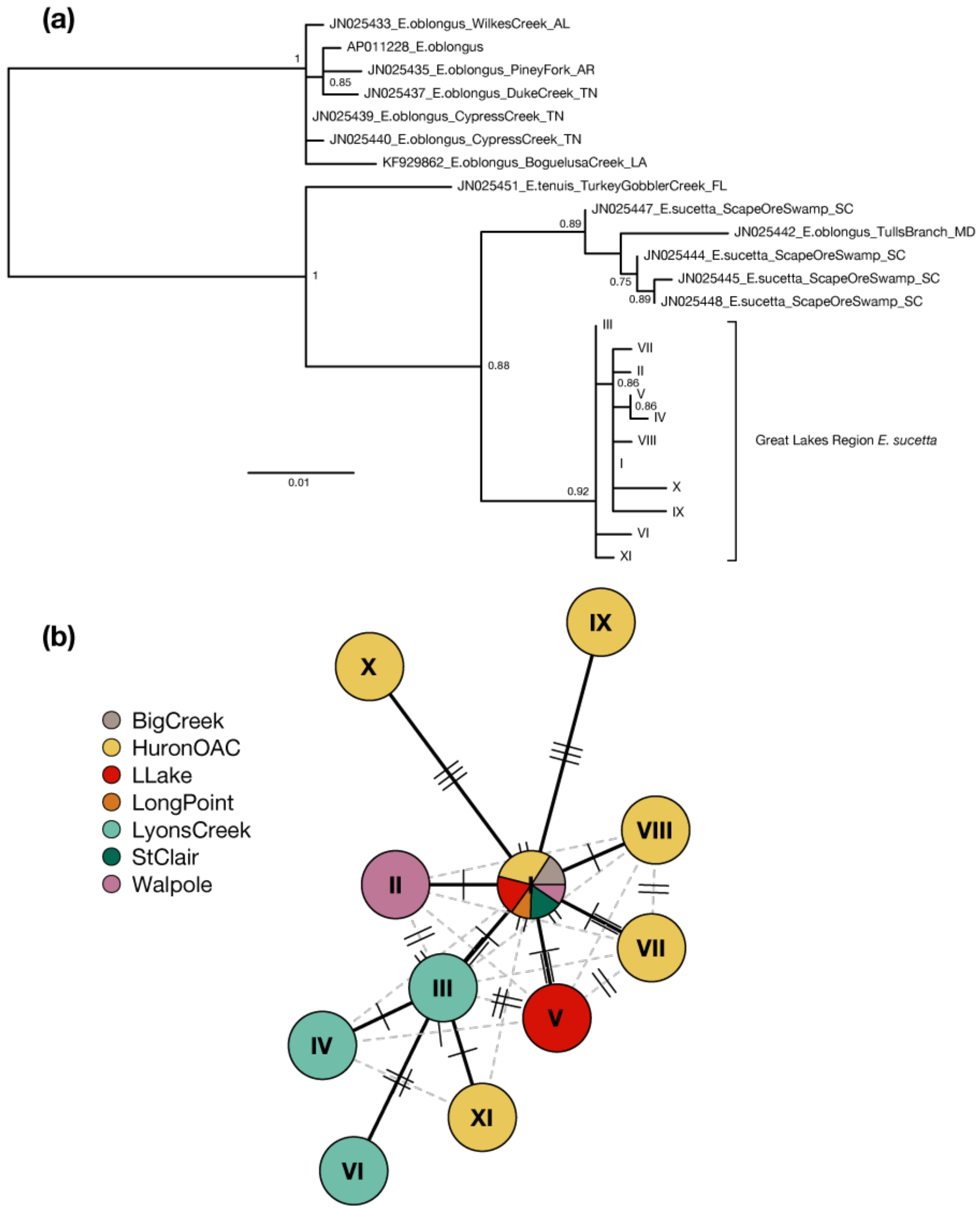

Figure 1. (a) Maximum likelihood tree of COI sequences from Lake Chubsucker and closely related species (only unique sequences shown). Where applicable, Genbank accession IDs and sample sites are shown. Lake Chubsucker haplotypes in Ontario are indicated with Roman numerals. (b) COI haplotype network for Lake Chubsucker from Ontario, where haplotypes are labelled with Roman numerals. Dashes along lines connecting haplotypes represent the number of mutational differences between haplotypes. Colours represent sampling localities where haplotypes were detected. This figure has been reproduced with permission from Hauser *et al.* (2019).

Special Significance

Although Lake Chubsucker is one of 13 sucker species found in the Great Lakes basin (Holm *et al.* 2009), it is the only member of the *Erimyzon* genus in the Canadian Great Lakes drainage. The ecological and genetic diversity that is contributed to Canada's overall freshwater fish biodiversity by this species may be in jeopardy. In addition, due to its preference for clear, well-vegetated wetland systems, its decline may be an indicator for declines in general wetland health.

DISTRIBUTION

Global Range

Lake Chubsucker exhibits a widespread distribution in North America with a continuous distribution in eastern United States from Virginia to Florida (Figure 2). Lake Chubsucker distribution in the United States is centred on the Gulf states and extends westward to eastern Texas and northward to Wisconsin and Michigan (NatureServe 2019). The most northerly extent of its distribution includes the Great Lakes drainage, with the only Canadian specimens recorded from the southern Great Lakes. The global range is estimated at approximately 200,000 to 2,500,000 km^2 (NatureServe 2019) but appears to be decreasing as Iowa and Pennsylvania populations are presumed to be extirpated, and New York populations are considered possibly extirpated (NatureServe 2019).

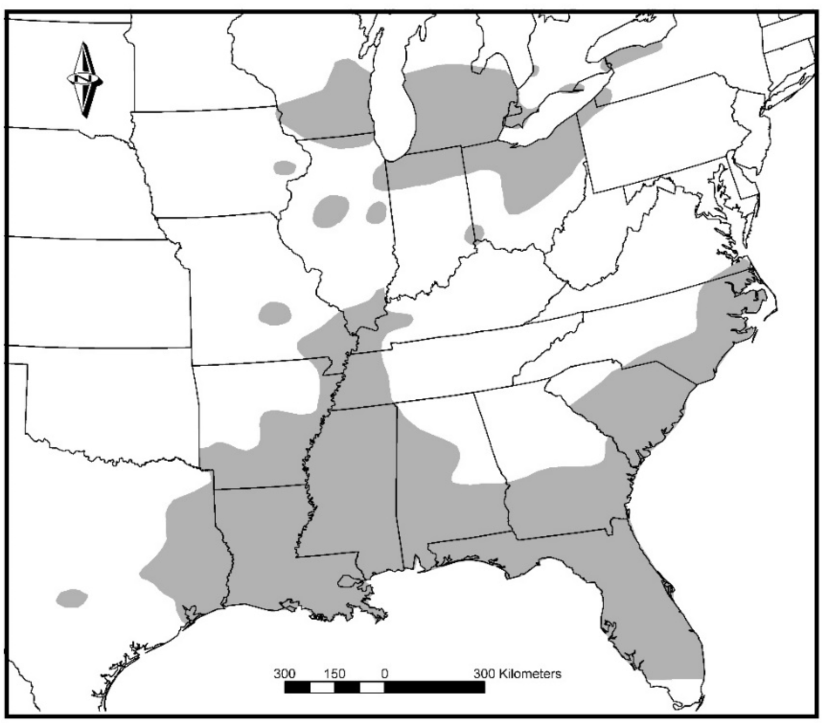

Figure 2. Distribution of Lake Chubsucker in North America (Reproduced from COSEWIC 2008).

Canadian Range

In Canada, Lake Chubsucker has been recorded from lakes Huron, St. Clair, and Erie, and a tributary of the Niagara River (Figure 3). All recorded accounts of Lake Chubsucker occur within this range; however, the species may have been more broadly distributed during pre-European times. The first record of Lake Chubsucker in Canada was reported from Point Pelee (Royal Ontario Museum ID: ROM15373) in 1949. It has been hypothesized that Lake Chubsucker dispersed through glacial waterbodies into the Lower Peninsula of Michigan and along the south shore of Lake Ontario during the late Pleistocene, and it has also been suggested that it was not collected prior to 1949 due to low abundances in habitats that were difficult to sample (Mandrak 1990). The Canadian distribution of Lake Chubsucker is limited to 10 extant localities (Old Ausable Channel, L Lake, Lake St. Clair, Walpole Island dyked marshes, St. Clair National Wildlife Area (NWA), Long Point Bay, Big Creek NWA (dyked marsh), Point Pelee National Park and Lyons Creek) and it is thought to be extirpated at three localities (Jeanette's Creek, Rondeau Bay, and Big Creek upper tributaries) (Figure 3).

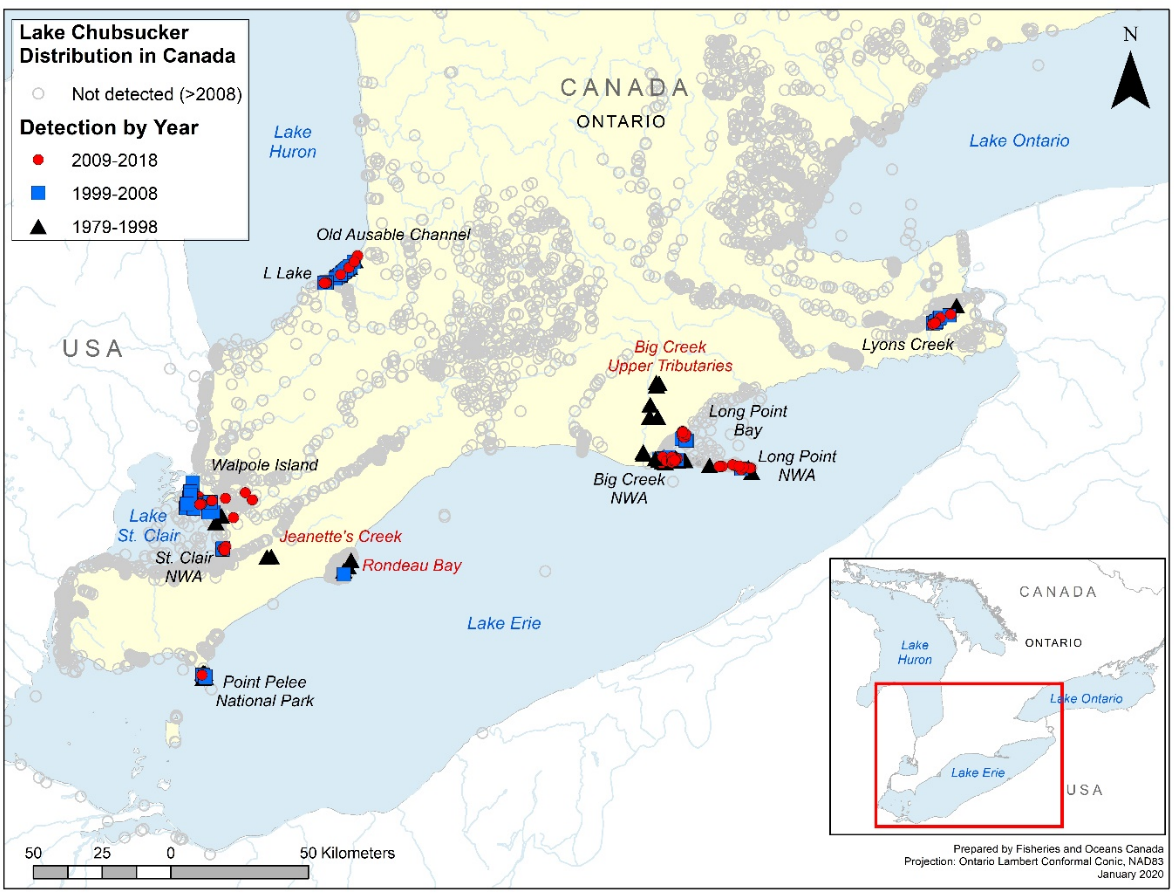

Figure 3. Distribution of Lake Chubsucker in Canada, including sites sampled since 2008 where the species was not detected (light grey circles). Localities where Lake Chubsucker are thought to be extirpated are indicated in red font.

The population status of Lake Chubsucker has been defined in the recovery potential assessment for this species (Bouvier and Mandrak 2011). This convention was followed for this status report as it is believed that many of the threats affecting Lake Chubsucker populations would affect a large proportion of its range simultaneously; however, the localities are separated by impassable barriers, limiting the possibility of dispersal between localities. One significant barrier to movement for Lake Chubsucker is dyked wetlands. In many of the wetlands where Lake Chubsucker is found, water levels are actively managed by pumping water in and out of dyked cells to maintain optimal water levels for waterfowl. In some cases, these pumps include screens, and it is unlikely that movement through the pumps is feasible. For each of the managed wetlands, determinations were made on the likelihood of movement of Lake Chubsucker and distinct localities are proposed accordingly.

In Lake Huron, the Old Ausable Channel and L Lake are two localities. It is likely that Lake Chubsucker historically inhabited the lower Ausable River prior to its diversion in the late 1800s; however, the species is no longer present in this system as the construction of the diversion has altered the aquatic ecosystem significantly and preferred habitat for Lake Chubsucker is no longer available (ARRT 2005; Staton *et al.* 2010). Lake Chubsucker is now restricted to the Old Ausable Channel, a closed system of high habitat quality (Staton *et al.* 2010), and L Lake, a small oxbow lake, which may have been historically connected to the lower Ausable River. This small, disconnected lake has been the focus of a preliminary depletion study (Reid unpubl. data 2019) and a mark-recapture study (Drake unpubl. data 2019) to determine population estimates.

There are four localities in Lake St. Clair and its associated tributaries. The first, Lake St. Clair proper, includes all waterbodies directly connected to the lake proper with movement between populations deemed to be possible. Populations associated with Lake St. Clair proper include Little Bear Creek, Prince Albert Drain, Collop Drain, the undyked wetlands of Walpole Island, and Maxwell cell (one of six cells within the Bear Creek Unit of the St. Clair National Wildlife Area). The second locality is the dyked wetlands of Walpole Island, which are separated from Lake St. Clair and St. Clair River by dykes, which are thought to be impassable. The third locality includes the West and East cells of the St. Clair Unit of the St. Clair National Wildlife Area, located approximately 8.5 km south of Mitchell's Bay. Movement between cells is made possible by water-control structures and pumps (ECCC 2016); however, movement of Lake Chubsucker into Lake St. Clair proper is unlikely. Jeanette's Creek, a tributary of the Thames River, is the fourth locality and was once likely continuous with Lake St. Clair proper; however, fragmentation by habitat alteration has isolated this locality and it is now deemed to be extirpated (COSEWIC 2008).

In Lake Erie, there are six distinct localities. Point Pelee National Park is the site of the first Lake Chubsucker record in Canada in 1949. The wetland complex of Point Pelee is a single locality. Point Pelee is composed of multiple ponds with varying levels of connectivity; however, Lake Chubsucker has only ever been recorded from Lake Pond, Redhead Pond, and Girardin Pond. The second Lake Erie locality is Rondeau Bay. There are very few records of Lake Chubsucker from Rondeau Bay, all recorded within the provincial park boundary. The third locality, Long Point Bay, is composed of all directly connected areas where movement between populations is deemed possible. This includes Turkey Point Marsh, Crown Marsh, Long Point Inner Bay, and Big Creek undyked marshes. Long Point National Wildlife Area is considered an independent locality as it is separated by a vast sand bar, acting as an impassible barrier, making movement from this locality to Long Point Bay populations unlikely. The dyked cells found within the Big Creek Unit of the Big Creek National Wildlife Area are an independent locality as movement between these cells and the Big Creek marsh system and Long Point Bay are unlikely. The last locality is the upper tributaries of Big Creek, including Stoney Creek, Silverthorn Creek, Lyndeock Creek, and Trout Creek. This locality, deemed to be extirpated, was likely continuous with Long Point Bay historically; however, habitat loss and alteration in this system have negatively affected its connectivity, and these areas no longer provide suitable habitat for Lake Chubsucker (COSEWIC 2008).

Lyons Creek, a tributary of the Niagara River, and its tributary Tea Creek are a separate locality. This system is generally considered highly degraded, with the exception of a 2 km portion of the creek where the species is extant that receives overflow from the Welland Canal. There is only a single historical Lake Chubsucker record from Tea Creek, recorded in 1958 and the species no longer occupies this tributary of Lyons Creek (COSEWIC 2008).

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) for Lake Chubsucker in Canada was calculated to be 23,478 km^2 for the time period of 2009-2018 (Figure 4). EOO was calculated following the convex hull polygon method (see COSEWIC 2021). There is a slight increase in EOO (1.3% or +297 km^2) for this time period compared to the previous 10 years (1999-2018; EOO=23,181 km^2), caused by minor shifts in point of capture within Lyons Creek, Old Ausable Channel, Lake St. Clair, Point Pelee National Park, and Long Point NWA. This slight increase is a result of varying sampling effort over time and should not be considered an increase in the distribution of the species. Conversely, when the EOO for the 2009-2018 (23,478 km^2) time period is compared to the EOO for all prior records (1949-2008; 24,133 km^2), a slight decrease in EOO is observed (-199 km^2), also due to varying sampling effort in key localities, such as Lyons Creek, Point Pelee National Park, and Long Point NWA.

The index of area of occupancy (IAO) for Lake Chubsucker in Canada for the 2009-2018 time period was calculated as 164 km^2 based on an overlaid grid cell size of 2 x 2 km following methods outlined in COSEWIC (2021). A slight increase in IAO (12 km^2 or 7.9%) was observed when the 2009-2018 time period is compared to the IAO from the previous 10 years (1999-2008 time period; IAO=152 km^2). This increase in IAO should be expected as it follows the publication of the Lake Chubsucker federal recovery strategy (Staton *et al.* 2010) and, consequently, additional research efforts, including search effort, have been made on the species over this time period. This increase in IAO does not represent discovery of any new Lake Chubsucker localities; however, an increase in sampling effort has increased the point distribution within known localities.

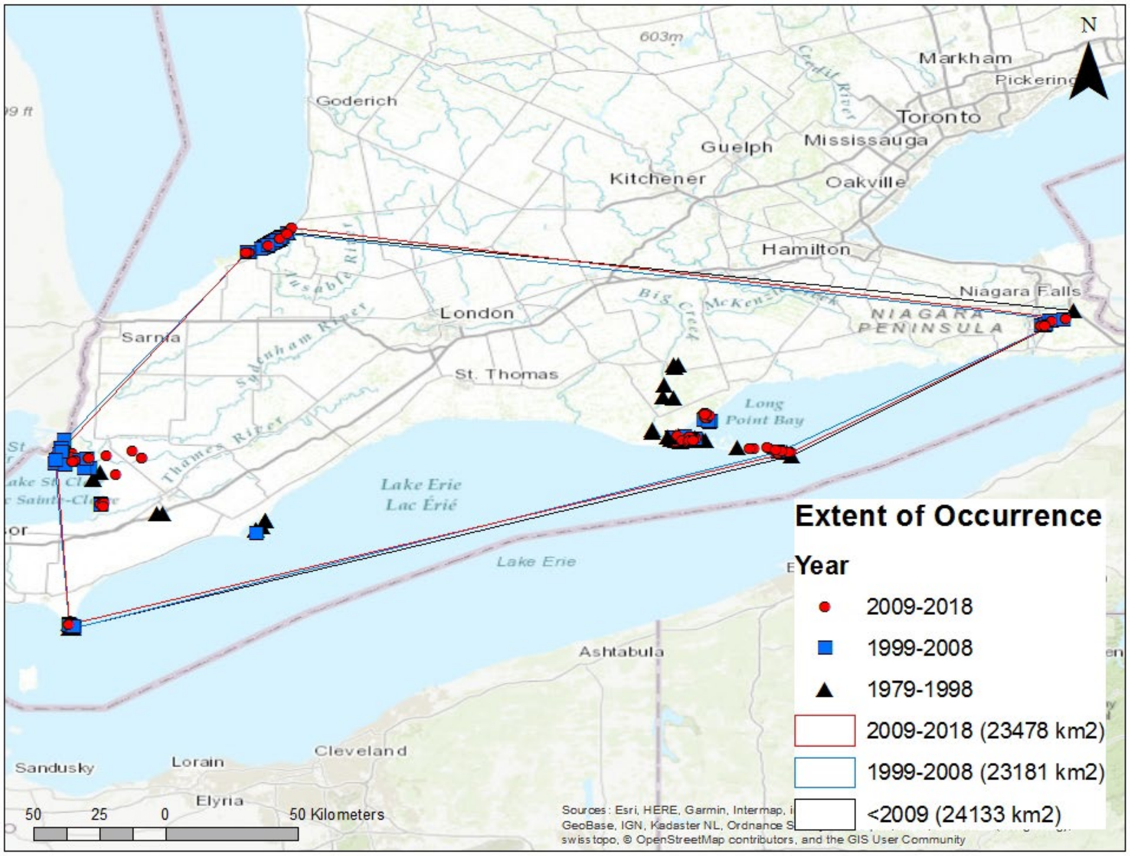

Figure 4. Extent of occurrence (km2) of Lake Chubsucker for three time periods: 2009-2018; 1999-2008; and, 1979-2008.

Search Effort

Some targeted sampling efforts have been made since the previous Lake Chubsucker status report (COSEWIC 2008). Field research targeting Lake Chubsucker has occurred in Lyons Creek (2010), L Lake (2010, 2012), Old Ausable Channel (2012), and Long Point Bay (2013) to confirm the continued presence of the species (DFO 2017). Additionally, targeted surveys were conducted in three tributaries of the Niagara River, in close proximity to Lyons Creek, to determine if Lake Chubsucker occupied a larger range in this area than was previously recorded; no Lake Chubsucker were detected during these efforts (DFO 2017). Attempts have also been made to collect field data through depletion and mark-recapture studies (L Lake and Lyons Creek) with the intent of calculating population size estimates (Drake unpubl. data 2019; Reid unpubl. data 2019). Moreover, ongoing fish community research in areas inhabited by Lake Chubsucker have opportunistically resulted in recent Lake Chubsucker occurrence records (Biotactic 2016; Rook *et al.* 2016; Drake unpubl. data 2019; Montgomery unpubl. data 2019; Reid unpubl. data 2019). A substantial amount of sampling effort has been realized throughout southwestern Ontario over the period of the last 10 years (Figure 3). This sampling effort was accomplished by deploying a wide variety of gear types, many of which are suitable for the detection of Lake

Chubsucker. All localities known to be inhabited by Lake Chubsucker have been sampled within this same 10-year period, with the exception of the upper tributaries of Big Creek, as this area no longer represents suitable habitat for freshwater fishes. All historical and recent Lake Chubsucker occurrence records have been summarized in Table 1.

HABITAT

Habitat Requirements

Lake Chubsucker is found in clear, warm, well-vegetated, shallow (< 2.5 m in depth) wetlands. Several wetland types are occupied by Lake Chubsucker in Canada, including dyked wetland cells (Walpole Island cells, St. Clair NWA, Big Creek NWA), small lakes (L Lake), old oxbow river channels (Old Ausable Channel), slow-moving sections of tributary streams (Little Bear Creek, Big Creek, Lyons Creek), agricultural drains (Prince Albert Drain and Collop Drain of Lake St. Clair), and coastal wetlands (Point Pelee, Rondeau Bay, Long Point Bay).

Detailed studies of the habitat requirements of Lake Chubsucker have not been undertaken; however, there is a strong positive relationship between Lake Chubsucker and the density and diversity of aquatic macrophytes (Bouvier and Mandrak 2011). Therefore, habitat requirements of Lake Chubsucker include the environmental conditions that promote abundant growth of native aquatic macrophytes. Water clarity to support photosynthesis and substrates to support root development of submergent and emergent plant species are presumed to be important habitat features (Lane *et al.* 1996a,b).

Due to infrequent captures of Lake Chubsucker in Canada, the specific habitat features needed to support larval, juvenile, and adult life stages of Lake Chubsucker are not well understood. Likewise, the habitat features necessary for feeding, cover, food supply, and reproduction are also not known. Several authors have summarized habitat features associated with the occurrence of adults and juveniles in certain areas, but range-wide habitat associations have not been summarized. Citing Mahon and Balon (1977) and Werner *et al.* (1977), Lane *et al.* (1996b) indicated that adult Lake Chubsucker have a high affinity for submergent and emergent vegetation, a moderate association with sand substrates, and a high association with silt substrates. Adults also display a high association with water depths of 0-2 m and generally reside in lentic ecosystems (Lane *et al.* 1996b). Spawning habitat is also poorly known and presumed to be similar to the habitat generally required by adults. Based on Goodyear *et al.* (1982) and Leslie and Timmins (1991), Lane *et al.* (1996a) noted that Lake Chubsucker generally occupy nursery habitats between 0-2 m, display high preference for silt and moderate preference for sand and clay. Nursery habitat is prominently lacustrine (Lane *et al.* 1996a).

Table 1. Summary of all known occurrence records of Lake Chubsucker in Canada (1949-2018). Gear: BEF=boat electrofisher; BPEF=backpack electrofisher; DP=dip net; FN fyke net; HN=hoop net; MFN=mini fyke net; MN=minnow trap; RN=roll nets; SN=seine net; UNK=unknown; VO=visual observation. The table has been modified from COSEWIC (2008), and updated with occurrences recorded since last status report.

Locality	Population	Year of survey	Lake Chubsucker targeted	Gear	Number captured	Source	Effort or CPUE data available
1. Old Ausable Channel	Old Ausable Channel	1982	No	UNK	≥2 (n=11; COSEWIC 2008)	Canadian Distribution Database (RMC42234; RMC42227)	No
	Old Ausable Channel	1997	No	UNK	≥2 (n=7; COSEWIC 2008)	Canadian Distribution Database (ROM71020; ROM71029)	No
	Old Ausable Channel	2001	No	UNK	≥1	ROM72661	No
	Old Ausable Channel	2002	No	SN; BEF; HN	13	DFO, unpubl. data (2019)	Yes
	Old Ausable Channel	2004	No	BPEF; SN	54	DFO, unpubl. data (2019)	Yes
	Old Ausable Channel	2005	No	SN	39	DFO, unpubl. data (2019)	Yes
	Old Ausable Channel	2009	No	BEF; SN	28	DFO, unpubl. data (2019); Ausable Bayfield Conservation Authority	Yes
	Old Ausable Channel	2010	Yes	SN	2	DFO, unpubl. data (2019)	Yes
	Old Ausable Channel	2010	No	NA*fish collected from overwinter fish kill	68	Ausable Bayfield Conservation Authority	No
	Old Ausable Channel	2012	Yes	SN	51	DFO, unpubl. data (2019)	Yes
	Old Ausable Channel	2015	No	UNK	23	DFO, unpubl. data (2019)	Yes
2. L Lake		2007	No	BEF; SN	≥18	DFO, unpubl. data (2019); Ausable 2007 IRF Fish Survey	Yes
		2010	Yes	SN	215	DFO, unpubl. data (2019); Reid, unpubl. data (2019)	Yes
		2018	Yes	SN	39	DFO, unpubl. data (2019)	Yes
3. Lake St. Clair	Lake St. Clair	1949	No	UNK	2	COSEWIC (2008)	No
	Lake St. Clair	1952	No	UNK	≥3	Canadian Distribution Database (RMC15686; RMC15685; RMC15684)	No
	Lake St. Clair	1979	No	UNK	1	Canadian Distribution Database (RMC35782)	No
	Various	1999	No	UNK	≥13 (n=117; COSEWIC 2008)	ROM (Various records)	No
	Various	2001	No	UNK	≥4 (n=10; COSEWIC 2008)	Canadian Distribution Database	No
	Various	2002	No	UNK	≥1	ROM74023	No

Locality	Population	Year of survey	Lake Chubsucker targeted	Gear	Number captured	Source	Effort or CPUE data available
	Little Bear Creek	2013	No	SN	2	DFO, unpubl. data (2019)	Yes
	Walpole undyked wetlands	2016	No	MFN; SN	47	DFO, unpubl. data (2019); Montgomery, unpubl. data (2019)	Yes
	Prince Albert Drain	2017	No	UNK	1	SAR Permit Database (16-HCAA-01491)	No
	Collop Drain	2018	No	SN	1	SAR Permit Database (18-PCAA-00005)	No
4. Walpole Island (dyked wetlands)		1999	No	UNK	39	ROM	No
		2001	No	UNK	≥125	Canadian Distribution Database	No
		2016	No	MFN; SN	21	DFO, unpubl. data (2019); Montgomery, unpubl. data (2019)	Yes
5. St. Clair National Wildlife Area (dyked wetland)	West cell	2004	No	BEF; HN	6	Bouvier (2006)	Yes
	West cell	2016	No	MFN	18	DFO, unpubl. data (2019); Montgomery, unpubl. data (2019)	Yes
	East cell	2016	No	MT; DN; VO	≥22	Biotactic, unpubl. report	Yes
	Maxwell cell	2016	No	MFN	1	Montgomery, unpubl. data (2019)	
	East cell	2018	Yes	MFN	6	(Barnucz *et al.* 2021)	Yes
6. Jeanette's Creek		1963	No	UNK	≥1	Canadian Distribution Database (CMNFI 67-0112.3)	No
		1965	No	UNK	≥1	Canadian Distribution Database (CMNFI 67-0112)	No
7. Rondeau Bay		1955	No	UNK	14	Canadian Distribution Database (Various ROM ID numbers)	No
		1963	No	UNK	≥3	Canadian Distribution Database (Various ROM ID numbers)	No
		1983	No	UNK	≥1 (n=12; COSEWIC 2008)	Canadian Distribution Database (RMC43412)	No
		2005	No	SN	1	SAR Permit Database (SECT 05 SCI 003)	No
8. Long Point Bay	Inner Bay	1951	No	UNK	5	COSEWIC (2008)	No
	Big Creek Inner Bay	1955	No	UNK	7	Canadian Distribution Database (RMC18081; RMC18080)	No
	Big Creek	1979	No	HN	2	MacLean (1979)	No
	Big Creek	1982	No	RN	4	Dewey (1982)	No
	Turkey Point Marsh	1985	No	UNK	1	COSEWIC (2008)	No
	Crown Marsh	1994	No	BEF	≥8	GLLFAS Electrofishing	No
	Inner Bay	1999	No	UNK	≥1	Canadian Distribution Database (RMC71965)	No
	Crown Marsh	2004	No	BEF	1	DFO, unpubl. data (2019)	Yes

Locality	Population	Year of survey	Lake Chubsucker targeted	Gear	Number captured	Source	Effort or CPUE data available
	Turkey Point Marsh	2007	No	BEF	22	DFO, unpubl. data (2019)	Yes
	Big Creek	2008	No	HN	2	DFO, unpubl. data (2019)	Yes
	Crown Marsh Turkey Point Marsh	2009	No	UNK	≥12	SAR Permit Database (SECT 08 SCI 028)	No
	Turkey Point Marsh	2010	No	SN; HN	2	SAR Permit Database (SECT 73 SARA C&A 10-019)	No
	Turkey Point Marsh	2011	No	UNK	37	SAR Permit Database (SECT 73 SARA C&A 11-029)	No
	Crown Marsh	2012	Yes	SN	87	DFO, unpubl. data (2019); Rook *et al.* (2016)	Yes
	Crown Marsh	2013	Yes	SN	21	DFO, unpubl. data (2019); Rook *et al.* (2016)	Yes
	Crown Marsh	2014	Yes	SN	88	DFO, unpubl. data (2019); Rook *et al.* (2016)	Yes
	Crown Marsh Inner Bay	2015	No	BEF	9	Marson *et al.* (2018); SAR Permit Database (15-PCAA-00010)	Yes
	Crown Marsh	2016	Yes	BEF; SN	7	Colm *et al.* (2018); S. Reid (MNRF)	Yes
	Crown Marsh	2017	Yes/No	BEF; SN	9	Colm *et al.* (2019a); SAR Permit Database (15-PCAA-00011)	Yes
	Crown Marsh Inner Bay	2018	Yes/No	BEF/SN	15	Colm *et al.* (2019b); SAR Permit Database (18-PCAA-00024)	Yes
9. Long Point NWA		1975	No	UNK	≥2 (n=177; COSEWIC 2008)	Canadian Distribution Database (RMC36575; RMC0568CS)	No
		2005	No	HN	1	DFO, unpubl. data (2019)	Yes
		2009	No	UNK	≥1	SAR Permit Database (SECT 08 SCI 028)	No
		2016	No	FN; MFN; SN	14	DFO, unpubl. data (2019); Montgomery, unpubl. data (2019)	Yes
		2017	No	MFN; SN; FN	54	SAR Permit Database (17-PCAA-00010)	Yes
10. Big Creek NWA (dyked marshes)		2005	No	HN; BEF	13	DFO, unpubl. data (2019)	Yes
		2016	No	MFN; SN	165	DFO, unpubl. data (2019); Montgomery, unpubl. data (2019)	Yes
11. Big Creek Upper Tributaries		1960	No	UNK	≥1	Canadian Distribution Database (CMNFI 60-0526A)	No
	Silverthorn Creek	1972	No	UNK	≥1	Canadian Distribution Database (RMC28646)	No
	Stoney Creek	1973	No	UNK	≥2	Canadian Distribution Database (OMNRS84; RMC30319)	No

Locality	Population	Year of survey	Lake Chubsucker targeted	Gear	Number captured	Source	Effort or CPUE data available
	Lynedoch Creek	1974	No	UNK	≥1	Canadian Distribution Database (RMC30875)	No
	Trout Creek	1979	No	UNK	≥2	Canadian Distribution Database (CMNFI 79-1175; CMNFI 79-1176)	No
12. Point Pelee National Park		1949	No	UNK	7	Canadian Distribution Database (RMC15373)	No
		1968	No	UNK	≥2	Canadian Distribution Database (CMNFI 78-0027; CMNFI 68-0316)	No
		1972	No	UNK	≥1	Canadian Distribution Database (CMNFI 72-0067)	No
		1983	No	UNK	≥1	Canadian Distribution Database (RMC43383)	No
		1993	No	UNK	≥1	Dibble *et al.* (1995)	No
		2003	No	HN; SN	25	Surette (2006)	Yes
		2016	No	FN	1	Bortoluzzi, unpubl. data (2017)	No
13. Lyons Creek	Tea Creek	1958	No	UNK	≥1 (n=4; COSEWIC 2008)	Canadian Distribution Database (RMC19732)	No
	Lyons Creek	2004	No	BEF	5	DFO, unpubl. data (2019)	Yes
	Lyons Creek	2008	No	BEF	28	A. Yagi (MNRF)	No
	Lyons Creek	2009	No	BEF	20	A. Yagi (MNRF)	No
	Lyons Creek	2010	Yes	SN	13	DFO, unpubl. data (2019); Reid, unpubl. data (2019)	Yes
	Lyons Creek	2013	Yes	SN	5	SAR Permit Database (SARA C&A 13-014)	Yes

Only sporadic captures of juvenile Lake Chubsucker have occurred in Canada. Leslie and Timmins (1997) documented the capture of age-0+ Lake Chubsucker in a vegetated drainage ditch in the Long Point Bay area, with water temperatures of 24-28 °C. Juvenile Lake Chubsucker have been captured in L Lake, St. Clair NWA, and Lyons Creek in the same habitat features where adults were collected (shallow, warm, with abundant submergent macrophytes; DFO unpubl. data 2019). Age 1+ Lake Chubsucker were found in areas of Long Point Bay that contained the plants *Eleocharis*, *Carex*, *Typha*, and *Potamogeton* (Leslie and Timmins 1997). Beyond these few observations, a detailed understanding of the habitat features necessary for the survival of larval and juvenile Lake Chubsucker is lacking.

Trends in the habitats that support Lake Chubsucker are not well understood; however, a decline in the availability of clear, warm, well-vegetated, and shallow wetlands is suspected due to agricultural effects and the impact of invasive species (Bouvier and Mandrak 2011). In particular, ongoing nutrient loading and sedimentation associated with agricultural practices are reducing the ability of many Lake Chubsucker habitats to support dense stands of native aquatic macrophyte species (e.g., downstream reaches of Lyons

Creek) and are suspected in the presumed extirpation of the species in several localities (e.g., Tea Creek). The ongoing spread of European Common Reed (*Phragmites australis*) is further degrading Lake Chubsucker habitat by reducing wetted area and native macrophytes in the few remaining wetland areas that are clear enough to produce dense stands of native species. It is hypothesized that low Great Lakes water levels in the 1990s-2000s facilitated the rapid spread of European Common Reed in Great Lakes wetlands (14-37% annually), including Long Point Bay (Jung *et al.* 2017). Exponential increases in the areal extent of the species have been predicted for Great Lakes wetlands, including Walpole Island (Mazur *et al.* 2014). Future reductions in wetland habitat quality are anticipated (Cudmore *et al.* 2017) should Grass Carp (*Ctenopharyngodon idella*), now established in the Lake Erie basin (Chapman *et al.* 2013), spread to areas inhabited by Lake Chubsucker. The loss of Lake Chubsucker habitat has also occurred due to drainage modifications, such as the conversion of surface watercourses to buried and/or tiled drains in parts of the Big Creek watershed, including those that previously supported Lake Chubsucker.

BIOLOGY

Feeding Strategy

Similar to other members of the sucker family, Lake Chubsucker is a bottom feeder, and its diet mostly consists of small crustaceans, molluscs, aquatic insects, filamentous algae, and plant material (Holm *et al.* 2009); however, there has not been a detailed study to determine diet composition for this species.

Life Cycle, Growth and Reproduction

The average total length (200 mm) reported by Holm *et al.* (2009) is much greater than that of the 790 Lake Chubsucker records collected by DFO, averaging 68 mm average TL (min = 12 mm, max = 255 mm; DFO unpubl. data 2019). This value represents both targeted and opportunistic sampling throughout the Lake Chubsucker range, 2002-2018, and likely includes the capture of adults, juveniles, and young of year. Holm *et al.* (2009) also reported the Ontario record to be 280 mm, while Coker *et al.* (2001) reported a maximum length of 292 mm.

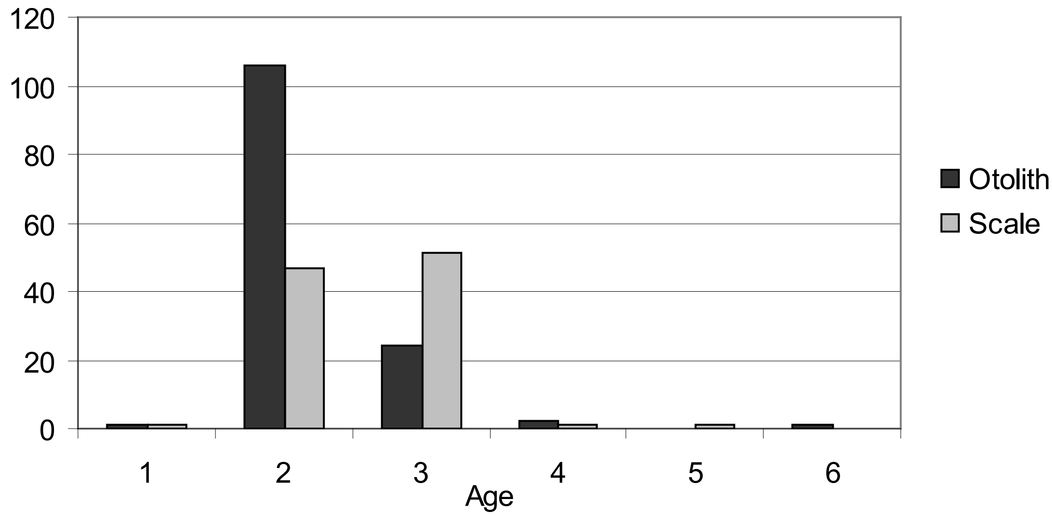

Figure 5. Age-frequency distribution resulting from otolith and scale interpretations of Lake Chubsucker collected in 2010 from the Old Ausable Channel after a winterkill event (Figure reproduced from Bouvier and Mandrak 2011).

Very limited information is available on Lake Chubsucker growth rates for Canadian populations. Leslie and Timmins (1997) reported size-at-age 0+ Lake Chubsucker in the Inner Bay of Long Point as 14.3 ± 3.9 mm mean TL on June 26, 19.1 ± 1.6 mm mean TL on July 4, and 28.8 ± 1.5 mm mean TL on July 24. Although the number of specimens collected each day was relatively small (n=19, 17, and 5, respectively), this approximate growth rate for a Canadian population concurs with that of 0.5 mm/day reported for Portage Lake, Michigan (Carlander 1969).

The maximum age of Lake Chubsucker reported in the literature is 8 years (Coker *et al.* 2001). A large winterkill occurred in the Old Ausable Channel in 2010 where 68 Lake Chubsucker were opportunistically collected (DFO unpubl. data 2019). Otolith and scales were removed from all collected specimens, which ranged in size from 91 to 199 mm TL. Results of age interpretation varied between otolith-based ages (1-6 years) and scale-based ages (1-5 years) with the maximum age of 6 being reported (Figure 5). Age of maturity has been reported at 3 years (Coker *et al.* 2001); however, as described in Young and Koops (2011), this age of maturity estimate was based on a propagation experiment in Highland, Michigan, where a population of Lake Chubsucker was raised in a trout-rearing pond (Cooper 1936). In this report, Cooper stated that "both sexes reach maturity in their third summer of life", which could be interpreted as either age 2 or age 3. A study from Nebraska found evidence that Lake Chubsucker matured at age 1 (Winter 1984), while a study from Illinois stated that Lake Chubsucker mature between ages 1 and 3 (Eberts *et al.* 1998).

Based on the average age of parents (maximum age + age of maturity)/2), generation time varies from 4 (6+2) to 5.5 (8+3) years.

Using data from the Old Ausable Channel winterkill (DFO unpubl. data 2019), and the total number of eggs estimates reported in Winter (1984), Young and Koops (2011) were able to derive a von Bertalanffy growth curve and a size-specific fecundity curve (Figure 6) that were used to produce fecundity estimates for Canadian Lake Chubsucker.

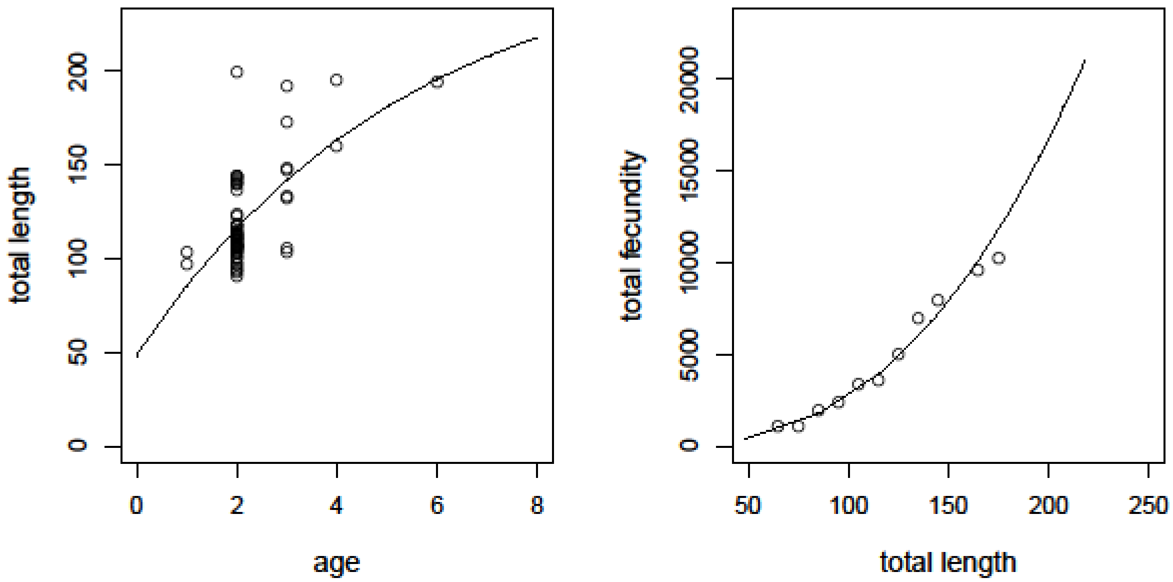

Figure 6. Left: von Bertalanffy growth curve, fitted to size-at-age data of Lake Chubsucker sampled from Old Ausable Channel. Right: size-specific fecundity (total number of eggs) of Lake Chubsucker in Nebraska (Winter 1984), and fitted exponential curve, used to estimate fecundity of Ontario Lake Chubsucker (Figure reproduced from Young and Koops 2011).

Breeding Habits

As there has been no new information made available on breeding habitats of Lake Chubsucker since the previous version of the status report, the following has been reproduced from COSEWIC (2008).

In North America, the annual spawning season of Lake Chubsucker varies from March to July (Cooper 1983). Examination of the gonads of several preserved specimens from Ontario indicated that Lake Chubsucker likely spawns between late April and June in Ontario (Mandrak and Crossman 1994). Using the length of the smallest specimen collected from the Inner Bay of Long Point, Leslie and Timmins (1997) estimated spawning to have occurred in late May at approximately 20 °C. They also estimated hatching to have occurred in early June.

At spawning time, the Lake Chubsucker moves to marshes to spawn (Loftus and Kushlan 1987). Males clear a spot in sand, silt, or often gravel. And the female deposits between 3 000 and 20 000 eggs, depending on her size, over vegetation, filamentous algae, grass stubble or the nest (Bennett and Childers 1966; Carlander 1969; Scott and Crossman 1973; Lane *et al.* 1996b; Coker *et al.* 2001). The eggs hatch at water temperatures between 22 and 29 °C (Cooper 1983). There is no parental care of the eggs (Coker *et al.* 2001).

Physiology and Adaptability

Lake Chubsucker has been described as a warmwater species, and has been detected in water ranging from 13.8 to 33.7 °C (DFO unpubl. data 2019). Temperature preference has not been empirically tested and is currently unknown for this species; however, Coker *et al.* (2001) suggested that it prefers temperatures of 28.2-34 °C.

Interspecific Interactions

Research is currently underway exploring the co-occurrence of Lake Chubsucker with other freshwater fishes (Bontje unpubl. data 2019). Freshwater fish occurrence data from the Old Ausable Channel, L Lake, and Long Point Bay is being used to determine which species consistently co-occur with Lake Chubsucker. Preliminary results indicate that Central Mudminnow (*Umbra limi*), Grass Pickerel (*Esox americanus vermiculatus*), Pugnose Shiner (*Notropis anogenus*), Golden Shiner (*Notemigonus crysoleucas*), Brown Bullhead (*Ameiurus nebulosus*), Blacknose Shiner (*Notropis heterolepis*), and Tadpole Madtom (*Noturus gyrinus*) consistently co-occur with Lake Chubsucker; however, the role that each of these species may play as it relates to Lake Chubsucker has yet to be determined.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

As indicated in the Search Effort section of this report, some efforts have been made to increase our knowledge of Lake Chubsucker population sizes and trends since the last status report (COSEWIC 2008). Specifically, a multiple-pass seining depletion study was undertaken in L Lake and Lyons Creek in 2010 (Reid unpubl. data 2019). The objective of this work was to obtain density estimates; however, insufficient sample units prevented meaningful calculation of mean population density. Alternatively, an estimate using data from the first sampling pass of each sampling unit was calculated and used to determine Lake Chubsucker mean densities and sampling period (Table 2).

Table 2. L Lake and Lyons Creek Lake Chubsucker density estimates (Reproduced with permission; Reid, unpubl. data).

	L Lake		Lyons Creek	
Variable	**June**	**August**	**June**	**August**
Total Captured	162	53	12	1
Mean First Pass CPUE (#/m^2)	0.0603	0.0083	0.0073	0
Std. Dev. First Pass CPUE (#/m^2)	0.1385	0.0127	0.0109	0
Mean Population Density (#/m^2)	0.0861	0.0119	0.0105	0
Std. Dev Population Density (#/m^2)	0.1385	0.0181	0.0156	0
Number of Sample Units	20	20	14	6

Subsequent to this initial attempt, a mark-recapture study was carried out in L Lake with the objective of calculating population size estimates. In this study, 43 sites were sampled in August 2018 using a multi-pass seining protocol, and a total of 34 Lake Chubsucker were captured and marked. The same sampling approach was implemented in September 2018 and, despite re-sampling all 43 sites, only five individuals were captured and none were marked, making the calculation of population density estimates unachievable.

A multi-year fish community assessment to determine the short- and long-term effects of habitat restoration activities on fishes at risk in the Crown Marsh area of Long Point Bay has been underway since 2012 (Rook *et al.* 2016; Reid unpubl. data 2019). Multiple ponds within the Crown Marsh complex, including both created ponds of differing ages and natural reference ponds, have been sampled using a multi-pass seining approach, resulting in the detection of 214 Lake Chubsucker.

From 2016 to 2019, research conducted by F. Montgomery (University of Toronto), in collaboration with DFO, targeted wetland systems throughout southwestern Ontario (Montgomery *et al.* 2020). Although this research did not target Lake Chubsucker, it captured a total of 320 individuals. In 2016, fieldwork was completed over a 13-week period at 249 sites across 24 wetlands, which included both mini-fyke net sampling and bag seines. The 2016 field sampling efforts resulted in the detection of 266 Lake Chubsucker. In 2017, a total of 346 sites in 24 wetlands were sampled over a 9-week period, resulting in the detection of an additional 54 Lake Chubsucker. This research resulted in the discovery of Lake Chubsucker in the Maxwell Cell of the Bear Creek Unit of the St. Clair National Wildlife Area, which had yet to be recorded, and confirmed Lake Chubsucker in many extant localities (e.g., Walpole Island dyked marshes, St. Clair National Wildlife Area - West cell, Long Point National Wildlife Area, and Big Creek dyked marshes).

As a result of a request to undertake a reservoir drawdown of the St. Clair Unit of the St. Clair National Wildlife Area, a fish inventory of the area was completed (Biotactic 2016). The species inventory was completed through a comprehensive survey of the fish community throughout the East cell from April to October 2016. Six different sampling gear types were utilized including minnow traps, fyke nets, cast nets, seine nets, dip nets, and angling, resulting in the detection of 22 Lake Chubsucker. In response to the successful detections in 2016, DFO returned to this area in 2018, sampling with mini-fyke nets, yielding an additional six individuals (DFO unpubl. data 2019).

Opportunistically, data resulting from the Species at Risk permitting process, has resulted in the detection of Lake Chubsucker in two new systems (Prince Albert Drain; Collop Drain), as well as confirmation of Lake Chubsucker in Turkey Point marshes (Permit #SECT 73 SARA C&A 11-029) with the detection of 37 individuals in 2011.

As reported in Bouvier and Mandrak (2011), there have been very few individuals captured from Rondeau Bay since the species was first detected in this system in 1955. The last known Lake Chubsucker from Rondeau Bay was detected in 2005 and, although the inner marshes of this system have been sampled on numerous occasions with the appropriate gear type, Lake Chubsucker has not been detected since that time. Likewise, with the exception of a single record from 2016 (Bortoluzzi unpubl. data 2017), Lake Chubsucker has not been detected in Point Pelee National Park since 2003; however, unlike Rondeau Bay, limited sampling in the park with the appropriate gear has been conducted since this area was surveyed in 2002-2003 by Surette (2006). Additional, targeted sampling should be completed to verify the presence Lake Chubsucker in Point Pelee National Park.

Abundance

Information on population sizes and trends, based on data available prior to 2009, was summarized in the recovery potential assessment (RPA) of Lake Chubsucker (Bouvier and Mandrak 2011; DFO 2011). Bouvier and Mandrak (2011) also included a qualitative ranking of the relative abundance index and population trajectory for all Canadian Lake Chubsucker localities. A level of certainty was assigned to both the relative abundance index and the population trajectory. The relative abundance index and population trajectory were then combined into a population status to determine the overall population status ranking. Applying the same evaluation procedure as described in Bouvier and Mandrak (2011), and in light of recent Lake Chubsucker records (2010-2018), revisions were made to the original relative abundance index classifications, where relative abundance of Lake Chubsucker was as medium for Old Ausable Channel, Walpole Island (dyked marshes), and Big Creek NWA (dyked marshes) and low or extirpated at all remaining localities. The revised population status remained poor for most extant populations, including L Lake, which was previously ranked Fair.

Additional research is required to gain a better understanding of Lake Chubsucker abundance throughout its range, and long-term standardized monitoring is required to inform its population trajectory.

Table 3. Revised relative abundance index, population trajectory, and population status for all Lake Chubsucker localities in Canada. Relative abundance index ratings have been revised to account for recent (2010-2018) Lake Chubsucker records (see Table 1) and are relative to the Old Ausable Channel population. Population status changed for bolded localities.

Locality	Revised Relative Abundance Index	Certainty	Revised Population Trajectory	Certainty	Revised Population Status
Old Ausable Channel	Medium	2	Stable	2	Fair
L Lake	Low	1	Unknown	2	Poor
Lake St. Clair	Low	3	Unknown	3	Poor
Walpole Island (dyked marshes)	Medium	3	Unknown	3	Poor
St. Clair NWA	Low	2	Unknown	3	Poor
Jeanette’s Creek	Extirpated	2	-	-	Extirpated
Point Pelee National Park	Low	2	Unknown	3	Poor
Rondeau Bay	Extirpated	3	-	3	Extirpated
Long Point Bay	Low	3	Unknown	3	Poor
Long Point NWA	Low	3	Unknown	3	Poor
Big Creek (upper tributaries)	Extirpated	2	-	-	Extirpated
Big Creek NWA (dyked marshes)	Medium	2	Unknown	3	Poor
Lyons Creek	Low	1	Unknown	2	Poor

Fluctuations and Trends

Long-term, repeated sampling at a site is required to evaluate population fluctuations and overall trend. For the majority of Lake Chubsucker populations, this level of effort has not been realized, with the majority of detections occurring due to opportunistic sampling events. A short-term research project focusing on determining the effects of restoration activities at Long Point Crown Marsh, Lake Erie, and whether wetland restoration efforts are supporting the recovery of fishes at risk, including Lake Chubsucker, was completed in 2012-2014 (Rook *et al.* 2016; DFO unpubl. data 2019; Reid unpubl. data 2019). The project quantitatively assessed the fish community in both natural and created wetlands of various ages, 2012-2014, employing a multi-pass seine net protocol (as described in Rook *et al.* 2016). Standardized mean relative abundance of Lake Chubsucker has been low throughout the extent of the project, with the greatest relative abundance recorded in 2012 (0.725 Lake Chubsucker/ seine net haul; Figure 7).

A similar sampling design, as described above, was conducted in adjacent ponds within the Long Point Crown Marsh Area from 2015 to 2018; however, the research objective differed in that open-water ponds were sampled to quantify the potential effects of *Phragmites* control on freshwater fishes. Lake Chubsucker was recorded throughout this study; however, standardized mean relative abundance of Lake Chubsucker was consistently low in these ponds (Figure 8; S. Reid unpubl. data 2019). These two research projects represent the only known multi-year monitoring efforts focused in an area known to be occupied by Lake Chubsucker.

Long-term quantitative data are not available for the majority of Lake Chubsucker localities; however, a qualitative relative abundance index and a population status index have been developed and applied to Lake Chubsucker localities (see **Abundance** section) A comparison between the original population status index (Bouvier and Mandrak 2011) and revised values (Table 3) indicates that the majority of Lake Chubsucker localities have either declined or remained static. The results of this revised population status assessment indicate that despite additional Lake Chubsucker detections since the last assessment, none of the Lake Chubsucker localities appear to have improved; L Lake population status has shifted from fair to poor; and Rondeau Bay has shifted from poor to extirpated.

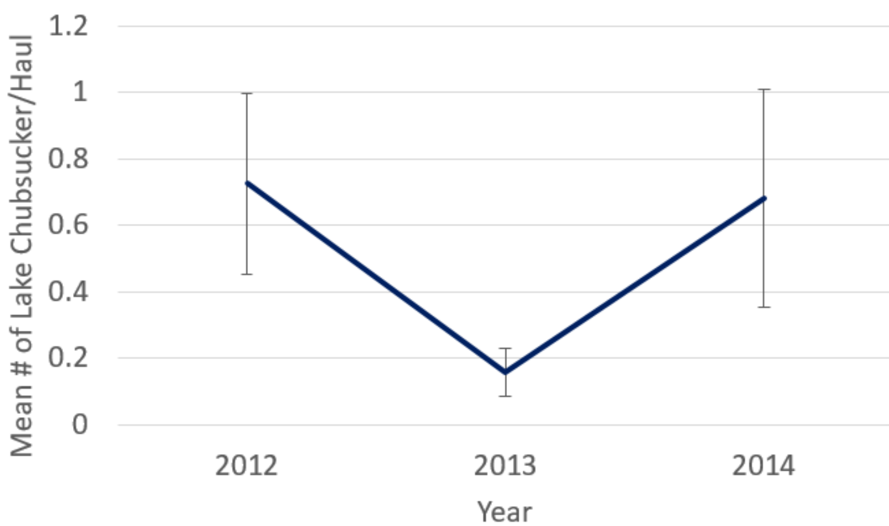

Figure 7. Mean Lake Chubsucker abundance estimates (± SE) obtained from 2012-2014 sampling of the Crown Marsh area of Long Point Bay (Rook *et al.* 2016; DFO, unpubl. data 2019; Reid, unpubl. data 2019).

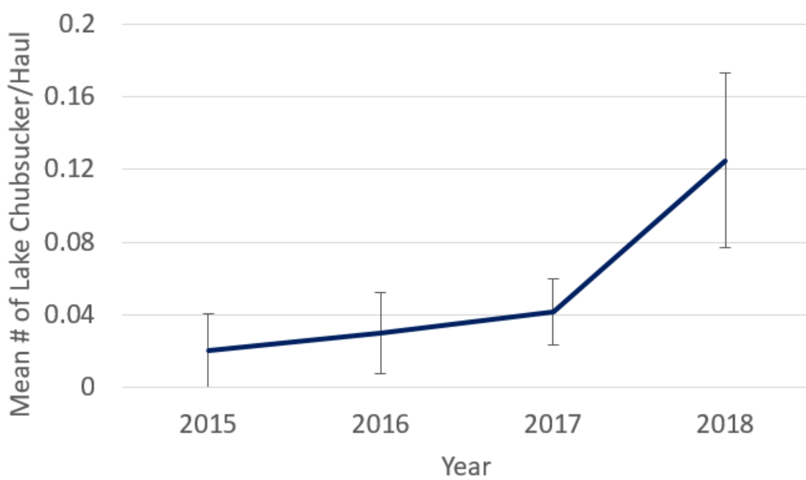

Figure 8. Mean relative abundance estimates (± SEM) of Lake Chubsucker obtained from 2015-2018 sampling of the Crown Marsh area of Long Point Bay (S. Reid unpubl. data 2019).

Rescue Effect

Very limited information is available on dispersal ability of Lake Chubsucker; however, the majority of Lake Chubsucker localities in Canada are found in areas where natural dispersal is thought to be unlikely due to the presence of dykes, dams, or other impassible barriers. The potential for a rescue effect to mitigate extirpation or population decline from the United States is unlikely. The closest American populations occur in Michigan where Lake Chubsucker is currently ranked S2S3 (ranging from imperilled to vulnerable; NatureServe 2019). Dispersal from other American populations on the southern shore of Lake Erie is also thought to be unlikely due to the distance between localities and unsuitable habitat conditions.

THREATS AND LIMITING FACTORS

Threats

The IUCN Threat Calculator was used to evaluate threats to Lake Chubsucker based on the classification system by Salafsky *et al.* (2008). Threats considered to impact the species, in decreasing order of threat impact, are natural system modification (very high-high impact), pollution (medium impact), climate change and severe weather (medium-low impact), and invasive and other problematic species and genes (low impact). The overall impact of these threats is considered to be of very high–high impact. Threats to Lake Chubsucker have been summarized based on Bouvier and Mandrak (2011) and DFO (2017), and the importance of these threats varies across the Canadian range (Bouvier and Mandrak 2011). Threats may impact Lake Chubsucker directly through decreased survival or changes in reproductive output, or indirectly through the modification of habitat features that support survival, growth, or reproduction.

7. Natural system modification (very high-high impact)

7.3 Other Ecosystem Modifications

Agriculture

Several agricultural practices have been attributed to the decline of Lake Chubsucker throughout the Canadian range (Bouvier and Mandrak 2011). Agricultural land use is widespread in southern Ontario and is the dominant form of land cover in drainages that support Lake Chubsucker in Canada. The primary effect of agriculture on Lake Chubsucker is increased flow of surface water leading to siltation in nearby watercourses, thereby reducing the conditions that promote the growth of aquatic macrophytes. Siltation due to agriculture is most pertinent to Lake Chubsucker populations directly adjacent to agricultural land use where flow-through effects lead to direct sediment inputs (Long Point Bay, Rondeau Bay, and Point Pelee). Agricultural effects stemming from the modification of surface flow are reduced in dyked wetlands.

Shoreline Development and Hardening

Shoreline hardening and other forms of shoreline modification have occurred in parts of the Lake Chubsucker range in Canada, principally boating channels and other shoreline areas within Lake St. Clair, Long Point Bay, and Lyons Creek. Hardening usually occurs through the installation of rock, metal, or other retaining structures near bankside locations to increase bank stability (i.e., protect against property loss) or for recreational purposes (maintain boat docking locations). Where hardening has occurred, the prominent effect to Lake Chubsucker habitat is the modification of water currents and sediment transport and changes in the composition and availability of substrate, which may influence the availability of macrophyte cover and food. However, empirical studies of the effect of shoreline hardening on Lake Chubsucker have not occurred.

Dredging

Similar to shoreline hardening, dredging is conducted in parts of the Lake Chubsucker range in Canada. Dredging occurs mainly in canals and channels used for boating in Lake St. Clair and Long Point Bay. Although Barnucz *et al.* (2015) indicated that dredging is likely to pose low impacts to fish species at risk in Lake St. Clair based on a control-impact study, the study was focused on sandy river mouths, not areas likely to be inhabited by Lake Chubsucker. Where dredging occurs in proximity to Lake Chubsucker, the activity may physically disturb individuals of the species and may also modify Lake Chubsucker habitat through changes to food supply, sedimentation, structure/cover, and macrophyte composition and availability.

Dredging recently occurred in Crown Marsh, Long Point Bay (2012-2015) as part of a large European Common Reed control and marsh restoration project (Rook *et al.* 2016). Dredging was undertaken to create new pond complexes following large-scale *Phragmites* removal. Following their creation, the new ponds were connected with existing channels and other watercourses in Crown Marsh in areas known to support Lake Chubsucker and several other fish species at risk (Rook *et al.* 2016). Field sampling detected Lake Chubsucker in one of several newly created ponds (Ankney Pond, Crown Marsh); however, the long-term consequence of pond creation on the viability of Lake Chubsucker is unknown, including whether created watercourses maintain ecological function through time and (or) connectivity with the surrounding marsh.

Where Lake Chubsucker occupies, or has access to, agricultural farm drains (e.g., Prince Albert and Collop drains) or other watercourses subject to agricultural drainage modification (e.g., Little Bear Creek), dredging to increase watercourse drainage capacity has the potential to impact Lake Chubsucker and its habitat through changes to food supply, sedimentation, structure/cover, and macrophyte composition and availability. Montgomery *et al.* (2018) found that the predominant impact of dredging in agricultural drains on small-bodied fish species at risk in southern Ontario is changes to habitat connectivity. However, the reliance of Lake Chubsucker on agricultural drains is poorly known beyond a few recent records of the species in these systems (Table 1). The conversion of natural watercourses to tiled drains has been implicated as the causative factor in the loss of Lake Chubsucker from the Big Creek drainage.

Aquatic Invasive Species

Aquatic invasive species (AIS) implicated in the current and future decline of Lake Chubsucker include fishes such as Round Goby (*Negobius melanostomus*), Rudd (*Scardinius erythrophthalmus*) (discussed under **Invasive and other problematic species and genes**), Common Carp (*Cyprinus carpio*), and Grass Carp (*Ctenopharyngodon idella*), and aquatic plants such as European Common Reed and Eurasian Watermilfoil (*Myriophyllum spicatum*). The ecological impact of AIS varies across the Canadian range of Lake Chubsucker, in part due to the different geographic range of each invasive species. Several mechanisms exist by which Lake Chubsucker may be affected by AIS, including generalized food web changes (all AIS) and the loss or modification of preferred habitat features (Common Carp, Grass Carp, European Common Reed, Eurasian Watermilfoil). In some cases, the effects of controlling AIS, especially activities to reduce the density of European Common Reed and Eurasian Watermilfoil, may negatively affect Lake Chubsucker. A description of each AIS and realized or potential impacts is provided below.

Common Carp has likely contributed to the decline of Lake Chubsucker through habitat-related effects. Common Carp is found throughout the Canadian range of Lake Chubsucker. A known ecosystem engineer, Common Carp can increase the turbidity of aquatic ecosystems by disturbing benthic sediments, thereby reducing light penetration and decreasing macrophyte abundance and diversity (Weber and Brown 2009). Common Carp may influence habitat quality of Lake Chubsucker by uprooting aquatic plants, which can modify the habitat features Lake Chubsucker require for feeding, cover, and reproduction. In addition to habitat effects imposed by Common Carp, habitat effects by Grass Carp, a species of increasing abundance in the Lake Erie drainage (Chapman *et al.* 2013; Embke *et al.* 2016), are expected to increase in importance for Lake Chubsucker. Although reproducing populations of Grass Carp are not known to occur in Canadian waters, unless control measures are taken, future expansion of Grass Carp into areas inhabited by Lake Chubsucker is likely (Lake St. Clair, Point Pelee, Rondeau Bay, Long Point Bay, and Lyons Creek) due to the lack of dispersal barriers (Cudmore *et al.* 2017). Given that Grass Carp feeds almost exclusively on aquatic vegetation (Pipalova 2002; Cudmore *et al.* 2017; van der Lee and Koops 2017), especially submergent macrophytes, impacts to habitat required by all life stages of Lake Chubsucker would occur should Grass Carp increase in Canadian waters. Although Rudd is also a direct consumer of aquatic macrophytes (Kapuscinski *et al.* 2014), herbivory by Rudd is expected to be of lower importance than Grass Carp for the viability of Lake Chubsucker populations.

Habitat-related impacts to Lake Chubsucker due to AIS have occurred due to the establishment and expansion of European Common Reed and Eurasian Watermilfoil. The distribution of both vascular plant species has expanded significantly within coastal and inland wetlands as a result of natural and human-mediated dispersal (Crow and Hellquist 2000; Wilcox *et al.* 2003; Trebitz *et al.* 2007; Whyte *et al.* 2008; Jung *et al.* 2017). Eurasian Watermilfoil is found throughout most of the range of Lake Chubsucker in Canada. The dominant effect of Eurasian Watermilfoil likely includes competition with native plants that Lake Chubsucker relies on for cover, feeding, and reproduction. The effect of the replacement of native plant species with Eurasian Watermilfoil is unknown, but likely imposes habitat-related effects on the species, especially if Eurasian Watermilfoil reaches higher densities than the native plants it replaces. A better understanding of the ecological effects of Eurasian Watermilfoil on Lake Chubsucker (e.g., spawning success, food supply, provision of cover) is required. European Common Reed is also found throughout the entire Canadian range, with the exception of the Old Ausable Channel, although populations of European Common Reed exist nearby. The expansion of European Common Reed has led to substantial reductions of wetted area and, as a result, reduction of preferred habitat features in many localities inhabited by Lake Chubsucker (Long Point Bay, Rondeau Bay, and Walpole Island; Mazur *et al.* 2014; Jung *et al.* 2017). Modelling indicates that substantial expansion of European Common Reed is expected in Long Point Bay (Jung *et al.* 2017); expansion in other parts of the Canadian range is expected if control activities are not implemented or are found to be ineffective.

The control of invasive macrophytes, such as European Common Reed and Eurasian Watermilfoil, may occur through chemical control agents, burning, cutting, spraying, or other forms of physical removal from a watercourse. Although control activities are likely to benefit Lake Chubsucker over the long term if intended reductions in invasive plants are achieved, the short-term effect on Lake Chubsucker from these activities (e.g., physical disturbance of individual Lake Chubsucker; increased sedimentation; disturbance of adjacent native wetland plans that Lake Chubsucker relies on for food and cover; bioaccumulation of chemical compounds) is poorly understood. Short-term effects from chemical agents, physical removal, or cutting may affect Lake Chubsucker directly and through habitat alterations.

7.2. Dams and water management/use

Drawdown of dyked wetlands and other water-level manipulations

Several populations of Lake Chubsucker exist in dyked wetlands in Lakes St. Clair and Erie (St. Clair National Wildlife Area, Lake St. Clair; Big Creek National Wildlife Area, Lake Erie; Turkey Point cells, Lake Erie). Wetland dykes have been in place for several decades, with dyking originally undertaken to maintain water availability in areas subject to water-level reductions and associated losses of wetland plant cover and abundance. However, increasingly the management of dyked cells, including those supporting Lake Chubsucker, has involved proposed water-level drawdowns to promote regeneration of aquatic macrophytes and establish ‘hemi-marsh’ conditions required by waterfowl. The consequences of water-level drawdown will be contingent on the amount and quality of refuge habitat available to Lake Chubsucker during the drawdown period. Poor refuge habitat may lead to stranding mortality, temperature-related mortality and excess predation during the low water period, and general habitat disturbance.

In addition to water-level drawdown of dyked cells, Lake Chubsucker is susceptible to water-level manipulations that may occur through the management of the Welland Canal as part of the St. Lawrence Seaway. The Lyons Creek population receives overflow water from the Welland Canal, which is pumped continuously into the headwaters of Lyons Creek. If pumping was to cease intentionally, or unintentionally due to pump malfunction or extreme water-level fluctuations in the canal system, immediate dewatering of the portion of Lyons Creek supporting Lake Chubsucker would be very likely. Dewatering would impact the availability of Lake Chubsucker habitat and could also lead to stranding-induced mortality depending on the magnitude of water-level fluctuation.

<u>9. Pollution (medium impact)</u>

Agriculture

Surface runoff from agriculture promotes nutrient loading in certain areas inhabited by Lake Chubsucker. Nutrient loading can increase primary production, modify water clarity, and alter the availability of aquatic macrophytes that Lake Chubsucker relies on for cover and food. Nutrient loading can also decrease the availability of dissolved oxygen, thereby increasing the potential for physiological consequences to the species. The effects of nutrient loading may be reduced in dyked wetland systems, but some level of nutrient loading may occur, contingent on the frequency with which intake water is obtained from sources that experience nutrient loading.

Industrial Activity

Most of the Canadian range of Lake Chubsucker is not subject to the effects of industrial activity, in part due to the number of populations that exist within provincially or federally protected lands (e.g., St. Clair National Wildlife Area; Big Creek National Wildlife Area; Long Point National Wildlife Area; Pinery Provincial Park). However, areas downstream of industrial outflows, such as Walpole Island and Lyons Creek, are susceptible. No studies have been conducted to evaluate the physiological consequences of exposure of Lake Chubsucker to industrial effluent. The section of Lyons Creek inhabited by Lake Chubsucker contains elevated levels of several compounds (polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), zinc, and p,p'-DDE), particularly within the sediment. Bioaccumulation of these compounds within benthic organisms has been documented (Milani *et al.* 2013), which may lead to contaminant effects for Lake Chubsucker given that these organisms constitute a key prey resource.

Polycyclic aromatic hydrocarbons (PAHs), and the contaminant DDT and its derivatives (DDD; DDE), exist in high concentrations in the sediment and soils of Point Pelee National Park (Crowe and Smith 2007; Clow *et al.* 2017). The direct impact of these compounds on Lake Chubsucker has not been assessed.

Urbanization

Most Lake Chubsucker populations are not directly affected by urbanization given the prominence of agricultural land use across the Canadian range. However, urbanization effects have occurred in the Old Ausable Channel. Many residential areas near Grand Bend have aging septic systems (K. Jean pers. comm. 2019), which have increased nutrient runoff directly into the Old Ausable Channel through surface flow and groundwater. Nutrient loading due to active septic systems has likely led to increases in nitrogen, but increases in phosphorus may have also occurred. Increased nutrients within the Old Ausable Channel have resulted in high levels of primary production and increased macrophyte growth, which have led to heightened periods of consumption and decay during late summer and early fall. Heightened decay has been associated with seasonal patterns of hypoxia in the channel (Zielger *et al.* 2021), including an extended winter period of hypoxia driven by the interaction between biological decay and ice cover. Deceased Lake Chubsucker and other fishes have been collected during the spring melt period, indicating that winterkill due to hypoxia is likely occurring within the Old Ausable Channel (K. Jean pers. comm. 2019). Winterkill is believed to be prominent during periods of extended ice cover; however, the relationship between ice cover, hypoxia, and mortality of Lake Chubsucker in the Old Ausable Channel remains poorly understood (Zielger *et al.* 2021).

Aging septic systems are currently operating near Point Pelee National Park and some areas of Long Point Bay. The potential for nutrient leaching into groundwater exists, but will pose relatively minor habitat-related impacts to Lake Chubsucker given the presumed minimal groundwater flow in these areas (J. Roy pers. comm. 2019). The chance of septic failure for these systems is generally thought to be low, but should failure occur, septic flow within surface waters (due to clogging or high water events) would have greater potential to lead to nutrient loading within the waters of Point Pelee National Park or Long Point Bay.

The application of salt (sodium chloride, NaCl) to increase transportation safety on roadways during winter, and resulting runoff into watercourses inhabited by Lake Chubsucker, has been identified as a possible threat to the species (J. Roy pers. comm. 2019). However, most areas inhabited by Lake Chubsucker do not exist in proximity to areas with high road density. Nonetheless, localized effects will occur, especially where relatively small watercourses have significant exposure to roadways (e.g., L Lake). Localized inputs of sodium chloride (whether due to surface flow or contamination of groundwater due to seepage) is of concern for the degradation of Lake Chubsucker habitat and related biotic processes, but in general, the scope and severity of this issue are poorly understood throughout the Canadian range.

<u>11. Climate Change (medium–low impact)</u>

Climate change is expected to modify habitat resources that Lake Chubsucker relies on to carry out its life history. However, the magnitude and direction of habitat change is difficult to predict due to the imprecision of forecasting methods and the potential for synergistic and antagonistic habitat effects under climate change. Therefore, as with most freshwater fishes, the effect of climate change on the viability of Lake Chubsucker is poorly understood.

Most climate-change scenarios predict increased air and water temperatures, decreased precipitation, and increased evapotranspiration in the Great Lakes region. The impacts of such effects could result in dramatic changes to primary productivity, carbon storage, lake and steam hydrology, and periods of ice cover (Woodwell *et al.* 1995; Schindler 1998; Urquizo *et al.* 2000). Higher water temperatures, lower water levels, and shifts in seasonal ice cover will no doubt lead to changes in Lake Chubsucker ecology and result in an invasion of new and exotic species. Overall, some fishes (e.g., warmwater species) would likely benefit, while others (e.g., coldwater species) would suffer. Northward migration of fish species, including invasive species, may occur, while local extinctions of native species are expected. Higher temperatures and lower water levels would also exacerbate water-quality problems, which would increase fish contamination and impair fish health (Lemmen and Warren 2004). Vulnerability indices developed to assess the vulnerability of Great Lakes coastal wetlands indicate that many species considered to be at-risk within the Great Lakes show that existing stresses may be exacerbated by climate change (e.g., Doka *et al.* 2006). High-risk native fishes include species, such as Lake Chubsucker, with limited geographic distribution, shallow water spawning, and a preference for vegetated habitat in all life stages (Lemmen and Warren 2004).

Brinker *et al.* (2018) assessed the vulnerability of 280 species in the Ontario Great Lakes basin to climate change, including Lake Chubsucker. The assessment was based on the application of the NatureServe Climate Change Vulnerability Index, which considers overall vulnerability as a function of the exposure of the species to climate change and the sensitivity or adaptive capacity in the near future (2041-2071). The assessment considered 20 factors involving species sensitivity and indirect exposure (e.g., historical thermal niche; dispersal limitation; change in disturbance regime; species interactions). Lake Chubsucker was identified as being ‘moderately vulnerable’ to climate change, defined as “abundance and/or range likely to decrease by 2050”, with moderate confidence (60 – 80% confidence). The assessed vulnerability of Lake Chubsucker was primarily based on ‘greatly increased vulnerability’ to anthropogenic barriers, and ‘somewhat increased vulnerability’ to natural barriers, historical thermal niche, physiological and hydrological niche, and disturbance, relative to the other assessed species.

8. Invasive and other problematic species and genes (low impact)

Several mechanisms exist by which Lake Chubsucker may be directly affected by AIS, including predation on Lake Chubsucker eggs or juveniles (Rudd, Round Goby), and direct competition with Lake Chubsucker (Rudd, Round Goby).

Round Goby, a small, benthic fish species native to the Ponto-Caspian region of Europe, has substantially increased its range throughout the Great Lakes basin and other areas of southern Ontario following its discovery in the Detroit River in the early 1990s (Jude *et al.* 1992; Kornis *et al.* 2012). Round Goby populations now exist in several watercourses inhabited by Lake Chubsucker (Long Point Bay, Point Pelee, Rondeau Bay), with future range expansion possible to other Lake Chubsucker populations, whether by natural dispersal or human-mediated movement. Direct evidence of a negative relationship between Lake Chubsucker and Round Goby does not exist; however, Round Goby has been implicated in the decline of other small-bodied native species, assumed to be the result of direct competition for food and habitat resources, and predation on eggs and larvae (Poos *et al.* 2009; Kornis *et al.* 2012; Abbett *et al.* 2013). Predation by Round Goby is anticipated to influence Lake Chubsucker, although the habitat features preferred by Lake Chubsucker may reduce exposure to high density Round Goby populations and, thus, reduce the severity of competition and predation as threat mechanisms. Rudd, a medium-sized wetland fish native to Europe, has also expanded its range into habitats occupied by Lake Chubsucker, including some sections of Lyons Creek (DFO unpubl. data 2019) and Long Point Bay (Kapuscinski *et al.* 2012b). Future range expansion of Rudd throughout the Canadian range of Lake Chubsucker is likely, especially to connected coastal wetlands such as Rondeau Bay, Point Pelee, and Walpole Island. As with Round Goby, the effect of Rudd on Lake Chubsucker is unknown. However, given shared habitat preferences (warm, still, well-vegetated wetlands) and an omnivorous feeding strategy (Kapuscinski *et al.* 2012a), direct predation and competition are likely. The establishment and ongoing range expansion of Round Goby and Rudd are also likely to cause generalized food web changes in areas where Lake Chubsucker occurs.

Illegal Stocking

Lake Chubsucker co-occurs with predatory sport fishes, such as Black Crappie (*Pomoxis nigromaculatus*), Largemouth Bass (*Micropterus salmoides*), and Northern Pike (*Esox lucius*) throughout much of its Canadian range. However, the historical composition of fish communities supporting Lake Chubsucker in Canada is poorly understood, making it difficult to determine the ecological significance of species’ co-occurrence and (or) illegal stocking. Illegal stocking has resulted in changes to the composition and productivity of native fish communities in many parts of North America (Johnson *et al.* 2009) and, in some cases, is presumed to have resulted in the introduction of new predatory species in areas inhabited by Lake Chubsucker, such as Northern Pike in the Old Ausable Channel. If introduced, predatory fishes may lead to the decline of Lake Chubsucker through predation and competition, which will have greatest impact when Lake Chubsucker is ecologically naïve to the predator.

Cumulative Effects

Most areas inhabited by Lake Chubsucker are characterized by small amounts of suitable habitat (e.g., ones to tens of km^2) due to restricted geographic boundaries in dyked wetland cells and other watercourses (e.g., L Lake, Old Ausable Channel) or underlying ecological factors (e.g., upper Lyons Creek receiving overflow water from the Welland Canal). The majority of inhabited localities are influenced by multiple threats (dyked cells: Common Carp, wetland plant invasions, water-level drawdown; Lyons Creek, water-level fluctuations, wetland plant invasions, contaminant effects; Old Ausable Channel: illegal introductions of Northern Pike and winterkill associated with poor nutrient controls). Although the interaction between multiple threats has not been evaluated, given the limited habitat area available to Lake Chubsucker within which multiple threats exist, it is highly likely that cumulative threat impacts on Lake Chubsucker are occurring.

Limiting Factors

The availability of clear, well-vegetated wetlands free from anthropogenic impairment is the only significant limiting factor of Lake Chubsucker in Canada.

Number of Locations

The most plausible serious threat to Lake Chubsucker is the expansion of AIS. In particular, the rapid expansion of European Common Reed, already at most Lake Chubsucker localities, is anticipated to affect most populations within the next decade as a result of lowering water levels, which previously caused its rapid spread during an earlier period of lower water levels (Jung *et al.* 2017). Grass Carp will likely expand into Lake Chubsucker habitat in the near future and have a serious impact on wetlands as its population increases (Cudmore *et al.* 2017). If not managed effectively, it is expected that these expansions of European Common Reed and Grass Carp in the habitat of most Lake Chubsucker populations could reduce the amount of habitat below MAPV and populations >50% within 1-3 generations for a majority of the populations. Therefore, there are likely 3-5 locations.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

In Canada, Lake Chubsucker occurs in publicly owned waters, and all fish habitat within these waters is protected by the federal *Fisheries Act*. Lake Chubsucker was listed as *Endangered* on Schedule 1 of the *Species at Risk Act* when the Act was proclaimed in June 2003. Lake Chubsucker is listed as Threatened under the provincial *Endangered Species Act, 2007* and, therefore, afforded protections under provincial legislation. Lake Chubsucker found in Point Pelee National Park is protected under the *Canada National Parks Act*, while those found in Long Point, Pinery and Rondeau provincial parks are protected under the *Provincial Parks and Conservation Reserves Act, 2006*.

Non-Legal Status and Ranks

Lake Chubsucker is currently listed as LC (Least Concern) on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (last ranked: 1 December 2001). NatureServe (2019) has given Lake Chubsucker a global status of G5, indicating that the species is secure globally (last ranked: 1 December 2001). The reason provided for this status is the large range of the species in the southeastern United States and southern Great Lakes states (NatureServe 2019). Nationally, Lake Chubsucker is given an N5 (Secure) rank (last ranked: 5 December 1996) in the United States, and an N2 (Imperilled) rank (last ranked: 21 December 2017) in Canada (NatureServe 2019). Consistent with national ranking, Ontario is S2 (Imperilled) (NatureServe 2019).

Habitat Protection and Ownership

On August 28, 2010, a description of Lake Chubsucker critical habitat in Big Creek National Wildlife Area, Long Point National Wildlife Area, St. Clair National Wildlife Area, and Point Pelee National Park was published in the Canada Gazette, Part I, Vol. 144, No. 35. As per subsection 58(2) of the *Species at Risk Act* (SARA), this description prohibits the destruction of the critical habitat identified in the Lake Chubsucker Recovery Strategy (Staton *et al.* 2010). On December 16, 2017, a Lake Chubsucker Critical Habitat Order was published in Canada Gazette Part I, Vol. 151, No. 50, to provide further protection to the species' critical habitat as per SARA subsection 58(1), enhancing the ability of the Minister of Fisheries and Oceans to protect critical habitat to support Lake Chubsucker recovery. Lake Chubsucker habitat is also protected under other federal legislation and regulation, such as the *Canada Wildlife Act*, *Canada National Parks Act*, and subsection 35(1) of the *Fisheries Act*, which prohibits serious harm to fishes, including "any permanent alteration to, or destruction of, fish habitat".

Provincially, Lake Chubsucker is listed on the *Endangered Species Act, 2007* (ESA), and the provincial recovery strategy was published on June 15, 2012 (Ontario Ministry of Resources 2012). Once a species is listed as extirpated, endangered or threatened under the ESA, it is automatically protected from harm or harassment, and its habitat is also protected from damage or destruction.

Lake Chubsucker populations in Big Creek NWA, Long Point NWA, St. Clair NWA, Point Pelee National Park, the Pinery Provincial Park and Rondeau Provincial Park are further protected by *Canada National Parks Act* regulations, Wildlife Area Regulations under the *Canada Wildlife Act*, and regulations under the Ontario *Provincial Parks and Conservation Reserves Act*. In many of these protected systems habitat modifications are prohibited or carefully regulated, which may indirectly afford additional habitat protection to Lake Chubsucker.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

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COLLECTIONS EXAMINED

No collections were examined directly for the completion of this report.

Appendix 1. Threat Calculator results for Lake Chubsucker.

THREATS ASSESSMENT WORKSHEET				
Species or Ecosystem Scientific Name	*Erimyzon sucetta*, Lake Chubsucker			
Element ID			**Elcode**	
Date :	10/21/2019			
Assessor(s):	Andrew Drake (report writer) , Lynn Bouvier (report writer), Jennifer Heron (facilitator), Nick Mandrak (Freshwater Fish SSC Co-chair) , Julien April (Freshwater Fish SSC member), Erin Carroll (external expert), Vicky McKay (external expert), Scott Reid (external expert), Jim Roy (external expert), Christina Davy (Ontario COSEWIC representative), Rachel Windsor (Parks Canada Agency), Scott Parker (Parks Canada Agency), Sarah Yuckin (Parks Canada Agency).			
References:				
Overall Threat Impact Calculation Help:			**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	1	0
	B	High	0	1
	C	Medium	2	1
	D	Low	1	2
Calculated Overall Threat Impact:			Very High	High
Assigned Overall Threat Impact:	**AB = Very High - High**			
Impact Adjustment Reasons:				
Overall Threat Comments				

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development						
1.1	Housing & urban areas						
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						Cattle or livestock wading into the waterways not a threat.
2.4	Marine & freshwater aquaculture						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3	Energy production & mining						
3.1	Oil & gas drilling						
3.2	Mining & quarrying						
3.3	Renewable energy						
4	Transportation & service corridors						
4.1	Roads & railroads						Road salt is scored under pollution.
4.2	Utility & service lines						
4.3	Shipping lanes						Dredging done for recreational, not shipping, purposes.
4.4	Flight paths						
5	Biological resource use						
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						NOTES: Forestry activities are a historical threat within the fish's range.
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance						
6.1	Recreational activities						Not caught during recreational fishing.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities						
7	Natural system modifications	AB	Very High - High	Pervasive (71-100%)	Extreme - Serious (31-100%)	High (Continuing)	
7.1	Fire & fire suppression						The use of these waterways for water to fight fires is not likely.
7.2	Dams & water management/use	C	Medium	Restricted (11-30%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Considers: 1. **Drawdown of dyked wetlands** and other water-level manipulations. Implicated in dyked wetlands; likely to cause stranding and substantial mortality; long-term recovery unclear. Also includes potential water-level manipulations in Lyons Creek due to pumping from Welland Canal. Because there are few populations where this could occur, scored in the restricted category, but has the potential to kill a lot of the fish in the population, thus extreme severity.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.3	Other ecosystem modifications	AB	Very High - High	Pervasive (71-100%)	Extreme - Serious (31-100%)	High (Continuing)	Considers: 1. **Agriculture**. Increased flow of surface water, leading to siltation and reduced macrophyte availability. Most prominent in Long Point Bay, Rondeau Bay, Point Pelee, but most populations affected. 2. **Shoreline Development and Hardening**. Boating channels and shoreline areas in Lake St. Clair, Long Point Bay, Rondeau Bay, and Lyons Creek. Changes in water currents, sediment transport, composition and availability of substrates that support macrophyte growth. 3. **Dredging**. Common in Lake St. Clair, Long Point Bay, Crown Marsh, occupied drains (Prince Albert Drain, Collop Drain). Mechanism is physical disturbance, changes to food supply, removal of macrophytes. Dredging implicated in loss of the Lake Chubsucker from Big Creek drainage. 4. **Control of invasive macrophytes**. Chemical control, burning, cutting, physical removal, primarily European Common Reed. Has occurred in Long Point Bay, Rondeau Bay, L Lake; proposed in St. Clair NWA, Big Creek NWA and other inhabited sites. Physical disturbance of Lake Chubsucker; increased sedimentation; disturbance of native plants; long-term consequences unclear. The following AIS were moved to this section because they are secondary or proximal threats to the Lake Chubsucker. 4. **Common Carp/Goldfish**. Found throughout Canadian range. Primary consequence is modification of habitat features required by Lake Chubsucker for feeding, cover, reproduction. 5. **Grass Carp.** Expected to increase range in coastal wetlands in next 10 years. Causes open water to become semi-aquatic, not suitable for fishes. Primary consequence loss of preferred habitat features (aquatic macrophytes). 6. **Eurasian Watermilfoil.** Expansion within coastal and inland wetlands; loss of native plant species. 7. **European Common Reed.** Found throughout range except Old Ausable Channel; loss of preferred plant species. Mechanism for decline of other invasive species poorly known (e.g., Round Goby extant in several areas where Lake Chubsucker occurs, but not direct evidence).

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8	Invasive & other problematic species & genes	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	
8.1	Invasive non-native/alien species/diseases	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Mechanism for direct impact of AIS poorly known. Considers 1. **Round Goby**. Inhabits Long Point Bay Bay, Point Pelee, Rondeau Bay, Walpole Island; future expansion expected to inland sites. Direct evidence of negative relationship does not exist, but negative effects common for other native species. 2. **Rudd**. Has expanded range into Lake Chubsucker habitats (Rondeau Bay, Point Pelee, Lyons Creek, Walpole Island). Direct competition likely. Both Round Goby and Rudd may lead to generalized food web changes. Other AIS moved to ecosystem modifications.
8.2	Problematic native species/diseases	D	Low	Restricted - Small (1-30%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Considers 1. **Illegal stocking**. Includes native predatory sportfishes such as Black Crappie, Largemouth Bass, Northern Pike. Historical composition of L Lake Chubsucker fish communities poorly understood. Illegal stocking of Northern Pike has been confirmed from Old Ausable Channel; consequences unclear.
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.1	Domestic & urban waste water	CD	Medium - Low	Large - Restricted (11-70%)	Moderate (11-30%)	High (Continuing)	Considers 1. **Aging septic systems in vicinity of Old Ausable Channel**. Increased nutrient input into OAC leading to high levels of macrophyte growth, heightened periods of decay and consumption. Consequence is low dissolved oxygen, possibly causing over-winter mortality via winterkill. This may apply to other sites, so perhaps this should have a higher scope, e.g. Point Pelee, Long Point Bay; sites include long-point inner bay and other areas; some work on Phosphorus and septic systems there is likely Nitrate inputs from systems but it isn't clear there is P inputs and P tends to not move from systems; so it depends on which one is the concern, P tending to be the eutrophication; part of the problem, is it's not flushed out, there are probably other sources and it's a matter of nutrients stored there and coming out each season; Need to look more into Point Pelee and scope (e.g., 350 potential septic tanks buried that may be leaching things). Road salt could impact some populations (e.g. Point Pelee, Long Point Bay, Old Ausable Channel, L Lake). Dilution effect at some sites.
9.2	Industrial & military effluents	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Considers 1. **Industrial effluent in Walpole Island populations**. 2. **Contamination** of Lyons Creek with PCBs, PAHs, DDE.
9.3	Agricultural & forestry effluents	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	Considers 1. **Surface runoff of nutrients from agriculture**. Increases primary production, decreases water clarity, decreases the availability of aquatic macrophytes. Relevant for Long Point Bay, Rondeau Bay, Point Pelee, Walpole Island, most dyked cells.
9.4	Garbage & solid waste						
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11	Climate change & severe weather	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	
11.1	Habitat shifting & alteration	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Considers. 1. **Habitat effects** (changes to primary productivity, lake and stream hydrology, periods of ice cover, changes in fish community due to colonization and extinction).Lack of protective shore ice at Point Pelee may affect populations. Changing lake levels with wetlands open to the lake, lowering wetland levels will promote expansion of European Common Reed.
11.2	Droughts						Area is unlikely to experience droughts; marshy areas are likely to be infilled with the invasive plants, which then gives the appearance of droughts because the area becomes more like a terrestrial ecosystem.
11.3	Temperature extremes						The fish is already a warm-water tolerant and has a wide range of temperature tolerances; therefore, it may not be impacted by temperature extremes.
11.4	Storms & flooding						Storm surges and impacts along the some of the areas at Point Pelee could be impacted by increased severity of winter storms.
11.5	Other impacts						
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							