Photo: Alan Dextrase (MNRF, retired)

Silver Shiner

(Notropis photogenis) in Ontario

Ontario Recovery Strategy Series

2023

Ministry of the Environment, Conservation and Parks

Ontario

About the Ontario Recovery Strategy Series

This series presents the collection of recovery strategies that are prepared or adopted as advice to the Province of Ontario on the recommended approach to recover species at risk. The Province ensures the preparation of recovery strategies to meet its commitments to recover species at risk under the *Endangered Species Act 2007* (ESA) and the Accord for the Protection of Species at Risk in Canada.

What is recovery?

Recovery of species at risk is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a recovery strategy?

Under the ESA a recovery strategy provides the best available scientific knowledge on what is required to achieve recovery of a species. A recovery strategy outlines the habitat needs and the threats to the survival and recovery of the species. It also makes recommendations on the objectives for protection and recovery, the approaches to achieve those objectives, and the area that should be considered in the development of a habitat regulation. Sections 11 to 15 of the ESA outline the required content and timelines for developing recovery strategies published in this series.

Recovery strategies are required to be prepared for endangered and threatened species within one or two years respectively of the species being added to the Species at Risk in Ontario list. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

What's next?

Nine months after the completion of a recovery strategy a government response statement will be published which summarizes the actions that the Government of Ontario intends to take in response to the strategy. The implementation of recovery strategies depends on the continued cooperation and actions of government agencies, individuals, communities, land users, and conservationists.

For more information

To learn more about species at risk recovery in Ontario, please visit the Ministry of Environment, Conservation and Parks Species at Risk webpage at: **www.ontario.ca/speciesatrisk**

Recommended citation

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Declaration

The recovery strategy for the Silver Shiner (*Notropis photogenis*) was developed in accordance with the requirements of the *Endangered Species Act, 2007* (ESA). This recovery strategy has been prepared as advice to the Government of Ontario, other responsible jurisdictions and the many different constituencies that may be involved in recovering the species.

The recovery strategy does not necessarily represent the views of all individuals who provided advice or contributed to its preparation, or the official positions of the organizations with which the individuals are associated.

The recommended goals, objectives and recovery approaches identified in the strategy are based on the best available knowledge and are subject to revision as new information becomes available. Implementation of this strategy is subject to appropriations, priorities and budgetary constraints of the participating jurisdictions and organizations.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy.

Responsible jurisdictions

Ministry of the Environment, Conservation and Parks
Fisheries and Oceans Canada

Executive summary

The *Endangered Species Act, 2007* (ESA) requires the Minister of the Environment, Conservation and Parks to ensure recovery strategies are prepared for all species listed as endangered or threatened on the Species at Risk in Ontario (SARO) List. Under the ESA, a recovery strategy may incorporate all or part of an existing plan that relates to the species.

Silver Shiner (*Notropis photogenis*) is listed as Threatened on the SARO List. The species is also listed as Threatened under the federal *Species at Risk Act* (SARA). Fisheries and Oceans Canada prepared the Recovery Strategy and Action Plan for Silver Shiner (*Notropis photogenis*) in Canada in 2022 to meet its requirements under the SARA. This recovery strategy is hereby adopted under the ESA. With the additions indicated below, the enclosed strategy meets all of the content requirements outlined in the ESA.

In addition to the habitat needs outlined in the federal recovery strategy, a 2022 study has found that intact riparian cover may provide Silver Shiner with important terrestrial food subsidies, including autumn food resources, that may promote successful overwintering. Another recent study of the same Silver Shiner population suggests that adult Silver Shiners are more likely to occupy reaches with higher average water depth, and to be more abundant in these reaches and in fish communities with abundant Common Shiner (*Luxilis cornutus*), Striped Shiner (*L. chrysocephalus*) and Rosyface Shiner (*Notropis rubellus*).

In addition to the threats outlined in the federal recovery strategy, low-head dams may represent a threat to Silver Shiner by altering upstream habitat characteristics, which in turn may affect local fish assemblages and promote the establishment of invasive species.

The Critical Habitat section of the federal recovery strategy provides an identification of critical habitat (as defined under the SARA). Identification of critical habitat is not a component of a recovery strategy prepared under the ESA. However, it is recommended that the approach used to identify critical habitat in the federal recovery strategy, along with any new scientific information pertaining to the Silver Shiner and the areas it occupies, be considered if a habitat regulation is developed under the ESA.

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1.0 Adoption of federal recovery strategy

The *Endangered Species Act, 2007* (ESA) requires the Minister of the Environment, Conservation and Parks to ensure recovery strategies are prepared for all species listed as endangered or threatened on the Species at Risk in Ontario (SARO) List. Under the ESA, a recovery strategy may incorporate all or part of an existing plan that relates to the species.

Silver Shiner (*Notropis photogenis*) is listed as Threatened on the SARO List. The species is also listed as Threatened under the federal *Species at Risk Act* (SARA). Fisheries and Oceans Canada prepared the Recovery Strategy and Action Plan for Silver Shiner (*Notropis photogenis*) in Canada in 2022 to meet its requirements under the SARA. This recovery strategy is hereby adopted under the ESA. With the additions indicated below, the enclosed strategy meets all of the content requirements outlined in the ESA.

1.1 Species assessment and classification

The following list is assessment and classification information for the Silver Shiner (*Notropis photogenis*). Note: The glossary provides definitions for the abbreviations and technical terms in this document.

- SARO List Classification: Threatened
- SARO List History: Threatened (2012), Special Concern (2004)
- COSEWIC Assessment History: Threatened (2011), Special Concern (1987, 1983)
- SARA Schedule 1: Threatened
- Conservation Status Rankings: G-rank: G5; N-rank: N2N3; S-rank: S2S3

1.2 Species description and biology

Species biology

A recent study at Sixteen Mile Creek, Oakville, Ontario (Burbank et al. 2022) examined the timing of Silver Shiner spawning activity and provides important new information on the timing of spawning at the northern extent of its range in Canada. Spawning occurred during a relatively short window from May 5 to 25 in 2018 and May 6 to June 12 in 2019. Models that incorporated Growing Degree Days (GDD; base of 5 °C) were able to accurately predict the timing of spawning in this species, which occurred between GDD5 of 97–340 degrees Celsius in 2018 and 107–486 degrees Celsius in 2019. Spawning occurred at average daily temperatures ranging from 15 to 22 degrees Celsius in 2018 and 12 to 20 degrees Celsius in 2019, which is a wider range than

previously reported in some studies. Although previous research in Alabama indicated that spawning was associated with large discharge events, Burbank et al. (2022) did not observe such an association. Instead, the authors found that spawning occurred after peak spring flows had passed but before the onset of low summer flows. The authors suggested that spawning later in the spring may be an adaptive strategy that allows individuals to build energy reserves prior to spawning.

1.3 Distribution, abundance and population trends

In addition to the occurrence information presented in the federal recovery strategy, there are unverified records of individual Silver Shiner collected in 1996, 1999, and 2012 in the Hamilton area (S. Richer pers. comm. 2023, iNaturalist 2023). Given the uncertainty of these records, and the time elapsed since the observations were made, targeted surveys should be completed in locations with suitable habitat in the Hamilton area to confirm the presence of a Silver Shiner population.

1.4 Habitat needs

A 2017 study of the Silver Shiner population in Sixteen Mile Creek, near Oakville, Ontario, characterized diet and rates of consumption within this population to determine the strength of its dependence on riparian vegetation cover for access to high-quality food resources. It was found that Silver Shiners consume more bankside terrestrial invertebrates, relative to aquatic invertebrates, during autumn when the former are most abundant. Some Silver Shiners had only terrestrial invertebrates in their stomachs at this time of year. Furthermore, Silver Shiner consumed significantly more terrestrial invertebrates in stream reaches where riparian vegetation cover was greatest. This suggests that intact riparian cover may provide Silver Shiner with important terrestrial food subsidies, including autumn food resources that may promote successful overwintering. (Burbank et al. 2022.)

A second study of the same Silver Shiner population, based on monitoring results from 2011 and 2016, investigated the associations of adult and juvenile Silver Shiners with both stream attributes and fish community composition. The results suggest that adult Silver Shiners are more likely to occupy reaches with higher average water depth, and to be more abundant in these reaches and in fish communities with abundant Common Shiner (*Luxilis cornutus*), Striped Shiner (*L. chrysocephalus*) and Rosyface Shiner (*Notropis rubellus*). Juvenile Silver Shiners tended to be more abundant in fish communities with abundant Fathead Minnow (*Pimephales promelas*) and Smallmouth Bass (*Micropterus dolomieu*). Not all fish community associations are thought to relate to the habitat needs of Silver Shiner; for example, the presence of Smallmouth Bass may be associated with juvenile Silver Shiner abundance because the former preys on the latter. However, some fish community associations may be more relevant: abundant Common Shiner and Striped Shiner may dilute the intensity of predation on Silver Shiner, particularly in structurally simple stream reaches (Lamothe and Drake 2022.)

1.5 Threats to survival and recovery

Low-head dams may represent a threat to Silver Shiner by altering upstream habitat characteristics, which in turn may affect local fish assemblages and promote the establishment of invasive species. A 2018 study published by Raab et al. found that low-head dams on the lower Grand River altered the stream morphology upstream of the dam, creating areas with wider channels, slow-moving deep water, and fine substrate. These changes are collectively referred to as a 'reservoir effect'. These habitat changes appeared to directly affect native fish assemblages, with the abundance of some fish species decreasing as the degree of reservoir effect increased. Importantly, the creation of these reservoir habitats upstream of the dams increases the suitability of these stream reaches for Round Goby and appears to facilitate Round Goby invasion.

The federal recovery strategy identifies several threats to the species linked to urbanization, such as pollution and nutrient/sediment loading. A recent study by Burbank *et al.* (2021) provides further evidence that Silver Shiner captured in urban reaches demonstrate higher mortality and altered growth compared to those from non-urban watercourses. These impacts may be due to the stressful conditions associated with urban stream reaches, and reduced availability of terrestrial invertebrate prey resulting from riparian habitat modifications.

1.6 Area for consideration in developing a habitat regulation

Under the ESA, a recovery strategy must include a recommendation to the Minister of the Environment, Conservation and Parks on the area that should be considered in developing a habitat regulation. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species. The recommendation provided below will be one of many sources considered by the Minister, including information that may become newly available following completion of the recovery strategy should a habitat regulation be developed for this species.

The Critical Habitat section of the federal recovery strategy provides an identification of critical habitat (as defined under the SARA). Identification of critical habitat is not a component of a recovery strategy prepared under the ESA. However, it is recommended that the approach used to identify critical habitat in the federal recovery strategy along with any new scientific information pertaining to the Silver Shiner and the areas it occupies, be considered if a habitat regulation is developed for the species under the ESA.

Glossary

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): The committee established under section 14 of the Species at Risk Act that is responsible for assessing and classifying species at risk in Canada.

Committee on the Status of Species at Risk in Ontario (COSSARO): The committee established under section 3 of the *Endangered Species Act, 2007* that is responsible for assessing and classifying species at risk in Ontario.

Conservation status rank: A rank assigned to a species or ecological community that primarily conveys the degree of rarity of the species or community at the global (G), national (N) or subnational (S) level. These ranks, termed G-rank, N-rank and S-rank, are not legal designations. Ranks are determined by NatureServe and, in the case of Ontario's S-rank, by Ontario's Natural Heritage Information Centre. The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by the letter G, N or S reflecting the appropriate geographic scale of the assessment. The numbers mean the following:

1 = critically imperilled
2 = imperilled
3 = vulnerable
4 = apparently secure
5 = secure
NR = not yet ranked

Endangered Species Act, 2007 (ESA): The provincial legislation that provides protection to species at risk in Ontario.

Species at Risk Act (SARA): The federal legislation that provides protection to species at risk in Canada. This Act establishes Schedule 1 as the legal list of wildlife species at risk. Schedules 2 and 3 contain lists of species that at the time the Act came into force needed to be reassessed. After species on Schedule 2 and 3 are reassessed and found to be at risk, they undergo the SARA listing process to be included in Schedule 1.

Species at Risk in Ontario (SARO) List: The regulation made under section 7 of the *Endangered Species Act, 2007* that provides the official status classification of species at risk in Ontario. This list was first published in 2004 as a policy and became a regulation in 2008.

List of abbreviations

COSEWIC: Committee on the Status of Endangered Wildlife in Canada
COSSARO: Committee on the Status of Species at Risk in Ontario
ESA: Ontario's *Endangered Species Act, 2007*

ISBN: International Standard Book Number
SARA: Canada's *Species at Risk Act*
SARO List: Species at Risk in Ontario List

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Appendix 1. Recovery Strategy and Action Plan for Silver Shiner (*Notropis photogenis*) in Canada

Species at Risk Act
Recovery Strategy Series

Recovery Strategy and Action Plan for the Silver Shiner (*Notropis photogenis*) in Canada

Silver Shiner

2022

Canada

Recommended citation:

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For copies of the recovery strategy, or for additional information on species at risk, including Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk Public Registry.

Cover illustration: © Joe Tomelleri

Également disponible en français sous le titre
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Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of a recovery strategy for species listed as Extirpated, Endangered, or Threatened and are required to report on progress five years after the publication of the final document on the Species at Risk Public Registry.

This document has been prepared to meet the requirements under SARA of both a recovery strategy and an action plan. As such, it provides both the strategic direction for the recovery of the species, including the population and distribution objectives for the species, as well as the more detailed recovery measures to support this strategic direction, outlining what is required to achieve the objectives. SARA requires that an action plan also include an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation. It is important to note that the setting of population and distribution objectives and the identification of critical habitat are science-based exercises and socio-economic factors were not considered in their development. The socio-economic evaluation only applies to the more detailed recovery measures (that is, the action plan portion).

The Minister of Fisheries and Oceans is the competent minister under SARA for the Silver Shiner and has prepared this recovery strategy and action plan, as per sections 37 and 47 of SARA. In preparing this recovery strategy and action plan, the competent minister has considered, as per section 38 of SARA, the commitment of the Government of Canada to conserving biological diversity and to the principle that, if there are threats of serious or irreversible damage to the listed species, cost-effective measures to prevent the reduction or loss of the species should not be postponed for a lack of full scientific certainty. To the extent possible, this recovery strategy and action plan has been prepared in cooperation with the Province of Ontario as per section 39(1) and 48(1) of SARA.

As stated in the preamble to SARA, success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this recovery strategy and action plan and will not be achieved by Fisheries and Oceans Canada (DFO) or any other jurisdiction alone. The cost of conserving species at risk is shared amongst different constituencies. All Canadians are invited to join in supporting and implementing this recovery strategy and action plan for the benefit of the Silver Shiner and Canadian society as a whole.

Implementation of this recovery strategy and action plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

Acknowledgments

This recovery strategy and action plan was prepared by P.L. Wong (DFO), P. Jarvis (DFO contractor), A. Boyko (DFO), J. Stacey (DFO), S. Staton (DFO), and J. Epp-Martindale (DFO). DFO would like to thank the following organizations for their support in the development of this recovery strategy and action plan: the Ontario Freshwater Fish Recovery Team, Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry, and the Ontario Ministry of the Environment, Conservation, and Parks. Mapping was produced by C. Bakelaar (DFO), A. Rivas Ruiz (DFO), and A. Geraghty (DFO).

Executive summary

Silver Shiner was listed as threatened under the *Species at Risk Act* (SARA) in 2019. This recovery strategy and action plan is considered one in a series of documents for this species that are linked and should be taken into consideration together, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report (2011), a recovery potential assessment (DFO 2013), and possibly further action plans. Recovery has been determined to be biologically and technically feasible.

The Silver Shiner is a relatively large minnow that belongs to the true minnow family (Leuciscidae). The species is restricted to North America, being widely distributed in the east-central United States, while in Canada it is restricted to southwestern Ontario.

The Canadian range of Silver Shiner appears to be restricted to tributaries of lakes Huron, St. Clair, Erie, and Ontario. Within the Lake Huron drainage, it has been found in the Saugeen River and one of its tributaries, and in the Lake St. Clair drainage, it has been found in the Thames River and tributaries. In the Lake Erie drainage, the species has been found in the Grand River and some of its tributaries, and in the Lake Ontario drainage it has been found in Bronte and Sixteen Mile creeks. In Canada, this species is threatened by many anthropogenic stressors, while being confined to a limited range comprising few populations.

The main threats facing the species are described in section 5 and include: contaminants and toxic substances, increases in turbidity, nutrient and sediment loading, as well as issues related to flow modification.

Population and distribution objectives establish, to the extent possible, the number of individuals and/or populations, and their geographic distribution, that is necessary for the recovery of the species. The population and distribution objectives for Silver Shiner are:

> Population objective: to ensure populations in the Saugeen River (including the North Saugeen River), Thames River and tributaries, Grand River and tributaries, Bronte Creek, and Sixteen Mile Creek (including East Sixteen Mile Creek) demonstrate signs of reproduction and recruitment, and are stable or increasing, with low risk from known threats.
>
> Distribution objective: to maintain the species' current distribution and restore its distribution in historically occupied reaches, where feasible and warranted, at the following locations:
>
> - Saugeen River (including the North Saugeen River)
> - Thames River (including the Avon River, Black Creek, Dingman Creek, Fish Creek, Medway Creek, Middle Thames River, North Thames River, Oxbow Creek, South Thames River, Stoney Creek, Trout Creek, Whirl Creek, and Wye Creek)
> - Grand River (including the Conestogo and Nith rivers)
> - Bronte Creek
> - Sixteen Mile Creek (including East Sixteen Mile Creek)

A description of the broad strategies to be taken to address threats to the species' survival and recovery, as well as research and management approaches needed to meet the population and distribution objectives are included in section 7.

For Silver Shiner, critical habitat (section 8) is identified to the extent possible, using the best available information, and provides the functions and features necessary to support the species' life-cycle processes and to achieve the species' population and distribution objectives. This recovery strategy and action plan identifies critical habitat for Silver Shiner in the Thames River (including the Avon River, Black Creek, Dingman Creek, Fish Creek, Medway Creek, Middle Thames River, North Thames River, Oxbow Creek, South Thames River, Stoney Creek, Trout Creek, Whirl Creek, and Wye Creek), the Grand River (including Conestogo and Nith rivers), Bronte Creek, and Sixteen Mile Creek (including East Sixteen Mile Creek).

The action plan portion of this document provides the detailed recovery planning in support of the strategic direction set out in the recovery strategy section of the document. The action plan outlines what needs to be done to achieve the population and distribution objectives, including the measures to be taken to address threats and monitor recovery of the species, as well as the required measures to protect critical habitat. An evaluation of the socio-economic costs of implementing the action plan and the benefits to be derived from its implementation is provided in section 9.

Recovery feasibility summary

The recovery of Silver Shiner is believed to be biologically and technically feasible. Recovery feasibility is determined according to four criteria outlined by the Government of Canada (2009)[1]:

1. Are individuals of the wildlife species that are capable of reproduction available now or in the foreseeable future to sustain the population or improve its abundance?

Yes. Although spawning has not been directly observed, the species' continued presence (as well as the existence of juveniles) indicates that reproducing populations exist in the Thames and Grand rivers, and Bronte and Sixteen Mile creeks. These populations could provide a basis for natural expansions and potential translocations or artificial propagation, if necessary.

2. Is sufficient suitable habitat available to support the species or could it be made available through habitat management or restoration?

Yes. Suitable habitat is present at several locations with extant populations (for example, Thames and Grand rivers, and Bronte and Sixteen Mile creeks). At reaches with historical records, suitable habitat may be made available through current and proposed restoration efforts. For example, improved water quality and habitat management (through stewardship and Best Management Practices [BMPs]) could improve and expand the extent of suitable habitat.

3. Can significant threats to the species or its habitat be avoided or mitigated?

Yes. Threats believed to pose a serious risk to Silver Shiner, such as sedimentation, nutrient and contaminant loading, can be mitigated through proposed recovery techniques. Through much of the Silver Shiner's range, restoration and mitigation efforts are already underway. For example, improved water quality and habitat management (through stewardship and BMPs) could improve and expand the extent of suitable habitat.

4. Do recovery techniques exist to achieve the population and distribution objectives or can they be developed within a reasonable timeframe?

Yes. Techniques to reduce identified threats (for example, BMPs to reduce sedimentation) and restore habitats are well known and have proven to be effective. If they are determined to be feasible and necessary, repatriations may be possible through captive rearing or adult transfers. Although these techniques have been successful for other freshwater leuciscids (for example, DeMarais and Minckley 1993) it is uncertain if they would work for Silver Shiner. There are no published studies on captive rearing for Silver Shiner.

[1] Government of Canada. 2009. *Species at Risk Act* Policies [Draft]. *Species at Risk Act*, Policies and Guidelines Series. Ottawa, Ontario. Environment Canada. 48 p.

Table of contents

1 Introduction

The Silver Shiner (*Notropis photogenis*) was listed as threatened under the *Species at Risk Act* (SARA) in 2019. This recovery strategy and action plan is part of a series of documents regarding Silver Shiner that should be taken into consideration together, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report (COSEWIC 2011) and the science advisory report from the recovery potential assessment (RPA; Fisheries and Oceans Canada [DFO] 2013), and possibly further action plans.

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets objectives and identifies the main areas of activities to be undertaken, while the action plan portion provides the detailed recovery planning that supports the strategic direction set out in the recovery strategy portion. Action planning for species at risk recovery is an iterative process. The implementation schedule (tables 4 to 6) in this recovery strategy and action plan may be modified in the future depending on the progression towards recovery.

The RPA is a process undertaken by DFO Science to provide the information and scientific advice required to implement SARA, relying on the best available scientific information, data analyses and modelling, and expert opinions. The outcome of this process informs many sections of the recovery strategy and action plan. For more detailed information beyond what is presented in this recovery strategy and action plan, refer to the COSEWIC status report and the RPA science advisory report.

2 COSEWIC species assessment information

Date of assessment: May 2011
Species' common name: Silver Shiner
Scientific name: *Notropis photogenis*
Status: Threatened
Reason(s) for designation: This small riverine fish is found at fewer than 10 locations and has a small area of occupancy. The susceptibility of the species to continuing habitat loss and degradation with increasing development pressure resulted in an increase in status.
Canadian occurrence: Ontario
Status history: Designated special concern in April 1983. Status re-examined and confirmed in April 1987. Status re-examined and designated threatened in May 2011.

3 Species status information

Table 1. Summary of existing protection or other status designations assigned to Silver Shiner.

Jurisdiction	Authority/organization	Year(s) assessed and/or listed	Status/description	Designation level
Ontario	Committee on the Status of Species at Risk in Ontario (COSSARO)	2011	Threatened	Population
Ontario	*Endangered Species Act,* 2007	2012	Threatened	Population
Ontario	NatureServe	2011	Imperilled/vulnerable (S2S3)[2]	Population
Canada	Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	2011	Threatened	Population
Canada	*Species at Risk Act* (SARA)	2019	Threatened	Population
Canada	NatureServe	2017	Imperilled/vulnerable (N2N3)	Population
United States[3]	NatureServe	1996	Secure (N5)	Population
International	NatureServe	1996	Secure (G5)	Species
International	International Union for Conservation of Nature (IUCN)	2012	Least concern	Species

Upon listing as a Threatened species, the Silver Shiner became protected wherever it is found in Canada by section 32 of SARA:

> "No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an Extirpated species, an Endangered species or a Threatened species." [subsection 32(1)]
>
> "No person shall possess, collect, buy, sell or trade an individual of a wildlife species that is listed as an Extirpated species, an Endangered species or a Threatened species, or any part or derivative of such an individual." [subsection 32(2)]

Under section 73 of SARA, the competent minister may enter into an agreement or issue a permit authorizing a person to engage in an activity affecting a listed wildlife species, any part of its critical habitat or its residences. In addition to specific consultation obligations, the competent minister must take into account specific factors when considering an application for a permit or agreement.

[2] Refer to NatureServe 2019 for full definitions of NatureServe conservation status ranks.
[3] Refer to NatureServe 2019 for state-specific designations.

4 Species information

4.1 Description

The Silver Shiner (figure 1) is a relatively large minnow that can grow to about 14 cm long. It has a silvery body with some blue or green iridescence, a dark stripe down the centre of the back and a long snout marked with two black crescents between the nostrils. Fins are transparent or white with no spots or other distinctive markings (COSEWIC 2011). The Silver Shiner can be distinguished from similar looking species such as the Rosyface Shiner (*Notropis rubellus*) and the Emerald Shiner (*N. atherinoides*) through: a) a dorsal fin that originates directly opposite the base of the pelvic fins; b) the presence of two black crescents between the nostrils; and, c) the presence of a black stripe along the back (DFO 2013).

Figure 1. Adult Silver Shiner. Photo courtesy of Upper Thames River Conservation Authority.

4.2 Population abundance and distribution

4.2.1 Global distribution and population abundance

The Silver Shiner has a wide distribution across east-central North America (figure 2). It occurs mainly in the Ohio and Tennessee River drainages (COSEWIC 2011). It is found in northern Georgia and Alabama, north through Tennessee, Kentucky, Indiana, Ohio, southeastern Michigan, and southwestern Ontario. To the east, it is found in southwestern New York, western Pennsylvania, West Virginia, Virginia, and North Carolina (COSEWIC 2011). In Canada, Silver Shiner is at its northern limit and is found only in Ontario. Globally, the species is considered secure (table 1) but reliable population estimates are rare. Silver Shiner is considered stable throughout much of its American range, where it is represented by a large number of subpopulations and locations (NatureServe 2019).

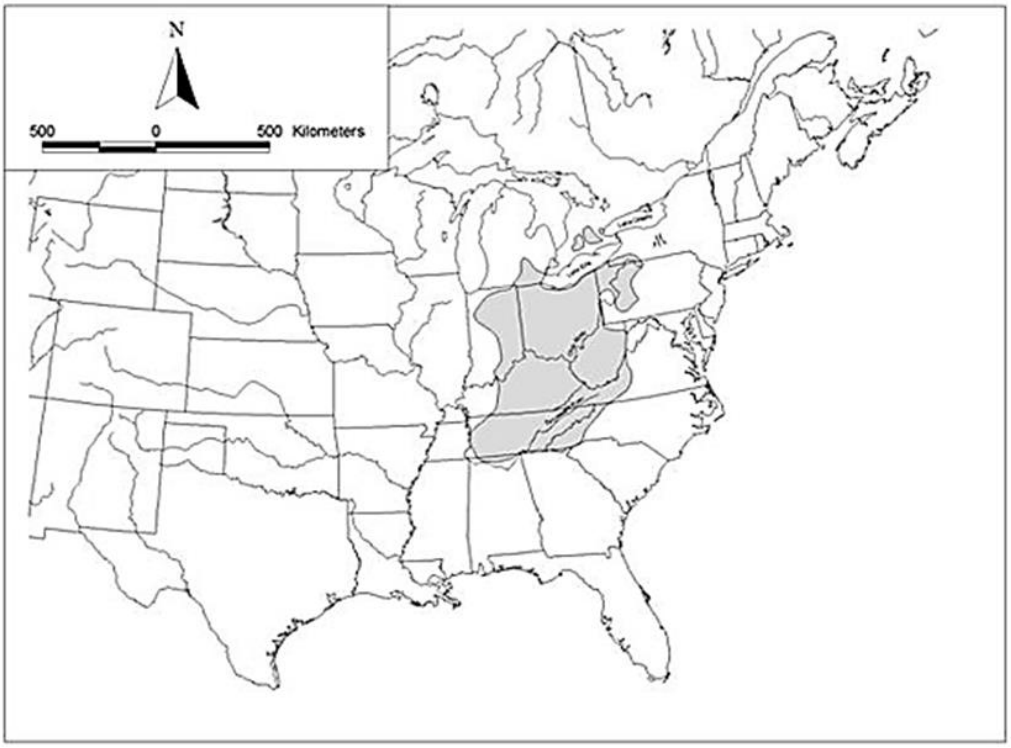

Figure 2. Global distribution of the Silver Shiner (from COSEWIC 2011).

4.2.2 Canadian distribution and population abundance

Due to several factors (for example, lack of regular monitoring, frequent misidentification, and limited overall sampling effort), the population dynamics of Silver Shiner are poorly characterized in Canada. However, recent sampling efforts have helped to refine the understanding of the species' range. Silver Shiner populations in Canada are restricted to southwestern Ontario in the watersheds of Lake Huron, Lake St. Clair, Lake Erie, and Lake Ontario (figure 3). Specifically, populations have been found in the Saugeen and North Saugeen rivers, the Thames River and tributaries (Avon, North Thames, Middle Thames, and South Thames rivers; Black, Dingman, Fish, Medway, Oxbow, Stoney, and Trout creeks; Fanshawe Lake), Grand River and some of its tributaries (Conestogo, Nith, and Speed rivers; Laurel, Schneider, Silver, and Whitemans creeks), Bronte Creek, and Sixteen Mile Creek (including East Sixteen Mile Creek) (Bouvier et al. 2013; DFO, unpubl. data; Upper Thames River Conservation Authority [UTRCA], unpubl. data). In 2019, the species was found in the Saugeen and North Saugeen rivers confirming its presence in this watershed (Gaspardy et al. 2021); the previous record (a single specimen, originally identified as a Rosyface Shiner) was collected in 1956 (collection locality unknown) (Bouvier et al. 2013). Silver Shiner was reported from Rogers and McKenzie creeks in the Grand River watershed; however, these records are erroneous and resulted from species code transcription errors (COSEWIC 2011).

Of the previously mentioned locations, several may be considered historical as Silver Shiner has not been observed in recent years. These include Fanshawe Lake (last known record 1988), Laurel Creek (1979), Schneider Creek (1977), Silver Creek (1949), Speed River (1981), and Whitemans Creek (1982). The species' extent of occurrence in Canada is less than 2% of its global extent of occurrence. Its area of occupancy is estimated to be 19.3 km (COSEWIC 2011). For further information on the distribution of Silver Shiner, refer to COSEWIC (2011) and Bouvier et al. (2013).

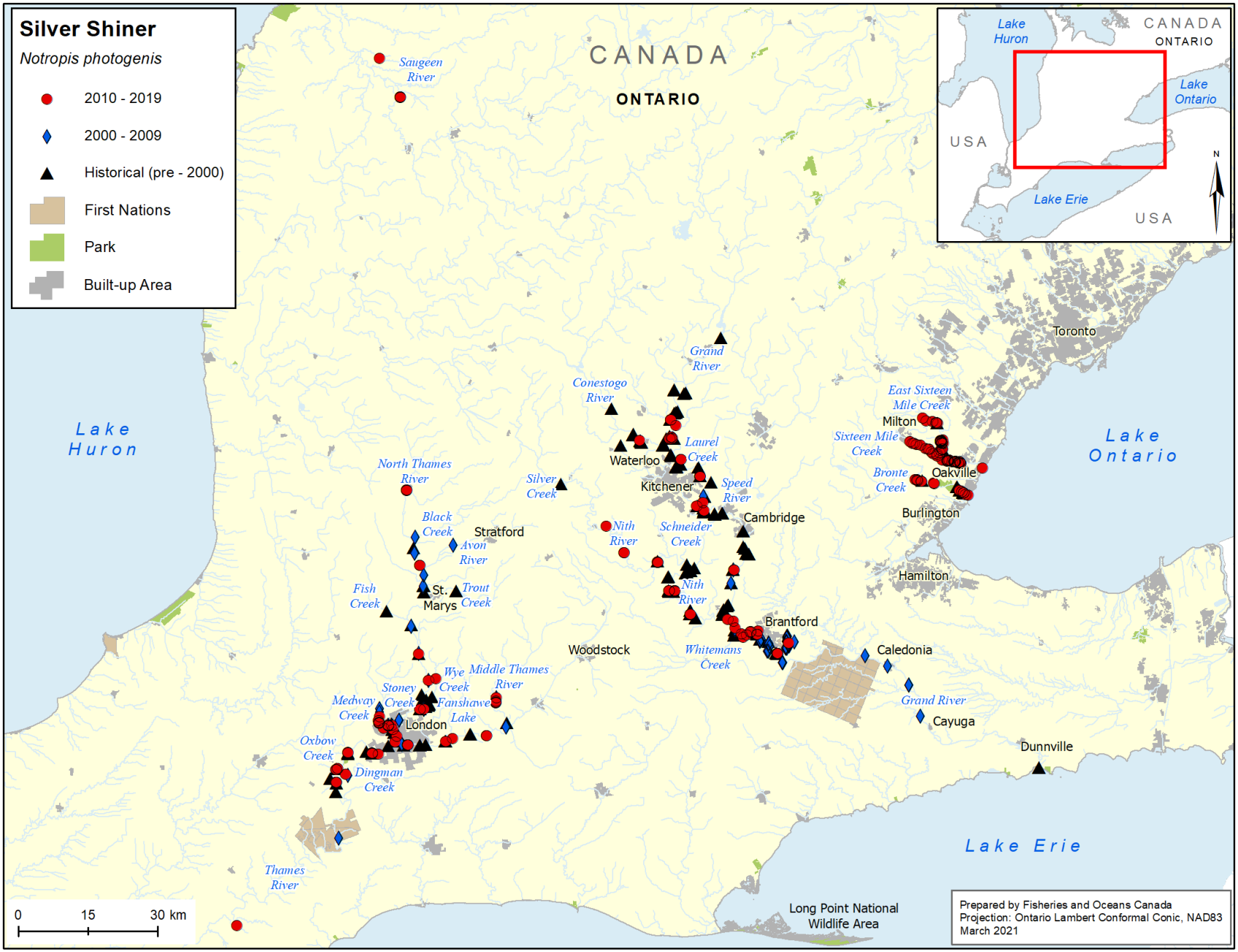

Figure 3. Distribution of Silver Shiner in Canada.

4.2.3 Population assessment

The status of Silver Shiner populations in Canada was assessed by Bouvier et al. (2013) (table 2). Populations were ranked in terms of their abundance and trajectory. Certainty assigned to each population status is reflective of the lowest level of certainty associated with population abundance or trajectory. Refer to Bouvier et al. (2013) for detailed methods used for the assessment of population status.

Table 2. Population status and associated certainty of individual Silver Shiner populations in Canada (Bouvier et al. 2013).

Population	Population status	Certainty
Grand River	Fair	Expert opinion
Thames River	Fair	Expert opinion
Bronte Creek	Poor	Expert opinion
Sixteen Mile Creek	Fair	Expert opinion
Saugeen River	Unknown	Expert opinion

4.3 Needs of the Silver Shiner

Spawn to hatch: Spawning habitat for this species is not well known; it is possible that spawning occurs in relatively deep riffles in habitat similar to that used by other shiners (*Luxilus*) and chubs (*Nocomis* species) (COSEWIC 2011). Spawning is believed to occur in late May to mid-June when water temperatures are between 18.1 and 23.5°C (COSEWIC 2011). In Ontario, gamete evidence suggested spawning occurs from early to mid-June when water temperature was approximately 24°C (Bunt 2016). Research conducted in spring 2018 resulted in the collection of larval Silver Shiner on June 8th at a growing degree day[4] (GDD) of 585°C, base 5°C, and on June 14th at a GDD of 671°C, base 5°C. On these dates, larval Silver Shiner total length was between 14 to 23 mm and 24 to 29 mm, respectively. This suggests spawning may occur earlier in Ontario, from early May to early June when air temperatures are between 11.6 and 21.9°C (DFO and University of Waterloo, unpubl. data).

Larval stage and young-of-the-year: There is little information available on the habitat needs of the larval stages of Silver Shiner. It has been reported that young-of-the-year (YOY) are most commonly associated with aquatic habitats with slower water than those preferred by adult fish (COSEWIC 2011). In the Grand River, YOY occupied gravel shoals with slower currents and warmer temperatures (Bunt 2016). In 2018, larval Silver Shiner were collected in slack areas adjacent to a run, in fairly shallow waters (<0.35 m; DFO and University of Waterloo, unpubl. data).

Adult: Silver Shiner generally prefers medium to large streams and rivers with moderate to fast flows and is associated with alternating pools and riffles or more turbulent regions below dams (COSEWIC 2011; Bouvier et al. 2013; Glass et al. 2016). Reported substrate types at Silver Shiner locations are variable and include cobble, gravel, sand, and silt (COSEWIC 2011; Glass et al. 2016). In the Grand River, Ontario, cobble was used most frequently in transitional habitat near backwater pools and areas adjacent to deep runs (Bunt 2016). Larger Silver Shiner occupied transition areas with heterogeneous and patchy habitat within backwater pools, runs and deep runs with cobble, often near areas influenced by groundwater seepage (Bunt 2016). In

[4] Growing degree days are used to estimate growth and development during the growing season with development only occurring when the temperature exceeds a minimum threshold or base temperature.

2011, Glass et al. (2016) conducted targeted surveys throughout the Ontario range of the Silver Shiner to determine the species' distribution and habitat use. Overall, they found that the species had a preference for sand and gravel substrates, water velocities of 0.25 to 0.49 m/s, and depths of 0.8 to >1 m. Additionally, Silver Shiner demonstrated a strong avoidance for areas of high velocity (>0.5 m/s) and shallow depths (<0.4 m). A review of 21 environmental factors influencing Silver Shiner distribution indicated that water depth was the most important variable associated with the occurrence of the species within a river reach; the presence of Silver Shiner was positively correlated with greater stream depth (Baldwin 1983; Glass et al. 2016). The thermal preferences and tolerances of this species are unknown (Bouvier et al. 2013). Silver Shiner has been captured in both clear and turbid waters (COSEWIC 2011; Bouvier et al. 2013) and it is unlikely that a relationship exists between water clarity and Silver Shiner occurrence (Baldwin 1983). For further information on the biology and habitat needs of Silver Shiner, refer to the RPA and the COSEWIC report.

Silver Shiner has been documented to feed primarily on insects, including juveniles and adults of aquatic species (COSEWIC 2011), which it obtains from both midwater and surface feeding strategies (Gruchy et al. 1973; Baldwin 1983; COSEWIC 2011); however, other prey items such as worms, crustaceans, and phytoplankton have also been documented within its stomach contents (COSEWIC 2011). In addition, Silver Shiner has been documented to leap from the water to feed on flying insects (Gruchy et al. 1973; Parker and Mckee 1980; Trautman 1981; Baldwin 1988), which may indicate that terrestrial species are also an important component of its diet. Research conducted in 2017 seems to support this; the stomach contents of 165 Silver Shiner were analyzed (in the summer and fall) and approximately 37% of the prey identified were of terrestrial origin, and 85% of stomachs examined contained one or more prey item of terrestrial origin (interestingly, a notable proportion of ants and wasps were found in ~14% of stomachs analyzed; DFO and University of Waterloo, unpubl. data). Consequently, the inclusion of terrestrial insect species as a dietary component may suggest that riparian vegetation could be an important indirect habitat feature as it may function to facilitate the availability of these specific prey items.

Limiting factors: Natural factors that may limit the distribution of Silver Shiner include stream gradient (the species appears to avoid shallow, high-gradient [>0.49 m/s] areas), water depth, and water temperatures. Colder weather may reduce winter survival and spawning success (Baldwin 1983). Water depth was found to be the most important factor influencing the occurrence of the species at the site level, though there is some evidence that this association is strongest for adult individuals.

Naturally occurring cycles of prolonged drought may affect spawning as there is some evidence that spawning occurs in relatively deep riffles in habitat similar to that used by other shiners. Silver Shiner has been recorded from warm streams and water temperatures, which likely limits the northern extent of the range of the species (COSEWIC 2011).

5 Threats

5.1 Threat assessment

Bouvier et al. (2013) assessed threats to Silver Shiner populations in Ontario. Known and suspected threats were ranked with respect to threat likelihood and threat impact for each population, which were then combined to produce an overall threat status (table 3). A certainty level was also assigned to the overall threat status, which reflected the lowest level of certainty

associated with either threat likelihood or threat impact. See Bouvier et al. (2013) and DFO (2013) for further details. Additional information is provided in the subsequent threat summaries. For more information on threats to Silver Shiner, refer to the COSEWIC report and the RPA.

Table 3. Summary of threats and threat status to Silver Shiner populations in Canada (the number in brackets refers to the level of certainty associated with each threat: 1 = causative studies; 2 = correlative studies; and, 3 = expert opinion; table adapted from DFO 2013).

Threat	Threat status in Grand River	Threat status in Thames River	Threat status in Bronte Creek	Threat status in Sixteen Mile Creek
Turbidity and sediment loading	Medium (3)	Medium (3)	High (3)	Medium (3)
Contaminants and toxic substances	High (3)	High (3)	High (3)	High (3)
Nutrient loading	High (3)	High (3)	High (3)	High (3)
Barriers to movement	Medium (3)	Medium (3)	Low (3)	Low (3)
Flow modification	Medium (3)	Medium (3)	Medium (3)	High (3)
Invasive species	Medium (3)	Low (3)	Medium (3)	Medium (3)
Incidental harvest	Low (1)	Low (1)	Low (1)	Low (1)

5.2 Description of threats

Contaminants and toxic substances

With a high degree of urbanization within the range of Silver Shiner, along with a preponderance of agricultural activities in the Thames and Grand River watersheds, the threat of contaminants and toxic substances to this species is considerable (COSEWIC 2011). The most significant threats appear to be toxic spills (for example, fuel, oils, manure, chemicals), and chloride (from road salt). Toxic spills are particularly common in southwestern Ontario and numerous manure spills have resulted in fish kills (COSEWIC 2011). The range of Silver Shiner is within Canada's most road-dense and heavily salted region, which can result in salinization of surface waters. Toxic compounds may have several significant effects at the population level, including impaired reproduction, disruption of behaviour, decreased resistance to pathogens and disruption of embryonic development (for example, Benoit et al. 1976; Collier et al. 1998; Hopkins et al. 2000; Hopkins et al. 2003).

Lampricide (granular Bayluscide [gB]) is currently being applied in Bronte Creek every three years to control Sea Lamprey (*Petromyzon marinus*) populations (COSEWIC 2011), which has the potential to impact Silver Shiner. Some research has been conducted in recent years to assess the impacts of lampricide applications on fish and mussel species at risk (for example, Newton et al. 2017; Andrews et al. 2021; Smyth and Drake 2021). Andrews et al. (2021) assessed the relative risk of gB applications for species at risk, including Silver Shiner, within the Great Lakes basin. The risk assessment was based on four metrics: 1) the extent of overlap of gB applications within the distribution of a species a risk; 2) the intensity of applications within the species' range; 3) the number records for the species found within the habitat type targeted for treatment (softer sediments where larval lamprey are found); and, 4) the standardized toxicity of gB to fishes and mussels based on focal or surrogate species. Results suggest that there was minimal overlap of gB applications with Silver Shiner locations (less than 1% of all gB applications overlapped Silver Shiner distribution from 2011 to 2017), and of the areas that

overlapped, only 22% of Silver Shiner records were found in habitats being targeted for treatment. The toxicity value used in the study was based on the LC50 for Fathead Minnow (*Pimephales promelas*) as there is currently no information on the toxicity of gB specific to Silver Shiner. Given an LC50 for Fathead Minnow, mortality was 3.5% at a Bayluscide concentration of 0.057 mg/L over eight hours. Given these results, the overall relative risk to Silver Shiner from gB applications was considered low (Andrews et al. 2021). Smyth and Drake (2021) estimated the mortality of fishes and mussels of conservation concern within four rivers in the Huron-Erie corridor, including the Thames River. In most cases, it was found that simulated applications resulted in no or low mortality of fishes and mussels; however, in less than 5% of cases, mortality of ones to tens of fishes occurred following a single application cycle. Results indicate that, in some cases, gB may result in mortality and population effects but that mortality may be mitigated by factors associated with the application cycle (for example, reducing the amount of gB applied, extending the period between cycles).

Other concerns include possible endocrine and reproductive effects on the Silver Shiner from contaminants contained in municipal effluent (for example, Jobling et al. 2003; Nash et al. 2004; Lajeunesse et al. 2011). Overall, the effects of contaminants on the Silver Shiner are poorly characterized and understanding often relies on circumstantial evidence.

Nutrient loading

The dominance of agricultural and urban activities in the watersheds containing Silver Shiner results in concerns over nutrient loading. Nutrients in the form of nitrogen (that is, ammonia, nitrates, nitrites) and phosphorus enter the watershed via urban and agricultural runoff, tile drainage, and wastewater treatment plants. Increased nutrient levels can result in eutrophication, including potentially toxic blooms of cyanobacteria. Eutrophication may result in decreased dissolved oxygen levels and induce metabolic stress for aquatic organisms that can result in a negative impact on population levels (for example, Munn and Hamilton 2003). Reductions in nutrient loading and pollution from agricultural, urban and industrial sources have produced a slight increase in Silver Shiner abundance and distribution in Ohio since 1990 (Yoder et al. 2005).

Turbidity and sediment loading

Turbid environments may inhibit prey detection (for example, Sweka and Hartman 2003) and mating success (for example, Burkhead and Jelks 2001) in a variety of fish species, while increased sediment loads may reduce primary productivity, macroinvertebrate availability, egg survival, and quality of spawning habitat (for example, Wood and Armitage 1997). Direct evidence on the effects of increased turbidity and sediment loading on Silver Shiner is sparse but Silver Shiner declines were documented in the Little Miami River (Ohio) following increased levels of sedimentation associated with physical alteration of the streambed; however, these declines were only observed in the short term (Schubert et al. 1987, as cited in Reid and Anderson 1999). It is possible that Silver Shiner is more tolerant of high levels of suspended solids (that is, turbidity), compared to high levels of sediment deposition, as it has been found in both clear and turbid waters and there seems to be no relationship between turbidity levels and Silver Shiner occurrence.

Increased siltation and turbidity in Silver Shiner habitats is most likely the result of agricultural activities and urban development, including watercourse and shoreline hardening, and channelization activities. Monitoring in the Thames and Grand rivers indicates poor water quality conditions currently exist (for example, Taylor et al. 2004; Loomer and Cooke 2011). A negative

impact on fish communities related to urbanization and agricultural activities has been observed in the Grand River (Fitzgerald et al. 1998; Wichert and Rapport 1998), while negative impacts on Silver Shiner populations due to siltation and turbidity have been reported in the United States (Miltner et al. 2004; Rasleigh 2004).

Barriers to movement

Dams and impoundments are common in the Grand and Thames River watersheds (over 200 dams), while additional barriers to movement of Silver Shiner include improperly designed and installed culverts resulting from land-use practices or storm events. Barriers to movement can restrict the species' access to important habitat (for example, spawning areas) and limit the potential for rescue effect from neighbouring populations. Hydrological and ecological changes associated with the presence of barriers have contributed to the loss or reduction of migratory and smaller-bodied riverine fishes (for example, Li et al. 1987; Pringle et al. 2000).

Impoundments may alter key characteristics of rivers, including flow regimes, water temperature and material cycling. Dams may result in the creation of reservoirs, which may favour the invasion or introduction of species not native to the watershed (for example, Brown Trout [*Salmo trutta*]) and, consequently, result in degradation of native fish populations (for example, Quinn and Kwak 2003). Silver Shiner has been documented to have undergone local extirpation in the cold tailwaters of the Barren River Lake dam in Kentucky following its construction 13 years prior (Hoyt and Robison 1980). In the Grand River watershed, a decline in populations of fluvial-specialist fishes, as well as species dependent upon warm water temperature cues to elicit spawning activity has been observed following the construction of dams and impoundments that impede fluvial connectivity and migratory pathways (Spence and Hynes 1971; Fitzgerald et al. 1998; Reid 2004).

Flow modification

Flow modification may threaten Silver Shiner populations through alteration of current velocities and a reduction in water levels. Water management issues are known for the Grand River where current and projected water demands may exceed the amount of water that is available (Grand River Conservation Authority 2014). Precipitous water drawdowns related to flood control and low flow augmentation may strand individuals or alter flows, resulting in habitat that is no longer suitable for Silver Shiner (Bouvier et al. 2013). Consumptive water withdrawal activities are also prominent in the Bronte Creek and Sixteen Mile Creek watersheds. Water for recreational purposes (for example, golf course irrigation) is the greatest use of water in both watersheds, while dams and reservoirs as well as agricultural and industrial activities were recorded, but at much lower levels (Bouvier et al. 2013).

Invasive species

The threat of invasion by native and non-native species on native fishes may take a variety of forms including direct competition for space and habitat, food and spawning sites, trophic disruption, potential introductions of new parasites, and disease transmission. Species that have invaded the range of Silver Shiner include: Greenside Darter (*Etheostoma blennioides*), Black Crappie (*Pomoxis nigromaculatus*), Central Stoneroller (*Campostoma anomalum*) (COSEWIC 2011), Round Goby (*Neogobius melanostomus*), and Sea Lamprey (*Petromyzon marinus*) (Bouvier et al. 2013). These species may negatively affect Silver Shiner populations by preying on their eggs and competing for resources or nest space. Since its introduction, Round Goby

(*Neogobius melanostomus*) has been implicated in the declines of a variety of native fish species (for example, Thomas and Haas 2004). Additional introductions of invasive species into these waters are most likely to occur through the movement of boats from infested areas, use of live baitfish or natural invasion of species introduced into the Great Lakes basin.

Stocking of non-native sportfishes: Since the 1940s, sportfishes have been stocked in waterbodies within the known range of Silver Shiner in the Grand River watershed. Since 1989, 20,000 to 25,000 Brown Trout have been stocked into the upper Grand River and this section of the river is now recognized as a world class Brown Trout fishing area (Portt et al. 2007; Bouvier et al. 2013). Brown Trout has also been stocked into the Conestogo River; over 200,000 trout were introduced to the river between 2003 and 2008 (Bouvier et al. 2013). Although there are no studies examining the effect of Brown Trout on Silver Shiner, predation by stocked sportfishes has been hypothesized to compound the negative impacts of habitat degradation on native fishes in the Grand River (Fitzgerald et al. 1998; Reid 2004). Additionally, research has indicated that native leuciscids are vulnerable to predation by Brown Trout (Penczak 1999; Nannini and Belk 2006) and declines in abundance of soft-rayed stream fishes (catostomids and leuciscids) has been associated with this introduced species (Garman and Nielsen 1982).

Incidental harvest

Silver Shiner is not a legal baitfish in Ontario (Ontario Ministry of Natural Resources and Forestry [OMNRF] 2019); however, fishery activities that indirectly harvest Silver Shiner have the potential to negatively impact population abundance. Of concern is the incidental bycatch of the species in commercial baitfish operations and during angler harvest of bait. The extent to which Silver Shiner is caught as bycatch during angler baitfish harvesting in Ontario is unknown. In contrast, the possibility of the bycatch of Silver Shiner during commercial harvests for live bait fisheries has been investigated (Drake and Mandrak 2014b). This research indicated that the potential bycatch of Silver Shiner is dependent on the harvest effort and strategy (gear type, site selection, sampling efficiency, etc.) applied within habitats where the species is present. Drake and Mandrak (2014b) found that a relatively high probability of bycatch exists when sufficient effort is applied; however, the level of mortality incurred as a result of such capture events is currently unknown. Another study (Drake and Mandrak 2014a) investigated the presence of imperilled fishes within samples taken from baitfish dealers across southern Ontario in 2007 and 2008 (a cumulative total of 16,886 fishes). No Silver Shiner were detected within this study (only one imperilled species, River Redhorse [*Moxostoma carinatum*], was detected), which may suggest that the species is not frequently captured within baitfish harvests. However, should Silver Shiner be caught as bycatch, the ability of baitfish harvesters to sort and remove the species from target baitfishes is unknown, but likely to be low (especially if the Emerald Shiner is the target species; Bouvier et al. 2013). Bycatch remains a concern and should be considered a potential threat.

Climate change

Climate change is expected to have significant effects on aquatic communities of the Great Lakes basin through several mechanisms, including: increases in water and air temperatures, reductions in water levels, shortening of the duration of ice cover, increases in the frequency of extreme weather events, emergence of diseases and shifts in predator-prey dynamics (Lemmen and Warren 2004). It is anticipated that the effects of climate change will be widespread and should be considered a contributing factor impacting species at risk and their habitat. Not all of the effects of climate change will negatively affect species at risk; those species that are limited

in their range by cool water temperature (for example, Silver Shiner) may expand their distribution northward provided that dispersal corridors of suitable habitat are available (Chu et al. 2005). As the effects of climate change on Silver Shiner are highly speculative, it is difficult to determine the impact that this will have on the populations and, as such, it was not included in the threats table (table 3). Current and anticipated implications of climate change on Silver Shiner require further assessment.

Recovery

6 Population and distribution objectives

Population and distribution objectives establish, to the extent possible, the number of individuals and/or populations, and their geographic distribution, that is necessary for the recovery of the species. The population and distribution objectives for the Silver Shiner are:

> Population objective: To ensure populations in the Saugeen River (including the North Saugeen River), Thames River and tributaries, Grand River and tributaries, Bronte Creek, and Sixteen Mile Creek (including East Sixteen Mile Creek) demonstrate signs of reproduction and recruitment, and are stable or increasing, with low risk from known threats.
>
> Distribution objective: To maintain the species' current distribution[5] and restore its distribution in historically occupied[6] reaches, where feasible and warranted[7], in the following waterbodies:
>
> - Saugeen River (including the North Saugeen River)
> - Thames River (including the Avon River, Black Creek, Dingman Creek, Fish Creek, Medway Creek, Middle Thames River, North Thames River, Oxbow Creek, South Thames River, Stoney Creek, Trout Creek, Whirl Creek, and Wye Creek
> - Grand River (including the Conestogo River and Nith River)
> - Bronte Creek
> - Sixteen Mile Creek (including East Sixteen Mile Creek)

The populations at these locations could be considered recovered when they have returned to historically estimated ranges and demonstrate signs of reproduction and recruitment throughout their distribution. More quantifiable objectives will be developed once necessary surveys and studies have been completed (refer to section 8.2 schedule of studies to identify critical habitat). As historically occupied reaches in the watersheds listed above are connected to currently occupied reaches, the intent is to restore the species' distribution naturally (that is, through reducing threats and restoring areas with degraded habitat). Should natural re-colonization not occur, population augmentation and/or repatriation using wild stock and/or captive-reared individuals may be investigated.

Recent modelling conducted by Young and Koops (2013) estimated that the minimum viable population size (MVP) for Silver Shiner is 780,000 adults, given a 10% chance of a catastrophic event occurring per generation. However, the implementation of such a target is difficult without

[5] Currently occupied reaches: sites with live animals from 2000 onward.
[6] Historically occupied reaches: sites with records prior to 2000 (black triangles on figure 3).
[7] Further surveys may determine that the species is still extant (that is, present) at sites that are believed to be extirpated (that is, historical).

also having information on population demographics and spatial distribution, habitat quality and a more complete understanding of the life history of the species. More confident objectives relating to MVP can be developed and further validation of model results determined as understanding of this species is improved. New research from Burbank et al. (2021) confirmed the species has a shorter lifespan (probable maximum of four years; previous evidence suggested that it may be much higher); this appears to support the MVP above, which assumes a three-year lifespan. Further research is required on the population demographics, spatial distribution, and habitat quality.

Rationale: Further information is required before the population and distribution objectives can be refined. Knowledge of population demographics (extent, abundance, trajectories and targets) is currently limited.

7 Broad strategies and general approaches to meet objectives

7.1 Actions already completed or currently underway

Actions that have been completed include surveys, recovery potential modelling (see Young and Koops 2013), and species at risk outreach sessions. Additionally, Cudmore and Mandrak (2018) developed The Baitfish Primer, a guide to identify baitfish species of Ontario. This primer has been made available to commercial bait harvesters, anglers and the general public via OMNRF offices, ServiceOntario offices and the DFO website, and includes Silver Shiner, with the intention of reducing its incidental harvest. Research has been completed on the lifespan of Silver Shiner, which supports a maximum probable age of four years, and thermal occupancy, which ranges from 11.06 to 21.45°C (Burbank et al. 2020, 2021). Current research efforts by DFO and the University of Waterloo are focused on the importance of terrestrial invertebrates and riparian vegetation for feeding; the relationship between temperature and spawning timing; a fecundity analysis; and, the presence of parasites in Silver Shiner during the reproductive period, and potential implications of this (A. Drake, DFO, pers. comm. 2021). Finally, in the last few years, many projects for shoreline and instream works have been redesigned as a mitigation approach in areas of Silver Shiner occurrence.

Single- and multi-species recovery strategies and management plans have been developed for a variety of fish and mussel species at risk in Ontario, the distributions of which partly overlap with Silver Shiner. Recovery teams for these species are currently engaged in the implementation of recovery actions within these watersheds that will benefit Silver Shiner, and include, but are not limited to, the following species:

- Redside Dace (*Clinostomus elongatus*)
- River Redhorse (*Moxostoma carinatum*)
- Gravel Chub (*Erimystax x-punctatus*)
- Northern Madtom (*Noturus stigmosus*)
- Eastern Sand Darter (*Ammocrypta pellucida*) (Ontario populations)
- Northern Brook Lamprey (*Ichthyomyzon fossor*) (Great Lakes-Upper St. Lawrence populations)
- Fawnsfoot (*Truncilla donaciformis*)
- Kidneyshell (*Ptychobranchus fasciolaris*)
- Lilliput (*Toxolasma parvum*)
- Rainbow (*Villosa iris*)

- Round Hickorynut (*Obovaria subrotunda*)
- Round Pigtoe (*Pleurobema sintoxia*)
- Threehorn Wartyback (*Obliquaria reflexa*)
- Wavyrayed Lampmussel (*Lampsilis fasciola*)

Ecosystem-based recovery strategies that include Silver Shiner are:

- Thames River Recovery Strategy (Thames River Recovery Team 2005)
- Recovery Strategy for Fish Species at Risk in the Grand River in Canada (Portt et al. 2007)

Conservation authorities (Conservation Halton, Grand River, Upper Thames River, and Lower Thames Valley) continue to play a vital role in stewardship and public education programs that have resulted in increased awareness of species at risk and improvements to habitat and water quality throughout the range of Silver Shiner in Ontario.

7.2 Measures to be taken to implement the recovery strategy and action plan

Successful recovery of this species is dependent on the actions of many different jurisdictions. It requires the commitment and cooperation of the constituencies that will be involved in implementing the directions and measures set out in this recovery strategy and action plan.

This recovery strategy and action plan provides a description of the measures that provide the best chance of achieving the population and distribution objectives for Silver Shiner, including measures to be taken to address threats to the species and monitor its recovery, to guide not only activities to be undertaken by DFO, but those for which other jurisdictions, organizations and individuals have a role to play. As new information becomes available, these measures and the priority of these measures may change. DFO strongly encourages all Canadians to participate in the conservation of Silver Shiner by undertaking measures outlined in this recovery strategy and action plan.

Table 4 identifies the measures to be undertaken by DFO to support the recovery of Silver Shiner. Table 5 identifies the measures to be undertaken collaboratively between DFO and its partners, other agencies, organizations or individuals. Implementation of these measures will be dependent on a collaborative approach, in which DFO is a partner in recovery efforts, but cannot implement the measures alone. As all Canadians are invited to join in supporting and implementing this recovery strategy and action plan, table 6 identifies the measures that represent opportunities for other jurisdictions, organizations or individuals to lead for the recovery of the species. If your organization is interested in participating in one of these measures, please contact the Species at Risk Ontario and Prairie office.

Federal funding programs for species at risk that may provide opportunities to obtain funding to carry out some of the outlined activities include the Habitat Stewardship Program for Species at Risk (HSP), the Aboriginal Fund for Species at Risk, and the Canada Nature Fund for Aquatic Species at Risk (CNFASAR).

The measures included in this recovery strategy and action plan to be implemented by DFO will be subject to the availability of funding and other required resources. As indicated in the tables below, partnerships with specific organizations will provide expertise and capacity to carry out

some of the listed recovery measures. However, the identification of partners is intended to be advice to other jurisdictions and organizations and carrying out these actions will be subject to each group's priorities and budgetary constraints.

Table 4. Measures to be undertaken by Fisheries and Oceans Canada (DFO) to support the recovery of Silver Shiner.

#	Recovery measure	Broad strategy	Approach	Priority[8]	Threat(s) or concern(s) addressed	Status/ timeline[9]
1	Perform threat evaluation research to inform priorities for individual populations at the watershed scale. Consider developing spatial inventories of threat inputs to to allow analysis of cumulative effects.	Research	Threat evaluation	High	All	New/3 to 5 years
2	Conduct flow-needs assessments related to flood control and low-flow augmentation to determine how water level fluctuations affect all life stages of Silver Shiner. This research will inform water level management to mitigate impacts on Silver Shiner (for example, adopt minimum low-flow level recommendations during sensitive life-history stages such as spawning).	Research	Threat evaluation	Medium	Flow modification	New/3 to 5 years
3	Investigate the impacts of threats to Silver Shiner, such as non-native species interactions/competition with the Silver Shiner (for example, Brown Trout), and barriers to movement.	Research	Threat evaluation	Medium	All	New/3 to 5 years
4	Work with municipal planning authorities to encourage the protection of critical habitat for Silver Shiner within official plans. Recommend consideration of Silver Shiner's needs when developing projects at the design stage (that is, proponents) and when issuing permits (that is, resource managers).	Management and coordination	Coordination of activities	High	All	Ongoing

[8] "Priority" reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

- "high" priority measures are considered likely to have an immediate and/or direct influence on the recovery of the species
- "medium" priority measures are important but considered to have an indirect or less immediate influence on the recovery of the species
- "low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

[9] Timeline reflects the amount of time required for the measure to be completed from the time the recovery strategy and action plan is published as final on the Species at Risk Public Registry.

Table 5. Measures to be undertaken collaboratively between Fisheries and Oceans Canada (DFO) and its partners to support the recovery of Silver Shiner.

#	Recovery measure	Broad strategy	Approach	Priority[10]	Threat(s) or concern(s) addressed	Status/ timeline	Lead and partner(s)[11]
5	Develop a standardized index population and habitat monitoring program with a specific sampling and training protocol (to inform recovery measure 10).	Research	Standardized population and habitat monitoring program	High	All	New/1 to 2 years	DFO, MECP
6	Determine the life history of the Silver Shiner (for example, fecundity) to inform critical habitat identification and improve modelling efforts designed to determine quantifiable recovery targets.	Research	Life-history characteristics	High	All	Underway /4 to 5 years	DFO, MECP, conservation authorities, academia
7	If necessary (should natural re-colonization fail), investigate the feasibility of artificial propagation versus wild fish transfers for Silver Shiner repatriations.	Research	Repatriations (artificial rearing and translocations)	Low	All	New/2 to 3 years	DFO, MECP, conservation authorities, academia
8	Promote the integration of Silver Shiner recovery and protection into existing watershed plans.	Management and coordination	Coordination of activities	High	All	Ongoing	DFO, MECP, conservation authorities, academia, FGR

[10] ”Priority” reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

- "high" priority measures are considered likely to have an immediate and/or direct influence on the recovery of the species
- "medium" priority measures are important but considered to have an indirect or less immediate influence on the recovery of the species
- "low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

[11] MECP: Ministry of the Environment, Conservation and Parks; FGR: Friends of the Grand River

#	Recovery measure	Broad strategy	Approach	Priority[10]	Threat(s) or concern(s) addressed	Status/ timeline	Lead and partner(s)[11]
9	Involve local residents, partners, Indigenous groups, and appropriate agencies and groups in habitat improvement and threat mitigation activities.	Management and coordination	Coordination of activities	High	All	Ongoing	DFO, conservation authorities, FGR
10	Implement a standardized index population and habitat monitoring program with a specific sampling and training protocol.	Inventory and monitoring	Standardized population and habitat monitoring program	High	All	New/1 to 2 years	DFO, MECP, conservation authorities
11	Conduct targeted surveys of extant populations (for example, Saugeen River) using gear types proven effective at detecting Silver Shiner.	Inventory and monitoring	Assessment	High	Knowledge gaps	New/1 to 2 years	DFO, MECP, conservation authorities
12	Conduct targeted surveys at historical Silver Shiner locations (for example, Laurel Creek) using gear types proven effective at detecting the species.	Inventory and monitoring	Assessment	High	Knowledge gaps	New/2 to 3 years	DFO, MECP, conservation authorities
13	Conduct targeted surveys for undetected populations in areas with suitable habitat.	Inventory and monitoring	Assessment	Low	Knowledge gaps	New/3 to 4 years	DFO, MECP, conservation authorities
14	Monitor watersheds where Silver Shiner is present for invasive species of concern.	Inventory and monitoring	Invasive species monitoring	Medium	Invasive species	Ongoing	DFO, MECP, conservation authorities, FGR
15	Promote stewardship among landowners and Indigenous groups abutting aquatic habitats of Silver Shiner, and other local landowners with potential to have direct or indirect effects on the habitat of Silver Shiner.	Stewardship and outreach	Stewardship, habitat improvement	High	All	Ongoing	DFO, MECP, conservation authorities, FGR

#	Recovery measure	Broad strategy	Approach	Priority[10]	Threat(s) or concern(s) addressed	Status/ timeline	Lead and partner(s)[11]
16	Increase public awareness about potential impacts of invasive species on the ecosystem, including Silver Shiner and encourage the use of existing invasive species reporting systems.	Stewardship and outreach	Awareness	Medium	Invasive species	Ongoing	DFO, MECP, conservation authorities, FGR
17	Increase awareness of local bait harvesters about Silver Shiner and educate them on distinguishing it from similar species (for example, Emerald Shiner and Rosyface Shiner). Request voluntary avoidance of occupied Silver Shiner areas, and immediate release of Silver Shiner if incidentally caught, as defined under the Ontario Fishery Regulations (OMNRF 2019).	Stewardship and outreach	Awareness	Low	Incidental harvest	Ongoing	DFO, MECP, conservation authorities, FGR

Table 6. Measures that represent opportunities for other jurisdictions, organizations or individuals to lead to support the recovery of Silver Shiner.

#	Recovery measure	Broad strategy	Approach	Priority[12]	Threat(s) or concern(s) addressed	Potential/ confirmed jurisdictions or organizations[13]
18	Implement local stewardship programs to improve habitat conditions and reduce threats within critical habitat and other occupied habitats. Priorities and mitigation approaches to be informed through threat evaluation research. Identify existing habitat that would benefit from specific threat mitigation or other habitat improvement activities; undertake threat mitigation and/or habitat improvements to the extent possible and monitor results.	Stewardship and outreach	Habitat improvement	High	All threats	Conservation authorities, FGR
19	Address watershed-scale stressors to Silver Shiner populations and their habitat in cooperation with existing relevant aquatic ecosystem recovery teams.	Stewardship and outreach	Habitat improvement	High	All threats	Conservation authorities, FGR
20	Encourage public support and participation in the recovery of Silver Shiner by developing awareness materials and programs.	Stewardship and outreach	Awareness	Medium	All	Conservation authorities, FGR

[12] ”Priority” reflects the degree to which the measure contributes directly to the recovery of the species or is an essential precursor to a measure that contributes to the recovery of the species:

- "high" priority measures are considered likely to have an immediate and/or direct influence on the recovery of the species
- "medium" priority measures are important but considered to have an indirect or less immediate influence on the recovery of the species
- "low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

[13] FGR: Friends of the Grand River

7.3 Narrative to support the recovery planning and implementation tables

Recovery measures 1 to 3 (threat evaluation): Many of the threats (table 3) facing the Silver Shiner can be classified as widespread and chronic and represent general ecosystem threats affecting many other aquatic species (for example, see species listed in section 7.1). Efforts to remediate these threats will benefit many species in addition to Silver Shiner. Eastern Sand Darter, a threatened species, has been shown to co-occur with Silver Shiner and efforts to improve water clarity, for example, would likely benefit both species (Lamothe et al. 2019). Specific needs include defining tolerances to physical alterations (for example, susceptibility to changes in flow regimes and sedimentation rates). A variety of potential threats to Silver Shiner populations were identified in the COSEWIC report (COSEWIC 2011) and by species' experts (Bouvier et al. 2013). In particular, urbanization has been shown to reduce growth and survival of Silver Shiner (Burbank et al. 2021); however, the underlying threats are not well understood. Continued appraisal of contaminant impacts on Silver Shiner is necessary as the establishment of causal links between a decline and specific contaminants has yet to be achieved. The status, certainty, and cumulative effects of these threats should be confirmed throughout the species' distribution to ensure that appropriate and defensible recovery actions are undertaken.

The negative impacts of invasive species on Silver Shiner populations at multiple life stages requires investigation. This includes competition for food and space, loss of or alteration to critical habitat, as well as predation. Given the fact that new species (for example, Central Stoneroller, Black Crappie, and Round Goby) have already invaded and/or been introduced in all three watersheds where Silver Shiner occurs, it is critical to determine specifically how these new species are interacting with Silver Shiner. In addition, the potential negative impacts of non-native sport fishes (for example, Brown Trout and Rainbow Trout [*Oncorhynchus mykiss*]), requires further evaluation.

Recovery measure 5 (standardized population and habitat monitoring program): Sampling experiments to develop standardized methods to determine density and demographic information that will allow valid temporal analysis are required. The fish monitoring protocol should consider the methodologies used in background survey work and provide guidance on the time of sampling and the types of biological samples that should be collected (for example, scales, length, weight). For example, Silver Shiner appears to be captured more effectively via seine as compared to electrofishing methods (Baldwin 1983). The use of a standardized sampling protocol will allow for increased comparability among locations and over time when implemented.

Recovery measure 6 (life-history characteristics): Determination of the life history of the Silver Shiner is required to inform critical habitat determination and allow for clear focus of recovery planning and actions. Of particular importance to improving modelling efforts designed to ascertain quantifiable recovery targets, is determination of fecundity and survival rates during the first year. Research has been initiated that will characterize the fecundity of Silver Shiner (A. Drake, DFO, pers. comm., 2021) and early results from this research suggest fecundity estimates ranging from 311 – 2768 eggs (DFO and University of Waterloo, unpubl. data).

Recovery measure 7 (repatriations [artificial rearing and translocations]): The potential for supplementation as a tool for Silver Shiner recovery needs to be investigated should natural re-colonization from currently occupied to historically occupied reaches not occur. This might include the rearing of specimens within aquaculture facilities, or alternatively, the transfer of wild

fish specimens from a stable donor population. Donor populations should be carefully selected to ensure that translocated individuals are likely to experience adequate fitness relative to their new environment.

Recovery measures 4, 8 to 10 (coordination of activities): Many of the threats affecting Silver Shiner populations are similar to those affecting other aquatic species. Therefore, efforts to remediate these threats should be done in close connection with other recovery teams and relevant groups to eliminate duplication of efforts. Similarly, working relationships with Indigenous groups, municipal planners, wastewater treatment facility operators, etc. will help to provide further protection and or restoration for Silver Shiner.

Recovery measures 11 to 13 (assessment): Key first steps in recovery planning are to determine the current distribution and estimate the abundance of Silver Shiner in Canada. Further sampling is required to better understand all known extant populations and to detect new records in areas with the greatest potential for Silver Shiner habitat (for example, other reaches of currently occupied river systems). Sampling in Fanshawe Lake, Fish, Laurel, Schneider, Silver, and Whitemans creeks, Saugeen River, Sixteen Mile Creek between the Queen Elizabeth Highway and Dundas Street, and upper portions of the Grand River, is required to ascertain the status of the species at these locations.

Recovery measures 15, 18 and 19 (stewardship, habitat improvement): Threats and habitat degradation present at extant sites should be evaluated to determine if they pose immediate or long-term risks of extirpation. Where specific habitat restoration activities or threat mitigation options are available, they should be pursued and monitored for success. In all likelihood, the Silver Shiner is sensitive to poor water quality. Supporting stewardship activities, such as planting, leaving riparian buffer strips, restricting livestock access to streams, preventing untreated or under-treated sewage or manure run-off into waterways, and minimizing chemical and fertilizer applications to lands adjacent to waterways, would maintain or improve water quality in Silver Shiner habitats. Best Management Practices (BMPs) represent a good tool to provide clear direction for improved methods of operation for industries, such as agriculture or forestry. To be effective, BMPs should target primary threats affecting currently occupied habitat and, in particular, critical habitat. Once threats have been evaluated for extant populations, the results will inform local stewardship programs for threat mitigation. As with other fishes, measures to improve habitat for Silver Shiner may include stewardship actions involving BMPs for agricultural properties (Ontario Ministry of Agriculture, Food and Rural Affairs [OMAFRA] 2016) and residential properties (School of Environmental Design and Rural Development 2007) within the catchment areas of the critical habitat identified. The stewardship activities outlined here represent a non-exhaustive selection of activities that can be encouraged within these predominantly agricultural watersheds to help reduce the impacts of terrestrial practices on aquatic ecosystems.

Recovery measures 16, 17 and 20 (awareness): Public participation in the recovery process for Silver Shiner is essential as the primary threat to its populations result from diffuse non-point source inputs relating to the general agricultural and urban activities within these watersheds. Recovery cannot occur without the full participation of local citizens and landowners. This high priority action should occur prior to, or concurrent with, all subsequent communications and public outreach-type recovery activities, including any printed materials. Where appropriate, a multi-species communication approach will be applied to increase efficiency.

Various organizations have already undertaken public education efforts to prevent the further spread of invasive species. Duplicating efforts or competing for funding are counterproductive;

instead, DFO will support and encourage the continuance of these education efforts as they also support Silver Shiner recovery.

8 Critical habitat

8.1 Identification of Silver Shiner critical habitat

8.1.1 General description of Silver Shiner critical habitat

Critical habitat is defined in SARA as "…the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species." [subsection 2(1)]

Also, SARA defines habitat for aquatic species as "… spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced." [subsection 2(1)]

For Silver Shiner, critical habitat is identified to the extent possible, using the best available information, and provides the functions and features necessary to support the species' life-cycle processes and to achieve the species' population and distribution objectives.

This recovery strategy and action plan identifies critical habitat for Silver Shiner as run, riffle or pool areas in streams with slow to moderate flow for juveniles and moderate to fast flow for adults within the Thames River (including the Avon River, Black Creek, Dingman Creek, Fish Creek, Medway Creek, Middle Thames River, North Thames River, Oxbow Creek, South Thames River, Stoney Creek, Trout Creek, Whirl Creek, and Wye Creek), Grand River (including the Conestogo River and Nith River), Bronte Creek, and Sixteen Mile Creek (including East Sixteen Mile Creek).

Critical habitat includes the entire 'bankfull' channel width, the meander belt width and the riparian vegetation within it, and associated 30 m of riparian vegetation* extending from the meander belt width. The exception to this is for watercourses that are classed as municipal drains (under the Ontario *Drainage Act*) and that have had previous channel realignment work conducted. In this case, critical habitat includes the entire bankfull channel width as well as 30 m of riparian vegetation on each side of the bankfull channel (meander belt is not included).

*riparian vegetation does not include existing anthropogenic impervious surfaces.

It is unknown if the critical habitat identified in this recovery strategy and action plan is sufficient to achieve the species' population and distribution objectives. The schedule of studies outlines the research required to acquire more detailed information about the critical habitat identified to achieve the species' population and distribution objectives.

8.1.2 Information and methods used to identify critical habitat

Within the streams currently occupied by Silver Shiner, an ecological classification system was used in the identification of critical habitat. The OMNRF's Aquatic Resource Areas (ARA) mapping was used as the base unit for defining stream reaches. ARAs are aggregations of stream segments with similar physical and biological characteristics. Therefore, if the species has been found in one part of an ARA, it would be reasonable to expect that it would be present in other spatially contiguous areas of the same stream segment. While ARA segments generally represented relatively homogenous habitat conditions, an exception was noted in the Thames River and Grand River. In the case of the Grand River, the very long ARA segment was broken at the point where stream gradient flattens out by using river gradient profiles to exclude the lower reaches of the river below Cayuga. In the Thames River, a single ARA segment extended from upstream of London down to Lake St. Clair. In this case, the segment was broken at Melbourne Road, as it is around this area that the physiography changes from a sand plain to a clay plain, resulting in habitat conditions that are less suitable for Silver Shiner.

Within all identified stream segments, critical habitat consists of: the bankfull channel width[14], the meander belt width of the stream and the riparian vegetation within it, and associated riparian vegetation extending 30 m from the meander belt[15] width (measured horizontally) (figure 4). The inclusion of the meander belt width and associated riparian vegetation recognizes the naturally dynamic nature of riverine systems (stream channels move within the meander belt over time) and the importance of riparian areas to highly sensitive stream ecosystems that support Silver Shiner. This is consistent with guidance provided in the Canadian Science Advisory Secretariat (CSAS) research document: "Review of Information to Guide the Identification of Critical Habitat in the Riparian Zone for Listed Freshwater Fishes and Mussels" (Caskenette et al. 2020). Caskenette et al. (2020) state that riparian features should be considered critical habitat when they: 1) are necessary to maintain aquatic features and/or water quality attributes of aquatic features identified as critical habitat; and/or, 2) support the life-cycle functions necessary for the survival or recovery of listed freshwater fishes and mussel species or their host species. The inclusion of the riparian vegetation is also consistent with science-based guidelines developed for guiding habitat rehabilitation in Great Lakes Areas of Concern, which recommend a minimum of 30 m of naturally vegetated adjacent lands on both sides of the stream (Environment Canada 2004). Over the long term, the meander belt and riparian vegetation are essential to the maintenance of instream habitat attributes required to support the needs of Silver Shiner.

The exception to the above description is for reaches of municipal drains[16] (as classified under Ontario's *Drainage Act*) that have been previously channelized. In these cases, critical habitat includes the entire 'bankfull' channel width as well as 30 m of riparian vegetation on each side of the bankfull channel (the meander belt is not included). Note that although these watercourses are classified as municipal drains, the majority of them are essentially natural systems and the likelihood of maintenance being required in these areas is low.

[14] Bankfull stream width is the width of the stream or river at bankfull discharge, which is the flow at which water begins to leave the channel and move into the floodplain.
[15] The meander belt is the land area on either side of a watercourse representing the furthest potential limit of channel migration. Areas within the meander belt may someday be occupied by the watercourse; areas outside of the meander belt will not.
[16] For more information on municipal drains see (Kavanagh et al. 2017).

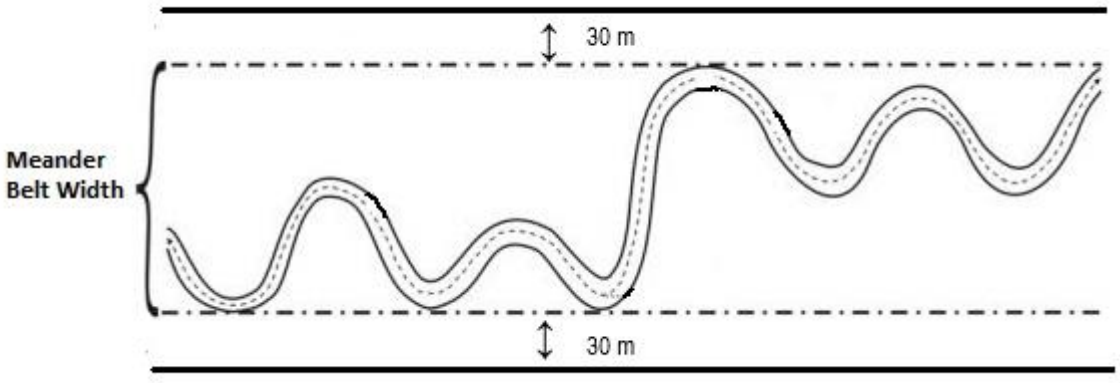

Figure 4. Diagram illustrating meander belt width plus 30 m riparian vegetation extending from the meander belt width (figure adapted from Parish Geomorphic [2001]).

8.1.3 Identification of critical habitat

Geographic information:

The areas delineated on the following maps (figures 5 to 9) represent the extent of critical habitat that can be identified at this time. Note that the areas delineated include the entire 'bankfull' channel width, the meander belt width and the riparian vegetation within it, and associated riparian vegetation extending 30 m from the meander belt width. The exception to this is areas classified as municipal drains under Ontario's *Drainage A*ct and that have had previous channel realignment work completed; in these cases, the areas delineated include the entire 'bankfull' channel width as well as 30 m of riparian vegetation on each side of the bankfull channel.

For Silver Shiner, critical habitat is identified in the Thames River (including the Avon River, Black Creek, Dingman Creek, Fish Creek, Medway Creek, Middle Thames River, North Thames River, Oxbow Creek, South Thames River, Stoney Creek, Trout Creek, Whirl Creek, and Wye Creek), Grand River (including the Conestogo River and Nith River), Bronte Creek, and Sixteen Mile Creek (including East Sixteen Mile Creek) (figures 5 to 9). Critical habitat for Silver Shiner has not been identified at this time in the Saugeen River as the species was only recently detected and further sampling is required to determine extent and status of the population; however, critical habitat may be identified at a future date should new information to support it become available.

The location(s) of the critical habitat's functions, features, and attributes have been identified using a bounding box. This means that the critical habitat is not comprised of the entire area within the identified boundaries but only those areas within the identified geographical boundaries (table 7) where the described biophysical feature and the function it supports occur, as described in table 8. The bounding box (that is, the area within which critical habitat is found) includes all contiguous ARA segments from the uppermost stream segment with Silver Shiner records (current and historical) to the lower most stream segment with Silver Shiner records (current and historical). In some cases, there may be some smaller ARA segments between the uppermost and lowermost segments that do not contain Silver Shiner records but given their proximity to segments that do contain records they were included. Table 7 provides the geographic coordinates that situate the boundaries within which critical habitat is found for Silver

Shiner; these points are indicated in figures 5 to 9. Explanations for the areas within which critical habitat is found (the area) are provided below.

Note that permanent anthropogenic structures that may be present within the delineated areas are specifically excluded; it is understood that maintenance or replacement of these features may be required at times.[17] Additionally, current agricultural production within the 30 m riparian zone may continue provided the function of the riparian zone is not diminished.

Thames River and tributaries: The area within the Thames River and its tributaries (figure 5 and 6) is described below; this represents a total river reach of approximately 360 km in length.

- North Thames River and tributaries (Whirl Creek, Black Creek, Avon River, Trout Creek, Fish Creek, Wye Creek, Stoney Creek, Medway Creek): In the North Thames River, beginning at Mitchell and continuing downstream to its confluence with the main stem of the Thames River; in Whirl Creek, beginning at Hwy 8 and continuing downstream to its confluence with the North Thames River at the south end of the town of Mitchell; in Black Creek, beginning at Hwy 8, and continuing downstream to its confluence with the North Thames River; in the Avon River, beginning in the city centre of Stratford and continuing downstream to its confluence with the North Thames River; in Trout Creek, beginning approximately 0.6 km downstream of Wildwood Lake and continuing downstream to its confluence with the North Thames River; in Fish Creek, beginning at Perth Rd. 151 and continuing downstream to its confluence with the North Thames River; in Wye Creek, beginning approximately 0.5 km upstream of Fairview Rd., and continuing downstream to its confluence with the North Thames River; in Stoney Creek, beginning approximately 2 km downstream of Highbury Ave. N. and continuing downstream to its confluence with the North Thames River; and, in Medway Creek, beginning approximately at Richmond St., near the town of Arva, and continuing downstream to its confluence with the North Thames River.

- Thames River and tributaries (Oxbow Creek, Dingman Creek): In the Thames River, beginning at the Pittock Dam in Woodstock and continuing downstream to the south boundary of the Chippewas of the Thames First Nation Indian Reserve where it crosses Melbourne Road; in the Middle Thames River beginning approximately 3 km upstream of 27th Line and continuing downstream to the confluence with the Thames River; in Oxbow Creek, beginning just upstream of Coldstream Rd. and continuing downstream to its confluence with the Thames River; and, in Dingman Creek, beginning approximately 2 km upstream of Wonderland Rd. S. and continuing downstream to its confluence with the Thames River.

Grand River and tributaries: The area identified within the Grand River and its tributaries (figures 7 and 8) is described below; this represents a total river reach of approximately 384 km in length.

- Grand River: In the Grand River, beginning at the Shand Dam at Lake Belwood and continuing downstream to the Town of Cayuga.

[17] Depending on the type of maintenance or replacement it is encouraged that an application for a permit be submitted before work is conducted, to assess potential impacts to adjacent critical habitat.

- Conestogo River: In the Conestogo River, beginning at Conestogo Dam and continuing downstream to its confluence with the Grand River.

- Nith River: In the Nith River, beginning in the town of New Hamburg and continuing downstream to its confluence with the Grand River.

Bronte Creek: The area within Bronte Creek (figure 9) is described below; this represents a total river reach of approximately 31 km in length.

- Beginning just upstream of Guelph Line near Lowville Park, and continuing downstream to the outlet at Lake Ontario.

Sixteen Mile Creek and East Sixteen Mile Creek: The area within Sixteen Mile Creek and East Sixteen Mile Creek (figure 9) is described below; this represents a total river reach of approximately 47 km in length.

- Sixteen Mile Creek: In Sixteen Mile Creek, beginning just upstream of Derry Rd. in Milton and continuing downstream to the outlet at Lake Ontario.

- East Sixteen Mile Creek: In East Sixteen Mile Creek, beginning approximately 3 km upstream of Derry Rd. and continuing downstream to the confluence with Sixteen Mile Creek.

The following critical habitat maps (figures 5 to 9) depict the areas within which critical habitat is found for the Silver Shiner. For the most up-to-date maps, please visit DFO's aquatic species at risk map webpage.

To assist with identifying the boundaries of the areas within which critical habitat is found, geo-referenced location points (P1, P2, P3, etc.; Decimal Degrees [WGS 1984]) have been added to the figures in addition to the red/purple areas. Coordinates for these points can be found in table 7. For more information, refer to the legend of each map or DFO's aquatic species at risk map webpage.

Table 7. Coordinates locating the boundaries within which critical habitat is found for Silver Shiner[1,2].

Location	Point 1 – Latitude	Point 1 – Longitude	Point 2 – Latitude	Point 2 – Longitude
Thames River	42.754937	-81.472519	-	-
Avon River	43.372612	-80.983700	-	-
Black Creek	43.405291	-81.057202	-	-
Dingman Creek	42.910403	-81.258627	-	-
Fish Creek	43.248259	-81.299412	-	-
Medway Creek	43.052782	-81.297166	-	-
Middle Thames River	43.115283	-80.942900	-	-
North Thames River	43.469587	-81.198129	-	-
Oxbow Creek	42.963246	-81.414979	-	-
South Thames River	43.148852	-80.760565	-	-
Stoney Creek	43.043953	-81.236847	-	-
Trout Creek	43.264781	-81.080561	-	-
Whirl Creek	43.446318	-81.148705	-	-
Wye Creek	43.123059	-81.146386	-	-
Grand River	42.948997	-79.861160	43.734413	-80.337055
Conestogo River	43.675568	-80.715904	-	-
Nith River	43.376998	-80.711158	-	-
Bronte Creek	43.393003	-79.706053	43.431277	-79.908933
Sixteen Mile Creek	43.439378	-79.665718	43.505987	-79.864672
East Sixteen Mile Creek	43.554900	-79.827001	-	-

[1] All coordinates obtained using map datum WGS84

[2] Riverine habitats are delineated to the midpoint of channel of the uppermost stream segment(s) and lowermost stream segment.

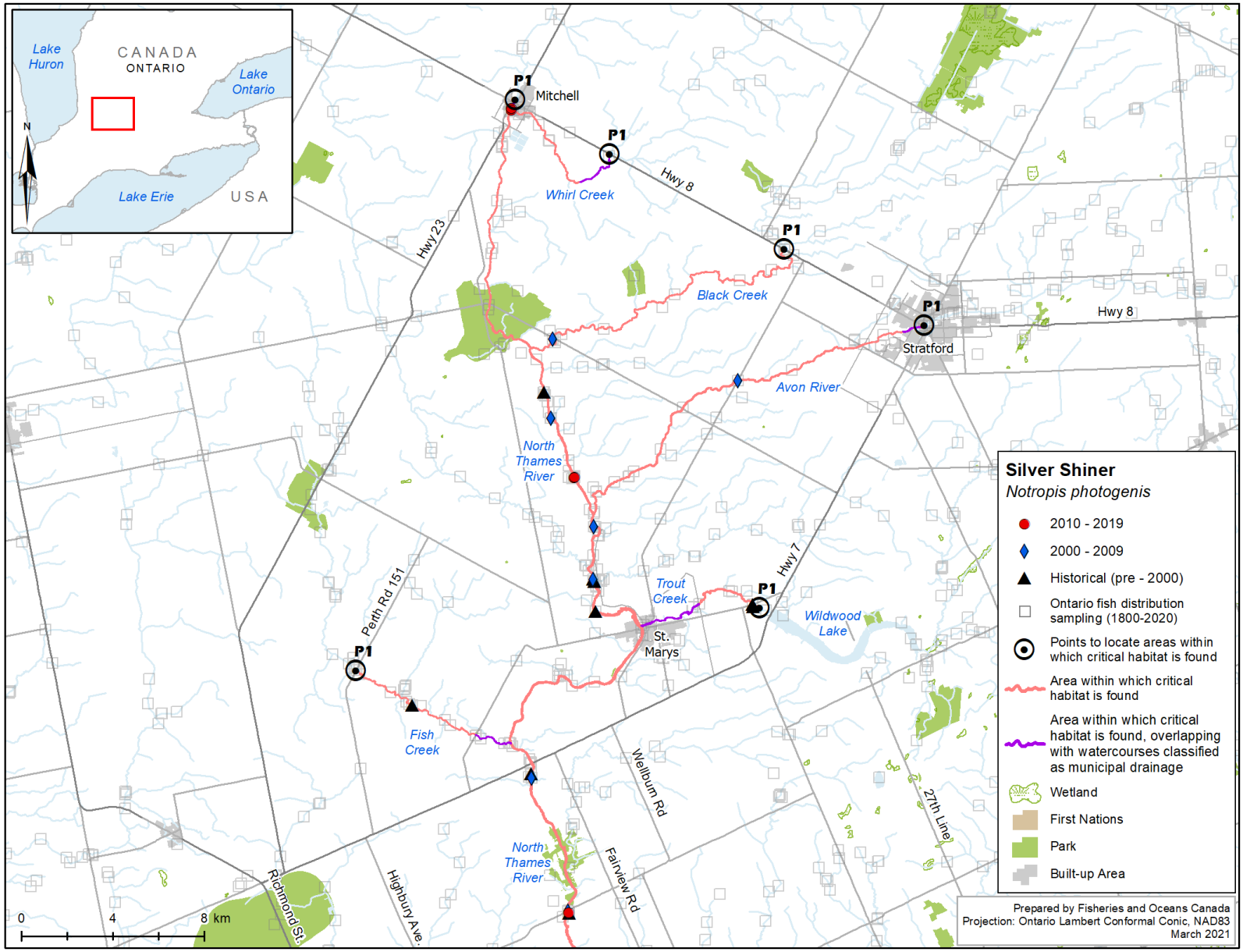

Figure 5. Area within which critical habitat is found for Silver Shiner in the North Thames River and tributaries. Note that the area delineated on the map is not all critical habitat; a site visit may be required to determine whether the features and attributes required to support the species' life functions are present (that is, the site contains critical habitat).

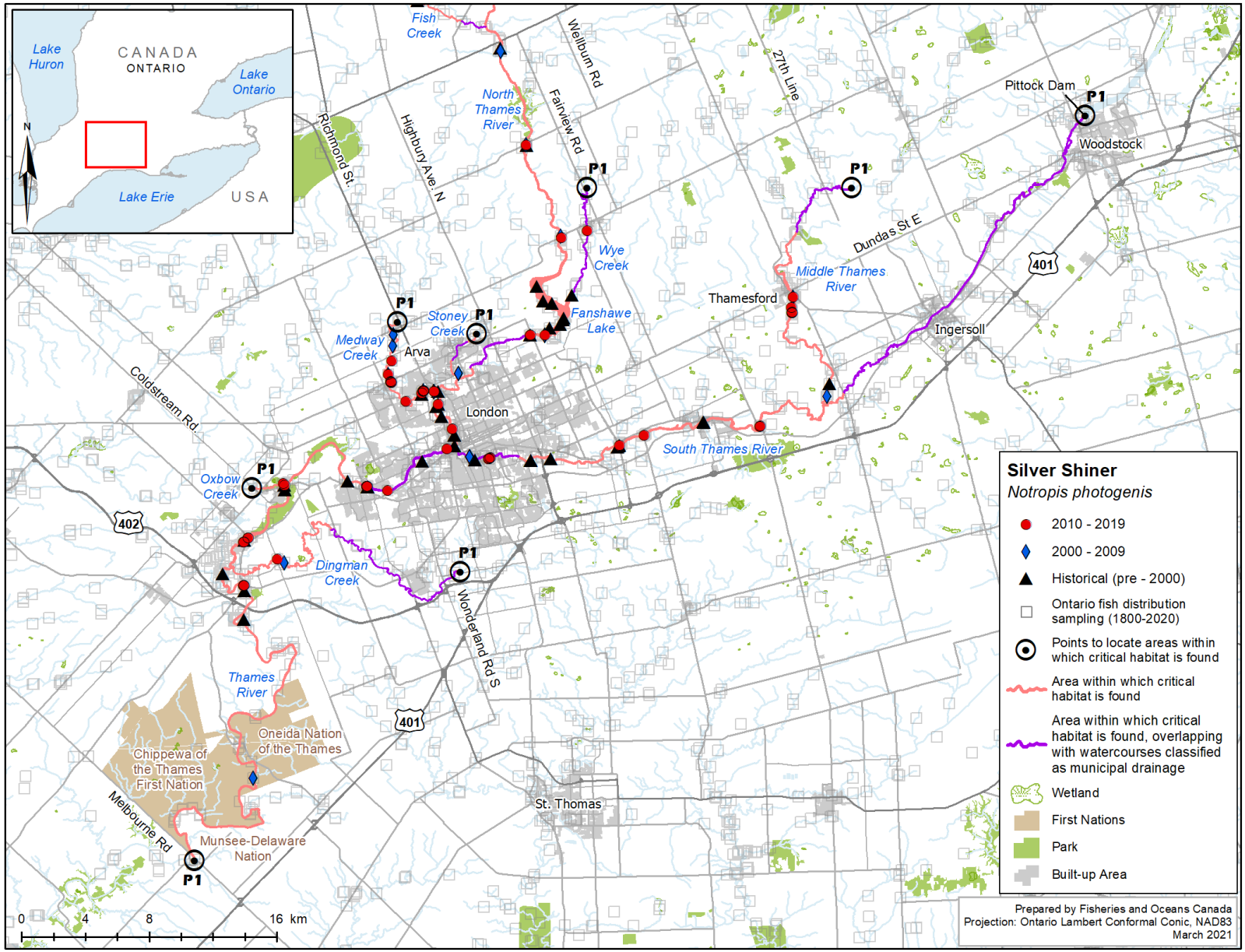

Figure 6. Area within which critical habitat is found for Silver Shiner in the Thames River and tributaries. Note that the area delineated on the map is not all critical habitat; a site visit may be required to determine whether the features and attributes required to support the species' life functions are present (that is, the site contains critical habitat).

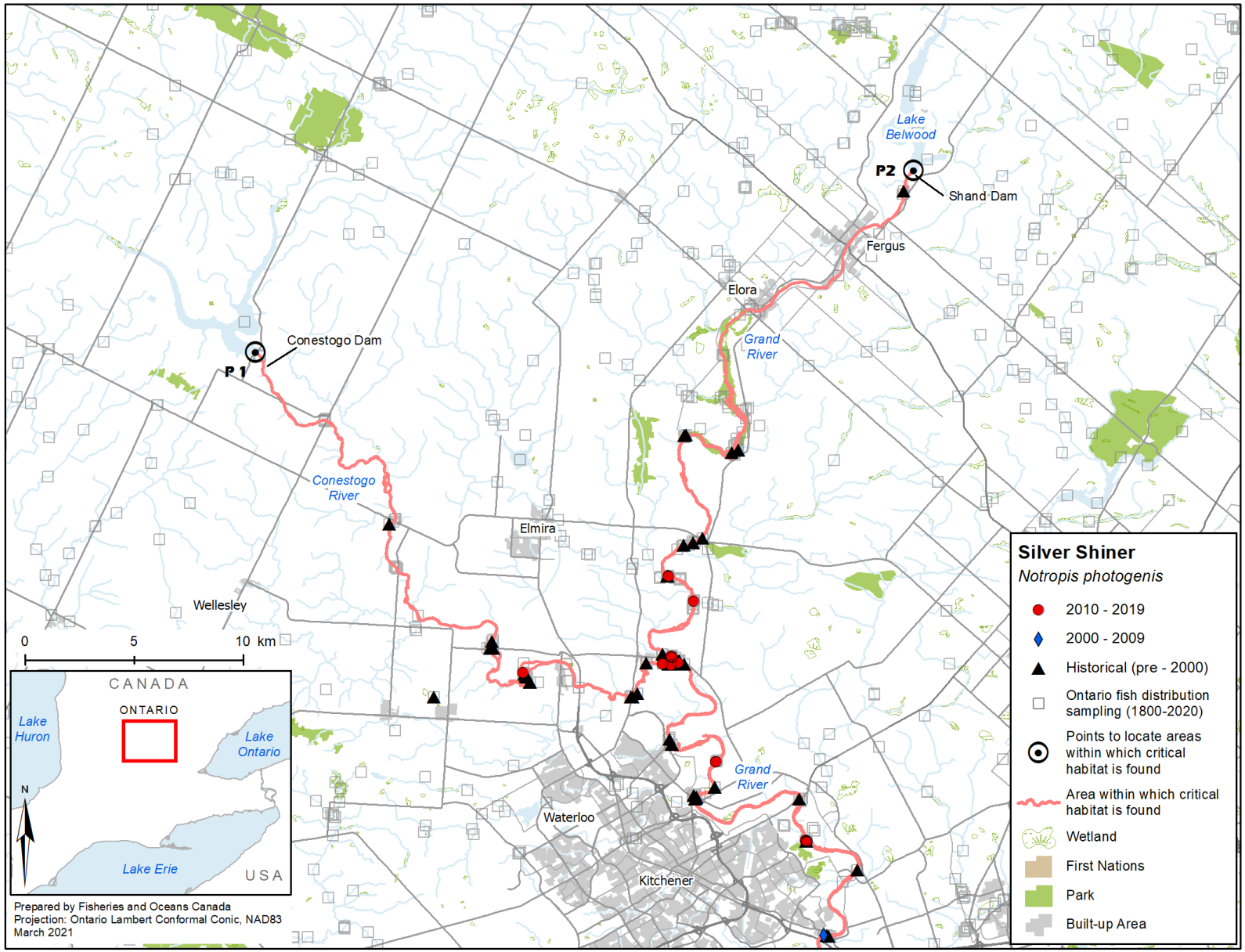

Figure 7. Area within which critical habitat is found for Silver Shiner in the Grand River and Conestogo River. Note that the area delineated on the map is not all critical habitat; a site visit may be required to determine whether the features and attributes required to support the species' life functions are present (that is, the site contains critical habitat).

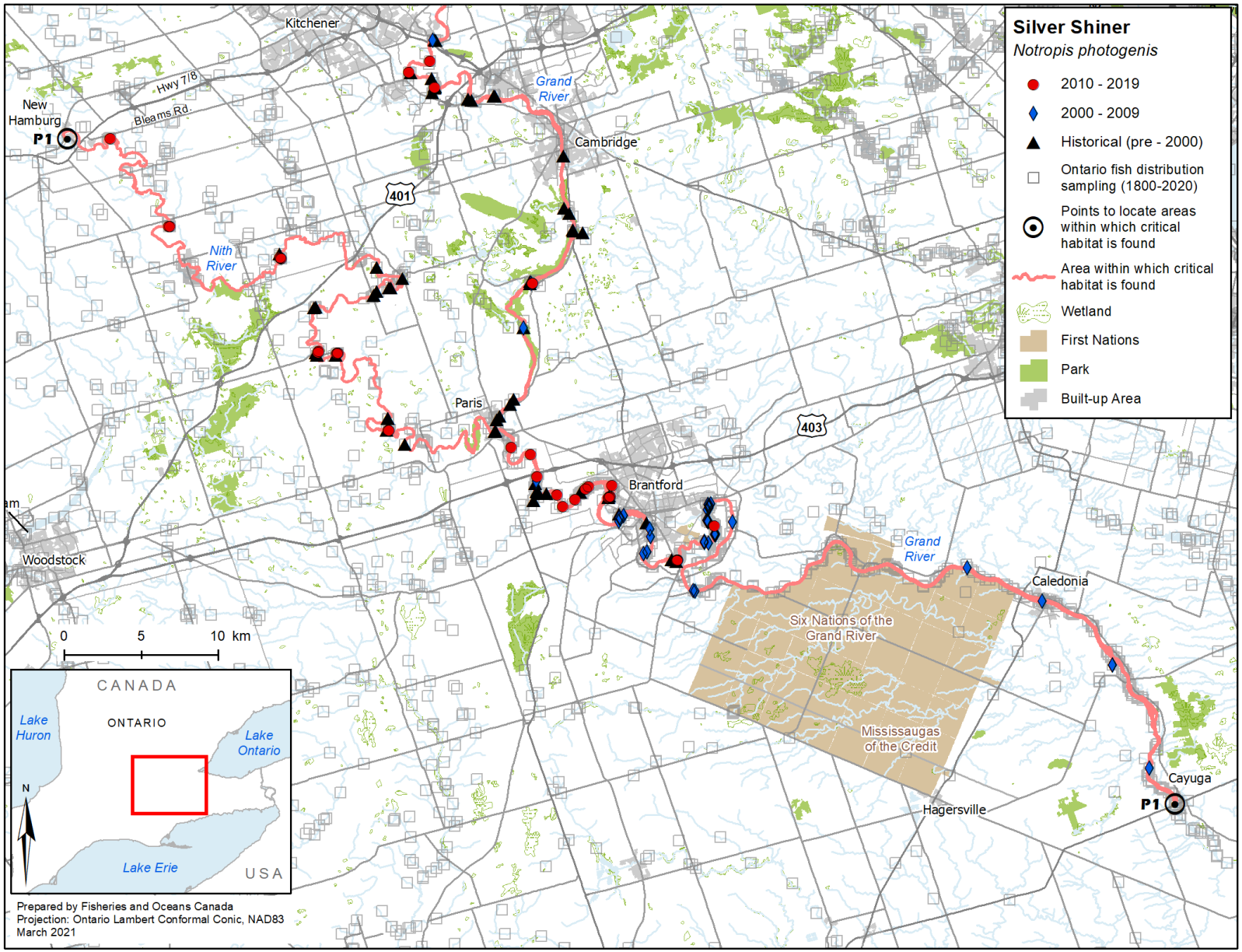

Figure 8. Area within which critical habitat is found for Silver Shiner in the Grand River and Nith River. Note that the area delineated on the map is not all critical habitat; a site visit may be required to determine whether the features and attributes required to support the species' life functions are present (that is, the site contains critical habitat).

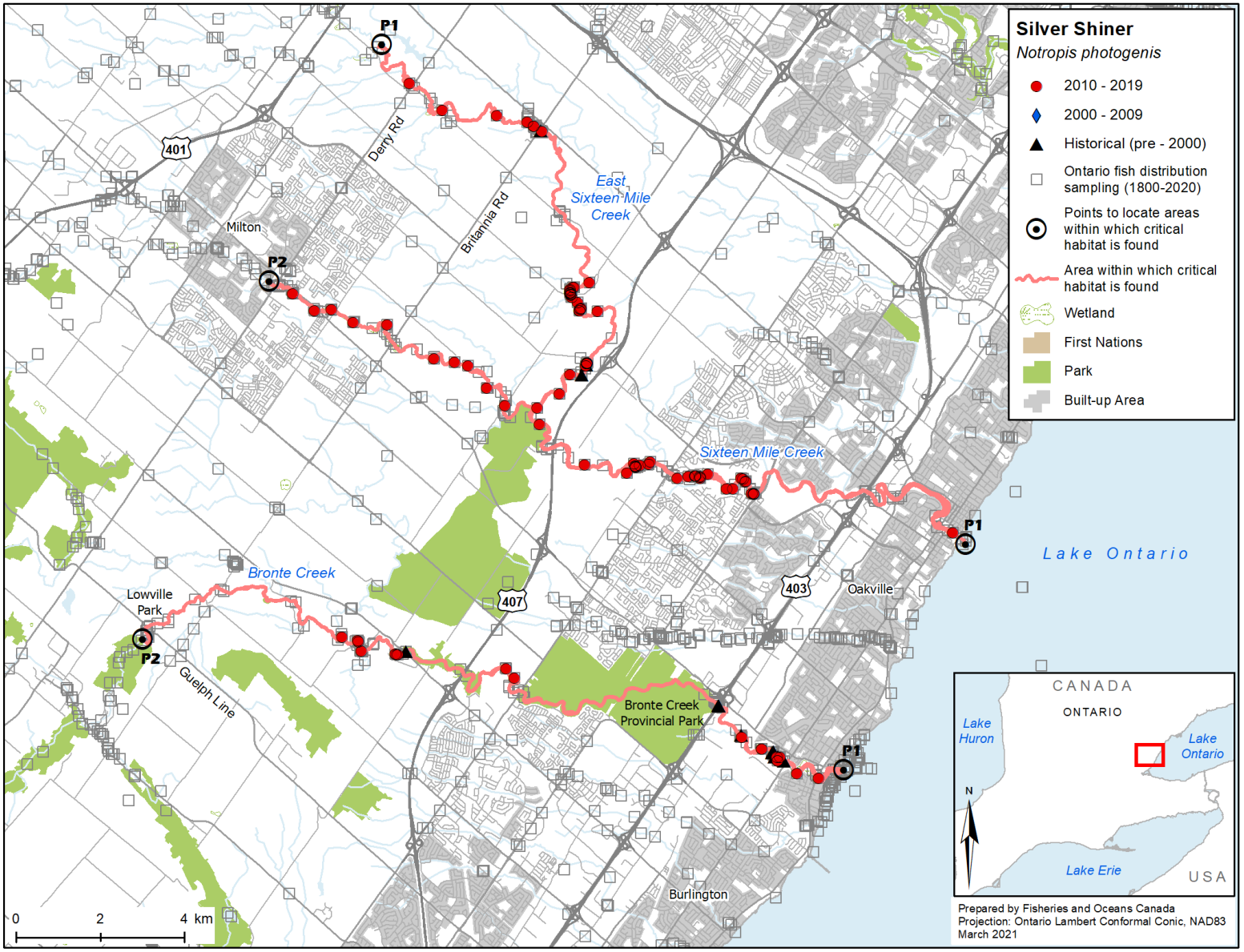

Figure 9. Area within which critical habitat is found for Silver Shiner in Bronte, Sixteen Mile, and East Sixteen Mile creeks. Note that the area delineated on the map is not all critical habitat; a site visit may be required to determine whether the features and attributes required to support the species' life functions are present (that is, the site contains critical habitat).

Biophysical functions, features, and attributes:

Table 8 summarizes the best available knowledge of the functions, features, and attributes for each life stage of the Silver Shiner (refer to section 4.3 needs of the Silver Shiner for full references). Note that not all attributes in table 8 must be present in order for a feature to be identified as critical habitat. If the features as described in table 8 are present and capable of supporting the associated function(s), the feature is considered critical habitat for the species, even though some of the associated attributes might be outside of the range indicated in the table.

Table 8. General summary of the biophysical functions, features, and attributes of critical habitat necessary for the Silver Shiner's survival or recovery (table adapted from DFO 2013).

Life stage	Function[18]	Feature(s)[19]	Attribute(s)[20]
Spawning	Reproduction (spawning occurs May through June)	Run, riffle or pool areas of streams	• Spawning thought to occur when water temperatures are between 11.6 and 24°C
Egg to juvenile	Nursery, feeding, cover	Same as above	• Larval Silver Shiner have been found in slack water areas adjacent to runs
Juvenile (<60 mm total length)	Feeding, cover	Run, riffle, or pool areas of streams with slow to moderate flow and little to no aquatic vegetation	• Attributes assumed to be same as for adults (see below)

[18] Function: A life-cycle process of the listed species taking place in critical habitat (for example, spawning, nursery, rearing, feeding and migration). The function informs the rationale for its protection. The identification of critical habitat must describe how the functions support a life process necessary for the survival or recovery of species at risk.

[19] Feature: Every function is the result of a single or multiple feature(s), which are the structural components of the critical habitat. Features describe the essential structural component that provides the requisite function(s) to meet the species' needs. Features may change over time and are usually comprised of more than one part, or attribute. A change or disruption to the feature or any of its attributes may affect the function and its ability to meet the biological needs of the species.

[20] Attribute: Attributes are measurable properties or characteristics of a feature. Attributes describe how the identified features support the identified functions necessary for the species' life processes. Together, the attributes allow the feature to support the function. In essence, attributes provide the greatest level of information about a feature, the quality of the feature and how the feature is able to support the life-cycle requirements of the species.

Life stage	Function[18]	Feature(s)[19]	Attribute(s)[20]
Adult (from age 1 [onset of sexual maturity])	Feeding, cover	Run, riffle, or pool areas of streams with moderate to fast flow and little to no aquatic vegetation	• 0.6 to 2.5 m; greater water depth positively correlated with Silver Shiner populations • Moderate to fast (0.25 to 0.49 m/s) flowing riffles, runs, and alternating pools • Sand or gravel substrate • Dissolved oxygen levels sufficient to support Silver Shiner • Aquatic and terrestrial insects, worms, crustaceans and phytoplankton
All life stages	Feeding, cover, maintenance of water quality	Riparian zone	• Aquatic insects • Terrestrial insects • 30 m of riparian vegetation, which provides suitable habitat for terrestrial insects, consequently leading to their availability
All life stages	Spawning, cover, nursery, maintenance of water quality	Meander belt[21,22]	• Area on either side of a watercourse representing the farthest potential limit of channel migration through time

Studies to further refine knowledge on the essential functions, features, and attributes for various life stages of the Silver Shiner are described in section 8.2 (schedule of studies to identify critical habitat).

Summary of critical habitat relative to population and distribution objectives:

Using the best available information, critical habitat has been identified for Silver Shiner populations in the following watercourses (figures 5 to 9):

1. Thames River and tributaries
2. Grand River and tributaries
3. Bronte Creek
4. Sixteen Mile Creek and East Sixteen Mile Creek

These are areas that, based on current best available information, the Minister of Fisheries and Oceans considers necessary to partially achieve the species' population and distribution objectives required for the survival and recovery of the species. Additional critical habitat may be identified in future updates to the recovery strategy and action plan.

[21] The meander belt is not included for watercourses that are classed as municipal drains under Ontario's *Drainage Act* and have had previous channel re-alignment work completed.
[22] The meander belt includes and maintains stream channel through time, and maintains channel morphology (which preserves riffle and pool sequences). The meander belt area includes all of the potential flow paths that the watercourse follows over time.

8.2 Schedule of studies to identify critical habitat

Further research is required to refine the understanding of the functions, features, and attributes of the currently identified critical habitat necessary to support the species' population and distribution objectives and protect the critical habitat from destruction. This additional work includes the studies found in table 9.

Table 9. Schedule of studies to refine critical habitat for the Silver Shiner.

Description of study	Outcome/rationale	Timeline[23],[24]
Refine the habitat requirements, including species movement, migration, and spawning, of all Silver Shiner life stages.	There is limited knowledge on habitat requirements of all life stages of Silver Shiner. Determining habitat requirements for each life stage will help identify the critical habitat for the entire life history of the species (for example, ongoing research to examine the importance of riparian vegetation and presence of terrestrial insects as critical habitat features).	3 to 5 years
Refine amount, configuration, and description of critical habitat required to achieve recovery objectives if adequate information exists.	Refinement of recovery objectives as well as critical habitat description to meet these objectives.	Ongoing
Determine the physiological tolerance of Silver Shiner with respect to various water quality parameters (for example, nutrients, contaminants, water temperature) and check against existing standards.	Will help to refine functions, features and attributes of critical habitat.	5 years
Identify thresholds of tolerance to habitat modifications (for example, loss of riparian vegetation).	Will help to refine functions, features, and attributes of critical habitat.	5 to 7 years

8.3 Examples of activities likely to result in the destruction of critical habitat

Under SARA, critical habitat must be legally protected from destruction within 180 days of being identified in a final recovery strategy or action plan. For Silver Shiner critical habitat, it is anticipated that this will be accomplished through a SARA Critical Habitat Order made under subsections 58(4) and (5), which will invoke the prohibition in subsection 58(1) against the destruction of the identified critical habitat.

The following examples of activities likely to result in the destruction[25] of critical habitat (table 10) are based on known human activities that are likely to occur in and around critical habitat

[23] Timeline reflects the amount of time required for the study to be completed from the time the recovery strategy and action plan is published as final on the Species at Risk Public Registry.
[24] Timelines are subject to change in response to demands on resources and/or personnel and as new priorities arise.

and would result in the destruction of critical habitat if unmitigated. The list of activities is neither exhaustive nor exclusive and has been guided by the threats described in section 5. The absence of a specific human activity from this table does not preclude or restrict the Department's ability to regulate that activity under SARA. Furthermore, the inclusion of an activity does not result in its automatic prohibition, and does not mean the activity will inevitably result in destruction of critical habitat. Every proposed activity must be assessed on a case-by-case basis and site-specific mitigation will be applied where it is reliable and available. Where information is available, thresholds and limits have been developed for critical habitat attributes to better inform management and regulatory decision making. However, in many cases knowledge of a species and its critical habitat's thresholds of tolerance to disturbance from human activities are lacking and must be acquired.

In the future, threshold values for some stressors may be informed through further research. For some of the above activities, BMPs may be enough to mitigate threats to the species and its habitat; however, in some cases, it is not known if BMPs are adequate to protect critical habitat and further research is required.

[25] Destruction occurs when there is a temporary or permanent loss of a function of critical habitat at a time when it is required by the species.

Table 10. Activities likely to result in the destruction of Silver Shiner critical habitat (partially adapted from DFO 2013).

Threat	Activity	Effect- pathway	Function affected	Feature affected	Attribute affected
Turbidity and sediment loading	• Altering flow regimes causing erosion and changing sediment transport (for example, tiling of agricultural drainage systems, removal of riparian zones) • Work in or around water with improper sediment and erosion control (for example, overland runoff from ploughed fields, use of industrial equipment, cleaning or maintenance of bridges or other structures)	Improper sediment and erosion control or mitigation can cause increased turbidity levels, changing preferred substrates and their oxygen levels, potentially reducing feeding success or prey availability and possibly excluding fishes from habitat due to physiological impacts of sediment in the water (for example, gill irritation).	Spawning, nursery, feeding, cover	Run, riffle or pools of streams with slow to fast flow	• 0.6 to 2.5 m water depth • Aquatic and terrestrial insects, worms, crustaceans and phytoplankton • Sand and gravel substrates
Contaminants and toxic substances	• Release of urban and agricultural pollution into habitat • Introduction of high levels of chloride through activities such as excessive salting of roads in winter	Introduction of toxic compounds (for example, fuel, oil, manure, chlorides) into habitat used by this species can change water quality affecting habitat availability or use and prey availability.	Same as above	Same as above	• Aquatic and terrestrial insects, worms, crustaceans and phytoplankton • Dissolved oxygen levels sufficient to support Silver Shiner

Threat	Activity	Effect- pathway	Function affected	Feature affected	Attribute affected
Nutrient loading	• Over-application of fertilizer and improper nutrient management (for example, organic debris management, wastewater management, animal waste, septic systems and municipal sewage)	Improper nutrient management can cause nutrient loading of nearby waterbodies. Elevated nutrient levels can cause increased aquatic plant growth changing water temperatures and slowly changing preferred flows and substrates. Dissolved oxygen levels can also be negatively affected. The availability of prey species can also be affected if prey are sensitive to organic pollution.	Same as above	Same as above	• 0.6 to 2.5 m water depth • Aquatic and terrestrial insects, worms, crustaceans and phytoplankton • Sand and gravel substrates • Moderate to fast (0.25 to 0.49 m/s) flowing riffles, runs, and alternating pools • Dissolved oxygen levels sufficient to support Silver Shiner
Barriers to movement	• Dams, barriers • Improperly installed culverts	Rapid, repeated and prolonged changes in water flow (increases or decreases) can have a negative effect on Silver Shiner habitat, especially spawning habitat. Large changes in water flow can cause significant sediment deposition (for example, changing preferred substrates) or changes in prey abundance. Barriers can restrict access to important habitat areas and fragment fish populations affecting distribution of Silver Shiner.	Same as above	Same as above	• 0.6 to 2.5 m water depth • Aquatic and terrestrial insects, worms, crustaceans and phytoplankton • Moderate to fast (0.25 to 0.49 m/s) flowing riffles, runs, and alternating pools • Sand and gravel substrates

9 Evaluation of socio-economic costs and benefits of the action plan

SARA requires that the action plan component of the recovery document[26] (action plan) include an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation (SARA 49(1)(e), 2003). This evaluation addresses only the incremental socio-economic costs of implementing this action plan from a national perspective as well as the social and environmental benefits that would occur if the action plan were implemented in its entirety, recognizing that not all aspects of its implementation are under the jurisdiction of the federal government. It does not address cumulative costs of species recovery in general nor does it attempt a cost-benefit analysis. Its intent is to inform the public and to guide decision making on implementation of the action plan by DFO and its partners.

The protection and recovery of species at risk can result in both benefits and costs. The Act recognizes that "wildlife, in all its forms, has value in and of itself and is valued by Canadians for aesthetic, cultural, spiritual, recreational, educational, historical, economic, medical, ecological, and scientific reasons" (SARA 2003). Self-sustaining and healthy ecosystems with their various elements in place, including species at risk, contribute positively to the livelihoods and the quality of life of all Canadians. A review of the literature confirms that Canadians value the preservation and conservation of species. Actions taken to preserve a species, such as habitat protection and restoration, are also valued. In addition, the more an action contributes to the recovery of a species, the higher the value the public places on such actions (Loomis and White 1996; DFO 2008). Furthermore, the conservation of species at risk is an important component of the Government of Canada's commitment to conserving biological diversity under the International Convention on Biological Diversity. The Government of Canada has also made a commitment to protect and recover species at risk through the Accord for the Protection of Species at Risk. An estimate of the costs and benefits associated with this action plan are described below.

This evaluation does not address the socio-economic impacts of protecting critical habitat for Silver Shiner. Under SARA, DFO must ensure that critical habitat identified in a recovery strategy or action plan is legally protected within 180 days of the final posting of the recovery document. Where a SARA Critical Habitat Order will be used for critical habitat protection, the development of the Order will follow a regulatory process in compliance with the Cabinet Directive on Regulatory Management, including an analysis of any potential incremental impacts of the Order that will be included in the Regulatory Impact Analysis Statement. As a consequence, no additional analysis of the critical habitat protection has been undertaken for the assessment of costs and benefits of the action plan.

[26] That is, tables 4 to 6 and section 9

9.1 Policy baseline

The policy baseline consists of protection under SARA for Silver Shiner (the species was listed under SARA as Threatened in 2019), along with continued protection under the federal *Fisheries Act* and Ontario's *Endangered Species Act*, 2007 (ESA 2007). Further protections may be afforded to Silver Shiner and its habitat under other provincial legislation[27].

The policy baseline also includes recovery measures that were implemented prior to and after Silver Shiner was listed under SARA. These recovery measures include recovery strategies and action plans for other freshwater species as well as multispecies ecosystem-based recovery programs discussed in section 7.1 of this report.

9.2 Socio-economic costs of implementing this action plan

The majority of the recovery activities identified in this action plan are short-term (within the next two years), medium-term (within the next five years), or ongoing. Most of these activities focus on research, monitoring, engagement, education, and management to reduce threats and to inform and promote species recovery. Some of the actions are one-time projects (for example, research), likely funded from existing federal government resources. Implementation of local stewardship actions would be supported by programs such as HSP and the CNFASAR. In addition, most programs require a level of direct or in-kind support costs from applicants as matching funds[28]. The costs (direct and in-kind) associated with these actions are estimated to be low[29] and spread over the next five years[30].

Costs would be incurred by the federal government to implement the activities listed in the action plan. In-kind costs, such as volunteer time, providing expertise and equipment, would be incurred as a result of implementing activities listed in the action plan. Costs (including in-kind support) could be incurred by the province of Ontario and conservation authorities.

Ongoing recovery activities will be developed through a cooperative approach following discussions between other agencies, levels of government, stewardship groups and stakeholders allowing for consideration of costs and benefits during the process.

9.3 Benefits of implementing this action plan

The benefits of recovery actions required to ensure viable and stable populations of Silver Shiner and to return the species to its full historical distribution outlined in this action plan are difficult to quantify but are expected to be low and would occur over the long term. If

[27] Examples of other provincial legislation that provide habitat protection include, but may not be limited to, considerations under section 2.1.7 of the Provincial Policy Statement (2014) under Ontario's *Planning Act*, which prohibits development and site alteration in habitat of endangered and threatened species, except in accordance with provincial and federal requirements, as well as protection under the *Lakes and Rivers Improvement Act* in Ontario.

[28] For example, matching funds for HSP can come from landowners and/or provincial funding programs. This helps leverage additional support for recovery actions.

[29] Low costs are defined as less than $1 million annually, as per the socio-economic cost categories in SARA Implementation Guide for Action Plans for Fisheries and Oceans Canada, May 2015.

[30] Future expenditures cannot be determined in great detail as it is expected these activities would continue to be funded through existing government funding, including HSP and CNFASAR, where support is determined on a priority basis and based on availability of resources.

implemented, local stewardship programs to improve habitat conditions and reduce threats within critical habitat could potentially help to improve habitat and water quality. Some unquantifiable non-market benefits may also result with the implementation of the recovery actions contained in the action plan. Research (Rudd et al. 2016) found that Canadian households had positive and significant willingness to pay values for recovery actions that led to improvements for little known species at risk in southern Ontario.

In the absence of information on biological outcomes of the measures identified in the action plan, it is not possible to estimate the incremental benefits that can be directly attributed to the implementation of the recovery measures.

9.4 Distributional impacts

Governments and conservation authorities are expected to incur the majority of costs of implementing the action plan. Partners who choose to participate in recovery measures will also incur costs [31].

The Canadian public will benefit from the implementation of the action plan through the protection and recovery of Silver Shiner populations, through the protection of the ecosystem, through the maintenance of biodiversity in Canada, and through increased scientific knowledge.

10 Measuring progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives. A successful recovery program will achieve the overall aim of recovering populations to a state where they are stable or increasing and demonstrably secure with low risk from known threats. Progress towards meeting these objectives will be reported in the report on the progress of recovery strategy implementation.

Performance indicators:

1. The continued presence of Silver Shiner throughout its current distribution by 2023
2. Population trajectories in Bronte Creek and Sixteen Mile Creek determined by 2028
3. Distribution of Silver Shiner in the Saugeen River confirmed by 2024
4. Silver Shiner detected in formerly unoccupied sites within historical range by 2032 (that is, evidence of expansion)

Reporting on the ecological and socio-economic impacts of the recovery strategy and action plan (under section 55 of SARA) will be done by assessing the implementation of the recovery strategy and action plan after five years. Many measures in this recovery strategy and action plan will increase our understanding of the species, its status, and the threats it faces, and over time will contribute to monitoring Silver Shiner in Canada. This monitoring information will be used to report on the performance indicators and progress towards recovery in future reports on the progress towards recovery strategy implementation.

The broader ecological impacts of the implementation of this recovery strategy and action plan have been considered in its development. To report on the ecological impacts of implementation

[31] This section estimates costs associated with implementing the action plan only; costs to be compliant with prohibitions and requirements resulting from listing or orders to protect critical habitat are assessed in Regulatory Impact Analysis Statements.

(under section 55 of SARA), monitoring data for other ecological components have been identified, and include water quality and quantity monitoring data for the watersheds where the species is found, where it exists. Additionally, other sensitive species with ranges that overlap that of Silver Shiner (for example, Eastern Sand Darter, Redside Dace) could be monitored to track their trajectories and to document changes to overall fish community composition and abundance.

Reporting on the socio-economic impacts of the recovery strategy and action plan (under section 55 of SARA) will be done by providing information on the costs incurred to implement the action plan.

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Appendix A: effects on the environment and other species

In accordance with the Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals (2010), the *Species at Risk Act* (SARA) recovery planning documents incorporate strategic environmental assessment (SEA) considerations throughout the document. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or achievement of any of the Federal Sustainable Development Strategy's goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

This recovery strategy and action plan will clearly benefit the environment by promoting the recovery of the Silver Shiner. In particular, it will encourage the protection and improvement of riverine habitats. These habitats support species at risk from many other taxa (including birds, reptiles, mussels and plants) and thus the implementation of recovery actions for Silver Shiner will contribute to the preservation of biodiversity in general. The potential for these recovery actions to inadvertently lead to adverse effects on other species was considered. The SEA concluded the implementation of this document will clearly benefit the environment and will not entail any significant adverse environmental effects.

Appendix B: record of cooperation and consultation

Recovery documents are to be prepared in cooperation and consultation with other jurisdictions, organizations, affected parties, and others as outlined in the *Species at Risk Act* (SARA) section 39 and 48. Fisheries and Oceans Canada has utilized a process of species expert/subject matter expert review to seek input to the development of this recovery strategy and action plan. Information on participation is included below.

Subject matter expert reviewers

Name	Affiliation
Rebecca Dolson	Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry
Andrew Drake	Fisheries and Oceans Canada
Andrea Dunn	Conservation Halton
Scott Gibson	Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry
Aurora McAllister	Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry
Scott Reid	Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry

Jurisdictional review

Affiliation
Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry / Ontario Ministry of Conservation, Environment, and Parks
Environment and Climate Change Canada
Parks Canada Agency

In addition, consultation on the draft recovery strategy and action plan occurred through letters sent to potentially impacted Indigenous groups. Additional stakeholder, Indigenous, and public input was sought through the publication of the proposed document on the Species at Risk Public Registry from January 20, 2021 to March 21, 2021. Comments received informed the final document.