

Management Plan for the Northern Sunfish (*Lepomis peltastes*), in Canada (Great Lakes – Upper St. Lawrence Populations)

Northern Sunfish



2023

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Preface

Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of a management plan for species listed as special concern and are required to report on progress 5 years after the publication of the final document on the Species at Risk Public Registry, and every subsequent 5 years, until its objectives have been achieved.

The Minister of Fisheries and Oceans and the Minister responsible for the Parks Canada Agency are the competent ministers under SARA for the Northern Sunfish, and Fisheries and Oceans Canada has prepared this management plan, as per section 65 of SARA. In preparing this management plan, the competent ministers have 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 wildlife 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 management plan has been prepared in cooperation with the Governments of Ontario and Quebec as per section 66(1) of SARA.

As stated in the preamble to SARA, success in the conservation of this species depends on the commitment and cooperation of many different groups that will be involved in implementing the directions and measures for the conservation of the species set out in this plan and will not be achieved by Fisheries and Oceans Canada and the Minister responsible for Parks Canada, 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 management plan for the benefit of the Northern Sunfish and Canadian society as a whole.

A SARA management plan includes measures for the conservation of the species of special concern to prevent it from becoming threatened or endangered. The competent ministers must prepare a management plan that includes measures for the conservation of the species that the ministers consider appropriate. These measures for the conservation of the species are set out to achieve the management objective identified in the management plan. Implementation of this plan is subject to priorities, and budgetary constraints of the participating jurisdictions and organizations.

Acknowledgements

The management plan was prepared by Jessica Epp-Martindale (Fisheries and Oceans Canada [DFO] Ontario and Prairie Region) and Joshua Stacey (DFO Ontario and Prairie Region), with the support of Patricia Desilets (DFO Quebec Region), France Pouliot (DFO Quebec Region), and Arianne Savoie (DFO Quebec Region). Mapping was produced by Adriana Rivas-Ruiz. To the extent possible, this management plan has been prepared with input from the Ontario Ministry of the Environment, Conservation and Parks and the Quebec Ministère des Ressources naturelles et des Forêts (MRNF). DFO would also like to express its appreciation to all individuals and organizations who have contributed to the conservation of the Northern Sunfish.

Executive summary

In 2016, the Committee of the Status of Endangered Wildlife in Canada (COSEWIC) split the Northern Sunfish populations into 2 designable units: 1) Great Lakes – Upper St. Lawrence

populations, and, 2) Saskatchewan – Nelson River populations. The Great Lakes – Upper St. Lawrence populations were assessed as special concern in Canada and listed on Schedule 1 of the *Species at Risk Act* in 2019. The COSEWIC designation was based on the species' decline with relatively small and likely patchy distribution. The Saskatchewan – Nelson River populations were assessed as not at risk. The content of this management plan is restricted to the Great Lakes – Upper St. Lawrence populations, which encompasses eastern and southern Ontario, and southern Quebec.

The Northern Sunfish is a member of the genus *Lepomis* in the Centrarchidae family. Previously, the Northern Sunfish was believed to be a subspecies of the Longear Sunfish. However, it is presently considered to be a full species distinct from the Longear Sunfish, which is not found in Canada. The Northern Sunfish typically grows to an average length of 80 mm, making it one of the smaller sunfish species found in Canada. It can be differentiated from other *Lepomis* species by its long opercular flap that angles upwards with a red/orange posterior margin. The global range of the Northern Sunfish is restricted to North America where it is found in the Mississippi River drainage basin, Great Lakes and St. Lawrence River system, and Nelson River drainage basin. This species has a disjunct distribution throughout most of its range in Canada, outside of southwestern Ontario where the majority of records exist. It occurs in northeastern Ontario, southern Ontario, eastern Ontario, and southern Quebec. The Northern Sunfish is found in clear waters of warm lakes, ponds, and watercourses, requiring gravel or cobble substrates for spawning.

The main threats (section 5) affecting the survival of Northern Sunfish are habitat degradation through siltation, and agricultural and urban pollution. Other lower impact threats include the effects of invasive species, and angling and bait fisheries.

The management objective (section 6) for Northern Sunfish is to maintain self-sustaining populations throughout its range in the Great Lakes and upper St. Lawrence River system to ensure the long-term viability of the species in its natural environment.

Management approaches to assist in meeting the objectives listed above have been organized into the following categories (section 7): research; inventory and monitoring; stewardship and outreach; and, management and coordination. Each approach also has several key actions that will be undertaken to obtain the desired outcome.

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1. Introduction

The Northern Sunfish (*Lepomis peltastes*) (Great Lakes – Upper St. Lawrence populations) was listed as special concern under the *Species at Risk Act* (SARA) in 2019. This management plan is part of a series of documents regarding Northern Sunfish that should be taken into consideration together, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report ([COSEWIC 2016](#)). A management plan includes measures for the conservation of the species to ensure that a species of special concern does not become threatened or endangered. It sets objectives and identifies measures for the conservation of the species to support achieving the management objectives.

2. COSEWIC species assessment information

Date of assessment: May 2016

Common name (population): Northern Sunfish (Great Lakes – Upper St. Lawrence populations)

Scientific name: *Lepomis peltastes*

COSEWIC status: special concern

Reason for designation: This is a small-bodied member of the sunfish family that inhabits shallow vegetated areas of warm lakes, ponds, and slow flowing rivers. Its spatial distribution is relatively small and likely patchy. It is suspected that the index of area of occupancy and abundance of the species have declined. Threats are variable across its range, with some areas of declining habitat quality and other areas with improving habitat quality. Overall, the threats of siltation, contaminants, and invasive species were assessed as high. The species is likely to become threatened unless these threats are effectively ameliorated.

Canadian occurrence: Ontario/Quebec

COSEWIC status history: The species was considered a single unit and designated not at risk in April 1987. When the species was split into 2 separate units in April 2016, the "Great Lakes – Upper St. Lawrence populations" unit was designated special concern.

3. Species status information

The Northern Sunfish is considered to be globally secure (G5) (NatureServe 2022). It is ranked as presumed extirpated (SX) in Pennsylvania, critically imperilled (S1) in New York, and vulnerable in Ontario, Quebec, and Minnesota (NatureServe 2022). In Illinois, Indiana, and Ohio, this species' status has not been assessed by NatureServe (table 1). Northern Sunfish (Great Lakes – Upper St. Lawrence populations) was assessed as special concern by COSEWIC in 2016 (COSEWIC 2016) and was listed under SARA in 2019. In Ontario, the species was listed as special concern under the Ontario provincial *Endangered Species Act* in 2017. In Quebec, Northern Sunfish is listed under the *Act respecting threatened or vulnerable species (Loi sur les espèces menacées ou vulnérables)* as a species likely to be designated as threatened or vulnerable.

Table 1. Summary of existing protection or other status designations assigned to Northern Sunfish (Great Lakes – Upper St. Lawrence populations).

Jurisdiction	Authority/organization	Year(s) assessed and/or listed	Status/description	Designation level
Ontario	<i>Endangered Species Act, 2007</i>	2017	special concern	Population: Great Lakes – Upper St. Lawrence
Ontario	Committee on the Status of Species at Risk in Ontario	2016	special concern	Population: Great Lakes – Upper St. Lawrence
Quebec	<i>Act respecting threatened or vulnerable species</i>	2010	Likely to be designated as threatened or vulnerable	Population
Canada	<i>Species at Risk Act</i>	2019	special concern	Population: Great Lakes – Upper St. Lawrence
Canada	Committee on the Status of Endangered Wildlife in Canada	2016	special concern	Population: Great Lakes – Upper St. Lawrence
Canada	NatureServe	2013	N3 ¹ - Vulnerable	Species
United States ²	NatureServe	2013	N5 - Secure	Species
International	NatureServe	2013	Global: G5- Secure	Species

SARA section 32 prohibitions do not apply upon listing the Northern Sunfish as special concern and, therefore, no permits are required under section 73 of SARA. Further, the identification and protection of critical habitat and species' residence is not required under SARA for species listed as special concern.

The *Fisheries Act* provides for the protection of aquatic species at risk. The *Fisheries Act* provides a framework for (a) the proper management and control of fisheries; and, (b) the conservation and protection of fish and fish habitat, including by preventing pollution.

¹ Refer to [NatureServe 2022](#) for full definitions of NatureServe conservation status ranks.

² Refer to [NatureServe 2022](#) for state-specific designations.

4. Species information

4.1. Species description

The following description has been adapted from Holm et al. (2009) unless otherwise noted. The Northern Sunfish has a small, very deep, laterally compressed body typical of members of the genus *Lepomis*. The average length is 80 mm, with the largest recorded in Ontario being 170 mm. The maximum age of the Northern Sunfish is estimated to be 8 years (COSEWIC 2016). It has a long opercular flap that angles upwards with a red/orange posterior margin. Adult males retain juvenile characteristics including bands on the side of the body and spotting on dorsal and anal fins (Trautman 1981).

The Northern Sunfish can be further distinguished from Bluegill (*L. macrochirus*) and Green Sunfish (*L. cyanellus*) by its lack of a large black blotch on the dorsal fin. The Pumpkinseed (*L. gibbosus*) can be differentiated from the Northern Sunfish by its prominent red spot on the opercular flap and dark spots on the dorsal and anal fins. Spawning males are brightly coloured with a blue or green back, orange belly, rusty orange spots on the dorsal and anal fins, and blue to black pelvic fins (figure 1).

Previously, the Northern Sunfish was believed to be a subspecies of the Longear Sunfish (*L. megalotis*), with the former being distinguished by its smaller size and shorter opercular flap. However, it is presently considered to be a full species, distinct from the Longear Sunfish (Page et al. 2013), which is not found in Canada.



Figure 1. Northern Sunfish (*Lepomis peltastes*) male. Photo by Shawn Staton (Fisheries and Oceans Canada [DFO]).

4.2. Population abundance and distribution

4.2.1. Global range

The Northern Sunfish is restricted to North America (figure 2). The species' range extends from southern Quebec, southern and eastern Ontario, northern Ohio, Michigan, Indiana, northeastern Illinois, eastern Wisconsin, north-central Minnesota, to northwestern Ontario. North-central Minnesota has a disjunct population. Disjunct or possibly relict populations are also found in central/western Wisconsin, and southern Illinois (COSEWIC 2016). Northern Sunfish is considered extirpated in Iowa (Page and Burr 2011).

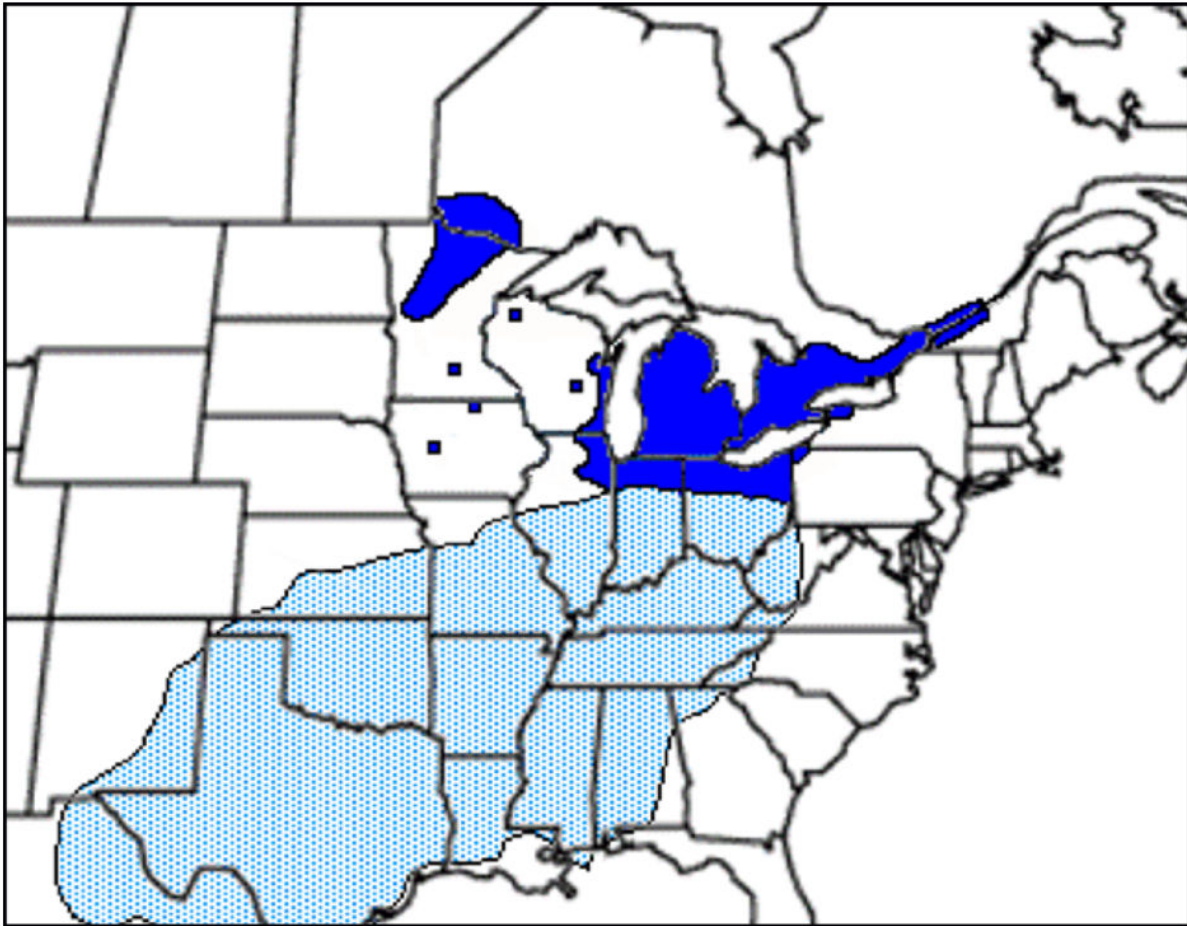


Figure 2. Global distribution of the Northern Sunfish (dark blue) with the range of the closely related Longear Sunfish (light blue) (COSEWIC 2016 as modified from Page and Burr 1991).

4.2.2. Canadian range

The Canadian range of Northern Sunfish is within the Great Lakes, St. Lawrence, and Nelson River watersheds, including stream systems and tributaries to lakes Huron, Erie, and Ontario, and the Rainy, Ottawa, and St. Lawrence rivers (COSEWIC 2016).

Ontario

In Ontario, Northern Sunfish is primarily found in Lake Huron, Lake St. Clair, and Lake Erie tributaries (figure 3a). The majority of the records occur in southwestern Ontario, with a few records in the Bighead, Sauble, Saugeen, and Teeswater River watersheds, as well as a population in Georgian Bay tributaries near Port Severn. Historical records exist in eastern Ontario, in the Ottawa, Raisin, and Delisle rivers. Recent sampling has found populations in Lake Ontario tributaries, in the Trent and Moira rivers, and the Bay of Quinte. Only 1 record exists for Point Pelee National Park and this remains unverified as there is no voucher, and subsequent sampling has not resulted in any records.

Sampling effort for Northern Sunfish has been inconsistent as it is typically captured incidentally. Northern Sunfish may still persist in areas where the species was historically detected; however, a lack of sampling at such locations precludes any inferences regarding potential occupancy. In the upper Thames River near Woodstock, Northern Sunfish was captured at 1 location in 2007 and 2012, and 2 locations in 2019 (DFO, unpubl. data), where it had not been caught since the 1970s. At the mouth of the Maitland River, 8 individuals were caught in 2019 (DFO, unpubl. data), the first records at this location since 1987. Northern Sunfish was captured in 2 new locations in 2019, the St. Clair River and Lake Huron, near Kettle Point (DFO, unpubl. data).

Quebec

Sampling activities in Quebec were carried out largely by the Quebec Ministère des Ressources naturelles et des forêts (MRNF). Despite regular sampling, Northern Sunfish remains a rare species in Quebec's waterways. Most of the observations are historical, with the most recent record dating back to 2005, in the Châteauguay River.

Northern Sunfish records are limited to tributaries of the St. Lawrence River in southwest Quebec (figure 3b). Most of the observations come from the Châteauguay River watershed (Le Grand Marais River and Châteauguay River), Saint John Creek, Lake St. Louis, and Lake of the Two Mountains. Fewer records come from the Ottawa, Nord, and Delisle rivers. In addition, MFFP recently reviewed existing data, and several historical records that appear in COSEWIC (2016) have been removed (Lake Saint-Pierre and Brome Lake) due to uncertainties in species identification (figure 3b).

4.2.3. Global population size and trends

Current overall population sizes and trends of the Northern Sunfish are difficult to accurately quantify as the species has not been monitored regularly over time. Most sampling has not been conducted using gear types and/or approaches to target Northern Sunfish. Additionally, reliable identification of Northern Sunfish can be difficult, further confusing attempts to quantify population sizes and trends.

4.2.4. Canadian population size, status, and trends

Northern Sunfish in Canada has been subdivided into 2 designatable units (DUs), one encompasses the northwestern Ontario (Saskatchewan – Nelson River) populations and the other includes the Great Lakes – Upper St. Lawrence populations (COSEWIC 2016). The separation into 2 DUs is based on the species' distribution within different Freshwater Biogeographic Zones and an 800 km gap between the DUs that is unoccupied (COSEWIC

2016). The Saskatchewan – Nelson River populations were assessed as not at risk by COSEWIC (2016). The content of this management plan is restricted to the Great Lakes – Upper St. Lawrence populations, which encompasses eastern and southern Ontario, and southern Quebec.

Population estimates for Northern Sunfish in Canada are not available as most of the records resulted from general fish surveys instead of targeted surveys. Populations within southern Ontario may be decreasing, particularly in upstream portions of the Maitland, Grand, and Thames watersheds where the majority of Northern Sunfish were detected before 1984 (COSEWIC 2016). Quebec populations appear to be declining, as no new specimens have been collected since 2005, despite sampling efforts in watersheds throughout southern Quebec.

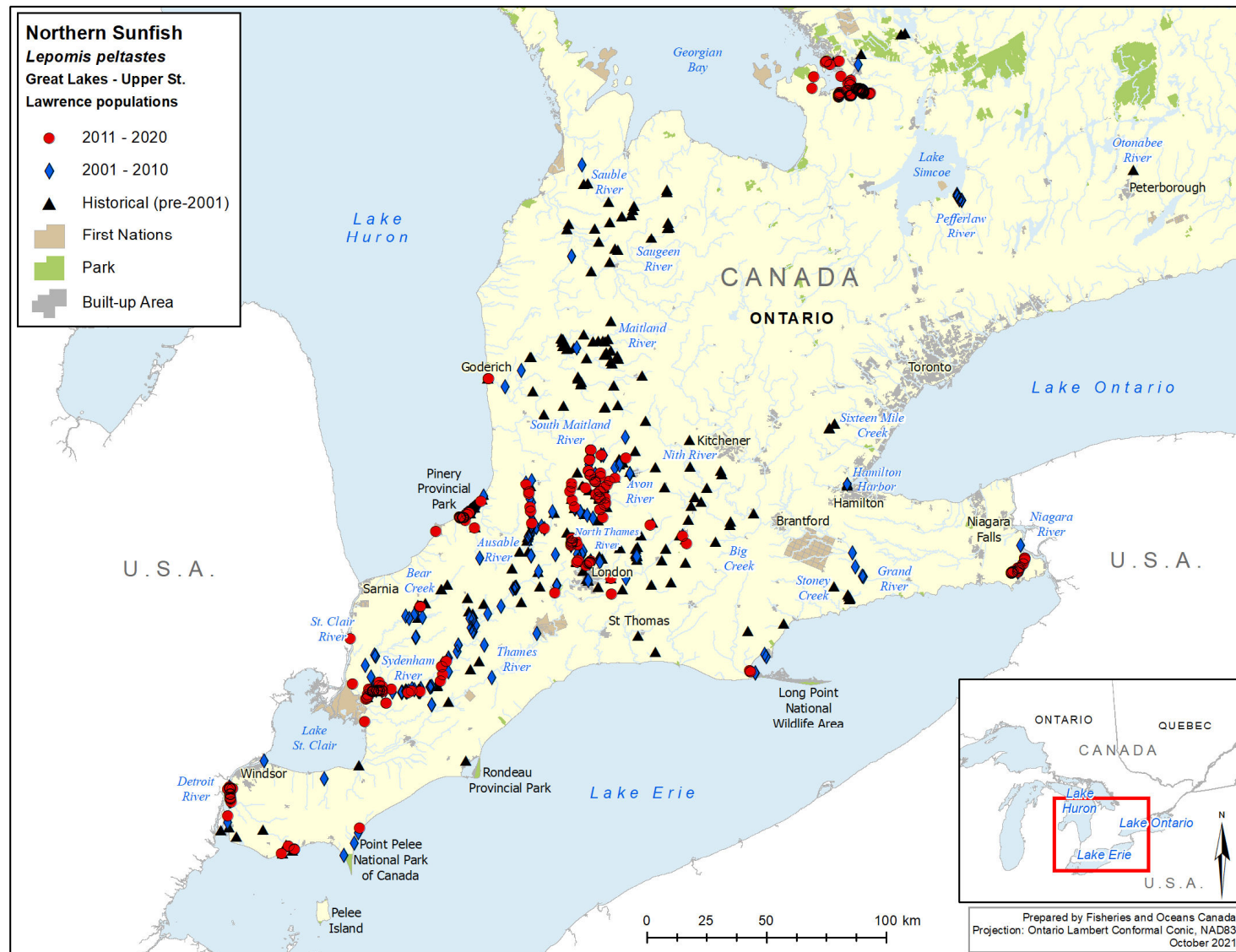


Figure 3a. Distribution of Northern Sunfish (Great Lakes – Upper St. Lawrence populations) in southwestern Ontario.

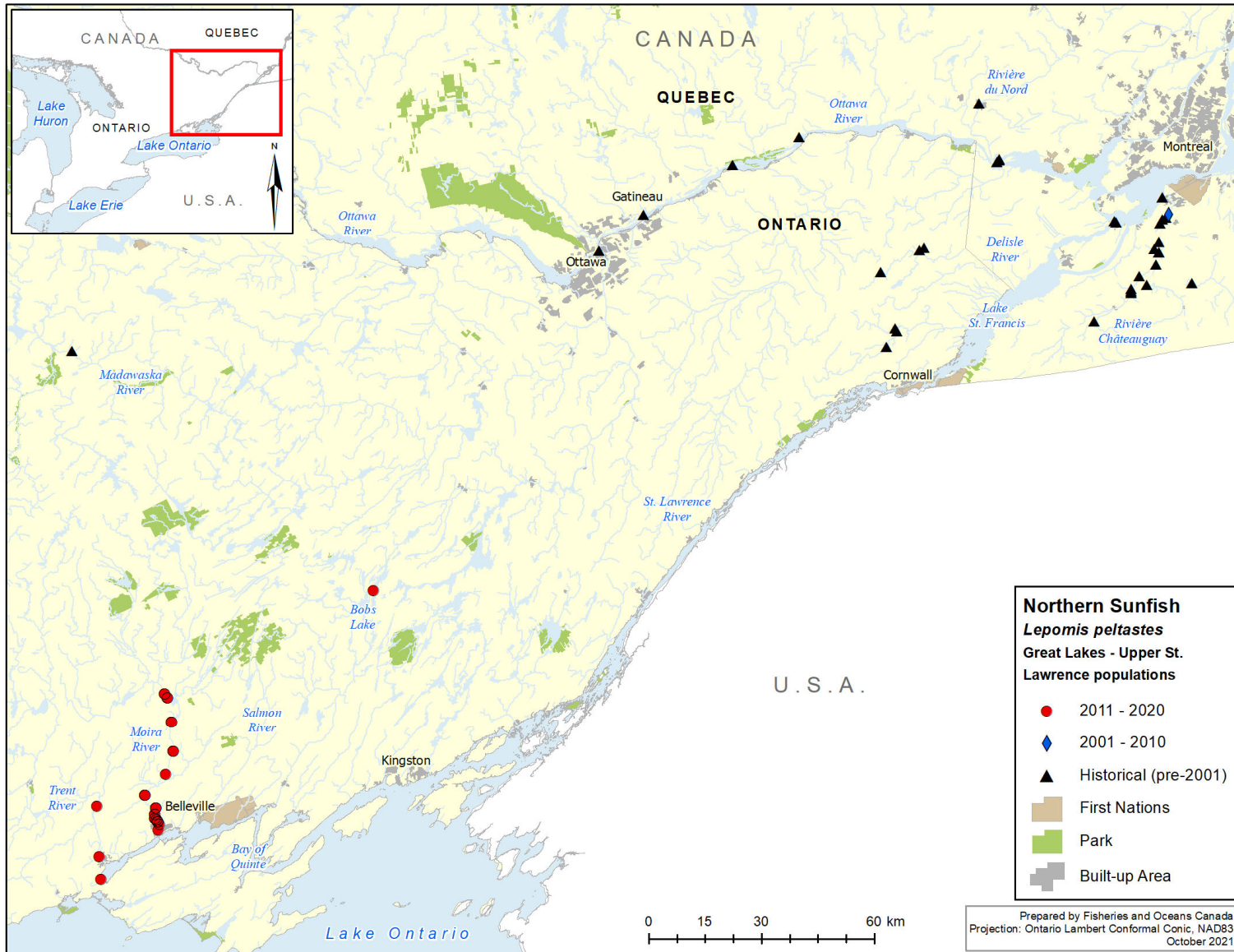


Figure 3b. Distribution of Northern Sunfish (Great Lakes – Upper St. Lawrence populations) in eastern Ontario and Quebec.

4.3. Needs of the Northern Sunfish

Habitat and biological needs

Spawn to hatch: Northern Sunfish reaches sexual maturity at 3 to 4 years of age (COSEWIC 2016). In Canada, Northern Sunfish spawns in June and July when water temperatures reach 22° C (Holm et al. 2009). Males form colonies and excavate circular nests in shallow water consisting of gravel or cobble substrates (Holm et al. 2009; COSEWIC 2016). During courtship, males make grunting noises, presumably to attract females to the nest (Scott and Crossman 1998). Males guard the adhesive eggs until hatching and attend to the young for approximately 1 week (figure 4; Scott and Crossman 1998; COSEWIC 2016). Nursery habitat consists of “shallow areas with mixed vegetation and mineral substrate” (Hall-Armstrong et al. 1996; COSEWIC 2016). Alternative reproductive tactics are utilized by Northern Sunfish; sneaker males who are small and cryptically coloured have been observed in the Thames River (Keenleyside 1972). Sneaker males enter the nests of larger territorial males and release sperm when the females release their eggs.



Figure 4. Male Northern Sunfish guarding nest. Photo by Dustin Boczek.

Young-of-the-year and juveniles: Like other sunfish species, Northern Sunfish juveniles show an affinity to densely vegetated habitats that offer protection from predators (Goddard and Mathis 1997; Collingsworth and Kohler 2010).

Adults: Northern Sunfish is found in warm lakes, ponds, and watercourses with low flow, in or around areas of aquatic vegetation (Scott and Crossman 1998; COSEWIC 2016). Intolerant of turbidity and siltation, clear water is essential for Northern Sunfish survival (Trautman 1981; COSEWIC 2016). Little is known about the movement of this species, although it appears as though the species is limited in its movements (COSEWIC 2016). Northern Sunfish is an opportunistic feeder reported to feed near the surface of the water (Trautman 1981), with a diet

consisting of small aquatic and terrestrial insects, molluscs, crustaceans, small fishes, and fish eggs (Holm et al. 2009; COSEWIC 2016).

Ecological role

The Northern Sunfish is a valuable component of the food web, as a middle level consumer it provides a link between higher and lower trophic levels (Goddard and Mathis 1997; Stewart and Watkinson 2004). The Northern Sunfish is included in the diets of wading birds and predatory fishes, including black basses (*Micropterus* spp.) (COSEWIC 2016).

Limiting factors

Movement of Northern Sunfish appears to be limited, with seasonal dispersal unknown in Canada; however, its movement is restricted within and presumably, among watersheds (COSEWIC 2016). Northern Sunfish is considered a poor colonizer and slow to re-populate habitat following its removal (Carlander 1997). The species' requirement for clear water and associated vegetation, paired with the likelihood that its dispersal capability is limited, leave Northern Sunfish vulnerable to a wide range of pressures related to pollution, siltation, and habitat destruction.

Hybridization among Centrarchids, especially *Lepomis* species, is a common occurrence (Keenleyside 1978). The Northern Sunfish has been documented to hybridize with Pumpkinseed, Bluegill, Green, and Orange-spotted (*L. humilis*) sunfishes (Keenleyside 1978; Trautman 1981; Scott and Crossman 1998). The distribution of these species overlap with Northern Sunfish in the Great Lakes – Upper St. Lawrence region. Hybridizations of Northern Sunfish with Bluegill, as determined by morphometric characters, have been reported in Ontario. Genetic analysis of Northern Sunfish collected from the lower Tonawanda Creek in New York state in 2013-2014 found all specimens were Bluegill-Northern Sunfish hybrids, whereas similar analyses conducted in 2005, identified 23 specimens as purebred Northern Sunfish (Sanderson-Kilchenstein 2015). The level of impact hybridization has on Northern Sunfish populations is currently unknown.

5. Threats

5.1. Threat assessment

An assessment and prioritization of threats to Northern Sunfish was informed by COSEWIC's species status report (COSEWIC 2016) with input from experts from each province and is detailed in table 2. Threats are ranked based on their relative impact, spatial extent, and expected severity and have been prioritized starting with the greatest perceived threat to the survival of the species (throughout its known current and historical ranges) based on the strongest evidence. There may be some variability in the severity and level of concern for some threats for individual populations. Threat assessment, particularly where evidence is limited, is an ongoing process linked to both species assessment and, where applicable, management. The threat classification parameters are provided in footnotes to the table. For more details on the threat assessment process, refer to the [Guidance on Assessing Threats, Ecological Risk and Ecological Impacts for Species at Risk](#) (DFO 2014a).

Table 2. Threat classification table for Northern Sunfish (Great Lakes – Upper St. Lawrence populations).

Threat	Level of concern ³	Extent ⁴	Occurrence ⁵	Frequency ⁶	Severity ⁷	Causal certainty ⁸
Pollution (turbidity and sediment loading)	High	Widespread	Current	Continuous	High	High
Pollution (contaminants)	High	Widespread	Current	Continuous	High	Medium
Pollution (nutrient loading)	High	Widespread	Current	Continuous	High	Medium
Invasive species	Low	Widespread	Current	Continuous	Low	Low
Fishing and harvesting aquatic resources	Low	Widespread	Current	Seasonal	Low	Low

5.2. Description of threats

Pollution (turbidity and sediment loading):

The main threat for Northern Sunfish is sediment loading and resulting turbidity. This threat may impact a species' vision, consequently affecting its behaviour, including feeding and predator avoidance. In addition, elevated turbidity may also adversely affect respiration. It can also reduce the amount of aquatic vegetation present, as a result of decreased light penetration, which may negatively impact Northern Sunfish, a species that is frequently associated with aquatic vegetation (COSEWIC 2016).

The majority of records for Northern Sunfish occur in southwestern Ontario and Quebec where land use is dominated by agriculture, a major contributor of suspended sediments in watersheds. Agriculture is also present in Lake Ontario tributaries, including the areas surrounding the Trent and Moira rivers. Intensive agricultural practices that contribute to increased turbidity and sediment loading include deforestation, loss of riparian vegetation cover, drain maintenance activities, tile drainage, channel alterations, and poorly constructed water

³ Level of Concern: signifies that managing the threat is of (high, medium or low) concern for the management of the species. This criterion considers the assessment of all the information in the table.

⁴ Extent: spatial extent of the threat in the species' range/waterbody (widespread/localized).

⁵ Occurrence: current status of the threat (for example, current, imminent, anticipated).

⁶ Frequency: frequency with which the threat occurs in the species' range/waterbody (seasonal/continuous).

⁷ Severity: reflects the population-level effect (High: very large population-level effect, Moderate, Low, Unknown).

⁸ Causal certainty: reflects the degree of evidence that is known for the threat (High: available evidence strongly links the threat to stresses on population viability; Medium: there is a correlation between the threat and population viability, for example, expert opinion; Low: the threat is assumed or plausible).

crossings. Loss of riparian vegetation cover increases the susceptibility of watercourses to agricultural runoff as well as bank erosion. Drain maintenance activities (that is, sediment removal) results in the removal of aquatic vegetation, which Northern Sunfish relies on throughout its life cycle. Other potential sources of suspended material include untreated wastewater and surface run-off from urban areas.

Historical populations of Northern Sunfish in Ohio from several rivers where they were once abundant, have been lost due to increased turbidity and siltation (Trautman 1981). Northern Sunfish was only found in watercourses where siltation was minimal and some aquatic vegetation was present (Trautman 1981), providing further evidence of this species' intolerance to turbid conditions.

Pollution (contaminants):

Generic threats to aquatic communities include inputs of potentially toxic chemicals (for example, chlorides, pesticides, metals, pharmaceuticals, flame retardants) via overland run-off, spills, and effluent discharge, along with human/animal waste inputs. 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 (Benoit et al. 1976; Collier et al. 1998; Hopkins et al. 2000; Hopkins et al. 2003). In addition, a study by Thomas et al. (2017) on emerging contaminants of concern⁹ in the Great Lakes, found that the reproductive potential and sustainability of exposed *Lepomis* sp. populations may be negatively affected by smaller gonads and less mature gametes. The specific sensitivity of Northern Sunfish to these threats is largely unknown and requires further studies.

Pollution (nutrient loading):

The dominance of agricultural and urban activities in the watersheds containing Northern Sunfish 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 run-off, 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 (for example, Munn and Hamilton 2003). High nutrient levels, with total phosphorus levels often exceeding provincial water quality objectives, have been recorded in the Thames and Sydenham rivers (Upper Thames River Conservation Authority 2017; Lower Thames Valley Conservation Authority 2018; St. Clair Region Conservation Authority 2018). The specific sensitivity of Northern Sunfish to nutrient loading is unknown and requires further investigation.

Invasive species:

Dextrase and Mandrak (2006) indicated that while habitat loss and degradation is the predominant threat affecting aquatic species at risk in Canada, invasive species are the second most prevalent threat. Round Goby (*Neogobius melanostomus*) is an invasive species that is most likely to pose a threat to Northern Sunfish due to its widespread invasion of the Great Lakes (COSEWIC 2016). Round Goby is a known nest predator and may also indirectly limit the

⁹ Emerging contaminants of concern are any chemical that has not been previously detected or only detected as insignificant levels in the environment. It can include pharmaceuticals and personal care products.

reproductive success of Centrarchids due to the increased energy required to defend nests (Steinhart et al. 2004). The impacts of Round Goby on Northern Sunfish populations remains a knowledge gap and further investigations are required (COSEWIC 2016). The Green Sunfish is native to Ontario, where it is considered to be at the northern limit of its range; however, it is considered an invasive species in Quebec. Monitoring is needed to determine the distribution and abundance of this species and its impacts on Northern Sunfish populations in Quebec.

Fishing and harvesting aquatic resources:

Although this species is small and not generally targeted by recreational fishing (COSEWIC 2016), incidental harvest in angling, commercial baitfish, and commercial fishery operations are potential threats. Northern Sunfish could easily be misidentified as a different *Lepomis* species by inexperienced persons. Baitfish harvesting is regulated in Ontario and regulations are in place that prohibit the use of Centrarchid species as a baitfish. Since April 1, 2017, the use or possession of live baitfish, regardless of the species, is prohibited in Quebec, including during winter fishing. In addition, the use of dead sunfish is also prohibited as baitfish in Quebec.

As one of the most colourful freshwater fishes in Canada, the brilliant colouration of male Northern Sunfish makes it an appealing species for the pet trade. Northern Sunfish made its first appearance in the aquarium trade in Winnipeg in 2003 (Stewart and Watkinson 2004). In Ontario and Quebec, the extent to which Northern Sunfish is affected by the aquarium trade remains unknown.

6. Management Objective

The management objective establishes, to the extent possible, the number of individuals and/or populations, and their geographic distribution, that is necessary to prevent Northern Sunfish (Great Lakes – Upper St. Lawrence populations) from becoming endangered or threatened or to allow for the removal of the species from schedule 1 of SARA. The management objective for Northern Sunfish (Great Lakes – Upper St. Lawrence populations) is to maintain self-sustaining populations throughout its range in the Great Lakes and upper St. Lawrence River system to ensure the long-term viability of the species in its natural environment.

7. Broad strategies and conservation measures

7.1. Actions already completed or currently underway

Several recovery strategies, action plans, and management plans have been developed for aquatic species at risk that are found in watersheds occupied by Northern Sunfish. It is expected that many of the recovery actions and conservation measures identified in the single and multi-species ecosystem-based documents listed below will benefit Northern Sunfish populations; many of these recovery actions and conservation measures are underway. The Government of Canada has provided funding to support the implementation of conservation measures for species at risk through programs such as the [Habitat Stewardship Program for Species at Risk \(HSP\)](#), [Canada Nature Fund for Aquatic Species at Risk \(CNFASAR\)](#), and the [Aboriginal Fund for Species at Risk \(AFSAR\)](#). The funds provided through these programs have supported several projects that focus on stewardship, education and outreach, monitoring, and/or research for species at risk, including Northern Sunfish.

Ecosystem-based recovery strategies and action plans for watersheds occupied by Northern Sunfish include the following:

- Action Plan for the Ausable River in Canada: An Ecosystem Approach (DFO 2020)
- Action Plan for the Sydenham River in Canada: An Ecosystem Approach (DFO 2018a)
- Recovery Strategy for Fish Species at Risk in the Essex-Erie Region in Canada: An Ecosystem Approach (Essex-Erie Recovery Team 2008)
- Recovery Strategy for Fish Species at Risk in the Grand River in Canada (Portt et al. 2007)
- Recovery Strategy for Species at Risk in the Ausable River 2005-2010: An Ecosystem Approach (Ausable River Recovery Team 2005)
- Recovery Strategy for the Thames River Aquatic Ecosystem (Thames River Recovery Team 2005)

DFO single and multi-species recovery strategies, action plans, and management plans have been developed for a variety of fish and mussel species at risk, the distributions of which partly overlap with Northern Sunfish. DFO, other jurisdictions, organizations and/or individuals are currently engaged in the implementation of recovery actions and conservation measures within these watersheds that will benefit Northern Sunfish, and include but are not limited to the following species:

- Bridle Shiner (*Notropis bifrenatus*)
- Channel Darter (*Percina copelandi*)
- Eastern Sand Darter (*Ammocrypta pellucida*)
- Fawnsfoot (*Truncilla donaciformis*)
- Grass Pickerel (*Esox americanus vermiculatus*)
- Kidneyshell (*Ptychobranchnus fasciolaris*)
- Northern Brook Lamprey (*Ichthyomyzon fossor*)
- Northern Riffleshell (*Epioblasma rangiana*)
- Pugnose Minnow (*Opsopoeodus emiliae*)
- Pugnose Shiner (*Notropis anogenus*)
- Rayed Bean (*Villosa fabalis*)
- Round Hickorynut (*Obovaria subrotunda*)
- Round Pigtoe (*Pleurobema sintoxia*)
- Salamander Mussel (*Simpsonaias ambigua*)
- Snuffbox (*Epioblasma triquetra*)
- Spotted Gar (*Lepisosteus oculatus*)
- Threehorn Wartyback (*Obliquaria reflexa*)
- Wavyrayed Lampmussel (*Lampsilis fasciola*)

There are no known studies on Northern Sunfish currently underway.

7.2. Broad strategies

In an effort to meet the goal and objectives of the management plan, 4 categories of actions have been identified. These actions comprise the strategies required to protect, maintain and improve Northern Sunfish populations and habitat. Many of these actions can and should be performed in conjunction with other recovery and management teams dealing with individual species at risk and ecosystem-based approaches. Ensuring that Northern Sunfish is considered

where feasible in surveys, and in outreach and educational efforts targeted at species at risk, will result in more efficient and cost-effective conservation efforts.

Management priorities for Northern Sunfish have been assigned to 4 key categories as follows:

1. Research
2. Management and coordination
3. Inventory and monitoring
4. Stewardship and outreach

7.3. Conservation measures

Success in the conservation of this species is dependent on the actions of many different jurisdictions, industries, non-governmental organizations, Indigenous groups, and Canadians in general; it requires the commitment and cooperation of the constituencies that will be involved in implementing the measures set out in this management plan.

The measures set out in this management plan provide the best chance of achieving the management objective for Northern Sunfish to guide both activities undertaken by DFO as well as those for which other jurisdictions, organizations, and individuals may have a role to play. As new information becomes available, these measures and their associated priorities may change. DFO strongly encourages all Canadians to participate in the conservation of Northern Sunfish by undertaking conservation measures outlined in this management plan.

Tables 3, 4 and 5 summarize those actions that are recommended to support the management goals and objectives. If your organization is interested in participating in one of these measures, please contact the Species at Risk office within Ontario and Prairie Region at fwisar@dfo-mpo.gc.ca, or within Quebec Region at Lep-Sara-Qc@dfo-mpo.gc.ca. Federal funding programs for species at risk that may provide opportunities to obtain funding to carry out some of the outlined activities include HSP, CNFASAR, and AFSAR. Other levels of government may also provide funding opportunities for those interested in undertaking activities to conserve Northern Sunfish populations.

While DFO has already commenced efforts to implement the conservation of Northern Sunfish, the measures included in this management plan that have yet to be implemented by DFO will be subject to the availability of funding and other required resources (human resources, time, equipment, etc.). Where appropriate, partnerships with specific organizations and sectors will provide the necessary expertise and capacity to carry out the listed conservation measures. However, the identification of partners is intended to be suggestions to other jurisdictions and organizations, and carrying out these actions will be subject to each agency's priorities and budgetary constraints.

Table 3. Measures for the conservation of the Northern Sunfish (Great Lakes – Upper St. Lawrence populations) to be undertaken by Fisheries and Oceans Canada.

#	Conservation measure	Broad strategy	Priority ¹⁰	Threats or concerns addressed	Timeline ¹¹
1	Threat evaluation: Investigate the impacts of drain maintenance on Northern Sunfish (that is, riparian vegetation removal, sediment removal), determine if mitigation measures currently in place are reducing adverse effects, and make recommendations on further mitigation measures if warranted.	Research	High	Turbidity	3 to 5 years
2	Threat evaluation: Investigate relationships and interactions between Northern Sunfish and the fish community.	Research	Low	Knowledge gaps	3 to 5 years
3	Coordination of activities: Work with municipal planning offices and planning officials, including drainage superintendents and municipal inspectors, to develop and adopt land management practices that minimize negative impacts on Northern Sunfish and its habitat.	Management and coordination	High	All	Ongoing

¹⁰ Priority” reflects the degree to which the action contributes directly to the conservation of the species or is an essential precursor to an action that contributes to the conservation of the species:

- "High" priority measures are considered likely to have an immediate and/or direct influence on the conservation of the species
- "Medium" priority measures are important but considered to have an indirect or less immediate influence on the conservation of the species
- "Low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

¹¹ Timeline reflects the amount of time required for the measure to be completed from the time the management plan is published as final on the Species at Risk Public Registry.

Table 4. Measures for the conservation of the Northern Sunfish (Great Lakes – Upper St. Lawrence populations) to be undertaken by Fisheries and Oceans Canada and its partners.

#	Conservation measure	Broad strategy	Priority ¹²	Threats or concerns addressed	Timeline ¹³	Potential partners ¹⁴
4	Threat evaluation: Increase the understanding of threats to Northern Sunfish (that is, explore overlap with, and impact from, other invasive species such as Round Goby, Green Sunfish [in Quebec], and European Common Reed [<i>Phragmites australis australis</i>]); update threat assessment as new information becomes available.	Research	Medium	All threats	Long term	OMNRF, MRNF, conservation authorities, academia
5	Genetic characterization: Assess genetic structure among and within Northern Sunfish populations and assess the degree to which hybridization may be occurring throughout the species' distribution.	Research	Medium	Knowledge gaps	Medium term	Academia
6	Assessment: Conduct surveys within the historical distribution of Northern Sunfish (for example, Maitland, Saugeen, Raisin, Delisle, Ottawa, Nord, and Châteauguay rivers, Lake of Two Mountains and Lake Saint-Louis) to confirm current status/abundance.	Inventory and monitoring	High	Determine population trends and refine population and	Medium term	OMNRF, MRNF, conservation authorities, Indigenous groups

¹² Priority” reflects the degree to which the action contributes directly to the conservation of the species or is an essential precursor to an action that contributes to the conservation of the species:

- "High" priority measures are considered likely to have an immediate and/or direct influence on the conservation of the species
- "Medium" priority measures are important but considered to have an indirect or less immediate influence on the conservation of the species
- "Low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

¹³ “Timeline” separates measures into 3 categories based on the projected length of time it will take to accomplish them:

- “Short term” equals 1 to 2 years
- “Medium term” equals 3 to 5 years
- “Long term” greater than 5 years

¹⁴ OMNRF: Ontario Ministry of Natural Resources and Forestry; ENGO: Environmental Non-Government Organizations; OFAH: Ontario Federations of Anglers and Hunters; ROM: Royal Ontario Museum; MRNF: Quebec Ministère des Ressources naturelles et des forêts

#	Conservation measure	Broad strategy	Priority ¹²	Threats or concerns addressed	Timeline ¹³	Potential partners ¹⁴
				distribution objectives		
7	Assessment: Implement a standardized index population and habitat monitoring program with a species-specific sampling protocol.	Inventory and monitoring	Medium	Achievement of population objectives and knowledge gaps	Medium term	OMNRF, MRNF, academia, conservation authorities
8	Assessment: Conduct surveys to detect new populations; determine the extent and abundance of any new populations detected, for example, in the Lake Champlain Richelieu watershed (Maxwell and Carlson 2018).	Inventory and monitoring	Low	Refine population and distribution objectives	Long term	OMNRF, MRNF, Indigenous groups, conservation authorities
9	Stewardship: Promote stewardship (including Best Management Practice [BMP] implementation) and facilitate access to funding sources among conservation groups, landowners (for example, farmers), Indigenous groups, and other interested parties.	Stewardship and outreach	High	All threats	Long term	Landowners, Indigenous groups, angling groups, ENGO's, conservation authorities
10	Habitat improvement: Implement local stewardship programs to improve habitat conditions and reduce threats within occupied habitats. For example, plant riparian buffers or cover crops to reduce peak flow, leaching, soil loss, and fertilizer and pesticide inputs.	Stewardship and outreach	High	Pollution (turbidity, sediment loading and contaminants)	Long term	Landowners, municipalities, conservation authorities ENGO's
11	Awareness: Encourage public support and participation by developing awareness materials and programs, particularly within the agricultural, recreational fishing, and aquarium trade communities, including increasing public awareness of the impacts of invasive species.	Stewardship and outreach	Medium	All threats	Medium term	Conservation authorities, ENGO's

#	Conservation measure	Broad strategy	Priority ¹²	Threats or concerns addressed	Timeline ¹³	Potential partners ¹⁴
12	Awareness: Deliver fish identification courses to fisheries biologists, technicians, and other resource managers.	Stewardship and outreach	Medium	Improve overall awareness	Long term	OFAH, ROM, MRNF

Table 5. Measures for the conservation of the Northern Sunfish (Great Lakes – Upper St. Lawrence populations) that represent opportunities for other jurisdictions, organizations, or individuals to lead.

#	Conservation measure	Broad strategy	Priority ¹⁵	Threats or concerns addressed	Suggested other jurisdictions or organizations ¹⁶
13	Threat evaluation: Determine the physiological tolerance thresholds of Northern Sunfish with respect to various water quality parameters (for example, chloride, nutrients, turbidity, pesticides, contaminants, temperature), as well as the impact of other pertinent pollutants emitted from agricultural practices and wastewater treatment plants, and check against existing standards.	Research	Medium	Pollution (turbidity and sediment loading, contaminants)	ECCC, OMNRF, MECP, MRNF, conservation authorities, academia
14	Threat evaluation: Investigate the impacts that hybridization with <i>Lepomis</i> species may have on Northern Sunfish (for example, reduced fitness, competition, sterility).	Research	Medium	Knowledge gaps	OMNRF, conservation authorities, academia
15	Threat evaluation: Determine the impact of recreational fishing and bait harvest on Northern Sunfish.	Research	Low	Biological resource use	OFAH, OMNRF, conservation authorities, academia

¹⁵ Priority” reflects the degree to which the action contributes directly to the conservation of the species or is an essential precursor to an action that contributes to the conservation 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

¹⁶ ECCC: Environment and Climate Change Canada; MRNF: Quebec Ministère des Ressources naturelles et des forêts; OMNRF: Ontario Ministry of Natural Resources and Forestry; MECP: Ontario Ministry of the Environment, Conservation and Parks; OFAH: Ontario Federations of Anglers and Hunters

7.4. Description of measures for the conservation of the species

Broad strategy 1: Research

Threat evaluation (measures 1, 2, 13 to 15): Threat evaluation is required to determine a variety of potential impacts to Northern Sunfish. Drain maintenance activities, including sediment removal (dredging), and riparian and aquatic vegetation removal, have the potential to impact fish populations. Current mitigation measures in place to protect species occurring in drains, such as Northern Sunfish, include clearing half (in Ontario) or one third (in Quebec) of the bottom of the drain to retain aquatic vegetation (Kavanagh et al. 2017; Ministère de l'Agriculture des Pêcheries et de l'Alimentation du Québec 2020). Effectiveness monitoring activities are required to determine if this mitigation measure is sufficient to reduce harm to Northern Sunfish or if further mitigation measures are required.

The significance of contaminants as a threat to Northern Sunfish requires further study, particularly the impact(s) of chloride (that is, from road de-icing applications). Impacts of pollutants from agricultural practices and wastewater treatment should be determined as the majority of populations occur in highly agricultural areas or are in close proximity to urban areas.

The impact, if any, that Round Goby has on Northern Sunfish relating to nest predation and competition for food and space must be examined. Determining the geographic overlap that exists between these 2 species will assist in quantifying the threat. In addition, the significance of competition with other species, if any, should be examined to help understand community dynamics and provide insight into Northern Sunfish occurrence. Sanderson-Kilchenstein (2015) suggest that hybridization among sunfish species is a potential cause of Northern Sunfish decline in New York state. This hypothesis requires further evaluation for the Great Lakes – Upper St. Lawrence populations.

In addition, Green Sunfish was first detected in the Yamaska River, Quebec, in 2007 (Vachon et al. 2021). Adults have a varied diet and can ingest prey as large as 50% their size, including native fish species and their eggs. The Green Sunfish is aggressive in nature and also competes with native species for food resources. Furthermore, it has high fecundity, an ability to survive in a range of habitats, and tolerates extreme environmental conditions. Its ability to hybridize with other sunfish species (for example, Northern Sunfish, Bluegill) has been confirmed (Scott and Crossman 1998). All of these characteristics increase the risk of Green Sunfish spreading, especially under climate change, and having adverse effects on native wildlife. Monitoring is needed to determine the distribution and abundance of this species and its impacts on Northern Sunfish populations in Quebec.

European Common Reed (*Phragmites australis australis*) may also be impacting aquatic species by transforming aquatic habitat into terrestrial. The presence of European Common Reed in watercourses occupied by Northern Sunfish needs to be investigated to determine the impact this invasive species may be having. Other invasive plant species (for example, Water Solider [*Stratiotes aloides*], Starry Stonewort [*Nitellopsis obtuse*]) could also have an impact on Northern Sunfish and more research is required to explore the potential impacts.

Genetic characterization (measure 5): Focused efforts are required to determine if there is genetic variation among the Great Lakes – Upper St. Lawrence populations. Such investigations would characterize population structure, dispersal patterns among watersheds (if any), and inform the potential for rescue effect, and the potential translocation or supplemental stocking should it be deemed warranted in the future. These investigations could also inform future

COSEWIC assessments of Northern Sunfish by re-evaluating designatable units based on genetic variation. In addition, genetic analysis would allow an assessment of the extent of hybridization and its impacts on Northern Sunfish populations.

Broad strategy 2: Management and coordination

Coordination of activities (measure 3): The majority of Northern Sunfish records occur in areas dominated by agricultural activities and/or urban areas. Promoting awareness with municipal planning offices and planning officials, including drainage superintendents who are responsible for drain maintenance activities that may harm Northern Sunfish, is essential to protect the species. Working on relationships with planning offices to develop and adopt land and water management practices that are beneficial to the species will help minimize impacts to Northern Sunfish.

Broad strategy 3: Inventory and monitoring

Assessment (measures 6 to 8): Focused efforts are required to determine the current distribution of Northern Sunfish at extant and historical locations, as well as to detect new populations in high probability locations. Historical locations that should be sampled include, but are not limited to, the Sauble, Saugeen, Maitland, Thames, Grand, Raisin, and Delisle rivers and tributaries, as well as Lake Erie tributaries (for example, Stoney Creek). In Quebec, sampling sites should focus on the Châteauguay River and its tributaries, as well as the Ottawa River where records of the species are the most numerous. In Ontario, Northern Sunfish has recently been discovered at new locations in the Trent and Moira rivers, suggesting that our knowledge on its distribution is incomplete. New sampling locations should focus on Lake Ontario and Upper St. Lawrence tributaries, where gaps currently exist in the distribution of Northern Sunfish. Sampling efforts could also include environmental DNA (eDNA) analyses as an exploratory first step to determine new areas to target using conventional monitoring methods (for example, electrofishing, seining); notably in the area of the Lake Champlain Richelieu watershed, where specimens have been found in the Lake Champlain watershed in the United States (Maxwell and Carlson 2018).

A standardized monitoring program is needed to generate robust estimates of population size and trends over time at extant locations. Development of the monitoring program should determine the probability of detection of Northern Sunfish in relation to time of year, gear type, and habitat. The monitoring program should be designed to allow for quantitative tracking of changes in population abundance and demographics. The program could include analyses of habitat use (including preference for specific species of aquatic vegetation), availability, and changes in these parameters over time with respect to known threats. Population estimates have not been available for Northern Sunfish to date due to inconsistent sampling. Population monitoring approaches should ideally be undertaken in the North Thames and Sydenham rivers where the majority of recent records exist, as well as in the Moira River to provide insight on eastern populations within this designatable unit.

Broad strategy 4: Stewardship and outreach

Stewardship (measures 9, 10): Active promotion of stewardship activities will raise community support for the conservation of Northern Sunfish, and increase opportunities to improve aquatic habitats and land management practices. Habitat improvement activities should be coordinated with existing groups and initiatives (for example, ecosystem-based recovery programs), and direction, technical expertise/contacts, and information on financial incentives (for example,

existing funding opportunities for private landowners, Environmental Non-Governmental Organizations, and Indigenous groups) should be made available. Important activities for habitat improvement include: best management practices for agriculture, establishment of riparian buffers, nutrient and manure management, and livestock exclusion fencing as a means of reducing contaminants, nutrients, and sediment inputs into watercourses where Northern Sunfish is present.

Awareness (measures 11, 12): Similarities between Northern Sunfish and other *Lepomis* species (for example, Pumpkinseed) may lead to incidental harvesting and the belief that this species is common and widespread or does not exist. Awareness materials and programs that include key identification features need to be developed and used to educate the public, as well as promoting the release of Northern Sunfish by recreational fishers. Additionally, Northern Sunfish should be considered in existing communication and outreach programs for both ecosystem-based recovery and for other aquatic species at risk. Various organizations have already undertaken public education efforts to prevent the further spread of invasive species, DFO will support and encourage the continuation of these education efforts.

8. Measuring progress

To measure the progress toward meeting the long-term objectives of this management plan, the following performance indicators have been identified:

1. Knowledge of the species biology and population characteristics have improved to facilitate conservation of the species and achieve the management objective by 2027;
2. The continued presence of Northern Sunfish throughout its current distribution by 2027; and,
3. Threats to the populations have been identified and actions have been taken to mitigate those threats by 2027.

Detailed reporting on implementation of this management plan under section 72 of SARA will be done by assessing progress towards implementing the broad strategies and conservation measures. The implementation of this management plan will be monitored every 5 years after the plan has been posted to the Species at Risk Public Registry.

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Appendix A: Effects on the environment and other species

A strategic environmental assessment (SEA) is conducted on all *Species at Risk Act* recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. 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.

Management planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that plans 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 plan itself, but are also summarized below.

This management plan will clearly benefit the environment by promoting the conservation of the Northern Sunfish. The potential for the plan to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this plan will clearly benefit the environment and will not entail any significant adverse effects. The readers should refer to the following sections of the documents in particular: Needs of the Northern Sunfish (section 4.3); Threats (section 5); and, Broad strategies and conservation measures (section 7).