

Management Plan for the Silver Chub, *Macrhybopsis storeriana*, in Canada

Silver Chub



March 2010



About the *Species at Risk Act* Management Plan Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003, and one of its purposes is “*to manage species of special concern to prevent them from becoming endangered or threatened.*”

What is a species of special concern?

Under SARA, a species of special concern is a wildlife species that could become threatened or endangered because of a combination of biological characteristics and identified threats. Species of special concern are included in the SARA List of Wildlife Species at Risk.

What is a management plan?

Under SARA, a management plan is an action-oriented planning document that identifies the conservation activities and land use measures needed to ensure, at a minimum, that a species of special concern does not become threatened or endangered. For many species, the ultimate aim of the management plan will be to alleviate human threats and remove the species from the List of Wildlife Species at Risk. The plan sets goals and objectives, identifies threats, and indicates the main areas of activities to be undertaken to address those threats.

Management plan development is mandated under Sections 65–72 of SARA (www.sararegistry.gc.ca/approach/act/default_e.cfm).

A management plan has to be developed within three years after the species is added to the List of Wildlife Species at Risk. A period of five years is allowed for those species that were initially listed when SARA came into force.

What's next?

Directions set in the management plan will enable jurisdictions, communities, land users, and conservationists to implement conservation activities that will have preventative or restorative benefits. Cost-effective measures to prevent the species from becoming further at risk should not be postponed for lack of full scientific certainty and may, in fact, result in significant cost savings in the future.

The series

This series presents the management plans prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as plans are updated.

To learn more

To learn more about the *Species at Risk Act* and conservation initiatives, please consult the Species at Risk Public Registry (www.sararegistry.gc.ca).

**Management Plan for the Silver Chub (*Macrhybopsis storeriana*) in
Canada [Proposed]**

March 2010

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PREFACE

The Silver Chub is a freshwater fish and is under the responsibility of the federal government. The *Species at Risk Act* (SARA, Section 65) requires the competent minister to prepare management plans for species listed as Special Concern. The Silver Chub was listed as a species of Special Concern under SARA in 2003. The development of this management plan was led by Fisheries and Oceans Canada - Central and Arctic Region, in cooperation and consultation with many individuals, organizations and government agencies, including the Province of Manitoba, Province of Ontario and Parks Canada Agency.

The plan meets SARA requirements in terms of content and process (SARA sections 65-68). Success in the conservation 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 plan and will not be achieved by Fisheries and Oceans Canada or any other party alone. This plan provides advice to jurisdictions and organizations that may be involved or wish to become involved in activities to conserve this species. In the spirit of the Accord for the Protection of Species at Risk, the Minister of Fisheries and Oceans invites all responsible jurisdictions and Canadians to join Fisheries and Oceans Canada in supporting and implementing this plan for the benefit of the Silver Chub and Canadian society as a whole. The Minister will report on progress within five years.

RESPONSIBLE JURISDICTIONS

Under the *Species at Risk Act*, the responsible jurisdiction for the Silver Chub is Fisheries and Oceans Canada. The Silver Chub occurs in Manitoba and Ontario, and their respective governments also cooperated in the production of this management plan.

AUTHORS

This document was prepared by Amy L. Boyko and Shawn K. Staton on behalf of Fisheries and Oceans Canada.

ACKNOWLEDGMENTS

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STRATEGIC ENVIRONMENTAL ASSESSMENT

A strategic environmental assessment (SEA) is conducted on all SARA management 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 on 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 management of the Silver Chub. 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 reader should refer to the following sections of the document in particular: description of the species' habitat and biological needs, ecological role and limiting factors; effects on other species; and, the management implementation actions.

EXECUTIVE SUMMARY

The Silver Chub (*Macrhybopsis storeriana* Kirtland, 1845) is a stout minnow ranging 102-152 mm in total length. Colouring is a pale grey-green on the back, becoming silver on the sides and silvery white below. In Canada, the species is found in Ontario (Lake Erie, Lake St. Clair and Lake Huron) and Manitoba (Assiniboine, Red and Rosseau rivers and Lake Winnipeg). Globally, Silver Chub populations are considered Secure (G5) and, in the United States, it is ranked as Secure (N5). In Canada, the species is ranked as Vulnerable (N3) (Manitoba [S3]; Ontario [S2]). There is limited information available concerning the size of Silver Chub populations in Canada. It appears that populations are stable in the Assiniboine and Red rivers; the status of the Lake Winnipeg population is unknown. Populations in Lake Erie appear to be recovering after drastic declines due to lake eutrophication. Recent population trends in lakes St. Clair and Huron and parts of its Manitoba range are unknown due to limited targeted sampling.

In Canada, Silver Chub inhabit large lakes and medium- to large-sized rivers with moderate currents, and substrates of silt or sand, but the species is sometimes associated with hard substrates such as gravel, rubble, boulder or bedrock.

Known and suspected threats to the Silver Chub in Canada include habitat degradation, sediment and nutrient loading, exotic species, baitfish harvesting, altered coastal processes and climate change. Although some threats to the species have decreased in recent years (e.g., nutrient loading in Lake Erie), the extent to which they are currently impacting the species needs to be evaluated.

This management plan has benefited from the existing recovery strategy for the Essex-Erie region (an area that includes western Lake Erie, the Detroit River and the southern shores of Lake St. Clair), which includes the Silver Chub. Some measures have already been taken that will directly or indirectly benefit the species, such as the Lake Winnipeg Action Plan, which aims to reduce nitrogen and phosphorous levels in the lake, as well as existing monitoring programs that provide population data on Silver Chub populations.

The long-term management goal (over the next 20 years) for the Silver Chub is to maintain, or enhance, existing populations in Canada, and to improve the quality and quantity of their associated habitats. The management goal will be achieved primarily through the implementation of relevant species-specific or ecosystem-based recovery approaches, in cooperation with relevant single/multi-species and ecosystem-based recovery programs, to mitigate identified threats. The following short-term (over the next five to ten years) objectives have been established to assist with meeting the management goal:

- i. Determine the extent, abundance and population demographics of existing populations;
- ii. Identify key habitat requirements;
- iii. Determine long-term population and habitat trends;
- iv. Identify and mitigate threats to the species and its habitat;
- v. Continue to coordinate management efforts with relevant recovery teams (e.g., ecosystem-based recovery teams) and other agencies and complimentary groups/initiatives; and,
- vi. Continue to increase public awareness regarding the distribution, threats and management of the Silver Chub.

Several management approaches have been identified to ensure the conservation of the Silver Chub, which include background surveys, monitoring (population and habitat) and research (biology, habitat requirements, threat evaluation).

The development and implementation of management actions is being coordinated with other species at risk recovery teams throughout the range of the Silver Chub in southwestern Ontario, which will facilitate information sharing. Coordination with other recovery teams will also help to ensure that proposed management actions do not negatively impact other species at risk found within the range of the Silver Chub; management actions may, in fact, enhance or facilitate the recovery of other species at risk.

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1.0 SPECIES INFORMATION

1.1 Species Assessment Information from COSEWIC

Date of Assessment: May 2001

Common Name (population): Silver Chub

Scientific Name: *Macrhybopsis storeriana*

COSEWIC Status: Special Concern

Reason for Designation: The Silver Chub has a disjunct Canadian distribution. It is impacted by deteriorating water quality and appears to be in decline in parts of its range in Ontario and Manitoba.

COSEWIC Status History: Designated Special Concern in April 1985. Status re-examined and confirmed in May 2001. Last assessment based on an update status report.

1.2 Description

The Silver Chub (*Macrhybopsis storeriana* Kirtland, 1845) (Figure 1) is a stout minnow ranging 102-152 mm in total length (Scott and Crossman 1998). Species in the genus *Macrhybopsis* are characterized by the following features: a slender barbel at the end of the maxillary (corner of upper jaw); moderate-sized subterminal mouth; snout projecting beyond the mouth; and, fewer than 50 lateral line scales (Mandrak and Holm 2001). The Silver Chub is distinguished from other species in the genus by its large eyes located on the upper half of the head, a shorter snout, silvery sides without markings and a more anterior oriented dorsal fin (Mandrak and Holm 2001). Colouring is a pale grey-green on the back, becoming silver on the sides and silvery white below. A faint dusky lateral band is usually present. The caudal fin is lightly pigmented except for the lower three or four rays, which are completely white and unpigmented (Scott and Crossman 1998).

Silver Chub can be confused with large spottail shiner (*Notropis hudsonius*), gravel chub (*Erimystax x-punctatus*) and species in the *Nocomis* genus. It is distinguished from the spottail shiner by the presence of a terminal barbel; it lacks the distinct, dark, x-shaped spots that are characteristic of the gravel chub; and, its snout projects further beyond the mouth than that of *Nocomis* spp. Additionally, *Nocomis* spp. have smaller eyes than the Silver Chub and a more pigmented body that is not usually silvery (Mandrak and Holm 2001).

The Silver Chub is the only member of the genus *Macrhybopsis* in Canada, and the Great Lakes populations are lacustrine forms that are morphologically distinct from the riverine forms found throughout most of its range (Mandrak and Holm 2001). Both the Great Lakes and Lake Winnipeg drainage populations are geographically isolated from the majority of other Silver Chub populations, which inhabit the Mississippi drainage, and could be genetically distinct.



Figure 1. Silver Chub (*Macrhybopsis storeriana*). Photo: E. Holm, ROM.

1.3 Populations and Distribution

Distribution:

Global Range (Figure 2): The following has been adapted from Mandrak and Holm (2001). The range of the Silver Chub extends from Lake Winnipeg and the southern Great Lakes basin south to the Gulf of Mexico. In the Great Lakes basin, the species is limited to lakes Erie and St. Clair, and the extreme southern portion of Lake Huron. In the Lake Winnipeg drainage, it is found in southern Lake Winnipeg and in the Assiniboine and Red river drainages of Manitoba, North and South Dakota and Minnesota. The Silver Chub occurs in the Mississippi River system from Minnesota south to the Gulf of Mexico. In the northern part of its Mississippi basin range, it extends from Nebraska to New York, and, in its Gulf Coast range, it extends from the Mobile Bay basin to the Lake Pontchartrain drainage. An isolated population also exists in the Brazos River drainage of Texas.

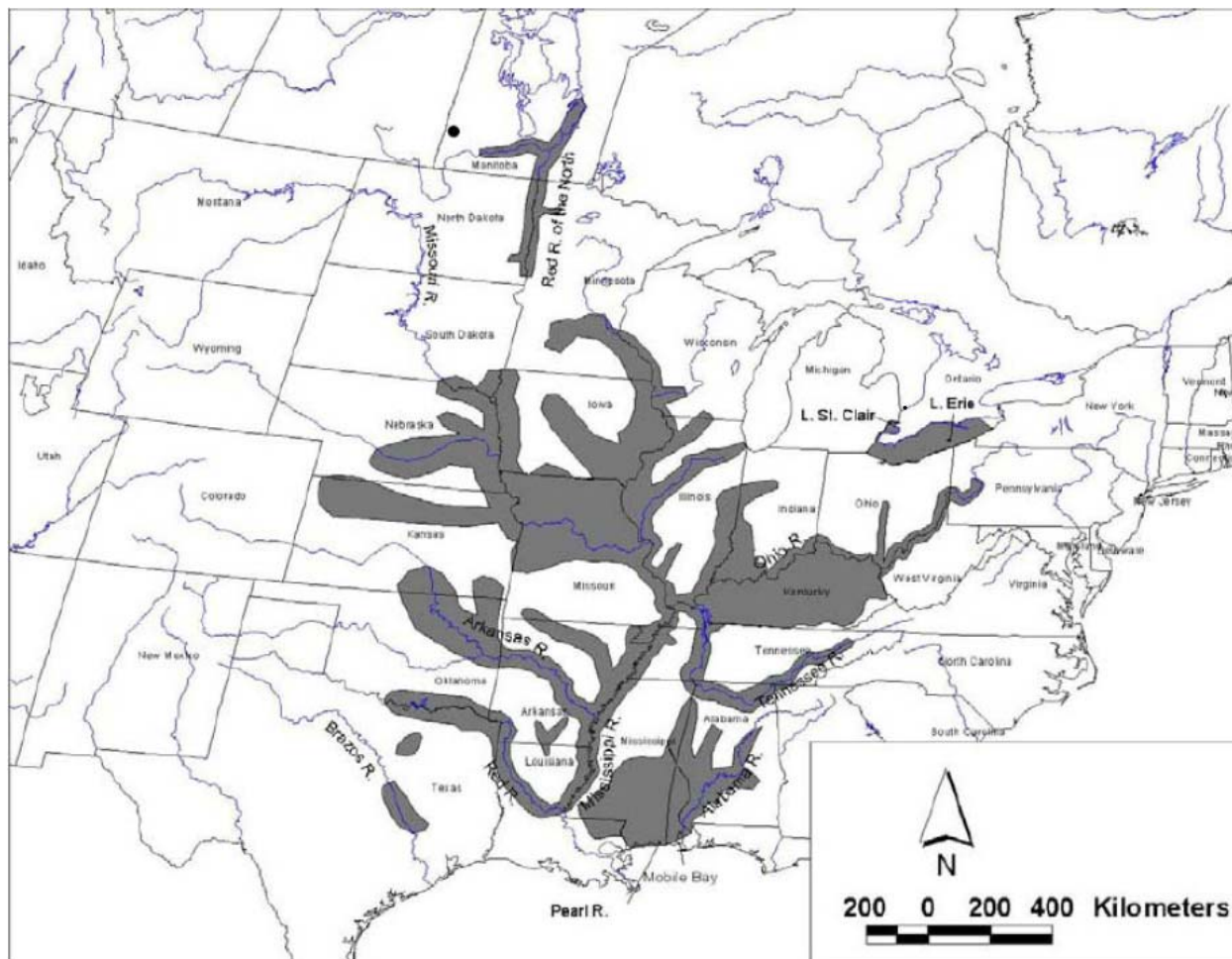


Figure 2. Global distribution of the Silver Chub (adapted from Mandrak and Holm 2001).

Canadian Range (Figure 3a,b): In Ontario, the Silver Chub has been collected along most of the north shore of Lake Erie and the south and east shores of Lake St. Clair. As of 2000, most of the records for Lake Erie were collected prior to 1960 and in the 1990s; whereas, the Lake St. Clair records were collected in the 1970s and 1980s (Mandrak and Holm 2001). Since 1980, the species has been collected primarily in the western basin of Lake Erie (Port Dover, in the eastern basin, is the easternmost point that the species has been caught, and it is generally rare in the eastern basin), Lake St. Clair, and at a single location in Lake Huron. The increase in records from the western basin of Lake Erie in the 1990s and 2000s are likely a reflection of the species' recovery since its decline in previous decades. In Manitoba, prior to 1980, the range of the Silver Chub included the Assiniboine River and the Red River from the mouth of the Morris River north to the mouth of the Assiniboine River (Mandrak and Holm 2001). Based on sampling conducted in the 1980s, 1990s and 2000s, its range includes the Red River from the United States border north to Lake Winnipeg, and Lake Winnipeg proper (Mandrak and Holm 2001, D. Watkinson, DFO, pers. comm. 2008). Sampling conducted in the 2000s expanded the species distribution to include upper parts of the Assiniboine River in Manitoba (D. Watkinson, pers. comm. 2008).

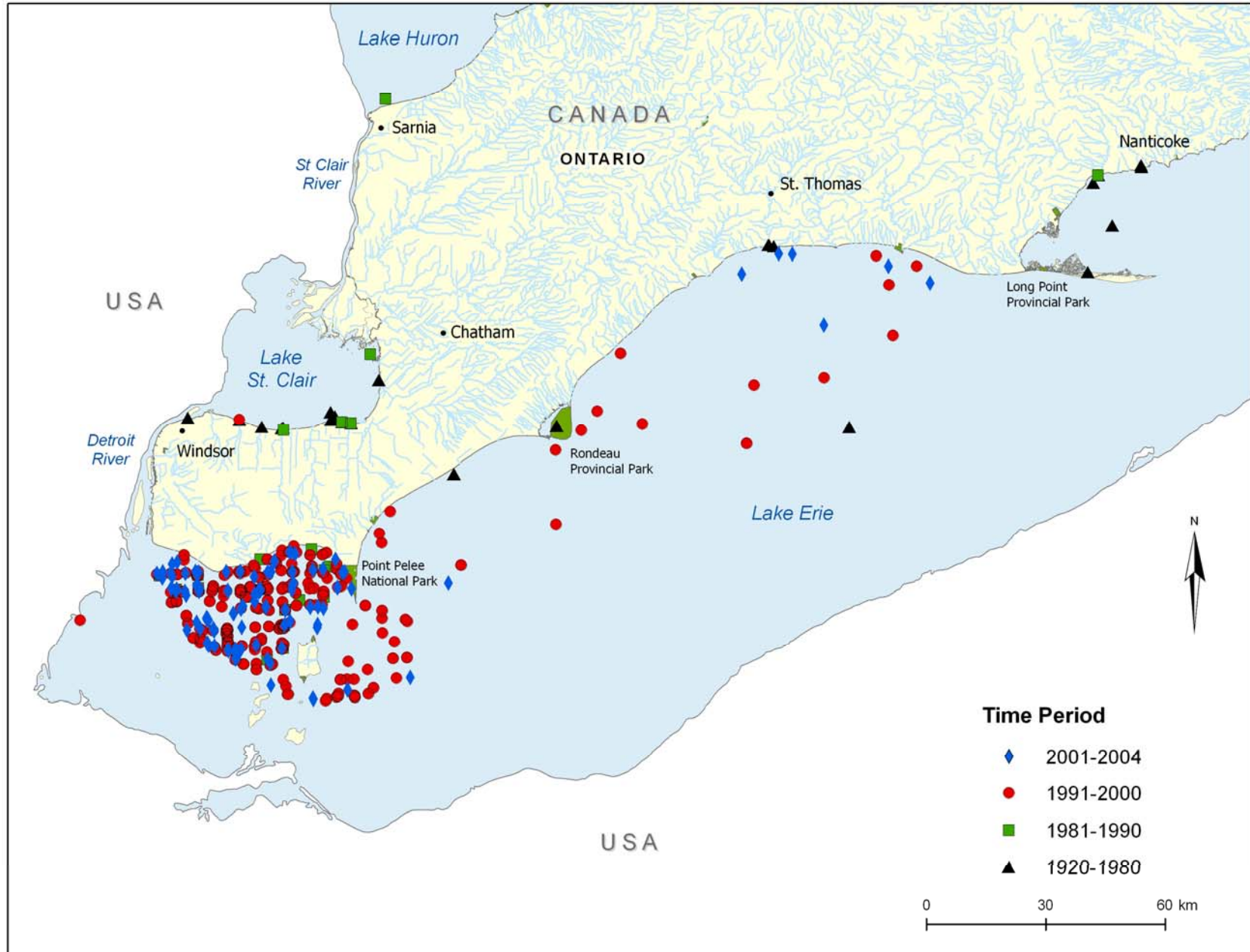


Figure 3a. Canadian range of the Silver Chub – Ontario. Recent OMNR trawl/gill net data not included on map.

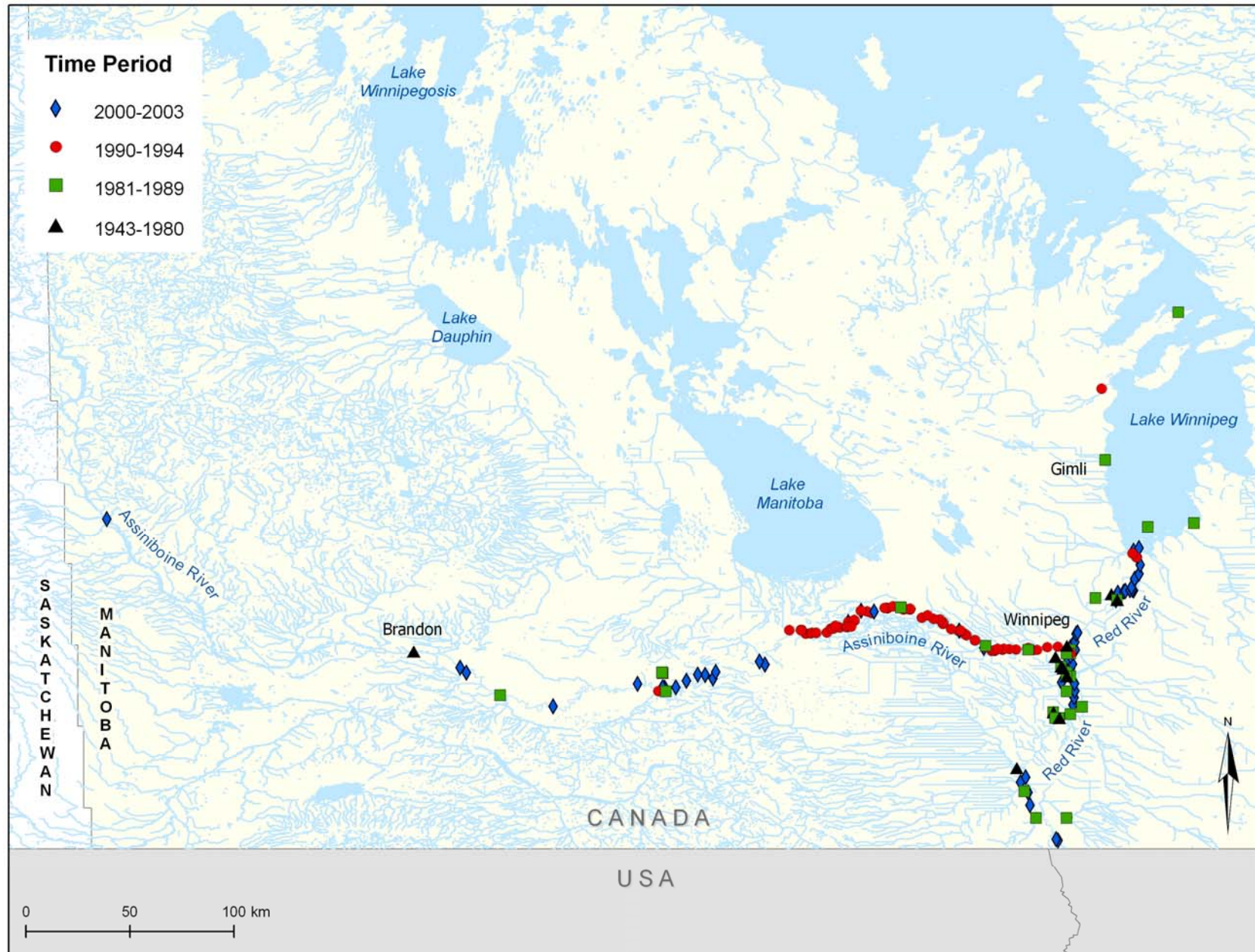


Figure 3b. Canadian range of the Silver Chub – Manitoba.

Percent of Global Distribution in Canada: Less than 5% of the species' global distribution is currently found in Canada.

Population Size and Status:

Global Population Size and Status: Globally, Silver Chub populations are considered Secure (G5). There are limited data available on the size of Silver Chub populations in the United States. Nationally, it is ranked as Secure (N5), and sub-nationally it is ranked Possibly Extirpated (SH) in New York and Critically Imperilled (S1) in Pennsylvania (NatureServe 2007). A complete list of national and sub-national ranks is in Table 1.

Table 1. Canadian and American national and sub-national NatureServe ranks for the Silver Chub (NatureServe 2007).

Canada and U.S. National Rank (NX) and Provincial/State Rank (SX)	
Canada (N3)	Manitoba (S3), Ontario (S2)
United States (N5)	Alabama (S5), Arkansas (S3?), Georgia (S2), Illinois (S5), Indiana (S4), Iowa (SNR), Kansas (S3S4), Kentucky (S4S5), Louisiana (S4), Michigan (S2S3), Minnesota (SNR), Mississippi (S4), Missouri (S3), Nebraska (S4), New York (SH), North Dakota (SNR), Ohio (S3), Oklahoma (S4), Pennsylvania (S1), South Dakota (S2), Tennessee (S5), Texas (S3), West Virginia (S3S4), Wisconsin (S3)

Canadian Population Size and Status: In Canada, the Silver Chub is ranked Vulnerable (N3) nationally, Vulnerable (S3) in Manitoba and Imperilled (S2) in Ontario (NatureServe 2007). It is considered a species of Special Concern by the OMNR (NHIC 2007) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; COSEWIC 2001). The Silver Chub is also listed as Special Concern under the province of Ontario's *Endangered Species Act, 2007* and Canada's *Species at Risk Act* (Schedule 1).

There is limited information available concerning the size of Silver Chub populations in Canada; however, some inferences can be made from available data. It appears that populations are stable in the Assiniboine and Red rivers, while the status of the Lake Winnipeg population is unknown due to the limited number of records. Manitoba Water Stewardship, in partnership with the Lake Winnipeg Consortium and DFO, have conducted annual pelagic trawling surveys of Lake Winnipeg since 2002 and no Silver Chub have been detected to date; however, given the large number of fishes sampled, it is possible that Silver Chub were confused with more common species (B. Scaife, Manitoba Water Stewardship, pers. comm. 2008).

Populations in the western and central basins of Lake Erie appear to be recovering after drastic declines, as a result of poor water quality, that began in the late 1940s and persisted until the mid-1980s (Mandrak and Holm 2001). The Silver Chub has not been caught in the eastern basin of Lake Erie since 2001 (near Port Dover), despite annual trawling surveys conducted in the eastern basin by the OMNR (OMNR 2006).

The species may be less abundant in the eastern basin as a result of its greater depth (average depth is 24 m [OMNR 2006]) and its cooler water temperatures (water temperatures generally take longer to increase compared to western and central basins [OMNR 2006]). Silver Chub

are typically found at 7-12 m and are rarely caught at 20 m (Mandrak and Holm 2001). Silver Chub catches vary from year to year in OMNR surveys conducted on Lake Erie; in 2006, a total of 49 Silver Chub were caught in OMNR surveys (gill net and trawl) while 29 were caught in 2007 (M. Belore, OMNR, pers. comm. 2008). The OMNR seined nearshore areas of the western and west-central basins of Lake Erie in 2007 and did not catch any Silver Chub (M. Belore, pers. comm. 2008).

Surveys conducted in Lake St. Clair by the OMNR in 1979-1981 and 1990-1996 caught moderate numbers of Silver Chub in 1980, 1981 and 1990; in 1991-1996 only one specimen was caught (in 1994; Mandrak and Holm 2001). Additionally, the OMNR seined nearshore habitats in Lake St. Clair in 2007, but Silver Chub were not detected (M. Belore, pers. comm., 2008).

The Michigan Department of Natural Resources conducted annual trawl surveys in Lake St. Clair (including the Canadian side) in 1996-2001 and did not catch any Silver Chub (Thomas and Haas 2004), despite using mesh sizes effective at detecting Silver Chub. The current status of Silver Chub in Lake St. Clair is unknown.

Recent population trends in Lake Huron and parts of the species' Manitoba range are unknown due to limited targeted sampling.

It is difficult to draw conclusions regarding the status of Canadian populations of Silver Chub as many, if not all, of the surveys that have detected the species were not specifically targeting Silver Chub. Targeted surveys, using gear types proven efficient at detecting the species and sampling at appropriate times, will provide a more accurate picture of the status of the Silver Chub in Canada.

Nationally Significant Populations: None have been identified.

1.4 Needs of the Silver Chub

1.4.1 Habitat and biological needs

In Canada, Silver Chub inhabit large lakes and medium- to large-sized rivers with moderate currents, at depths of 7.6 – 12 m, although they have been caught as deep as 20 m (Kinney 1954). Substrate is typically silt or sand, but the species is also sometimes associated with hard substrates such as gravel, rubble, boulder or bedrock (Kinney 1954, Trautman 1981). Robison and Buchanan (1992) stated that the species appears to be tolerant of siltation and turbidity; however, in Ohio, it reached greatest abundance over substrates of clean gravel and sand, and appeared to be susceptible to many types of pollutants (Trautman 1981). In Winnipeg, the species is found in the Assiniboine and Red rivers, which can be very turbid as a result of clay soils. In the Arkansas River, the Silver Chub was found over sand substrate during the day but moved to shore (0.5 – 1 m) to feed at night (Robison and Buchanan 1992). The Silver Chub is not typically associated with aquatic macrophytes (Mandrak and Holm 2001).

Silver Chub spawn in spring or early summer (May to July) at water temperatures of 19-23°C (Mandrak and Holm 2001); however, there is some uncertainty regarding where the species spawns and its spawning habitat requirements. Scott and Crossman (1998) stated that the species likely spawns in open water, while Kinney (1954) observed that, in Lake Erie, the species moved nearshore presumably to spawn. Goodyear *et al.* (1982) suggested that Silver Chub historically spawned over clean gravel substrates in tributaries of Lake Erie.

Depending on the life-stage and available prey, the Silver Chub feeds on a variety of items. In the United States, the species' diet consisted of aquatic insect larvae, Coleoptera, Hemiptera, molluscs, crustaceans and water beetles (Becker 1983, Mandrak and Holm 2001). In Lake Erie, young Silver Chub fed on insect larvae and small crustaceans, while older individuals preyed primarily on mayfly nymphs (*Hexagenia* spp.; Scott and Crossman 1998). The examination of stomach contents of 12 specimens from Lake Erie revealed that eight out of 12 fish contained mayfly nymphs. Other items included fish eggs, zebra mussels (*Dreissena polymorpha*), ostracods and caddisflies (Mandrak and Holm 2001). Alternatively, in 2000, a study examining the gut contents of 110 Silver Chub revealed that 86% of the stomachs dissected contained zebra mussels while only 10% contained *Hexagenia* spp. (N.E. Mandrak, unpubl. data). However, the Silver Chub specimens used in the study were collected from June to November (N.E. Mandrak, unpubl. data), while those collected by Kinney (1954) between February and May, had a high percentage of *Hexagenia* spp. in their guts. Therefore, Silver Chub may switch prey items, depending on seasonal availability, and mayfly nymphs may be more predominant in their diet in early spring, when the nymphs emerge from the substrate and swim to the surface.

1.4.2 Ecological role

The Silver Chub is common at times in the western basin of Lake Erie and in the main stem of the Assiniboine and Red rivers and, as such, might be an important prey species for commercial fishes such as walleye (*Sander vitreus*) and yellow perch (*Perca flavescens*) (Mandrak and Holm 2001).

1.4.3 Limiting factors

Silver Chub are limited by water temperature – Kinney (1954) stated that the species requires water temperatures of 7.2 – 10°C for six or seven months and 21°C for three months to sustain normal growth and allow reproduction. Dissolved oxygen levels are also a limiting factor as Kinney (1954) noted that the species died in an aquarium when oxygen levels fell to 4.4 mg/l. This may be of particular concern in lacustrine environments (e.g., Lake Erie) where anoxic conditions can arise as a result of nutrient loading combined with high water temperatures. Silver Chub may also be limited by competition with and/or predation by yellow perch.

1.5 Threats

Known and suspected threats that affect the Silver Chub include poor water quality (i.e., nutrient loading and resultant eutrophication) and its impacts on Silver Chub prey species, habitat degradation, sediment loading, exotic species, altered coastal processes, climate change and baitfish harvesting (Mandrak and Holm 2001, EERT 2008). Although some threats have decreased in recent years (e.g., nutrient loading in Lake Erie), the extent to which these may currently impact the species has not been fully evaluated and further research into their effects is required.

1.5.1 Threat classification

Table 2 summarizes, in order of concern, all known and suspected threats to the Silver Chub in Canada. Seven threats were ranked based on their expected relative impacts, spatial extent and expected severity. The threat classification parameters are defined as follows:

Extent – spatial extent of the threat in the waterbody (widespread/localized);

Frequency – the frequency with which the threat occurs in the waterbody (seasonal/continuous);

Causal Certainty – the level of certainty that it is a threat to the species (High – H, Medium – M, Low – L);

Severity – the severity of the threat in the waterbody (H/M/L); and,
Overall Level of Concern – composite level of concern regarding the threat to the species (H/M/L).

Table 2. Threat classification table for the Silver Chub in Canada (adapted from EERT 2008).

Specific Threat	Extent (widespread/localized)	Frequency (seasonal/continuous)	Causal Certainty (high, medium, low)	Severity (high, medium, low)	Overall Level of Concern (high, medium, low)
Habitat Degradation	Widespread	Continuous	High	High	High
Nutrient Loading	Widespread	Continuous	High	High	High
Sediment Loading	Widespread	Continuous	Medium	High	High
Climate Change	Widespread	Continuous	Medium	High	High
Exotic Species	Widespread	Continuous	Low	Medium	High
Altered Coastal Processes	Widespread	Continuous	Low	Low	Low
Baitfish Harvesting	Localized	Seasonal	Low	Low	Low

1.5.2 Description of threats

The following descriptions have been adapted primarily from the Essex-Erie Recovery Strategy (EERS; EERT 2008).

Habitat Degradation – Modification of inland watercourses through subsurface and surface drainage activities has negatively affected hydrological networks and reduced the extent and quality of aquatic habitat. The species' historical spawning habitat (clean gravel substrates) within tributaries of Lake Erie has become degraded, and it is believed that the species no longer utilizes these areas (Goodyear *et al.* 1982, EERT 2008). Other factors that are related to habitat degradation, such as sediment and nutrient loading, are dealt with in their own sections.

Nutrient Loadings – Nutrients (nitrates and phosphates) enter waterbodies through a variety of pathways, including: manure and fertilizer applications to farmland; manure spills; sewage treatment plants; and, faulty domestic septic systems. Nutrient enrichment of waterways can negatively influence aquatic health through algal blooms and associated reduced dissolved oxygen concentrations. The Silver Chub was almost lost from Lake Erie in the 1960s, likely as a result of eutrophication and associated low oxygen levels that negatively impacted water quality and the invertebrate food supply for the Silver Chub (Mandrak and Holm 2001). Phosphorous loadings reached a high of 29 000 tonnes in 1968, resulting in a collapse in *Hexagenia* spp. populations. As a result of improved water quality in the late 1980s, *Hexagenia* spp. populations recovered and, in 2004, the mean density of *Hexagenia* spp. in western Lake Erie was 195 nymphs/m², which is close to the density range of Excellent (201-300 nymphs/m²), set by Ohio's Lake Erie Quality Index (OLEC; Krieger *et al.* 2007). Phosphorous levels in Lake Erie showed a significant overall downward trend from 1976 to 1999 (Nicholls *et al.* 2001). However, data from 2000-2004 suggest a continued increasing trend in phosphorous since 1994 at a rate of approximately 1.4µg/L/year; the underlying reasons for this increase in phosphorous are unknown (U.S. EPA 2007). In the Assiniboine and Red rivers of Manitoba, a

major concern is non-point source nutrient enrichment from agricultural runoff as well as the growing hog industry, with high density hog farms being established throughout the watersheds of the Assiniboine and Red rivers (Manitoba Conservation 2000). Significant increases in total nitrogen and phosphorous have occurred in the Assiniboine and Red river drainages in the past 30 years; increases ranged from 29% to 62% for total phosphorous, and from 54% to 57% for total nitrogen in the Red and Assiniboine rivers, respectively (Jones and Armstrong 2001). These two nutrients are major contributors to nutrient enrichment of waterbodies that can result in water quality degradation or eutrophication. Nutrient inputs in to these two watersheds have resulted in the eutrophication of Lake Winnipeg.

Sediment Loadings – Sediment loadings affect inland watercourses, coastal wetlands, and nearshore habitats through decreasing water clarity, increasing siltation of substrates, and may have a role in the selective transport of pollutants including phosphorous. Sediment loading can result in increased turbidity which can affect a species' vision and respiration. Excess sediment loadings are also related to siltation of substrates, which affect many species at risk and their habitats. Siltation can potentially impact a species through decreasing prey abundance as well as smothering eggs laid on the substrate. Although the Silver Chub has been captured from turbid rivers, it moved to cleaner water with gravel substrates when pools became excessively silted (Trautman 1981), and according to Robison and Buchanan (1992) the species reached its greatest abundance over clean, silt-free, substrates of sand and gravel. The impacts of high sediment loads on the Silver Chub in Canada are not fully understood. It seems likely that the species is more tolerant of high levels of suspended solids (i.e., turbidity), compared to high levels of sediment deposition, given that the species has been caught in the turbid (Secchi depths of 10-30 cm are not uncommon) Assiniboine and Red rivers at sites with little to no siltation.

Exotic Species – Exotic species may affect species at risk through several different pathways, including: direct competition for space and habitat; competition for food; smothering of the individual; and, restructuring of aquatic food webs (EERT 2008). There are now at least 182 exotic species that have invaded the Great Lakes basin since 1840 (Ricciardi 2006) and at least some of these species will affect species at risk populations to some extent. Dextrase and Mandrak (2006) indicated that while habitat loss and degradation is the predominant threat affecting aquatic species at risk, exotic species are the second most prevalent threat, affecting 26 of 41 federally-listed species across Canada. The common carp (*Cyprinus carpio*), round goby (*Neogobius melanostomus*) and zebra mussel are three exotic species that have had a dramatic effect on many aquatic species at risk and will continue to alter ecosystems and ecosystem processes. The round goby may negatively impact the Silver Chub through competition for food resources, as *Hexagenia* spp., the preferred prey of the Silver Chub, can also be an important food item for the round goby (French and Jude 2001). Krieger *et al.* (2007) suggested that predation by round gobies may be limiting the abundance of *Hexagenia* spp. in Lake Erie. This has the potential to negatively impact Silver Chub, given that Johnson *et al.* (2005) estimated the round goby population to be 9.9×10^9 individuals in the western basin in 2002. It is also possible that the round goby may feed on Silver Chub eggs or larvae. Possible impacts of zebra mussels on the Silver Chub are not known, but it is possible that the Silver Chub has benefited from the presence of the zebra mussel, as populations of both Silver Chub and its prey, *Hexagenia* spp., recovered shortly after the introduction of the zebra mussel in Lake Erie (Krieger *et al.* 1996). Reasons for the recovery of *Hexagenia* spp. are not fully understood; however, increasing water clarity as a result of the high filtering capability of zebra mussels, allowed increased light to penetrate great depths, thereby increasing benthic productivity (Fahnenstiel *et al.* 1995). This increase in benthic productivity may be one factor behind the re-colonization of Lake Erie by *Hexagenia* spp. Additionally, zebra mussels have

been found in the gut contents of Silver Chub (Mandrak and Holm 2001), and may provide a food source.

Altered Coastal Processes – The alteration of natural coastal processes through the hardening of shorelines and other activities such as sand and gravel mining has been suggested as a threat for species at risk fishes, including the Silver Chub (EERT 2008). The extent to which this impacts the Silver Chub is currently unknown as the species is believed to spend the majority of time offshore in open water areas.

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; changes 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). The Silver Chub has specific water temperature requirements (7.2 - 10°C for six or seven months; Kinney 1954), and it is possible that climate change may have an impact on the species through shifts in water temperatures. Climate change may also impact *Hexagenia* spp., the preferred prey of Silver Chub. *Hexagenia* spp. are sensitive to hypoxia (low dissolved oxygen levels; Krieger *et al.* 1996, 2007) and chronic hypoxia, at temperatures of $\leq 14^{\circ}\text{C}$, has been shown to reduce the survival rates of mayfly nymphs (20% survived for 8 days in hypoxic conditions), and this effect is increased at higher water temperatures (Krieger *et al.* 1996). Persistent hot conditions or unusual weather conditions that permit the establishment of a shallow hypolimnion over large areas of the western basin of Lake Erie, could lead to anoxic (lack of dissolved oxygen) conditions at the bottom of the lake (Krieger *et al.* 1996); this would likely have a negative impact on *Hexagenia* spp. populations. It is anticipated that the effects of climate change will be widespread and should be considered a contributing impact to species at risk and all habitats. Identifying mitigation measures to adapt and prevent negative implications as a result of climate change will require coordination with other agencies for research, recommended mitigation measures and monitoring.

Baitfish Harvesting – Baitfish harvesting is regulated in Manitoba with “bait fish” defined in Schedule 1 under the (federal) Manitoba Fishery Regulations, 1987, to include “Minnows, except carp and goldfish”, which would make the Silver Chub a legal baitfish species. Currently, there are eight commercial baitfish harvesters licensed on the Red River who seine for baitfish. There are also eight harvesters licensed for the Lake Winnipeg south basin; however, production in the lake proper is low, and is most likely confined to harvesters seining areas near shore, particularly near the mouth of the Red River or other rivers flowing into the lake. In some cases, baitfish harvesters are also commercial fishermen who use their baitfishing licence to market incidental catch of small tullibee/ciscoes of little interest to the food market. No studies have been conducted on harvested baitfish to determine the occurrence of Silver Chub.

The Silver Chub is not a legal baitfish in Ontario (OMNR 2008).

Incidental harvest as a result of commercial fishing has been described as a potential threat to the Silver Chub (Mandrak and Holm 2001); however, the minimum mesh size of commercial gill nets in Lake Erie is 57 mm, and during OMNR surveys, 99% of Silver Chub were caught in mesh sizes less than 57 mm (M. Belore, pers. comm. 2008). Therefore, incidental catch from commercial operations in Ontario is not likely to present a serious threat to the Silver Chub. Similarly, incidental harvest is not considered a threat to populations in Manitoba where the minimum commercial gill net size is approximately 76 mm (D. Watkinson, pers. comm. 2008).

1.6 Actions Already Completed or Underway

Essex-Erie Recovery Strategy: The goal of the strategy is, “to maintain and restore ecosystem quality and function in the Essex-Erie region to support viable populations of fish species at risk, across their current and former range” (EERT 2008). Included in this strategy are recovery/management initiatives for the Silver Chub as well as 14 other fish species at risk.

Coordination with Species at Risk Recovery Teams: (The following information has been adapted from the EERS [EERT 2008]).

The development and implementation of management actions is being coordinated with other species at risk recovery teams throughout the range of the Silver Chub in southwestern Ontario. For example, many of the members of the Ontario Freshwater Fishes Recovery Team (OFFRT) are also members of one or more other recovery teams and efforts to formalize communication pathways with each of the other teams should be encouraged. One area where coordination with other recovery teams would benefit greatly is during implementation of habitat improvement activities (particularly with ecosystem-based recovery teams). By sharing information with other recovery teams, funding can be acquired to implement projects which provide multiple benefits. Coordination with other recovery teams will also help to ensure that proposed management actions do not negatively impact other species at risk found within the range of the Silver Chub; management actions may in fact enhance or facilitate the recovery of other species at risk.

Lake Winnipeg Action Plan: In 2003, an action plan was announced to help protect Lake Winnipeg. The Plan is a commitment to reduce nitrogen and phosphorus loads to pre-1970s levels. The Lake Winnipeg Action Plan was developed in part from scientific research conducted through the [Nutrient Management Strategy](#) and will be updated as studies continue (Government of Manitoba 2007).

Detroit River Remedial Action Plan: To improve environmental conditions in the Detroit River Area of Concern, a Remedial Action Plan (RAP) has been developed. The plan was initiated in 1987 as a partnership between Canadian and U.S. federal governments, provincial and state governments, with cooperation from industry, municipalities, other stakeholders and the Detroit River Bi-national Public Advisory Committee (Environment Canada 2008).

Recent Surveys: The following table summarizes recent fish surveys conducted by various organizations throughout the range of the Silver Chub. The majority of these surveys did not specifically target the Silver Chub.

Table 3. Summary of recent fish surveys throughout the range of the Silver Chub. The species was detected during surveys that are in bold.

Waterbody/General Area	Survey Description (years of survey effort)
Lake St. Clair	<ul style="list-style-type: none"> • Nearshore fish community survey, OMNR[†] (2005, 2007)^a • Fish community survey, Michigan DNR (1996-2001)^b • Essex-Erie targeted sampling for fishes at risk, DFO (2007)^{a, c} • Fall trap-net survey, OMNR (1974-2007, annual)^e • Young-of-the-year index seine survey, OMNR (annual)^a
Detroit River	<ul style="list-style-type: none"> • Fish-habitat associations of the Detroit River, DFO and University of Windsor (2003-2004)^{a, d} • Coastal wetlands of Detroit River, DFO and University of Guelph (2004-2005) • Fish community surveys, DFO and OMNR (2003, 2004)^d
Lake Erie	<ul style="list-style-type: none"> • Interagency trawling survey in western basin, OMNR (1987-2007, annual)^b • Coastal wetlands along Lake Erie (2004-2005)^e • Partnership gill net survey, lake-wide, OMNR (1989-2007, annual)ⁱ • Nearshore beach seining surveys, OMNR and DFO (2005-2006)^a (Reid and Mandrak 2008) • Nearshore seine survey, west and west-central basins, OMNR (2007)^a
Point Pelee	<ul style="list-style-type: none"> • Fish species composition study (Surette 2006), University of Guelph, DFO and PPNP (2002-2003)^{a, c, f, g, h}
Rondeau Bay	<ul style="list-style-type: none"> • Fish community surveys, OMNR and DFO (2004-2005)^{a, d, f}
Long Point Bay	<ul style="list-style-type: none"> • Index surveys, OMNR (annually)^b • Essex-Erie targeted sampling for fishes at risk (Turkey Point), DFO (2007)^{a, c, d}
Assiniboine River	<ul style="list-style-type: none"> • Instream flow needs long-track fish survey, DFO (1995, 1996, 2001, 2002)^d
Red River	<ul style="list-style-type: none"> • Species at risk fish survey, DFO (2002-2003)^d
Lake Winnipeg – North Basin, South Basin, Channel Area	<ul style="list-style-type: none"> • Species distribution and abundance, pelagic trawling surveys, Manitoba Water Stewardship, Lake Winnipeg Consortium, DFO (2002-present, annually)^b

[†] Acronyms: OMNR – Ontario Ministry of Natural Resources; DNR – Department of Natural Resources; DFO – Fisheries and Oceans Canada; and, PPNP – Point Pelee National Park

Gear type: a – seine net; b – trawl; c – trap net; d – boat electrofishing; e – backpack electrofishing; and, f – fyke net; g – minnow trap; h – Windemere trap; i – gill net

1.7 Knowledge Gaps

In Canada, the Silver Chub has not been thoroughly studied, and there are numerous aspects regarding its biology and ecology that remain unknown – this information is required to refine management approaches. For example, it is not clear where the species spawns – Scott and Crossman (1998) assumed that Silver Chub spawned in open water, while Kinney (1954) reported that the species leaves the open waters of Lake Erie to spawn nearshore. Goodyear *et al.* (1982) indicated that the species historically moved into tributaries of Lake Erie to spawn. The exact nature and extent of the threats currently facing the Silver Chub are also unknown.

2.0 MANAGEMENT

The following goals, objectives and management approaches were adapted from the EERS (EERT 2008). The management goal will be achieved primarily through the implementation of ecosystem recovery/management approaches (where applicable), in cooperation with relevant single/multi-species and ecosystem-based recovery programs, to mitigate identified threats. See Section 4.0 for a list of recovery programs relevant to the management of the Silver Chub.

2.1 Goal

The long-term goal (over the next 20 years) is to maintain, or enhance, existing populations of Silver Chub in Canada, and to improve the quality and quantity of its associated habitats.

2.2 Objectives

- i. Determine the extent, abundance and population demographics of existing populations;
- ii. Identify key habitat requirements;
- iii. Determine long-term population and habitat trends;
- iv. Identify and mitigate threats to the species and its habitat;
- v. Continue to coordinate management efforts with relevant recovery teams (e.g., ecosystem-based recovery teams) and other agencies or complimentary groups/initiatives; and,
- vi. Continue to increase public awareness regarding the distribution, threats and management of the Silver Chub.

2.3 Actions

2.3.1 Background surveys

Conduct targeted population and habitat surveys in Lake St. Clair and other historical locations where recent population trends are unknown. Such surveys will determine the range, abundance and population demographics of the species. Sampling methods should be standardized, include a relevant assessment of habitat characteristics, and should employ techniques proven effective at detecting Silver Chub, such as trawling and/or seining (See Portt *et al.* [in press] for sampling methods effective at detecting the Silver Chub). Efforts will be coordinated with surveys for Endangered and Threatened fishes as appropriate/feasible.

2.3.2 Monitoring

Where possible, collect standardized index population and habitat data through existing monitoring programs (e.g., OMNR Lake Erie annual trawls, Lake Winnipeg annual trawls [conducted by Manitoba Water Stewardship in partnership with the Lake Winnipeg Consortium and DFO], Endangered/Threatened species monitoring). Data collected through existing monitoring programs will allow for quantitative tracking of changes in population abundance and demographics and analyses of habitat use and availability, and changes in these parameters over time. Where feasible, monitoring protocols should take into account the sampling methods used in the background survey work and provide guidance on the time of sampling. The intent is not to develop a stand-alone monitoring program but to harmonize population and habitat data needs with existing monitoring programs.

2.3.3 Research

Research on the biology, life-history and habitat requirements of the Silver Chub is a requirement as little is currently known about the species, such as where it spawns, the spawning act itself and age-specific habitat requirements. Additionally, information on the

seasonal habitat requirements and habitat use is needed to identify occupied and potentially suitable habitat for the species. If feasible, samples collected during annual OMNR index surveys of the western basin of Lake Erie should be kept for studies on the biology, reproduction and life-history of the Silver Chub. Data collected from background surveys and monitoring will help to inform research activities with respect to spatial and temporal considerations (e.g., spawning times and locations).

Potential threat factors impacting extant populations need to be investigated and evaluated. For example, the impacts of altered coastal processes and exotic species, such as the round goby on the Silver Chub, are unknown. Assessing the threats to individual populations may provide insight to lessen their influence.

2.3.4 Threat Mitigation

Steps should be taken to mitigate immediate known threats as well as threats informed through research (Section 2.3.3). Threat mitigation will be accomplished primarily through the implementation of recovery approaches from relevant ecosystem-based and single/multi-species recovery programs.

2.3.5 Coordination with recovery teams and other complimentary initiatives

The EERS, an ecosystem-based strategy, has incorporated the requirements of the Silver Chub. As well as species-specific considerations, the EERS employs basin-wide strategies to improve environmental conditions such as water quality, benefiting the Silver Chub and other species. In addition, the implementation of Silver Chub management actions will be coordinated with recovery approaches for Endangered and Threatened species with distributions that overlap that of the Silver Chub (see Section 4.0 for list of species). A coordinated approach between the OFFRT and other species- or ecosystem-based recovery teams that maximizes opportunities to share resources, information and combine efficiencies is recommended.

2.3.6 Outreach and communication

The OFFRT will raise awareness regarding the Silver Chub, within the scientific and conservation communities that are involved in the management and monitoring of freshwater fishes in Ontario. Additionally, the Silver Chub should be considered in existing communication and outreach programs for both ecosystem-based recovery as well as Endangered and Threatened aquatic species, to instill the awareness of the need to protect freshwater fishes and ensure the health of aquatic freshwater ecosystems.

2.4 Effects on Other Species

Proposed management actions will benefit the environment in general. It is likely that implementation of the suggested management actions will benefit a wide variety of native species, including other co-occurring species at risk. Many of the stewardship and habitat improvement activities will be implemented through ecosystem-based recovery programs that have already taken into account the needs of other species at risk. No negative impacts on other species resulting from implementation of Silver Chub management actions are expected.

3.0 PROPOSED IMPLEMENTATION SCHEDULE

Fisheries & Oceans Canada encourages other agencies and organizations to participate in the conservation of the Silver Chub through the implementation of this management plan. The agencies below have been identified as partners for implementing the recommended actions.

Table 4 summarizes those actions that are recommended to support the management goals and objectives. The activities implemented by Fisheries & Oceans Canada will be subject to the availability of funding and other required resources. Where appropriate, partnerships with specific organizations and sectors will provide the necessary expertise and capacity to carry out the listed action. However, this identification is intended to be advice to other agencies, and carrying out these actions will be subject to each agency's priorities and budgetary constraints.

Table 4. Proposed implementation schedule.

Action	Objectives	Priority	Threats Addressed	Participating agencies		Schedule (years)
				Ontario	Manitoba	
Background Surveys	i, ii	Necessary	All	DFO, OMNR, CA	DFO	2010-2014*
Monitoring	ii, iii	Necessary	All	DFO, OMNR, CA	DFO, LWC, MWS	2010-2014*
Research	ii, iii, iv	Necessary	All	DFO, OMNR, CA	DFO	2010-2016*
Threat Mitigation	iv	Necessary	All	DFO, OMNR, CA	DFO, LWC, MWS	Ongoing*
Coordination with Recovery Teams	v	Beneficial	All	DFO, OMNR, CA	DFO	Ongoing*
Outreach and Communication	vi	Beneficial	All	DFO, OMNR, CA	DFO	Ongoing*

[†] Timeframes are subject to change in response to demands on resources.

* In conjunction with relevant single-species and ecosystem-based recovery strategies

† See section: 1.5.2 Description of Threats

†† Acronyms:

DFO – Fisheries and Oceans Canada

OMNR – Ontario Ministry of Natural Resources

CA – Conservation Authorities

LWC – Lake Winnipeg Consortium

MWS – Manitoba Water Stewardship

4.0 ASSOCIATED PLANS

The Silver Chub is included in the ecosystem-based Essex-Erie Recovery Strategy (EERT 2008). Other ecosystem-based recovery strategies that may be applicable to the conservation of the Silver Chub are the Sydenham River Recovery Strategy (Dextrase *et al.* 2003) and the Thames River Recovery Strategy (TRRT 2005); both of these watersheds contribute a significant loading of sediments and nutrients to Lake St Clair where the Silver Chub is known to occur. Fishes with single-species recovery strategies that have distributions overlapping that of the Silver Chub include northern madtom (*Noturus stigmosus*) and pugnose shiner (*Notropis anogenus*).

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6.0 CONTACTS

The following members of the Ontario Freshwater Fish Recovery Team were involved in the development of the management plan for the Silver Chub:

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Doug Watkinson	Fisheries and Oceans Canada
Anne Yagi	Ontario Ministry of Natural Resources

APPENDIX 1. RECORD OF COOPERATION AND CONSULTATION

The Silver Chub Management Plan was prepared by Fisheries and Oceans Canada (DFO) with input from representatives of the Ontario Ministry of Natural Resources (OMNR), Ontario Ministry of the Environment (MOE) and Manitoba Water Stewardship. All members of existing ecosystem-based recovery teams (Ausable River, Thames River, Sydenham River, Grand River and Essex-Erie region) were invited to participate in the development of this management plan. These included federal and provincial governments, academic institutions, conservation authorities and First Nations groups/agencies (including Six Nations EcoCentre, Chippewas of the Thames, Delaware Nation, Munsee-Delaware First Nation Oneida Nation of the Thames and Southern First Nations Secretariat).

During the development of this proposed management plan, DFO has attempted to engage all potentially affected native communities by sending information packages to the Chief and council and asking for comments on the plan. In Ontario, these packages were sent to Aamjiwnaang First Nation, Caldwell First Nation, Six Nations of the Grand, Walpole Island First Nation, Metis Nation of Ontario (MNO) Captain of the Hunt for Regions 7 and 9, and the MNO senior policy advisor. In Manitoba, packages were sent to Brokenhead Ojibway Nation, Dakota Plains First Nation, Fort Alexandra First Nation, Long Plain First Nation, Roseau River Anisnabe First Nation, Sioux Valley Dakota Nation and Swan Lake First Nation. Members of these communities may have travelled or harvested fish from the waters where this species was historically found. Follow-up telephone calls were made to each community office to ensure that packages were received and to ask if they would like to schedule a meeting to learn more about species at risk in general and the proposed management plan in particular. To date, no requests for meetings have been received. Only one community offered comments indicating that this was a species that was not commonly utilized.

DFO has prepared a list of non-government organizations and municipalities which may be impacted by the proposed management plan. Information packages have been prepared to inform these groups that the proposed management plan is about to be approved and invites each group to comment on the plan. As well, an announcement has been prepared and will be placed in newspapers with circulation in the area where the Silver Chub was historically found to inform landowners and the general public about the management plan, and to request their comments. These packages will be sent and the announcements published at the time the proposed management plan is posted on the SARA registry.