Rare, Threatened, and Endangered Fish Species of Southern Ontario: Status Reports

Submitted to: Department of Supply and Service
Department of Fisheries and Oceans
National Museum of Natural Sciences

September 1980

Beak Consultants Limited

RARE, THREATENED AND ENDANGERED FISHES IN SOUTHERN ONTARIO: STATUS REPORTS

A Report for

DEPARTMENT OF SUPPLY AND SERVICES
DEPARTMENT OF FISHERIES AND OCEANS
NATIONAL MUSEUM OF NATURAL SCIENCES

September 1980

EXECUTIVE SUMMARY

Status reports for thirteen species of fish which have been considered for inclusion in the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) list of rare, threatened, endangered and extinct fishes of Canada were prepared. The Canadian ranges of all species for which status reports have been prepared are mainly contained within southern Ontario.

During the period August 1979 to September 1980 a records and field research program was conducted. The records research component of this program consisted of a search of all available Ontario Ministry of Natural Resources data, federal and provincial museum records, and an extensive literature review. Scientific authorities were also invited to comment on source information and to contribute data when possible. The field research program was separated into two sampling units, the first extended from August to October 1979, and the second from May to June 1980. Seines and electrofishing units were used. Over two hundred samples were taken throughout southern Ontario. Nine of the thirteen species for which status reports were prepared were captured during this survey. The proposed status, population trend, major water body of capture and justification for proposing a status for each species is given opposite the species names in Table 1.

Table 1: Rare, threatened and endangered fish species of southern Ontario, Status Summary

SPECIES	STATUS	POPULATION TREND	OCCURS IN	STATUS JUSTIFICATIONS
Spotted gar Lepisosteus oculatus	Rare	Uncertain	Lake Erie, Lake St. Clair	fringe of range restricted range in Canada low population numbers
Stoneroller Campostoma anomalum	Rare	Stable or Expanding	Thames River, Niagara River	fringe of range restricted range in Canada locally abundant
Redside dace Clinostomus elongatus	Threatened	Declining	Tributaries to western Lake Ontario, Grand R., Saugeen R.	low population numbers restricted range in Canada man-induced habitat degradation
Silver chub Hybopsis storeriana	Rare	Uncertain	Lake Erie, Lake St. Clair St. Clair R., possibly S. Man.	fringe of range restricted range in Canada low population numbers
Gravel chub Hybopsis x-punctata	Endangered	Possibly Extirpated	Thames R.	fringe of range restricted range in Canada extremely low population numbers possible habitat degradation
Pugnose Shiner Notropis anogenus	Endangered	Possibly Extirpated	Lake Erie, St. Lawrence R.	habitat degradation restricted range in Canada extremely low population numbers
Pugnose minnow Notropis emiliae	Threatened	Declining	Lake St. Clair, Thames R., Sydenham R., tributaries to Lake Erie	northern fringe of range restricted range in Canada low population numbers man-induced habitat degredation
Silver shiner Notropis photogenis	Rare	Stable	Grand R., Thames R.	fringe of range restricted range in Canada locally abundant
Spotted sucker Minytrema melanops	Rare	Uncertain	Lake St. Clair, Thames R., Lake Erie, Sydenham R.	fringe of range restricted range in Canada low population numbers
River redhorse Moxostoma carinatum	Threatened	Declining	Mississippi R., Grand R., Ausable R., S. Que.	restricted range in Canada low population numbers population possibly reduced by removal of adult specimens
Black redhorse Moxostoma duquesnei	Threatened	Uncertain	Grand R., Thames R., tributaries to Lake Erie	restricted range in Canada low population numbers man-induced habitat degredation
Brindled madtom Noturus miurus	Rare	Stable	Sydenham R., Lake St. Clair, Lake Erie and its tributaries	fringe of range restricted range in Canada low population numbers
Blackstripe topminnow Fundulus notatus	Rare	Stable	Sydenham R.	fringe of range restricted range in Canada man-induced habitat degradation

Each status report provides species specific information on distribution, population structure and biology of Canadian populations. Comparative and supplementary information are included from pertinent literature.

The status of a species was determined using the formulated data base. Each species was placed into a category of rare, threatened or endangered, no species was designated extinct. The categories of rare, threatened, endangered, and extinct are taken from approved COSEWIC terminology, that being:

RARE SPECIES: Any indigenous species of fauna or flora that, because of its biological characteristics, or because it occurs at the fringe of its range, exists in low numbers or in very restricted areas in Canada but is not a threatened species.

THREATENED SPECIES: Any indigenous species of fauna or flora that is likely to become endangered in Canada if the factors affecting its vulnerability do not become reversed.

ENDANGERED SPECIES: Any indigenous species of fauna or flora whose existence in Canada is threatened with immediate extinction through all or a significant portion of its range, owing to the action of man.

EXTIRPATED SPECIES: Any indigenous species of fauna or flora no longer existing in the wild in Canada but existing elsewhere.

EXTINCT SPECIES: Any species of fauna and flora formerly indigenous to Canada but no longer existing anywhere.

Immediate threats to the welfare of a species are determined and general and specific recommendations for the maintenance and monitoring of each species in Canada are proposed. Each status report contains a list of museum specimens and literature references used during the preparation of the individual report.

ACKNOWLEDGEMENTS

BEAK is indebted to many individuals and organizations that assisted in the gathering and preparing of information for this report. To those persons who provided information, records or specimens we express our thanks: D. Bowen, D. Craig, E. Crossman, C. Fernando, C. Gilbert, G. Goodchild, C. Gruchy, D. Hector, J. Hamilton, E. Holmes, P. Hunter, R. Jenkins, M. Keeleyside, T. Keller, R. Knight, E. Kott, R. Krause, D. Krewtzweiser, D. Lee, J. Leslie, B. Lewies, E. Magnin, P. Mason, D. McAllister, S. Nepszy, J. Pain, M. Petzal, B. Scott, T. Sowden, and B. Trautman. We are particulary grateful to D. McAllister and C. Gruchy, National Museum of Natural Sciences, and G. Robins for their encouragement and guidance. We sincerely appreciate the assistance given by the Ontario Ministry of Natural Resources, the Royal Ontario Museum and the National Museum of Natural Sciences in providing specimens and collection records.

We thank E. Crossman and B. Scott for permission to use specimen drawing from "Freshwater Fishes of Canada", and P. Buerschaper for drawings of the stoneroller, blackstripe topminnow, spotted sucker and silver shiner. Thanks to D. Lee and associated editors of "Atlas of North American Freshwater Fishes" for use of North American species distribution maps. Special thanks to E. Kott for his assistance and expertise in preparing the black redhorse status report and to D. Hector for providing newly captured specimens of the silver chub and the spotted sucker.

CONTENTS

INTRODUCTION

During the spring of 1979, Dr. D. E. McAllister and C.G. Gruchy, both of the National Museum of Natural Sciences and G.L. Robins of the Department of Fisheries and Oceans submitted to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) a list of twenty-two species of fish that were believed to be rare, threatened, endangered or extinct in Canada.

Canadian studies of these fish had been undertaken in the minority of cases. A very small Canadian data base existed for the majority of species that were included in the COSEWIC submittal. A need for further data with which to determine the status of these fish in Canada was recognized.

Beak Consultants Limited (BEAK) successfully submitted an Unsolicited Proposal to the Department of Supply and Services and was awarded a contract to research and prepare status reports on thirteen fish species that appeared in the COSEWIC submittal. Those species are:

Spotted gar	*Lepisosteus oculatus* (Winchell)
Stoneroller	*Campostoma anomalum* (Rafinesque)
Redside dace	*Clinostomus elongatus* (Kirkland)
Silver chub	*Hybopsis storeriana* (Kirkland)
Gravel chub	*Hybopsis x-punctata* (Hubbs and Crowe)

Pugnose shiner	*Notropis anogenus* Forbes
Pugnose minnow	*Notropis emiliae* (Hay)
Silver shiner	*Notropis photogenis* (Cope)
Spotted sucker	*Minytrema melanops* (Rafinesque)
River redhorse	*Moxostoma carinatum* (Cope)
Black redhorse	*Moxostoma duquesnel* (Lesueur)
Brindled madtom	*Noturus miurus* Jordan
Blackstripe topminnow	*Fundulus notatus* (Rafinesque)

The Canadian ranges of these fish species are primarily restricted to southern Ontario.

This report contains the results of an intensive field and records survey for the above fish species. The status of each of these fish is proposed with recommendations for the monitoring and maintenance of each in Canada.

STUDY AREA

The field study initiated for this program required the sampling of previous capture sites for each of the thirteen fish species under consideration. This program format required that much of southwestern Ontario and sections of eastern Ontario comprise the study area. During this study over 200 locations were sampled from Lake St. Clair to the St. Lawrence River (Figure 1).

Watersheds and major water bodies that were sampled included: Lake St. Clair, Sydenham River, Thames River, Lake Erie, Kettle Creek, Catfish Creek, Dedrick Creek, Grand River, Niagara River, Bronte Creek, Sixteen Mile Creek, Credit River, Humber River, Rouge River, Duffins Creek, St. Lawrence River and Mississippi River.

A diverse assemblage of habitats were sampled. Descriptions of each sampling site are supplied in the field collections data-sheets held at the National Museum of Natural Sciences (Ref. No. NMC79-1014 to 79-1213 and 80-0854 to 80-0903. Colour photographs of many of the sampling sites accompany the data-sheets.

Most of these aquatic environments have been influenced by mans' activities for a century or more. Forest clearing, agricultural, urban, and industrial develop-

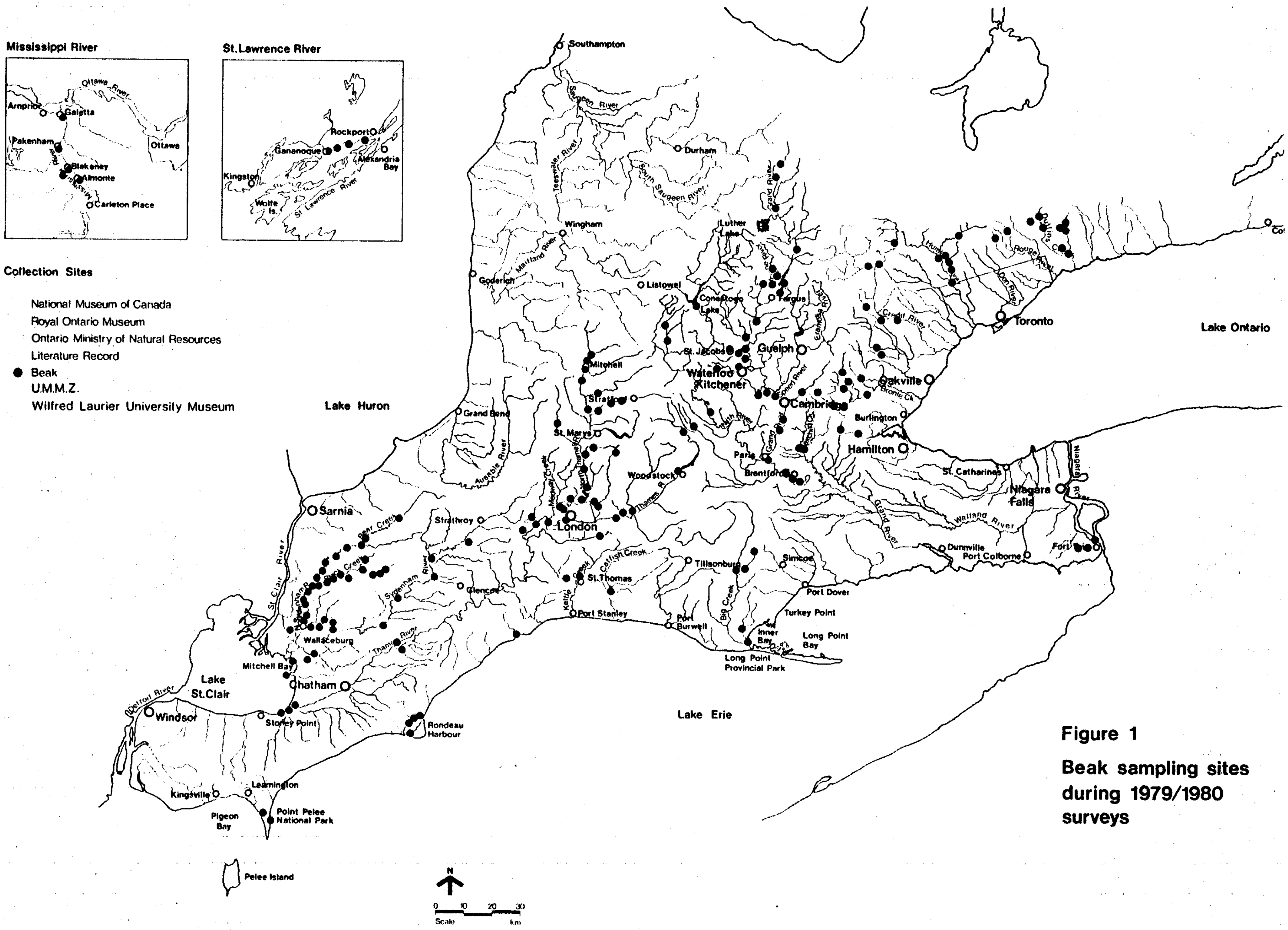


Figure 1

Beak sampling sites during 1979/1980 surveys

ment and associated waste disposal, impoundment for flood control and power production, channelization and bank stabilization through urban centres, road and bridge construction, and tiling and drainage ditch construction have substantially altered the primitive state of these rivers. These activities have resulted in increased erosion, introduction of municipal and industrial contaminants, alteration of streamflow regimes, elimination of riverine habitat, increased suspended solids and siltation, and increased nutrient loading. Some sections of these rivers, such as headwaters, urban parkland, crownland, swamps, marshes, and farm woodlots, still reflect original aquatic habitat.

Changes in the aquatic communities have occurred in conjunction with these habitat changes. The effects of such changes on an individual species may range from population expansion into previously unfavourable habitat, to species displacement into marginal habitat and possible extirpations from whole drainage basins due to deteriorating habitat quality, or to ecological pressures.

STUDY DESIGN

BEAK initiated a literature and records search prior to undertaking the field program. Locality records were obtained from the National Museum of Natural Sciences, the Royal Ontario Museum, the Ontario Ministry of Natural Resources, various university collections and the published literature.

Based on the information obtained from these data searches, the sampling program was divided into two time periods. Most of the sampling was accomplished between 15 August and 15 October 1979. This period coincided with low water levels in many of the watersheds. A second sampling period extending from 5 May to 30 June 1980 was timed to collect spawning fish.

Field crews collected fish samples from prior capture sites. Collections were made using 6 or 12 m long seines, dip nets and Smith-Root Type VII electrofishers.

Following the capture of a species of concern, various habitats were sampled in the immediate area of capture to determine species habitat preferences. Once this had been accomplished, the distribution of that species within a watershed was delineated by sampling similar habitats upstream and downstream of the capture location.

Field data sheets from the Ichthyology Division of the National Museum of Natural Sciences were used to record the necessary data that were collected at each sampling site. Catch-per-unit-effort, relative abundance, population estimates, and observed habitat preference were also recorded. Habitat and specimen photos were taken at the majority of sampling sites to supplement the written description. Physicochemical data such as water temperature, water velocity, turbidity, pH, and dissolved oxygen concentration were recorded at a number of sampling sites.

When possible, fish were identified to species in the field. When a species of concern was identified in a sample, a representative collection was preserved along with a subsample of other fish species from the same locality. Specimens identified but not kept for preservation were released.

Fish samples that were kept for further reference, were preserved in the field in 10% Formalin and were later transferred to 45% isopropyl alcohol.

Field identifications of fish were verified in BEAK's Toronto laboratory. When necessary, specimens were taken to the Royal Ontario Museum for further verification. Lengths (mm), weights (g), sex and state of sexual development were recorded for each size class. External parasites were also noted and identified.

For age determination, scales were removed from above the lateral line, below the anterior insertion of the dorsal fin for soft-rayed fish, and scales from below the lateral line, immediately posterior to the pelvic fin for spiny-rayed fish. Scales were read separately by two people. Validation of the applicability of scales for age determinations was not available for all species examined. For each species the methodology is outlined in the pertinent status report.

Stomach contents were removed and identified to the lowest practical taxonomic level (i.e., order or family). Numeric, frequency of occurrence, and volumetric methods were employed to express the importance of a food item in the diet of a fish (See Legler 1956 for more details.)

Specimens captured during spawning periods were examined to determine sexual development following a modification of the method proposed by Nikolski (1963). Relative fecundity was estimated by gravimetric methods: a subsample of 100 eggs was weighed and an estimate of total egg numbers per individual was calculated from total ovary weight.

Specimens of four of the 13 species were not collected. In these cases, or when the number of specimens captured was very low, museum specimens were used to supplement the data base. Personal communications with scientific authorities, and Ontario Ministry of Natural Resources personnel were relied on heavily in the evaluating of the status of those species which were not captured.

STATUS REPORT FORMAT

Each status report follows the same outline. The information contained in each section is detailed below. The format for these status reports has been altered from the approved outline for status reports suggested by COSEWIC for two reasons:

1. The flexibility for including new data, derived from this study, was not present within the framework of the approved format. For the majority of fish species dealt with in this report, it was the first Canadian study that had been undertaken. Following the approved format would have neccessitated the exclusion of new information that otherwise may not have been reported.

2. Many of the subheadings included within the approved format are not applicable to the fish species considered in this report, or they required data that is unavailable at this time due to a lack of historical Canadian data.

In the light of the above factors, a revised outline for reporting the status of species included in this report was formulated with the aid of C.G. Gruchy and

D.E. McAllister of the National Museum of Natural Sciences. The resulting format allowed for the presentation of information that was used to access the status of all thirteen fish species included in this report. This format also permits the inclusion of all new data derived from this study, and the necessary comparison with pertinent literature sources.

The following format is used for status reports:

INTRODUCTION

Each status report is headed with the common and scientific name for the species. A scaled line drawing illustrates each species. The proposed status of the species appears below the line drawing. In the text, a general description is given of the North American and Ontario range of the species, and the distance to or the location of the nearest species population center.

This is followed by a summary of pertinent literature emphasizing Canadian data sources. A brief history of the occurrence of the species in Canada, and the reasons for proposing a special status for the species is included. When a status has been assigned to a species in the literature or by a government agency it is noted. Distinguishing characteristics of the species are also provided.

DISTRIBUTION

Information on the distribution of species included in this report are presented both in written and graphic form. North American and Canadian distributions are given. The North American distribution of a species is outlined first. A North American spot distribution map (adapted from Lee *et al*. (1980)) is included. Additional Canadian records were added to these maps when possible. A detailed account of the Canadian distribution is then provided. Watersheds and specific locations of capture are given. The Canadian ranges of the majority of species are within southern Ontario. However, when a species occurs in other parts of Canada a written account of this portion of the Canadian range is included. A study area map that details records and sources is provided for each species. The distribution of lake-inhabiting species is shown as barred areas when there are insufficient data on actual capture sites.

POPULATION

A discussion of population trends, estimates of population size, population centers, and probable causes of alteration of population structure are included in this section. A synopsis of the occurrence of each species in Canadian waters is outlined with reference to prior studies. BEAK's efforts to obtain specimens during this study are described and an analysis of the status of each species based on available information is given.

THREATS

Threats to a species are outlined. The threats which appear in this section have immediate consequences or will pose a threat to the species in the near future and exclude long-term forms of habitat degradation. For example, dam and bridge construction, livestock degradation, ditching, or changes to a fishery would be included in this section, but general changes in temperature regimes and gradual increases in siltation and turbidity due to expanding urbanization or natural changes in species composition would not be included.

Specific locations and sources of the proposed threat are given where possible.

STATUS

Principal factors used to formulate the status of each species are reviewed in point form. Finally, a recommendation for the Canadian status of the individual species is given. The approved terminology for designating the status of a species by COSEWIC was used for this analysis, as follows:

RARE SPECIES: Any indigenous species of fauna or flora that, because of its biological characteristics, or because it occurs at the fringe of its range, or for some other reason, exists in low numbers or in very restricted areas in Canada but is not a threatened species.

THREATENED SPECIES: Any indigenous species of fauna or flora that is likely to become endangered in Canada if the factors affecting its vulnerability do not become reversed.

ENDANGERED SPECIES: Any indigenous species of fauna or flora whose existence in Canada is threatened with immediate extinction through all or a significant portion of its range, owing to the action of man.

EXTIRPATED SPECIES: Any indigenous species of fauna or flora no longer existing in the wild in Canada but existing elsewhere.

EXTINCT SPECIES: Any species of fauna and flora formerly indigenous to Canada but no longer existing anywhere.

BIOLOGY

The biology section comprises several subsections that summarize observations and data obtained during our field surveys and literature reviews. The biology of a species is reported by describing habitat, growth, reproduction, food, parasites, predators, and relation to man. Habitat information includes type of water body, stream gradient, substrate, vegetation and cover. Water temperature, dissolved oxygen, and turbidity data are also given. Data on growth rates, maximum size, age and sexual maturity are summarized. The spawning habits, seasonal development, fecundity, and sexual dimorphism are considered in the subsection dealing with reproduction. Food relationships are discussed in relation to life history stages as far as possible. External parasites were noted during the processing of fish specimens but, literature sources are the basis for most parasite information. Predator notes are included when observations on species composition at a collection site suggested a predator-prey relationship or when reference has been made to predators in the literature or through personal communications. Species relation to man focuses on the ecological and direct use the species may have both to the public and scientific community.

RECOMMENDATIONS

Specific recommendations are proposed for each species based on the information obtained during this study. Some of these recommendations are generally applicable while others are site and population specific. We hope that these recommendations will be instituted after further review.

LIST OF SPECIMENS

All known Canadian museum specimens are listed along with museum collection number, number of specimens, locality, date of capture, and collector's name. In some cases museum records did not contain all of the above information. Although every attempt was made to provide complete lists there may have been some collections or information that was overlooked. These lists provide information which is otherwise difficult and time consuming to obtain. The main sources for records were the National Museum of Canada and the Royal Ontario Museum. When University collections were used, the museum of holding is identified. Collections made during this study were deposited at the National Museum of Natural Sciences in Ottawa.

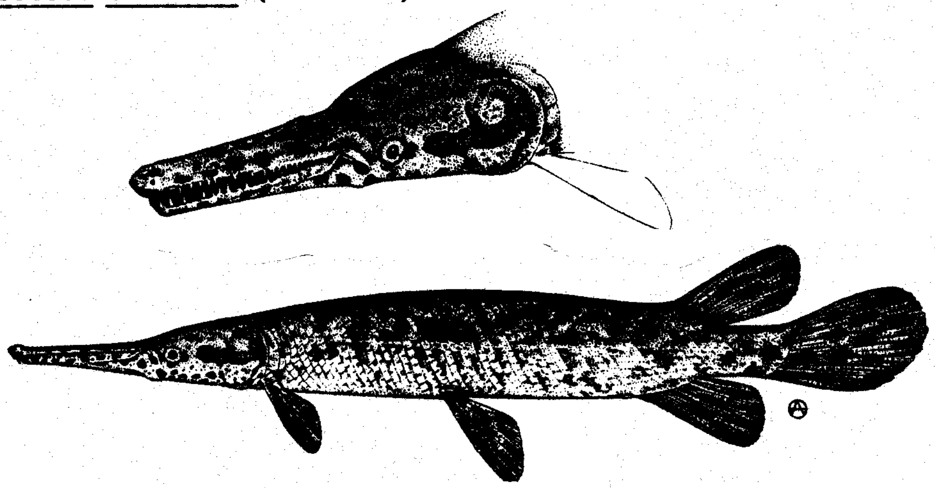
REFERENCES

Literature sources referred to in a report are listed in alphabetical order at the end of that report. Certain references are in manuscript or unpublished form and these references are as complete as possible at the time of submission of this report.

STATUS REPORTS

SPOTTED GAR

Lepisosteus oculatus (Winchell)



Proposed Status: RARE

The spotted gar, *Lepisosteus oculatus*, occurs in the fresh and brackish waters of central and south-central North America. Its range in Canada is limited to southern Ontario. The spotted gar has been reported from the Great Lakes in Ohio and the Mississippi River system in Michigan.

It is one of three species of gar found in the Great Lakes drainage, the longnose gar, *Lepisosteus osseus* and the shortnose gar, *Lepisosteus platostomus* being the remaining two. The shortnose gar and the spotted gar were taxonomically confused until 1941 when two distinct species were recognized (Hubbs and Lagler 1941). These two species do not share a common range in the Great Lakes basin. The spotted gar is sympatric only with the longnose gar in Canada.

The biology of the spotted gar in Canada is virtually unknown. Scott (1967) and Scott and Crossman (1973) summarized available information for this species in Canada. Redmond (1964) studied the life history of the spotted gar in Missouri. Suttkus (1963) and Wiley (1976) outlined general biology and biogeography of this species. Trautman (1957), Cook (1959), Miller and Robinson (1973), Douglas (1974), Clay (1975) and Pflieger (1975) provided short descriptive accounts of this species in the United States.

Thirteen specimens of the spotted gar have been collected from Canadian waters since it was first reported in 1913 (NMC 58-0192). Due to its infrequent occurrence in Canadian waters McAllister and Gruchy (1977) reported its status in Canada as rare. Elsewhere, the spotted gar is considered endangered only in Ohio (Ohio Department of Natural Resources 1976). There are no indications that this species is threatened in other parts of its range.

The spotted gar is distinguished from the longnose gar by head colour, snout length and lateral line scale count. The spotted gar has a spotted head; its snout is wide, least snout width 6 to 8 times in snout length; and lateral line scales vary in number from 53 to 57. The longnose gar does not have a spotted head; it has a long, narrow snout, least snout width 14 to 18 times in snout length; and it has a higher lateral line scale count than the spotted gar, usually 61 to 65 (McAllister and Gruchy 1980).

DISTRIBUTION

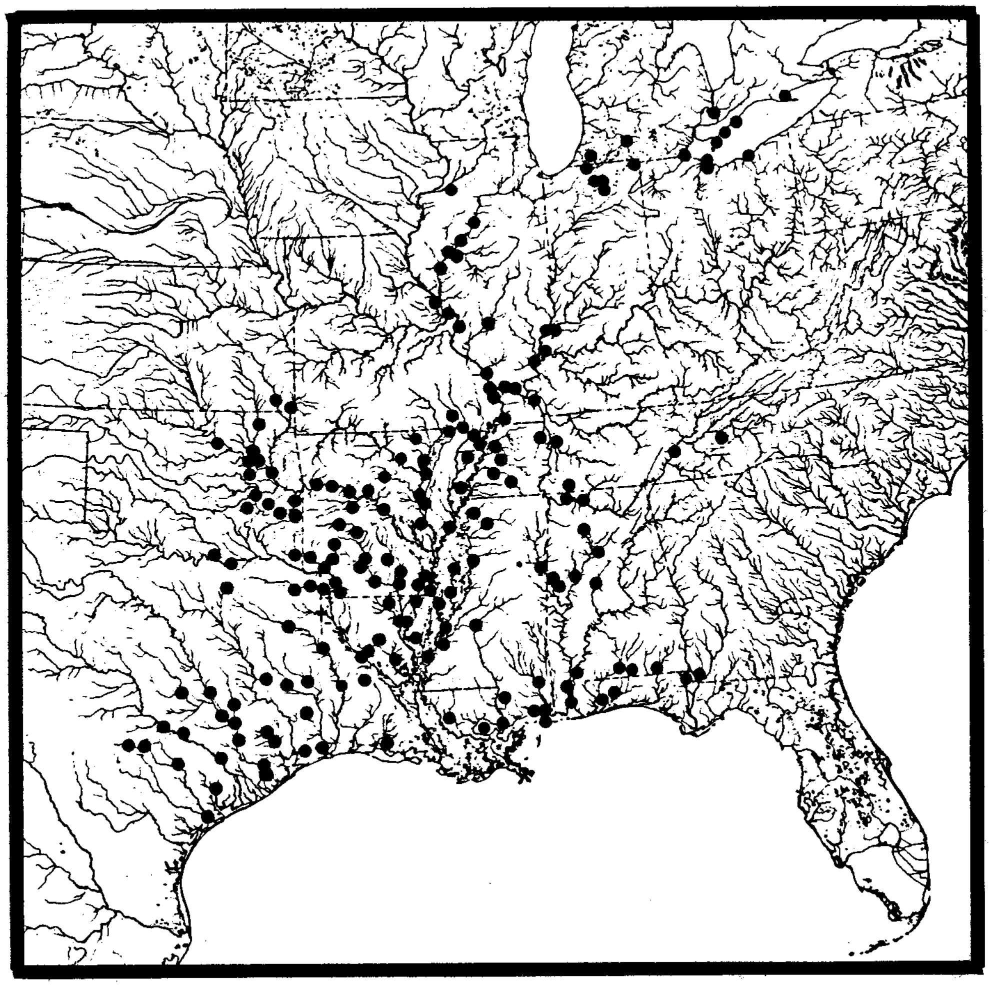
The spotted gar is essentially a southern species, occurring in the United States in all of the states bounded by the Gulf of Mexico, but it does extend north into the Mississippi River and Great Lakes drainages (Figure 1).

It occurs in the fresh and brackish waters along the Gulf of Mexico from northern Florida in the east to the Rio Grande River system in northeastern Mexico in the west. In the Mississippi River basin it has been reported from Mississippi north through Louisiana, Arkansas, Tenessee, Kentucky, Oklahoma, southeastern Kansas, Kentucky, Missouri and to Illinois, Indiana and Michigan. In the Great Lakes basin this species has been reported from Lake St. Clair and Lake Erie.

In Canadian waters the spotted gar has been reported in Lake Erie from Long Point Bay, Norfolk County (42°40'N, 80°10'W), Rondeau Bay, Kent County (42°17'N, 81°53'W) and at Point Pelee, Essex County (41°57'N, 82°31'W). It has also been reported from the St. Clair River and in the Lake St. Clair drainage (Scott and Crossman 1973). In the Lake St. Clair drainage it has been collected near the mouth of the Thames River, Kent County (42°19'N, 82°27'W), (Figure 2).

POPULATION

The spotted gar usually occurs in small numbers throughout much of its range



North American distribution of the spotted gar *Lepisosteus oculatus*. Adapted from Lee (1980)

Figure 1

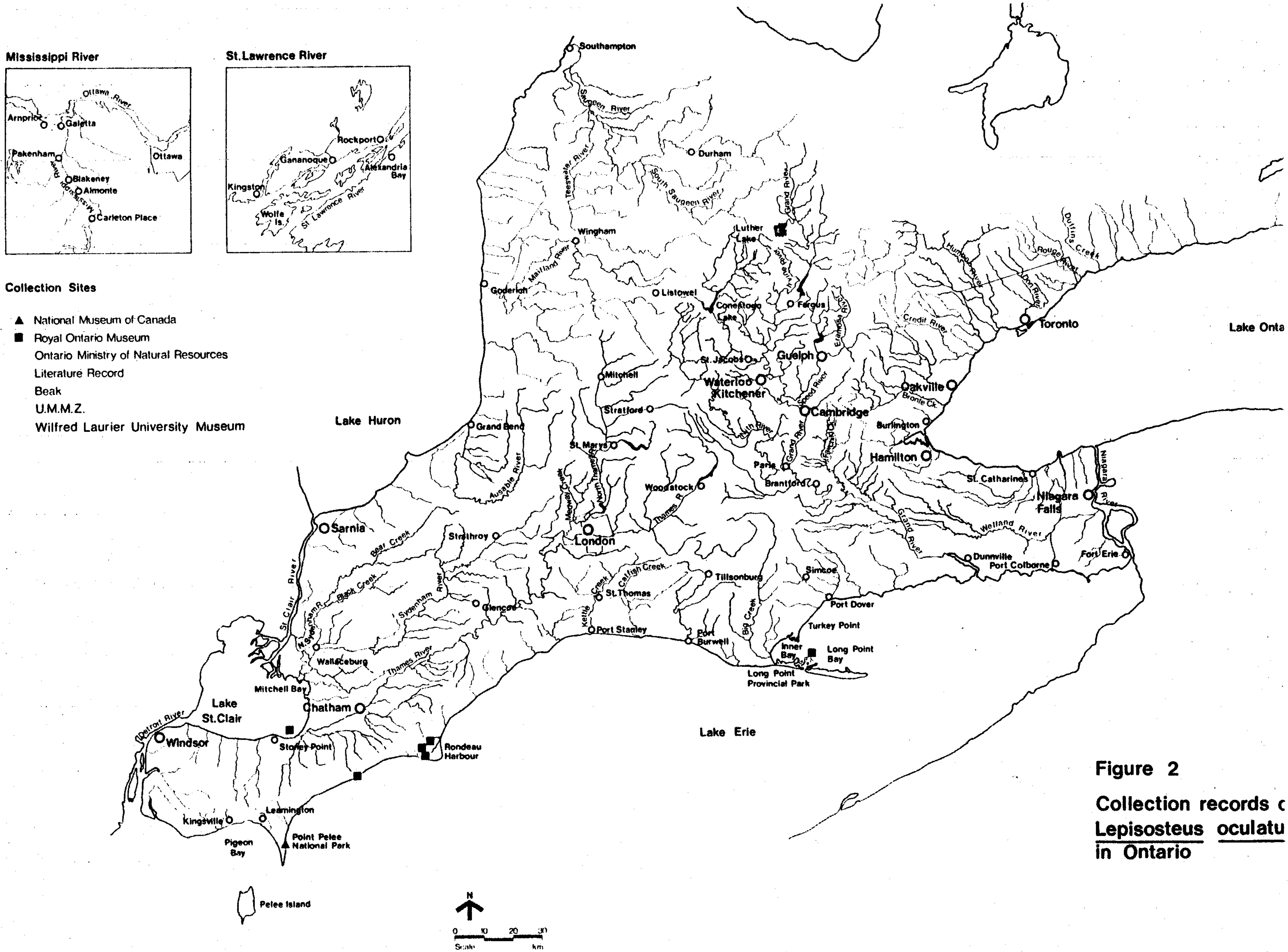


Figure 2

Collection records c **Lepisosteus oculatu** **in Ontario**

(Cross 1967, Clay 1975, and Pflieger 1975). In Canada, the spotted gar is sporadically collected; the most recent reported capture was in 1975 in Rondeau Harbour. No spotted gar were captured during this study.

Based on Canadian capture records, it is suggested that a small breeding population has existed in Rondeau Harbour. Ontario Ministry of Natural Resources records show that longnose gar are commonly captured in Rondeau Harbour, but spotted gar are infrequently captured. Only spot records occur for spotted gar elsewhere in the Great Lakes. The continued presence of the spotted gar in Canadian waters is unconfirmed. It has likely escaped capture in some areas within its Canadian range due to its solitary nature and the lack of sampling in its preferred habitat.

Suitable habitat for spotted gar spawning is present along much of the north shore of Rondeau Harbour. Similar habitat exists in Long Point Bay and at Point Pelee which are prior capture sites, however, the absence of recent captures in these areas, despite intensive sampling, (Ward 1973, Reid 1978, Hamley and MacLean 1979) suggests that breeding populations of this species do not exist or are extremely small.

The spotted gar has been captured in Lake St. Clair very sporadically. The status of sustained populations in Lake St. Clair is unclear; whether specimens obtained represent members from a breeding population or are transient records from a Lake Erie based population is unknown.

Long-term population trends suggest that the population of spotted gar in the Great Lakes is decreasing. Trautman (pers. comm.) suggested that this species has become increasingly rare in Ohio waters as a result of habitat degradation and destruction. Shoreline development along the north shore of Lake Erie will in all probability have a detrimental effect on areas which now provide suitable gar habitat. Information gathered from commercial bait dealers and fishermen working in the western basin of Lake Erie suggest that fishermen experience difficulties in recognizing more than one species of gar, and that commonly all gar are commonly killed when captured because of their piscivorous feeding habits. It is possible that spotted gar numbers would be reduced through the Lake Erie commercial fishing industry.

THREATS

There are no impending developments that will pose an immediate threat to the welfare of this species in Canada.

STATUS

The following statements were considered valid after review of available information and were used in the evaluation of the status of the spotted gar in Canada.

1. A small, reproducing population of spotted gar is suspected to be present in the vicintiy of Rondeau Harbour.
2. Available information does not allow definative analysis of population structure.
3. The Canadian population of spotted gar occurs at the northern extremity of its North American range.
4. It is unlikely that the spotted gar was common in the Great Lakes prior to recorded collections.
5. The spotted gar has become increasingly rare in the Great Lakes basin due to long-term habitat destruction.

Based on information evaluated during this study, it is recommended that the spotted gar be classed as a rare species in Canada.

BIOLOGY

Much of the pertinent literature states that the biology of the spotted gar is similar to that of the longnose gar, but no detailed discussions seem to be available (Scott and Crossman 1973).

The following observations were made at prior capture sites in southwestern Ontario. Most capture sites were in quiet bays and backwater areas along Lake Erie's north shore, with only one capture site occuring in Lake St. Clair.

Bottom substrates were composed of clays, detritus, and soft muck. A single capture site in Rondeau Bay had a gravel and stone bottom which was devoid of aquatic macrophytes, however, dense aquatic vegetation was present a few hundred meters from the capture site. Aquatic vegetation was usually dense at capture sites. Spatterdock (Nuphar sp.), cattails (Typha sp.) and waterweed (Anacharus sp.) were abundant. Turbidity varied among capture sites (Secchi disk range from 30 cm to over 3 m) and dissolved oxygen levels ranged from 9 to 11 mg/L at water temperatures from 15° to 17°C in September. This species is tolerant of warm waters and low dissolved oxygen levels, and can survive in these conditions for extended durations (Scott 1967).

Museum specimens of spotted gar taken in Canadian waters range from 40 to 66 cm (TL). The average length of these specimens was 57 cm (TL). Canadian specimens were not aged. Trautman (1957) stated that young-of-the-year spotted gar in Ohio range in length from 18 to 25 cm (TL), while adults range from 41 to 91 cm (TL) and weigh from 450 to 2,270 g. Redmond (1964) reported that one-year-old spotted gar in Missouri are approximately 25 cm long and three-year-old fish are about 51 cm long. Linear regressions of length and weight were calculated for Alabama populations of the spotted gar (Carlander 1969). Maximum age for this species in Canada is unknown, but Redmond (1964) recorded a maximum age of 18 years in Missouri.

Growth rates for the spotted gar have been calculated by Riggs and Moore (1960) for Oklahoma populations; young spotted gar grew between 1.4 and 2.1 mm in length and increased between 0.7 to 1.3 g per day during July and August. Redmond (1964) found that male spotted gar grow faster than females until age 2, after which females grow more rapidly. Females grow larger, and live longer than males (Scott and Crossman 1973). Pflieger (1975) reported that in Missouri males mature when they are 2 or 3 years old while females do not mature until their third or fourth year.

Spotted gar are believed to spawn during the spring in Ontario (Scott 1967). Specimens collected from Canadian waters could not be examined during this study to determine their spawning condition, however, published data from more southerly populations may be pertinent. Suttkus (1963) reported that spotted gar spawn during the spring in Louisiana, in shallow warm water where aquatic vegetation is abundant. In Missouri, this species was observed spawning in late April in rapidly flowing waters emptying from an area of flooded timbers (Redmond 1964).

Spawning areas may exist in the inflowing streams of Rondeau Harbour. These streams are heavily vegetated and may be used by the longnose gar as spawning areas. Commercial fishermen working in Rondeau Harbour state that during May and June, gar are quite common in the harbour, but are less frequently observed in later months. It is believed that this apparent increase in gar numbers in the harbour may be related to spawning activity.

Virtually nothing is known regarding the actual spawning of the spotted gar. Suttkus (1963) stated that spawning adults ranged in length from 522 to 575 mm and that males were generally smaller than females at spawning. Many of the specimens captured in Ontario waters fall into this size range and therefore could be considered mature and of spawning potential.

Cook (1959) briefly outlined the spawning activity of this species. He states that gar spawn in pairs over aquatic weeds, submerged brush, and debris, spreading semi-adhesive eggs over the bottom materials. Eggs hatch within a week. The larval gar cling to aquatic plants and debris or hang from the surface film by a disc-like maxillary structure.

Spotted gars are generally considered voracious piscivores. Although factual data on the food habits of this species are limited, it is believed that virtually all fishes that share its warm water habitat may be considered as food for this species (Redmond 1964). Carlander (1969) states that feeding activity is heaviest during the morning. Scott (1967) listed the yellow perch (Perca flavesecens) and minnows (Cyprinidae) as forming a large part of the diet of the spotted gar in Canada. Redmond (1964) noted that in Missouri the first foods in the diet of young-of-the-year spotted gar included mosquito larvae and small crustaceans. Fish were incorporated into the diet of young spotted gar at an early age and the banded killifish (Fundulus diaphanus) was considered one of the primary prey species. Adults fed mostly on gizzard shad (Dorsoma cepadianum), which made up 90% of their diet, and to a much lesser extent on freshwater shrimp, crayfish and aquatic insects. Both the gizzard shad and banded killifish were captured in Rondeau Harbour as well as a variety of sunfishes and minnows.

Crabs (Callinectes sapidus) are considered a major food item in southern populations of spotted gar (Darnell 1958, Lambou 1961); what use crustaceans are as food items for spotted gar in Canada is unknown.

Parasites have not been identified from this species. Hoffman (1967) listed various Trematodes, Cestodes, Hematodes, Acathocephalens and Crustacea as parasites of gar.

The spotted gar is usually considered a nuisance fish by commercial and sport fishermen because of its piscivorous feeding habits. Gar are usually destroyed by commercial fishermen and are a favourite species of bow fishermen in some parts of the United States. Their flesh is edible, but is not preferred and their eggs are toxic to warm blooded mammals (Pflieger 1975).

RECOMMENDATIONS

The following recommendations are suggested for the maintenance and monitoring of the spotted gar population in Canada.

1. The Ontario Ministry of Natural Resources should hold and transport to a museum facility all spotted gar specimens from Ontario.
2. Identification information should be made available to concerned agencies. It is also recommended that an education program be initiated by the Ontario Ministry of Natural Resources to ensure that commercial fishermen recognize the importance of this species.
3. A population survey by the Ontario Ministry of Natural Resources should be conducted in conjunction with future fisheries surveys and commercial catch inspection programs.
4. Further study should be implemented to assess the importance of shoreline marshes and the impact of lakeshore development on the habitat requirements of this species.

LIST OF SPECIMENS

A list of spotted gar specimens, captured in Canada, from the National Museum of Canada (NMC), Royal Ontario Museum (ROM) and the Ontario Ministry of Natural Resources (OMNR) is provided below:

NMC 58-0192 (2) Ontario Lake Erie at Point Pelee, Essex County, May 18, 1913, Patch. ROM 1712 (1) Ontario Lake Erie at Port Crewe, Kent County, 1925. ROM 10498 (1) Ontario Lake Erie at Port Crewe, Kent County, 1938. ROM 13864 (7) Ontario Lake Erie, Long Point Bay, Norfolk County off Port Rowan, November 12, 1947, commercial fisherman. ROM 17603-17609 (1 each) Ontario Lake Erie at Rondeau Bay, April 23, 1955. ROM 2178 (1) Ontario Lake St. Clair, 4.0 km west of Thames River mouth, Essex County, March 5, 1962. OMNR AC 655 Ontario Rondeau Harbour, Kent County northwest shore August 27, 1975. OMNR AC 655 Ontario Rondeau Harbour, Kent County, Lagoon adjacent to Erieau Channel 1975.

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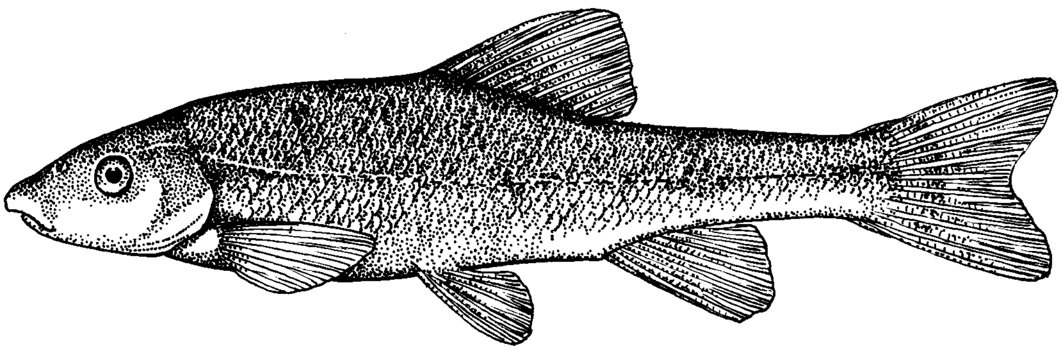
STONEROLLER

Campostoma anomalum (Rafinesque)



Proposed Status: RARE

The stoneroller, Campostoma anomalum (Cyprinidae), is widely distributed in streams of the United States but is known in Canada only from the Thames River and Niagara River watersheds of southern Ontario. This species is common in Ohio and Michigan.

Extensive biological information has been accumulated on stonerollers in the United States. Kott and Humphreys (in preparation) provided notes on habitat and species associations of Thames River populations. Lennon and Parker (1960), Miller (1962, 1964) and Menzel (1978) provided accounts of various aspeces of the life history of this species. Trautman (1957), Cross (1967), Pflieger (1975), and Burr (1980) summarized biological information for this species.

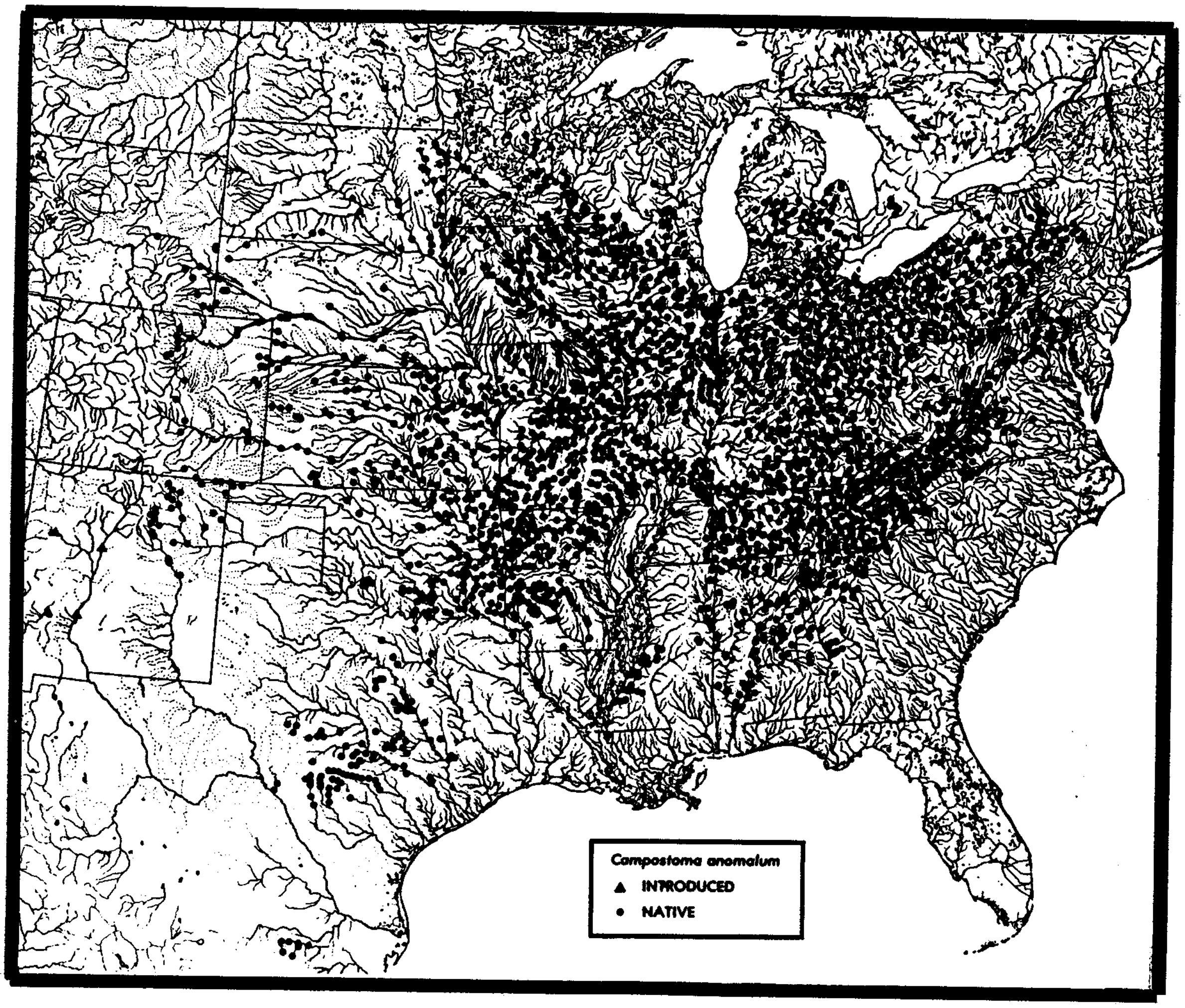
The stoneroller is abundant throughout its range in the eastern and central United States; although, Canadian specimens were not collected until 1972 (Gruchy *et al*. 1973). The species was first reported in Canada from a small area of the Thames River watershed of southern Ontario. Due to its restricted distribution in Ontario, McAllister and Gruchy (1977) classified the stoneroller as rare in Canada.

The stoneroller bears some resemblance to *Nocomis* species and young suckers, but can easily be distinguished by the anatomy of its mouth. A cartilaginous sheath, which is most conspicuous on the lower jaw, replaces the fleshy lips found in most cyprinids. Trautman (1957), Pflieger (1975) and Burr (1980) provided detailed descriptions of the stoneroller.

DISTRIBUTION

The following account of the distribution of the stoneroller is based on the spot distribution map of Burr (1980) and on data collected during the present study.

The stoneroller occurs in streams throughout much of the eastern and central United States (Figure 1). In the west, scattered populations occur in the Dakotas including sections of the Red River watershed in the Hudson Bay drainage



North American distribution of the stoneroller *Campostoma anomalum*. Adapted from Burr (1980)

Figure 1

system. Scattered populations also occur in the Mississippi River basin in Wyoming, Colorado, and New Mexico. In the south, the stoneroller is found in the Rio Grande watershed in New Mexico, Texas, and Mexico, and in the headwaters of many rivers along the Gulf slope from Texas to Georgia. The eastern limit of the range of the stoneroller extends to the Atlantic drainage along the eastern limit of the Appalachian highlands from Georgia to New York. In the northern part of its range, this species occurs in a few tributaries of Lake Ontario in New York and Ontario, in the Lake Erie and Mississippi River drainages of Ohio, in the Lake St. Clair drainage of Ontario, and in the Mississippi River basin of Wisconsin and Minnesota.

In Ontario, the stoneroller is found primarily in the Thames River watershed. A small number of specimens have also been reported from the Niagara River (Figure 2). In the Thames River watershed, the stoneroller occurs in the North Thames River from Mitchell, Middlesex County (43°27'30"N, 81°12'20"W), to London, Middlesex County (42°58'45"N, 81°58'45"W) and in the Thames River from Dorchester, Middlesex County (42°59'13"N, 81°03'58"W) to London. Collections have also been made from Whirl Creek, Fish Creek, Nineteen Creek, Otter Creek, Gregory Creek, Wye Creek, Stoney Creek, Medway Creek, and the Avon River which flow into the North Thames River and from Pottersburg Creek and Waubuno Creek which flow into the Thames River.

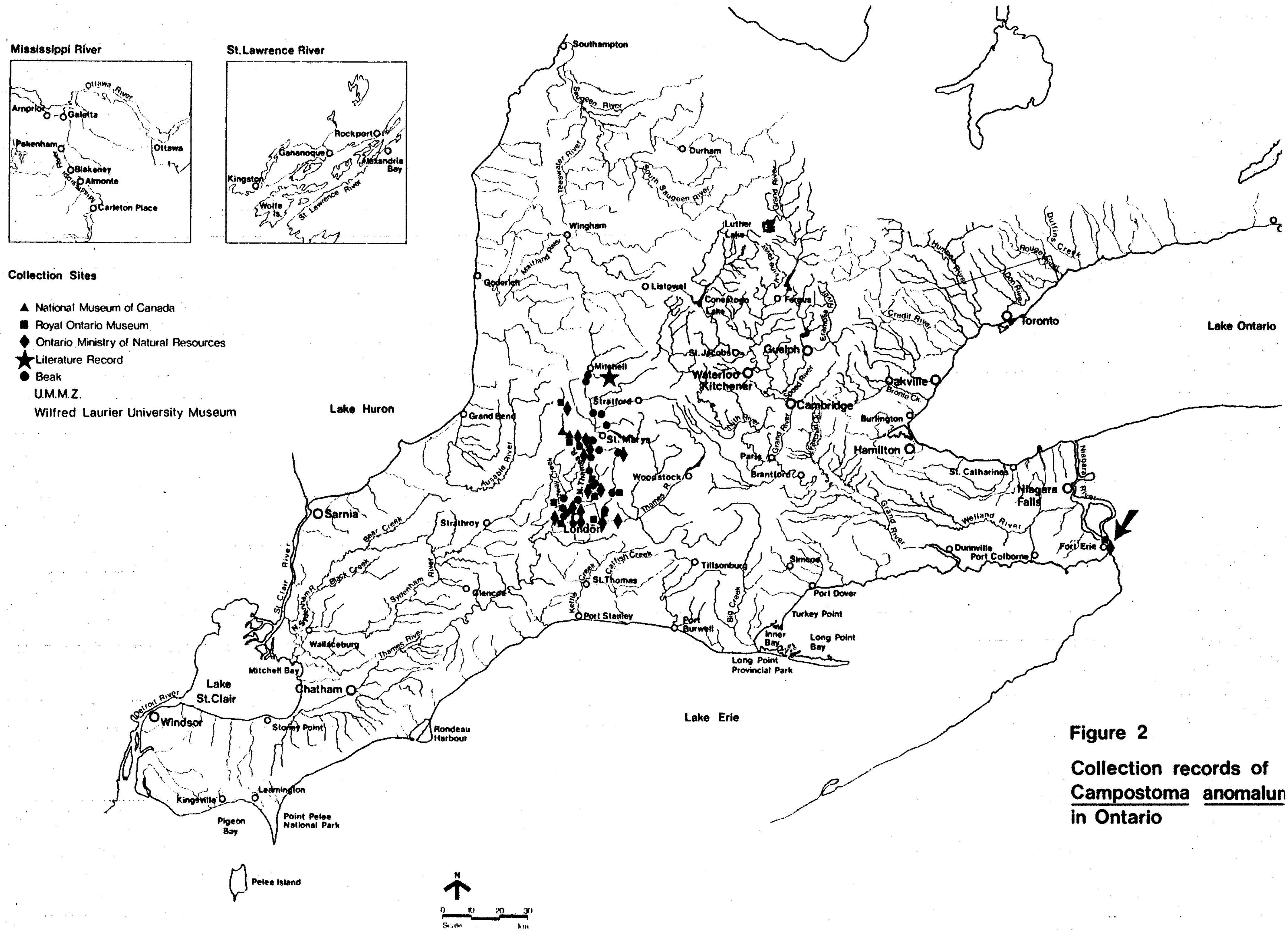


Figure 2

Collection records of <u>Campostoma anomalum</u> in Ontario

Stonerollers have also been collected in Ontario from the Niagara River at the mouth of Frenchman's Creek near Fort Erie, Welland County (42°56'42"N, 78°55'30"W) and from the Niagara River at Fort Erie (42°56'22"N, 78°55'05"W).

POPULATION

The stoneroller is locally very abundant and frequently appears to be the most common species in the North Thames River and its tributaries. At two areas in the North Thames River, densities of stonerollers were estimated at 37 fish and 130 g and 66 fish and 400 g per 100 m^2 using DeLury's (1947) method. In a riffle section of Gregory Creek, a density of 372 stonerollers and 200 g per 100 m^2 were estimated. This species is rare in fast-flowing streams where the depth exceeds 0.5 m, but is common in shallow riffles with macrophyte cover and in shallow pools. Small stonerollers commonly occur in schools of more than 100 fish in shallow backwaters.

The stoneroller is apparently rare in the main stream of the Thames River. The Ontario Ministry of Natural Resources (O.M.N.R.) has reported stonerollers in only two collections from the Thames River above its confluence with the North Thames River. Only one specimen was captured from this section during the 1979 survey.

The stoneroller is also rare in the Niagara River. Collections of this species have been made at only two locations and no specimens were captured during the present study or during a survey carried out in this area by the O.M.N.R. in 1979.

Throughout its North American range, the stoneroller is often the most abundant fish. Lewis and Elder (1953) stated that this species is "by far the most abundant fish" in headwater streams of southern Illinois. Lennon and Parker (1960) found the stoneroller in every watershed of Great Smoky Mountains National Park in such abundance that in some streams, "this minnow outnumbers and outweighs all other species of fish combined". These authors reported standing crops of stonerollers ranging from 7 to 235 fish and 190 to 5856 g per 100 m^2.

Male and female adults and juvenile stonerollers were captured in the Thames River watershed during the 1979 survey, indicating that this population is viable and reproducing. Adults in spawning condition were observed by Kott (pers. comm.) in Whirl Creek, a tributary of the North Thames River, and during our spring 1980 survey in Gregory Creek and Fish Creek.

The range of the stoneroller population in the North Thames River appears to have expanded considerably over the past seven years. The survey of Gruchy *et al.*, in 1972 covered many of the areas where this species is now abundant

(Gruchy pers. comm.), yet specimens were captured only in Fish Creek and its tributary, Nineteen Creek. In surveys carried out by the O.M.N.R. up to 1975, stonerollers were captured over a wider area but no specimens were taken north of St. Marys in the North Thames River. The apparent distribution of this species in 1979 in the North Thames River as documented in this study was considerably more extensive than indicated by earlier O.M.N.R. surveys, suggesting continued expansion of the population.

THREATS

The distribution of stonerollers in Ontario is influenced by stream gradient; slow-flowing deep sections of rivers and lakes do not provide adequate habitat. Lake Fanshawe, an impoundment lake on the North Thames River created in the mid 1950's, does not provide suitable habitat for stonerollers; however, upstream and downstream populations seem unaffected by this impoundment.

The proposed Glengowen dam located on the North Thames River would destroy a portion of stoneroller habitat between St. Marys and Fullurton, but habitat destruction should not ramify to areas outside of the proposed impoundment and spillway.

STATUS

The following statements were considered valid after review of available information and were used in the evaluation of the status of the stoneroller in Canada.

1. An expanding population of stonerollers is present in the Thames River watershed. A very small population may be present in the upper Niagara River.
2. Available information indicates that the Thames River population is stable or expanding in range and numbers. Data on the Niagara River population do not allow definative analysis of population structure or trends.
3. The stoneroller is one of the most widely distributed cyprinids in the central and eastern United States. In Canada this species occurs at the northern fringe of its North American Range.
4. The stoneroller does not appear threatened with extinction in Canada due to the actions of man.

Based on information evaluated during this study, it is recommended that the stoneroller be classed as a rare species in Canada.

BIOLOGY

The stoneroller is found in both pool and riffle areas of small to medium-sized streams. Stream widths at capture sites in the Thames River watershed range from 2 to 3.5 m. In riffle areas, these fish often congregate in clumps of macrophytes, particularly Potamogeton pectinatus, where water velocities are reduced. Large stonerollers are usually found in relatively deep riffles and pools (maximum depth about 1.5 m) while smaller fish are more common in shallow pools and riffles. Throughout its range, the stoneroller prefers creeks and small rivers (Lennon and Parker 1960).

Stream gradient may impose a limitation to the range of the stoneroller in the Thames River watershed. The average gradient over its range in the North Thames River is 1.4 m/km. Stream gradients in tributary streams inhabited by this species range from 1.0 to 3.7 m/km. In North Carolina, this species is abundant in gradients of 42 m/km but is absent from streams with gradients of 83 m/km (Lennon and Parker 1960). Downstream from London where the stoneroller is absent, the gradient in the Thames River drops quickly to an average of 0.5 m/km. This species is also absent from low gradient streams in the United States (Lennon and Parker 1960).

During the 1979 survey, stonerollers were usually captured over clean rubble or gravel bottoms with some areas of sand and silt. In the main stream of the Thames River above its confluence with the North Thames River, the rubble bottom is generally matted with filamentous algae, and stonerollers are apparently rare.

Lennon and Parker (1960) also noted that this species appears to prefer a clean bottom.

The stoneroller is tolerant of variations in water quality. In mid-September, this species was found in clear water at temperatures of 17.5 to 25°C and oxygen concentrations of 3 to 17 mg/L. Wong and Clark (1976) reported that diurnal fluctuations of 3 to 25 mg O_2/L are common at times of low flow in the North Thames River. Turbidity levels also fluctuate considerably in the Thames River watershed. Turbidity increases are due largely to soil erosion in this intensively farmed region.

Hubbs and Lagler (1947), Trautman (1957), and Burr (1980) noted that stonerollers prefer clear water. While Trautman (1957) stated that this species is not noted for its ability to withstand oxygen depleted, polluted, or silted habitats, Miller (1964) and Burr (1980) indicated that stonerollers are relatively tolerant of variations in water quality. This species may also avoid acidic waters (Lennon and Parker 1960).

Information on the over-wintering habitat of the stoneroller is conflicting. Kott and Humphreys (1980) collected specimens from the North Thames River watershed along the relatively calm, vegetated edges of pools as ice was beginning to form. Miller (1964) also suggested that as winter approaches, stonerollers congregate in pools and backwaters and commonly occur under stones and bottom debris to excape increased currents. Trautman (pers. comm.), however, stated that stonerollers over-winter in riffles. It appears that Ontario populations more likely congregate in pools and backwaters during winter months.

Twenty-five stonerollers, including individuals from all length classes collected during the 1979 survey, were aged by the scale method described by Hubbs and Cooper (1936) and Lennan and Parker (1960). In September, young-of-the-year ranged from 2.3 to 3.9 cm (SL) and from 0.2 to 1.0 g. (preserved weight), 1+ fish ranged from 4.1 to 6.2 cm (SL) and from 1.3 to 4.4 g, 2+ fish ranged from 5.5 to 8.7 cm (SL) and from 3.7 to 15.1 g and 3+ fish ranged from 8.2 to 9.9 cm (SL) and from 15.2 to 22.0 g. No specimens appeared to be older than 3+, suggesting that stonerollers have a life span of 3 to 4 years in the Thames River watershed.

The age-length relationship determined for Thames River stonerollers is similar to those given by Lewis and Elder (1953) and Gunning and Lewis (1956) for Illinois populations, and by Carlander (1969) for Ohio populations. In the northern states, this species has a maximum age of about 3+ years and maximum total lengths reported are 14.3 cm in Illinois, 15.2 cm in Michigan and 17.8 cm in Ohio (Gunning and Lewis 1956, Hubbs and Cooper 1936, and Trautman 1957, respectively).

Lewis and Parker (1960) found a maximum age of six years and a maximum length of 28.7 cm for stonerollers in North Carolina.

Male and female specimens in spawning condition were captured in small tributaries of the North Thames River in mid-May at water temperatures of 14 to 16°C. Specimens were all spawned in creeks where the water temperature averaged 21°C in late May. Miller (1964) and Smith (1935) reported a wider temperature range for spawning stonerollers in the United States, Miller stated that spawning begins in mid-April and continues until early June over a temperature range of 14 to 24°C in New York and Smith suggested an even wider spawning temperature range of 12 to 27°C for Illinois populations.

Few specimens were captured in the main stream of the North Thames River during the spring survey. Schools of spawning stonerollers were captured in riffles and steadies of small tributary creeks (usually less than 3 m in width) with clean gravel bottoms. The water velocity in these creeks ranged from .30 to .45 m/sec. Dissolved oxygen levels averaged 10 to 16 mg/L.

The spawning process has been described in detail by Langlois (1937) and Miller (1962, 1964). Males construct nests in gravel in both slow water and riffle areas. Males are territorial and guard these nests. Eggs are covered with sand and fine gravel during and after the spawning act. Stonerollers will also use nests of other cyprinids while other species may spawn over stoneroller nests (Miller 1964).

Specimens captured during the spawning period were dissected and their gonads examined. Females over 7 cm (SL) were mature and males over 7.5 cm (SL) were mature. This suggests that maturity is reached during the second or third summer in Ontario. In Michigan, this species also reaches maturity during its second or third summer (Hubbs and Cooper 1936). In North Carolina, most stonerollers mature during their third or fourth year and females usually mature before males (Lennon and Parker 1960).

Reed (1958) described the embryology and early larval stages of this species. Hatching requires 69 to 70 h at 20°C. Egg counts for Ontario specimens averaged 1340 for females 10 cm (TL). Menzel (1978) described hybrids of stonerollers with common shiners (Notropis cornutus).

Among the cyprinids, the stoneroller exhibits the most extreme development of the nuptual tubercles (Hubbs and Cooper 1936). Large tubercles were present on the snout and forebrain area with small tubercles over the body length.

The gut contents of 21 stonerollers collected during the 1979 survey were examined. Filamentous algae was the major food item and accounted for an average of 23% of the gut content volume (range 0 to 90%). The foreguts of 86% of the specimens examined contained filamentous algae. Other plant material ranked second in importance in the diet, but accounted for an average of only 0.6% of the gut content volume (range 0 to 5%) and was present in only 29% of the specimens. Small amounts of microcrustaceans including ostracodes and cladocerans were present in 19% of the specimens and accounted for about 0.1% of the gut content volume in each case. All foreguts contained sand or silt which composed an average of 76% of the volume (range 8 to 99.9%).

Lennon and Parker (1960) reported that stonerollers feed mostly on periphyton in North Carolina. Carlander (1969) stated that this species feeds primarily on algae but also consumes some chironomid larvae. Trautman (1957) reported that stonerollers consume "micro-plants and small animals". This species was observed scouring the bottom over the spawning areas of rosyface shiners (*Notropis nubellus*) (Pfeiffer 1955) and black redhorse (*Moxostoma duquesnei*) (Bowman 1959), but egg predation was not verified in either case.

The sub-terminal mouth and cartilaginous lips of the stoneroller are morphological adaptations that likely aid in bottom feeding and the removal of periphyton from hard substrates. Like most herbivores, the stoneroller also has a greatly elongated intestine, and black peritoneum.

Predation on stonerollers by other fish in the Thames River watershed was not observed. Smallmouth bass (Micropterus dolomieui) and rock bass (Ambloplites rupestris) are largely piscivorous and are common in streams inhabited by stonerollers. Due to the abundance of stonerollers in much of the upper Thames River watershed, this species likely accounts for a significant portion of the diet of piscivorous species. According to Lennon and Parker (1960), centrarchides appear to control the number of stonerollers by predation.

Most stonerollers collected from Ontario in 1979 harboured the black-spot trematode Uvulifer to some extent, and infestations were heavy in some specimens. Berra and Au (1978) found that black-spot infestations are often heavier in this species than in most other cyprinids. Hoffman (1967) provided a check list of stoneroller parasites that included Protozoa, Trematoda, Cestoda, Nematoda, Acanthocephala, and Mollusca.

Lennon and Parker (1960) summarized the importance of stonerollers to man. This species is locally favoured both as a food fish and as a bait fish in the United States. Fishermen use bits of worms on small hooks to catch these fish when they congregate over spawning beds. This species is reputed to be one of the best bait minnows for bass, walleye, and catfish. It can be raised in bait production ponds and makes an interesting aquarium fish. This species is also known to limit the production of rainbow trout by destroying trout redds during spawning.

RECOMMENDATIONS

The following recommendations are suggested for the maintenance and monitoring of the stoneroller populations in Canada:

1. Further study should be implemented to document the life history of the stoneroller in Canada. It is suggested that studies be carried out at the university level.
2. Identification information should be made available to concerned agencies.
3. Measures that will ensure against transport of stonerollers outside of the Thames River watershed for baitfish or sport use should be investigated.
4. The Ontario Ministry of Natural Resources should monitor and document Canadian stoneroller populations.
5. Records of this species in Canada outside of the Thames River watershed should be investigated by concerned agencies and specimens should be retained for museum collections.
6. Proposed dam construction within the range of the stoneroller should be critically evaluated to mitigate severe impacts.

LIST OF SPECIMENS

A list of stoneroller specimens, captured in Canada from the National Museum of Canada (NMC) and the Royal Ontario Museum (ROM) is provided below:

NMC 72-207 (several) and ROM 28311 (10), Nineteen Creek, Perth County, August 14, 1972. C.G. Gruchy and R.H. Bowen. NMC 72-208 (2), Fish Creek, Perth County, August 14, 1972, Gruchy and Bowen. ROM 30921 (2), Waubuno Creek, Middlesex County, August 16, 1974, Scott and Duckworth. ROM 30751, North Thames River, Middlesex County, August 18, 1974, Rampley and Wagner. ROM 30747 (10), North Thames River, Middlesex County, August 19, 1974, Rampley and Wagner. ROM 30932 (7), Waubuno Creek, Middlesex County, August 20, 1974, Scott and Duckworth. ROM 30755 (3), Fish Creek, Huron County, August 22, 1974, Rampley and Wagner. ROM 30756 (3), Fish Creek, Perth Count, August 22, 1974, Rampley and Wagner. ROM 30761 (6), Wye Creek, Middlesex County, August 23, 1974, Rampley and Wagner. ROM 30939 (5), Pottersburg Creek, Middlesex County, August 28, 1974, Scott and Duckworth. NMC 74-320, Nineteen Creek, Perth County, October 22, 1974, Gruchy and D.E. McAllister. ROM 30974 (3), unnamed tributary of Medway Creek, Middlesex County, June 6, 1975, Scott and Payne. ROM 34332, Niagara River, Niagara County, July 21, 1977, Mallholland and Dubois. NMC 79-1102 (4), North Thames River, Middlesex County, September 10, 1979, P.M. McKee and L. Cole.

NMC 79-1103 (3), North Thames River, Middlesex County, September 11, 1979, McKee and Cole. NMC 79-1104 (3), North Thames River, Perth County, September 11, 1979, McKee and Cole. NMC 79-1105 (7), North Thames River, Perth County, September 11, 1979. McKee and Cole. NMC 79-1106 (7), North Thames River, Perth County, September 11, 1979, McKee and Cole. NMC 79-1111 (5), Avon River, Perth County, September 12, 1979, McKee and Cole. NMC 79-1112 (6), Otter Creek, Perth County, September 12, 1979, McKee and Cole. NMC 79-1114 (8), Waubuno Creek, September 12, 1979, McKee and Cole. NMC 79-1118, Thames River, Middlesex County, September 13, 1979, McKee and Cole. NMC 79-1127 (2), North Thames River, Perth County, September 17, 1979, McKee and Cole. NMC 79-1128 (7), North Thames River, Middlesex County, September 18, 1979, McKee and Cole. NMC 79-1129 (7), Waubuno Creek, Middlesex County, September 18, 1979, McKee and Cole. NMC 79-1130 (5), Waubuno Creek, Oxford County, September 18, 1979, McKee and Cole. NMC 79-1131 (6), Gregory Creek, Middlesex County, September 18, 1979, McKee and Cole. NMC 79-1132, Gregory Creek, Middlesex County, September 18, 1979, McKee and Cole. NMC 79-1133 (3), Pottersburg Creek, Middlesex County, September 18, 1979, McKee and Cole. NMC 79-1134 (3), Medway Creek, Middlesex County, September 18, 1979, McKee and Cole. NMC 79-1200 (6), North Thames River, Middlesex County, October 3, 1979, B.J. Parker and McKee. NMC 79-202 (ca. 15), Stoney Creek, Middlesex County, October 3, 1979, B.J. Parker and McKee. NMC 80-0855(20) Gregory Creek, Middlesex County, May 14, 1980, B.J. Parker and

Brinkman. NMC 80-0856 (1), North Thames River, Middlesex County, May 15, 1980, B.J. Parker and Brinkman. NMC 80-0859 (1), Otter Creek, Perth County, May 15, 1980, B.J. Parker and Brinkman. NMC80-0860 (40), Fish Creek, Huron County, May 15, 1980, B.J. Parker and Brinkman.

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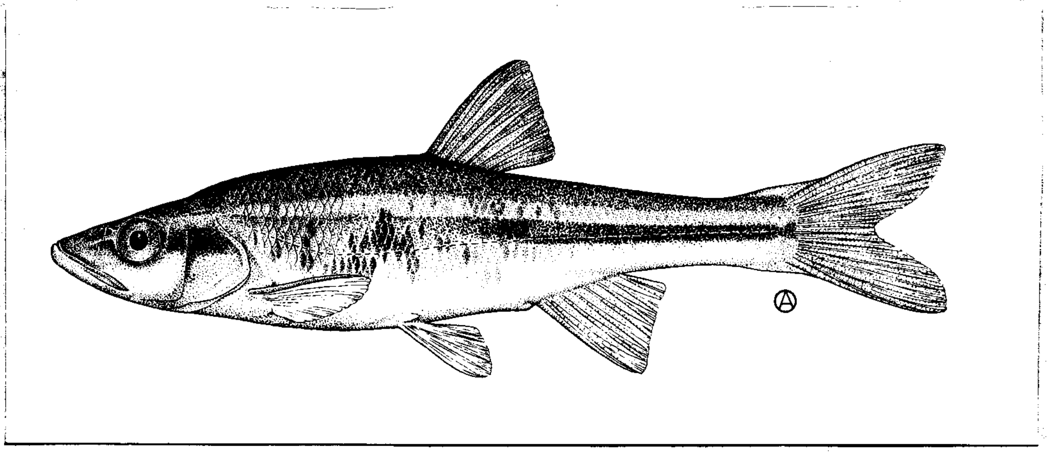
REDSIDE DACE

Clinostomus elongatus (Kirtland)



Proposed Status: THREATENED

The redside dace, Clinostomus elongatus (Cyprinidae) has a wide but discontinuous distribution in streams of the upper Mississippi River basin and the Great Lakes basin. In Canada, this species occurs in streams flowing into Lake Ontario, Lake Erie, and Lake Huron in southern Ontario.

Although no biological studies of Canadian populations of redside dace have been undertaken, a few biological studies have been carried out on this species in the United States. Koster (1939) studied reproduction and Schwartz and Norvell (1958) investigated feeding, growth, and sexual dimorphism.

These authors also provided notes on habitat. Trautman (1957) provided biological notes on Ohio populations of redside dace. Scott and Crossman (1973) and Gilbert (1980) summarized earlier literature.

McAllister and Gruchy (1977) classified the redside dace as threatened in Canada, since it was thought to occur only in streams flowing into western Lake Ontario "where it is much less common now than 30 years ago" (Scott and Crossman 1973). Gilbert (1980) reported that although the redside dace may be locally abundant, it is generally rare and has recently been extirpated from many areas. This species is considered threatened in Michigan (Miller 1972), drastically reduced in Ohio (Trautman 1957), and extirpated in Indiana (Gilbert, 1980). Greene (1935) suggested that the redside dace is in the process of extinction due to its inability to compete effectively with more common cyprinids.

The redside dace is distinguished from other Ontario minnows by its long, pointed snout, by its elongated, upturned mouth, and by the horizontal red band which is present during early spring on its sides. More detailed descriptions were provided by Trautman (1957), Scott and Crossman (1973), and McAllister and Gruchy (1980).

DISTRIBUTION

The following account of the distribution of redside dace is based on the distribution map of Gilbert (1980) and on information collected in the present study.

The range of the redside dace is discontinuous, and comprises several disjunct populations. (Figure 1). In the west, this species occurs in the upper Mississippi River basin in Minnesota and the Lake Michigan and upper Mississippi basins of Wisconsin. East of Lake Michigan, this species has been collected from Indiana (where it is now extirpated), Michigan, Ohio, Kentucky, Pennsylvania, New York, Maryland, and Ontario, including portions of the upper Mississippi River, Great Lakes, and Atlantic Ocean drainages.

In Ontario, the redside dace occurs primarily in watersheds draining into western Lake Ontario, but has also been collected from the Grand River watershed and the Saugeen River watershed flowing into Lake Erie and Lake Huron respectively (Figure 2).

The redside dace has been collected from watersheds draining

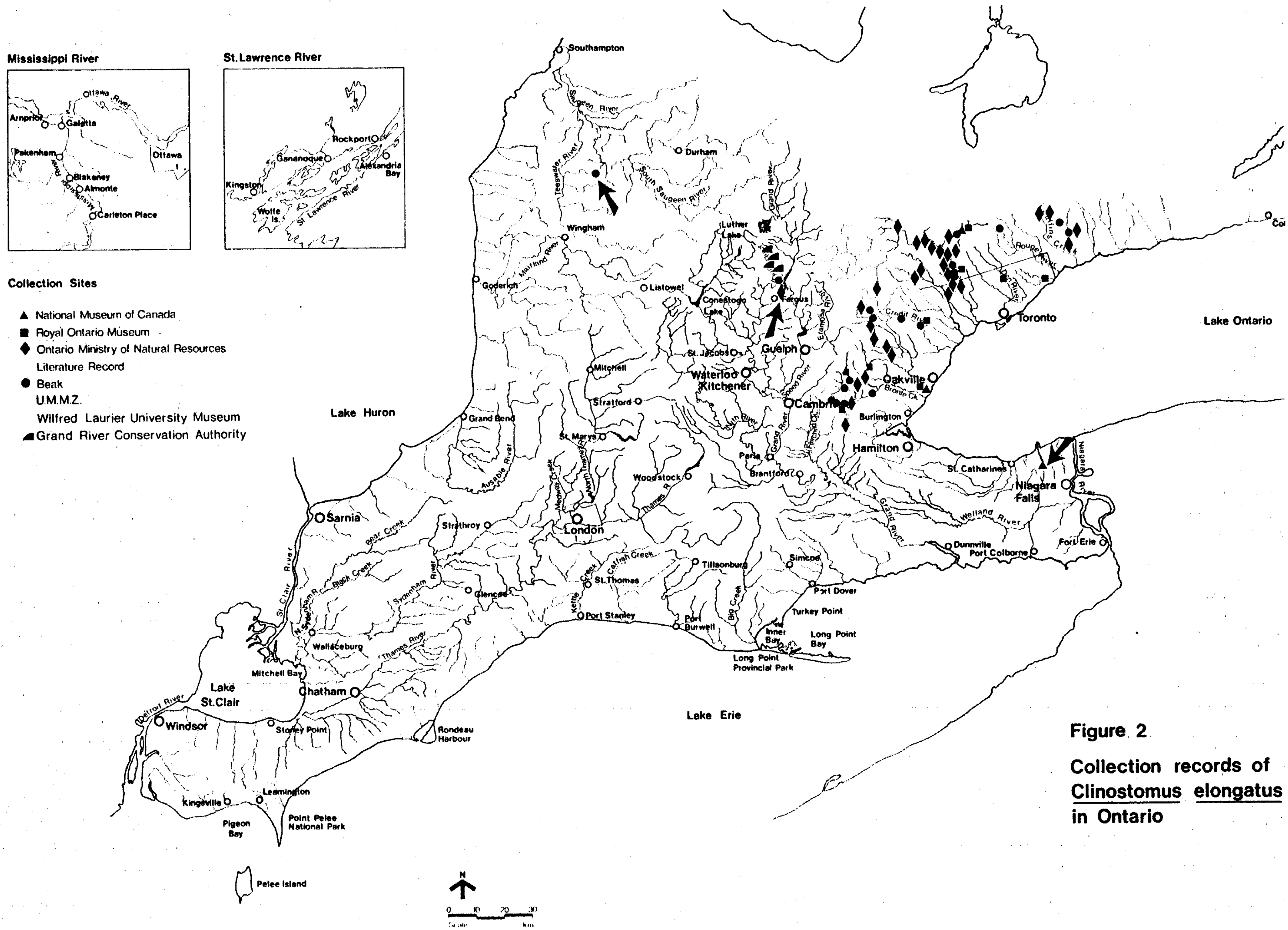


Figure 2

Collection records of <u>Clinostomus elongatus</u> in Ontario

North American distribution of the reside dace,

Clinostomus elongatus, Adapted from Gilbert (1980)

Figure 1

into western Lake Ontario from Whitby to St. Catharines, Ontario. Coordinates are given for the mouths of streams at Lake Ontario in the following description of the distribution in the Lake Ontario basin. Collections of redside dace have been made from unspecified localities of Pringle Creek (43°51'N, 78°56'W) and Lynde Creek (43°51'N, 78°57'W(near Whitby, Durham County; from Mitchell Creek, West Duffin Creek and Duffin Creek in the Duffin Creek watershed north of Pickering, Durham County (43°49'N, 79°02'W); from the Rouge River near Richmond Hill, York County (43°48'N, 79°97'W); from Highland Creek at Toronto, York County (43°46'N, 79°08'W); from the Little Don River in the Don River watershed at North York, York County 43°39'N, 79°21'W); from the West Humber River, the East Humber River and the Humber River in the Humber River watershed north of Toronto, York and Peel County (43°38'N, 79°28'W); from an unspecified location of Etobicoke Creek, York and Peel County (43°35'N, 79°33'W); from Fletchers Creek, Black Creek, Silver Creek, an unnamed tributary, and the Credit River in the Credit River watershed near Streetsville, Brampton, and Halton Hills, Peel and Halton Counties (43°26'N, 79°40'W); from Fourteen Mile Creek near Oakville, Halton County (43°25'N, 79°41'W); from Bronte Creek between Mountsberg and Lowville, Wentworth and Halton County (43°24'N, 79°43'W); from the Spencer Creek watershed in areas upstream from West Flamborough, Wentworth County (43°16'N, 79°55'W); from an unspecified locality of Twelve Mile Creek near St. Catharines, Welland County (43°11'N, 79°17'W); and from the seventh lock of the Welland Canal, near St. Catharines, Lincoln County (43°14'N, 79°13'W).

In the Lake Erie basin of Ontario, redside dace have been collected from the Grand River watershed in the Irvine River, the Nith River, and the Grand River. This species has been found in the Irvine River watershed from the West Luther-West Garafraza Township boundary (43°51'20"N, 80°24'30"W) to 3km west of Belwood, Wellington County (43°47'48"N, 80°21'42"W). In the Nith River, the redside dace is known from only one collection made at an unspecified location in 1952 (ROM 24858). The Ontario Ministry of Natural Resources identified redside dace in a collection taken from the Grand River downstream from Belwood Lake near Fergus, Wellington County (43°43'N, 80°22'W), but specimens were not retained.

Redside dace have been collected at two localities in the Saugeen River watershed, Lake Huron basin. In 1977, specimens were taken from Greenock Creek, a tributary of the Teeswater River, approximately 4km southwest of Walkerton, Bruce County (44°05'N, 81°20'W). An earlier collection made during 1957 at an unspecified locality in the Saugeen River watershed confirms the early presence of this species in the Lake Huron basin.

POPULATION

The redside dace is generally uncommon, but is locally abundant throughout its range in Ontario. An estimate of the relative sizes of these populations can be made by comparing the numbers of redside dace and the total numbers of fish captured. Where it was captured, redside dace accounted for 1% to 78% of all fish caught. At the only site in the Irvine River where it was captured during this study, redside dace composed 44% of the catch. Information on the population in the Saugeen River watershed is lacking.

The Ontario Ministry of Natural Resources (O.M.N.R.) found redside dace in every survey of the Humber River watershed it was "never in sufficient numbers to be described as common" (Wainio and Hester 1973).

The redside dace has recently shown apparent population declines and possible extirpations in Ontario; collections of this species have not been made from the Pringle Creek, Lynde Creek, Highland Creek, Don River, Etobicoke Creek, Twelve Mile Creek, Welland Canal, or Nith River watersheds for at least 20 years. This species was taken at four sites in the Sixteen Mile Creek watershed by the O.M.N.R. from 1973 to 1975, but efforts to locate it in this watershed during the 1979 survey were unsuccessful. Failure to collect this species in many streams during recent years suggests severe population declines or extirpations.

Reduced population levels may be partially attributable to sampling technique. The redside dace selects a habitat that may be overlooked during sampling. In slow-flowing sections of the East Humber River and Bronte Creek sampled during 1979, redside dace were significantly less abundant in mid-stream than along edges covered by low overhanging bushes where sampling is more difficult. In surveys of the Humber River watershed carried out by the O.M.N.R. in 1972, one survey team found this species at only two locations while a second team found it to be considerably more common and widespread throughout the watershed (Wainio and Hester 1973).

Habitat alteration has likely contributed to recent decreases in the numbers of redside dace in Ontario. It prefers cool, clear water and is apparently quite sensitive to turbidity (Trautman 1957). This type of habitat has diminished considerably throughout southern Ontario due to intensive agricultural practices and urbanization. Most of the streams in which the redside dace has been reported have been drastically altered by urbanization. During this study, populations of this species were confined primarily to headwaters where habitat alteration has not been severe.

Disjunct populations of redside dace in the Grand and Saugeen River watersheds suggest that this species was once widespread in Ontario. Trautman (1957) and Gilbert (1980) stated that this species has recently disappeared from many areas where it once occurred. Because of the spottiness of its distribution in general, Greene (1935) suggested that it was moving toward extinction.

Both adult and juvenile redside dace were taken during this study, indicating the continued existence of reproducing populations. However, the increasingly discontinuous distribution of this species in Ontario indicates that the redside dace is becoming more uncommon.

THREATS

There are no impending developments that will pose an immediate threat to the welfare of this species in Canada.

STATUS

The following statements were considered valid, after review of the available information, and were used in the evaluation of the status of the redside dace in Canada:

1. Populations of redside dace are present in the tributaries of Lake Ontario, Lake Erie, and Lake Huron.
2. Reproducing populations occur in tributaries of western Lake Ontario and in the Grand River watershed. Data on a population in the Lake Huron basin (Teeswater River) does not allow definitive analysis of population structure or trends.
3. The range of the redside dace in North America is discontinuous and comprises several disjunct populations.
4. The redside dace has recently shown apparent population declines and possible extirpations in Ontario due to deterioration in habitat quality.
5. The redside dace is likely to become endangered in

Canada if habitat degradation is not terminated or reversed.

Based on information evaluated during this study it is recommended that the redside dace be classified as threatened in Canada.

BIOLOGY

In Ontario, the redside dace occurs in pools and slow-flowing sections of relatively small headwater streams which have both pool and riffle habitat. Stream widths at capture sites during the 1979 survey averaged about 5m (range 1 to 10cm). Depths at capture sites were usually about 1m, although specimens were captured in stream sections ranging between 0.3 and 2.0m in depth. Schwartz and Norvell (1958) found redside dace in pools of small headwater streams having an average width of about 9m and a depth of about 1m. Trautman (1957) and Gilbert (1980) also noted that this species prefers small to medium sized streams.

Edge cover is an important habitat requirement of the redside dace. At most collection sites during this study this species was most abundant in streams under overhanging bushes and herbaceous plants, particularly beside undercut banks. All sites were shaded to a large degree. Trautman (1957) also noted that this species occurs in shaded areas and near edge cover. This preference for edge cover and shade may be related to requirements for cool temperatures, and to feeding habits.

During this study, redside dace were captured over bottom types of various combinations of boulders, gravel, sand, clay, silt, mud, and detritus. Submerged branches and logs were also frequently present. Schwartz and Norvell (1958) found this species over gravel, sand, and mud bottoms. Trautman (1957) reported that it occurs over clean gravel, sand, and bedrock bottoms where organic detritus and submerged brush or roots may be present. Gilbert (1980) stated that this species occurs in rubble and gravel-bottomed streams.

The redside dace is usually found in relatively clear water in Ontario. Streams were clear and colourless at most collection sites with hard bottoms, and clear and brown-tinged in streams with organic bottoms. Water was considered turbid (Secchi disc transparency ca. 0.3m) at only two collection locations. This species prefers clear water and is apparently quite sensitive to turbidity (Trautman 1957; Scott and Crossman 1973).

Little is known of temperature and dissolved oxygen requirements of the redside dace. Temperature and dissolved oxygen levels at collection sites during August and September ranged from 14 to 23°C and 4 to 11.5mg/L, respectively. Temperatures were usually less than 20°C and dissolved oxygen concentrations were usually at least 7mg/L. Trautman (1957), Scott and Crossman (1973) and Gilbert (1980) reported that this species prefers cool temperatures.

Water quality deterioration from coal mine pollution, domestic and industrial pollution, and agricultural practices caused the depletion of this species in many parts of Ohio (Trautman 1957).

Ages of 58 specimens of redside dace collected from mid-August to late September during the 1979 survey were determined by the scale method as described by Schwartz and Norvell (1958). Ranges in standard lengths and preserved weights are as follows:

Age	No.	SL (cm)	Weight (g)
0+sexes combined	19	2.3 - 3.5	0.1 - 0.7

1+sexes combined	10	3.5 - 4.5	0.6 - 1.4
2+males	13	5.0 - 6.3	1.9 - 4.3
2+females	13	4.8 - 6.7	1.9 - 4.9
3+males	2	6.5 - 6.9	4.9 - 6.0
3+females	9	6.3 - 7.8	4.6 - 8.5

The age-length relationship of Ontario specimens is similar to that found by Koster (1939) for redside dace in New York while lengths reported for specimens from Ohio (Trautman 1957) and Pennsylvania (Schwartz and Norvell 1958) are greater. The maximum age and length reported for New York specimens are 4+ and 7.9cm (Koster 1939). Schwartz and Norvell (1958) reported a maximum age of 3+ for redside dace in Pennsylvania. Trautman (1957) gave the maximum length in Ohio as 11.4cm. The growth rate of this species generally decreases by a 50% increment annually (Schwartz and Norvell 1958).

Female redside dace captured during this study were generally larger than males of the same age, as also noted by Koster (1939) and Schwartz and Norvell (1958).

Gonads of 40 specimens collected in late summer and 10 specimens captured in mid-May were examined. All age 1+ specimens were immature. Most 2+ fish and all age 3+ redside dace examined from the May collections were in prespawning or ripe condition. These data suggest that some redside dace may spawn at age 2+ and that the majority of age 3+ fish are mature.

Redside dace captured in the East Humber River in the second week of May at water temperatures ranging from 16° to 19°C were ripe or in prespawning condition, none had spawned. The redside dace spawns during the latter half of May at water temperatures of 18°C or higher in New York (Koster 1939). Spawning in Ontario probably takes place at water temperatures above 19°C.

Spawning was not observed during this study; however, it was noticed that pools that had been areas of concentration for this species the previous summer were vacant during spring sampling. This data suggests that the redside dace may move to and concentrate in spawning areas, probably in riffles or gravel and sand bars. The spawning process was detailed by Koster (1939).

Egg counts for redside dace captured during May varied from an estimated 423 to 1,971 eggs per female averaging 7.5cm (SL).

Koster (1939) gave egg numbers which suggest a consistent variance; he found that counts ranged from 409 to 1,526 eggs per female. Larval development has not been described.

Sexual dimorphism in the redside dace has been noted in previous studies (Koster 1939 , Trautman 1957, Schwartz and Norvell 1958, Scott and Crossman 1973). Males usually have proportionately larger pectoral fins than females. Body colouration is more intense on the male than on the female, particularly during spawning. The breeding male has small nuptual tubercles distributed over nearly all of the body while the breeding female has smaller, less widely distributed tubercles (Scott and Crossman 1973).

Gut content analysis of 47 redside dace collected during this study indicates that this species feeds primarily at the surface (Table 1). Insects accounted for about 92% of the average gut content. All specimens with food in their foregut had fed on insects. Adult diptera was the commonest food item and accounted for 86% of the average insect volume. The presence of Nematoda, Ostracoda, Hydracarina, and immature aquatic Insecta in many specimens indicates that benthic and mid-water feeding is of secondary importance to this species.

Young-of-the-year generally consumed higher proportions of smaller food items, particularly immature aquatic Insecta, than did larger specimens. Schwartz and Norvell (1958) also found that terrestrial Insecta, primarily Diptera, accounted for most of the diet and noted a general increase in the size of food items comsumed as the size of the fish increased. They noted that the diet of redside dace from Pennsylvania varied seasonally. A decrease in the amount of adult Diptera and Ephemeroptera with the progression of spring and an increase in the relative importance of Hymenoptera and Coleoptera during summer was observed.

Feeding habits of specimens maintained in an aquarium were also noted during this study. Redside dace feed readily on artificial food at the surface and in mid-water and will occassionally take food particles from the bottom. The large, upturned mouth appears well suited to seizing food items at the surface and in mid-water. Schwartz and Norvell (1958) observed redside dace jumping into the air to capture flying insects.

Predation by other animals on redside dace has not been reported. Piscivorous fish species were captured infrequently at or near redside dace capture localities during this study.

Potential predators in Ontario include brook trout (*Salvelinus fontinalis*), rainbow trout (*Salmo gairdneri*), black crappie (*Pomoxis nigromaculatus*), and rock bass (*Ambloplites rupestris*).

The redside dace is of little direct importance to man due to its very limited distribution (Scott and Crossman 1973).

RECOMMENDATIONS

The following recommendations are suggested for the maintenance and monitoring of the redside dace in Canada:

1. The Ontario Ministry of Natural Resources should hold and transport to a museum facility redside dace specimens captured in Ontario. Particular attention should be given to specimens captured in the Lake Erie and Lake Huron basins.
2. Identification information should be made available to concerned agencies.
3. Protective measures should be investigated to ensure that this species is not depleted in number by bait dealers or local fishermen.
4. Measures should be taken to avoid severe erosion and deposition of materials into streams during construction

4. activities in the vicinity of streams inhabited by redside dace.

5. Where possible, steps should be taken to protect stream banks from damage by livestock and man.

6. Buffer zones of natural vegetation should be established along streams inhabited by redside dace. Stream bank restoration projects in damaged areas should be encouraged. Such programs could be most easily initiated in critical habitat areas under government ownership.

7. Alteration to the present gradient and flow regimes of watercourses which are inhabited by redside dace should be investigated to mitigate the effects on redside dace populations.

LIST OF SPECIMENS

A list of redside dace specimens, captured in Canada, from the National Museum of Canada (NMC) and the Royal Ontario Museum (ROM) is provided below:

ROM 3802 (12), Etobicoke Creek, York County, July 5, 1926; ROM 3796 (5), Don River near Oriole, York County, August 16, 1926; ROM 11748, Rouge River, York County, April 13, 1935; ROM 24858 (27), Nith River, 1952; ROM 15637, Highland Creek near Highway 2, York County, October 22, 1952, W.B. Scott and E. Taylor; ROM 15972, Humber River at Kleinburg, York County, December 6, 1953, W.H. Carrick; ROM 24788 (25), Saugeen River, Bruce County. 1957, Ontario Department of Planning and Development; ROM 24663 (23), Twelve Mile Creek, Welland County, 1958, P.D.P.D.; ROM 2113, Pringle Creek, Durham County, May 29, 1959; ROM 21401 (6), Lynde Creek, Durham County, 1959; NMC 60-4578, Welland Canal, Welland County, July 1, 1960, J.W. Scoggan; NMC 60-0533A, Fourteen Mile Creek, Halton County, August 25, 1960, J.W. Scoggan; NMC 60-0534A, Etobicoke Creek, York County, August 25, 1960, J.W. Scoggan; ROM 29999 (11), Oakville Creek, Halton County, July 23, 1973, Miliani, Dunlop and Young; ROM 30647 (3), East Humber River, York County, August 9, 1974, MTRCA; NMC 79-1849, Bronte Creek, Wentworth County, June 29, 1979, Halton Conservation Authority; NMC 79-1015 (5), East Humber, York County, August 16, 1979, B. Parker and P. McKee; NMC 79-1016 (24), August 16, 1979, B. Parker and P. McKee; NMC 79-1018, East Humber River, York County, August 17, 1979, B. Parker and P. McKee; NMC 79-1020, East Humber River, York County, August 17, 1979, B. Parker and P. McKee; NMC 79-1021 (7), East Humber River, York County, B. Parker and P. McKee; NMC 79-1022 (11), East Humber River, York County, B. Parker and P. McKee; NMC 79-1064 (7), Irvine River, Wellington County, August 29, 1979, B. Parker and P. McKee; NMC 79-1080, Duffins Creek, Durham County, September 4, 1979, B. Parker and P. McKee; NMC 79-1082 (4), Bronte Creek, Wehtworth County, September 5, 1979, B. Parker and P. McKee; NMC 79-1085 (33), Spencer Creek, Wentworth County, September 5, 1979, B. Parker and P. McKee, NMC 79-1086 (2), Unnamed tributary of Bronte Creek, September 6, 1979, B. Parker and P. McKee; NMC 79-1087 (7), Unnamed tributary of Bronte Creek, Wentworth County, September 6, 1979, B. Parker and P. McKee; NMC 79-1090 (23), Bronte Creek, Wentworth County, September 6, 1979, B. Parker and P. McKee; NMC 79-1093 (2), Unnamed tributary of Credit River, Peel County, September 6, 1979, B. Parker and P. McKee; NMC 79-1094 (8), Fletchers Creek, Peel County, September 7, 1979, B. Parker and P. McKee; NMC 79-1096 (5), Unnamed tributary of Black Creek, Peel County, September 7, 1979, B. Parker and P. McKee; NMC 79-1094 (9), Mitchell Creek, Durham County, September 28, 1979, B. Parker and M.J. Fenton; NMC 79-1199 (6), Tributary to Rouge River, September 28, 1979, B. Parker and M.J. Fenton; NMC 79-1205A (2), Greenock Creek, approximately 6km S.W. of Walkerton, 1977, D. Krewtzweiser.

Table 1: Gut contents of 36 specimens* of redside dace collected in 1979 from streams flowing into western Lake Ontario and eastern Lake Erie. Volumes refer to percentages of total gut contents.

Food Item	Volume %	Frequency of Occurrence %
Orthoptera	4.7	5.6
Odonata (naiads)	0.1	2.8
Trichoptera (larvae and pupae)	4.0	11.1
Coleoptera (adult)	0.9	2.8
Hymenoptera (adults)	2.8	8.3
Diptera (adults)	79.7	94.4
(pupae)	0.1	2.8
(larvae)	0.2	11.1
Hydracarina	1.0	13.9
Ostracoda	0.2	2.8
Nematoda	5.5	33.3
Unidentified eggs	5.5	5.6
Plant material	2.8	2.8

* 11 other specimens had empty foreguts

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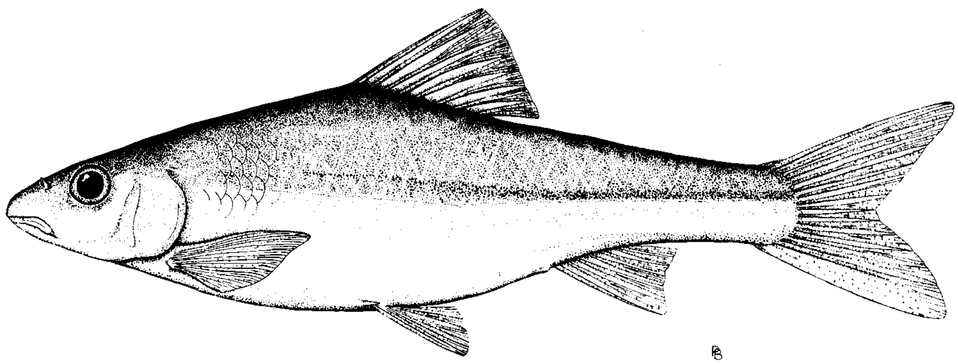
SILVER CHUB

Hybopsis storeriana (Kirtland)



Proposed Status: RARE

The silver chub, Hybopsis storeriana (Cyprinidae) occurs in the freshwaters of central North America. This species is reported in Canada from southwestern Ontario, and in southern Manitoba (Keleher and Kooyman 1957, Scott and Crossman 1973). Populations of silver chub are known from Ohio and Michigan.

Little has been written on the biology of the silver chub in Canada. Life history and descriptive information for this species were summarized by Trautman (1957), Carlander (1969) and Scott and Crossman (1973). An unpublished Ph.D. thesis on the life history of silver chub in western Lake Erie is the most extensive study on this species (Kinney 1954).

The silver chub was considered common in the western basin of Lake Erie during the early 1950's. Reports of capture of this species declined in the early 1960's. Efforts by the Royal Ontario Museum to obtain specimens from Lake Erie during the latter half of the 1960's from commercial fishermen and the Ontario Ministry of Natural Resources were unsuccessful. The last specimen taken in Canada during this period was collected in Lake Erie at Port Stanley in 1960 by the National Museum of Canada.

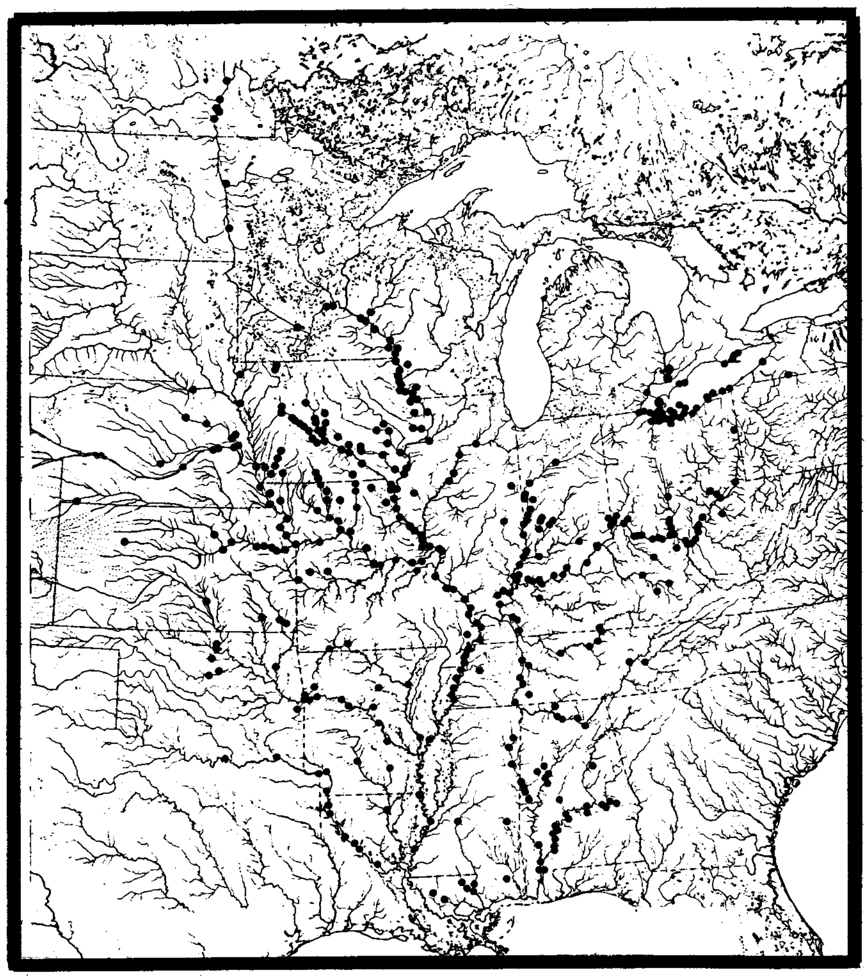
The apparent population decline of the silver chub in Lake Erie during the 1950's and early 1960's and the scarcity of specimens collected during the late 1960's and early 1970's led Scott and Crossman (1973) to believe that the silver chub was rare in Lake Erie. McAllister and Gruchy (1977) listed this species as endangered in Canada. In the United States the silver chub is threatened in Michigan and South Dakota (Miller 1972) and endangered in Ohio (Ohio Department of Natural Resources 1976).

The silver chub is distinguished from other cyprinids in Ontario by a combination of characteristics: it has a well developed barbel at the posterior end of its maxillary, its snout projects considerably beyond its mouth, and it has large deciduous scales usually 38 to 41 along the lateral line (McAllister and Gruchy 1980). The silver chub was described by Forbes and Richardson (1920), Kinney (1954), and Scott and Crossman (1973).

DISTRIBUTION

The silver chub is restricted to the freshwaters of central United States and Canada, from the Gulf states in the south through the Mississippi River basin to the Great Lakes and Red River drainages in the north. A geographically isolated population exists in the lower Brazos River drainage in Texas. (Figure 1).

Along the Gulf of Mexico, it has been collected in the Alabama, Pearl, and Mississippi River drainages. The silver chub occurs northward in the Mississippi River and associated river drainages through Arkansas, Missouri, western Tennessee, Kentucky, Illinois, Ohio, Iowa, Wisconsin and Minnesota. It has also been recorded in Oklahoma, Kansas, and Nebraska in the Red, Arkansas, and Missouri River systems. The silver chub has been captured in North Dakota, Minnesota and Manitoba in the Red River drainage. In Manitoba, the silver chub has been collected from the Red and Assiniboine River systems at Winnipeg (Scott and Crossman 1973). Keleher and Kooyman (1957) stated that the known northern limit



North American distribution of the silver chub, *Hybopsis storeriana*. Adapted from Gilbert (1980)

Figure 1

of this species has been extended to include St. Andrews Locks on the Red River at Selkirk (50^o09'N, 96^o52'W).

In the Great Lakes basin the silver chub occurs from the St. Clair River, south through Lake St. Clair and Lake Erie in Michigan, Ohio and Ontario. In Lake Erie (Figure 2) the silver chub has been reported in Canada from Port Dover, Haldimand Co. (42^o47'N, 80^o04'W) Lynn River, Norfolk Co. (42^o 47'N, 80^o12'W), Clear Creek, Norfolk Co. (42^o35'N, 80^o35'W), Long Point Bay, Norfolk Co. (42^o40'N, 80^o10'W), Port Stanley, Elgin Co. (42^o40'N, 81^o13'W), and Rondeau Bay (Rondeau Harbour), Kent Co. (42^o17'N, 81^o53'W) and at a number of locations around Pelee Island, Essex Co. (41^o47'N, 82^o40'W) and Pigeon Bay, Essex Co. (42^o01'N, 82^o41'W). In Lake St. Clair the silver chub has been reported mainly from the southwestern shoreline in the vicinity of the Thames River mouth, Kent and Essex Co. (42^o19'N, 82^o27'W). Scattered collections of this species in Mitchell Bay, Kent Co. (42^o28'N, 82^o26'W) have also been recorded. The silver chub has been reported from the St. Clair River in the vicinity of Belle River, Michigan (Texas Instruments Ltd. 1976) and at the Lambton Generating station near Sombra, Lambton Co. (42^o42'N, 82^o29'W) (Leslie et. al. 1979).

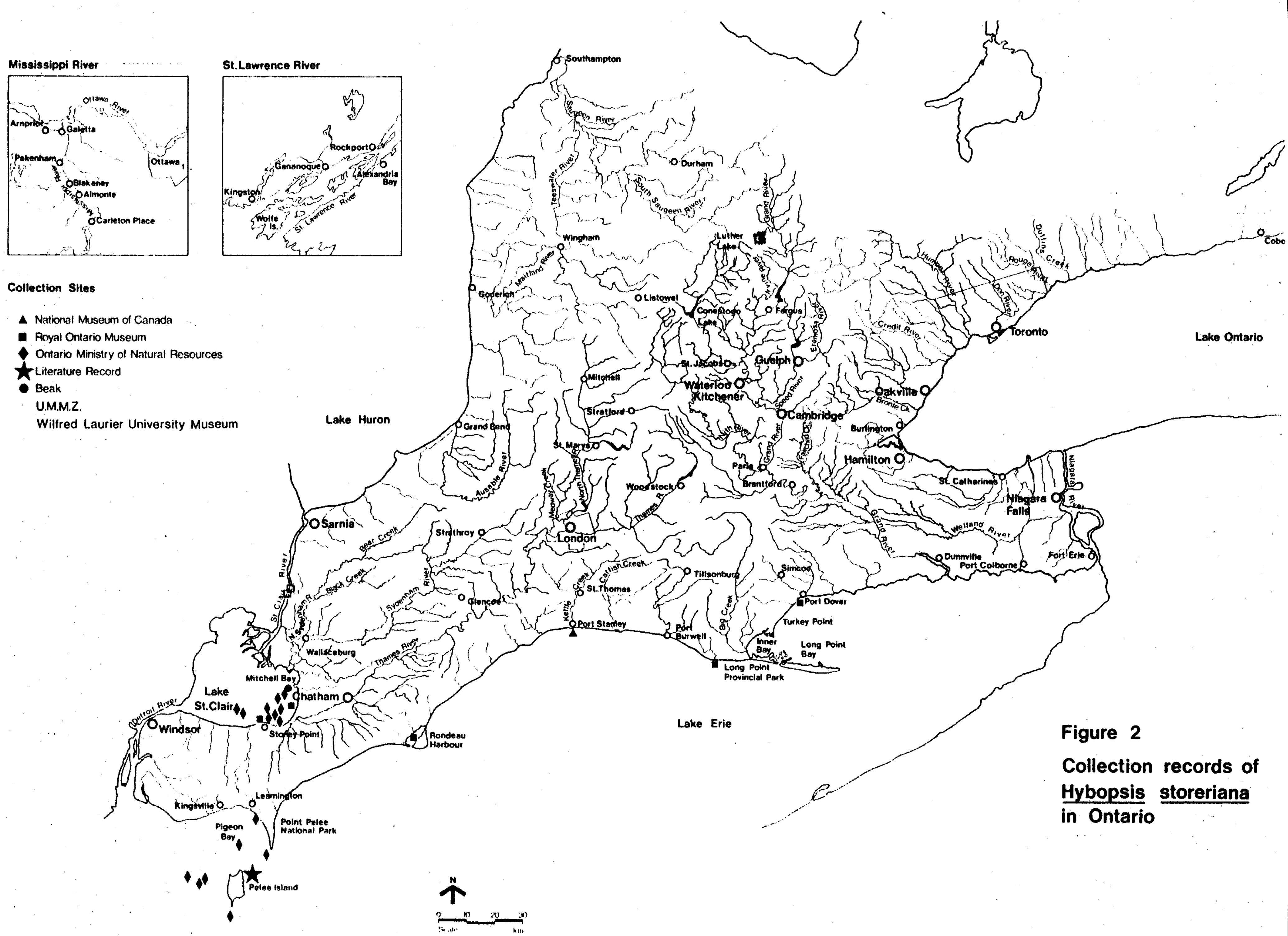


Figure 2

Collection records of **<u>Hybopsis storeriana</u>** **in Ontario**

POPULATION

The population structure of the silver chub in Canada is undetermined. Data compiled by the Ontario Ministry of Natural Resources suggests that there are reproducing populations of this species in Lake St. Clair and the western basin of Lake Erie. The continued existence of this species in Manitoba is uncertain. Mr. W. Lysack (pers. comm.) of the Manitoba Department of Natural Resources believes that if this species is present in Manitoba, it is extremely rare.

There has not been a specific study to determine the population structure of the silver chub in the Great Lakes drainage since Kinney's report in 1954. The population of silver chub in the western basin of Lake Erie was estimated at a minimum of 20 silver chub per acre (Kinney 1954). Data collected by the OMNR during the 1970's confirm the continued presence of silver chub in the western basin of Lake Erie and Lake St. Clair, but are inadequate to estimate population numbers.

Approximately 80 silver chub were collected by the Ontario Ministry of Natural Resources in the western basin of Lake Erie from 1977 to 1979 by otter trawl and gill net (Table 1). Catches-per-unit-effort in the western basin of Lake Erie ranged from 2.0 to 4.5 silver chub per hour of trawling. Roughly 1,000 silver chub were captured in Lake St. Clair during the 1970's by seine and bottom trawl (Table 1). Catches-per-unit-effort for trawls varied from 2 to 23 silver chub per hour. Total numbers of silver chub captured and catch-per-unit-effort for that period peaked during 1974. Silver chub accounted for 0.02 to 1.3 percent of the total number of fish captured by otter trawl. Catch-per-unit-effort data from Lake Erie and Lake St. Clair suggest that the relative abundance of silver chub in both lakes is low.

To what extent the silver chub has invaded the St. Clair River is not known. Its presence in the St. Clair River was verified in 1975 by the capture of two adult silver chub near Belle River (Texas Instruments Ltd. 1975). Leslie *et. al.* (1979) reported that 98,000 larval silver chub were entrained in two days at the Lambton Generating Station on the St. Clair River but, following further examination of specimens from the Lambton Generating Station by larvae fish taxonomists positive identification could not be made.

During this study, BEAK acquired four adult silver chub from Mitchell Bay, Lake St. Clair through the Lake St. Clair Fisheries Assessement Unit, OMNR.

THREATS

There are no impending developments that will pose an immediate threat to the welfare of this species in Canada.

STATUS

The following statements were considered valid after review of available information and were used in the evaluation of the status of the silver chub in Canada:

1. A reproducing population of silver chub is present in Lake St. Clair and Lake Erie.
2. Available information does not allow definitive analysis of population structure or trends.
3. The Canadian population of silver chub is at the north-eastern extremity of its North American range.
4. The silver chub in Canada does not appear threatened with immediate extinction due to the actions of man.

Based on information evaluated during this study, it is recommended that the silver chub be classed as a rare species in Canada.

Biology

The biology of the silver chub has received little attention in Canada. The silver chub has been collected in Canada only from the open waters of Lake Erie and Lake St. Clair. This species has been captured elsewhere in stream, lake and river habitats. Kinney (1954) stated that the silver chub is an inhabitant of large silty rivers and clear lakes and rarely enters small streams. Kinney believed that collections of silver chub made in or near the mouths of such streams during the spring are possibly due to positive thermotropic migrations. Trautman (1957) reported that in Ohio the silver chub was usually found in low gradient streams but would move to clear streams of higher gradient to escape temporary influxes of silt.

Collections of silver chub by the OMNR in Lake St. Clair and Lake Erie are from waters under 10 meters in depth. Kinney (1954) suggested that the silver chub preferred the shallow waters of the western basin of Lake Erie. The majority of Kinney's collections were from waters under 10 meters in depth. Capture depths of up to 20 meters have been recorded in Lake Erie (Woolman 1895; Fish 1935; and Trautman 1957).

Substrate composition at capture localities of the silver chub range from gravel to silt. Kinney (1954) suggested that in

Lake Erie the silver chub was most numerous over soft bottoms. Trautman (1957) stated that the silver chub occurs in greatest numbers over rather clean, gravelly or sandy bottoms.

There is some indication that this species is intolerent of low dissolved oxygen levels. Kinney (1954) suggested that temporary hypoxic conditions created in the western basin of Lake Erie in 1953, during a period of thermal stratification, could have stressed silver chub population stability.

Since 1953, hypoxic conditions have been recorded in the western basin of Lake Erie on several occassions (Carr _et al_. 1965, Leach and Nepszy 1976).

Seasonal water temperature fluctuations are thought to limit the distribution of this species. Kinney (1954) considered the silver chub a southern species which requires water temperatures above 4 to $10^{o}C$ for six to seven months of the year and above 21^{o} for at least three months to sustain normal growth and permit reproduction. Water temperatures in the western basin of Lake Erie and the southeastern sector of Lake St. Clair fall into these constraints. Silver chub have been captured in Lake St. Clair from waters ranging between 4 and $25^{o}C$.

Kinney (1954) used scales to age silver chub and found that males and females seldom live more than three years, although the occasional female lives to age four. Annulus formation was completed by May or early June. Age 1+ silver chub ranged from 55 to 145mm in length, age 2+ from 110 to 155mm (SL) and age 3+ from 145 to 170mm (SL) in Lake Erie (Kinney 1954). A collection of nine silver chub taken from Lake Erie near Hen Island by the OMNR on July 12, 1978 averaged 70mm (TL). These specimens are believed to be 1+ fish. Specimens of silver chub captured in Lake St. Clair

Silver chub taken during this study averaged 15cm in total length. The longest Canadian specimen is approximately 20cm in total length. Trautman (1957) gave the maximum size for silver chub in Ohio as 231mm in length and 170g in weight. Pflieger (1975) stated that in Missouri adult silver chub are commonly 9 to 14cm in length and individuals above 15cm in length are rare.

Too few specimens are available to determine growth rates for Canadian populations of this species. Kinney (1954) stated that the length and weight are about the same for both sexes in the young-of-the-year and 1+ age groups. He also found that the growth rate for young-of-the-year and 1+ fish is approximately 60mm per year and for 2+ and 3 + silver chub the growth rate decreases to 25mm and 15mm respectively. Kinney suggested that females are slightly heavier than males due to increases in egg size and weight.

The spawning habits of the silver chub are not known (Pflieger 1975). It is thought that in the Great Lakes drainage this species spawns in open waters (Scott and Crossman 1973). Kinney (1954) reported that the silver chub spawns in late July or early August when water temperatures reach 18°C. Most spawning took place in waters above 21°C. Trautman (1957) found spawned adults dead on Ohio beaches in June and July. Scott and Crossman (1973) stated that dead silver chub noted by Trautman may have been the result of spawning mortality. Leslie et al. (1979) reported capturing larval silver chub in the St. Clair River from June 13 to the 21st, suggesting that spawning takes place earlier than mid-June.

Age 2 + silver chub examined during this study were sexually mature. Kinney (1954) reported that most one-year-old fish are sexually mature. Kinney estimated the number of eggs per female as:365 plus 746 times the ovary weight in grams.

Immature eggs are light yellow and mature eggs are light orange. Time to hatching is unknown (Kinney 1954).

Four larval stages were described by Fish (1932). Larval silver chub have been taken in bottom trawls at depths of 18 to 20m in Lake Erie (Scott and Crossman 1973).

Food habits could not be determined for Canadian populations due to a lack of specimens available for stomach analysis. The following information is summarized from Kinney (1954). Silver chub feed primarily on benthic organisms. Young-of-the-year silver chub feed on Copepoda (40% by volume), Tendipedidae-larvae and pupae (35% by volume), Daphnia (10% by volume) and small amounts of Trichoptera, Sphaeriidae, Ostracoda and Oligochaeta. Approximately two-thirds of the food of adult silver chub consists of Ephemeroptera nymphs; Hexagenia comprising more than 65% of those nymphs. Minor components of the stomach volume were small molluses, Daphnia, Gammarus, and small fish. Following the decline of Hexagenia populations in Lake Erie, during the 1950's, greater use was made of chironimids and Gammarus as a food supply (Scott and Crossman 1973).

The silver chub probably serves as food for several species of piscivorous fish. Burbot (Lota lota), sauger (Stizostedion canadense) and walleye (Stizostedion vitreum), were listed as predators of the silver chub by Kinney (1954).

Specimens obtained during this study were captured by ice fishermen who considered the silver chub an excellent bait fish for walleye. Harlan and Speaker (1951) reported that in Iowa the silver chub is a popular bait fish and Jordan and Evermann (1908) regarded the silver chub as a superior bait fish for bass (Micropterus). Use of the silver chub as a bait fish is not thought to significantly affect population numbers of the silver chub in Ontario waters.

RECOMMENDATIONS

The following recommendations are suggestions for maintenance and monitoring of the silver chub population in Canada:

1. The Ontario Ministry of Natural Resources should hold and transport to a museum facility all silver chub specimens captured in Lake Erie or Lake St. Clair.
2. Identification information should be made available to concerned agencies.
3. Protective measures should be investigated to insure that this species is not depleted in number by bait dealers

or local fishermen.

4. A population survey by the Ontario Ministry of Natural Resources be carried out in conjunction with future experimental bottom trawling.
5. Further study be implemented to determine spawning areas and population trends.

LIST OF SPECIMENS

A list of the silver chub specimens captured in Canada from the National Museum of Canada (NMC) and the Royal Ontario Museum (ROM) is provided below:

ROM 1986, Lake Erie, off Nanticoke, Haldimond County; ROM 1987, Lake Erie, off Rondeau Bay, Kent County; ROM 13963, Lake Erie, Long Point Bay, Norfolk County; ROM 17855, 1947; ROM 17856, 1947; ROM 17857, Clear Creek, Lake Erie, Norfolk County, 1949; ROM 17858, Lake Erie, 1949; ROM 17859, Lake Erie, Long Point, 1950; ROM 18341 (2), Lake Erie, 2km West of Lynn Creek, Norfolk County, July 16, 1948, E. Taylor; ROM 18731, Lockport, Manitoba; ROM 32545 (2), St. Lukes Bay, Lake St. Clair, January 1977; ROM 34976 (1), Lake St. Clair, off Stoney Point, July 22, 1974, OMNR; ROM 35049 (1), Lake St. Clair, southshore, Essex County, January 1979, Brad Ward; NMC 61-476A, Lake Erie, Port Stanley, Elgin County, July 16, 1960; NMC 80-0874(2), Lake St. Clair, Mitchell Bay, Kent County, February 2, 1980, D. Hector.

Table 1: Relative abundance of Hybopsis storeriana in western Lake Erie and Lake St. Clair (adapted from Ontario Ministry of Natural Resources data).

Lake Erie

Year	Location	Outboard Trawling		
		Effort (min.)	No. of fish	catch/h trawling
1977	west basin	150	5	2
1978	west basin	766	58	4.5
			All methods of capture	
1979	west basin		16	

Lake St. Clair

Year	Location	Effort (min.)	Outboard Trawling			Beach Seining		
			No. of Fish	Catch/h trawling	% of silver chub in total catch	No. of hauls	No. of fish	% of silver chub in total catch
1972	S.E. quadrant	1527	91	3.6				
1973	S.E. quadrant	1301	71	3.3	0.43	50	4	0.01
1974	S.E. quadrant	1782	686	23.1	0.14	77	83	.17
1975	S.E. quadrant	1432	48	2.0	1.30	56	4	.02
1976	S.E. quadrant	no data	(Improper	identifications)	no data	no data	no data	no data
1977	S.E. quadrant	no data	7	no data	no data	no data	no data	no data
1978	S.E. quadrant	no data	92	no data	no data	no data	no data	no data
1979	S.E. quadrant	no data	10	no data	no data	no data	no data	no data

* within 10 km of Thames River mouth

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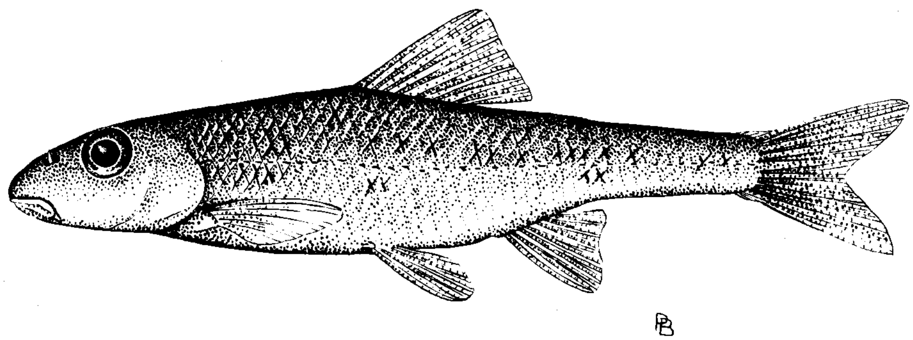
GRAVEL CHUB

Hybopsis x-punctata Hubbs and Crowe



Proposed Status: ENDANGERED

The gravel chub, Hybopsis x-punctata (Cyprinidae), has a wide but discontinuous distribution in east central North America. In Canada the gravel chub has been found only in the Thames River watershed of southwestern Ontario. This population is approximately 300km from the nearest gravel chub population, which is located in Ohio.

The species is represented by two subspecies (Hubbs and Crowe 1956). Populations in the northeastern Ohio River basin and in Ontario are assigned to H. x-punctata trautmani.

Little has been published regarding the biology of the gravel chub. Available data have been summarized by Trautman (1957), Scott and Crossman (1973), and McAllister and Gruchy (1977). Radforth (1944) outlined zoogeography and early distribution records for this species in Ontario.

The last reported collection of gravel chub from Canada was made in 1958. Scott and Crossman (1973) believed it doubtful that there were surviving Canadian populations. McAllister and Gruchy (1977) listed the gravel chub as endangered in Canada. This species is considered to be endangered in Kansas (Platt 1974) and has been recommended for endangered status in Wisconsin (Anonymous 1979).

The gravel chub is distinguished from similar species in Canada by the x- or y- shaped markings on its silvery sides, usually only faintly evident in Ontario specimens; its snout, which protrudes considerably beyond its mouth; and its lateral line scale count, which ranges from 43 to 45 (McAllister and Gruchy 1980).

DISTRIBUTION

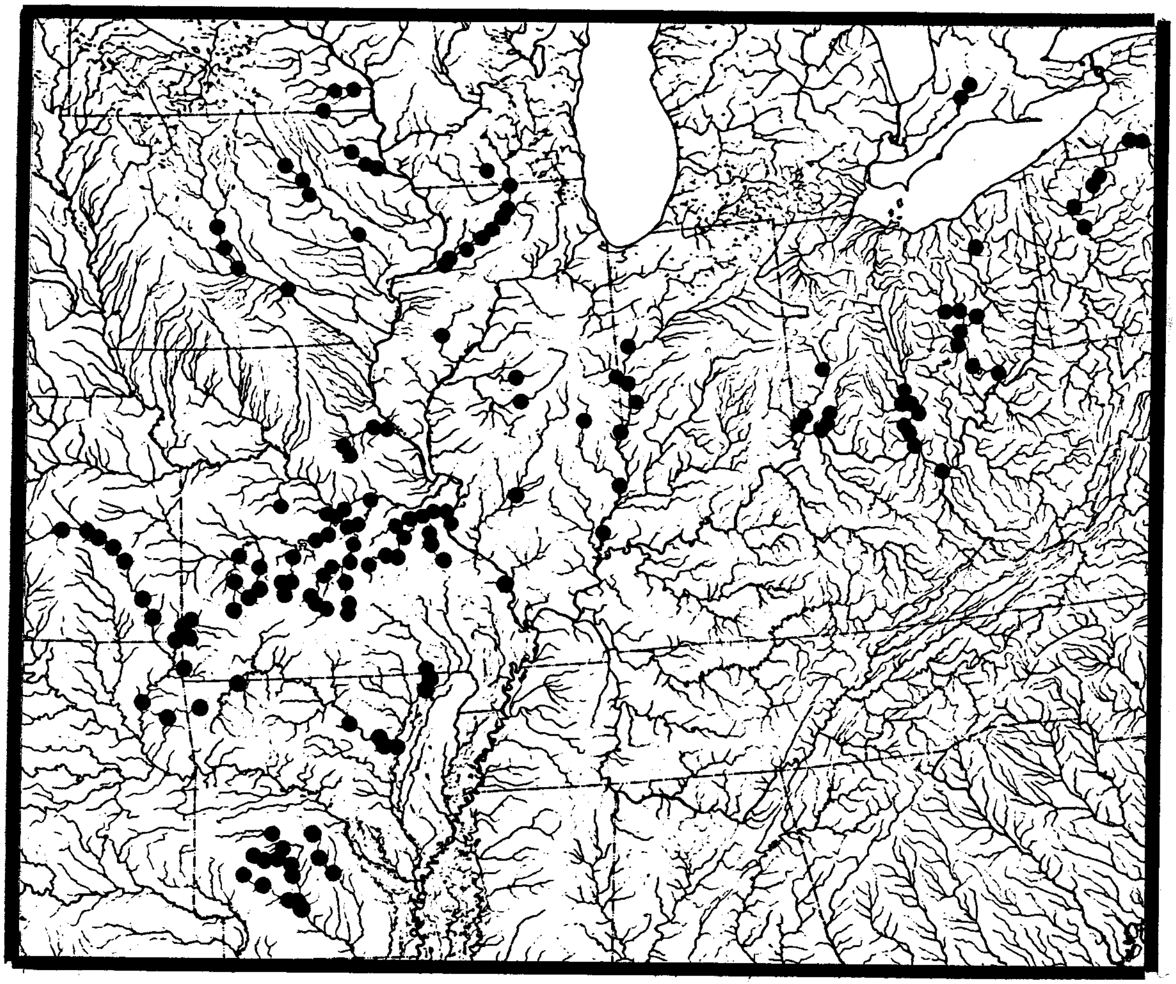
The following account of the distribution of the gravel chub is based on information provided by Gilbert (1980). The gravel chub occurs only in east central North America (Figure 1).

In the United States the gravel chub is restricted to the Mississippi River drainage. Its range extends from south-eastern Minnesota and Wisconsin, south through Iowa, Illinois, Indiana, Missouri, and Arkansas, west to eastern Kansas and Oklahoma, and east in the Ohio River watershed to north-western Pennsylvania and western New York. In the east it is apparently absent from areas south of the Ohio River. An isolated population in southwestern Ontario is the only evidence of this species existence in the Great Lakes basin.

The gravel chub has been reported in Canada from two localities in southern Ontario (Figure 2). The species was first reported, in Canada, in 1929 from the Thames River at the Muncey Indian Reserve, Middlesex County (42°50'N, 81°30'W). The second collection of the gravel chub was made in August, 1958 from the North Thames River in London (43°00'N, 81°16'W).

POPULATION

The paucity of collected materials from the Thames River watershed suggests that this population may have been localized. The



North American distribution of the gravel chub
Hybopsis x-punctata. Adapted from Gilbert (1980)

Figure 1

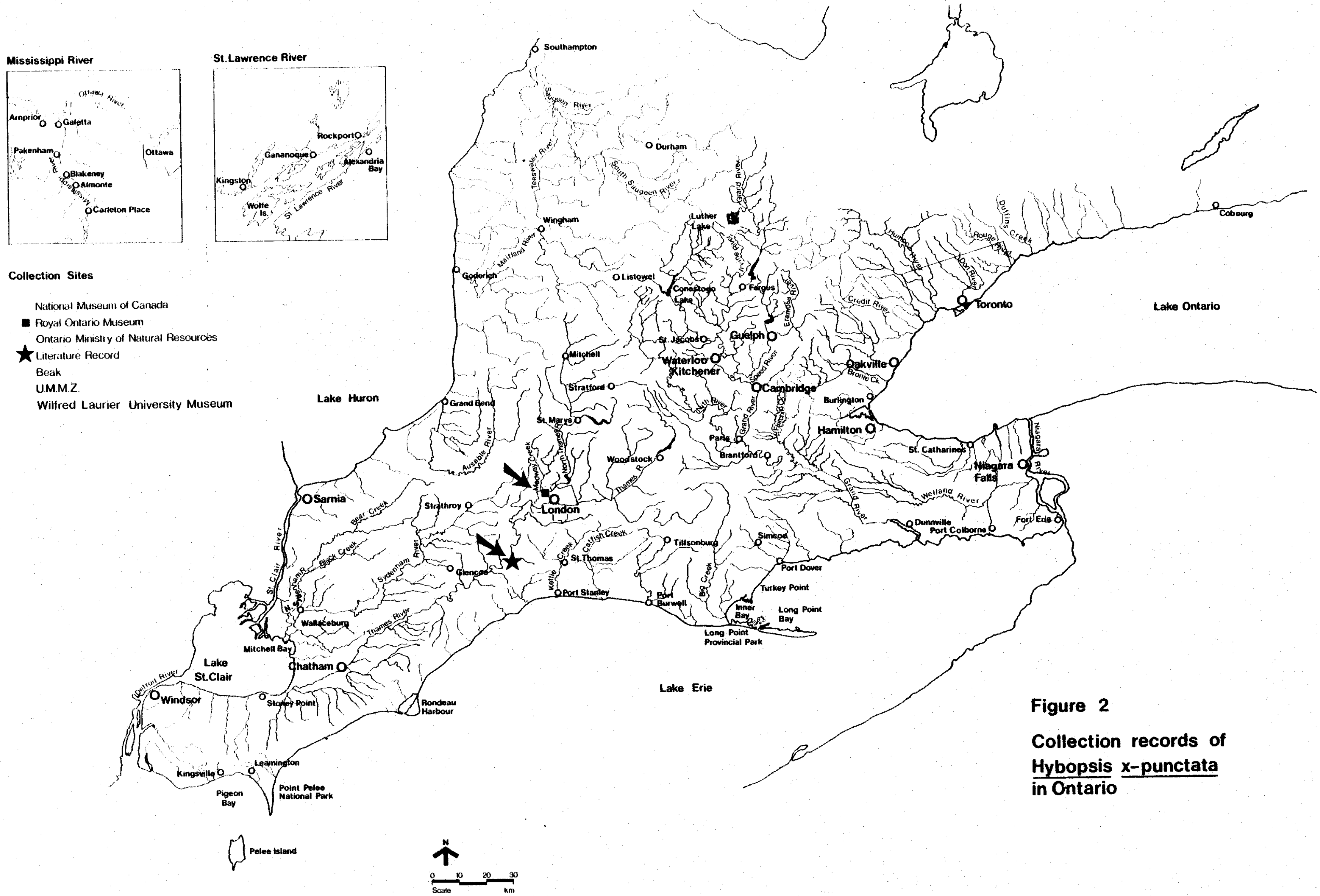


Figure 2

Collection records of <u>Hybopsis x-punctata</u> in Ontario

continued existence of this population is in doubt. Repeated attempts during this study, and during studies carried out by the National Museum of Canada and the Ontario Ministry of Natural Resources in the early 1970's failed to produce new specimens.

Trautman (1957) noted that increased siltation was associated with the extirpation of this species in many parts of Ohio. Similar habitat destruction in the Thames River system may have caused the depletion of the gravel chub in the Thames River to irrecoverable levels.

THREATS

Insufficient information regarding the continued existence of this species in Canada is available to determine if there are immediate threats to the welfare of this species in Canada by impending developments.

STATUS

The following statements were considered valid after review of available information and were used in the evaluation of the status of the gravel chub in Canada:

1. There is insufficient evidence to conclude that reproducing

populations of gravel chub exist in Canada.

2. The gravel chub is known in Canada at the northeastern fringe of its North American range. Canadian specimens provide the only evidence for this species existence in the Great Lakes basin.
3. The range of the gravel chub in Canada is restricted to a small portion of the Thames River watershed.
4. Water quality deterioration due to agricultural and urban influences in the Thames River watershed may have caused the depletion of the gravel chub population to irrecoverable levels.

Based on information evaluated during this study it is recommended that the gravel chub be classified as endangered in Canada.

BIOLOGY

The gravel chub was not captured during this study; therefore, only a review of Canadian capture localities and a comparison with data from more southerly populations of gravel chub can be provided.

Capture sites of the gravel chub in the Thames River are similar in habitat type. The Thames River, in the areas of capture, has a constant flow and is approximately 20 to 30m in width and averages 1 to 3m in depth; pool and riffle habitat predominate. The river bottom is composed of sand, rock and stone with areas of soft organics and silt. Siltation in the Thames River has caused the water to be quite turbid (Secchi disc less than 1m). Inflowing streams range from turbid and soft bottomed, to clear with rock and gravel substrates. Bank cover is minimal and instream vegetation is restricted to encrusting and filamentous algae. Water temperatures in August ranged from 21 to 24°C.

Pflieger (1975) reported that the gravel chub inhabits clear to moderately turbid streams with permanent flow and well-defined gravelly or rocky riffles. Pflieger states that in the Ozark Mountains this species is more abundant in the downstream sections of larger streams with moderate flow and slightly warmer and more turbid water than in headwaters. Trautman (1957) stated that Ohio populations of gravel chub prefer the large sand and gravel riffles and bars of moderate or large streams where the current keeps the river bottom free of unconsolidated silts and clays. These streams generally range in depth between 0.3m and 1.3m in the summer and 1.6m and 2.0m in winter. Trautman also noted that this species inhabits the deeper, slow-moving waters of rivers where siltation is minimal. The preferred microhabitat of the gravel chub was described by Moore and Paden (1950) as small cavities beneath rocks in riffle areas where the river current is reduced. Trautman (1957) reported the species avoided areas with aquatic macrophytes, larger species of algae, and aquatic mosses.

Gravel chub collected from the North Thames River ranged in length from 52mm to 77mm. Trautman (1957) reported that young-of-the-year in Ohio ranged between 28 and 65mm in total length; one-year-old fish between 40 and 70mm; and breeding adults from 64 to 90mm in total length, with a maximum of 102mm. Considering Trautman's data, it is probable that Ontario specimens are adults. Maximum age is unknown.

Gravel chub spawning has been reported to take place in Kansas in early spring on swift gravelly riffles (Cross 1967). No other data on reproduction has been published. (Scott and Crossman 1973).

The gravel chub probably feeds on epibenthic aquatic insects.

However, insufficient Canadian specimens were available for dissection during this study to substantiate this hypothesis. No detailed studies have been made of the feeding habits of this species. Davis and Miller (1967) found that the taste buds on the barbels of gravel chub were extremely large suggesting that this species feeds by probing under rocks and into crevices with its sensitive snout.

Parasitic infestation has not been noted for this species. Hoffman (1967) did not list the gravel chub in his parasite studies.

The importance of the gravel chub in the aquatic food chain is not known. It is suspected that piscivorous species, including small mouth bass, Micropterus dolomieui and rockbass, Ambloplites rupestris, which are common in the Thames River would feed on gravel chub if present. Scott and Crossman (1973) believed this species greatest importance to man may be as an indicator of pollution due to its sensitivity to siltation.

RECOMMENDATIONS

The following recommendations are suggested for the monitoring of the gravel chub population in Canada.

1. The Ontario Ministry of Natural Resources should hold and transport to a museum facility all gravel chub specimens captured in Ontario waters.
2. Identification information should be made available to concerned agencies.
3. Cyprinids collected by the Ontario Ministry of Natural Resources, the University of Western Ontario, and other concerned agencies near prior capture sites should be closely examined for the occurrence of gravel chub.
4. Should further specimens be collected in Canada, a study to determine population and life history parameters should be initiated and protective measures should be investigated.

LIST OF SPECIMENS

A list of gravel chub specimens captured in Canada from the National Museum of Canada (NMC) and Royal Ontario Museum (ROM) is provided below:

ROM8417 (2) Thames River, Middlesex County, C. Hubbs and D. Brown*. ROM20018 (4) Thames River, near University of Western Ontario, Middlesex County, 1958, D. Roseborough.

*Radforth (1944) states that this species was reported in the

Thames River at Muncey Indian Reserve by Hubbs and Brown (1929).

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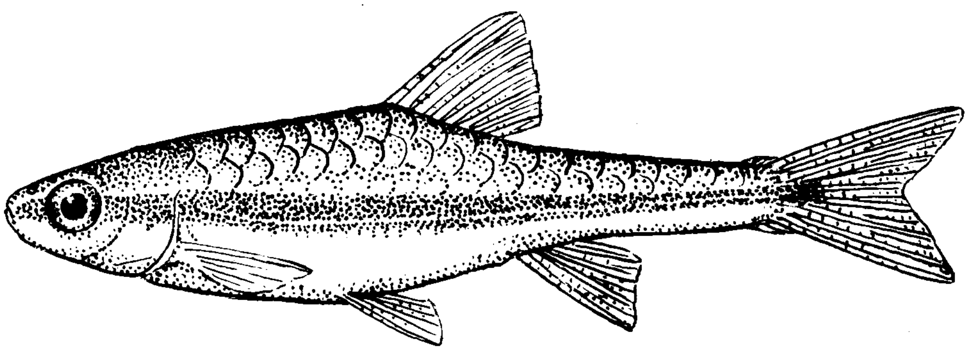
PUGNOSE SHINER

Notropis anogenus (Forbes)



Proposed Status: ENDANGERED

The pugnose shiner, Notropis anogenus, is regarded as one of the rarest cyprinids in the northern United States and Canada. In Canada it has been recorded at three localities in Ontario. Capture sites in Canada are approximately 135km from the nearest population of pugnose shiner.

Few studies have been made on the biology of the pugnose shiner. Trautman (1957) provided life history data for this species in Ohio. Bailey (1959) reviewed systematics and distribution, and Scott and Crossman (1973) summarized available information on this species in Canada. Gilbert (1980) lists type materials.

The pugnose shiner was last reported in Canadian waters in 1963. Prior to 1963 only three collections of this species had been made in Canada. The paucity of Canadian specimens suggests that the pugnose shiner is rare in Canada. The increasing rarity of this species throughout its North American range is thought to be a result of degradation and reduction of available habitat (Bailey 1959).

McAllister and Gruchy (1977) considered the pugnose shiner as threatened in Canada. This species is listed as endangered in Wisconsin (Miller 1972), and is believed to have been extirpated from Ohio (Trautman pers. comm.).

The pugnose shiner is distinguished from all other Ontario *Notropis* species except *N. cornutus* by its black peritoneum. It is similar in appearance to *N. emiliae*, but the pugnose shiner has eight dorsal fin rays as compared to nine dorsal fin rays in *N. emiliae* (McAllister and Gruchy 1980).

DISTRIBUTION

The range and distribution of the pugnose shiner were documented by Bailey (1959). Few range extensions have been added since the late 1940's; the present distribution of this species is probably much reduced from that represented in Figure 1.

North American distribution of the pugnose shiner, Notropis anogenus. Adapted from Bailey (1959)

Figure 1

Hubbs and Lagler (1947) described the range of this species as being restricted to the Great Lakes basin and north central United States. It has been recorded sporadically from the Red River basin of eastern North Dakota through the glacial lakes district of Minnesota, northern Iowa, Wisconsin, northern Illinois, Michigan, northern Indiana and Ohio to the Lake Ontario and St. Lawrence drainages of New York and Ontario.

In Canada the pugnose shiner has been reported from two regions in Ontario (Figure 2), at the outlet of Lake Ontario, near the mouth of the Gananoque River, Leeds County (44°20'N, 76°10'W) and in the western basin of Lake Erie, at Rondeau Harbour, Kent County (42°17'N, 81°53'W) and in ponds on the eastern side of Point Pelee, Essex County (82°30'N, 42°00'W). Reports of this species occurrence on the east side of Long Point, Lake Erie, seem to be in error.

POPULATION

The pugnose shiner was first reported in Canada in 1935 (Toner 1937). Subsequent collections were made during the early 1940's at Rondeau Bay and Point Pelee. Since the early 1940's only one collection of pugnose shiners, made in 1968, has been reported from Canadian waters.

During this survey all known capture localities were sampled, but no

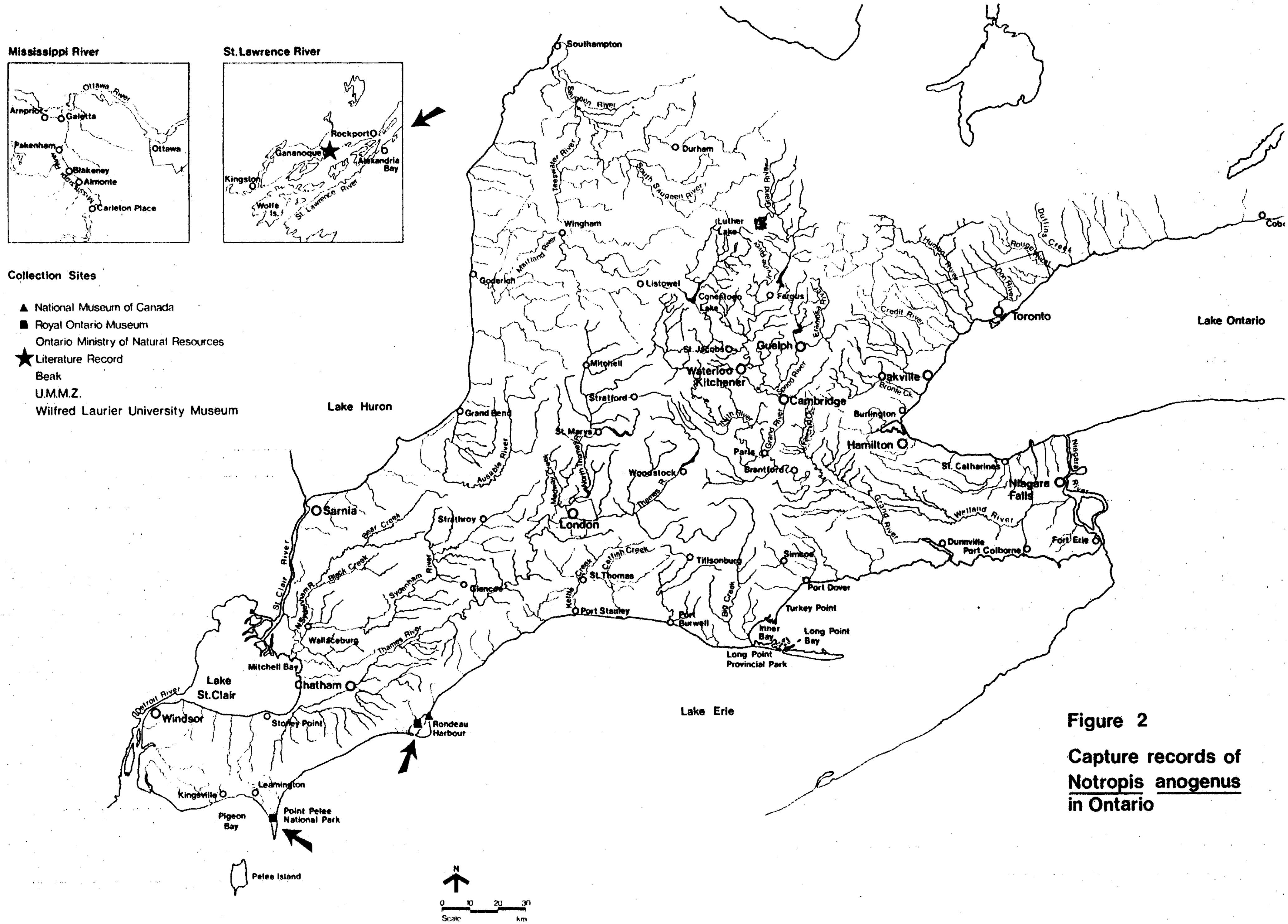


Figure 2

Capture records of <u>Notropis anogenus</u> in Ontario

pugnose shiners were captured. It did seem apparent to us, however, that small populations of the pugnose shiner may still exist in Canada. Collection and identification of this species are hampered by its small size, restricted distribution and habitat selectivity. Although, there is insufficient data to evaluate the population structure of this species in Canada we believe that, if present in Canada, populations are extremely small and each population is localized.

Published information suggests that over its range this species is becoming increasingly rare. Scott and Crossman (1973) suggested that this species may once have inhabited favourable habitats along the north shores of Lake Ontario and Lake Erie, but habitat destruction is believed to have diminished its range greatly. Trautman (1957) stated that collections of this species in Ohio during the 1930's were probably from isolated populations which later died out as a result of increased turbidity in its habitat. It is believed that similar long term habitat destruction in Ontario waters has decreased the numbers of this species to low levels in very restricted habitats, if they have not already been extirpated.

THREATS

There are no impending developments that will pose an immediate threat to the welfare of this species in Canada.

STATUS

The following statements were considered valid after review of available information and were used in the evaluation of the status of the pugnose shiner in Canada:

1. There is insufficient evidence to conclude that reproducing populations of pugnose shiners are extant in Canada.
2. The pugnose shiner occurs in Canada at the northern fringe of its North American range. It has been suggested that this species is naturally rare throughout its North American range.
3. Canadian records suggest that populations are small and geographically isolated.
4. Evidence suggests that the amount of available habitat has diminished in quality and quantity due to a general decline in water quality and an increase in lakeshore development.
5. The pugnose shiner appears threatened with immediate extinction in Canada due to the actions of man.

Based on the information evaluated during this study, it is recommended that the pugnose shiner be classed as an endangered species in Canada.

BIOLOGY

The pugnose shiner was not captured during this survey; therefore, only a review of Canadian capture localities and a comparison with published data can be provided.

In Canada, the pugnose shiner has been recorded from sheltered inshore ponds and protected bays proximal to large water bodies. Substrates at Point Pelee and Gananoque were usually composed of sand and detritous, but in Rondeau Harbour bottom substrates were predominantly clay. All localities where the pugnose shiner had been captured were heavily vegetated, both emergent and submergent aquatic macrophytes were present. Turbidity and siltation were minimal at Point Pelee and Gananoque (Secchi disc approximately 1.5m); however, at Rondeau Harbour turbidity was much higher (Secchi disc approximately 0.3m). During sampling in August, water temperatures ranged from 15 to 18^{o}C and dissolved oxygen ranged from 9 to 11 mg/L in Rondeau Harbour and at Point Pelee.

Trautman (1957) suggested that this species is usually found in clear, well vegetated lakes and low gradient streams with sand, mud, and detrital bottoms.

Of the three known capture sites investigated during this study, Point Pelee appears to provide the most favourable habitat for the continued existence of the pugnose shiner in Canada.

Little has been published on the age and growth of this species. Trautman (1957) stated that adults ranged between 33 to 48mm in length and Carlander (1969) gave the maximum length of this species as 56mm total length. Specimens from Ontario waters ranged in length from 38 to 51mm total length, and therefore, it is assumed that specimens captured in Ontario were adults.

Spawning is thought to occur in late spring in Ontario waters. A female collected in mid-June 1941 at Point Pelee contained a few large eggs, suggesting that it was partly spent and that spawning was in progress at that time (Scott and Crossman 1973). Females full of eggs were taken in May and June in Illinois (Forbes and Richardson 1920).

The feeding habits of the pugnose shiner in Canada are unknown, and specimens are unavailable for dissection to determine stomach content. Scott and Crossman (1973) suggested that its extremely small mouth probably restricts its diet to minute plants and animals.

Two species of Protozoa, *Henneguya brachyura* and *Myxobolus aureatus*, are the only parasites Hoffman (1967) listed for this species. Parasites have not been noted for Canadian specimens.

The pugnose shiner probably falls prey to several species of piscivorous fish. Examination of the stomach contents of possible predators, especially from Point Pelee National Park, may prove beneficial in obtaining information on this species in Canada.

Due to its restricted distribution and rarity of capture, the pugnose shiner is believed to be of little importance to man (Scott and Crossman 1973). It may have some value as an example of mans impact on the environment.

RECOMMENDATIONS

The following recommendations are suggested for the monitoring of the pugnose shiner population in Canada:

1. The Ontario Ministry of Natural Resources and Parks Canada should hold and transport to a museum facility all pugnose shiner specimens captured in Ontario waters.
2. Identification information should be made available to

concerned agencies.

3. Cyprinid surveys should be carried out in areas of prior capture.

4. Should further specimens be collected in Canada, a study to determine population and life history parameters should be initiated and protective measures should be investigated.

LIST OF SPECIMENS

A list of pugnose shiner specimens captured in Canada from the National Museum of Canada (NMC), the Royal Ontario Museum (ROM), and the University of Michigan Museum of Zoology (UMMZ) is provided below:

NMC 67-114 Ontario, Kent County, Rondeau Provincial Park, Lake Erie, R.E. King and C. Roy, June 16, 1963. ROM 14056 (53) Ontario, Kent County, Rondeau Bay (Rondeau Harbour), Lake Erie, J.R. Dymond, June 13, 1941. ROM 14056 (52), Rondeau Bay (Rondeau Harbour), Lake Erie, Kent County, July 13, 1941, Dymond. UMMZ 130932 (19), Rondeau Harbour, S.E. shore just outside Provincial Park, Kent County, August 31, 1940, Hubbs party. UMMZ 130910 (23), E. shore of larger lake on Point Pelee, Point Pelee National Park, Essex County, August 31, 1940, C.L., L.C., and Clark Hubbs. ROM 14055 (70), lake in Point

Pelee Park, Essex County, July 13, 1941, J.R. Dymond. UMMZ 104540, St. Lawrence River, Gananoque Leeds County, July 21, 1937, G.C. Toner. UMMZ 107901 below falls, Gananoque River, Gananoque, Leeds County, April 25, 1935.

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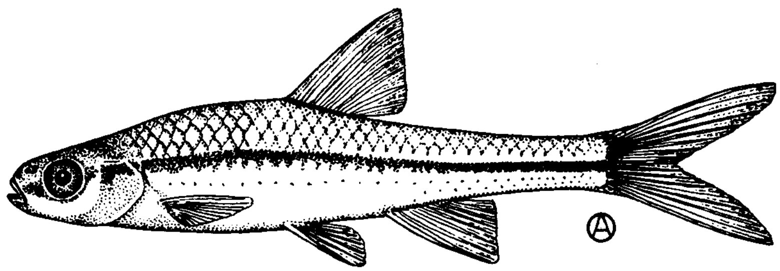
PUGNOSE MINNOW

Notropis emiliae (Hay)



Proposed Status: ENDANGERED

The pugnose minnow, Notropis emiliae (Cyprinidae), is found primarily in the Gulf states and the Mississippi River basin in central North America. In Canada this species occurs in the Lake St. Clair and possibly Lake Erie drainages of southwestern Ontario. Populations in Canada are separated from United States populations by approximately 200km.

Information on the biology of Canadian populations of pugnose minnows is "almost as rare as the species itself in Canadian waters" (Scott and Crossman 1973). Gilbert and Bailey (1972) and Gilbert (1980) summarized available life history information for this species.

The pugnose minnow was first reported in Canadian waters in 1935 (ROM 8956). Very few specimens have been recorded in Canada since that time. Due to the extreme rarity of this species, its restricted distribution in Canadian waters, and its apparent sensitivity to habitat alteration, McAllister and Gruchy (1977) classified the pugnose minnow as endangered in Canada. It is variably listed as rare, threatened, or extirpated in Ohio (Trautman 1957, Van Meter and Trautman 1970) and endangered in Missouri (Miller 1972).

The pugnose minnow is distinguished from similar species in Canada, by its very small, up-turned mouth and its nine fully developed dorsal fin rays. Other superficially similar cyprinids normally have eight dorsal rays (McAllister and Gruchy 1980).

Complete descriptions of the pugnose minnow were provided by Trautman (1957), Gilbert and Bailey (1972), and Scott and Crossman (1973). Gilbert and Bailey (1972) also discussed systematics, and downgrading the former generic name Opsopoeodus to subgeneric status in Notropis.

DISTRIBUTION

The following account of the distribution of the pugnose minnow is based on the spot distribution map of Gilbert and Bailey (1972), supplemented by information gained in the present study (Figure 1).

The pugnose minnow is found from the Nueces River in Texas eastward through the Gulf states to the Edisto River drainage of South Carolina. Its range extends northward along the Mississippi drainage to southeastern Minnesota, and eastward in the Ohio River basin to southeastern Ohio and west West Virginia. In the Great Lakes basin this species has been reported from the Lake Winnebago drainage of Wisconsin, from southern Lake Michigan in Illinois, and from Lake St. Clair and Lake Erie and their tributary streams in Michigan, Ohio, and Ontario. A subspecies endemic to Florida occurs from the St. John River drainage south to Lake Okeechobee.

In Ontario the pugnose minnow has been reported from only 10 localities (Figure 2). It has been captured in the Detroit River above Amherstburg, (42°07'10"N, 83°06'45"W), in six localities in the North Sydenham River watershed extending from Bear Creek below Brigden, Lambton County (42°45'48"N, 82°19'51"W) to the North Sydenham River above Wallaceburg, Lambton County (42°38'20"N, 82°22' 32"W), in an unnamed tributary of the East Sydenham River near Tupperville, Kent County (42°36'10"N, 82°16'22"W), in Lake St. Clair at Mitchell Bay, Kent County (42°28'N, 82°24'W), and in the Thames River near Delaware, Middlesex County (42°55'N, 81°26'W). The precise location of capture of the Thames River specimens is not recorded, however, Keenleyside (pers. comm.) stated that the collection was likely taken from an oxbow lake adjacent to the main stream.

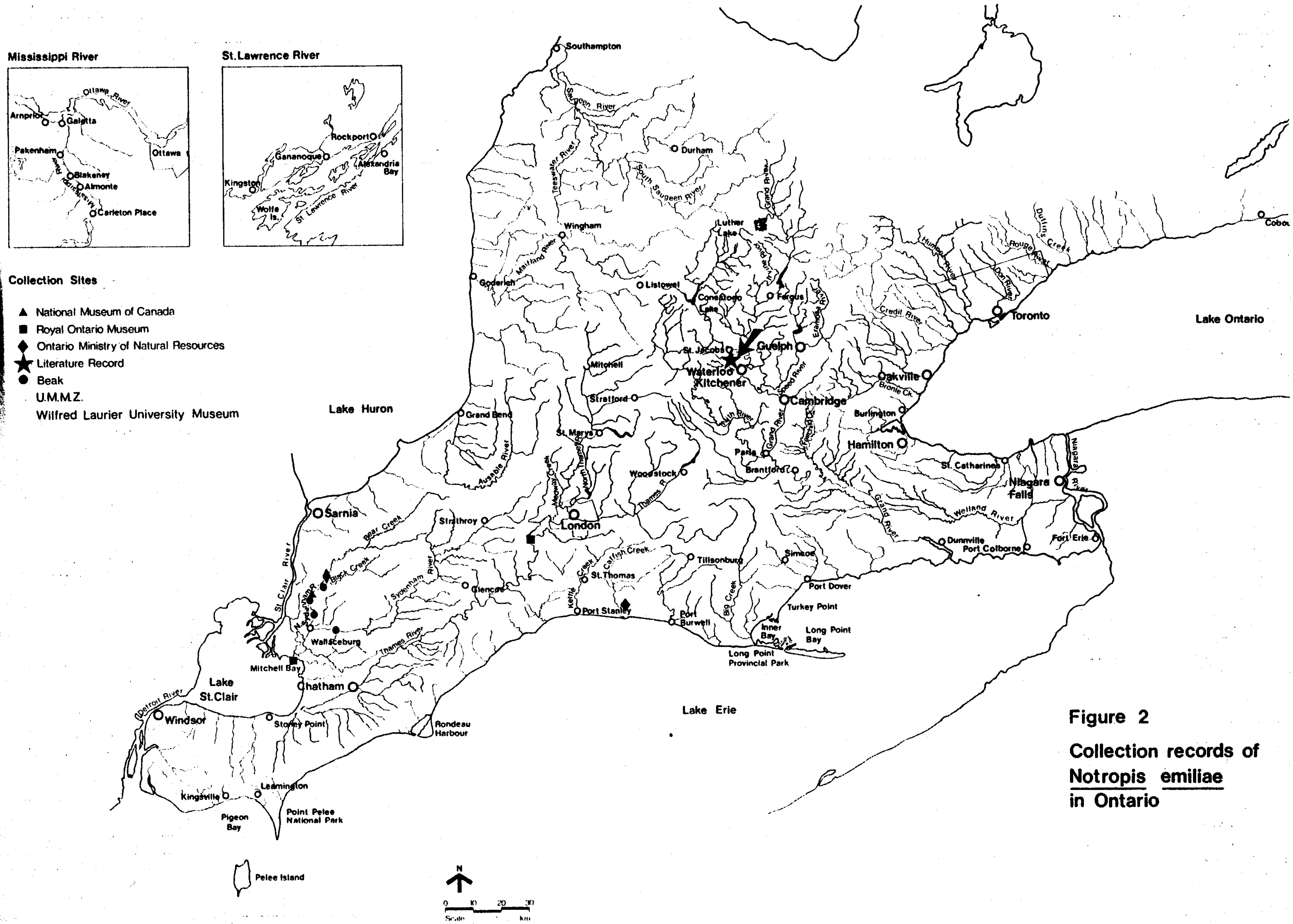


Figure 2

Collection records of <u>Notropis emiliae</u> in Ontario

Pugnose minnows have been reported from Lake Erie tributaries in Ontario, but specimens were not retained. Mr. P. Hunter, of the Ontario Ministry of Natural Resources listed this species in a collection taken in 1972 from Burnt Mill Creek, a tributary of Catfish Creek, Elgin County (42°42'00"N, 81°01'09"W). Hamor and Fernando (1978) reported capturing pugnose minnows in a Grand River tributary, Laurel Creek, Waterloo County (42°29'N,80°34'W).

POPULATION

The population structure of the pugnose minnow in Canadian waters is not fully known. On the basis of the number of confirmed captures it is suspected that the population of pugnose minnows in the Lake St. Clair drainage is quite small.

Intensive efforts to capture pugnose minnows during the 1979 survey produced only eight specimens. Catch-per-unit-effort values for the North Sydenham River were low and ranged from 0 to 3.3 specimens per $100m^2$ of area seined.

The known range of the pugnose minnow in the Sydenham River system was extended during the 1979 survey, although it is unlikely that this represents an expansion of the population. It is possible that the rarity of the pugnose minnow and its confinement to a restricted habitat has permitted small populations to exist undetected at these locations until the present study. The largest Canadian collection of pugnose minnows was made in the Thames River watershed, where seven specimens were collected in 1968 (ROM 26480).

Collections from the Thames River and tributary streams of Lake Erie suggest that disjunct populations of pugnose minnows are extant in southwestern Ontario and that this species may once have been more widely distributed.

The turbid habitats where pugnose minnows were captured during the 1979 survey differ from the preferred clear-water habitat described by Trautman (1957), Gilbert and Bailey (1972), and Scott and Crossman (1973). This suggests that the Sydenham River watershed provides only marginal habitat. Trautman (1957) reported that this species was probably common in Ohio prior to 1930 in clear, weedy, quiet waters. Urbanization and agricultural practices subsequently led to the siltation of these habitats and eventual extirpation of the pugnose minnow from many parts of its range. The siltation of streams in southwestern Ontario may be similarly detrimental to Canadian populations of pugnose minnow.

THREATS

There are no impending developments that will pose an immediate threat to the welfare of this species in Canada.

The following statements were considered valid after review of available information and were used in the evaluation of the status of the pugnose minnow in Canada.

1. A small population of pugnose minnows is present in the North Sydenham River and in Mitchell Bay. If the specimens collected are representative of one or more populations is not known.
2. There is insufficient information to evaluate the structure of possible populations in the Thames River or in Lake Erie tributaries; however, these populations are likely small and isolated.
3. Man-induced siltation of preferred clearwater habitats has led to the extirpation of this species within areas of its North American range.
4. The North Sydenham River provides marginally suitable habitat for this species; man-induced siltation has reduced the quantity of available, suitable habitat.
5. Pugnose minnow populations in Canada are situated at the northeastern edge of its North American range.

Based on information evaluated during this study it is recommended that the pugnose minnow be classed as a threatened species in Canadian waters.

In Ontario, the pugnose minnow is found in low gradient streams, rivers, and lakes. Average gradients at capture sites in the Sydenham River watershed range from less than 0.02m/km to approximately 0.20m/km. Specimens were taken in pond-like, weedy embayments and along river edges. Capture sites in Mitchell Bay had soft clay and silt substrates.

Aquatic macrophytes were always present at capture sites. Heavy growths of spatterdock (Nuphar sp.) were noted at several capture localities. Pugnose minnows were captured in the North Sydenham River in 0.5 to 1.5m of water by encircling clumps of weeds with a seine net.

High levels of suspended solids were evident at all capture locations during the 1979 survey; secchi disc transparency of 10cm was typical in most of the North Sydenham River. Water transparency was higher in Mitchell Bay. Pugnose minnows were caught in September when water temperatures ranged from 17.5 to 19^{o}C and dissolved oxygen concentrations were about 7mg/L.

Trautman (1957) stated that the pugnose minnow prefers sluggish, clear weedy waters, and believed that populations in turbid waters where siltation has resulted in the elimination of rooted aquatic plants, would be eliminated in a matter of years. The high turbidity at capture sites during the 1979 survey suggests that the North Sydenham River system may provide only marginal habitat for this species. Mitchell Bay may provide a more favourable habitat.

Little information has been published on the age determination of this species. Scales from several specimens were examined following methods outlined by Lagler (1947). Each scale appeared to have distinct annuli in the lateral fields; however, validation of the scale method of age determination in this species requires a larger sample. Maximum age was estimated at 3 years.

Ranges of lengths and preserved weights for one, two, and three-year-old specimens captured in September are as follows:

Age	No. Specimens	Standard Length (cm)	Weight (g)
1	2	2.9 - 3.2	0.24 - 0.29
2	5	3.4 - 3.7	0.57 - 0.73
3	1	4.6	1.19

In Ohio, young-of-the-year are 2.5 to 4.3cm long, one-year old fish are 3.3 to 5.1cm long, and adults are usually 3.8 to

5.8cm long, with a maximum recorded length of 6.4cm (Trautman 1957).

Data on reproduction in this species are limited. Gilbert and Bailey (1972) stated that in Florida males are in spawning condition from March to September and gravid females were captured from January to September. Gilbert and Bailey also mentioned that specimens in spawning condition were taken in late May in Arkansas. Forbes and Richardson (1909) collected gravid females and tuberculate males in mid-June in Illinois. It is suspected that populations in Ontario spawn in late spring or early summer.

The feeding habits of pugnose minnows have been studied by Gilbert and Bailey (1972) for Florida specimens. Chironomid larvae, filamentous algae, copepods, cladocerans, hydrachnids and minute amounts of larval fish and fish eggs were identified from stomach contents. Of four Ontario specimens of pugnose minnow examined, two had empty foreguts, one contained unidentifiable material, and one contained 60 percent adult Diptera and 40 percent larval Trichoptera by volume.

Scott and Crossman (1973) believed that the strongly upturned mouth of the pugnose minnow suggests a mid-water or surface feeding habit.

Predation on pugnose minnows by other fishes has not been described. Piscivorous species captured in the same locations as pugnose minnows in 1979 include northern pike (Esox lucius), white crappie (Pomoxis annularis), rock bass (Ambloplites rupestris), and largemouth bass (Micropterus salmoides).

A low level infestation of "black spot" (Neascus) was noted on one pugnose minnow taken during the 1979 survey. Bangham and Hunter (1939) reported that of 10 specimens examined from Lake Erie, two were infected with trematodes and larval or immature cestodes. Hoffman (1967) also listed trematodes as parasites of the pugnose minnow.

The pugnose minnow is too rare and restricted in distribution to be of any real importance to man in Canada (Scott and Crossman 1973). Due to its apparent sensitivity to turbidity, this species may have some importance as an environmental indicator in the Lake St. Clair watershed.

RECOMMENDATIONS

The following recommendations are suggested for the maintenance and monitoring of the pugnose minnow populations in Canada:

1. The Ontario Ministry of Natural Resources should hold and transport to a museum facility all pugnose minnow specimens captured in Ontario.
2. Identification information should be made availa ble to concerned agencies.
3. Records of this species in Canada outside of the Lake St. Clair drainage should be investigated by concerned agencies and specimens should be retained for museum collections.
4. Should pugnose minnow populations be identified outside of the North Sydenham River, that is, in more favourable habitats, protective measures should be investigated to insure the continued existence of this species in Canada.

LIST OF SPECIMENS

A list of pugnose minnow specimens, captured in Canada, from the National Museum of Canada (NMC) and the Royal Ontario Museum (ROM) is provided below:

ROM 8956 (2), Mitchell Bay, Lake St. Clair, Kent County, July 6, 1935, K.H. Doan; ROM 14073 (3), Detroit River, Essex County, June 11, 1941, Dymond and Harkness; ROM 26480 (7), Thames River, Middlesex County, 1968, J. Young and R. McCarter; ROM 35781 (2), Mitchell Bay, Lake St. Clair, Kent County, June 2, 1979, E. Holmes; NMC 72-199, North Sydenham River, Lambton County, August 12, 1979, C.G. Gruchy and R.H. Bowen; NMC 79-1154, unnamed tributary of East Sydenham River, Kent County, September 25, 1979, P.M. McKee and B.A. Hindley. NMC 79-1051, North Sydenham River, Lambton County, September 25, 1979, B.J. Parker and P.M. McKee. MNC 79-120 (2), Bear Creek, Lambton County, September 27, 1979, McKee and Hindley. NMC 79-1207 (4), North Sydenham River, Lambton County, September 27, 1979, McKee and Hindley.

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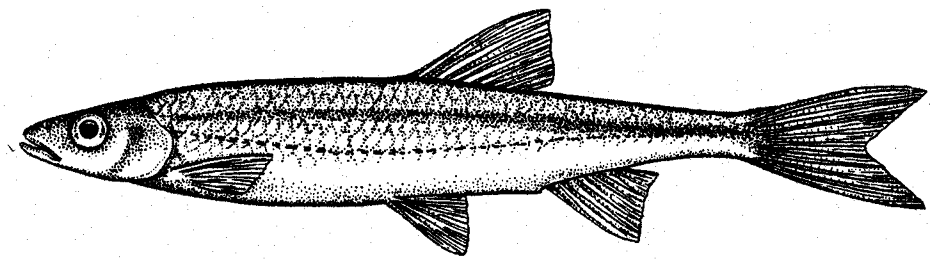
SILVER SHINER

Notropis photogenis (Cope)



Proposed Status: RARE

The silver shiner, Notropis photogenis (Cyprinidae), is found in freshwater streams of the Ohio and upper Mississippi River basins and in portions of the drainages of Lake St. Clair and Lake Erie. In Canada, this species is known only from the Thames and Grand River watersheds of southwestern Ontario. Canadian populations of the silver shiner are approximately 300km from the nearest United States population and approximately 500km from major population centers.

Little is known about the biology of the silver shiner. Trautman (1957) and Gilbert (1980) gave summaries of biological information.

Gruchy *et al*. (1973) provided some biological data on Canadian specimens.

The silver shiner was first collected in Canada in 1971. Due to its recent discovery and restricted distribution in Canada, this species was classified as rare in this country (McAllister and Gruchy 1977). The silver shiner is considered threatened in Michigan (Miller 1972), declining in Ohio, and uncommon to rare in Lake Erie tributaries in Ohio (Trautman 1957; Gilbert 1980).

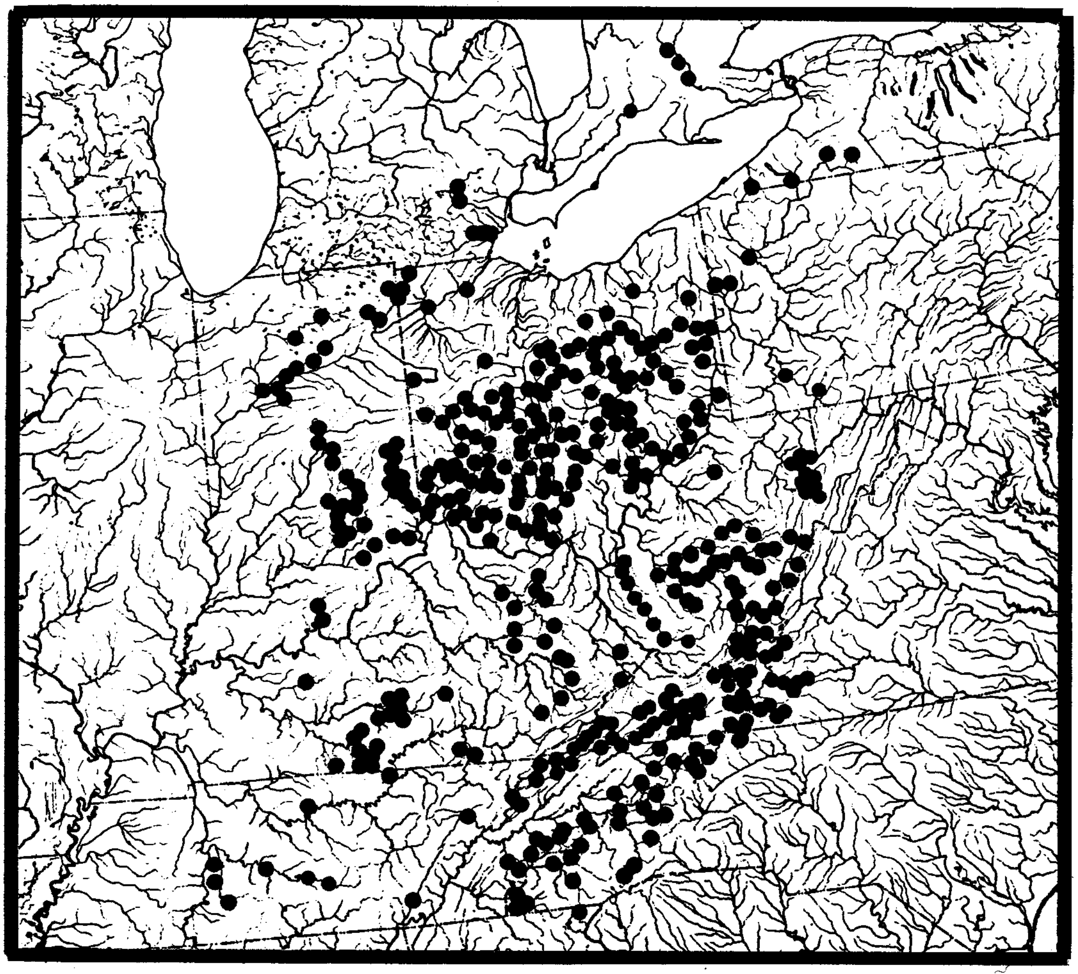
The silver shiner is often confused with the rosyface shiner, *Notropis rubellus* and emerald shiner, *Notropis atherinoides*. Silver shiners and rosyface shiners are similar in appearance, and frequently inhabit the same streams. Gruchy *et al*. (1973) described distinguishing features of silver, rosyface, and emerald shiners. Silver shiners attain a maximum length (SL) of nearly 11cm, while rosyface and emerald shiners grow to maximum lengths of about 6 and 7cm. respectively. The insertion of the pelvic fin of the silver shiner is directly below the origin of the dorsal fin, while the dorsal fin of the rosyface and emerald shiner has its origin posterior to the pelvic insertion. Silver shiners possess a narrow and more clearly defined mid-dorsal stripe than do either rosyface or emerald shiners. The dorsal pigmentations of silver and emerald shiners are less dense than the pigmentation of rosyface shiners. A pair of dark, crescent-shaped markings is present medial to the nostrils in silver shiners, but is absent in rosyface and emerald shiners. Gruchy *et al*. (1973) and Trautman (1957) detailed several other morphometric and meristic characteristics.

DISTRIBUTION

The following account of the distribution of the silver shiner is based on the spot distribution map of Gilbert (1980) and is supplemented by information collected in the present study (Figure 1).

The silver shiner is found throughout most of the Ohio River basin in West Virginia, western New York, Ohio, Indiana, and Kentucky, although, it is absent in the western lowlands of the Ohio River. This species also occurs in the Wabash River watershed of Indiana and the upper Tennessee River watershed in the Appalachian Mountains.

In the Great Lakes basin, (Figure 2) the silver shiner is found in tributaries of Lake Erie in Ohio, Michigan and Ontario, and in the Lake St. Clair drainage of Ontario.



North American distribution of the silver shiner, *Notropis photogenis*. Adapted from Gilbert (1980)

Figure 1

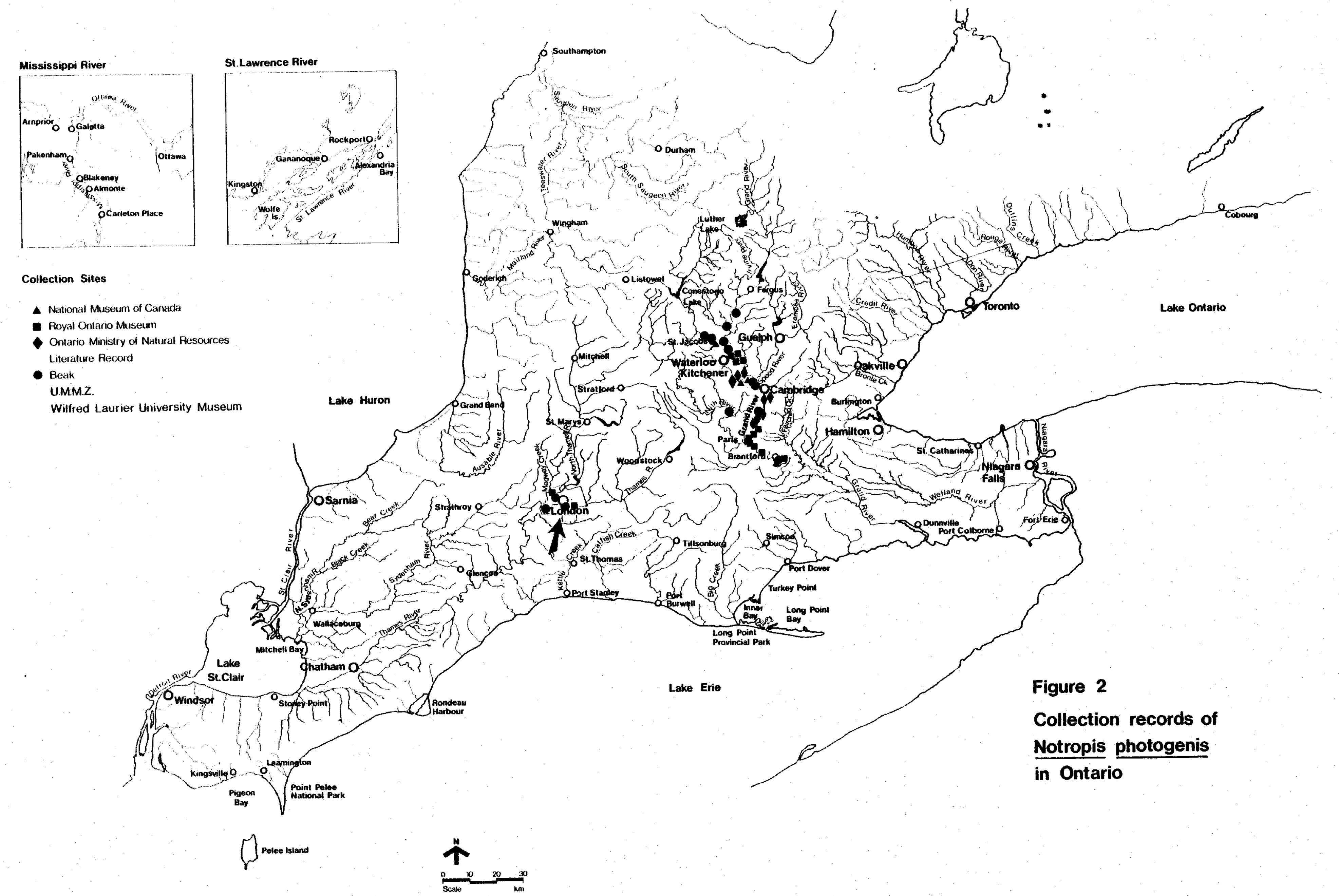


Figure 2

Collection records of ***Notropis photogenis*** **in Ontario**

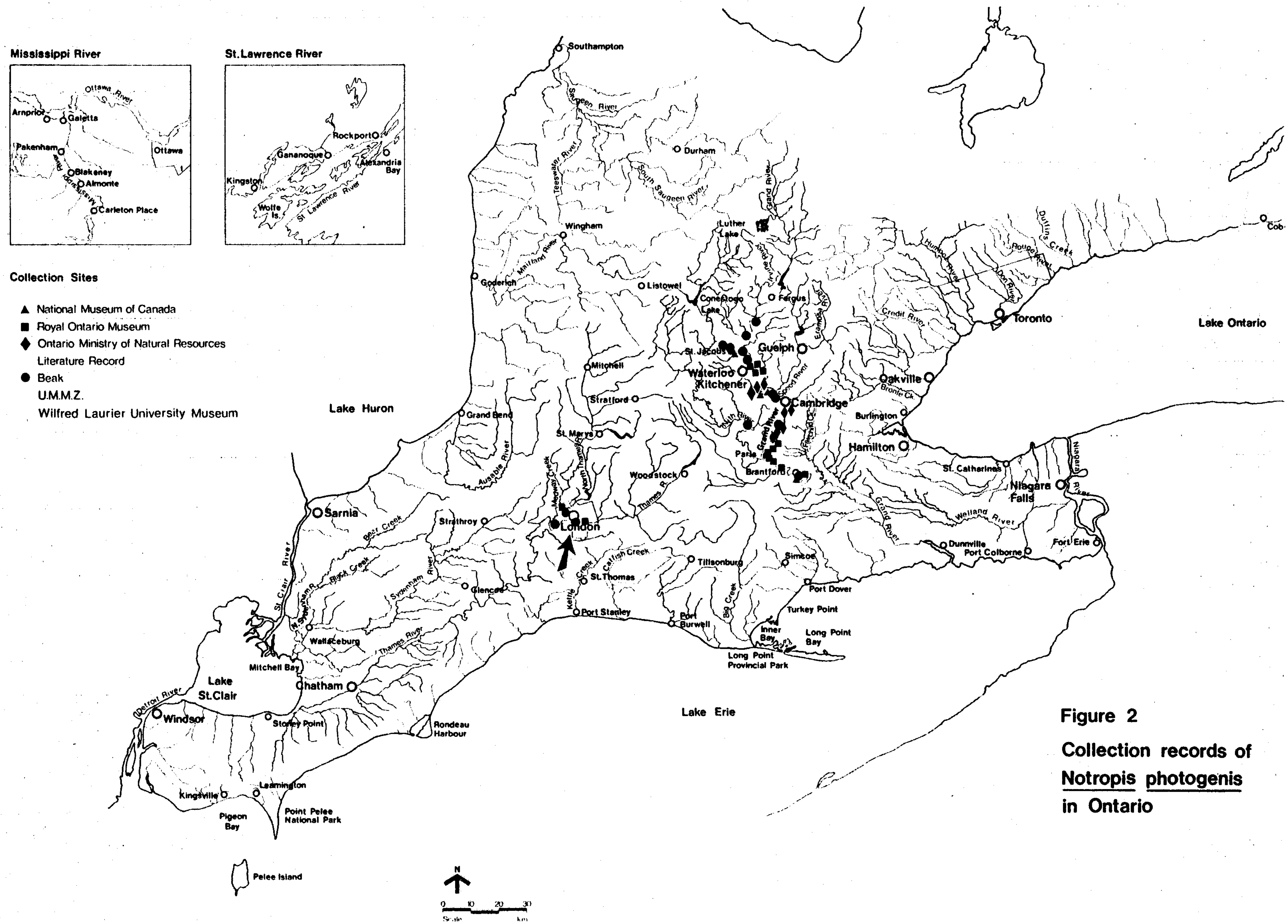


Figure 2

Collection records of <u>Notropis</u> <u>photogenis</u> in Ontario

In the Grand River watershed of Ontario, the silver shiner is known from the main stream, the Conestogo River, and the Nith River. Grand River specimens have been collected from 7km south of Elora, Wellington Co. ($43^{o}37"25"N$, $80^{o}37'00"W$) to Brantford, Brant Co. ($43^{o}08'30"N$, $80^{o}17'20"W$). In the Conestogo River, this species occurs in the lower stretch of the river below the dam at St. Jacobs, Waterloo Co. ($43^{o}32'10"N$, $80^{o}34'25"W$). Nith River specimens were taken near Ayr, Waterloo Co. ($43^{o}17'40"N$, $80^{o}28'13"W$).

In the Lake St. Clair drainage, the silver shiner population is apparently centred near the city of London, Middlesex Co. in the Thames River watershed. All specimens were collected within an 8km radius of the city centre ($42^{o}59'22"N$, $81^{o}14'57"W$): from the North Thames River, from Medway Creek, and from the Thames River both upstream and downstream of the North Thames confluence.

POPULATIONS

The silver shiner is locally abundant in the Grand and Thames River watersheds. During the 1979 survey, catches averaged 37 silver shiners per $100m^2$ of area seined (range:less than 1 to 82). This species comprised one to 90% of the total number of fish captured at each station. Schools of silver shiners occurred in areas of moderate current and eddies below dams, and most schools were composed of individuals of all length classes.

The silver shiner appears to inhabit only some of the available habitat within its range. Several sampling stations in the Grand and Thames River watersheds seemed to provide suitable habitat, however, few or no specimens were captured. This species is rare or absent from smaller tributary streams and slow-flowing sections of the main rivers.

The silver shiner was not discovered in the Grand River until 1971, but the population has likely been present for much longer (Gruchy et al. 1973). A recent invasion of the Grand River by this species is improbable since large areas of unsuitable habitat separate this Ontario watershed from the nearest populations in the United States. It is also unlikely that silver shiners were introduced by sport fishermen since these fish survive only for short periods in bait buckets. Earlier specimens may have been confused with rosyface shiners as reported by Trautman (1957). The silver shiner is a popular bait fish among sport fishermen using the Grand River watershed.

Large silver shiners were observed in bait buckets during the 1979 survey and the anglers properly distinguish this species on the basis of size. The wide-spread popularity of silver shiners indicates a regional tradition in the use of this minnow for bait, and a long-established population of this species in the Grand River watershed.

The silver shiner was not discovered in the Thames River watershed until 1974 (ROM 30918) and this population is apparently restricted to the London area. There are insufficient data to determine whether this represents a relict population or a recently introduced population.

Alternately, the silver shiner may have remained undetected in Ontario at much lower population levels until recently. Trautman (pers. comm.) similarly reported that this species was only recently found in Ohio's Grand River after many years of sampling.

THREATS

The primary factor that appears to limit the distribution of the silver shiner in Ontario is stream gradient. Dam construction within the range of this species would create unsuitable lentic habitat. The proposed West Montrose dam would have minimal impact on the silver shiner since it would be constructed near the upstream limit of this species in the Grand River watershed.

STATUS

The following statements were considered valid after review of available information and were used in the evaluation of the status of the silver shiner in Canada:

1. Apparently stable reproducing populations of silver shiners are present in the Thames and Grand River watersheds.
2. Canadian populations of silver shiners occur at the northeastern extremity of their North American range.
3. The silver shiner does not appear threatened in Canada due to the action of man.

Based on the information evaluated during this study, it is recommended that the silver shiner be classed as a rare species in Canada.

BIOLOGY

The silver shiner inhabits medium to large streams with considerable current (Trautman 1957; Gruchy et al. 1973, Gilbert 1980). Stream widths at capture sites during the 1979 survey ranged from 5 to 100m, but only two locations had widths of less than 30m. Alternating pools and riffles characterized most sites. Large catches were also taken in turbulent waters below dams. All specimens were taken in stream sections ranging between 20 to 100cm in depth. Deeper waters were not sampled during this survey.

Along the course of the Grand River, stream gradient appears to limit the distribution of the silver shiner. Over the range of this species in the Grand River, the average gradient is 1.4m/km. An abrupt drop in gradient to an average of less than 0.3m/km, in downstream sections beginning immediately below Brantford, corresponds with the downstream limit of the distribution of the silver shiner. An increase in gradient to 5.7m/km through the Elora Gorge appears to impose an upstream limit to its range. Average gradients over the range of this species in the Nith and Conestogo Rivers are 1.4 and 1.9 m/km, respectively.

In the Thames River watershed, the silver shiner is known only from London where average gradients range from 0.5 to 1.4m/km.

In Ontario, the silver shiner is found mainly over pebble and cobble bottoms with occasional boulders and areas of gravel, sand and silt. Large catches were also taken over uniform concrete aprons below dams. Therefore, substrate type does not appear to limit the distribution of this species in Ontario. Trautman (1957), Gruchy et al. (1973), and Gilbert (1980) noted that this species usually occurs over rocky bottoms.

The silver shiner does not appear to live in close association with aquatic macrophytes. During the 1979 survey, macrophytes were abundant at some capture sites and absent at others. Heavy growths of Potamogeton pectinatus are characteristic of the Grand River between Kitchener and Brantford. The catch of silver shiners per-unit-effort showed no apparent correlation with plant abundance. A school of silver shiners was observed skirting the edge of a stand of Myriophyllumse. Gruchy et al. (1973) also captured Ontario specimens in streams with some submergent vegetation. Trautman (1957) and Gilbert (1980) stated that this species avoids rooted aquatic plants.

Throughout its range in the Grand and Thames River watersheds, the silver shiner occurs in streams of variable water quality. During the 1979 survey, specimens were captured in clear to clear and green-tinged water with low levels of turbidity.

Following heavy precipitation, suspended solid levels can increase considerably due to erosion of the intensively formed soils in the region. Dissolved oxygen and temperature levels in the Grand and Thames River watersheds ranged from 8.5 to 13mg/L and 20 to 23.5°C, respectively, in late summer during the 1979 survey. Wong and Clark (1976) found wide diurnal fluctuations in dissolved oxygen concentrations in southern Ontario streams. Gruchy et al. (1973) captured silver shiners in muddy to cloudy water in the Grand River. Trautman (1957) and Gilbert (1980) noted that silver shiners prefer clear streams.

Little information has been published on the age and growth of silver shiners. The scale method of age determination has not been validated for this species. Specimens from the 1979 survey were divided into size classes using length-frequency data, and scales were examined from several individuals of each size class. Scales were removed as described by Lagler (1956). The silver shiner has cycloid, deciduous scales with foci situated in the anterior portion causing considerable crowding of circuli in the anterior field. Annuli were determined on the basis of crowding patterns and the discontinuity of circuli in the lateral and anterior fields. The scale method should be investigated in future studies to ensure its validity.

Age-length determinations were carried out for 20 specimens collected in 1979. In August and September, young-of-the-year ranged from 3.5 to 5.9 cm (SL) and 0.7 to 2.5g (preserved weight), 1+ fish was 5.5 to 7.7cm (SL) and 2.1 to 4.9g, and 2+ fish were 8.7 to 9.8cm (SL) and 6.7 to 12.5g. Only one 3+ specimen (8.8cm (SL), 9.1g) was examined, suggesting that most individuals have a maximum age of 3 winters. Gruchy et al. (1973) examined Grand River specimens and reported that juveniles are 3.25 to 5.45cm long (SL) and that adults are 5.70 to a maximum of 10.85cm long (SL) in late July and early August. Trautman (1957) gave lengths of 3.8 to 6.1 cm for young-of-the-year silver shiners captured in October and lengths of 5.1 to 7.6cm for one-year-olds in Ohio. These data suggest that growth is rapid, particularly during the first year, and that the growth rate is similar in Ontario and Ohio.

Few investigations of reproduction in silver shiners have been documented. Results of the examination of 30 specimens collected during the 1979 survey indicate that most silver shiners mature during their second summer. Twelve specimens less than 5.5cm long (SL) were examined, and three of these had maturing gonads. All specimens longer than 6 cm (SL) were mature. These observations suggest that a few may spawn at age 1 but most spawn at age 2. Gruchy et al. (1973) stated that adults from the Grand River are 5.7cm (SL) and longer, while Trautman (1957) reported that adults in Ohio are usually longer than 6.9cm. Breeding males have small tubercles on the upper surface of the pectoral fins, on the head, and on the scales of the anterior part of the body (Trautman 1957).

Silver shiners spawn in the Grand River during mid-June. Specimens captured on June 4 were in pre-spawning condition. Water temperatures averaged 17^{o}C. Samples were collected in areas in which high numbers of silver shiners had been captured during the fall of 1979; however, very few adult silver shiners were captured in early June. Inflowing creeks were also sampled in an attempt to locate adults of this species, with no success. A return trip on June 24 produced many spent adult specimens using the same collection procedures as used in early June. Water temperatures averaged 22^{o}C. Based on this data it is suggested that silver shiners spawn at water temperatures between 17^{o} and 24^{o}C. The actual area of spawning is not known but deep flowing stretches of the Grand River over 1m deep are suspected spawning areas.

Hybridization occurs rarely with the common shiner, *Notropis cornutus* (Trautman 1957), indicating that the silver shiner also spawns during late spring or early summer.

Gut content analysis of 36 specimens collected during this study indicates that the silver shiner is primarily a surface feeder (Table 1). Insects comprised more than 90 percent of the volume of the identifiable gut contents. Adult Diptera were present in three-quarters of the specimens examined and accounted for an average of more than half of the total identifiable gut volume. The presence of large amounts of immature aquatic insects in many specimens indicates that benthic organisms are also important in the diet. Smaller amounts of nematodes, microcrustaceans, hydrachnids, and filamentous algae were also found in the gut. Considerable variation was found in gut contents among specimens, indicating that the silver shiner is an opportunistic feeder.

Gruchy *et al*. (1973) examined the stomachs of nine specimens from the Grand River and found the diet to be composed primarily of adult and larval insects with small amounts of turbellarians. Trautman (1957) reported that silver shiners may jump into the air to capture flying insects.

Predation on silver shiners by other animals has not been reported prior to this study. A smallmouth bass, Micropterus dolomieui, was observed by the authors to lunge from aquatic macrophyte cover to seize a large silver shiner in the Grand River. Rock bass, Ambloplites rupestris, were commonly captured in the Grand and Thames River watersheds and may prey upon silver shiners.

Silver shiner specimens collected in Ontario show no external evidence of parasitic infestation. Berra and Au (1978) reported very few cysts of the black-spot trematode Uvilifer in this species, and suggested that the fast-flowing water inhabited by silver shiners discourages the attachments of the free-swimming larval parasite. Hoffman (1967) reported infestation of this species by the trematode Neodactulogyrus.

Man's use of the silver shiner in Ontario is limited. Many anglers favour this species as a bait minnow for warmwater game fish in the Grand River watershed.

RECOMMENDATIONS

The following recommendations are suggested for maintenance and monitoring of the silver shiner population in Canada:

1. Further study be implemented to document the life history

of the silver shiner in Canada. It is suggested that these studies be carried out at the university level.

2. Identification information should be made available to concerned agencies.
3. Measures which will ensure against transport of silver shiners outside of the Thames and Grand River watersheds for baitfish or sport use should be investigated.
4. The Ontario Ministry of Natural Resources should monitor and document Ontario silver shiner populations.
5. Records of this species in Canada outside of the Thames River and Grand River watersheds should be investigated by concerned agencies and specimens should be retained for museum collections.
6. Proposed dam construction within the range of the silver shiner should be critically evaluated to mitigate severe impacts.

LIST OF SPECIMENS

A list of silver shiner specimens, captured in Canada, from the National Museum of Canada (NMC) and the Royal Ontario Museum (ROM) is provided below:

NMC 71-850. Grand River, Brant County, R.H. Bowen; NMC 71-854 (11), Grand River at Schneider Creek mouth, Waterloo County, Bowen; NMC 71-855 (8), Grand River, Waterloo County, Bowen; NMC 71-857 (18), Conestogo River, Waterloo County, Bowen. Collections by R.H. Bowen in 1971 were captured from July 29 to August 8. ROM 28349 (5), Grand River, Brant County, October 19, 1971, W.B. Scott, E.J. Crossman, and P. Buerschaper; ROM 28991 (7), Grand River, Brant County, October 19, 1971, Scott _et al_.; ROM 30918 (7), Thames River, Middlesex County, August 7, 1974, Scott and Duckworth; ROM 30967 (52), Grand River, Brant County, July 29, 1975, D. Leslie; ROM 30968 (30), Grand River, Brant County, July 23, 1975, Leslie; ROM 30972 (23), Medway Creek, Middlesex County, June 4, 1975, Scott and Payne; ROM 32249 (7), Grand River, Brant County, July 6, 1976, R.L. Isbester _et al_.; ROM 32250 (14), Grand River, Waterloo County, July 7, 1976, Isbester _et al_.; ROM 32254 (20), Grand River, Waterloo County, July 5, 1976, Isbester _et al_.; ROM 32290 (5), Grand River, Waterloo County, August 3, 1979, Isbester _et al_.; ROM 32292 (15), Grand River, Waterloo County, July 28, 1976, Isbester _et al_.; ROM 32298 (5), Grand River, Brant County, July 6, 1976, Isbester _et al_.; NMC 79-1056 (4), Grand River, Waterloo County, August 27, 1979, B.J. Parker and P.M. McKee; NMC 79-1057 (25), Grand River, Waterloo County, August 27, 1979, Parker and McKee; NMC 79-1058 (4), Grand

River, Wellington County, August 27, 1979, Parker and McKee; NMC 79-1068 (15), Conestogo River, Waterloo County, August 29, 1979, Parker and McKee; NMC 79-1069, Conestogo River, Waterloo County, August 30, 1979, Parker and McKee; NMC 79-1071 (15), Conestogo River, Waterloo County, August 30, 1979, Parker and McKee; NMC 79-1072 (30), Grand River, Waterloo County, August 30, 1979, Parker and McKee; NMC 79-1102 (2), North Thames River, Middlesex County, September 13, 1979, McKee and Cole; NMC 79-1118 (5), Thames River, Middlesex County, September 13, 1979, McKee and Cole; NMC 79-1119 (7), Thames River, Middlesex County, September 13, 1979, McKee and Cole; NMC 79-1141 (10), Nith River, Waterloo County, September 20, 1979, McKee and Cole; NMC 79-1147 (17), Grand River, Brant County, September 20, 1979, McKee and Cole. NMC80-0863, Grand River, at Bridgeport, Waterloo County, June 4, 1980, P. McKee and K. Rowan; NMC80-0870, Grand River, Grand Riber at Bridgeport, Waterloo County, June 25, 1980, P. McKee; NMC80-0871, Conestogo River, at St. Jacobs, Waterloo County, June 25, 1980, P. McKee.

Table 1: Gut contents of 36 specimens* of silver shiners collected in 1979 from the Grand River and Thames River watersheds. Volumes refer to percentages of total gut contents.

Food Item	Volume %	Frequency of Occurrence %
Trichoptera (larvae and pupae)	2.0	11.1
Lepidoptera (larvae)	1.0	5.6
Ephemeroptera (nymphs)	5.7	13.9
Homoptera (adults)	0.6	2.8
Coleoptera (adults)	9.6	22.2
Hymenoptera (adults)	0.1	2.8
Diptera (adults)	30.9	75.0
(pupae)	3.4	22.2
(larvae)	7.9	44.4
Hydracarina	0.01	5.6
Crustacea (Cladocera and Copepoda)	0.01	5.6
Nematoda	1.4	61.1
Filamentous Algae	0.1	2.8
Unidentifiable Material	34.4	88.9

* One specimen had an empty foregut

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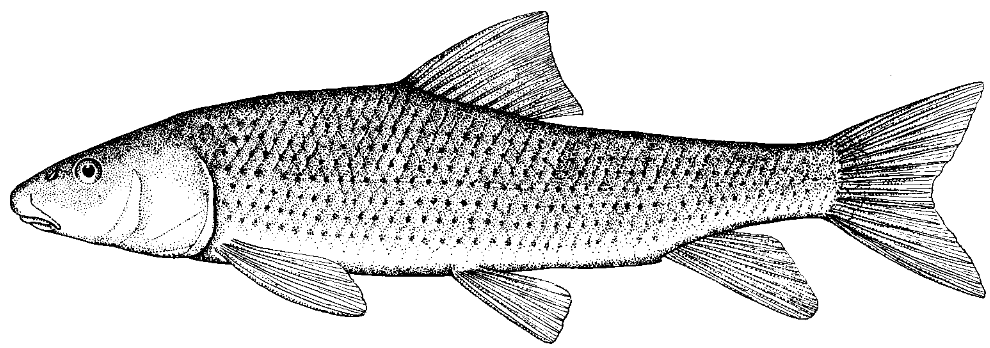
SPOTTED SUCKER

Minetrema melanops (Rafinesque)



Proposed Status: RARE

The spotted sucker, Minetrema melanops (Catostomidae), ranges through much of central and eastern North America. In Canada it is known only in Ontario, in the drainages of Lake Erie and Lake St. Clair. This species has also been reported in Ohio and Michigan.

Little is known of the biology of the spotted sucker in Canadian waters, although several studies have been carried out in other sectors of its range. McSwain and Gennings (1972) and White and Haag (1977) provided life history information on populations of spotted sucker in the southern states. Developmental stages of this species were reported by Hogue and Buchanan (1977). Trautman (1957), Scott and Crossman (1973), and Gilbert and Burgess

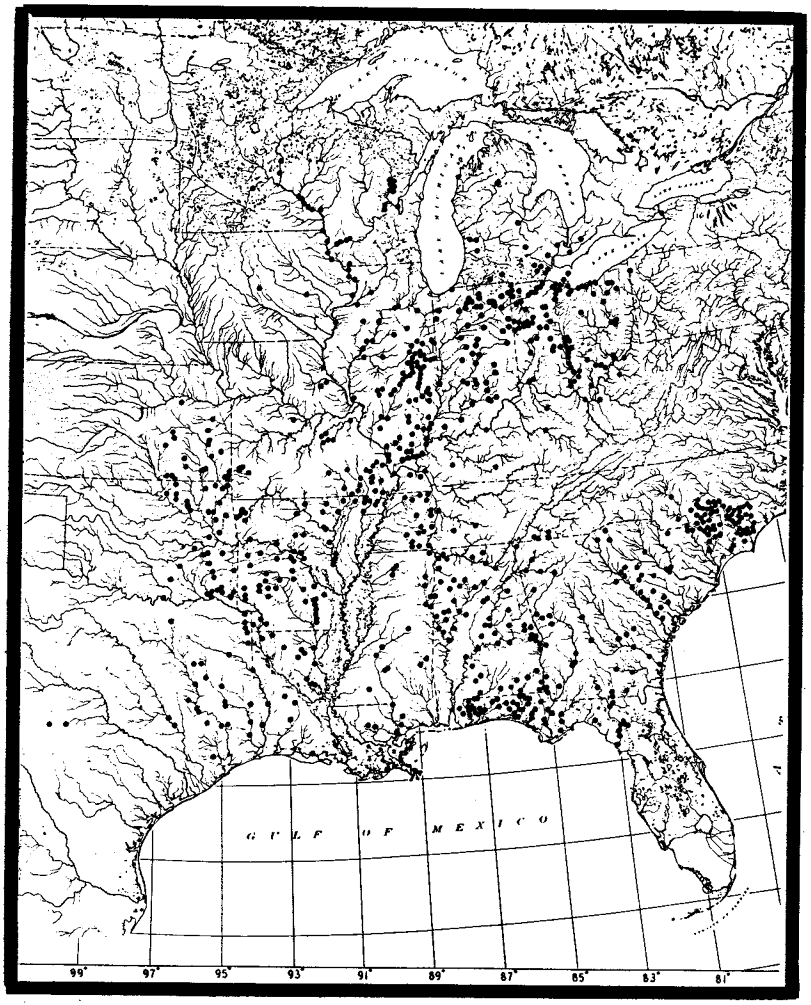
(1980) provided descriptions and summarized available information for this species. McAllister and Gruchy (1977) commented on the status of this species in Canada.

The first spotted sucker taken from Canadian waters was captured in 1962 from Lake St. Clair (Crossman and Ferguson 1963). Since then, only nine specimens have been reported in Canada, the most recent in April, 1980. The infrequent occurrence of this species in Canadian waters led Scott and Crossman (1973) and McAllister and Gruchy (1977) to state that the spotted sucker is rare within its Canadian range. Elsewhere, this species is considered endangered in Maryland, and has disappeared from much of its range in Illinois (Gilbert and Burgess 1980). It is also becoming less numerous in Ohio (Trautman pers. comm.) and Kansas (Cross 1967).

This species is distinguished from other catastomids in Canada by its distinctive colour pattern, consisting of eight to ten horizontal rows of black spots, one per scale, extending over the whole body length beyond the head. (Scott and Crossman 1973, McAllister and Gruchy 1980).

DISTRIBUTION

The spotted sucker is restricted to the freshwaters of central and eastern North America (Figure 1). This species occurs throughout much of the Mississippi River basin from Louisiana in the south to Minnesota and Wisconsin in the north, and east in the Ohio River drainage to Ohio, Michigan



North American distribution of the spotted sucker, *Minytrema melanops*. Adapted from Gilbert and Burgess (1980)

Figure 1

and Pennsylvania. It is found along the Gulf coast from the Colorado River drainage in eastern Texas to the Swannee River drainage in Florida. The spotted sucker is also recorded along the Atlantic coast from Georgia to North Carolina. In the Great Lakes basin the spotted sucker occurs in the drainages of Lake Michigan, Lake Huron, Lake St. Clair and Lake Erie.

In Canada the spotted sucker has a limited distribution in southwestern Ontario (Figure 2). It has been reported from Lake St. Clair, in Lot 2, Kent County (42°21'N, 82°25'W), and near the mouth of the Thames River, Essex County (42°19'N, 82°27'W), and (42°19'N, 82°25'W). It has entered the East Sydenham River and has been collected south of Wallaceburg, Kent County (42°35'42"N, 82°21'30"W) and south of Alvinston, Middlesex County, (42°46'05"N, 81°50'00"W). Collections in Lake Erie are restricted to the western basin, the only specific locality being off Point Pelee, Essex County (41°57'N, 82°45'W).

POPULATION

The population structure of the spotted sucker in Canada is not known. Only nine specimens have been reported from Canadian waters. Crossman and Ferguson (1963) suggested that the first specimen captured in Lake St. Clair was a stray from populations on the west side of Lake St. Clair rather than evidence of a population spread across Lake St. Clair to Canadian waters. Recent collections suggest that a reproducing population may be

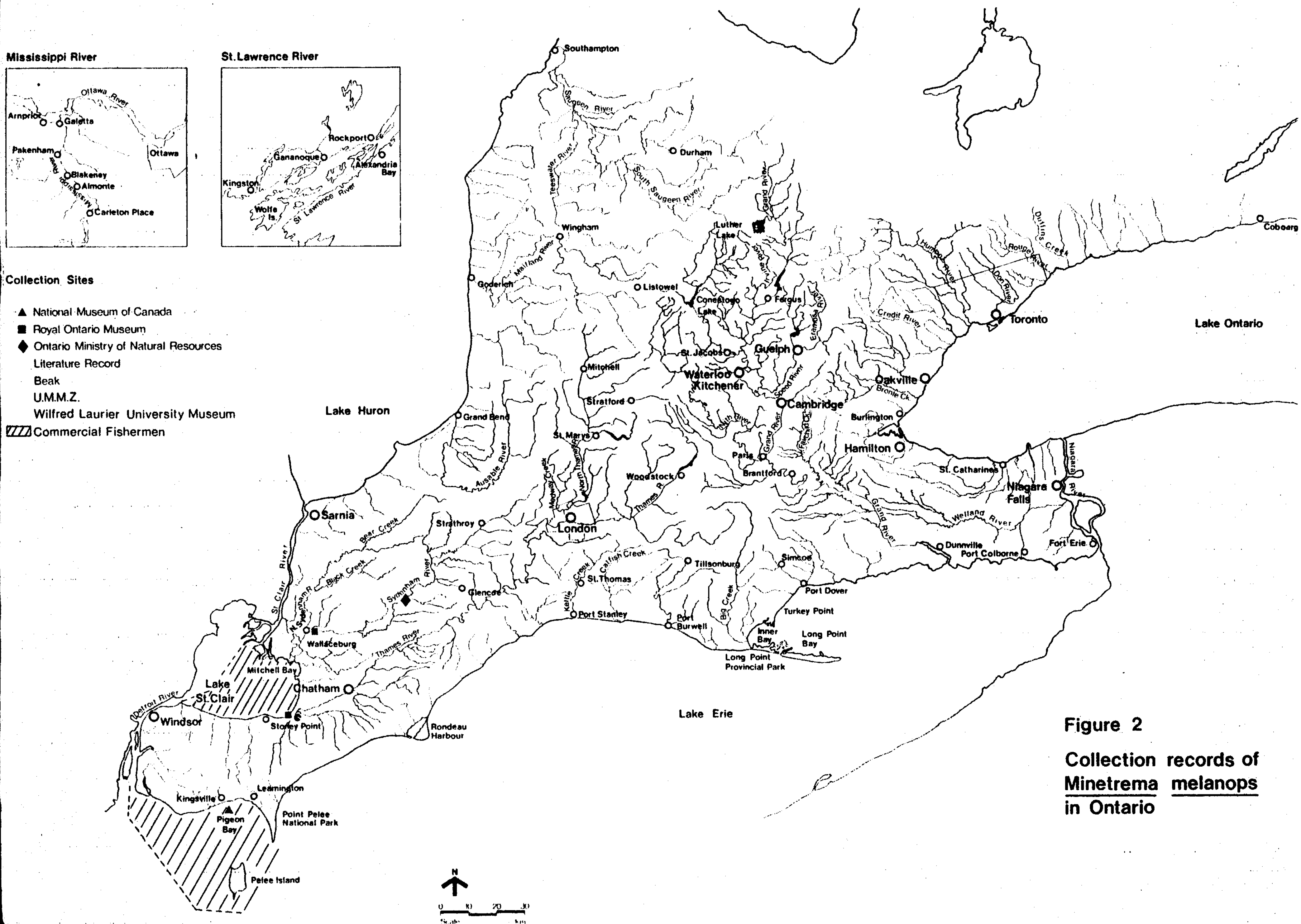


Figure 2

Collection records of <u>Minetrema melanops</u> in Ontario

present in Canada. During this study one spotted sucker was captured in the lower Thames River by the Lake St. Clair Fisheries Assessment Unit, O.M.N.R. This specimen was a mature female in breeding condition. Mr. R. Krause, a commercial trap net fishermen from Leamington, indicated that he has been capturing an average of about 3 spotted suckers per year in the western basin of Lake Erie.

Kirtland (1851) and Jordan (1882) stated that the spotted sucker was common in Lake Erie. Since that time population levels appear to have decreased. Trautman (1957) reported that since the 1920's there had been a pronounced decrease in the abundance of this species in Ohio. Trautman believed that the decrease in abundance of this species in Ohio began prior to 1920 and was caused by destruction of its habitat due to increased siltation. He also suggested that specimens taken between 1920 and 1950 occurred only as strays. Trautman (pers. comm.) said that the spotted sucker is rarely captured in the western basin of Lake Erie and that population levels in Lake Erie must be quite low.

Lake St. Clair populations may be more numerous than that speculated by Trautman for Lake Erie. Mr. R. Haas of the Michigan Department of Natural Resources (pers. comm.) states that the spotted sucker is commonly captured in trap net sampling carried out in Lake St. Clair. Exact numbers were unavailable.

The majority of spotted sucker specimens captured in Ontario waters have been adults. Both male and female specimens have been taken. The possibility of a small breeding population of spotted suckers existing in the Ontario waters of Lake Erie and Lake St. Clair is quite high, however, it will remain speculative until breeding records or young-of-the-year spotted suckers are obtained from Canadian waters.

The Thames River and Sydenham River may provide adequate spawning areas for the spotted sucker. The capture of this species in these rivers, and the presence of other catastomids which have similar spawning requirements as the spotted sucker suggest that suitable spawning areas exist in the Thames and Sydenham Rivers.

THREATS

Insufficient information regarding the population structure and distribution of the spotted sucker in Canada is available to determine if there are immediate threats to the welfare of this species in Canada by impending developments.

STATUS

The following statements were considered valid after review of available information and were used in the evaluation of the status of the spotted sucker in Canada:

1. A small reproducing population of spotted suckers exists in the western

basin of Lake Erie, and in Lake St. Clair.

2. There is some indication that portions of this population may be using the Thames and Sydenham Rivers as spawning areas.
3. The spotted sucker is known in Canada at the northeastern fringe of its North American range.
4. A decrease in abundance of the spotted sucker in bordering waters since the 1920's is linked to increased siltation, and subsequent degr dation of available habitat.
5. There is insufficient information available to determine if this species is threatened by the actions of man which will cause its extirpation in Canada.

Based on information evaluated during this study it is recommended that the spotted sucker be classified as rare in Canada.

BIOLOGY

In Canada the spotted sucker has been captured in lake and sluggish river environments. Trautman (1957) noted that this species has been captured in lakes, rivers, oxbows, sloughs and streams in Ohio. Elsewhere, it has been collected in all types of slow flowing water bodies from intermittent streams to large lakes and impoundments (Douglas 1974).

Bottom substrates at spotted sucker capture sites in Ontario range from hard clays to sand, gravel, and rubble. Pflieger (1975) reported this species was found over soft organic bottoms, but it is generally considered to prefer firm to hard substrates (Cross 1967, Gilbert and Burgess 1980).

The spotted sucker has been reported from water bodies with dense aquatic macrophyte growths (Cross 1967), however, records from Canadian collections of this species are lacking habitat data and therefore between this species and aquatic macrophytes cannot be substantiated.

The spotted sucker prefers clear warm waters where turbidity is minimal (Trautman 1957). This species has been captured in the East Sydenham River where turbidity is moderate to heavy (Secchi disc appoximately 45 cm). The spotted sucker is more tolerant to siltation than some other catostomids, especially if siltation is only intermittently heavy (Miller and Robinson 1973). Trautman (1957) stated that this species was found in water bodies where siltation was extremely low. He suggested that the closely bound gill covers in this species make it intolerant to turbid waters, pollutants and flocculent clay silt substrates. Cross (1967) suggested that the habitat of the spotted sucker was especially vulnerable to unfavourable change (mainly siltation) because of intensive cultivation along low gradient streams that are preferred by this species. Oxygen and temperature tolerances are not known for the spotted sucker.

Adult spotted sucker average 230 to 280 mm in length (Scott and Crossman 1972). Ontario specimens averaged 367 mm (TL), considerably longer than that reported by Scott and Crossman. The smallest Canadian specimen was 275mm (TL), the largest 440mm (TL) and weighed 1235g. Scales from two large specimens, 358mm and 373mm (TL) were aged at 7 and 8 years respectively. The maximum age reported for this species in populations from the United States appears to be 6 years (Carlander 1969).

Trautman (1957) reported that young-of-the-year spotted sucker taken in Ohio during October ranged in length from 5.1 to 10.2cm. Adults ranged from 22.9 to 38.1cm in length and weighed between 170 and 794g. The largest specimen from Ohio measured 450mm in length and weighed 1361g. Dwarf forms were reported by Trautman but growth data was not included for these fish.

Pflieger (1975) stated that spotted sucker in Oklahoma attain a length of about 15.5cm in the first year and average 29, 34, 41, and 44cm at the end of succeeding years. Data on growth rates between sexes have not been published.

Age of maturity is not known for Canadian populations, but a female in breeding condition, captured in April in the Thames River was aged at 5 years. Pflieger (1975) reported that spotted suckers in Missouri reached maturity at age 3. Dwarf forms captured in Ohio are reported to mature at a length of 150mm (Trautman 1957).

The spotted sucker spawns during late spring or early summer. The single female specimen captured in April was in prespawning condition. The water temperature at the time of capture was 7°C. Tuberculated males have been recorded in early June in Ohio (Trautman 1957). McSwain and Gennings (1972) reported that spawning took place in Georgia Creeks in waters ranging from 12 to 19°C. McSwain and Gennings also stated that spawning spotted sucker were observed in riffle areas over coarse limestone rubble where the water depth averaged 40cm. The flow rate in the riffle area was estimated at 1.4m^3/sec. Depressions behind large rocks were often used as spawning sites.

Spawning groups of spotted suckers observed in Georgia consisted of 3 individuals, two males and one female. The ratio of males to females on the spawning grounds was estimated at 1:1. Spawning activity was described by McSwain and Gennings (1972). They observed semi-buoyant eggs drifting downstream after a union. Observations suggested that males and females may spawn more than once.

An estimated 38,000 eggs were contained within the one mature specimen captured in the Thames River. Spotted sucker eggs hatch within 7 to 12 days after fertilization (Jackson 1957). Larval development was described by Hogue and Buchanan (1977) and White and Haag (1977).

Breeding males have two dark lateral bands separated by a pinkish band along the midside. Males are tuberculated on the snout, anal fin and both lobes of the caudal fin. Few tubercles appear around the eye and lower cheek region and on the ventral surface of the head.

Data on the feeding habits of the spotted sucker in the Great Lakes are minimal. Specimens were not available for stomach content analysis during this study. Feeding habits of the spotted sucker in Kentucky have been described by White and Haag (1977). They found that the food preferences and feeding habits of the spotted sucker show distinct changes through the various life stages. Larval spotted sucker 12 - 15mm (TL), began feeding in midwater and at the surface on zooplankton and diatoms while the yolk was still present in the gut. At 25 to 30mm (TL) the spotted sucker ceased to feed at mid-depths and were observed feeding over patches of sand. Larvae up to 25mm (TL) were observed feeding in shallow backwaters of creeks. At approximately 50mm (TL) they began feeding on bottom benthic organisms, sand began appearing in the gut at this length. Specimens longer than 50mm (TL) had feeding habits similar to adults. Adult spotted sucker feed individually or in loose aggregations in quiet waters, over clean sand bars, during the day. By volume, the largest percentages of particles in the stomach of adults were organic fragments and sand. Copepods, cladocerans, chironomids, and diatoms were identified as major food items. Molluses have been mentioned by Miller and Robinson (1973), Harlan and Speaker (1956) and Pflieger (1975) as an important food item in the diet of spotted suckers.

The protozoan, Myxosoma microthecum, was the only parasite Hoffman (1967) listed for this species. Hart and Fuller (1974) stated that an unidentified mussel had been listed as a parasite of the spotted sucker in Kentucky.

Young spotted suckers are probably preyed upon by several piscivorous fish and birds which are known from the same areas. This species is only incidentally captured in the Great Lakes basin, usually by hook and line or in trap nets. Jackson (1957) suggests that spotted suckers are captured for human consumption in the southern limits of its range. Those captured in commercial fishing in Ontario are lumped with other rough fish and sold as mullet or used for agricultural purposes.

RECOMMENDATIONS

The following recommendations are suggested for the maintenance and monitoring of the spotted sucker population in Canada:

1. The Ontario Ministry of Natural Resources should hold and transport to a museum facility all spotted sucker specimens captured in Lake Erie, Lake St. Clair and associated watersheds.
2. Identification information should be made available to concerned agencies. It is also recommended that an education program be initiated by the Ontario Ministry of Natural Resources to ensure that commercial

fishermen recognize the importance of this species.

3. A population survey should be conducted by the Ontario Ministry of Natural Resources in conjunction with future fisheries surveys and commercial catch inspection programs.
4. Further study should be implemented that would identify spawning and nursery areas for the Lake St. Clair and Lake Erie population.
5. Should population centers or important life history areas be identified, measures to protect this species should be investigated.

LIST OF SPECIMENS

A list of spotted sucker specimens, captured in Canada, from the National Museum of Canada (NMC) and the Royal Ontario Museum (ROM) and the Ontario Ministry of Natural Resources (OMNR) is provided below:

ROM 21894 (1), Lake St. Clair, Kent Co., Lot 2, about 4km North of Thames River mouth, Archibald and Johnston, April 1962; ROM 22894 (3), Lake St. Clair, Kent Co., Uthe J., 12 May, 1964; ROM 28919 (1), Lake St. Clair, Thames River mouth, Johnston and Goodchild, 1 May, 1973; ROM 30961 (1), East Sydenham River, Kent Co., near Wallaceburg, Sosiak and MacLennan, 04 July, 1975; NMC 77-0185 (1), Lake Erie, Essex Co., west of Point Pelee, Ontario Ministry of Natural Resources, 15 November, 1976; NMC 77-0187 (1), Lake Erie, Essex Co., west of Point Pelee, Ontario Ministry of Natural Resources, 15 November, 1976; NMC 77-0336 (1), Lake Erie, western basin, Ontario Ministry of Natural Resources, November 1977; OMNR AC552 (1), East Sydenham

River, Middlesex Co., south of Alvinston, 15 July, 1975; NMC 80-0866(1), River, 2km from mouth, Essex Co., 11 April, 1980, D. Hector.

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Miller, R.J., and H.W. Robinson. 1973. The fishes of Oklahoma. Oklahoma State Univ. Press. Stillwater, Okl. 240 p.

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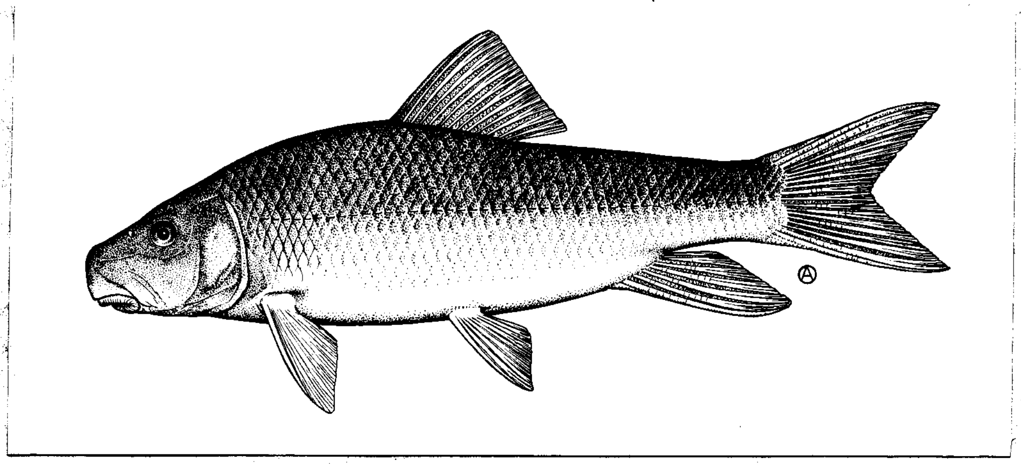
RIVER REDHORSE

Moxostoma carinatum (Cope)



Proposed Status: THREATENED

The river redhorse, *Moxostoma carinatum*, (Catastomidae) is found in fresh-water rivers and lakes in eastern North America. In Canada this species occurs in southern Ontario and southwestern Québec. Elsewhere, the closest populations of the river redhorse are believed to be in Kentucky and Missouri, approximately 1,300km to the southwest, although isolated populations may exist in several localities between those areas and Canadian population centres.

Little has been written on the biology of the river redhorse. Available information was summarized by Trautman (1957), Carlander (1969), Jenkins (1970) and Scott and Crossman (1973). Hackney *et al*. (1967) gave life history information for Alabama river redhorse. Mongeau *et al*. (1974) provided distributional information for Québec populations and McAllister and Gruchy (1977) commented on the status of this species in Canada.

The river redhorse is infrequently found in Canadian waters. Vladykov (1942) first reported this species from Canada in Quebec. Populations exist in southwestern Québec, but this species is considered rare in that area (Mongeau *pers. comm.*). Isolated populations of this species exist in eastern Ontario and possibly in southwestern Ontario.

Due to the infrequent occurrence of river redhorse in Canada and its apparent decrease in abundance throughout its range, McAllister and Gruchy (1977) listed the river redhorse as rare in Canada. This species is considered rare, threatened or endangered in several parts of its range. It is listed as endangered in Kansas (Platt 1974) and Ohio (Ohio Department of Natural Resources 1976), threatened in Florida (Gilbert 1978), rare in Missouri, and it is believed to be extirpated from Michigan, much of Iowa, Illinois, Indiana and Pennsylvania (Jenkins 1970).

The river redhorse has often been misidentified, as are many of the species in the genus *Moxostoma*. The river redhorse is distinguished from all other redhorse in Canada except *M. hubbsi* by its molar-like pharyngeal teeth; all other members of this genus have slender comb-like teeth. The river redhorse has about 12 caudal peduncle scales while the copper redhorse has approximately

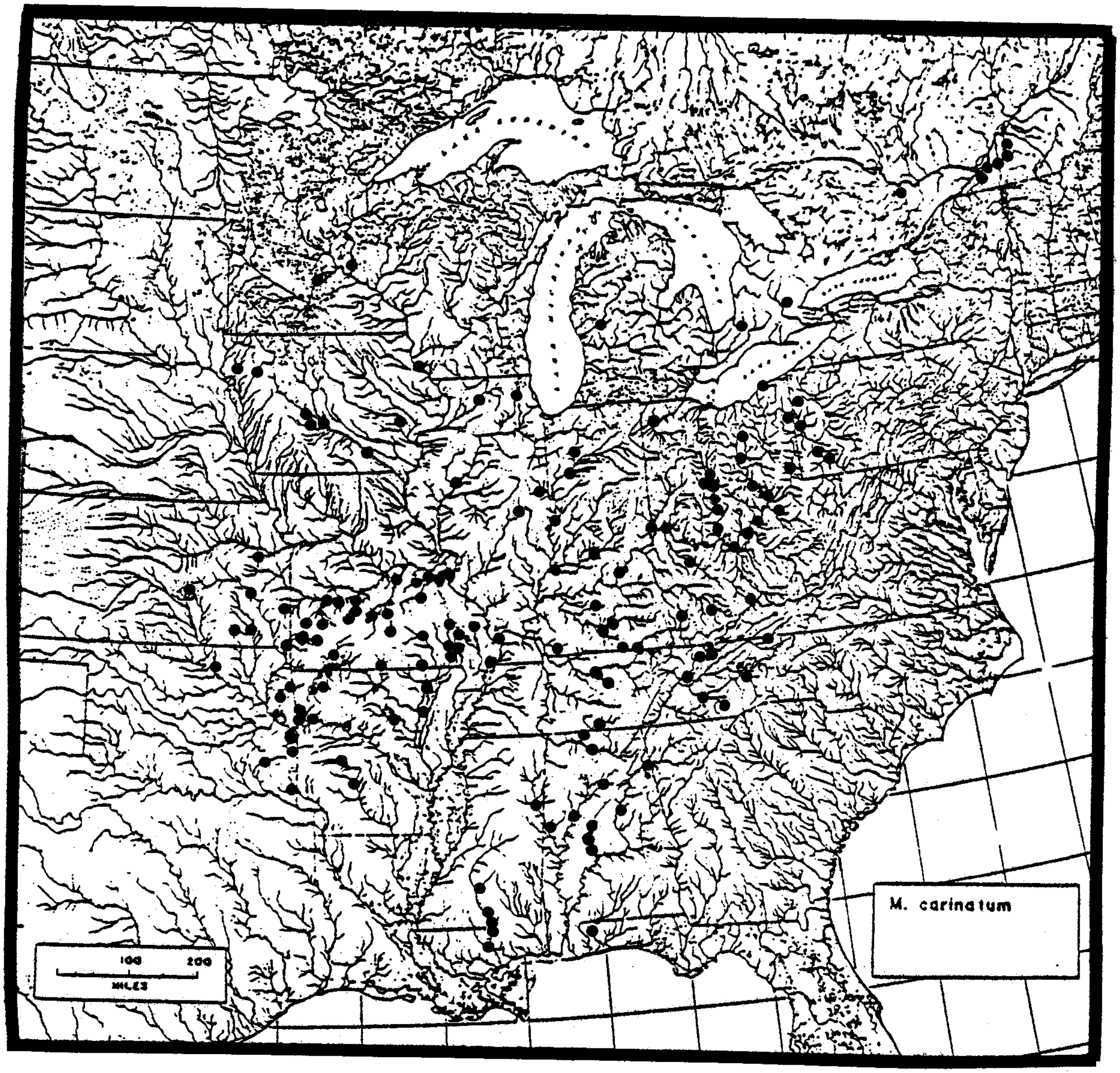
16 caudal peduncle scales (McAllister and Gruchy 1980). Systematics, meristics and morphometrics of the river redhorse were investigated by Jenkins (1970).

DISTRIBUTION

The range of the river redhorse extends through much of the central United States from the Gulf states northward through the Mississippi basin to the southern Great Lakes and St. Lawrence River drainages (Figure 1). The present range of this species is believed to be much reduced and disjunct in nature from that shown in Figure 1 (Jenkins 1970; Scott and Crossman 1973).

In the southern United States the river redhorse has been found in the Pearl, Tombigbee, Alabama, and Escambia River watersheds. In the Mississippi River basin the river redhorse has been reported in Arkansas, eastern Oklahoma and Nebraska, Missouri, Kansas, Iowa, Illinois, and Minnesota; it has also been reported from the Tennessee River system, and the Ohio River system to western Pennsylvania. It is absent from the Mississippi River south of the Kentucky-Tennessee state border and also in the Missouri River (Jenkins 1970). In the Great Lakes drainage, the river redhorse has been rarely collected from tributary streams of Lake Michigan, Lake Huron, and Lake Erie. This species has been captured in the Mississippi River in eastern Ontario and from southwestern Québec in the St. Lawrence drainage.

In Ontario (Figure 2), the river redhorse has been captured in the Mississippi



North American distribution of the river redhorse, Moxostoma carinatum. Adapted from Jenkins (1980)

Figure 1

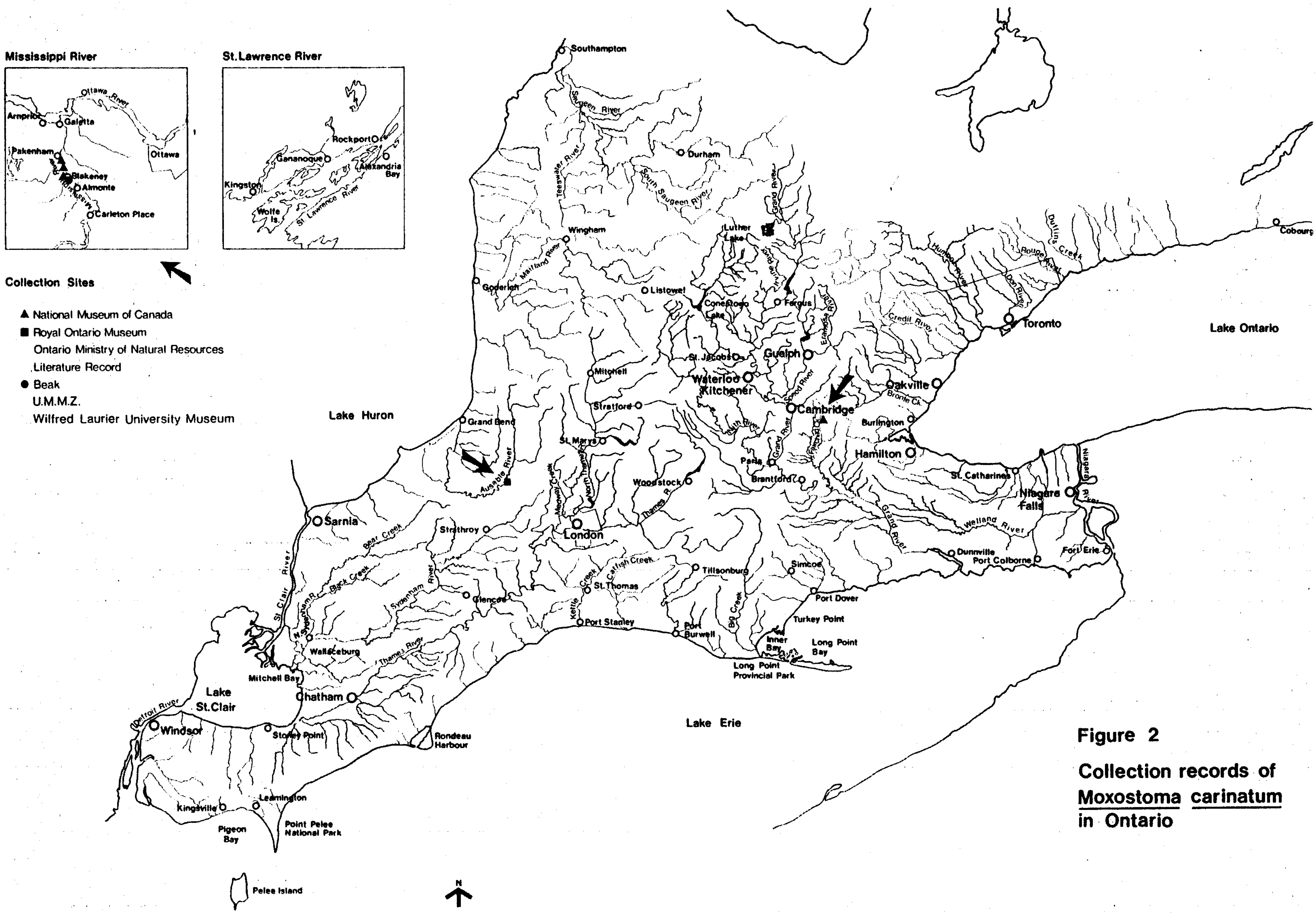


Figure 2

Collection records of *Moxostoma carinatum* in Ontario

River system, a tributary of the Ottawa River, at Pakenham, Lanark County (45^{o}17'N, 76^{o}23'W), at Blakeney, Lanark County (45^{o}16'N, 76^{o}15'W) and in the Indian River, Lanark County (45^{o}15'N, 76^{o}15'W), a single specimen was taken in the Ottawa River at the mouth of Brewery Creek, Regional Municipality of Ottawa-Carleton (45^{o}28'N, 75^{o}32'W); this species is also known from Fairchild Creek, a tributary of the Grand River in Brant County (43^{o}07'N, 80^{o}07'W) and from the Ausable River, Middlesex County (43^{o}N, 81^{o}W).

In Québec the river redhorse has been captured in the St. Lawrence River and its tributaries from Lake St. Louis to the eastern outflow of Lake St. Pierre. Self-sustaining populations exist in the Richelieu and Yamaska River watersheds (Mongeau et al. 1974).

POPULATION

Populations of the river redhorse in Canada are widely separated. Reproducing populations are reported only from the Mississippi River in Lanark County and in southwestern Québec.

During this study river redhorse were captured only in the Mississippi River system, however, effort was not expended in southwestern Québec or in the Ausable River in southwestern Ontario. This species was not captured in Fairchild Creek.

The Mississippi River supports a small breeding population of river redhorse. An estimate of the relative size of this population was made by comparing the total number of redhorse suckers to river redhorse suckers captured or observed in the Mississippi River. During 1977 the National Museum of Canada collected approximately 80 shorthead redhorse, Moxostoma macrolepidotom, 6 silver redhorse, M. anisurum and 3 river redhorse from the Mississippi River at Pakenham. During 1979 our divers identified only 2 large river redhorse suckers in the Mississippi River while approximately 100 shorthead redhorse and greater redhorse M. valenciennesi were observed. Relative to other redhorse sucker species in the Mississippi River, the river redhorse comprises only about 5% of the redhorse population. Adults and immature river redhorse have been captured in the Mississippi River but young-of-the-year have not. The river redhorse population in the Mississippi River appears to be limited in distribution to a 55km section of river from Galleta to Almonte (See Figure 2). Waterfalls at Almonte prevent the upstream dispersal of this species in the Mississippi River. Movement downstream into the Ottawa River is possible, but the presence of the river redhorse in the Ottawa River near the mouth of the Mississippi River are unconfirmed. Single specimens captured in the Ottawa River suggest that populations of river redhorse remain undetected in this water system.

River redhorse in the Mississippi River may be under significant stress from sport fishing. The Mississippi River at Pakenham and Blakeney is intensively fished during the summer months (approximately 250 man h/ha/year). In 1977 between 3 to 10 redhorse suckers were commonly captured at Blakeney each weekend, and comparable numbers were taken at Pakenham. It is suspected that mature adult river redhorse are no less susceptible to capture than other species of river redhorse and may be more frequently captured than other species due to their large size. A reduction in the number of redhorse in the Mississippi River at all sampling stations was observed between the 1977 and 1979 surveys.

In Québec, the river redhorse is considered generally rare in comparison to other related species (Mongeau *pers. comm.*). This species is believed to have breeding populations in the Yamaska and Richelieu River watershed however, these populations are small. The river redhorse was listed as rare at all stations on the Richelieu River and abundant only at 2 of 24 stations on the Yamaska River (Mongeau 1979 a and b). Jenkins (1970) stated that the river redhorse comprised only 5% of all redhorse taken in the Yamaska River. Jenkins also noted that portions of the lower Yamaska River were unsuitable for river redhorse due to industrial pollution and siltation. Collections of river redhorse elsewhere in southwestern Québec are few and population centres have not been identified.

Reports of the occurrence of river redhorse in Fairchild Creek are based on a single collection of 5 immature specimens captured in 1971. The continued existence of this species in this watershed is unlikely. Siltation and pollution in Fairchild Creek may have degraded water quality to a level unsuitable for river redhorse. A single collection of 2 adult river redhorse in 1936 is the only indication of this species occurring in the Ausable River system.

It is quite possible that the river redhorse is more widely distributed in Ontario than capture records suggest. Populations of the river redhorse may have gone unnoticed because of difficulties in adequately sampling its preferred habitat and in identifying specimens. Trautman (1957) also noted that its presence was often unsuspected in rivers in Ohio until mass fish kills produced specimens.

THREATS

The only known surviving population of river redhorse in Ontario may be threatened through the removal of adult specimens by sportfishermen. Possible threats to Québec and southwestern Ontario populations are undetermined.

STATUS

The following statements were considered valid after review of available information and were used in the evaluation of the status of the river redhorse in Canada:

1. Populations of river redhorse are present in the Mississippi River, Ontario, and in the Yamaska and Richelieu Rivers in Québec.

2. All known populations in Canada are small in number and restricted in distribution.
3. Watercourses in southwestern Ontario in which this species had been recorded may no longer be suitable for habitation as a result of man's actions.
4. Canadian populations of this species are disjunct from surviving populations in the United States.
5. The only known surviving population of river redhorse in Ontario is decreasing in number due to the actions of man.

Based on information evaluated during this study it is recommended that the river redhorse be classed as a threatened species in Canadian waters.

BIOLOGY

The river redhorse has been captured in lakes and rivers within its Canadian range. This species prefers moderate to large rivers with gravel, rubble and bedrock bottoms where siltation is minimal (Trautman 1957, Jenkins 1970). The river redhorse is often associated with rivers which have riffle and pool habitats and swift flow. Occassionally this species is collected in fluvial lakes and impoundments, but the river redhorse does not fare well in these environments (Jenkins 1970).

River redhorse captured in the Mississippi River in Ontario were taken from fast-flowing pools in a 300m long chute and a catch-pool of a 1 to 2m high waterfall. Stream gradient is approximately 1.5m/km over the entire river, but rapid changes in elevation are evident at both capture localities. Water flow volumes fluctuate in the Mississippi River from 14.6m^3/s in late summer to 142m^3/s during spring floods (Ontario Ministry of the Environment 1977). The river bed in these areas is composed of limestone and granite bedrock, and rubble. A 1 to 2cm layer of detritus covered the bottom in areas of slackened current.

This species was not observed in slow-moving stretches of the Mississippi River which had abundant macrophyte growth and soft substrates. Jenkins (1970) also noted that this species is rarely captured in deeper waters of slow flows which have silt and sand bottoms. Aquatic vegetation at capture sites on the Mississippi River was restricted to encrusting and short filamentous algae, with patches of aquatic macrophytes growing in slack-water areas.

Turbidity was quite low at capture sites (Secchi disc transparency approximately 1m). Jenkins (1970) stated that the river redhorse is intolerant of turbid waters, and increased turbidity and siltation are usually followed by decreases in population numbers. Trautman (1957) also reported reduction in population numbers for this species in heavily silted and polluted rivers and streams in Ohio. In the Mississippi River water temperatures reach 25°C during the summer, and dissolved oxygen levels as low as 3mg/L have been recorded (Ontario Ministry of the Environment 1977). However, dissolved oxygen levels usually average 7 to 10mg/L during summer months when water temperatures are highest.

Collection information for river redhorse from southwestern Ontario is inadequate to establish habitat preference in that area.

Ten river redhorse collected in Ontario waters were aged using the scale method. Annuli are distinct on river redhorse scales, however, specimens over age 7 were difficult to age due to crowding of annuli along the outer edges of the scale. Purkett (1958) also used scales to calculate lengths for age classes of this species. Calculated lengths for Ontario specimens at each age class are:

	Standard Length		
Age	Calc.	Range	Increment
1	60	57- 64	60
2	103	94-114	43
3	152	133-171	49
4	189	166-202	37
5	246	231-272	57
6	311	262-352	65
7	345	282-373	34
8	373	317-404	28

Standard Length

Age	Calc.	Range	Increment
9	402	346-432	29
10	379	379	-
11	390	390	-
12	410	410	-
13	438	438	-
14	461	461	-

N = 10

The oldest specimen captured in Ontario was collected during this study and was aged at 14 years (NMC 79-0174). The maximum age recorded for river redhorse in the United States is 12 years (Carlander 1969). Growth rate for mature Ontario river redhorse was approximately 40% slower than the growth rate calculated by Purkett (1958) for Missouri populations. The calculated growth for young-of-the-year river redhorse in Ontario was approximately 60mm. Hackney et al. (1967) reported growths of up to 100mm for pond-raised young-of-the-year specimens captured in August and up to 161mm for specimens captured in natural waters.

The largest specimen reported from Ontario waters was 617mm (TL) long and weighed approximately 2814g (NMC 79-1981). This specimen was not aged. Trautman (1957) stated that the largest Ohio specimen was 737 m. in length and weighed 4761g. He also stated that Ohio River fishermen reported river redhorse weights up to 6272g, but this species usually ranged from 333 to 610mm in length and 448 to 3136g in weight. Too few river redhorse specimens are available from Ontario collections to formulate an accurate length-weight relationship. However, Carlander (1969) provided a length-weight relationship for Missouri populations that may be useful for Ontario populations, that is:

$$\log w = -4.8 + 2.9 \log/L$$

where w= weight
L= standard length

Male and female river redhorse are not known to differ in growth rate, and observed sex-related differences in size are not conclusive (Jenkins 1970). Age at maturity is not known.

Spawning river redhorse have not been observed in Canadian waters. Hackney _et al_. (1967) detailed spawning in Alabama. The river redhorse spawns in large rivers, but may use the upper reaches of some large tributaries (Jenkins 1970). Trautman (1957) observed spawning migration in Ohio. This species spawns in the spring in Alabama during April at water temperatures ranging from 22 to 24^{o}C (Hackney _et al_. 1967). In the Mississippi River watershed in Ontario this temperature range is reached in late May or early June (Ontario Ministry of the Environment 1977). Tuberculate males were captured in early June in Québec (Jenkins 1970). Males collected in early July in Québec (Jenkins 1970) and in late July in the Mississippi River by the National Museum of Canada had tuberculate scars. Hackney _et al_.

(1967) observed spawning river redhorse over gravel shoals in water from 0.15 to 1m deep. Males constructed redds varying in size from 1.2 to 2.4m in diameter and from 20 to 30cm in depth. Hackney et al. described males as being territorial, but the spawning act required 2 males and 1 female. The second male would join the first in the redd just prior to the spawning act and would leave during the spawning act or immediately thereafter. Males tended to spawn with females larger than themselves.

Eggs are scattered into the gravel during spawning. Hatching takes place in approximately 6 days in 24°C water (Hackney et al. 1967). Hackney et al. counted from 6,078 to 23,085 eggs for individuals 45 to 56cm (TL) respectively. Eggs were relatively large, usually 3 to 4mm in diameter during spawning. Larval development was described by Hackney et al. (1967). Jenkins (1970) noted that males have large tubercles on the head and on the caudal and anal fins, females did not.

River redhorse feed extensively on benthic organisms. This species has only been observed foraging over firm substrates where siltation was minimal. Gut contents examined suggest that feeding is selective, only a small percentage of the gut contents were inorganic bottom debris. Large food items are not found by random filtering of bottom sediments, but rather by sight. River redhorse were attracted towards an introduced bait and would take the bait either on the bottom or in mid-water.

The gut contents of 10 river redhorse were examined during this study to determine diet. Specimens 100 to 150mm in length fed primarily on chironomid larvae and pupae in about equal volumes. Food items found in specimens 200 to 250mm long included chironomid larvae and pupae, Crustacea, Trichoptera and Coleoptera. The diet of specimens over 300mm in length varied. The gut contents of specimens captured during 1977 were composed mainly of Gastropoda, approximately 80% by volume. Other food items that were present but in small quantities included larval Trichoptera, Chironominae, and Crustacea. The gut contents of 2 river redhorse specimens captured in 1979 contained Ephemeroptera nymphs, (30% by volume), crayfish (20%), Nematodes (20%), Trichoptera (10%) and insignificant amounts of Chironomids and Gastropodes. Hackney et al. (1967) also found that the river redhorse fed largely on bivalve molluscs. Smaller quantities of insect larvae were also consumed. Forbes and Richardson (1920) found that the diet of two Illinois specimens included one-third molluscs and two-thirds insect larvae, mainly mayflies and beetles.

Predation by piscivorous fish and birds on river redhorse is believed to be minimal and is likely restricted to young-of-the-year and 1+ fish. The rapid growth rate of young-of-the-year would exclude this species from the diet of many predators. The large adult size which river redhorse attain, and their elusive nature may preclude serious predation on the adults except by man.

This species is classed as a course fish by the Ontario Ministry of Natural Resources and therefore not protected by catch limits, minimum size restriction or spear fishing regulations. Sport-fishing in the described habitat areas may affect population numbers. The effects of chemical alteration of the Mississippi River system by fertilizers, pesticides, toxicants and acid rain are not known.

This species was not included in Hoffman's (1967) parasite studies, but Williams (1978) described a cestode from the intestinal tract of the river redhorse.

RECOMMENDATIONS

The following recommendations are suggested for the maintenance and monitoring of the river redhorse populations in Canada:

1. The Ontario Ministry of Natural Resources should hold and transport to a museum facility all river redhorse specimens captured in Ontario.
2. Further data should be collected and a survey should be carried out to determine population structure and trends for Québec populations.
3. Identification information should be made available to concerned agencies.
4. Identification of redhorse suckers by the Ontario Ministry of Natural Resources should be carried to the species level.
5. Reports of the occurrence of this species outside known localities

should be investigated to determine population size.

6. A trap net, tagging and creel census studies should be carried out on the Mississippi River to determine river redhorse population levels and trends.

7. Efforts to locate spawning and nursery areas for river redhorse populations should be continued. When located, protective measures to insure the continued existence of this species in Canada should be investigated.

LIST OF SPECIMENS

A list of river redhorse specimens, captured in Canada, from the National Museum of Canada (NMC) and the Royal Ontario Museum (ROM) is provided below:

ROM 28250 (2), Ausable River, Middlesex County, August 10, 1936, C.V. Kerswill; NMC 64-0197 (1), Indian River, tributary of Mississippi River, August 16, 1962, D.E. McAllister and F.R. Cook; NMC 71-0873 (5), Fairchild Creek, Brant County, August 7, 1971, R.H. Bowen; NMC 77-0212 (1), Mississippi River, at Blakeney, Lanark County, July 10, 1977, S. Cumba; NMC 79-0989, (2), Mississippi River, at Blakeney, Lanark County, September 16, 1979, A. Morgan; NMC 79-1186 (2), Mississipi River, at Blakeney, Lanark County, September 24, 1979, B. Parker and B. Hindley; NMC 80-0929, Mississippi River, at Pakenham, August 04, 1977, B. Parker and D.E. McAllister.

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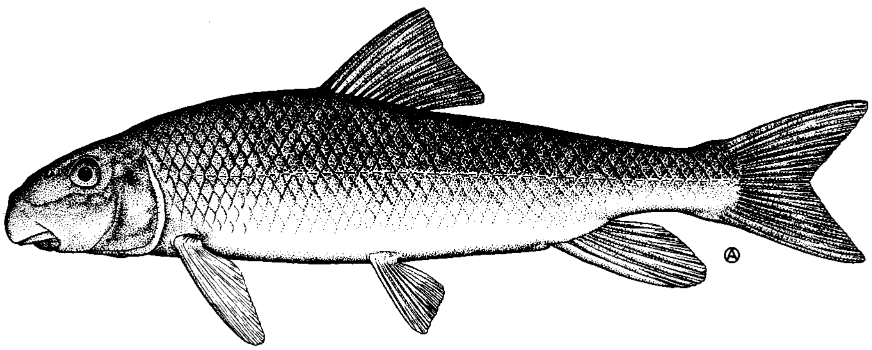
BLACK REDHORSE

Moxostoma duquesnei (Lesueur)



Proposed Status: ENDANGERED

Report prepared in conjunction with E. Kott, Wilfred Laurier University, Waterloo, Ontario.

The black redhorse, Moxostoma duquesnei, (Catostomidae), is restricted to the freshwaters of eastern North America. In Canada it is confined to swift flowing streams and rivers in southwestern Ontario. Populations of black redhorse are known from Ohio and Michigan.

Little has been published on the biology of this species in Canada; however, information on United States populations is more extensive. Trautman (1957) provided descriptive and biological information on this species in Ohio, Bowman

(1959) carried out an extensive life history study on black redhorse in Missouri, and Jenkins (1970) reviewed systematics, distribution, and ecology. Carlander (1969) and Scott and Crossman (1973) summarized available information.

Hubbs and Brown (1929) first reported this species in Canada from tributary streams flowing into Lake Erie. Repeated collection attempts in subsequent years failed to confirm its continued existence in Canada. A paucity of collected materials coupled with decreased suitable habitat areas in southwestern Ontario suggested to Scott and Crossman (1973) that this species had been extirpated from Canadian waters.

The continued existence of this species in Canada has been confirmed only recently. In 1977 small populations of black redhorse were discovered in the Grand River system (Kott *et al*. 1979) and in the North Thames River (Osmond pers. comm.).

McAllister and Gruchy (1977) listed this species as endangered in Canada. Elsewhere, it is listed as threatened in West Virginia (Miller 1972), rare in Iowa, Wisconsin, and Minnesota (Harlon and Speaker 1969; Jenkins 1970) and of varying abundance in Ohio (Trautman pers. comm.).

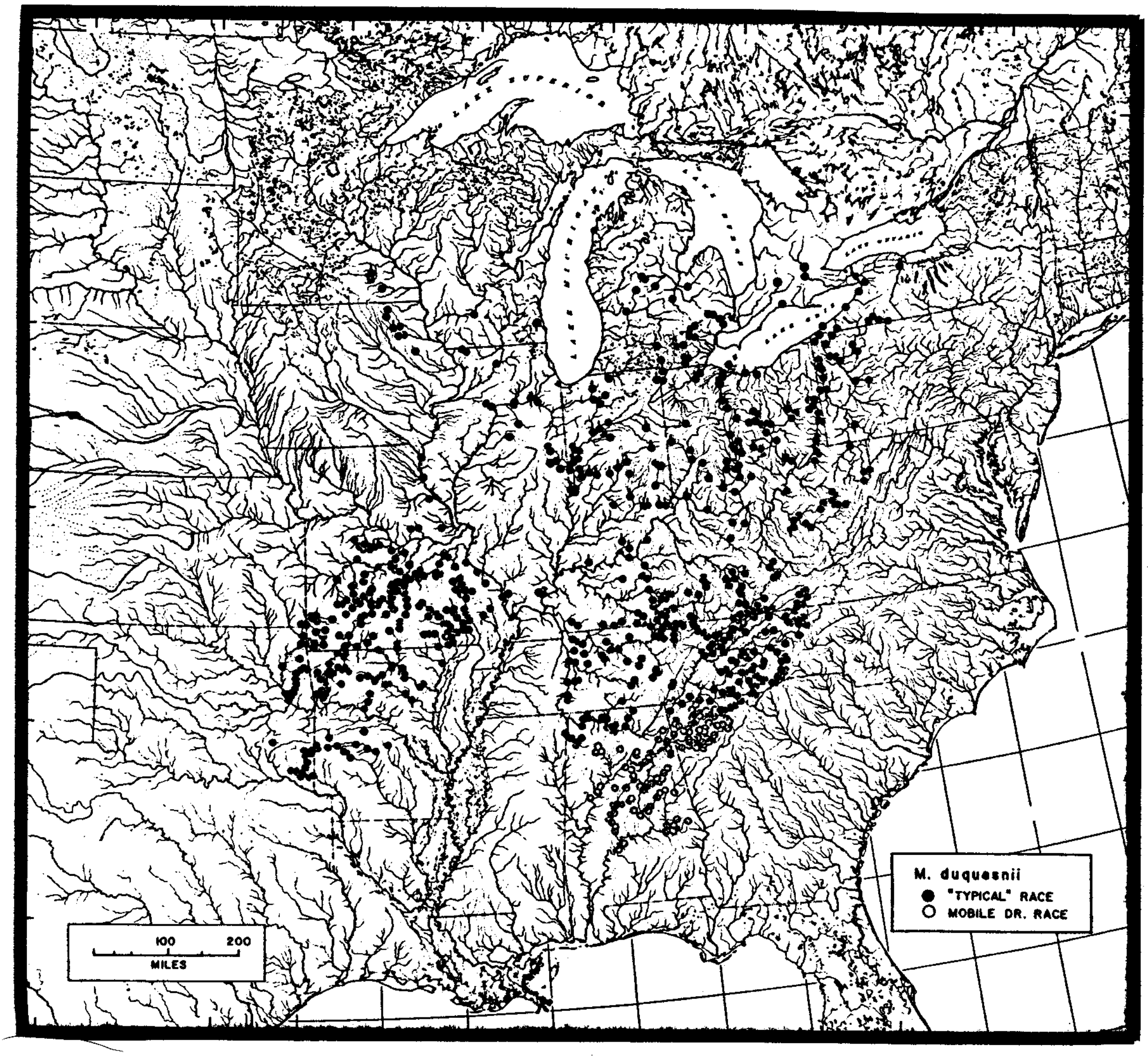
The black redhorse is one of the species of redhorses which in life possesses a spotty caudal fin rather than a red one. This is a characteristic it shares with the golden redhorse (M. erythrurum), a species it closely resembles. The two species are best separated on lateral line scale counts. The black redhorse has 45 or more scales, whereas the golden has 44 or fewer. The black redhorse has 16-20 predorsal scales and often 10 rays in the pelvic fins. Spawning males of the black redhorse lack tubercles on the head region, unlike the golden redhorse which possess numerous well-developed tubercles on the head.

DISTRIBUTION

The black redhorse is widely distributed through much of the Mississippi River basin, extending north into the Great Lakes basin and south of the Mobile River drainage on the Gulf slope. (Figure 1).

In the Mississippi basin it is common through the Appalachian Highlands to northern Alabama and in upland areas of Arkansas, Missouri, eastern Oklahoma, and Kansas, but is absent through the lowlands of the lower Mississippi River.

Regions of lesser relief in Ohio, Indiana, Illinois and southern Michigan have more localized populations. It is present but rare in northeastern Iowa and southwestern Minnesota. Jenkins (1970) stated that a distinct and separate population exists in the headwaters of the Mobile River drainage of the Gulf coast.



North American distribution of the black redhorse, Moxostoma duquesnei. Adapted from Jenkins (1980)

Figure 1

The black redhorse has been recorded from the Great Lakes basin in southern Wisconsin, Michigan, Ohio, western New York (Genessee River System), and southern Ontario.

In southern Ontario the black redhorse has been collected in the Grand River south of Elora, Wellington County (43°38'N, 80°26'W), and near Winterbourne, Wellington County (43°33'N, 80°28'W), and in the Nith River, a tributary of the Grand River, near Ayr, Waterloo County (43°17'45"N, 80°28'10"W) and just north of Plattsville, Oxford County (43°18'30"N, 80°37'30"W). In the North Thames River this species has been identified from only one locality, near Motherwell, Perth County (40°20'N, 81°11'W). In 1929, specimens were collected from Cedar Creek near Preston (not located) and in Catfish Creek near Jaffa, Elgin County (42°44'N, 81°03'W) which flows directly into central Lake Erie. A previously unreported single black redhorse specimen (ROM 29852) was captured in the Maitland River system, in Belgrave Creek, Huron County (43°48'N, 81°27'W) in 1973 which extends the range of this species in Canada to include tributary streams of southern Lake Huron. Black redhorse have been reported from Lake Huron tributaries in Michigan.

POPULATION

The black redhorse is reported from the Grand River system, Thames River system,

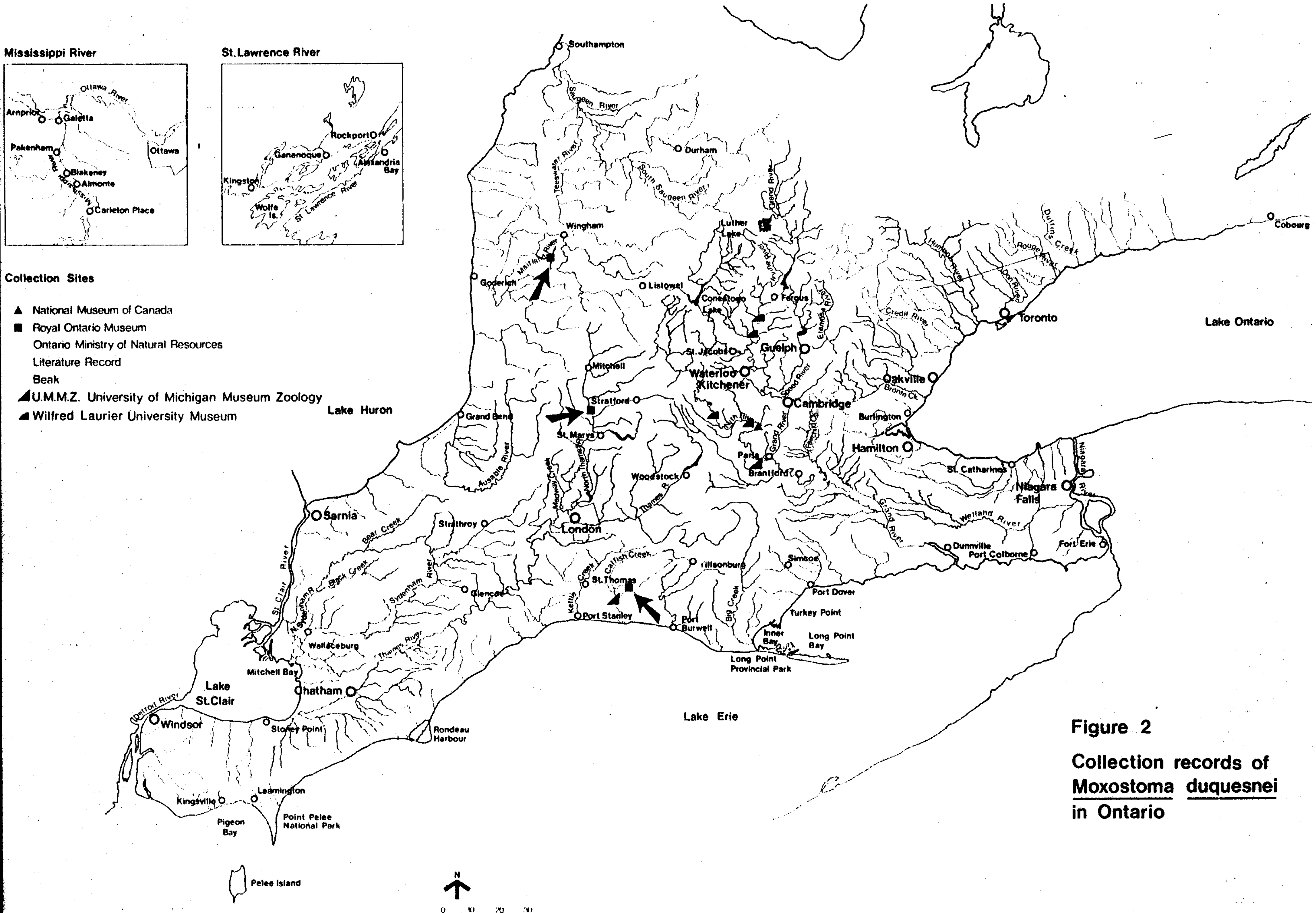


Figure 2

Collection records of <u>Moxostoma duquesnei</u> in Ontario

and the Maitland River system in southern Ontario. Reproducing populations are known only in the Thames and Grand River systems. Since these are small populations which have recently been discovered, no data are available on the absolute sizes of these populations. An estimate of the relative size of the Grand River population can be made by comparing the number of fingerlings of this species and of the golden redhorse that have been collected from the Nith River. For every black redhorse collected, 10 golden redhorse were collected.

Since spawning has been observed in the Grand River itself, and young have been collected from the Nith River, the Grand River population is believed to be a reproducing population. The ratio of males:females at time of spawning was 6:11. Because of the small sample involved, this ratio is not significantly different from a 1:1 ratio.

The Grand River population may differ from other populations of black redhorse in that the lateral line scale counts are generally higher than from other areas (average 47.7 for 15 adults). Whether all individuals in the Grand River watershed belong to one breeding population or separate breeding populations is not presently known.

As yet, it is not known if the black redhorse is found in other major tributaries of the Grand River such as the Speed River, Eramosa River, Conestogo River and Horner Creek, all of which may have suitable spawning habitat.

The Thames River population is presently under investigation, but at the time of report submittal the presence of the black redhorse in the Thames River system is based on the capture of several juvenile specimens.

Study of the life history of the black redhorse is expected to continue at Wilfred Laurier University.

THREATS

The black redhorse is restricted in distribution in Ontario to low silt areas of moderate to high gradient streams. In the Grand River system, the movement of the black redhorse is restricted by dams at Elora, and at Bellwood Lake and at New Hamburg. The suggested West Montrose dam would destroy the only identified spawning grounds for this species in the Grand River system. A dam has also been suggested for the Nith River north of Ayr, the only other area where spawning may occur in the Grand River system. Although some protection has been afforded this species by the Waterloo Region, which declared the lower portions of the Nith River ecologically sensitive, the Grand River population may be seriously threatened by planned dams.

The only area in which the black redhorse has been identified in the North Thames River is also under study for the proposed Glengowen dam.

These dams would not only seriously affect the black redhorse populations in Canada due to a reduction in the number of suitable spawning areas, but would also affect their non-spawning periods since impoundments do not provide a suitable habitat.

STATUS

The following statements were considered valid after review of available information and were used in the evaluation of the status of the black redhorse in Canada:

1. Small reproducing populations of black redhorse are present in the Grand and Thames River watersheds. The status of a possible population in the Maitland river system is undetermined.
2. In Canada the black redhorse occurs at the northern fringe of its North American range.
3. The black redhorse is considered rare, threatened, or endangered in much of its North American range.
4. The black redhorse appears threatened with extinction in a major portion of its Canadian range due to the actions of man.

Based on information evaluated during this study, it is recommended that the black redhorse be classified as endangered in Canada.

BIOLOGY

The black redhorse inhabits moderate-sized (15 to 20 m^3/sec), cool, clear streams with sand, gravel and bedrock bases where siltation is minimal. The stream is often composed of riffle and pool habitats with a moderate flow (Trautman 1957, Moore 1957, and Bowman 1959).

This species is found in the Grand River system where the gradient ranges from 1.2 to 1.5 m/km. Immature black redhorse were captured in shallow pools below riffles (Kott *et al*. 1979). Bowman (1959) observed young-of-the-year black redhorse in similar pool areas. Adults of this species are also thought to inhabit pool areas. Bowman (1959) noted that adults were often observed in single level aggregations in pools below riffles during summer and that as winter approached the adults moved to deep holes to overwinter.

Capture localities in Ontario had gravel and boulder bottoms with very few aquatic macrophytes. Bowman (1959) noted, however, that young-of-the-year black redhorse were often observed among beds of water willow, *Justica americana*. The water at capture localities was usually clear with low turbidity. This species is intolerant of very turbid waters and increased turbidity and siltation are usually followed by decreases in black redhorse populations (Trautman 1957; Jenkins 1970; and Scott and Crossman 1973).

Impoundments also seem to furnish relatively little suitable habitat for this species. Various impoundment surveys have shown that black redhorse population declined following impoundment of the river system (Bowman 1959).

Age can be determined using the scale method according to Bowman (1959). He gives the time of annulus formation as April or May for specimens under 6 years old, but somewhat later for older fish in Missouri. Annulus formation in Ontario populations is probably slightly later.

Only 17 specimens were available for estimating age and forming back-calculated lengths. Calculated standard lengths for each age class are as follows:

	Calc. SL	
Age	Mean(mm)	Range (mm)
1	85	68 - 98
2	141	123 - 163
3	200	169 - 226
4	258	238 - 286
5	292	268 - 328
6	320	285 - 357
7	329	303 - 354
8	345	303 - 354

The maximum length for Canadian specimens is 375 mm (SL) and 419 mm (FL) (WLU 6268). Trautman (1957) listed the largest Ohio specimen as 439 mm long and 1019 g. Maximum age was given as 10 years by Bowman (1959). Too few Canadian specimens of the black redhorse are available to formulate a length to weight relationship but a rough estimate for Canadian populations could be made using Bowman's (1959) equations:

Niangua River, Missouri :	$\log w = 4.58 + 2.94 \log l$	n = 1619
Big Piney River, Missouri:	$\log w = 4.59 + 2.95 \log l$	n = 1775

Increments of growth for aged specimens from Ontario suggest that there is rapid growth in young-of-the-year black redhorse (0 + up to 85 mm SL) followed by decreased but constant growth in 1+, 2+ and 3+ fish (1+, 2+, 3+ fish growth increment approximately 58 mm per year). After the black redhorse reaches age 4+, growth rate decreases in each successive year.

Bowman (1959) suggested that a similar decrease in growth rate for black redhorse from Missouri after age 3 may be attributed to the attainment of sexual maturity; he did not observe significant differences in growth rates between sexes.

The black redhorse spawns during late spring. In the Grand River adult individuals have been observed on the spawning grounds as early as May 15 when the water temperature was 9°C. On May 28, 1979 two of four males and, one of two females had running milt or eggs. Water temperature at the time was 15°C. On June 4 of four females collected, one was spent, one partially spent and the other two were running freely. By June 7, the spawning area was vacated. Bowman (1959) noted that spawning of black redhorse in Missouri took place at water temperatures ranging from 13 to 22°C.

Spawning black redhorse in the Grand River were observed in a riffle zone where the water depth averaged 29 cm and the bottom was gravel. Bowman (1959) believes that adult black redhorse do not home to any particular shoal, however, only specific shoals are chosen for spawning. Many apprently suitable shoals are passed to reach a specific shoal. Movements of up to 9 kilometers, up and down stream, to reach spawning shoals have been recorded (Bowman 1959). The chief requirements seem to be a depth of about 0.5 m, and bottom type of 70% rubble, 10% rock and 20% sand and gravel.

Spawning groups of black redhorse observed in the Grand River consisted of 3 individuals, two males and one female. Spawning activity was similar to that described in the literature (Bowman 1970). No nest as such was formed but the spawning activity cleared a rather extensive area in the gravel. Fertilized eggs were deposited in the gravel of the spawning shoal.

After spawning, the gonads are exhausted. Signs of development begin again in August and continue through the fall. By October, the eggs are quite large and can easily be counted. Testes have also greatly increased in size. Insufficient data are available for the period from December to March.

In eight females from the Grand River, 3,644 to 11,552 eggs (average 5,258) were counted. The count of 11,552 is the highest recorded for this species.

Larval development was not observed in Ontario populations of this species but is not expected to differ from that described by Bowman (1959). Nursery areas have not been defined but are believed to be shallow pools and areas of slackened current in the main Grand and Thames Rivers.

Sexually mature black redhorse are thought to spawn annually (Bowman 1959). At what age this species reaches sexual maturity in Ontario is not known but it is suspected that 4 year old fish spawn.

No sexual dimorphism in the colour of male and female black redhorse from the Grand River was noted. This is similar to the observation of Jenkins (1970). However, in populations studied by Bowman (1970) males developed a light pink mid-lateral band. In males, tubercles occur on the anal fin and the caudal fin, especially on the lower lobe. Although females usually lack tubercles, a single female possessed a few tubercles on the lower lobe of the caudal fin.

Data on the food habits of Canadian populations of this species are minimal since stomachs examined from spawning specimens were empty. Bowman (1970) described the feeding habits of this species in Missouri. He found that in general the black redhorse is a bottom-feeding species. It was usually observed feeding in schools of 15 to 20 fish over gravel or boulder bottoms just below riffles. Its suctorial mouth is well adapted for taking in bottom materials containing soft-bodied invertebrates. Most feeding is in the early hours of night throughout much of the year, except during spawning when adults do not seem to feed.

Bowman noted that young-of-the-year black redhorse use slack water areas of streams as feeding habitats, often near emergent aquatic vegetation. Small specimens of 65 mm in length or less feed principally on phytoplankton (70% by frequency of occurence). Other food items are cladocerens and copepods in about equal frequencies and rotifers in small amounts. As young-of-the-year fish grow beyond 65 mm, aquatic insects become the principal food item. Further increases in age and growth are accompanied by a shift to include larger aquatic insects in the diet. Selectivity and opportunities may influence the diet of adult black redhorse. This species is not known to feed on the spawn of other fish species.

Parasites of the black redhorse include the trematodes Anonchohaptor anomalus and Neodactulogripus duquesni (Hoffman 1967).

In the Grand River, the most important predator may be man. An active bow fishery exists in the upper Grand River region for carp (Cyprinus corpio). Most bow fishermen do not distinguish between carp and redhorse suckers. Also, carp enter their spawning areas toward the end of the redhorse spawning period. As a result, many redhorse are taken for carp by bow fishermen, and then are left to rot along the rivers' edge.

To a less extent, redhorse are also susceptible to rod fishermen who are seeking carp. The black redhorse is easily taken by hook and line using worms. Redhorse would be most susceptible to this fishery before and after spawning is completed.

Pike, (Esox lucius) and snapping turtles, (Chelydra) have been observed feeding on black redhorse which have been caught in gill nets. Pike are believed to be predators of most species of suckers (Scott and Crossman 1973). During the early life history of the black redhorse, other more common suckers which also occur in the Grand River such as the white sucker, (Catostomus commersoni) golden redhorse, shorthead redhorse, (M. macrolepidotum) and possibly the greater redhorse, (M. valenciennesi) likely compete for food with the black redhorse, particularly during early life history stages.

RECOMMENDATIONS

The following recommendations are suggested for the maintenance and monitoring of the black redhorse in Canada:

1. The Ontario Ministry of Natural Resources should hold and transport to a museum facility all redhorse specimens captured in the Grand, Thames, and Maitland River watersheds for positive identification.
2. Identification information should be made available to concerned agencies.
3. Protective measures should be investigated to insure that this species is not depleted in number by bow fishermen.
4. Intensive studies should be undertaken as soon as possible in the vicinity of proposed dam sites in the Thames and Grand River watersheds to assess the impact of impoundment in black redhorse populations.
5. Records of this species in Canada outside of the Thames and Grand River watersheds should be investigated by concerned agencies and specimens should be retained for museum collections.
6. Museum collections should be reviewed in order to clarify the identification of redhorse species.

LIST OF SPECIMENS

A list of black redhorse specimens captured in Canada from the National Museum of Canada (NMC), the Royal Ontario Museum (ROM), Wilfred Laurier University (WLU) and the University of Michigan, Museum of Zoology (UMMZ) is provided below:

UMMZ 85887 (45) Catfish Creek, Elgin County, July 27, 1927, Brown and Rupp. UMMZ 89075 (3) Cedar Creek, Oxford County, September 5, 1928, C. Hubbs, (data uncertain). ROM 1975 (1) Catfish Creek, Elgin County, March 21, 1926, H.C. White. ROM 9367 (1) Catfish Creek, Elgin County, March 26, 1937, H.C. White. ROM 10364 (1) Catfish Creek, Elgin County, March 6, 1938, H.C. White. ROM 29852 (1) Belgrave Creek, Huron County, August 22, 1973, J. Tilt. WLU 5233 (1) Nith River, Waterloo County, June 29, 1977, E. Kott and G. Humphreys. WLU 5594 (1) Nith River, Oxford County, October 21, 1976, E. Kott and G. Humphreys. NMC 78.0001 (1) Nith River, Oxford County, October 21, 1976, E. Kott and G. Humphreys. WLU 6245 (1), 6249 (1) Grand River, Wellington County, May 16, 1979, E. Kott. WLU 6268 (1), 6269 (1) Grand River, Wellington County, May 29, 1978, E. Kott. WLU 6260 (1) Grand River, Wellington County, May 24, 1978, E. Kott. WLU 6251 (1) Grand River, Wellington County, June 5, 1979, E. Kott. WLU 6252 (1) Grand River, Wellington County, June 6, 1979, E. Kott. WLU 6264 (1), 6265 (1), 6267 (1) Grand River, Wellington County, May 29, 1979, E. Kott. ROM 26380 (5) North Thames River, Perth County, August 23, 1979, D. Osmond.

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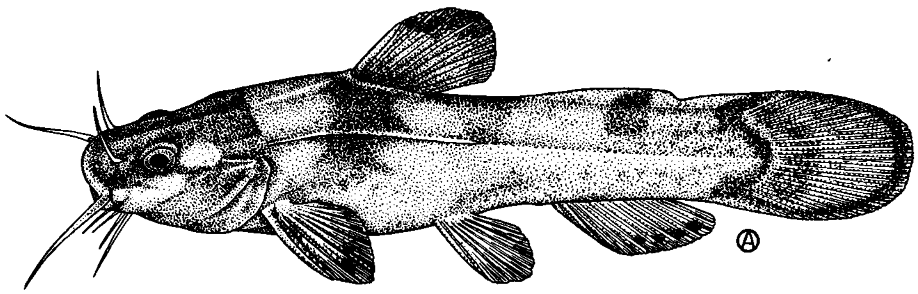
BRINDLED MADTOM

Noturus miurus Jordan



Proposed Status: RARE

The brindled madtom, Noturus miurus, a small member of the catfish family is found only in the freshwaters of east central North America. In Canada, this species occurs rarely in southwestern Ontario in stream, river, and lake environments. Reproducing populations of brindled madtoms are known from Ohio and Michigan.

The ecology of this species in Canada is poorly known. Taylor (1969) and Bowen (1980) have conducted intensive studies on the brindled madtom in the United States. Taylor (1969) reviewed systematics, distribution, and life history. Bowen (1980) provided data on habitat preferences, growth, reproduction, and feeding habits in an Ohio stream. Trautman (1957) provided a description of the brindled madtom and life history information for Ohio specimens. Radforth (1944) suggested possible dispersion routes into the Great Lakes basin and lists several early Ontario capture sites. Scott and Crossman (1973) summarize published information and McAllister and Gruchy (1977) comment on the status of this species in Canada.

The brindled madtom is quite rare in Canada, being captured sporadically in southwestern Ontario during the past fifty years.

In Canada, this species is considered rare by McAllister and Gruchy (1977). Miller (1972) did not consider the brindled madtom as threatened or endangered in any part of the United States but Platt (1974) suggested that it was rare in Kansas. Van Meter and Trautman (1970) believed that populations of this species were somewhat reduced from prior levels.

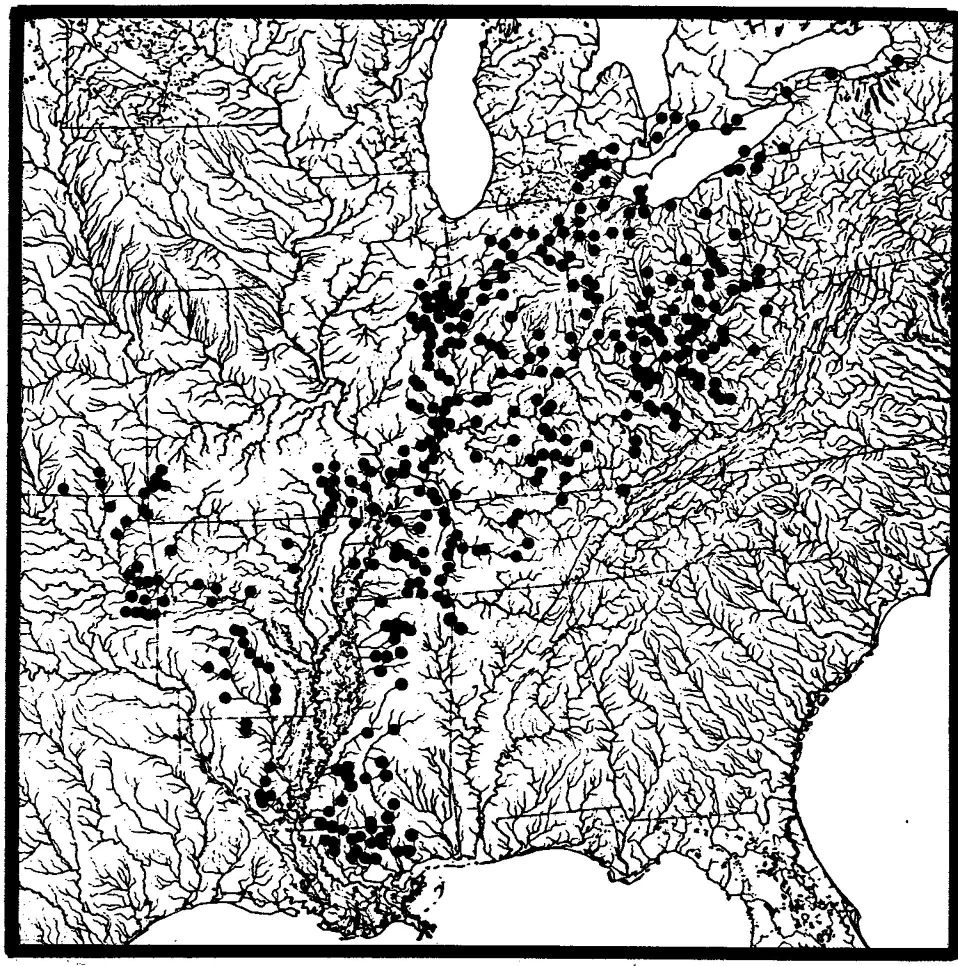
The brindled madtom can be distinguished from the tadpole madtom, Noturus gyrinus by the saddle markings over the back of the brindled madtom and the protrusion of the upper jaw over the lower jaw of the brindled madtom. The tadpole madtom has no saddlemarks on its back, no protruding upper jaw, and is somewhat potbellied. The saddlemarkings, smaller adult-size and toothed pectoral fin spine of the brindled madtom distinguish it from the stonecat Noturus flavus.

DISTRIBUTION

The following account of the distribution of the brindled madtom is based on the spot distribution map of Rhode (1980) and is supplemented by information from various literature sources. The brindled madtom is found in the lower Great Lakes basin, the Mississippi River system and the Pearl River system (Figure 1).

In the Mississippi River system the brindled madtom is recorded from the Mississippi River, the Ohio River valley, the Tennessee River valley and the Arkansas River system. Reports of this species occurring in the Illinois River system, and in the states of Wisconsin, Illinois, Minnesota and Iowa are questionable (Taylor 1969). A collection from the Kaskaskia River, Illinois has been verified (Taylor 1969). In the Great Lakes basin the brindled madtom has been recorded from tributaries of Lake St. Clair, and Lake Erie in Ontario, Michigan, and Ohio. Scott and Crossman (1973) reported this species from the Niagara River. Taylor (1969) reported the brindled madtom from the Finger Lakes, New York state, which drain into Lake Ontario. Taylor also states that this species does not occur in Lake Huron or Lake Superior, and that records from Lake Michigan are in doubt.

In Canada the brindled madtom occurs in Lake Erie and its tributary streams and in tributary streams of Lake St. Clair (Figure 2). In the Lake Erie basin it



North American distribution of the brindled madtom, *Noturus miurus*. Adapted from Rhode (1980)

Figure 1

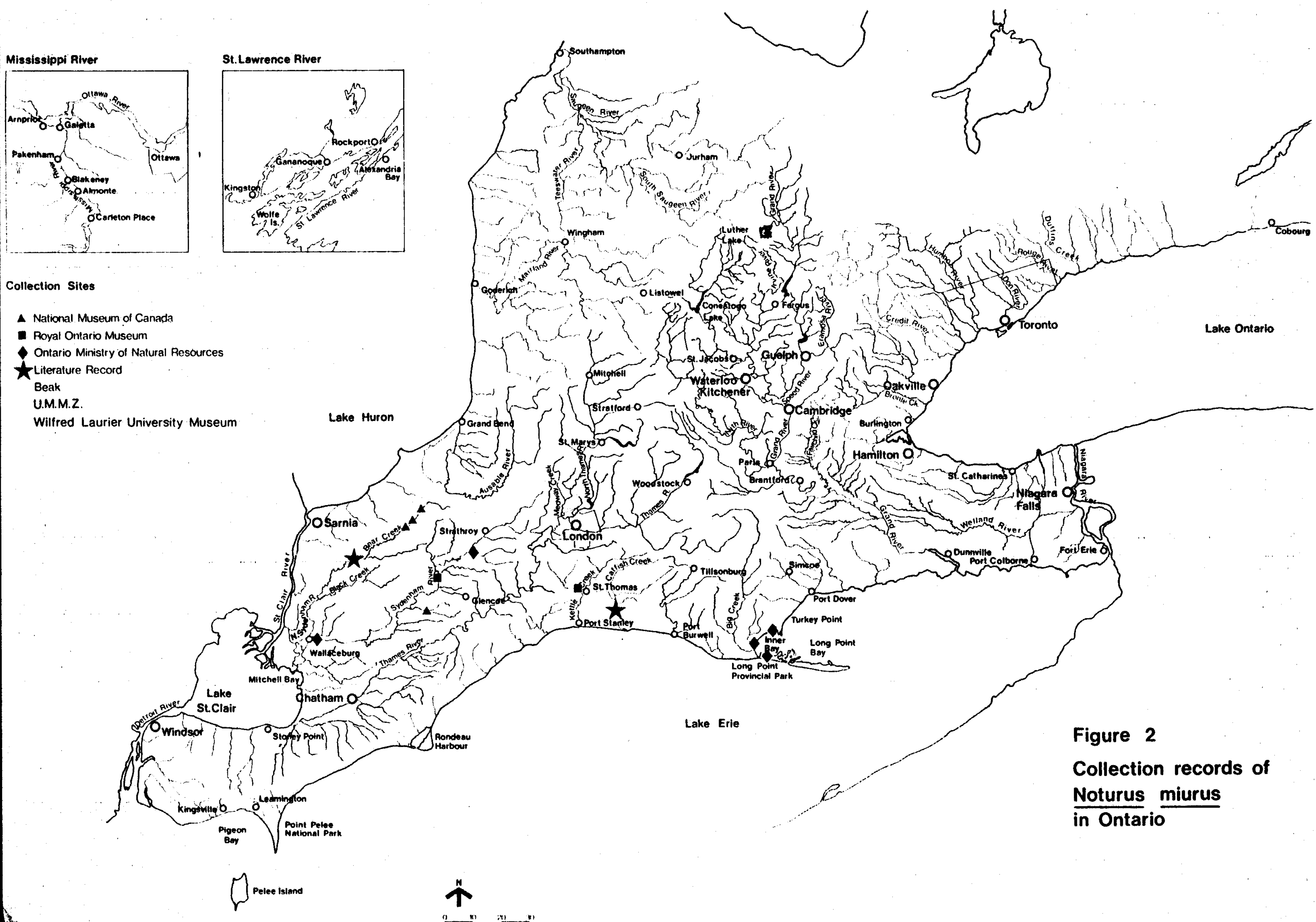


Figure 2

Collection records of <u>Noturus miurus</u> in Ontario has been reported from Long Point Bay, Norfolk County (42°40'N, 80°10'W) (Reid 1978); Turkey Point, Norfolk County (42°40'N, 80°22'W); Dedrick Creek, Norfolk County (42°37'N, 80°28'W); Catfish Creek, Elgin County (42°39'N, 81°00'W) (Radforth 1944) and Dodd Creek, Elgin County (42°46'N, 81°12'W). In the Lake St. Clair basin it has been captured in the Sydenham River at Wallaceburg, Kent County (42°35'N, 82°21'W); in an unnamed tributary of the Sydenham River, Middlesex County (42°53'N, 81°41'W); Sydenham River, near Alvinson, Lampton County (42°49'N, 81°52'W); Bear Creek, Warwick and Enniskillen Twp., Lambton County (42°58'N, 81°58'W) and Fansher Creek, Lambton County (42°39'N, 82°00'W).

POPULATION

The population structure of the brindled madtom in Canada is not fully known. Reports of the occurrence of this species in southern Ontario date back to 1929 (Radforth 1944). These early reports are from the Sydenham River, near Alvinston, and in Dedrick Creek which flows into Lake Erie. Recent capture records, from the mid-1970's, closely approximate the localities from which this species was collected fifty years ago.

Although collections of the brindled madtom are sporadic and temporally dissociated, museum records suggest that small viable populations may be present in southern Ontario. Records from Lake Erie, at Long Point and Turkey Point, and from inflowing tributaries of Lake Erie, Kettle Creek, Catfish Creek, and

Dedrick Creek suggest that one or more small populations are present in the Long Point area. Records from the Sydenham River watershed suggest that small populations are located there, the distribution of capture sites from the North Sydenham River and the East Sydenham River suggest that this species is widespread through the Sydenham River watershed. A specimen from the lower Sydenham River may be a transient either from upstream populations in the Sydenham River or from Lake St. Clair populations. Although this species has not been reported from the Canadian waters of Lake St. Clair, it has been recorded from Lake St. Clair in Michigan. Mr. C. Haas, of the Michigan Department of Natural Resources (pers. comm.) suggests that the brindled madtom is commonly captured in Lake St. Clair.

A review of specimens captured during the 1970's shows that both adult and immature specimens were captured, suggesting that there are breeding populations in the vicinity of the above areas.

Determination of population levels of the brindled madtom are complicated by its naturally secretive and nocturnal habits. Specialized sampling procedures are required to capture this species (Bowen, 1980). Repeated efforts to capture this species during this study were unsuccessful, although a variety of capture methods were applied during day and night sampling. Based on the effort expended in attempting to capture this species during this survey, and the low numbers of specimens that have been reported in Ontario it is probable that population levels of this species are extremely low.

The brindled madtom has been reported from such a diversity of habitats it is difficult to substantiate theories of habitat destruction or degradation and their effects on population numbers.

THREATS

There are no impending developments that will pose an immediate threat to the welfare of this species in Canada.

STATUS

The following statements were considered valid after review of available information and were used in the evaluation of the status of the brindled madtom in Canada.

1. Reproducing populations of brindled madtom may be present in the Long Point area of Lake Erie and in the Sydenham River watershed.
2. Available information does not allow definitive analysis of population structure or trends.
3. The Canadian population of the brindled madtom is at the northeastern extremity of its North American range.
4. The brindled madtom in Canada does not appear threatened with immediate extinction due to the actions of man.

Based on information evaluated during this study, it is recommended that the brindled madtom be classed as a rare species in Canada.

BIOLOGY

The brindled madtom was not captured during this survey; therefore, only a review of Canadian capture localities and a comparison with data from more southerly populations can be provided. Information from a life history study by Bowen (1980) based on an Ohio population of the brindled madtom is believed quite pertinent for Ontario populations.

In Canada the brindled madtom has been captured in lake, river and stream environments. Scott and Crossman (1973) reported that specimens taken in Ontario were from clear, fast flowing streams with gravel bottoms. Collections made during the 1970's diversified the habit preference by including shallow lake environments over detrital and sand bottoms, and moderate to base gradient streams that were sluggish and turbid. Trautman (1957) stated that the largest populations of this species in Ohio were located in base or low gradient streams with substrates composed of sand and organic debris where viscous clayey silts were negligible or absent. Smaller numbers of brindled madtoms occurred in the riffles of sluggish to moderate flow and occasionally in pools among aquatic vegetation such as pond weed. Trautman (1980) suggested that the brindled madtom had been captured under flat rocks in shallow waters around the Bass Islands in Lake Erie. Pflieger (1975) and Taylor (1969) report brindled madtoms in low gradient streams over a variety of substrates including sand, debris and soft mud or muck.

Bowen (1980) provides more detailed information on habitat preference. He found that during the summer months overhanging protective bank edges and eddies created by riffles in moderate to low gradient stream sections were preferred. Pools may serve as overwintering habitat. The stream which he studied was about 0.3 m deep in capture areas. Bottoms composed of detritous or large flat rocks and sand were preferred.

Based on this description of preferred habitat it is suggested that the majority of prior capture sites in southwestern Ontario provide only a marginally suitable habitat. Water quality in the lower Sydenham River may no longer be suitable for the brindled madtom as a result of the deposition of clayey silts.

Little information has been published on the age and growth of the brindled madtom in Canada. Bowen (1980) describes a new method of age determination by the use of otoliths. Maximum age was identified by retaining live specimens in an aquarium system until death. Bowen found that the maximum age was approximately 26 months. He also recorded a maximum length of 126 mm. The largest Canadian specimen is 87 mm total length (NMC 72-0181). Trautman (1957) reported a maximum size of 132 mm. Trautman also provided lengths at various ages: young-of-the-year in Ohio ranged from 25-56 mm in length by October, 36-64 mm in length after one year and 56-97 mm in length for adults. Differences in growth rate between male and female have not been noted. Bowen (1980) believes that individuals mature during their third summer, however, specimens under 50 mm were sexually mature. Bowen (1980) found that the brindled madtom spawned at temperatures ranging from 25-27°C in Ohio usually during the last two weeks in July and the first two weeks in August. Brooding pairs constructed nests under flat rocks up to 1 m in diameter in areas with slight currents. Scott and Crossman (1973) noted that in Michigan spawning took place in mid to late summer at temperatures of 25.6°C over a bottom of silt and mud in the vicinity of emergent vegetation. Taylor (1969) and Bowen (1980) suggest that brooding pairs may utilize open-ended tin cans for brooding areas when other suitable natural habitat is at a premium. Bowen observed spawning activity and nest building in aquaria. He noted that both parents are involved in nest building and in nest guarding after spawning. Several days after spawning he observed that the female left the nest and the male continued to guard the eggs until hatching occurred (in about 2 weeks). Average number of young per female was forty. Taylor (1969) noted that the number of eggs or young in six broods ranged from 34 to 46. Eggs are large, amber and adhesive (Scott and Crossman 1973).

Hybrids occur between the brindled madtom and the tadpole madtom, _Noturus gyrinus_ and slender madtom, _Noturus exilis_ (Trautman 1957, and Taylor 1969).

Bowen (1980) has conducted food habit studies over a 12 month period and suggests that the brindled madtom feeds heavily on drift invertebrates. From stomach analysis of 276 individuals he found that chironomid larvae predominated followed by copepods and trichopterens. Scott and Crossman (1973) suggest they are nocturnal in habit; and Bowen reported that the majority of brindled madtoms captured during his study were captured at night suggesting nocturnal feeding habits.

Predators of the brindled madtom are believed few as a result of its secretive and nocturnal habits. Gar are the only documented predators for this species (Scott and Crossman 1973).

Hoffman (1967) lists only four trematodes and concludes that the brindled madtom is relatively parasite-free. The dominant parasites which infested this species in an Ohio population were members of the Proteocephalidae (Cestoda) (Bowen 1980). The following parasites have been recorded for the brindled madtom:

Monogenetic Trematodes	
Cleidodiscus pricei	Bowen 1980
Digenetic Trematodes	
Bucephalus elegans	Bowen 1980
Crepidostomum ictaluri	Hoffman 1967
C. cooperi	Hoffman 1967
Neascus sp.	Bangham and Hunter 1939

Cestodes

Corallobothrium fimbriatum	Bangham and Hunter 1939
Bothriocephalus sp.	Bangham and Hunter 1939
Proteocephalidae	Bowen 1980

Nematodes

Spinitectus gracilis	Bowen 1980
Spiroxys contorta	Bowen 1980

Leeches

Piscicola punctata	Bowen 1980

Copepoda

Argulus appendiculosus	Bowen 1980

The brindled madtom is so rarely encountered in Canada that its relationship to man is solely based on its unknown ecological role (Scott and Crossman 1973).

RECOMMENDATIONS

The following recommendations are suggested for the maintenance and monitoring of the brindled madtom population in Canada:

1. The Ontario Ministry of Natural Resources should hold and transport to a museum facility all brindled madtom specimens captured in Ontario waters.
2. Identification information should be made available to concerned agencies.

3. Night sampling should be incorporated into lake and stream surveys.
4. Should further specimens be collected in Canada, a study to determine population and life history parameters should be initiated and protective measures should be investigated.

LIST OF SPECIMENS

A list of the brindled madtom specimens, captured in Canada, from the National Museum of Canada (NMC) and the Royal Ontario Museum (ROM) is provided below:

ROM 6675, Sydenham River, near Alvinston, Lambton County, July 8, 1929. ROM 18388, Lake Erie, near Turkey Point, Norfolk County, July 26, 1956. NMC 72-0175, Fansher Creek, Lambton County, August 10, 1972, C.Gruchy and R. Bowen. NMC 72-0181, Bear Creek, Lambton County, August 10, 1972, C. Gruchy and R. Bowen. NMC 72-0201(8) Bear Creek, Lambton County, August 13, 1972, C. Gruchy and R. Bowen. ROM 30384, Dodd Creek, Elgin County, August 16, 1973. ROM 29936, Dedrick Creek, Norfolk County 1976.

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_____________. 1980. Zoology Department, Ohio State University, Columbus, Ohio. Personal Communication.

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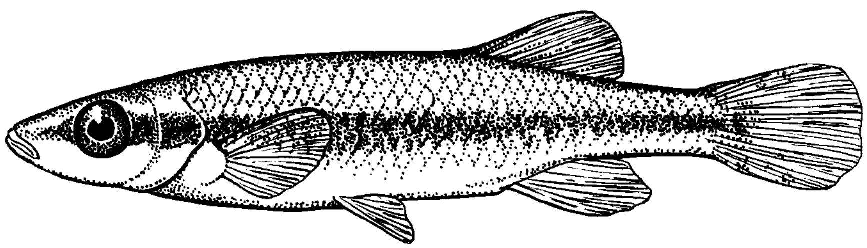
BLACKSTRIPE TOPMINNOW

Fundulus notatus (Rafinesque)



Proposed Status: RARE

The blackstripe topminnow, Fundulus notatus, is one of three killifishes (Cyprinodontidae) occurring in Canada and one of two found in Ontario. This species is common throughout much of the Mississippi River basin and Gulf states. In Canada it is known only from the Sydenham River system in southwestern Ontario. This population is approximately 200 km north of the nearest United States population.

The biology of Canadian populations of the blackstripe topminnow had not been investigated prior to this study. The biology of this species in the United States has been discussed by Carranza and Winn (1954), Trautman (1957), Atmar and Stewart (1972) and Nieman and Wallace (1974). Shute (1980) summarized available biological information.

The blackstripe topminnow was first reported in Canadian waters in 1972 (Gruchy *et al*. 1973). Due to its restricted distribution in Canada, this species was listed as rare in Canada by McAllister and Gruchy (1977). It is not considered rare, threatened, or endangered elsewhere in its range.

The blackstripe topminnow is distinguished from the banded killifish, *Fundulus diaphanus*, the only sympatric cyprinodontid in Canada by body colouration and lateral line scale count. The blackstripe topminnow has a black lateral band that extends from the tip of its snout to the base of its caudal fin and a lateral line scale count which ranges from 32 to 35. The banded killifish does not have a lateral band along the length of its body, and has more scales along the lateral line, usually 40 to 55 (McAllister and Gruchy, 1980).

An opalescent spot on the top of the head makes specimens of the blackstripe topminnow readily identifiable in life. This spot quickly disappears after death.

DISTRIBUTION

The following account of the distribution of the blackstripe topminnow is based on the spot distribution map of Shute (1980) and information obtained during this study.

The blackstripe topminnow is widely distributed throughout much of central North America (Figure 1). It occurs in the Gulf states from the San Antonio River drainage in Texas east to Mobile Bay tributaries in western Alabama. In the Mississippi River basin, this species is found in many lowland areas from southern Mississippi north through Arkansas, Tennessee, Missouri, Nebraska, Indiana, Illinois, Ohio, Michigan, Iowa, and Wisconsin. In the Great Lakes Basin it has been collected in tributary streams of southern Lake Michigan, Lake St. Clair, and Lake Erie.

In Canada the blackstripe topminnow is limited to the North Sydenham River watershed in southwestern Ontario (Figure 2). It has been captured in the North Sydenham River from Wallaceburg, Lambton Co. (42°38'20"N, 82°22'32"W) to Bear Creek at Petrolia, Lambton Co. (42°17'12"N, 82°08'55"W). This species also occurs in Fox Creek (42°48'N, 82°09'W) and Crooked Creek, (42°46'N, 82°16'W) both tributaries of Black Creek in Lambton County. A single collection of blackstripe topminnows was made from Otter Creek, Kent Co. (42°36'58"N, 82°18' 05"W), which enters the North Sydenham River at Wallaceburg. A single specimen was also taken by the National Museum of Canada in Mollys Creek, Kent Co. (42°36'N, 82°10'W) which flows into the Sydenham River near Dresden, but there is some doubt as to the validity of this collection (Gruchy pers. comm).

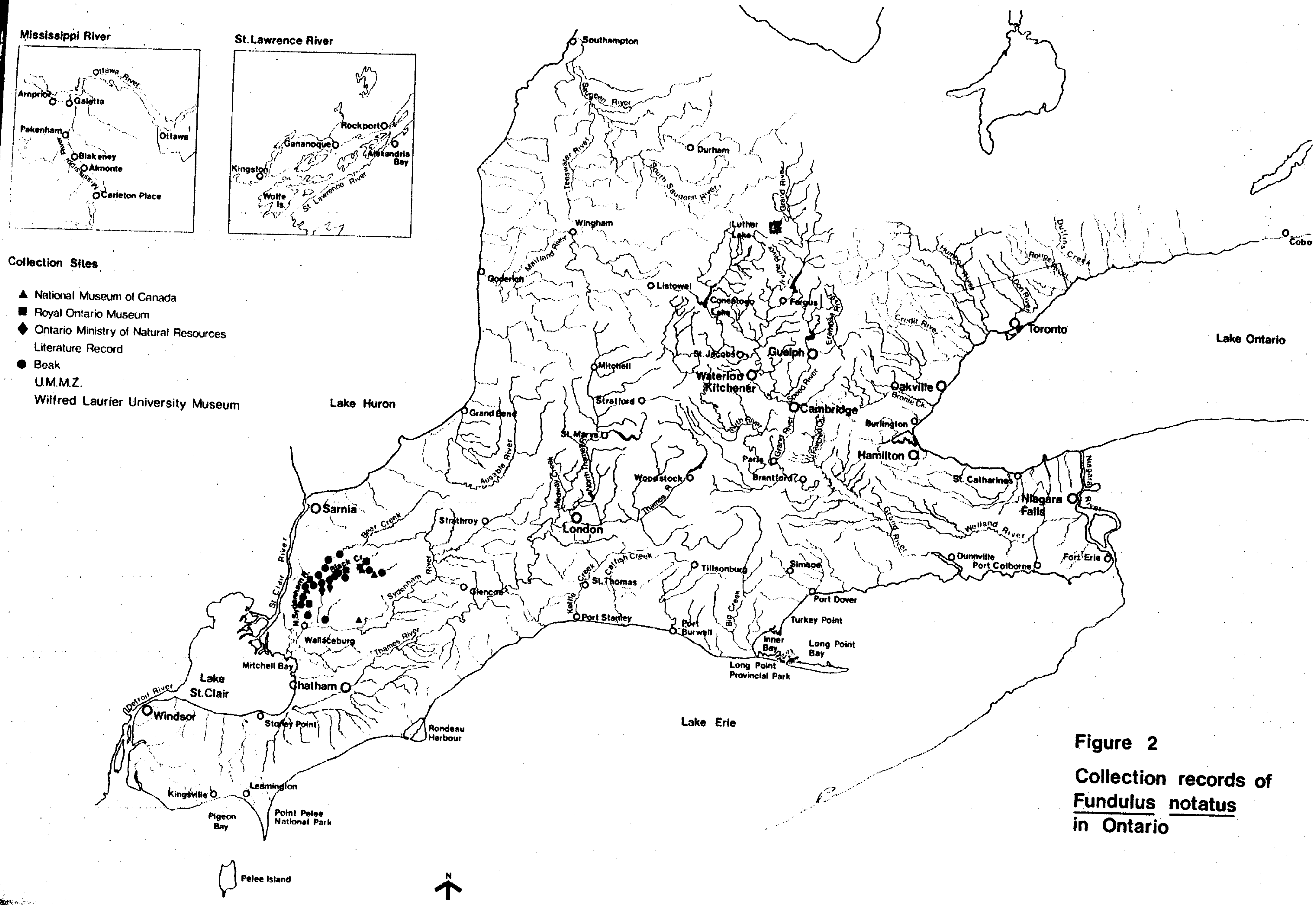


Figure 2

Collection records of <u>Fundulus notatus</u> in Ontario

POPULATION

In the North Sydenham River watershed the blackstripe topminnow is frequently present, usually in low numbers. The main population centre may be in the lower reaches of Black and Bear Creeks and in the upper reaches of the North Sydenham River. Adults and young were observed in this area in relative abundance. Few blackstripe topminnows were observed near the upstream and downstream limits of its distribution in the North Sydenham River system. Individuals and groups of 3 to 5 were observed. Adults and juveniles were captured in the same localities.

Intermittent stream pools in the headwaters of Black Creek seemed to provide optimal habitat; 20 to 30 blackstripe topminnows were observed in a long, narrow pool about 200 m^2. Destruction of aquatic vegetation and bank cover by livestock limits available habitat area in the headwaters of Black Creek. Few specimens were collected in these altered habitats.

Intrusion of less turbid water from the St. Clair River into the North Sydenham River at Wallaceburg appears to limit the downstream movement of this species and may limit the further dispersal of the blackstripe topminnow in the Lake St. Clair drainage. Riffles and increased gradient above Petrolia curtail the upstream movement of this species in Bear Creek.

Gruchy (pers. comm.) suggested that this species was a recent arrival to Ontario waters, perhaps moving across from Michigan via extensive marshy areas in Lake St. Clair into the North Sydenham River.

The recent expansion of the range of the blackstripe topminnow to the North Sydenham River and the tolerence of this species to turbid water suggests that it is well-suited to the habitat provided by the North Sydenham River system and is likely to increase in numbers and possibly find its way into new, suitable habitat areas in the Lake St. Clair drainage.

THREATS

Habitat degradation resulting from livestock usage has decreased available habitat for this species in the Sydenham River system. Bank destruction is limited to small sections of Black and Bear Creeks. Widespread bank degradation is limited by agricultural use of adjacent lands, much of these lands are crop lands and therefore not open to livestock use and subsequent degradation. It is unlikely that the population of blackstripe minnows in Ontario will be stressed in the near future as a result of habitat destruction.

STATUS

The following statements were considered valid after review of available information and were used in the evaluation of the status of the blackstripe topminnow in Canada.

1. A reproducing population of blackstripe topminnows is present in the Sydenham River system.
2. The blackstripe topminnow occurs in Canada at the northern fringe of its North American range.
3. The North Sydenham River watershed provides optimal habitat for the blackstripe topminnow.
4. Habitat destruction within the Canadian range of this species is localized and it is unlikely that the population of blackstripe topminnows in Canada is under immediate threat by man.

Based on the information evaluated during this study it is recommended that the blackstripe topminnow be classed as a rare species in Canada.

BIOLOGY

In Ontario, the blackstripe topminnow occurs in permanent and intermittent sluggish creeks and rivers. Stream gradients in the North Sydenham River watershed range from 0.02 m/km to over 6 m/km. This species was found in permanent flowing waters with gradients less than 0.7 m/km. The blackstripe topminnow was found in intermittent streams with higher gradients. Specimens were collected from Crooked Creek, which has a gradient of about 5.6 m/km, and also in the headwaters of Black Creek, where the gradient averages 1.4 m/km. Isolated pools of water, 1 to 2 metres deep, separated by dry stream bed characterize the upper reaches of Black Creek during the late summer. Water flow is virtually absent between these pools.

Trautman (1957), and Shute (1980) also reported that the blackstripe topminnow prefers small to large low gradient streams and Atmar and Stewart (1972) mentioned that this species is found in pools in intermittent streams, as was found in Black Creek.

Emergent and floating aquatic macrophytes and low overhanging terrestrial plants are extensively used as cover by the blackstripe topminnow. In the North Sydenham River, cover is available only near the river edges. This species was rarely observed beyond this edge-cover in open waters. Blackstripe topminnows were observed in mid-stream in smaller tributaries, but protective cover was always nearby. In areas where edge-cover had been destroyed by livestock the blackstripe topminnow was less numerous or absent.

On several occasions during this study, this species was observed actively seeking and utilizing in-stream cover. When approached, these fish would dart into dense growths of cattails (Typha), arrowhead (Sagittari latifolia), or spatterdock (Nuphar).

Erosion of fine clay soils from the surrounding countryside results in high turbidity in the North Sydenham River watershed. The blackstripe topminnow appears to be quite tolerant of waters with high turbidity, and may prefer such habitats. This species becomes more numerous in the North Sydenham River as turbidity increases. Inflow of clear St. Clair River water into the North Sydenham River increases water transparency from approximately 10 cm 4.5 km upstream, to approximately 35 cm near Wallaceburg. It is over this 4.5 km stretch of river that the downstream distribution of blackstripe topminnows ends. Shute (1980) also reported that this species occurs in streams of moderate to high turbidity. Trautman (1957) observed that this species is more tolerant of turbidity than is the banded killifish and tends to replace the banded killifish when turbidity increases. Paradoxically, Trautman also reported marked decreases in the abundance of blackstripe topminnows in sections of Ohio which showed the greatest increases in turbidity from 1925 to 1950 and stated that the largest populations are found in relatively clear water.

The blackstripe topminnow is apparently tolerant of a wide range in water quality. Water temperatures at capture sites ranged from 20 to 25°C. Temperatures in some of the isolated pools in the headwaters of Black Creek were warmer as a result of decreased water-flow during hot weather. Oxygen levels of 7 and 8.5 mg/l were measured in two pools in Black Creek, but oxygen levels in the shallow isolated pools likely decrease at night since aeration is minimal.

In winter, the blackstripe topminnow abandons its surface swimming habit and moves to deeper waters among vegetation and plant debris (Carranza and Winn 1954).

Blackstripe topminnows collected in Ontario were aged using scales as described by Nieman and Wallace (1974). Scales from 15 specimens captured during August 1979 and from 8 specimens captured between June and August of 1972 were aged. Standard lengths of young-of-the-year of this species ranged from 1.5 to 3.2 cm while 1+ fish ranged from 3.8 to 5.0 cm and 2+ fish ranged from 4.1 to 5.1 cm in length. The largest fish captured in 1979 was 5.0 cm in length (SL) and weighed 2.34 g (preserved weight). Total lengths given by Trautman (1957), Carlander (1969), and Nieman and Wallace (1974) range from 50 to 70 mm (TL) with a maximum length of 74 mm (TL).

The maximum age of Ontario specimens was 2 years. Nieman and Wallace (1974) reported 3+ specimens, however, Carranza and Winn (1954), Trautman (1957), Thomerson (1966) and Atmar and Stewart (1972) reported 2+ as the maximum age of blackstripe topminnows.

Sex-related differences in size in this species are not apparent except when females are distended with eggs (Carranza and Winn 1954; Nieman and Wallace 1974).

The wide range in lengths of 0+ blackstripe topminnows stems from the protracted spawning period and rapid growth rate during the first year of life. A lower growth rate is reported from 1+ to 2+ fish. According to Nieman and Wallace (1974), rapid growth during the first year and slow growth thereafter is typical of short-lived species such as the blackstripe topminnow.

Reports of the spawning period of blackstripe topminnows in Ontario are lacking but Carranza and Winn (1954) have observed reproductive activity of this species in Michigan from early May to the third week in August. A similar spawning period is likely in Ontario waters.

Spawning takes place in growths of aquatic vegetation. Carranza and Winn (1954) stated that during the breeding season, females are often observed in thick vegetation along the shoreline, while males congregate further from shore. As spawning activity increases, territories are established parallel to the shore by mating pairs. Twenty to thirty adhesive eggs are extruded and fertilized one at a time. Each egg is then propelled into the submerged vegetation by the male. Spawning may continue over an extended period as more eggs ripen.

Spawning behaviour, spawning substrate, and description of egg and larval stages of the blackstripe topminnow were described by Foster (1967).

Sexual demorphism is quite apparent in the blackstripe topminnow. Differences exist in fin shape, fin marking, and body colouration. The male exhibits dark verticle bars extending above and below the mid-lateral stripe, but these bars are absent in the female. The male has yellowish fins while the female has white fins. The posterior portions of the dorsal and anal fin are elongated in the male and rounded in the female. Colouration and fin shape are related to sex recognition, display, and the reproductive act. A full description of reproduction behavior is provided by Carranza and Winn (1954).

Blackstripe topminnows were often observed feeding alone or in small groups just under the water surface. The upturned mouth of this species also suggests a surface feeding habit. The foregut contents of 13 blackstripe topminnows collected during the 1979 study were composed primarily of adult terrestrial insects (47.5% by volume, 100% by frequency of occurrence), indicating that surface feeding is important to this species (Table 1). The presence of larval insects, crustaceans, molluscs and filamentous algae indicates that mid-water and bottom foraging is also important. Considerable variation was found among the diets of the fish examined.

Atmar and Stewart (1972) studied the feeding habits of the blackstripe topminnow and also found that terrestrial insects comprised much of the diet, while snails, aquatic insects, and microcrustaceans accounted for much less of the diet. These authors also found that algae are apparently ingested incidentally during the consumption of prey, but are not digested.

Variation in prey selected by this species was attributed to an opportunistic feeding habit.

Information on predation of F. notatus by piscivores is scant. Piscivorous fish were apparently absent in many of the isolated pools of Black Creek during the 1979 survey. Piscivorous species captured in Bear Creek and the north Sydenham River with the blackstripe topminnow were longnose gar (Lepisosteus osseus), northern pike (Esox lucius), rock bass (Ambloplites rupestris), white crappie (Pomoxis annualris) and largemouth bass (Micropterus salmoides). Predation by some of these fish on blackstripe topminnows is very likely. Atmar and Stewart (1972) suggested that low numbers of larger blackstripe topminnows may be due to selective predation by the belted kingfisher (Megaceryle alcyon) in Texas.

Parasitic copepodes of the genus Lernaea infested 2 of 16 blackstripe topminnows examined from the 1979 survey. Hoffman (1967) listed cestodes, nematodes and Acathocephala as parasites of this species, and Shira (1913), as cited by Hart and Fuller (1974), found this species was parasitized by unionid glochidia.

It is unlikely that this species has any direct economic value for man.

RECOMMENDATIONS

The following recommendations are suggested for the maintenance and monitoring of the blackstripe topminnow in Canada.

1. The Ontario Ministry of Natural Resources should monitor and document blackstripe topminnow populations in Ontario.
2. Concerned agencies should hold and transport to a museum facility specimens taken outside of the North Sydenham River watershed.
3. Identification information should be made available to concerned agencies.
4. In the event that new populations of this species are identified outside of the North Sydenham River watershed, each population should be investigated to determine range and population size.
5. Resource and development plans for the North Sydenham River system should be evaluated as to the form and extent of disturbance to blackstripe topminnow habitat.
6. Destruction of stream bank cover by livestock in the headwaters of Black Creek should be investigated by the St. Clair Conservation Authority.
7. Seepage from oil wells into Black Creek in the vicinity of Oil Springs should be curtailed.

LIST OF SPECIMENS

A list of blackstripe topminnow specimens captured in Canada from the National Museum of Canada (NMC) and the Royal Ontario Museum (ROM) is provided below:

NMC 72-184 (38), Black Creek, Lambton County, Aug. 10, 1972, C.G. Gruchy and R.H. Bowen. ROM 28312 (10), Black Creek, Lambton County, Aug. 10, 1972, Gruchy and Bowen. NMC 72-186, Mollys Creek, Kent County, Aug. 12, 1972, Gruchy and Bowen. NMC 72-199 (10), North Sydenham River, Lambton County, Aug. 12, 1972, Gruchy and Bowen. NMC 74-0318 (3), Black Creek, Lambton County, Oct. 22, 1974, Gruchy and D.E. McAllister. ROM 31071 (85), Black Creek, Lambton County, Aug. 5, 1975, A.J. Sosiak et al. ROM 37707 (10) North Sydenham River, Lambton County, Aug. 6, 1975. Sosiak and MacLennan. ROM 34405 (13), North Sydenham River, Lambton County, Aug. 7, 1975, Sosiak and MacLennan. NMC 79-1028 (3), Black Creek tributary, Lambton County, Aug. 21, 1979, B.J. Parker and P.M. McKee. NMC 79-1033 (4), Fox Creek, Lambton County, Aug. 21, 1979, Parker and McKee. NMC 79-1038 (7), Black Creek, Lambton County, Aug. 22, 1979, Parker and McKee. NMC 79-1041 (7), Bear Creek, Lambton County, Aug. 22, 1979. Parker and McKee. NMC 79-1043 (4), Bear Creek, Lambton County, Aug. 22, 1979. Parker and McKee, NMC 79-1049 (3), Bear Creek, Lambton County, Aug. 23, 1979, Parker and McKee. NMC 79-1050 (13), North Sydenham River, Lambton County, Aug. 23, 1979, Parker and McKee. NMC 79-1155 (4), Otter Creek, Kent County, Sept. 25, 1979, McKee and B.A. Hindley. NMC 79-1206 (2), Bear Creek, Lambton County, Sept. 27, 1979, McKee and Hindley. NMC 79-1207 (2), North Sydenham River, Lambton County, Sept. 27, 1979, McKee and Hindley.

Table 1: Gut contents of 13 specimens of *Fundulus notatus* collected in August and September from the North Sydenham River watershed, southern Ontario.

Food Item	Volume[1] (%) mean	(s)[2]	Frequency of Occurrence (%)
Thysanoptera adult	5.6	(7.8)	45
Trichoptera larvae	0.4	(1.4)	8
Hymenoptera adult	9.7	(14.4)	54
Coleoptera adult	1.5	(4.3)	15
Diptera adult	30.7	(31.4)	69
pupae	5.4	(12.5)	23
larvae	12.9	(20.0)	54
unidentified insect fragments	20.7	(16.8)	92
Acarina	0.6	(2.2)	15
Cladocera	2.5	(2.4)	70
Copepoda	1.0	(2.8)	15
Ostracoda	2.1	(5.6)	38
Gastropoda	1.0	(2.5)	15
filamentous algae	5.8	(14.1)	22

1 Volumes refer to percentage of total gut contents.

2 Standard deviation.

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