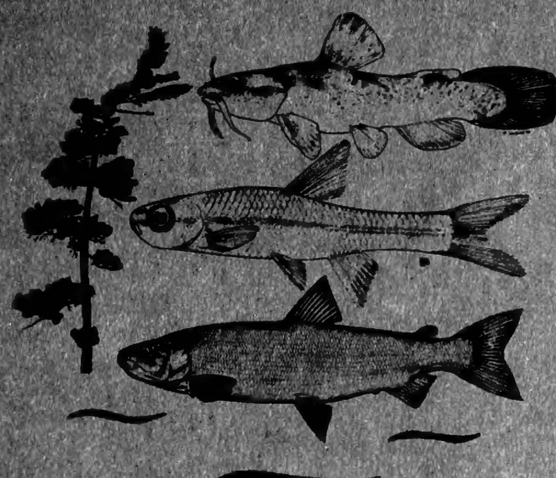
Syllogeus 54

Rare, Endangered and Extinct Fishes in Canada

Don E. McAllister
Brad J. Parker
Paul M. McKee



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RARE, ENDANGERED
AND EXTINCT FISHES
IN CANADA

Don E. McAllister
Ichthyology Section
National Museum of Natural Sciences
Ottawa, Ontario K1A 0M8

Brad J. Parker
210 Steeles Ave W., Apt. 901
Brampton, Ontario

and

Paul M. McKee
1405-301 Dixon Road
Weston, Ontario
M9S 1S2

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Dedicated to

RODERICK HAIG-BROWN

naturalist

angler

author

educator

and

conservationist

1908-1976

ABSTRACT

The overall status of Canada's freshwater and marine fish faunas is reviewed and general problems affecting the environment are discussed. General solutions recommended to solve these problems include in brief: 1) creation of natural history preserves; 2) legislation to encourage 10 metre green banks with the natural herbage and trees to reduce erosion and siltation; improved reforestation policies; 3) better enforcement of antipollution laws and immediate action to reduce acid rain; 4) increased reforestation programs with research funds on polycultural silviculture; 5) increased support for basic faunal and floral surveys, taxonomic research by museums and publication of monographs and popular guides; 6) new support for life history and ecological studies on the many species lacking any such studies; 7) establishment of a network of environmental and biota monitoring stations to detect early changes; 8) increased funding for poorly known groups of fauna and flora, including fishes; 9) increasing awareness of fisheries managers of location of rare and endangered populations and caution in introducing exotic species and "reclaiming" lakes and streams; 10) preservation of any dead specimens found of rare, threatened or endangered fishes and shipment to Curator of Fishes, National Museum of Natural Sciences, Ottawa K1A 0M8.

Thirty-seven species classed provisionally or by COSEWIC as rare, threatened, endangered, extirpated in Canada, or extinct are discussed under the headings: Canadian status, Status elsewhere, Taxonomic status, Distinguishing features, Habitat, Biology, Protective measures taken, and Recommendations (for protection). Canadian range maps are provided for each species and several species and their habitats are illustrated. Other possible candidate species for inclusion are listed. Four species of fishes are known to have been extirpated or to have become extinct in Canadian waters.

Taxa and their status are: Acipenser brevirostrum, shortnose sturgeon - rare, Polyodon spathula, paddlefish - extirpated, Lepisosteus oculatus, spotted gar - rare, Sardinops sagax caerulea, Pacific sardine - rare, Salvelinus fontinalis timagamiensis, aurora char - endangered, Coregonus sp., Squanga whitefish - threatened, Coregonus sp., Opeongo whitefish - endangered, Coregonus canadensis, Acadian whitefish - endangered, Coregonus hoyi, bloater - rare, Coregonus johannae, deepwater cisco - extinct, Coregonus kiyi, kiyi - rare, Coregonus nigripinnis, blackfin cisco - extirpated save in Lake Nipigon, Coregonus reighardi, shortnose cisco - rare, Osmerus spectrum, pygmy smelt - rare, Campostoma

anomalum, central stoneroller - rare, Clinostomus elongatus, redside dace - threatened, Hybognathus argyritis, western silvery minnow - rare, Hybopsis storeriana, silver chub - endangered, Hybopsis x-punctata, gravel chub - extirpated, Notropis anogenus, pugnose shiner - endangered, Notropis dorsalis, bigmouth shiner - rare, Notropis emiliae, pugnose minnow - endangered, Notropis photogenis, silver shiner - rare, Rhinichthys cataractae ssp., Nooky dace - rare, Rhinichthys cataractae smithi, Banff longnose dace - endangered, Rhinichthys osculus, speckled dace - rare, Catostomus sp., Salish sucker - endangered, Minytrema melanops, spotted sucker - rare, Moxostoma carinatum, river redhorse - rare, Moxostoma duquesnei, black redhorse - endangered, Moxostoma hubbsi, copper redhorse - threatened, Noturus miurus, brindled madtom - endangered, Fundulus notatus, blackstripe topminnow - endangered, Cottus confusus, shorthead sculpin - threatened, Allolumpenus hypochromis, Y-prickleback - rare, Gasterosteus sp., giant stickleback - rare, Stizostedion vitreum glaucum, blue walleye - extinct.

Over 200 references are cited.

RÉSUMÉ

Le statut global de l'ichtyofaune marine et dulçaquicole du Canada est révisé et les problèmes généraux qui affectent l'environnement sont discutés. Des solutions générales recommandées pour résoudre ces problèmes comprennent en bref 1) la création de réserves fauniques naturelles; 2) une législation pour encourager le maintien de 10 mètres de rive verte pourvue d'herbages naturels et d'arbres pour réduire l'érosion et le limonage; 3) une meilleure mise en vigueur des lois antipollution et une action immédiate pour réduire les pluies acides; 4) une augmentation des programmes de reboisement avec fonds de recherche sur la sylviculture mixte; 5) une aide accentuée pour les études de base de la faune et de la flore, pour la recherche taxonomique par les musées et pour la publication de monographies et de guides populaires; 6) un nouvel appui pour des études de cycle vital ainsi que des études écologiques des nombreuses espèces peu étudiées sous cet angle; 7) l'établissement d'un réseau de stations de contrôle environnemental et biotique pour détecter les premières variations; 8) un accroissement de fonds pour l'étude des groupes peu connus de la faune et de la flore, y compris les poissons; 9) la sensibilisation des administrateurs de pêcheries sur les emplacements de populations rares et en danger de disparition, incluant la prudence dans l'introduction d'espèces exotiques et l'assèchement des lacs et des rivières; 10) la préservation de tout spécimen, trouvé mort, de poissons rares, menacés ou en danger de disparition, et leur expédition au Conservateur des poissons, Musée national des Sciences naturelles, Ottawa K1A 0M8.

Trente-sept espèces classées provisoirement ou par COSEWIC comme étant rares, menacées d'extinction, en danger de disparition, déracinées au Canada, ou disparues sont discutées sous les rubriques suivantes: Statut canadien, Statut à l'étranger, Statut taxonomique, Caractéristiques distinctives, Habitat, Biologie, Mesures protectrices en vigueur, et Recommandation (pour protection). Des cartes de distribution canadienne sont fournies pour chaque espèce, et plusieurs espèces et leurs habitats sont illustrées. D'autres espèces à candidature possible sont énumérées. Quatres espèces de poissons sont connus étant extirpés ou disparus des eaux canadiennes.

Les taxons et leur statut sont les suivants: *Acipenser brevirostrum*, esturgeon à museau court - rare, *Polyodon spathula*, spatulaire - extirpée, *Lepisosteus oculatus*, lépisosté tacheté - rare, *Sardinops sagax caerulea*, sardine du Pacifique - rare, *Salvelinus fontinalis timagamiensis*, omble de fontaine aurora - en danger de disparition, *Coregonus*

sp., corégone du Squanga - menacée, *Coregonus* sp., corégone de l'Opeongo - en danger de disparition, *Coregonus canadensis*, corégone d'Acadie - en danger de disparition, *Coregonus hoyi*, cisco de fumage - rare, *Coregonus johannae*, cisco de profondeur - disparue, *Coregonus kiyi*, cisco kiyi - rare, *Coregonus nigripinnis*, cisco à nageoires noires - extirpée sauf au Lac Nipigon, *Coregonus reighardi*, cisco à museau court - rare, Osmerus spectrum, éperlan nain - rare, *Campostoma anomalum*, roulle-caillou - rare, *Clinostomus elongatus*, méné long - menacée, *Hybognathus argyritis*, méné d'argent - rare, *Hybopsis storeriana*, méné à grandes écailles - en danger de disparition, *Hybopsis x-punctata*, gravelier - extirpée, *Notropis anogenus*, méné camus - en danger de disparition, *Notropis dorsalis*, méné à grande bouche - rare, *Notropis emiliae*, petit-bec - en danger de disparition, *Notropis photogenis*, méné-miroir - rare, *Rhinichthys cataractae* ssp., naseux du Nooky - rare, *Rhinichthys cataractae smithi*, Banff naseaux de rapides - en danger de disparition, *Rhinichthys osculus*, naseaux moucheté - rare, *Catostomus* sp., meunier des Salish - en danger de disparition, *Minytrema melanops*, meunier tacheté - rare, *Moxostoma carinatum*, suceur ballot - rare, *Moxostoma duquesnei*, suceur noir - en danger de disparition, *Moxostoma hubbsi*, suceur cuivré - menacée, *Noturus miurus*, chat-fou tacheté - en danger de disparition, *Fundulus notatus*, fondule rayé - en danger de disparition, *Cottus confusus*, chabot à tête courte - menacée, *Allolumpenus hypochromis*, lompénie i-grec - rare, *Gasterosteus* sp., épinoche géante - rare, *Stizostedion vitreum glaucum*, doré bleu - disparue.

Plus de 200 références sont citées.

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To all those organizations and persons who contributed most of what is meritorious in this study, the authors are deeply grateful. The first author accepts responsibility for the many flaws.

Nous sommes sans limites
Et l'abondance est notre mère
Pays ceinturé d'acier
Aux grands yeux de lacs
A la bruissante barbe résineuse
Je te salue et je salue ton rire de chutes.
Pays casqué de glaces polaires
Auréolé d'aurores boréales
Et tendant aux générations futures
L'étincelante garbe de tes feux d'uranium
Nous lançons contre ceux qui te pillent et t'épuisent
Contre ceux que parasitent sur ton grand corps d'humus et de neige
Les imprécations foudroyantes
Qui naissent aux gorges des orages.

Gilles Hénault

Tiré de _Je Te Salue_, les Editions de l'Hexagone

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INTRODUCTION

The purpose of this paper is to bring together what is known and what is unknown about the lives of some of Canada's rarer fishes in the hopes that they may be saved for future generations to enjoy. Elspeth Huxley sagely summarized the groups of reasons for conserving the natural world under the Four Pillars of Conservation: Ethical, Esthetic, Scientific and Economic (Vladykov, 1973).

The first Canadians found the waters rich in fishes. Blessed with lakes and streams, representing one quarter of the world's freshwater and one of the world's longest coastlines fronting on three ocean basins, many fish habitats, from mountain tarns and torrents, vast lakes, sunlit kelp forests to quiet deep sea depths. In these waters dwell about 1,000 kinds of fishes. We do not yet know precisely how many. With only two ichthyologists at the National Museum and three full-time ichthyologists at two provincial museums to cover over three million square miles of territory, recently expanded to the 200 nautical mile limit, we are still exploring our fish fauna and finding new species. In the last eight years over 35 species new to Canada's Arctic coast and over 50 species on the Pacific coast have been discovered.

Some general environmental problems affecting survival of several fishes and recommendations for their solution will be mentioned in the following paragraphs. In our general comments we have often gone beyond the aquatic environment; the terrestrial, aerial, and aquatic environments are inextricably linked. Particular problems effecting individual species will be mentioned in individual species accounts.

General Problems

Before the coming of Europeans, Indians and Inuit harvested fishes wisely for food. Soon after the coming of Europeans, major changes in the environment took place. The clearing of the primeval forests influenced seasonal water flow and temperature. No longer did forest leaves fall into the water and form an important source of nutrients in the food pyramid for invertebrates and bacteria. Farming practices further subjected the land to increased rapid-runoff and erosion. Eroded sediments smother bottom life in streams, reduce plant growth, interfere with the gills of fishes and the development of eggs. Fertilizers and pesticides used on farms or in control of forest pests may have deleterious effects on fishes or their food - many insecticides are toxic to fishes.

As the populations of Canada increased, the development of towns and industries began to influence the environment. Pollution from paper mills and sewage began lowering water quality. Some 2,800 compounds are now known in the Great Lakes, 100 times the number known at the beginning of the decade. John Teal, Woods Hole Oceanographic Institution, observed in October 1981 (Ottawa Citizen) that even tissue samples from deep sea fishes showed traces of pesticides. Often the effects of degradation were slow and hence insidious. Few people notice gradual deterioration over the decades and hence corrective action is seldom taken or taken too late. This is not the case when disasters like oil spills take place. Direct and "shadow" effects of the mining industry in Canada have had a poor record in the reclamation of mining lands in Canada (Marshall, 1982).

The construction of hydroelectric dams has extirpated numerous populations of valuable commercial and sport fishes in Canada. A dam on the Tusket River, Nova Scotia has probably been partly responsible for the decimation of the endangered Acadian Whitefish. Etnier, Starnes and Bauer (1979) document the serious reduction in diversity of the Tennessee River fauna, the richest in North America, and conclude that although their knowledge of the biota is incomplete, they could unequivocally say that the environmental effects of any major water project will never be "insignificant." The planned $3-billion expansion of the Kemano project by the Aluminum Company of Canada would create a second diversion tunnel from the Nechako River reservoir and a dam and a tunnel to divert water into the reservoir from the Skeena River system and other facilities. The fishing industry and Fisheries and Oceans Canada biologists fear this would threaten 40% of the Fraser river salmon stock (Victoria Times-Colonist, 7 January 1984).

Particularly insidious and on the increase is acid rain fallout from mine smelters, such as at Sudbury, coal-powered power plants, such as those in Ontario presently without scrubbers to reduce acid emissions and B.C. Hydro's planned massive generating station at the Hat Creek coalfield near Kamloops which, if equipped with scrubbers, would still dump over 100,000 tonnes of sulphur dioxide into the atmosphere (Victoria Times - Colonist editorial, 22 May 1981). High smoke stacks spread (up to 1000 km) but do not cure the problem. Motor vehicle exhaust emission regulations are less strict than desirable in Canada (less so than in California) and add to the problem. While Canada and the provinces have been lax in controlling sulphur dioxide and nitrous oxides emissions and must not further delay action, it may be noted that our good neighbours to the south also contribute to the problem. Ohio's thermal plants emit more sulphur dioxide than all of Ontario's

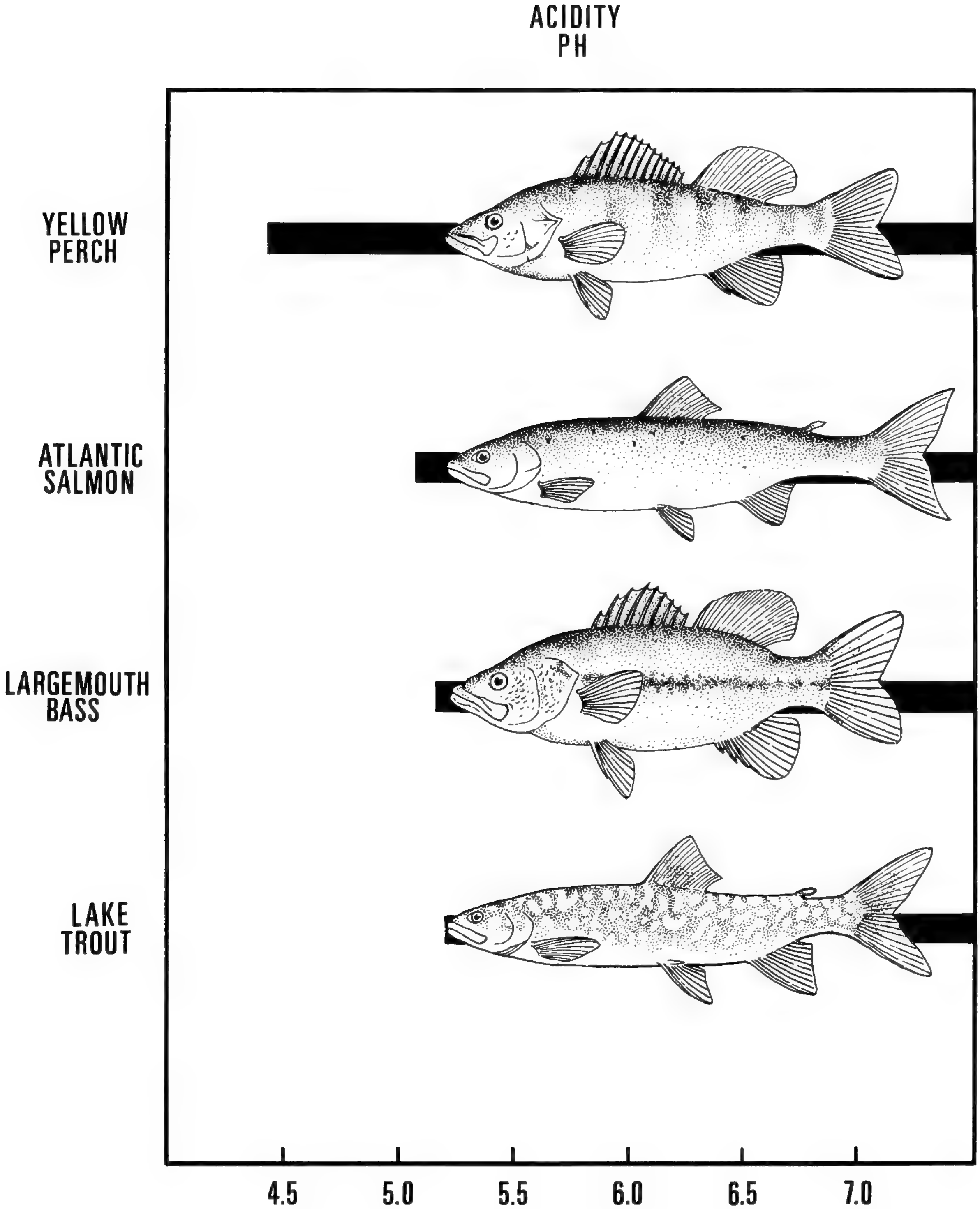

FIGURE 1: The pH scale from 0 to 14 measures acidity with 0 being highly acidic, 7 indicating neutrality and 14 caustic. Each unit indicates 10-fold increase. The end of the bars indicates where adverse effects appear.

sources combined including the world's largest single source at Sudbury. However, Ontario Hydro has increased its sulphur dioxide emission during 1980 to 1984 from 50% to 60% of Canada's emissions from thermally generated electricity (Subcommittee on Acid Rain, 1984). For an overview of acid precipitation read the acid rain primer by Pollution Probe (1981), acid rain, the silent crisis by Weller (1980), and time lost, a report by the Subcommittee on Acid Rain (1984; write the Subcommittee, House of Commons, Ottawa, Ontario K1A 0A6). Pallative measures such as dumping lime into lakes has provided only temporary reductions, a few months, in acidity of some lakes, and cannot hope to be economically applied to Canada's thousands of lakes. Acid rain is a broad spectrum pollutant which affects life from bacteria to the sugar maple[1], from animal plankton to fishes and man. Attacking one or two symptoms is unsound environmentally and cost-benefit-wise; only stopping acid rain will work.

Already, acid rain has wiped out the natural populations of one endemic Canadian subspecies, the aurora trout, and several hundred lakes (140 near Sudbury alone) in Ontario are no longer able to support fish populations (Ottawa Citizen, 2 June 1979, p. 14; 11 July 1979, p. 19). Laurentides Provincial Park, Québec has suffered a 30% decline in fish catch between 1970 and 1978 due to acid rain. Acid rain threatens, if it has not already extirpated the Tusket River, N.S. population of Acadian whitefish, one of the two known populations of this unique Canadian species. Kennedy (1980) reported that 59% of lake trout eggs incubated in an acidified lake died or failed to gastrulate by 15 days, and 60% of the surviving embryos displayed gross anatomical malformations at a pH of 6.2. Even parks such as Ontario's Algonquin Park, and nature preserves are not immune to airborne pollution and no longer protect our fauna and flora. Spawning, fry hatch, early development and even egg maturation have been identified as critically sensitive (Jeffries, Cox, and Dillon, 1979). Bone is decalcified in fishes in acidified lakes, while manganese levels are greatly increased; death may result from accumulation of aluminum on gill surfaces (Fraser and Harvey, 1982). A 1984 Parks Canada consultant reported hazardous levels of mercury in some of Pukaskwa National Park fishes, probably due to release of mercury by acid rain. Molluscs are especially sensitive to high acidities and mussels die

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[1] The Ottawa Citizen (17 July 1984) reports forestry officials now blame the well-established decline of maple syrup producing sugar bushes in recent years on acid rain.

at a pH of 6. Molluscs form an important component of the diet of the river redhorse (rare) and copper redhorse (threatened). Johnson (1982) reviewed in depth the effect of acid rain on fisheries.

Increasing dependence on coal because of the oil shortage, may augment the problem. Lakes in the Canadian shield, unbuffered by limestone, are particularly sensitive (Beamish, 1974). Acid precipitation in south-central Ontario is more acidic than that in Sudbury and this region has very low buffering capacity (Dillon, et al., 1978). Concentrations from snowpack may cause extremely elevated acid levels during spring runoff (Jeffries, Cox, Dillon, 1979), which may be critical to the eggs and young of spring spawners. Spring pH values in a tributary to Harp Lake in Muskoka dropped from more than 6.5 to less than 5.5 more than tenfold increase in acidity (Ontario Ministry of the Environment, 1980). The effects of acid rain and snow are not limited to aquatic life, forests (visit Sudbury) and crops are also threatened. Acid rain starves forests of such nutrients as sodium, potassium and magnesium, removes the protective wax from the leaves and destroys the outer layer of cells. In Sweden in the 1970s acid rain reduced by one percent a year the yield of wood from its forests. Persons living in areas of high acid precipitation are advised to let their taps run before using the water which may be contaminated by copper and lead leached out of the pipes.

In March 1984 Canada and nine other nations, but not the United States, signed an international pact to reduce sulphur dioxide emissions by at least 30% by 1993 and promised to reduce nitrous oxides by unspecified amounts. In 1980 Canada and the United States signed a Memorandum of Intent to negotiate a transboundary air pollution agreement "including the already serious problem of acid rain". In January 1984 the United States rejected a joint pollution control program with Canada, and in March 1984 Canada committed itself to unilateral reductions in sulphur dioxide of 50% by 1994.

Three other problems may be mentioned. Overfishing has been a problem with several species. This is most notable in those species such as lake sturgeon which may take 15 or more years to reach maturity. At one time sturgeon were so abundant that they were fed to pigs or dug into the earth as fertilizer (Scott and Crossman, 1979). Overfishing resulted in a decline of catch in Lake of the Woods of 90% from 1893 to 1900. By 1957 the catch stood at 0.005% of the 1893 maximum. The decline or extinction of the deepwater ciscos or chubs and the blue pike in the Great Lakes has been significantly affected by overfishing. A second problem, chiefly for migratory species, has been the construction of dams which may affect upstream and downstream movement of adults and young. Lake Ontario used to have its own runs of Atlantic salmon, but the construction of dams for grist and saw mills on its tributaries blocked the spawning runs and the native salmon were extirpated by 1900 (Parsons, 1973). The dam on the Tusket River was probably a factor in the decline of Acadian whitefish in that river system. British Columbia Hydro is planning the construction of five dams on the Stikine and Iskut rivers, one of which will be the highest arch dam in North America (270 m); the fauna of the Stikine is very poorly known. A dam projected for the Liard River would wipe out a highly genetically distinct form of lake chub, Couesius plumbeus, found at Liard Hotsprings.

Canada has contributed significantly to the loss of the world's forests which are disappearing at the rate of 50 acres a minute through over-harvesting and underplanting; provincial governments and private companies have chosen to argue over who is responsible for reforestation while one of our major resources is rapidly declining. Forests contribute to the balance of oxygen and carbon dioxide in the atmosphere, the flow and temperature of run-off from rains and snow, building and protecting the soil from erosion (Plamondon, 1982), and providing the habitats for myriad species of wildlife. Even though the forst industry is one of the most important in Canada ($24 billion) and even though forests have been managed in Europe for centuries, Canada is cutting more trees than it plants. Only one quarter of the 800,000 hectares of timber cut each year is replanted by man. Forest fires and acid rain are an increasing threat. Meanwhile governments and industry debate whose is the responsibility. One person with a chain saw can cut 1256 black spruce per day, one person with a shovel can plant up to 2000 young trees a working day. My daughter Sylvie planted 40,000 trees in 8 weeks at 10¢ per tree. Surely that 10¢ per tree which will produce square metres of paper for books or cubic metres of wood for homes, protect soil and water resources, and delight the eye is one of the most advantageous investments.

Courses in ecology should be required in all faculties such as commerce, engineering, agriculture, mining, education, and law. Interfaculty degrees should be encouraged. Primary and secondary school students should be taught the multiple values of our forests, be shown the effects of bad logging practices and the benefits of modern silviculture, and be given the chance to plant trees.

There are several reviews of information on endangered fishes in Canada and United States. McPhail (1980b) discussed the distribution and status of freshwater fishes in

FIGURE 2: Leaves from trees provide energy for single-celled organisms, insects, crustaceans and other life on which fish feed. Trees also shade the water, moderate water flow and snow melt and prevent soil erosion.

British Columbia, Nero and Wrigley (1977) wildlife in Manitoba, COSEMEQ (1981) in Quebec, Isnor (1981) in Nova Scotia, Nelson and Paetz (1982) in Alberta, Clayden, McAlpine and Guidry (1984) in New Brunswick, McAllister and Gruchy (1978), and Campbell (1984) reviewed rare and endangered species for Canada. Williams (1976) reviewed the United States act on endangered species, and Deacon et al. (1979) and Ono, Williams and Wagner (1983) the rare threatened, endangered and extinct species of fishes in North America. There were 45 threatened (12) and endangered (33) species of fishes in United States (Endangered Species Technical Bulletin (7(1):8), but more recently the Federal Register (1982) listed 148 fish species of concern as endangered or threatened in U.S. Clearly, even if it should be our philosophy to do so, we cannot leave it to the U.S.A. to ensure survival of species which do occur in Canada.

General Recommendations

1) Introduction of legislation into provinces not yet having it, for creation of natural history preserves especially for the protection of animals and plants. Creation of federal and provincial nature reserves to protect broad examples of our fauna and flora (special preserves for individual species are mentioned under species). These should include Pacific, Arctic, Bering, Gulf of Mexico and Atlantic coasts and drainages, lakes, streams, rivers, coastal and offshore reserves. McAllister and Gruchy (1978) discuss the selection and need of reserves for offshore banks and the continental slopes. These recommendations were based on preserving representative samples of habitats and ichthyofaunas. Little attention has been paid to designing reserves, but McDowall (1984) listed 6 important factors in designing freshwater fish reserves in New Zealand: natural habitat, adequate size, permanent water supply, absence of exotic species and of exploitation, and for diadromous species, access to and from the sea. The idea behind these general reserves is to protect examples of our faunas, undisturbed now before they become rare or threatened. To properly serve their purpose, these reserves should be clearly distinguished from parks with recreational goals. Exotic species should be excluded from the reserves and connecting waterways.

2) Enactment of legislation to encourage keeping 10 metre strips of natural vegetation along banks of streams and rivers, unfarmed and unlogged. Makowecki (1980) lists 10

benefits to streambank protection and outlines Alberta's functioning program. Plamondon (1982) discusses effects of logging practices and green buffer strips on sedimentation and turbidity of streams. Green bufferstrips will have to be wider where streams run at the base of slopes which would otherwise be logged (Hume, 1980). Initially, this may reduce production of crops and logs but in the long run the protection given to the water table and erosion of the soil, the ultimate resources, will generate long term benefits to both the farmer and the logger. At the same time, it will enhance the aquatic fauna for fishing, and water quality for other uses (including hydro power generation) through more constant seasonal water flow (more constant watertable, fewer droughts and fires, greater tree growth), cooler summer temperatures, less suspended soil, farm wastes, fertilizers and pesticides. Hydroelectric dams will have longer life spans when the in-flows are silt free. Streamside vegetation provides insect and other food for fishes. Clear cutting of forests should be avoided for much the same reasons as unprotected stream banks. Dissolved oxygen and salmon egg-to-fry survival are markedly reduced following sedimentation from logging (Hartman, 1981), as well as the densities of the larger invertebrates and fish populations are vulnerable to water quality changes and siltation from placer mining (Hartman, 1980B).

Streams are often channelized and wetlands drained without serious environmental appraisal or even adequate cost-benefit studies or public hearings. Channelized streams reduce habitat and species diversity, are subject to high summer temperatures and winterkill, while rarely benefitting the fish fauna[1]. Channelization may result in shifts from insectivore and insectivore-piscivores species to omnivore and herbivore-detritivores (Schlosser, 1982). Of southern Ontario's original wetlands, over 75% have already been lost. About 40% of Saskatchewan's wetlands have been drained and a further 2% are lost each year, mainly to agriculture (Pratt, 1982). Drainage projects should be exposed to environmental assessment and to cost-benefit analyses by impartial experts and at the expense of the proponents. And natural lakeshore margins vital to the ecosystem, are rapidly being lost on the Great Lakes and smaller lakes.

[1] The bigmouth shiner, one of few species to live in channel-like habitat, has been found to increase in channelized streams.

3) Stricter enforcement through better staffing of anti-pollution teams[2] and where necessary better legislation, with immediate action to control sources of acid rainfall endangering fauna and flora even in parks. As a temporary short term-measure only, the introduction of lime as a buffering agent into acidified lakes - but only hand in hand with simultaneous enforcement of acid fallout regulations. Yukon has 9 conservation officers for 518,000 square kilometres (Hartman, 1980a).

   Specific legislation on oil pollution is needed, with enormous oil tankers sailing from Alaska, along B.C.'s rugged coast to Washington, and continuing shipments to and exploration along the Atlantic coast. Often critically sensitive are those egg and larval stages which live just below the surface, as oil tends to float. The particular dangers of oil spills in the Arctic were pointed out by Don McAllister (1977). Hydraulic mining in Yukon destroys fish habitat by siltation. General fish habitat policy recommendations were made by Fisheries and Oceans Canada (1983).

4) Increased incentives for a better balance between logging and reforestation. In British Columbia and Ontario for example, trees are being cut faster than they are being replaced - a very short-sighted policy. This is especially important as our non-renewable supplies of hydrocarbons such as oil and gas are being exhausted. Our forests have an enormous potential as sources of building materials, paper, organic chemicals, energy, as refuges for both wildlife and man. Special funds for research on the benefits of polyculture of trees should be introduced; we already know the problems caused by growing huge fields of a single species of crop plants. Trees are also important in conserving soil and maintaining the balance of oxygen and carbon dioxide in the earth's atmosphere. Canada's failure to replace its forests is contributing to a serious world-wide problem.

5) Increased support for a thorough co-ordinated faunal and floral survey, and taxonomic research and status reports on Canada's natural history heritage, with publication of a series of popular guide books by provincial and national museums. Distributional data on most biota has been collected haphazardly during local surveys and much is out of

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[2] Yukon has 9 conservation officers for 518,000 square kilometres (Hartman, 1980a).

date. Many areas are unsurveyed or poorly surveyed. The survey would give a fresh data base from which to evaluate the current status of our fauna and flora. A number of new species have not yet even been named by science through lack of support. Two species of fishes were added to the Ontario fauna in 1980, and 50 to the B.C. coast between 1973 and 1980, and over 300 to the Canadian freshwater and marine fauna in the 15 years between 1969 and 1984. How little we know our fauna and flora.

6) Support is needed for a series of life history and ecological studies that are looking for these species in Canada. Proper protection can be given to a species only when we know its requirements. One sheet of typewriter paper would exceed the space needed to describe our present knowledge of the life history of the Acadian whitefish. Scott and Crossman (1979) drew to attention in the introduction to the <u>Freshwater Fishes of Canada</u> to the lack of information on aspects of biology of numerous Canadian fishes.

7) A network of federal monitoring stations be set up across Canada using standardized collecting gear and methods to monitor changes in fauna, flora and environment. This will provide a base line for measuring changes in abundance and deterioration of the environment.

8) Although millions of dollars have been spent to try and save birds and mammals, little has been spent on studying and preserving other species of animals and plants. This imbalance should be resolved by increased funding from the public and private sectors.

9) Fisheries managers should exert great caution in introducing exotic species. Public hearings should be held prior to introductions. Competition, predation, environmental modification (as in carp), or diseases or parasites carried by exotic species may harm native faunas. When introductions are made in drainage basins shared by other provinces, states or countries, it is unethical not to secure their approval for introductions. It is beholden upon wildlife managers to be aware of the distribution of rare, threatened and endangered species and subspecies in their jurisdiction when making introductions, reclaiming lakes, or approving industrial or other projects.

Before lakes are "reclaimed" (poisoned) for replanting with sport fishes, a committee of taxonomic advisors should be consulted. At least two populations of rare taxa have been unknowingly destroyed in Canada by lake poisoning programs.

As McPhail (1980b) pointed out, due to reclaiming lakes and stocking programs, it is difficult to find native genotypes of sport fishes uncontaminated by hatchery stocks. And before poisoning lakes, complete samples of the fauna and flora should be preserved in museums as permanent records for future reference.

10) Specimens of any rare or endangered fish species found dead should be preserved in 10% formalin, labelled with full details of where and when it was found and deposited in a museum. These may provide valuable information on age, growth reproduction, parasites, taxonomy and distribution. Specimens may be sent collect to: Curator of Fishes, National Museum of Natural Sciences, National Museums of Canada, Ottawa, Ontario, K1A 0M8.

Categories

Between the category extinct and an undisturbed healthy natural population, many different degrees of depletion are possible. For this reason and the lack of information on many species, categorization into rare, threatened, or endangered is difficult. This is further complicated by distribution, some species may be restricted geographically but common locally while others although widespread geographically may be rare at any one location. However, for the purposes of indicating the relative degree of threat it is still useful to try to approximately categorize the Canadian and world status of each species in the list, subjective though it may be.

It is hoped that status reports and population estimate studies will be financed and form the basis for a more quantitative evaluation of status following the suggestions of Peden (1979). It is further hoped that provinces and federal government departments will follow the terminology used by COSEWIC (see below) for classifying species which are at risk, or that they all agree to follow ICUN terminology. Clayden, McAlpine and Guidry (1984) class New Brunswick species as rare and vulnerable. Use of different classification schemes make it difficult to compare status in different parts of its range in Canada.

The status given in this report is provisional unless we indicate it is on the list of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Only 11 of the 37 forms described in this publication have been classified as of April 1984.

COSEWIC is a national committee that reports on the status of species and assigns them a risk category. The committee includes representatives of federal, provincial and territorial governments, and national conservation agencies. The status designated by COSEWIC has no binding effect in law, it may have a moral influence. Even the support to write reports (not to fund research) comes largely from the World Wildlife Fund (Canada), other organizations and individuals, and not COSEWIC. This situation contrasts strongly with that in the United States where the Endangered Species Act of 1973 provides extensive legal protection and other resources not only to protect but also to assist in the recovery of endangered species. COSEWIC may be contacted by writing: Secretary, Committee on the Status of Endangered Wildlife in Canada, Environment Canada, Place Vincent Massey, 16th floor, Room 1625, 361 St-Joseph Boulevard, Hull, Québec K1A 0E7.

The categories, following approved COSEWIC terminology, may be defined as follows:

EXTINCT — Any species of fauna and flora formerly indigenous to Canada but no longer existing anywhere, e.g. blue walleye, *Stizostedion vitreum glaucum*.

EXTIRPATED — Any indigenous species of fauna or flora no longer existing in the wild in Canada but existing elsewhere, e.g. the paddlefish, *Polyodon spathula* is extirpated in Canada, but survives in United States.

ENDANGERED — 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, e.g. pugnose minnow, *Notropis emiliae*, endangered in Canada.

THREATENED — Any indigenous species of fauna or flora that is likely to become endangered if factors affecting its vulnerability do not become reversed, e.g. Squanga whitefish, *Coregonus* sp., threatened in Canada and world.

RARE — 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, e.g. Opeongo whitefish, Coregonus sp.; rare in Canada (and world). Requires careful watching.

DEPLETED — Although still occurring in numbers adequate for survival, the species has been heavily depleted and continues to decline at a rate substantially greater than can be supported, e.g. lake sturgeon, Acipenser fulvescens. Not a COSEWIC category.

INDETERMINATE — Apparently endangered or threatened but insufficient data currently available on which to base a reliable assessment of status. Not a COSEWIC category.

Species, like sea horses, which drift into Canada waters and which do not normally reproduce there, are excluded from consideration since expatriates do not comprise an element of our normal fauna.

Species Deleted from Previous Lists

The following species, including previous lists, are deleted for reasons given.

Alosa aestivalis (Mitchill) - blueback herring/alose d'été (f.)

McAllister and Gruchy (1978) listed this species as rare for Canada. But studies by Messieh (1977) and work by Brian Jessop, communicated by M.J. Dadswell, 16 September 1979, suggest it is less rare than previously thought, comprising 17-53% of gaspereau, Alosa pseudoharengus runs in the Miramichi, Shubenacadie and Margaree rivers and a spawning escapement of 81,300 to 185,300 in the years from 1971 to 1977.

Coregonus alpenae (Koelz) - longjaw cisco/cisco à grande bouche

Clarke and Todd (in Lee *et al.*, 1980) and Todd, Smith and Cable (1981) synonymized *Coregonus alpenae* Koelz with *Coregonus zenithicus* (Jordan and Evermann), itself an endangered species according to Deacon *et al.* (1979). But as Clarke and Todd (*op. cit.*) have shown there are at least 12 populations extant of *C. zenithicus* outside of the Great Lakes in northwestern Ontario, Manitoba, Saskatchewan and Northwest Territories, we do not regard *C. zenithicus* as endangered or even rare.

Thunnus thynnus thynnus (Linnaeus, 1758) - bluefin tuna/thon rouge (m.)

Greenwalt and Gehringer (1975) proposed that this subspecies be classified as threatened. But U.S. authorities have declined to act on this proposal.

Format

Following the family and species names, scientific, English and French (masculine and feminine are abbreviated m. and f. to indicate the gender of the French names), species are treated under headings as follows:

Canadian status: The Canadian range, status and size of populations and trends in-so-far as are known. Known threats to existance of Canadian population are mentioned.

Status elsewhere: As under Canadian status, but for populations outside of Canada - which generally means in U.S.A.

Taxonomic status: This section is included for taxa whose status is not resolved. This may include uncertain subspecific designation, species or subspecies which have not yet been named, or other problems.

Distinguishing features: Provides a résumé of distinctive characters which together with the illustration of the species and known range should help identify the specimen. However in the minnow and sucker families it would be preferable to identify specimens with keys in a national (Scott and Crossman, 1979) or provincial fish book, or better to send the specimen to an expert.

Habitat: To preserve a species it is essential to know and protect its habitat. This section sumarizes what is known of the environmental parameters at collection sites. Secchi disk readings express the depth in metres that a white disk can be seen, thus providing a measure of clarity of the water.

Biology: This section summarizes what is known of spawning, growth, age, feeding, predators, parasites.

Protective measures taken: This describes what laws, if any, prohibiting capture or protecting portions of its range, have been passed.

Recommendations: This describes ways of assuring continued existence of the species such as studies of biology, habitat, taxonomy, control or removal of threats, establishment of preserves, etc. No species of endangered fish is as well known as the whooping crane or whistling swan. I'm not aware of behavioral (ethological) studies on any of the fish in the body of the list. Tolerance to acidity (from acid rainfall) is known for exceedingly few Canadian species. It is evident that funding should be shifted from some of the better known to the more poorly known species or better still that additional funding should be found.

Canadian range maps: The range in Canada is mapped for each species. Only the Canadian portion of the distribution is shown for those species that range into the United States. Several kinds of fish occur only in Canada; for these species the caption reads "World range". Forms found only in Canada are: aurora charr, Squanga whitefish, Opeongo whitefish, Acadian whitefish, Banff Longnose dace, Y-prickleback, and the giant stickleback.

For American ranges of species which extend south into the United States of America, the reader may refer to Lee *et al.* (1980), *Atlas of North American Freshwater Fishes*. Most of these maps show the historical range; the range of many species has contracted in recent years.

The present report was put together without any approved project funding, no continuing person-year assistance, but with the co-operation of many individuals, most listed in the acknowledgements, while occupied with an abundance of official projects. These constraints, and a wish to bring some facts to the public's attention, while there is yet some chance of remedial action, lead us to publish this in considerably less than perfect or complete form. Although we have failed in achieving our object, a text that throughout would be easy to read for the public and sufficiently authoritative for the scientist, we hope that at least some parts will be meaningful to these audiences. We have not been able to keep the text, written over several years, perfectly up-to-date and one species has become extinct during the preparation of the manuscript. Some COSEWIC status reports on fishes in preparation at this moment will probably be completed by the time this is published. Status reports on individual species in mimeographed form may be obtained at cost, usually $2 to $3, by writing:

Canadian Nature Federation
75 Albert Street
Ottawa, Ontario
K1P 6G1

As of April 1984 COSEWIC had approved status for the following 11 of the 26 species for which reports have been submitted:

shortnose sturgeon	rare
speckled dace	rare
giant stickleback	rare
blueback herring	not in any menaced category
spotted gar	rare
spotted sucker	rare
silver shiner	rare
river redhorse	rare
Charlotte unarmoured stickleback	rare
Acadian whitefish	endangered
shorthead sculpin	threatened

Additionally, we may point out that Canada is signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Persons wishing to ship material of listed species must have the appropriate export and import permits for Appendix I species (rare or endangered), Appendix II species (liable to become rare or endangered), and Appendix III species (not necessarily endangered but are managed within the listing nations). The only Canadian fish species listed are the shortnose sturgeon (*Acipenser brevirostrum*) in Appendix I, and the Atlantic sturgeon (*Acipenser oxyrhynchus*) in Appendix II. CITES is administered in Canada by: Administrator, Convention on International Trade in Endangered Species, Canadian Wildlife Services, Environment Canada, Ottawa, Ontario K1A 0E7.

ACIPENSERIDAE

sturgeons esturgeons

Acipenser brevirostrum Le Sueur, 1818 - shortnose sturgeon/esturgeon à museau court (m).

The sturgeon family has been on earth for at least 70,000,000 years. Three of the world's 23 species are found in eastern Canada and another two in British Columbia. Dams, overfishing and pollution have reduced or extirpated populations of many sturgeons. Restoration of sturgeon populations takes many years as they mature late in life. Males of the shortnose sturgeon mature at 12 years and females at 18 years. Canada is fortunate enough to have one of the healthiest populations of shortnose sturgeon, which ranges south to Florida. Hopefully, by improving the water quality of the St. John River system, we will be able to preserve this relict of the Cretaceous age peacefully munching shellfish, for future generations to admire.

Canadian status: Classified as rare on the list of the Committee on the Status of Endangered Wildlife in Canada. A four year tagging study (Dadswell, 1979) resulted in a population estimate of 18,000 adults plus or minus 30% in the Saint John estuary, probably the largest single population of the species. Despite a moderate population in the Saint John River system in New Brunswick, its limited occurrence and unanswered questions on its spawning, recruitment, and population trends mean that additional research is required. Dadswell (1979) did not believe this population could be considered endangered as long as the Saint John estuary is protected from degredation. There is some mortality of shortnose sturgeon caught in nets set for other species (Gorham and McAllister, 1974). The long period needed to reach spawning age, 12 years for males, and 18 for females would require a very long recovery period if the population was ever reduced. The COSEWIC status report on this species is in press (Dadswell, 1984).

Status elsewhere: Listed as nationally endangered for the United States (Miller, 1972; Williams and Finnley, 1977; Deacon *et al.*, 1979; U.S. Department of Interior List of Endangered and Threatened Species). Listed as threatened with extinction by the *Convention*

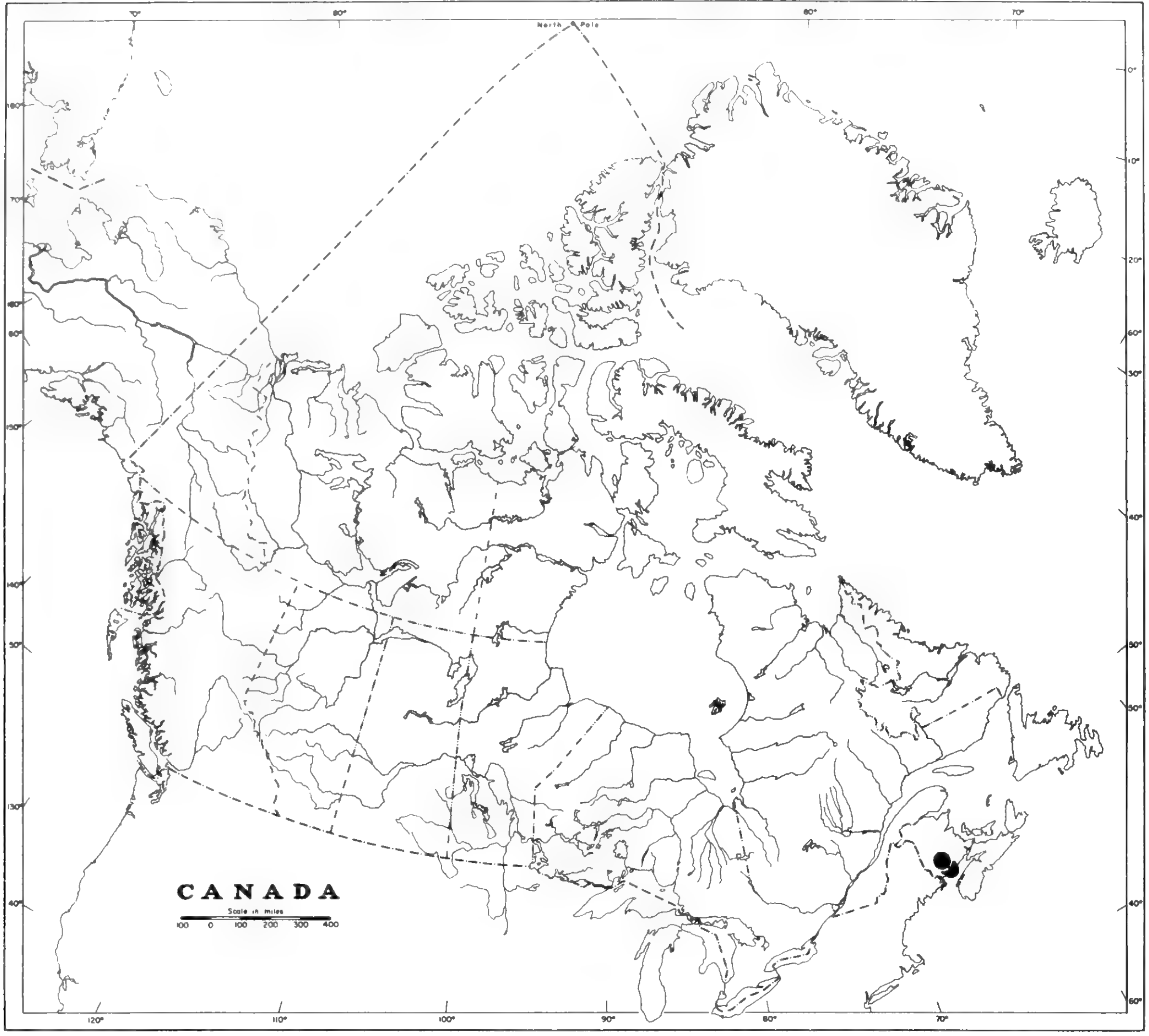

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FIGURE 3: Map of the former Canadian distribution of the shortnose sturgeon / esturgeon à museau court - Acipenser brevirostrum.

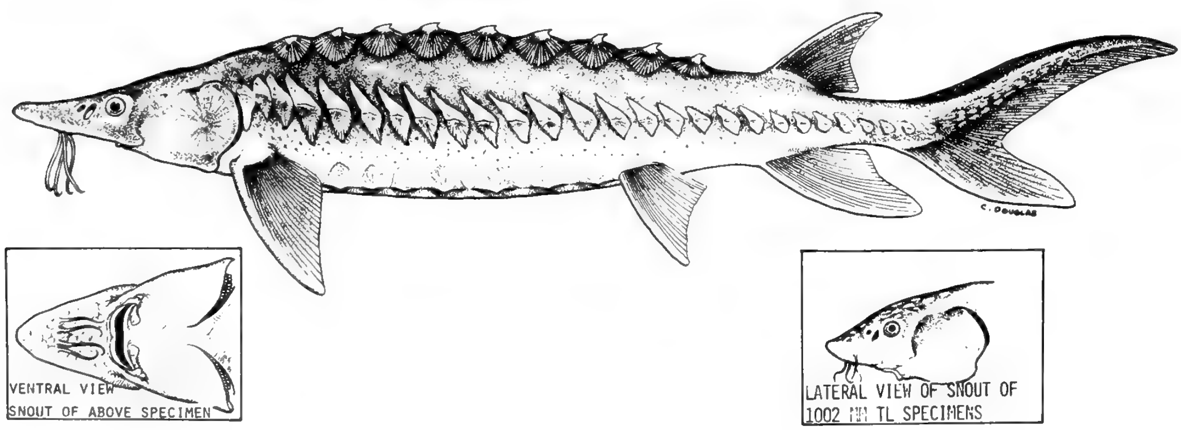

FIGURE 4: Drawing of the shortnose sturgeon / esturgeon à museau court - Acipenser brevirostrum. Males first spawn at an age of 12 years. Females first spawn at 18 years and some reach an age of 67 years.

on international trade in endangered species of wild fauna and flora but against which species Canada has placed a reservation. United States officially placed this species on the endangered species list 11 March 1967 (Federal Register 32(48):4001. Listed as endangered for Florida by Gilbert (1978a), "Extirpated?" for freshwaters of North Carolina (Bailey, J.R., 1977) and probably "extirpated" for marine waters of the same state. Recently captured in the Wynyah Bay system and is common in the Black River, South Carolina (M.J. Dadswell, in litt., June 1979). There have been no reports of this species in the Chesapeake Bay area since 1950, though it may still occur in modest numbers (Stauffer, Hocutt and Lee, 1978), but 4 were taken in the Elk River in 1978 (M.J. Dadswell). There were reports for the species in Florida in 1969, Hudson River, N.Y. in 1971, and Maine in 1973 (Dadswell, 1979); one caught in Penobscot River, Maine and is in Lower Connecticut River in 1978, and about 500 adults in spawning run in Hudson in 1979. Williams and Finnley (1977) listed habitat alteration, pollution and overfishing as threats to its survival. Those surviving in the Hudson river are commonly afflicted with fin rot, probably as a result of the high levels of pollution in this river (Ono, Williams and Wagner, 1983).

Distinguishing features: The following characters distinguish the shortnose from the Atlantic sturgeon, *Acipenser oxyrhynchus*, the only other sturgeon known from the Saint John River, N.B. (Gorham and McAllister, 1974).

	Shortnose sturgeon	Atlantic sturgeon
colour of intestine	dark	light
enlarged bony plates between anal fin & lateral row scutes	absent	present
snout	short and blunt	long and pointed
size	up to 1.4 m	up to 4.3 m

Habitat: This species inhabits the broader downstream portions of the Saint John River and its lake-like or bay-like tributaries, usually those ½ to 2 miles wide. Juveniles remain in riverine habitat of the upper estuary until they attain 45 cm whereupon they join the annual upstream migration of non-breeding adults in spring-summer and downstream in fall. An undetermined portion of the population is anadromous, spending part or all of a year in the Bay of Fundy (Dadswell, 1979). In winter they occur in deep water 12 - 18 metres deep, in spring and summer they move into shallower water. They have been caught in salinities of up to 30°/oo, but occur mostly in water of much lower salinity, averaging 20°/oo in the lower estuary during winter.

Biology: The following information is from Dadswell (1979). Both sexes "mature" at about 50 cm fork length or age 10, but gonad ripening and spawning is delayed. Males spawn first at about age 12, thenceforth at two year intervals, females at about 18 and thence at 3 to 5 year intervals. The sex ratio is 2:1 for females, males declining from 50% of the population after 20 years of age to nil at 30 years. Mean ripe egg diameter is 3.1 mm, and 28,000 to 200,000 eggs are laid. Spawning takes place in May-June at 10°-15°C in riverine sections of the upper estuary during the spring freshet. Salinity would be nil during this period. Data on reproduction in Connecticut River, Massachusetts is provided by Taubert (1980).

Feeding in fresh water was confined to the period May-October but continued all year in saline water. Juveniles ate mainly insects and crustaceans (but also contained up to 90% non-food items such as mud, stones and woodchips, so it is desirable to avoid dissemination of man-made wastes on foraging grounds); adults ate small molluscs. Foraging grounds of adults in the upper Saint John estuary were mainly in one to five metres depths. These areas were highly eutrophic with abundant macrophytes. Foraging in the saline lower estuary was over sand-mud bottoms five to fifteen metres deep.

Maximum known total length for the species is 143 cm (122 cm fork length) (Dadswell, 1979), weight 23.6 kg, age 67 years for females, and 97.0 cm fork length, 9.4 kg and 32 years for males. Most specimens were under 90 cm fork length, however. The smallest shortnose sturgeon captured was 11 mm in fork length during the spawning season of 1979 (M.J. Dadswell, June 1979).

Curiously, shortnose sturgeon appear to exhibit a kind of friendship. Specimens tagged together tended to be recaptured together even after one to three year intervals. It is highly unlikely this was due to chance.

Helminth, anthropod and nematode parasites are reported by Appy and Dadswell (1978).

Protective measures taken: New Brunswick fishery regulations (amendment list October 10, 1978, p. 12-22, copy kindly provided by D.J. Denny) forbid use of nets with mesh size less than 13 inches for sturgeon fishing, and fishing for, catching or killing sturgeon that are less than four feet in length (from extreme point of head to the tip of the tail). Fishing for sturgeon is forbidden without a license. These afford some measure of protection to the shortnose sturgeon which is usually smaller than the Atlantic sturgeon.

Recommendations: 1) Institution of a program to monitor population trends so that action may be taken if the population decreases.

2) Continued monitoring and reduction of pollution.

3) Study to locate the spawning sites, and nursery grounds for young under 18 cm length (M.J. Dadswell reports study in progress, June 1979).

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POLYODONTIDAE

paddlefishes spatules(f.)

Polyodon spathula (Walbaum, 1792) - paddlefish/spatulaire (m.)

The aptly named paddlefish sports a paddle-shaped snout and reaches a total length of about 5 feet or 1500 mm. With its capacious mouth and fine comb-like gill rakers, it strains small animals from the water. Around the turn of the century, the paddlefish disappeared from Canada and the Great Lakes. Now it survives only in the Mississippi Valley and adjacent Gulf slope drainages of the U.S. and even there it has been declining in recent years because of habitat loss and overfishing. As Canada's first fish to be extirpated, it leaves a lesson to be learned.

Canadian status: Extirpated. The authority for its occurrence in Lake Huron, Canada is Halkett (1906, p. 367) who reported.." a specimen of the paddlefish (*Polyodon spathula*) from near Sarnia, Ontario - long in the museum - is valuable because it is one of only a few specimens of that species which have been found in Canadian waters in recent times'" and Halkett (1913) who additionally reports it from the Spanish River, District of Sudbury (one specimen); Lake Helen, Nipigon River (one specimen); and Lake Erie (if from the

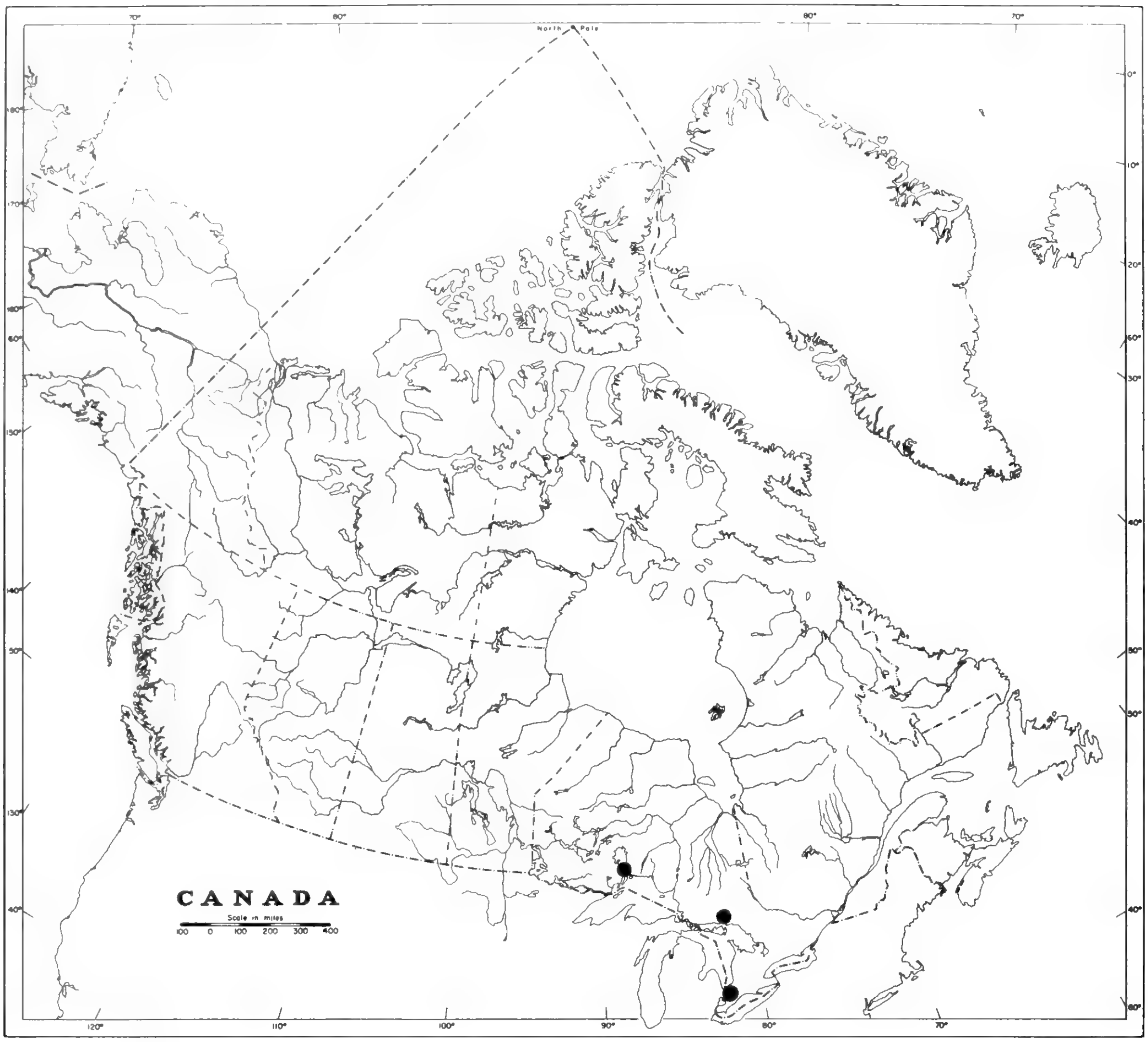

FIGURE 5: Map of the former Canadian distribution of the paddlefish / spathulaire - Polyodon spathula. The paddlefish was extirpated in Canada in the early 1900s.

Canadian side of the lake - one specimen). The two Sarnia specimens were discovered by divers attempting to re-float a ship (Montpetit, 1897, p. 221).

Status elsewhere: Extirpated in Ohio where a small population probably existed until at least 1903 until eradicated by dams blocking upstream spawning migration and/or destruction of spawning habitat (Trautman, 1957). Formerly abundant in the Mississippi Valley, apparently declining throughout its range because of habitat loss and overfishing. (Lee *et al.*, 1980). Threatened in Maryland, Minnesota, Pennsylvania, West Virginia and Wisconsin, endangered if still extant in North Carolina (Bailey, J.R., 1977). Habitat threatened in North Carolina (Deacon *et al.* 1979). See bibliography by Bonislawsky and Graham (1979).

Distinguishing features: Distinguished from other Canadian freshwater fishes by its long paddle-like snout. Maximum total length at least 120 centimetres, weight 67 kilograms.

Habitat: Large rivers, lakes and impoundments. Prefers quiet waters rich in plankton.

Biology: Spawns over gravel bars in large freeflowing rivers.

Recommendations: Too late to save the original population, but could be re-established.

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LEPISOSTEIDAE

gars lépisostés

Lepisosteus oculatus Winchell, 1864. Spotted gar/lépisosté tacheté (m.)

This species is so rare in Canada that there are only 13 specimens in Canadian museums. Little is known of its biology. The species is characterized by beak-like jaws with needl-sharp teeth, and spots on the head. A related species, the longnose gar, captures its prey by slowly sidling alongside of a small fish, then snatching the prey with a lightning-quick sideways twitch of the long needle-toothed jaws. The body is armoured with thick, hard,

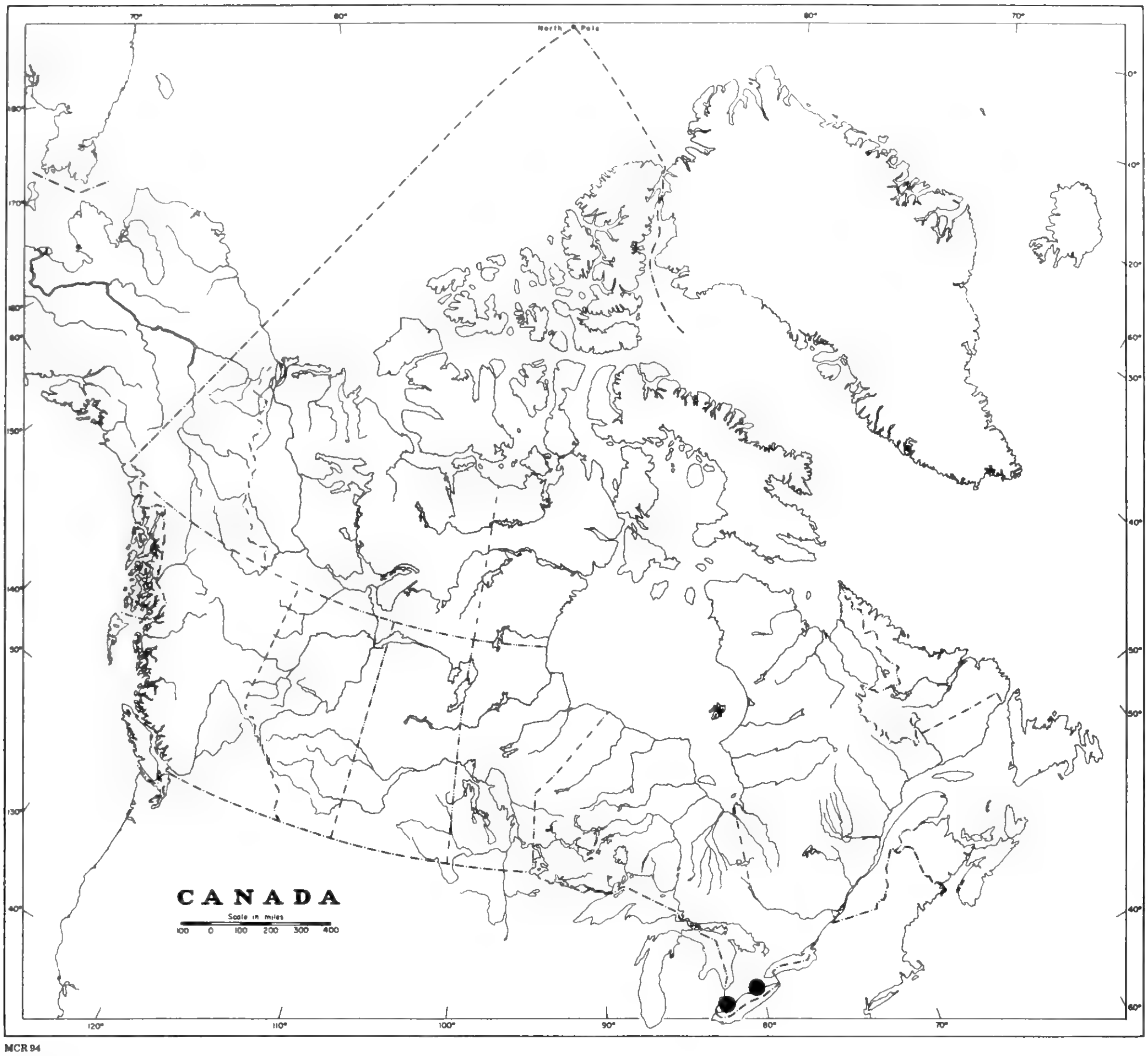

FIGURE 6A: Map of the Canadian distribution of the spotted gar / lépisosté tacheté - Lepisosteus oculatus. Only Canadian 13 specimens of longnose gar have been recorded in 67 years.

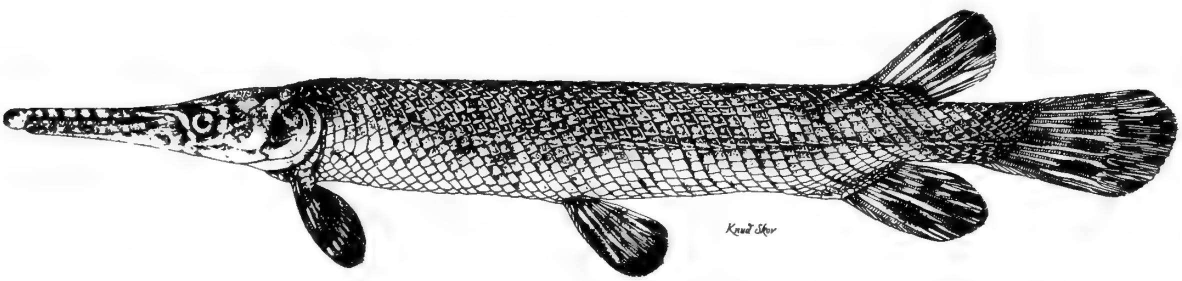

FIGURE 6B: Drawing of the spotted gar / lépisosté tacheté - Lepisosteus oculatus. The last of 13 voucher specimens ever taken in Ontario was caught in 1975. Its rarity is probably due to long-term habitat destruction.

almost rectangular-shaped scales. These scales would protect it from the jaws of most predators.

Canadian status: Rare (COSEWIC status, April 1983). This species is known from only four localities in southern Ontario and only thirteen specimens have been collected since it was first found in Canada in 1913. Documented localities are: Long Point Bay, Lake Erie, Norfolk Co.; Rondeau Bay and Harbour, Lake Erie, Kent Co.; Point Pelee, Lake Erie, Essex Co.; Lake St. Clair 4 km west of mouth of Thames River, Kent Co., all in Ontario. Despite recent (1973, 1978, 1979) intensive sampling, there have been no repeat captures at Long Point Bay and at Point Pelee, suggesting breeding populations do not exist or are very small. A small reproducing population is suspected to be present in Rondeau Harbour. The extensive adverse changes in the limnology of Lake Erie are too well known to require repeating here, save that they are greater than in any other of the Great Lakes. The available data suggests that the COSEWIC status is probably under-rated; it should probably be classified as at least threatened. Commercial fishermen and bait dealers in western Lake Erie kill all gar captured because the gars eat other fishes. The COSEWIC status report on this species is in press (Parker and McKee, 1984a).

Status elsewhere: Ranges from the Great Lakes south to the Gulf of Mexico, eastward along the Gulf Coast to western Florida, and westward to central Texas (Wiley, 1976). It is considered endangered in Ohio and occurs in small numbers throughout most of its range.

Distinguishing features: It shares the long narrow snout and hard diamond-shaped scales found in the longnose gar, Lepisosteus osseus. It may be distinguished from that species by its spotted head, and wider snout (least snout width 6-8 instead of 14-18 times in snout length), and 53-57 to instead of 61-65 lateral line scales. Average total length 570 mm, range 400-660 mm in Ontario. Wiley (1976) discusses its taxonomy and relationships.

Habitat: Lives in warm, or slow moving water with much aquatic vegetation or other cover (Lee and Wiley in Lee et al., 1980).

In Canada the spotted gar has been collected from sluggish rivers, and the quiet bays and backwater areas of lakes. Aquatic vegetation was usually dense and spatterdock (Nuphar), cattail (Typha), and common waterweed (Anacharus) were abundant at several capture sites. Bottom substrates were usually composed of clays, detritus, or soft muck. a single capture site in Rondeau Bay had a gravel bottom and was devoid of aquatic macrophytes, although dense aquatic vegetation was present a few hundred metres from the capture site. The water in Rondeau Harbour was quite turbid (Secchi disc visible at up to 15 cm). Water temperatures varied from 15 to 17°C and dissolved oxygen levels ranged from 9 to 11 mg/L. This species is tolerant of warm waters and low dissolved oxygen levels and can survive in these conditions for extended periods (Scott, 1967) because it can breathe air.

Biology: The biology of the spotted gar in Canada is virtually unknown. In the U.S. it spawns in warm shallows where rooted vegetation is abundant (Scott and Crossman, 1979). It matures at a length of 522-575 mm. In Canada the diet is almost exclusively fish and includes yellow perch and minnows.

Spotted gar taken in Canadian waters ranged from 40 to 66 cm in total length. The average length of these specimens was 57 cm total length. The age of Canadian specimens has not been studied. Trautman (1957) stated that young-of-the-year in Ohio range in length from 18 to 25 cm total length, while adults range from 41 to 91 cm total length and weigh from 450 to 2,270 g. Redmond (1964) reported that one-year-olds in Missouri are approximately 25 cm long and three-year-old fish are about 51 cm long. An 18 year old female was recorded in Missouri by Redmond (1964).

Growth rates for the spotted gar have been calculated by Riggs and Moore (1960) for Oklahoma populations where young spotted gar grew between 1.4 and 2.1 mm in length and increased between 0.7 to 1.3 grams per day during July and August. Redmond (1964) found that males grew faster than females until age 2, after which females grew more rapidly. Females grow larger, and live longer than males (Scott and Crossman, 1979). Pflieger (1975) reported that in Missouri males matured when they are 2 or 3 years old while females did 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 were not 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 shallow warm waters of Louisiana, 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). Auer (1982) summarizes what is known of development.

Protective measures: None taken.

Recommendations: We make the following recommendations for spotted gar in Canada:

1) Identification information should be made available to concerned agencies and individuals. Pocket identification cards should be distributed to commercial fishermen. One side of the card would show how to recognize the species, the other side would explain its rarity.

2) A population survey should be considered by the Ontario Ministry of Natural Resources in conjunction with future fisheries surveys and commercial catch inspection programs. Samples to learn more about age, reproduction and food should be taken.

3) Assessment should be made of the importance of shoreline marshes and impact of lakeshore development on habitat of this species.

4) All moribund specimens, even if incomplete, should be deposited in the National Museum of Natural Sciences, Ottawa or a provincial museum.

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CLUPEIDAE

herrings harengs

Sardinops sagax caerulea (Girard, 1854) - Pacific sardine/sardine du Pacifique (f.)

From 1941 to 1945, over 50,000 metric tons of Pacific sardines were caught in B.C.; in the next 5 years, about 2,000 metric tons, and no significant quantities have been caught since. Lack of successful reproduction, overfishing or replacement by the California anchovy when the Pacific sardine was heavily exploited have all been blamed for the Pacific sardine's decline.

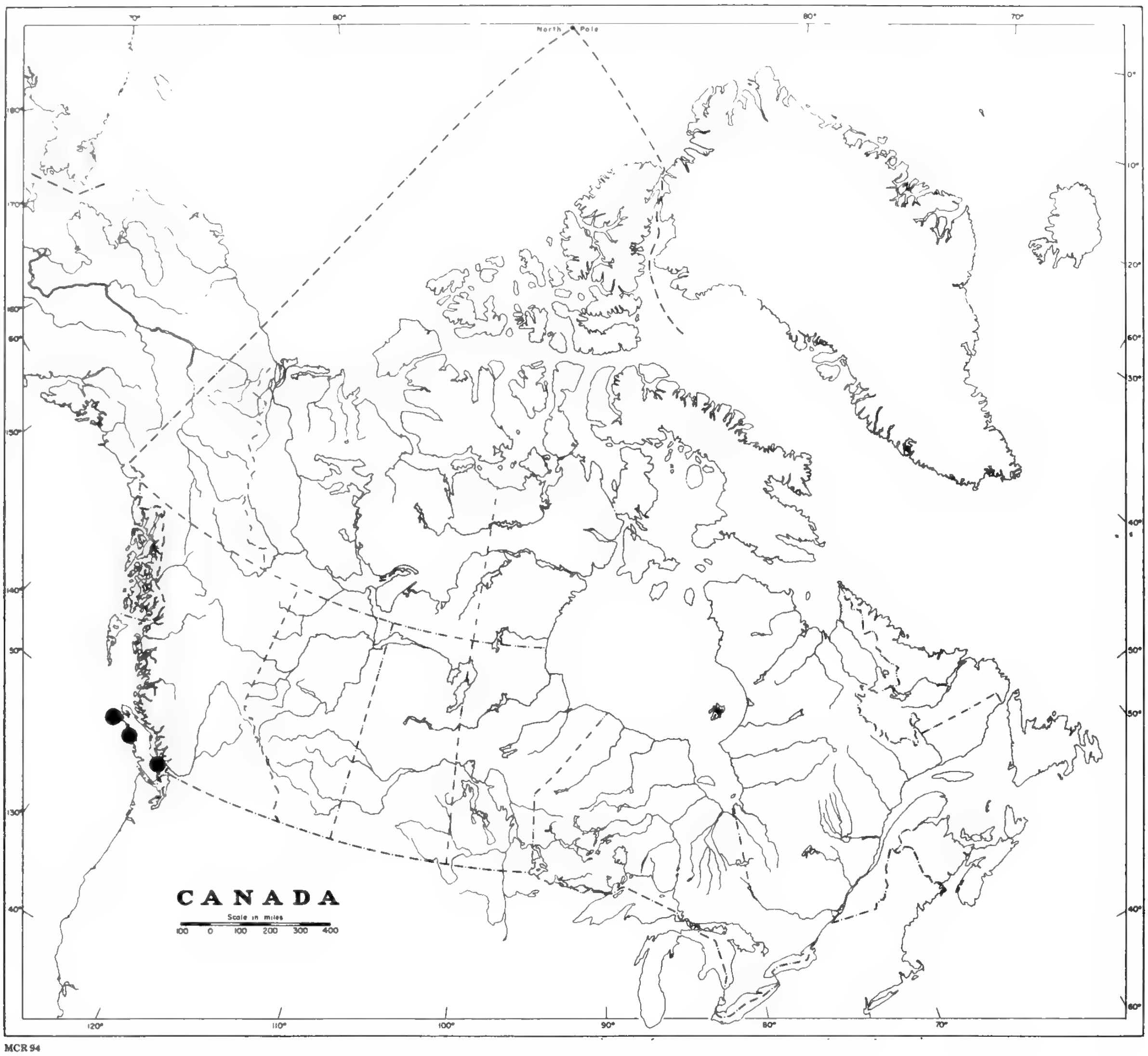

FIGURE 7: Map of the Canadian distribution of the Pacific sardine / sardine du Pacifique - Sardinops sagax caerulea. Overfishing probably lead to the great decline in numbers of the Pacific sardine.

Canadian status: Rare in British Columbia probably due to overfishing, unsuccessful reproduction in California, and/or ecological replacement by the California anchovy, *Engraulis mordax mordax* Girard.

Status elsewhere: In the North Pacific known from south-eastern Alaska, south to the Gulf of California. Although previous to 1950 there was a successful fishery in British Columbia, Washington and Oregon, there has been no fishery since that date (Hart, 1973). Even in California the fishery has been on the decline, there being a catch of only 15 million pounds in 1973 (R. McAllister, 1975) which is about 1% of the smallest annual catch from 1916 to 1960, in spite of a moritorium declared in June 1967.

Distinguishing features: Distinguished from the herring, *Clupea harengus pallasi*, by the presence of spots on the side and the fine lines on the gill cover, from the American shad, *Alosa sapidissima*, by the slender body, the short jaw extending only to below the pupil, and the weak instead of strong keels on the ventral scutes.

Habitat: The Pacific sardine is a migratory marine fish which moves north in summer and south in winter. Some overwintered in inlets on the west coast of Vancouver Island.

Biology: Spawning occurred in the offing of California and Baja California, mostly in April and May at temperatures between 15 and 18°C (Hart, 1970). About 30,000 to 65,000 pelagic (floating above bottom) eggs were laid by females at night. The young migrated inshore near beaches in schools. Food in Canada consisted mainly of diatoms, supplemented with copepods, other animals and plants.

Recommendations: 1) Restoration of the Canadian population will require restoration of the California stocks.

2) Investigators should be alert to report any occurrence of this species in Canada.

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SALMONINAE

<u>Salvelinus</u> <u>fontinalis</u> <u>timagamiensis</u> Henn and Rinkenbach, 1925 - aurora charr/omble de fontaine "aurora" (f.).

That acid rain poses real not theoretical problems, was demonstrated when acidified water, linked to sulphur dioxide emissions from Inco Ltd. smelters in Sudbury, wiped out the natural populations of aurora charr, leaving hatchery brood stock in only one lake. High levels of acidity have been shown to completely empty lakes of all fishes. We know that soil and rocks near Sudbury are practically barren of vegetation.

Although excessive acidity has been demonstrated to be lethal to fishes, other broader questions remain to be answered. Does it effect the bacteria, small plants and animals in the food pyramid? Will the vegetation on land slowly change when moderately acidified? At what point are toxic metals leached out of the rocks by acid rain?

However, the economic effects of acid rain on the tourist industry and the esthetic effects on the environment are firmly established. Should we not be urging industry and governments to take stronger action to reduce or eliminate emission of sulphur and nitrous dioxides from power stations, vehicles, smelters and factories?

<u>Canadian</u> <u>status</u>: Endangered. Original populations extinct, brood stock maintained in Alexander Lake and via hatchery stock in the districts of Gogoma, Hearst, Timmins, and Kirkland Lake, Ontario. The charr was planted in several barren or reclaimed Ontario lakes but in none of these lakes has there been evidence of natural reproduction to date (<u>in litt</u>., W. Keller, 31 July 1979). The brood stock maintained in Alexander Lake are pure aurora trout from carefully selected original stock (W. Keller). Reed Lake, the former stock lake for aurora trout, does not support a residual population and is presently a brook charr lake (W. Keller). Originally described from White Pine Lake, Temiskaming District, Ontario, and later found in nearby Whirligig and Wilderness lakes in Gamble and Corley townships at 47°27'N, 80°38'W, about 100 km north of Sudbury. These are in the headwaters of the east branch of the Montreal River, a tributary of the Ottawa River. It

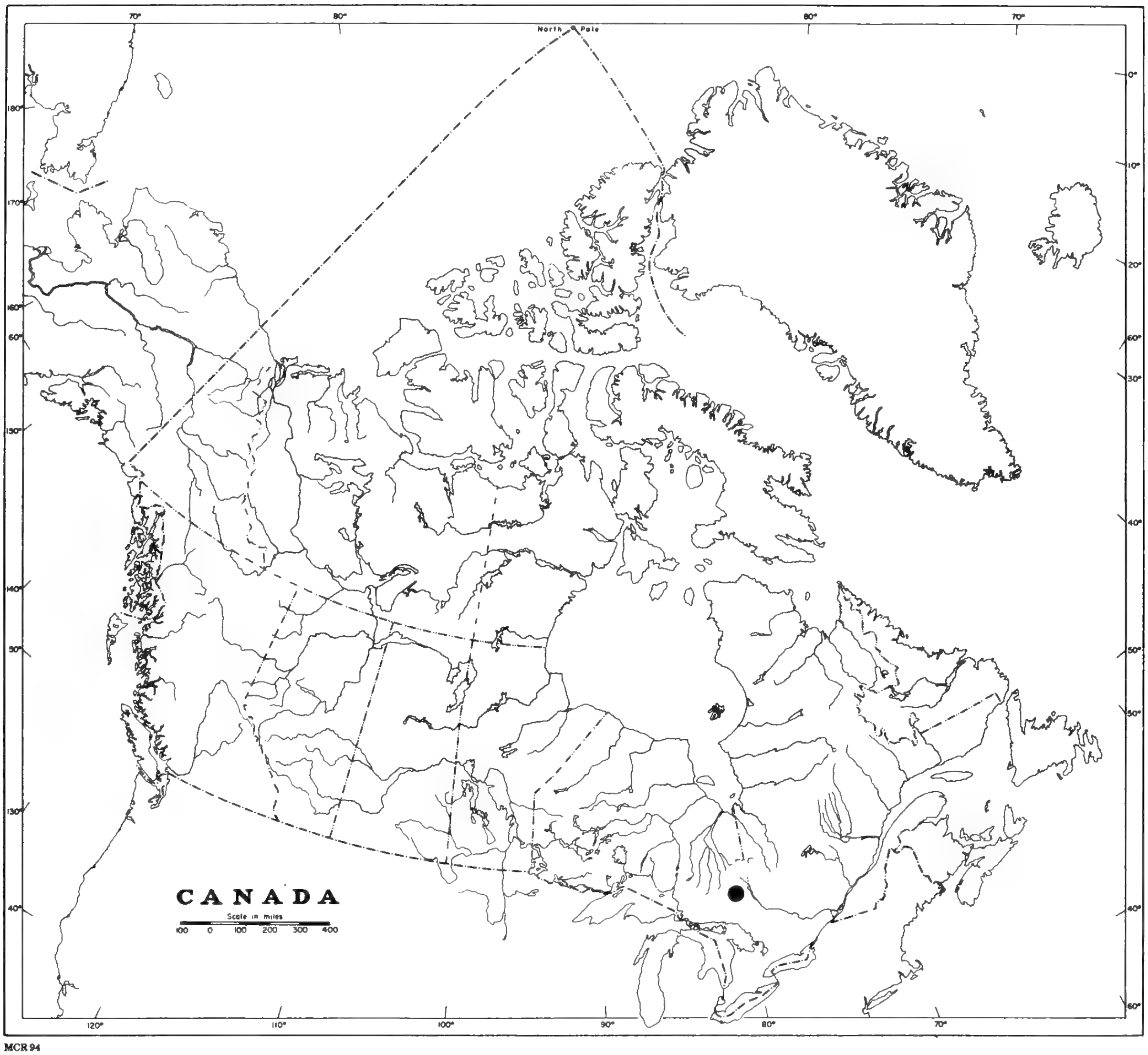

FIGURE 8: Map of the world distribution of the aurora charr / omble de fontaine "aurora", Salvelinus fontinalis timagamiensis. Acid rain killed all natural stocks of the aurora charr, leaving only introduced hatchery brood stock in Alexander Lake, Ontario.

was planted in the Cochrane District. Introduction of ordinary brook trout into its native lakes resulted in hybridization. Keller (1978) and Bartholm (1979) reported that the aurora trout in White Pine, Whirligig and Wilderness lakes have disappeared due to acid rain linked with sulphur dioxide emissions from Inco Ltd. smelters in Sudbury, probably about 1966. Acidity is measured on a pH scale of 0 to 14, acid to basic, with neutral water having a pH of 7. Excessive sulphuric acid in precipitation coupled with inherently low acid buffering capacity of these lakes resulted in a pH between 4.6 and 5.2 (normal pH for these lakes would be about 6.8). Below a pH of 5.5 adverse effects such as impaired reproduction in sensitive fish species such as trout, may be expected. Below pH 5.0 salmonids are generally eliminated (Keller, 1978).

Status elsewhere: Does not occur outside Canada.

Taxonomic status: The aurora charr was originally named as a distinct species, *Salvelinus timagamiensis*, and considered related to the Arctic charr, *Salvelinus alpinus* by Henn and Rickenbach (1925). Sale (1967) and Qadri (1968) concluded that it was not closely related to the Arctic charr and that it should be recognized as a subspecies of the brook charr, *Salvelinus fontinalis timagamiensis*. Aurora charr was originally sympatric in Whitepine Lake with native brook charr and showed little apparent hybridization, but apparently hybridized (judging by coloration) with brook charr which were introduced into Wilderness Lake (Sale, 1967). The two forms have been successfully hybridized at Hill Lake station hatchery. McGlade (1980) concluded, following study of karyotypic, electrophoretic and other characters, that the aurora charr was not sufficiently distinguished from other brook charr populations to constitute a valid subspecies. Colour was the only differentiating character according to McGlade (1980). We await examination of the formally published results of this study before withdrawing this species from the rare and endangered list (the published abstract has little data and apparently Qadri's diagnostic osteological characters were not examined).

Distinguishing features: The tail fin is square as in the brook charr, whereas it is slightly forked in the Arctic charr and deeply forked in the lake charr. Pyloric caecae number less than 55 in aurora and brook charr, 20-74 in Arctic charr, 93-208 in lake charr. Gill rakers number 15-22 in brook and aurora charr, 19-32 in Arctic charr and 16-26 in lake charr. The following table compares the aurora and brook charr. Bartholm (1979) reported the species ranged from 9 to 18 inches (230-460 mm), with the largest being 18¼ inches (464 mm) and 2¼ lb. (1 kg).

Table 1 Comparison between aurora and brook charr.
(from Sale, 1967 and Qadri, 1968)

Character	Aurora charr	Brook charr
Yellow spots & vermiculations	absent[1]	present
Red spots per side (mean, standard error, range)	1.4, 1.2, 0-6	11.2, 8.9, -
Caudal vertebrae (mean, standard error, range)	30.6, 0.14, 29-31	27.8, 0.15, 26-29
Total single neural spines (mean, standard error, range)	28.5, 0.4, 27-32	26.3, 0.5, 20-29
Number of ribs with bifid heads (mean, standard error, range)	34.5, 0.3, 33-36	33.2, 0.2, 31-36

Habitat: The following details on habitat and biology are from Sale (1967). Whitepine, Whirligig and Wilderness lakes in the Timagami Forest Reserve are at an altitude of about 430 m in a hilly forested area (pine, spruce, balsam, cedar, poplar and tamarack) of the Precambrian Shield. The bedrock is Precambrian gneiss. Whitepine Lake is 4.0 by 0.4 km with maximum depth 18 m and area 78 hectares, Whirligig with 11.5 m maximum depth and 11.5 hectares, Wilderness 10.7 m deep and 4.1 hectares. The lakes are highly oligotrophic (few nutrients, sparse plant and animal life) and clear water where a white disk can be seen at depths of 5.5 to 9.0 m. Maximum surface temperatures range from 20 to 23°C. The two larger lakes are stratified in summer with bottom temperatures of 10°C. The pH in 1962 or 1963 was 6.2 to 6.5 when trout still survived.

Biology: Aurora charr spawned in the first half of November on shoal areas in the lake, even though streams were available, whereas most brook charr spawn in streams. The eggs

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[1] But vermiculations may be seen in some preserved specimens (Qadri, 1968).

had incubation periods similar to brook charr. Growth rate was similar to brook charr, with two year olds 17 cm in fork length and 65 grams and five year olds 45 cm and 1092 grams. Maturity was reached in 2 or 3 years. The 2¼ lb. (1 kg) specimen was six years old.

Aurora charr fed on aquatic invertebrates, with over 90% of the diet comprising notonectids and gyrinids. Odonata, crayfish, chironomids, gammarids, and brook stickleback, *Culaea inconstans*, were also eaten.

Protective measures taken: The three lakes where it was found were made fish sanctuaries, but *Salvelinus fontinalis fontinalis* were introduced into Wilderness Lake and interbred with the aurora. Hybrid progeny of hatchery stock from Whirligig Lake were planted in Reed Lake, Bryce township, Seahorse Lake, Clifford Township, both in Temiskaming district; and in Lake No. 8, Swartman township, and Lizard Lake, Evelyn Townships, both in Cochrane District, and there is stock at two hatcheries (Sale, 1967; Clarke, 1969), including Hill Lake Hatchery (Bartholm, 1979). There has been a closed season on aurora charr since 1965. As of July 1979 aurora charr were in Alexander and Pallet lakes (Kirkland Lake District), Young and Claire lakes (Hearst District), Carol Lake (Gogoma District), and Big Club Lake (Timmins District). The original populations were subsequently destroyed by acid rainfall. An Aurora Charr Committee has been formed and is attempting to preserve the aurora charr through a hatchery program, to establish the charr in lakes where they can form self-sustaining populations, to make the species available to the angler in the future, and to settle its taxonomic status.

Recommendations: 1) Reduction in sulphur dioxide emissions from Sudbury to save other fish populations from being decimated.

2) Support for the work of the Aurora Charr Committee.

3) Study of diagnostic characters found by Dr. S.U. Qadri and a search for other characters in additional samples of aurora charr and a larger sample, specimen-wise and geographically, of the brook charr.

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Coregonus sp. - Squanga whitefish/corégone du Squanga (m.)

There are still undescribed large species of fishes such as the Squanga whitefish in Canadian waters. That populations of this and other species have been poisoned, through ignorance of their existence, to prepare lakes for the planting of sport fish, is appalling. It is evident that the knowledge of classification and distribution of Canada's fishes is still far from complete. Until more support is given to museums for taxonomic studies and faunal surveys, we risk losing distinct Canadian species when faunas or floras are intentionally or unintentionally wiped out. Taxonomic work cannot be entrusted to environmental consulting companies working on short notice just in advance of pipeline construction, opening of mines or other developments. Only museums have the expertise, collections and library resources to recognize and describe unknown species. Yet museums across Canada have not been given the staff and financial resources to accomplish the vital task of describing and mapping Canada's plant and animal resources.

Canadian status: Threatened. Endemic to Canada, known presently only from four lakes in southwestern Yukon Territory, Squanga, Teenah, Little Teslin and Dezadensh lakes, all in the Yukon drainage where it is sympatric with C. clupeaformis, and apparently as an introgressed population in Tatchun Lake. Previously also known in Hanson Lake, central Yukon, but that population was exterminated in 1963 for the purpose of planting rainbow trout, Salmo gairdneri. In two of these lakes it is threatened by a proposed pipeline (Bodaly, 1979). This and following information was obtained from C.C. Lindsey who is studying the species (in litt., 5 June 1979) and Bodaly (1979). A planned hydro-electric damming of the Teslin River (Hartman and Hayes, 1980) may affect Little Teslin Lake as well as Teslin Lake. A hydro-electric development has been proposed for Squanga Creek with the construction of an 8 metre storage dam on Teenah Lake and a one metre control weir on Squanga Lake.

Status elsewhere: Not known outside of Canada.

Taxonomic status: An undescribed species.

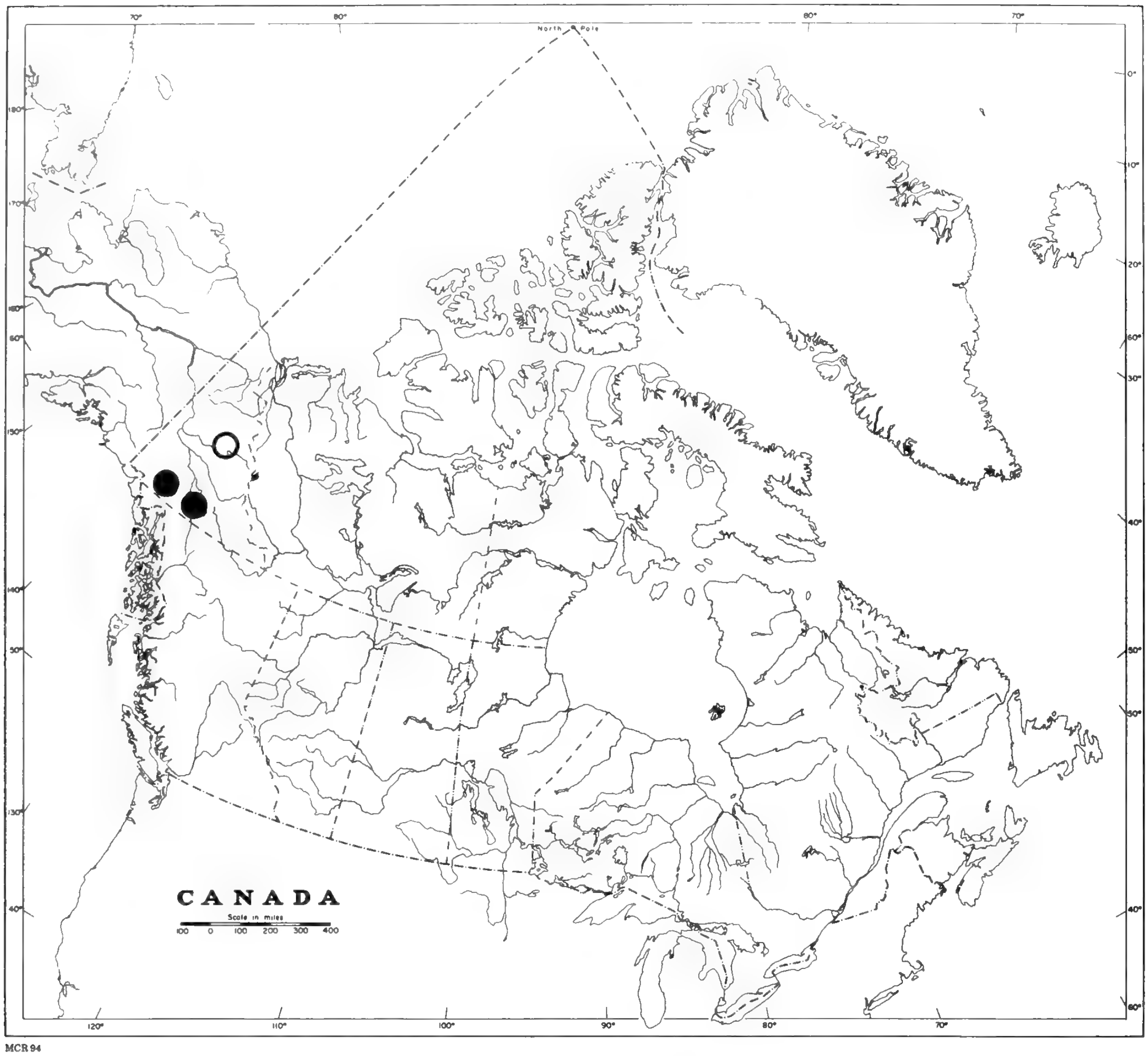

FIGURE 9: Map of the world distribution of the Squanga whitefish / corégone du Squanga - Coregonus sp. This species is known only in Canada. It has not yet been given a scientific name; more undescribed species are probably still waiting to be discovered in Canada. The Hanson Lake population (open circle) was poisoned for the purpose of planting with rainbow trout.

Distinguishing features: Characterized by a high gill raker counts, longer and closer rakers and smaller average size, slower growth, as well as by biochemical characters and ecological differences. The Squanga whitefish usually have 28-36 rakers, while sympatric *C. clupeaformis* have 24-27 rakers.

Habitat: Primarily an open-water plankton feeder, most abundant close to the surface over deep water, its habitat is therefore partially segregated from sympatric *Coregonus clupeaformis* which are typically benthic feeders in both shallow and deep water.

Biology: In Squanga Lake this species spawns in both inlet and outlet streams in November and December and are separated from lake whitefish at spawning time (Lindsey, 1963). It feeds on pelagic food composed mainly of crustacean plankton. In order of abundance in Dezadeash Lake the food items were cladocerans, copepods and chironomid pupae.

Protective measures taken: None.

Recommendations: 1) Crossing of the spawning areas on both the inlet and outlet streams of Squanga Lake by the proposed pipe-line should be abandoned in favour of a re-routed line remote from the lake. Construction of a pipe-line close to Little Teslin Lake would have to be planned to minimize erosion of disturbed soil into the lake which is without surface outflow.

2) An environmental impact study should precede any hydro-electric developments.

3) The species requires taxonomic study, description and naming. Its life history and ecological requirements of each life cycle stage should be studied.

4) Competing planktivores such as ciscos and predacious piscivores such as lake charr should not be planted in lakes inhabited by Squanga whitefish.

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Coregonus sp. Opeongo whitefish/corégone de l'Opéongo (m.)

The Opeongo whitefish is a bit of a mystery. Data from preliminary studies over 35 years ago suggested that the dwarf whitefish in Opeongo Lake might be genetically distinct. Ciscos, specialized plankton-feeding whitefish, were originally absent from the lake. In

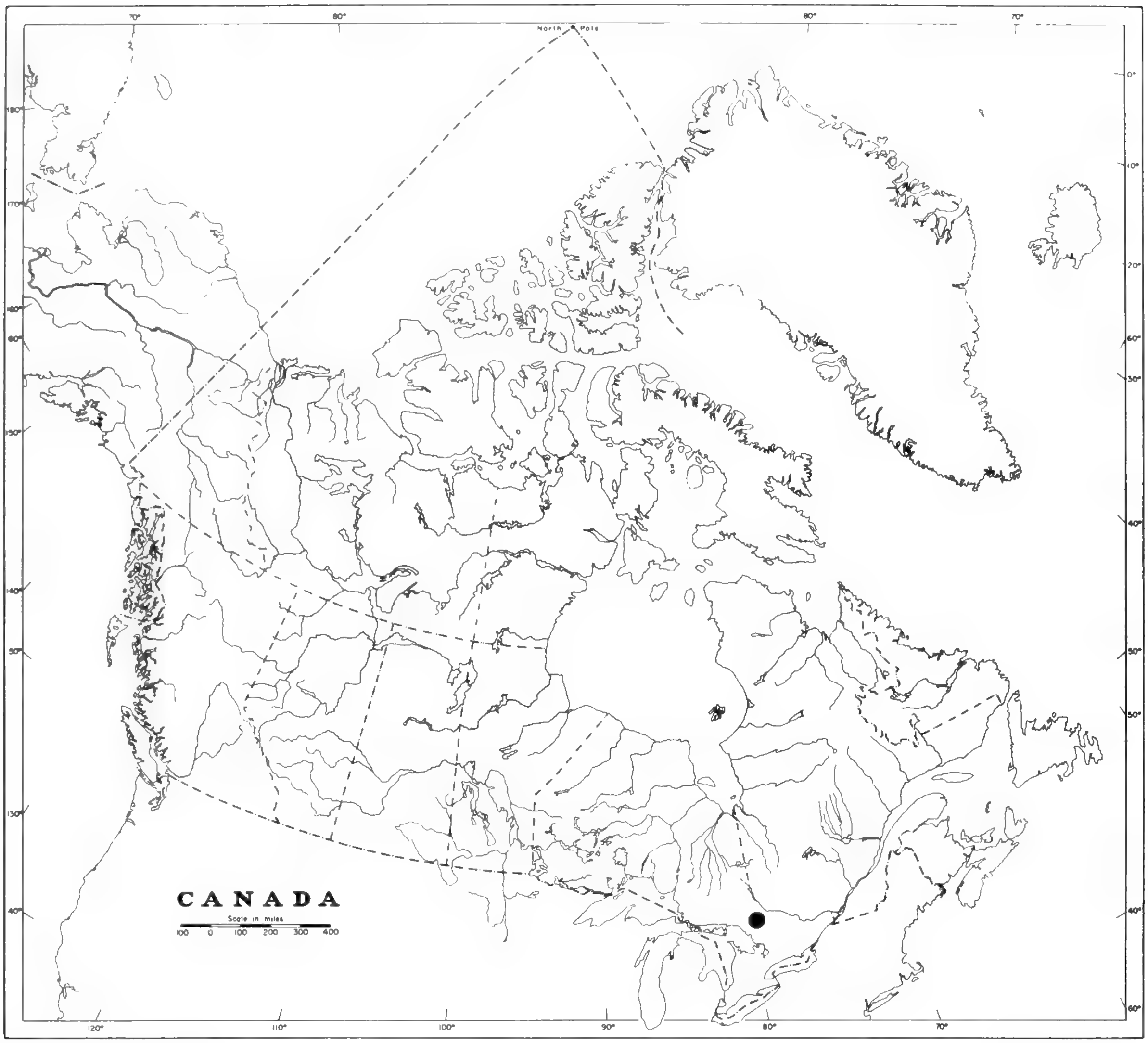

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FIGURE 10: Map of the world distribution of the endangered Opeongo whitefish / corégone de l'Opeongo - Coregonus sp. Acid rain, which is beginning to affect the waters of Algonquin Park, may pose a threat to this species. Opeongo Lake has been classed as moderately sensitive to acid precipitation.

the absence of ciscos, this population of lake whitefish had apparently evolved to fill the midwater plankton feeding cisco ecological niche.

But a few years ago the lake cisco, *Coregonus artedii*, was introduced into Opeongo Lake as food for lake charr. These cisco appear to have competed with the Opeongo whitefish whose population declined. However, it is still unknown if the Opeongo whitefish is a distinct species or simply a distinct spawning stock which may interbreed with the lake whitefish.

Canadian status: Endangered. Known from Lake Opeongo, Algonquin Park, Ontario (Kennedy, 1943 at 45°40'N, 78°25'W), where the dwarf Opeongo form is found sympatrically with lake whitefish, presumably *Coregonus clupeaformis*. Limited netting in the lake each year yields only 6-12 specimens recognizable as dwarf (*in litt.*, D. Cucin, 11 July 1979). The cisco, *Coregonus artedii*, introduced in the lake compete with the Opeongo whitefish, to its detriment. Acid precipitation is beginning to affect some of the lakes in the park.

Status elsewhere: Not known outside of Canada (unless the dwarf reported by Fenderson, 1964, from Maine is the same).

Taxonomic status: Kennedy (1943) reported two sympatric forms, one a dwarf and one large-sized (normals), in Opeongo lake differing in their morphology. This, their sympatry and Kennedy's belief that there was no intergradation between the two sympatric groups suggest that the dwarves may represent a distinct species. A scientific name has not been given to the dwarves. Discriminant function analysis of meristic counts by Ihssen *et al.* (1981) permitted separation of even all large Opeongo lake whitefish from lake whitefish in four other Ontario populations; this Opeongo population also displayed the largest genetic distance, based on electrophoresis of proteins, and the greatest homozygosity. However it is the dwarf Opeongo whitefish which differs most strongly (in gill raker and lateral line scale counts) from normal lake whitefish in Opeongo Lake and elsewhere in Ontario.

Distinguishing features: The statistics in the following sections are from Kennedy (1943) unless otherwise noted. Modally the mature dwarf Opeongo whitefish are 120 mm in total length and the large lake whitefish in the same lake 240 mm in total length. Pored lateral line scales average 77.3 (19 specimens) in dwarves, 83.3 (335) in mature lake whitefish

(82.0 in whitefish over 15 cm total length, 80.7 in lake whitefish less than 15 cm); these counts did not differ significantly between the scale counts of dwarves and immature normals of the same size only. Scale number differed significantly between normals over and under 15 cm according to Kennedy and presumably differed significantly between dwarves and normals above 15 cm long. Kennedy (1943) excluded a third group from the calculated curve on a log-log graph of scale diameter versus standard length because it fell too far from the curve; these had a mean scale count of 72.0 plus/minus 0.8; these were taken with special gear at one time of the year at one location. Ihssen et al. (1981) gave a pored lateral line scale count mean of 82.03 for normal Opeongo lake whitefish). Gill rakers in dwarves averaged 25.4 plus/minus 0.14 (63) and 27.4 plus/minus 0.22 (46) in immature normal Opeongo lake whitefish or 27.7 plus/minus 1.1 in all normal Opeongo lake whitefish (108) mature or immature; the difference was highly significant. Ihssen et al. (1981) gave normal Opeongo lake whitefish gill raker means of 28.13 plus/minus 0.16, or 28.37 plus/minus 0.18 counting rudiments. The vertebral count differences in the following table were reported as not significant in a chi-square test by Kennedy.

	Number of vertebrae								
	56	57	58	59	60	61	62	63	Total
Dwarves	-	6	14	47	28	20	1	1	117
Lake Whitefish	2	8	13	59	60	27	6	1	176

However when the counts were grouped to eliminate frequencies below 5, a chi-square value of 12.16 with 3 degrees of freedom, highly significant at a probability of between 0.01 and 0.005, was calculated. In other words re-analysis of Kennedy's data shows that meristic differences between the dwarf and lake whitefishes were significant are not due to chance. However, Kennedy in no case found a definite difference in body proportions between dwarves and normals.

The occurrence of significant differences in two sympatric populations suggests to the authors that two sibling species are involved. Presumably it is the dwarf which has not yet been described. Complicating the picture is the above-mentioned third group in the lake which averages 72.0 plus/minus 0.8 lateral line scales. The dwarves had scale counts almost exactly intermediate between these and the lake whitefish over 15 cm long suggesting the possibilty the dwarves might be hybrids. Obviously further investigation is required. The dwarves tended to grow more slowly than the lake whitefish, averaging 15 mm shorter in the first year and 60 mm shorter in total length in their fourth year. No dwarves older than 5 years were found, while some lake whitefish reached 14 years of age.

Habitat: Opeongo Lake is the largest lake in Algonquin Park, having an area of 53 square km (20.5 square miles). The elevation is 403 m, the mean depth 15 m (maximum 49 m), Secchi disk reading 5.5 m, the TDS 35, and the pH was 6.8 (Ihssen *et al.*, 1981). It is divided into three separate basins approximately equal in area, and joined by restricted channels, the North, East and South Arms. The shores are wooded down to high waterline and composed of granitic rock with a few sand beaches. Most of the bottom is black, sticky, loose muck (*Gavia* faeces), but there are numerous narrow shoreline ledges of granitic rock and several cobblestone shoals of a hectare or less in area. The water is soft, brown in color, and low in transparency. The lake is oligotrophic. In July and August the dwarves tended to be in depths of more than 15 metres at temperatures of 7-11°C, while the lake whitefish were between 8 and 15 metres at 11-18°C. At other seasons their distribution was more similar.

Biology: Aside from the age, growth and habitat data mentioned above, no other information on biology was found.

Protective measures taken: Some measures of protection is provided since Opeongo Lake is within the boundaries of Algonquin Park, a provincial park, although this does not protect it from air borne acid precipitation.

Recommendations: 1) Taxonomic study, description and naming of this form is required.
2) A basic life history study is needed with an estimate of its population size.
3) Introduction of a population into an other lake.
4) Reduction in emissions causing acid precipitation and buffering of the lake's water with limestone lime if necessary and feasible.
5) The possibility that some stock could be transplanted to a suitable lake free from ciscos and not at risk to acid rain should be investigated by a recovery team after careful study.

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Coregonus canadensis Scott, 1967 - Acadian whitefish/corégone d'Acadie (m.)

The Acadian whitefish is one of the half dozen species of fishes unique to Canadian waters. It is the only Canadian endangered fish ever to be featured on a postage stamp. Despite the fact that it is a unique Canadian species, that its range is very small, and that its status is endangered, very little is known of its life history, and nothing is known of the size of its populations. Small sums have been spent on very preliminary surveys in search of this species. More needs to be learned about this species and action is needed on conservation measures for this distinctive Nova Scotian species. Recent reports of high acidity (below 4.7) and extirpation of Atlantic salmon stocks in southeastern Nova Scotia (Dept. Fisheries and Oceans, 1981) and surveys by T. A. Edge suggest that the Acadian whitefish in the Tusket River is now extirpated by acid rain. There may be a small surviving population in the Anis River, a tributary to the Tusket estuary.

Canadian status: Endangered (Committee on the Status of Endangered Wildlife in Canada, April, 1984). Known only from Nova Scotia where it was/is found in the Tusket River system, Yarmouth County and the Petite Rivière system, Lunenberg County. Waters of the latter locality are better buffered against acid rain. There is a verbal report of a 17 inch (380 mm) long Acadian whitefish taken in a gaspereau net set near the mouth of the Annis River, Yarmouth County in April 1977 (Gilhen, 1977). The Tusket River population was ruthlessly exploited during upstream movement in October, where the building of a dam in 1929 and installation of an unsupervised fish ladder exposed the fish to poachers (and still may do). Because the fish ladder design does not properly attract the whitefish they are killed by turbine blades when they attempt to descend the sluices (Gilhen, 1977). Formerly abundantly caught in nets set for gaspereau in the Tusket River but now a rarity. In September 1982, evidence was found of small surviving populations in Millipsigate Lake, and three other small lakes in the same drainage system. Two were recorded in the Annis River estuary but none were found in the Tusket River, now with elevated levels of acidity, although they were formerly abundant in that river (pers. comm. T.A. Edge). The preliminary COSEWIC status report on this species is in press (Edge, 1984).

Status elsewhere: Does not occur outside of Canada. Listed as endangered for North America by Deacon et al. (1979).

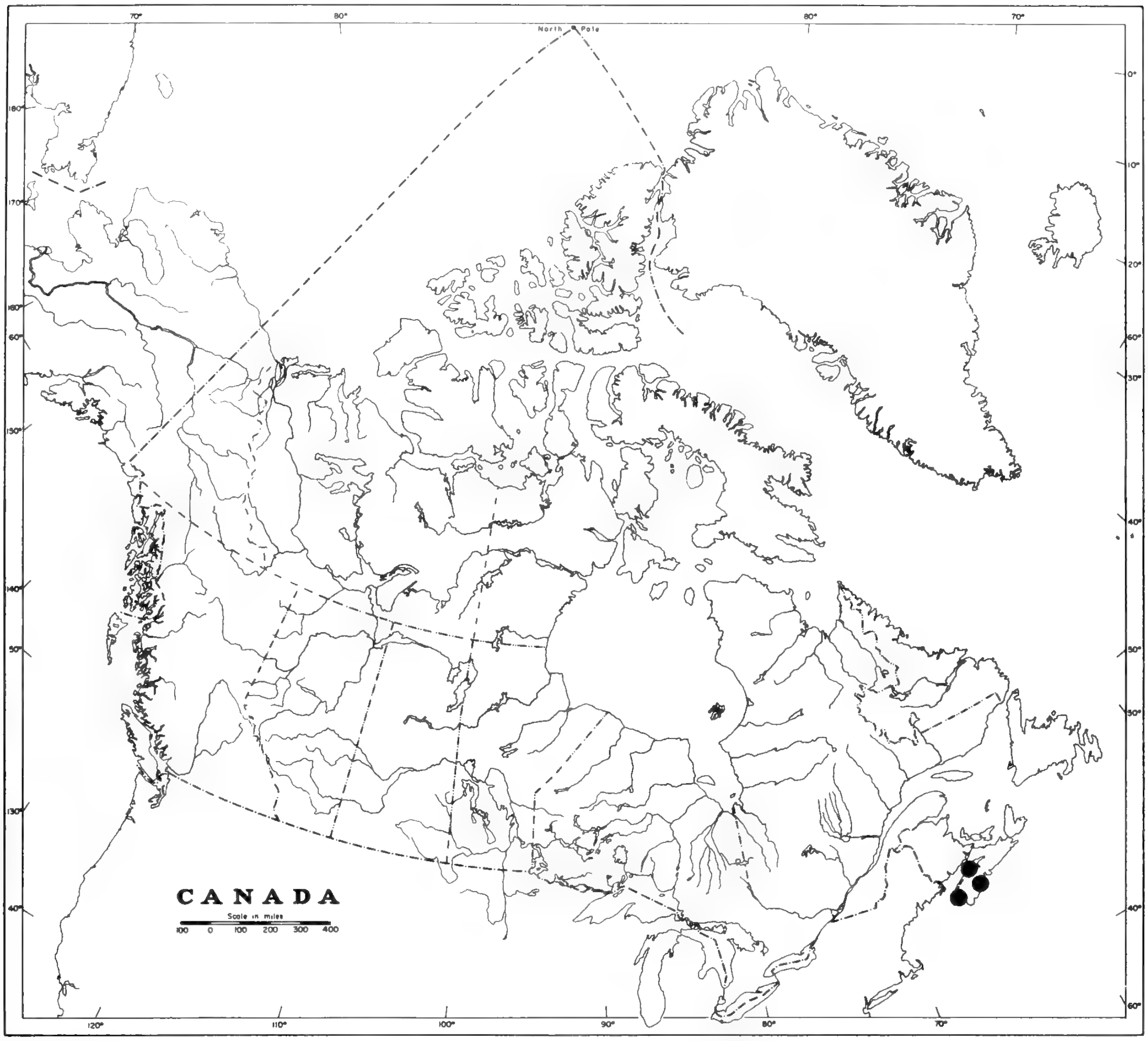

FIGURE 11A: Map of the world distribution of the Acadian whitefish / corégone d'Acadie - Coregonus canadensis. This species is only known in Canada and was recently pictured on a postage stamp. A dam impedes its migration on the Tusket River in Nova Scotia.

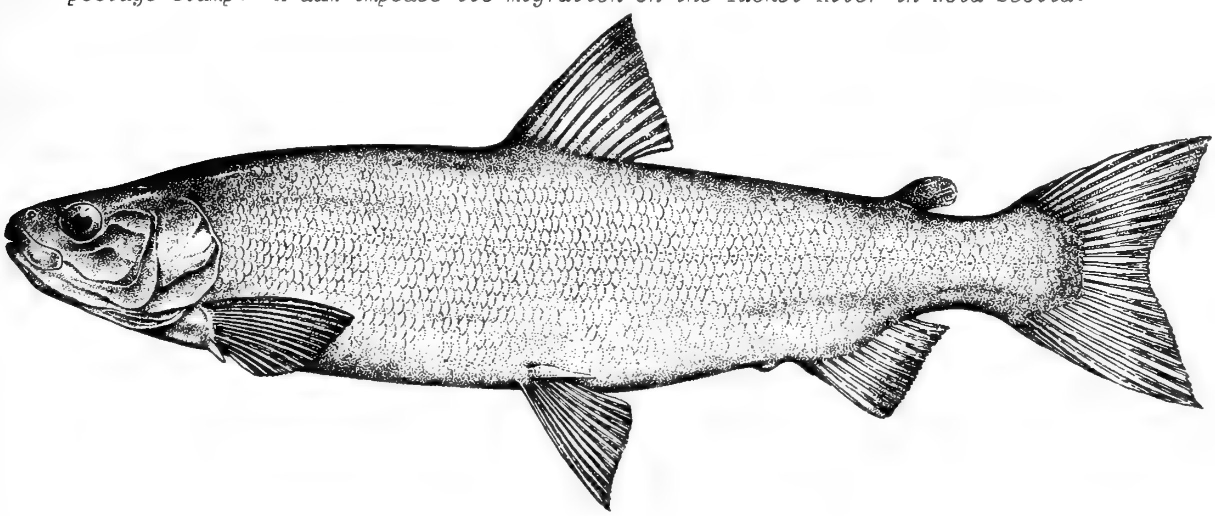

FIGURE 11B: Drawing of the Acadian whitefish / corégone d'Acadie - Coregonus canadensis. Acid rain, originating in Ontario and the United States, has wiped out one of the two main populations and is threatening the remaining one of this endangered species.

Taxonomic status: The name Coregonus canadensis Scott, 1967 is a junior primary homonym of Coregonus nasus canadensis Berg, 1932 and requires a replacement name. (Coregonus nasus canadensis Berg itself is a junior subjective synonym of Coregonus clupeaformis (Mitchill) according to Lindsey (1962). In other words a new scientific name is required. It has also been called Atlantic whitefish, but we feel that the adjective Acadian has more precise geographic connotations than Atlantic. Like the courageous Acadians of Canada, the Acadian whitefish has survived several threats to its existence.

Distinguishing features: The Acadian whitefish is clearly distinguished from the lake whitefish, the only other whitefish known in the Maritime Provinces, by its terminal instead of inferior mouth, its 91-100 instead of 70-85 lateral line scales, and its teeth on the premaxillaries and palatines of adults - present only in juveniles under 100 mm long of the lake whitefish. In the broad whitefish, Coregonus nasus, the maxillary is short and broad, its width more than twice its length whereas in the Acadian whitefish its width is less than half the length (Scott and Crossman, 1979). The axillary appendages are longer in the Acadian than in the lake whitefish.

Habitat: Virtually nothing is known of their habitat.

Biology: The Tusket River population was anadromous. They migrated upstream from the sea in mid-September to early November for spawning and return to the sea from mid-February to late March. Their food included amphipods, small periwinkles (Littorina littorea), and marine worms in Yarmouth Harbour. Nothing is known of their early and almost nothing of their later life history.

Protective measures taken: The Nova Scotia Fishery Regulations under section 34 of the Fisheries Act were amended 17 February 1970 by prohibiting the taking of Atlantic (synonym of Acadian) whitefish, Coregonus canadensis from all waters of the province by any method at any time of the year (in litt. 24 September 1973, D.F. Holmes, Conservation and Protection Branch, Maritimes Region).

Recommendations: Gilhen (1977) recommended the following measures:

1) Construction of an efficient fish ladder on the Tusket with guidance for downstream migrants as soon as possible.

2) Screening the turbine sluices (designs exist for automatically cleaning screens).

3) Education of people of Yarmouth and Lunenburg counties.

4) Survey of distribution in Nova Scotia and investigation of biology of Acadian whitefish, and a population estimate.

5) Building up a stock at the nearest fish culture station.

6) Study of limnology of the watersheds in which it is found.

7) Banning lake reclamation (poisoning) and planting of lake whitefish in southeastern Nova Scotia until the distribution of Acadian whitefish is known with certainty.

8) Control of emissions leading to acid rain.

9) Any moribund specimens found should be preserved or frozen and sent to the National Museum of Natural Sciences in Ottawa or a provincial museum.

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Coregonus hoyi (Gill, 1872) - bloater/cisco de fumage (m.)

The following five deepwater species of ciscoes share common problems. These species, formerly commercially important, have virtually disappeared under the influence of overfishing, sea lamprey predation, pollution and other factors. Sampling requires special deepwater gear and boats, and it is not absolutely certain whether some of the species are extinct or whether there are small surviving populations.

Canadian status: Probably no longer rare. Occurred in Lake Nipigon and Great Lakes except Lake Erie, possibly almost extirpated in Lake Ontario and completely extirpated in Lake Nipigon. The deepwater cisco fishery in Lake Michigan has recovered but is under catch quotas while quota restrictions for commercial harvest have been instituted for Canadian waters. One specimen was caught in Lake Ontario in 1982, the first in ten years. Populations identified as this species outside the Great Lakes basin were misidentified C. artedii or C. zenithicus (Clarke in Lee et al. 1980). Eutrophication, competition by rainbow smelt and alewife, and predation by sea lamprey are believed to have prevented re-establishment of ciscos in the Great Lakes following over exploitation. For latest information see Parker and McKee (1984e).

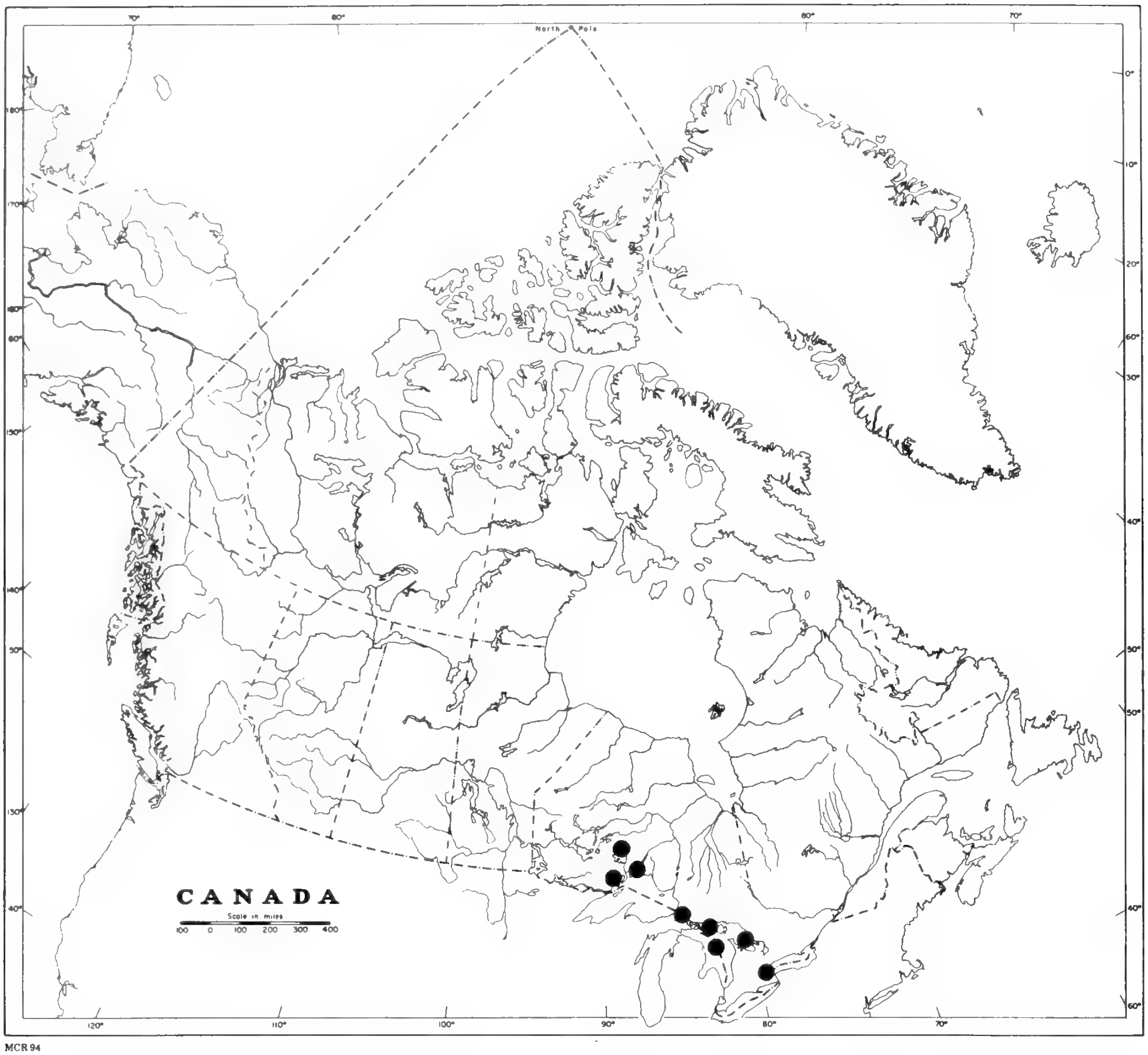

FIGURE 12: Map of the Canadian distribution of the bloater / cisco de fumage - Coregonus hoyi. The bloater was formerly abundant at depths of 35 to 125 meters in the Great Lakes where it was caught and smoked for consumption.

Status elsewhere: Has declined severely in American waters of the Great Lakes in recent years and is now the object of intensive state and federal efforts to protect the remaining stock and develop methods for regulating future harvests (Emery and Brown, 1978).

Distinguishing features: Unlike the lake and round whitefishes the snout is not vertical or bent under, instead the upper lip slopes back in line with the forehead; from other ciscos by the combination of: 37-48 gill rakers; lower jaw long and projecting beyond the upper and with a distinct tubercle at the tip; pigment on snout light, on lower jaw medium, eye small; small size - the smallest of the Great Lakes ciscos, usually under 200 mm in length.

Habitat: Most abundant at depths of 30-125 m in the Great Lakes.

Biology: Spawns in February and March from 35-90 m, laying 3000 - 19000 eggs (Emery and Brown, 1978). Larvae were most abundant betwen 90 and 110 m at 4.7°C. Auer (1982) describes larval development. Feeds mainly on plankton including *Mysis* and *Pontoporeia*. The slowest growing of all the Great Lakes ciscos. Ages of 10 or 11 years were reached. Formerly heavily preyed on by lake trout. Formerly the object of a fishery for smoking.

Protective measures taken: See above under Status elsewhere.

Recommendations: 1) A study should be made on how to ensure survival of the Lake Nipigon population.

2) Biologists working in the Great Lakes should be alert for specimens amongst cisco catches.

3) Action should be taken on antipollution recommendations for the Great Lakes.

4) Moribund specimens from lakes Ontario and Nipigon should be preserved and sent to the National Museum of Natural Sciences, Ottawa or a provincial museum.

5) Taxonomic studies should be undertaken to clarify the species status of *C. hoyi* and *C. kiyi*.

••

Coregonus johannae (Wagner, 1910) - deepwater cisco/cisco de profondeur (m.)

Canadian status: Extinct. In Canada was only known from the deeper waters of Lake Huron. Scott and Crossman (1979) reported it as rare in Lake Huron but its actual status was really unknown. Todd (in Lee et al., 1980) reports it as almost certainly extinct, and Parker and McKee (1984g) concluded it was extinct and their paper should be consulted for further details.

Status elsewhere: Elsewhere known only in Lake Michigan where it was last caught in 1951 (Scott and Crossman, 1973). Deacon et al. (1979) list it as endangered in North America by habitat destruction, overexploitation, and hybridization or competition, while Scott and Crossman (1979) indicated heavy commercial exploitation and predation by the sea lamprey. Todd (op. cit.) considered the species almost certainly extinct.

Taxonomic status: Todd (in Lee et al., 1980) reports this species to be very similar to C. zenithicus with which it may be conspecific.

Distinguishing features: Unlike lake and round whitefishes the snout is not vertical or bent under, instead the upper lip slopes back in line with the forehead. It is distinguished from other ciscos by the combination of 25-36 gill rakers (usually less than 33), jaws subequal, lower moderately stout; snout and lower jaw with little or no pigment; eye moderate in size. This was the largest of the deepwater Great Lakes ciscos, averaging 290 mm in length in Lake Michigan, and ranging from 250-300 mm in standard length.

Habitat: Information meagre. Ranged from 30 to 180 m in depth but rarely shallower than 65 m.

Biology: Matured at 165 mm in length or more. Spawned between mid-August and end of September. In Lake Huron the diet consisted mostly of Mysis with small quantities of Pontoporeia (crustaceans) and fingernail clams (Pisidium).

Protective measures taken: None.

Recommendations: Educational information should be made to concerned agencies.

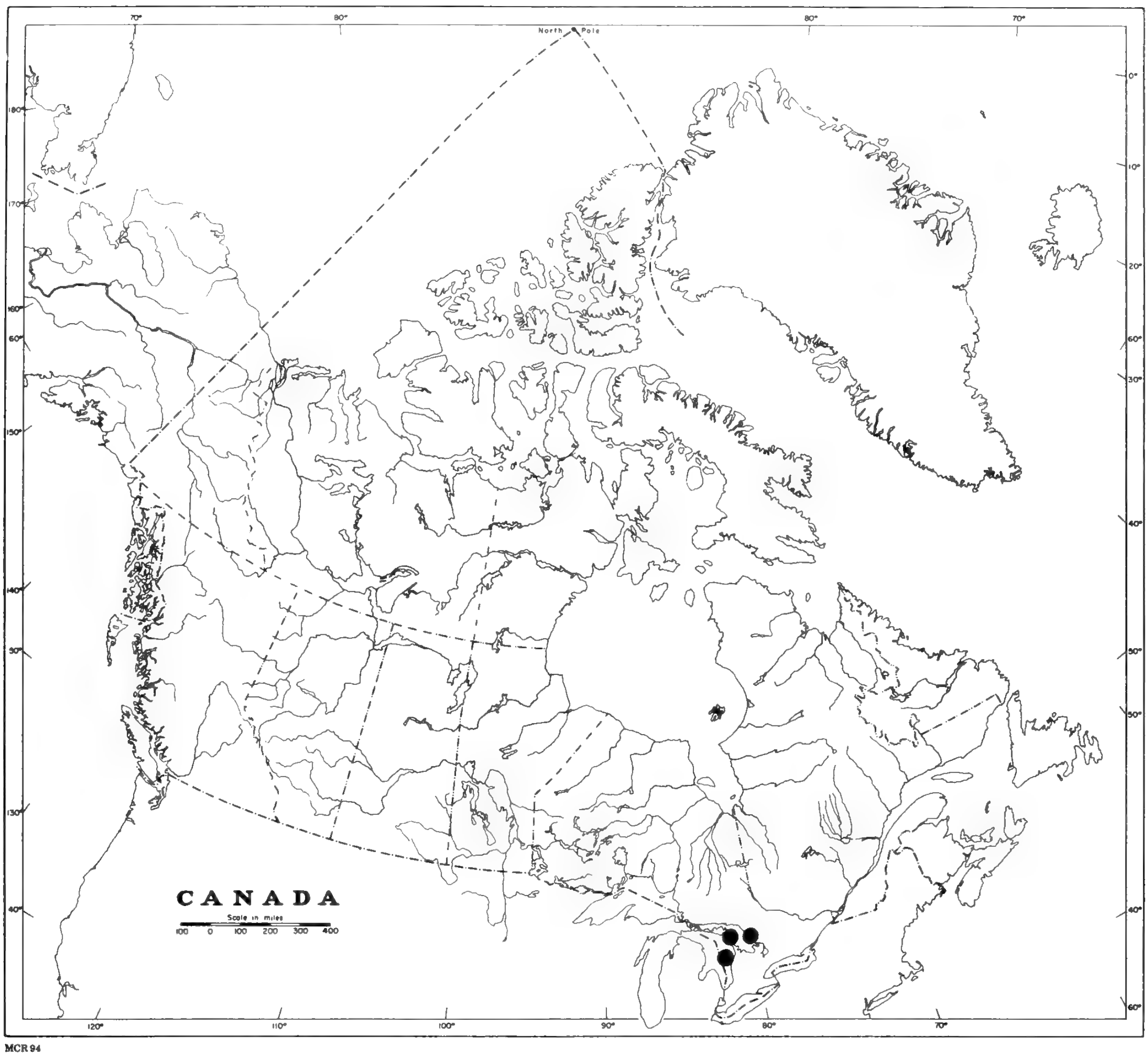

FIGURE 13: Map of former Canadian distribution of the deepwater cisco / cisco de profondeur - Coregonus johannae. This species is almost certainly extinct.

Coregonus kiyi (Koelz, 1921) - kiyi/cisco kiyi (m.)

Canadian status: Extirpated from much of its range but still common in Lake Superior (Parker and McKee, 1984f). Probably extirpated in Lake Ontario where the last specimen was seen in 1964 and reduced or extirpated in Lake Huron (Scott and Crossman, 1979, p. 231, 253-254). Consult Parker and McKee (1948f) for most recent information on this species. Smelt and alewife are/were competitors with ciscos in lakes Huron and Ontario.

Status elsewhere: Extirpated or extremely rare in Lake Michigan, listed as threatened in Michigan (Miller, 1972), extremely rare in Lake Huron (Todd *in* Lee *et al.*, 1980) where it was last caught in 1973 and protected as endangered in Wisconsin (Anonymous, 1979) while apparently common in Lake Superior (Parker and McKee, 1948f). Todd, Smith and Cable (1981) reported that the Lake Superior population was distinct from *C. hoyi*. Intense commercial exploitation is believed to have caused the collapse of Lake Michigan and Lake Ontario populations.

Distinguishing features: Unlike lake and round whitefishes the snout is not vertical or bent under and instead the upper lip slopes back in line with the forehead. From the other ciscoes by the combination of: 36-41 gill rakers; lower jaw long, thin and projecting; snout heavily and lower jaw moderately pigmented; eye large, body compressed. Adult size 140-250 mm in standard length.

Habitat: Deeper waters of lakes Ontario, Huron, Michigan and Superior, usually at 50-200 m and most frequently over 100 m (Scott and Crossman, 1979), and relatively common at 100-1810 m in Lake Superior (Todd, *op. cit.*), over bottoms of clay and mud.

Biology: Spawned from November or late October to January in 90-165 m in temperatures from 1.7-3.4°C at depths of 106-165 m. Growth was slow and specimens 8 years old averaged 269 mm in total length in Michigan. Average size was 254 mm and 170 grams. Females were usually heavier and lived longer than males reaching a maximum age of 10+ as compared with 7+ for males. Fed principally on the crustacean *Mysis relicta* and the amphipod *Pontoporeia hoyi*.

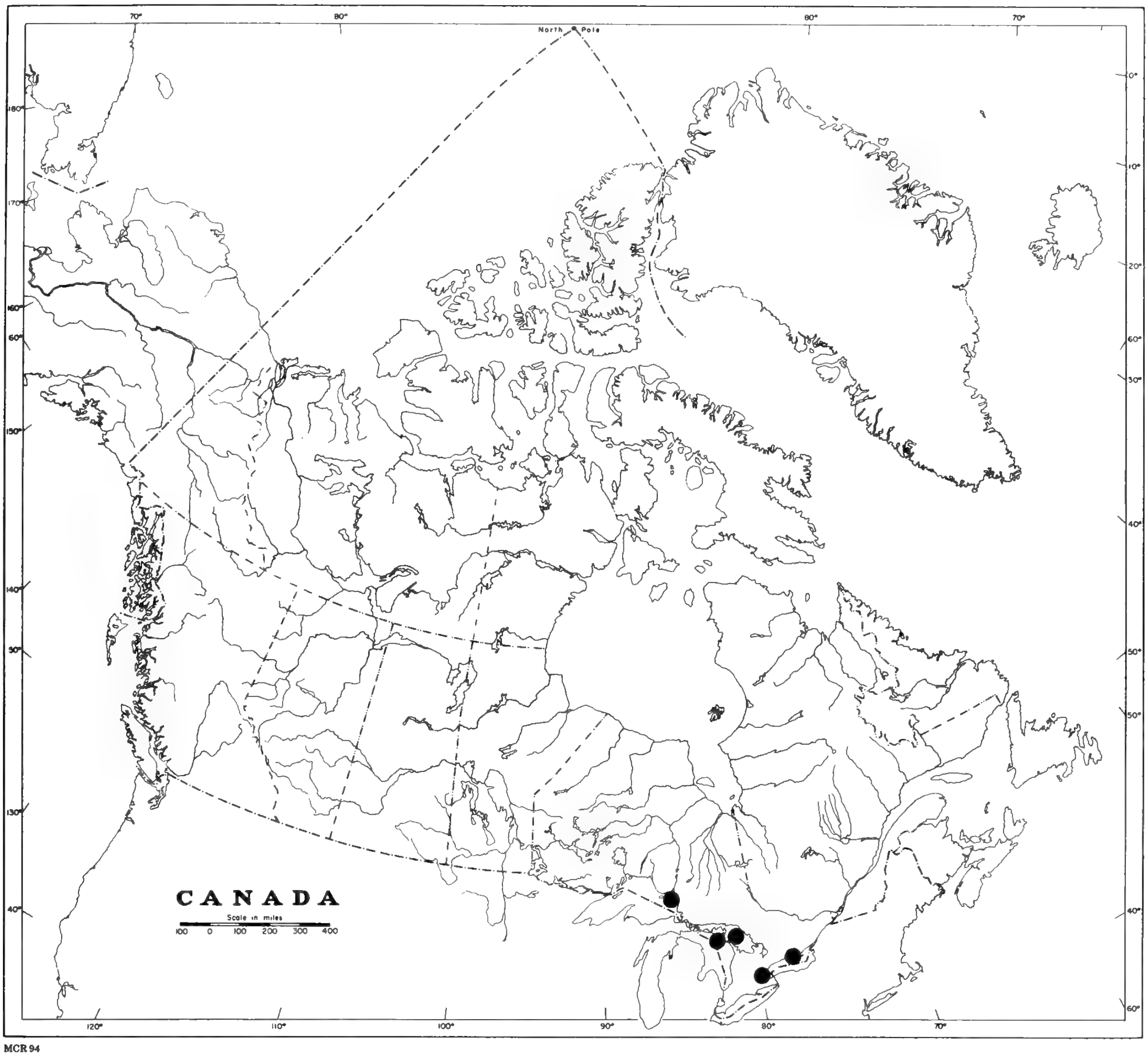

FIGURE 14: Map of the Canadian distribution of the kiyi / cisco kiyi - Coregonus kiyi. The kiyi may only survive today in Lake Superior and possibly in Lake Huron.

Protective measures taken: None.

Recommendations: 1) Representative collections of this species from Lake Superior or any collected from Lake Huron should be forwarded to the National Museum of Natural Sciences, Ottawa or a provincial museum.

2) Population and life history studies of this species should be considered for inclusion in management plans for Lake Superior's fisheries resources.

3) Taxonomic status of *C. hoyi* and *C. kiyi* should be undertaken to clarify species status.

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Coregonus nigripinnis (Gill, 1872) - blackfin cisco/cisco à nageoires noires (m.)

Canadian status: Rare. Probably extirpated in Lake Huron, Lake Superior and Lake Ontario (Parker and McKee, 1984h). Populations reported in the literature from inland lakes in northern Ontario, southern Manitoba, Alberta and Saskatchewan and N.W.T. are now assigned to *C. artedii* or *C. zenithicus* (Clarke and Todd in Lee *et al*. 1980). Apparently only the population in Lake Nipigon, *C. n. regalis*, survives (Clarke and Todd, *opp. cit*.). For recent information on this species see the summary by Parker and McKee (1984h).

Status elsewhere: Extirpated elsewhere.

Distinguishing features: Unlike lake and round whitefishes, the snout is not vertical or bent under, instead the upper lip slopes back in line with the forehead; from the other ciscos by the combination of 46-50 gill rakers, lower jaw stout and equal in length to upper, snout heavily and lower jaw moderately pigmented, body thick and deep, fins largely black. Maximum total length 510 mm (Smith, 1979).

Taxonomic status: Clarke (*in* Lee *et al*., 1980) considers populations outside of the Great Lakes basin to belong to *C. artedii* or *C. zenithicus*; *C. n. cyanopterus* of Lake Superior is conspecific with *C. zenithicus*, as may be *C. n. prognathus* of Lake Ontario (Clarke and Todd *in* Lee *et al*., 1980; Todd and Smith, 1980).

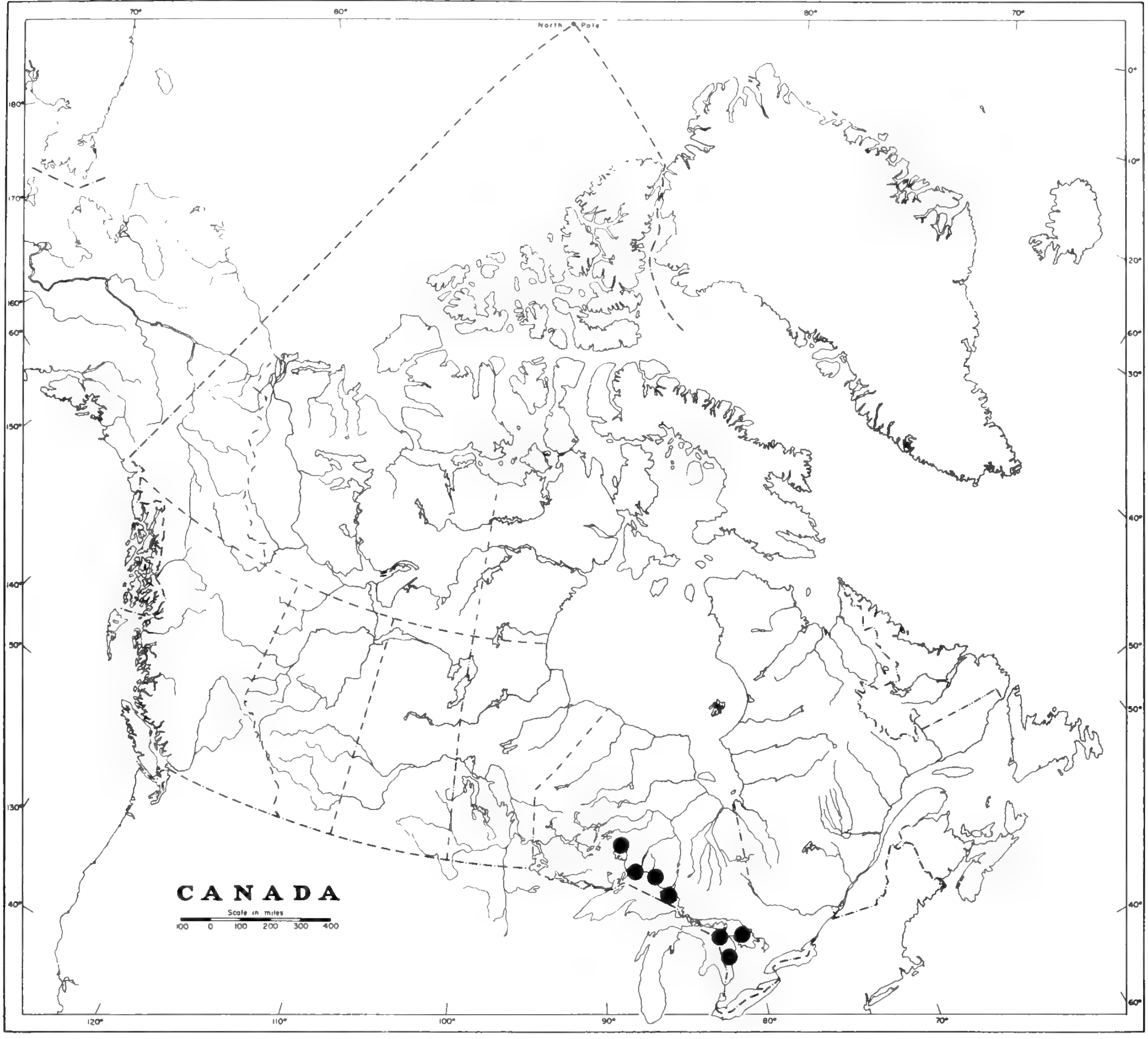

FIGURE 15: Map of the Canadian distribution of the blackfin cisco - cisco à nageoires noires - Coregonus nigripinnis. The blackfin cisco probably only survives today in Lake Nipigon.

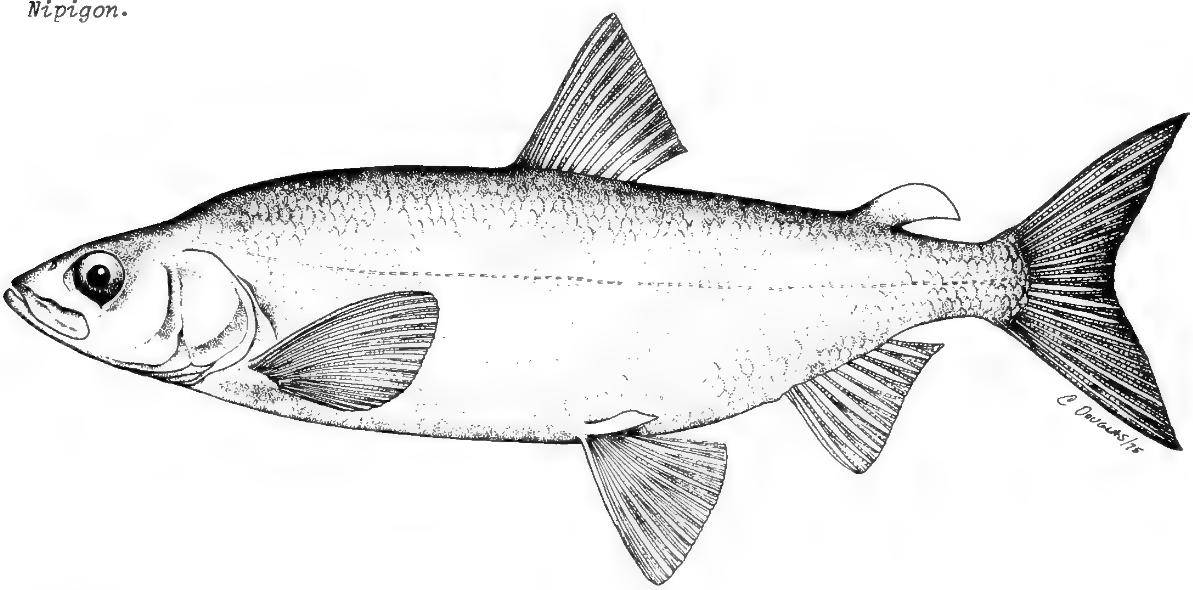

FIGURE 16: Drawing of the blackfin cisco / cisco à nageoires noires - Coregonus nigripinnis. This cisco occurred at depths of up to 160 metres in the Great Lakes before its extirpation there, and is classified as threatened in Lake Nipigon.

Habitat: Formerly present in deep waters, 90-160 m of lakes Michigan and Huron, and shallower water, 2-100 m in Lake Nipigon. Inhabitated deeper water than most other species.

Biology: Probably spawned from late November to January. Food consisted almost solely of the crustacean *Mysis relicta*, but a few stomachs were also found with plant, insect and fish remains. Formed the basic food for lake trout in deep waters of Lake Superior and possibly other lakes. Was also preyed on by the sea lamprey.

Protective measures taken: None

Recommendations: 1) Protection should be given to the Lake Nipigon population which is probably the only surviving population.

2) Population estimation and life history studies should be initiated on the remaining Lake Nipigon population.

3) Specimens thought to be blackfin ciscos should be deposited in the National Museum of Natural Sciences, Ottawa, or a provincial museum.

4) The taxonomy of this species should be investigated.

5) Educational information should be made available to concerned agencies.

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Coregonus reighardi (Koelz, 1924) - shortnose cisco/cisco à museau court (m.)

Canadian status: Rare. Extirpated in Lake Ontario, present but greatly reduced (less than 0.1% of all species) in Lake Superior if indeed this species, probably rare in Lake Huron, and status indeterminate in Lake Nipigon, Ontario (Scott and Crossman, 1979, p. 260-262). For recent information see summary by Parker and McKee (1984i).

Status elsewhere: Extirpated in Lake Ontario and Lake Michigan, not known in U.S. waters of Lake Huron, greatly reduced in Lake Superior. Protected as endangered in Michigan, now believed to be extirpated elsewhere in the United States (Anonymous, 1979) and currently under consideration by United States Fish and Wildlife Service as an endangered species. Over-exploitation lead to the collapse of populations in lakes Superior, Michigan, Huron,

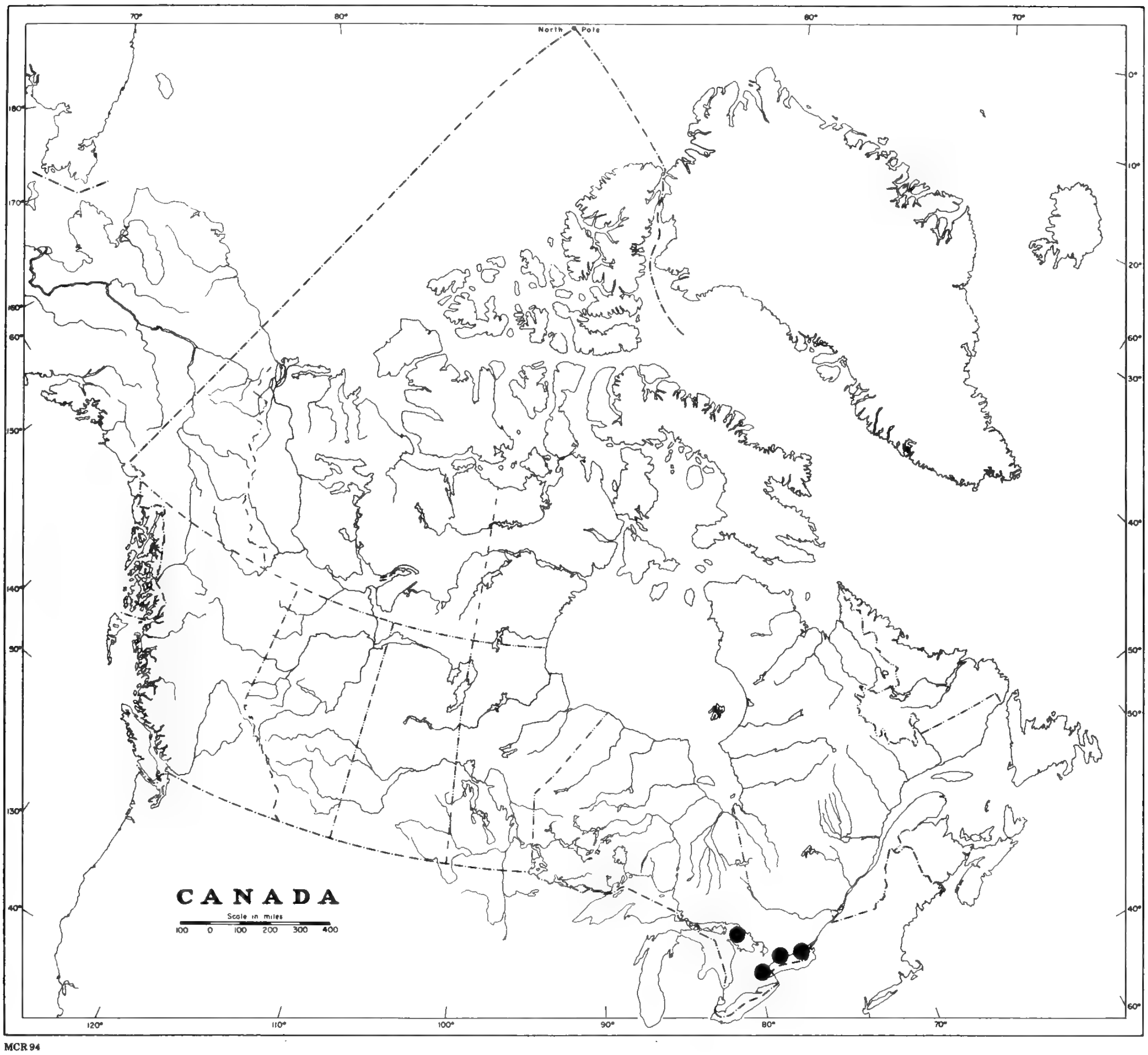

FIGURE 17: Map of the Canadian distribution of the shortnose cisco / cisco à museau court - Coregonus reighardi. The shortnose cisco is classified as threatened in Canada.

and Ontario and sea lamprey predation may have affected populations of the last three lakes.

Taxonomic status: Dr. R. McV. Clarke suggested in his thesis that *C. reighardi* is the same species as *C. zenithicus*, and he wrote us that at least one other researcher believed otherwise (*in litt.*, 25 November 1979). Todd (*in* Lee *et al.*, 1980) has unpublished evidence showing that *C. r. dymondi* is conspecific with *C. zenithicus*.

Distinguishing features: Unlike lake and round whitefishes, the snout is not vertical or bent under, instead the upper lip slopes back in line with the forehead. From the other ciscos distinguished by the combination of 34-38 gill rakers, lower jaw stout and shorter than upper, snout heavily and lower jaw moderately pigmented, snout short, body little compressed and deepest medially. Maximum total length 270 mm (Koelz, 1924).

Habitat: Lived in deep waters of lakes, 20-145 m (Scott and Crossman, 1979) and 18-55 m in Lake Nipigon.

Biology: Spawned in May and June (the only deepwater cisco which spawns in spring) in Lake Michigan at 37-145 m at temperatures of 3.8-4.7°C, but in recent years spawning behavior occurred in fall. Females lived two years longer than males, reaching 8 years. Lengths of 356 mm and weights of 439 grams were attained. Stomach contents principally included the crustaceans *Mysis relicta* and *Pontoporeia hoyi* but small numbers of copepods, aquatic insect larvae, fingernail clams are also found (Scott and Crossman, 1979).

Protective measures taken: None.

Recommendations: 1) Specimens thought to be *C. reighardi* should be preserved and deposited in the National Museum of Natural Sciences, Ottawa or a provincial museum. Specimens should be accompanied by data concerning depth of capture and location, water temperatures etc. Colour photographs or a description of colouration would be beneficial.

2) Taxonomic studies of this species complex should be encouraged.

3) Personnel from the Ontario Ministry of National Resources Commercial Catch Sampling programs should be provided adequate training to enable preliminary field identifications.

4) Baseline studies of deepwater habitats with suitable gear to collect deepwater fish species should be instituted. Areas of emphasis should begin at the deepwater margin traditionally fished by commercial fishermen.

5) Management policy developed for Great Lakes fisheries should indicate specific objectives for preservation of this species in Canadian waters.

6) Should shortnose cisco populations be identified the need for site specific life history and population studies should be reviewed.

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OSMERIDAE

smelts éperlans

Osmerus spectrum Cope, 1870 - pygmy smelt/éperlan nain (m.)

This diminutive species, the pygmy smelt, seldom exceeds 4 inches or 125 mm in length. In Canada it is known to occur naturally in only two lakes, one in Québec and one in New Brunswick. Lanteigne and Cronin (1981) provide a status report on this species in Canada.

A search with appropriate gear is needed to see if pygmy smelt occur in other Canadian lakes. That the species was discovered in Lac Heney was an accident, shows our lack of knowledge of the Canadian fauna and flora. This lake happened to be the site of the biological station of the University of Ottawa and the life history of the smelt in the lake happened to be chosen for a thesis topic and through this happenstance evidence for a second smelt species was uncovered. How many more new species and records would be discovered if a thorough taxonomic and biotic survey of Canada was supported?

Canadian status: Rare. Known to be native in Canada only in Lac Heney (Lac Poisson Blanc), in the Gatineau River basin of the Ottawa-St. Lawrence drainage, Gatineau County, Québec about 75 km north of Ottawa (75°55'N, 46°02'W) and in Utopia Lake, Charlotte County, New Brunswick. It has been introduced into Meach and Ouimet lakes, Gatineau County from Utopia Lake. The population size of two and three year olds in Lac Heney was estimated at about 22 million (Delisle, 1969), but there is some suggestion that it is not as common in 1984 as it was then. The species is not known in any other lakes in Canada, but studies

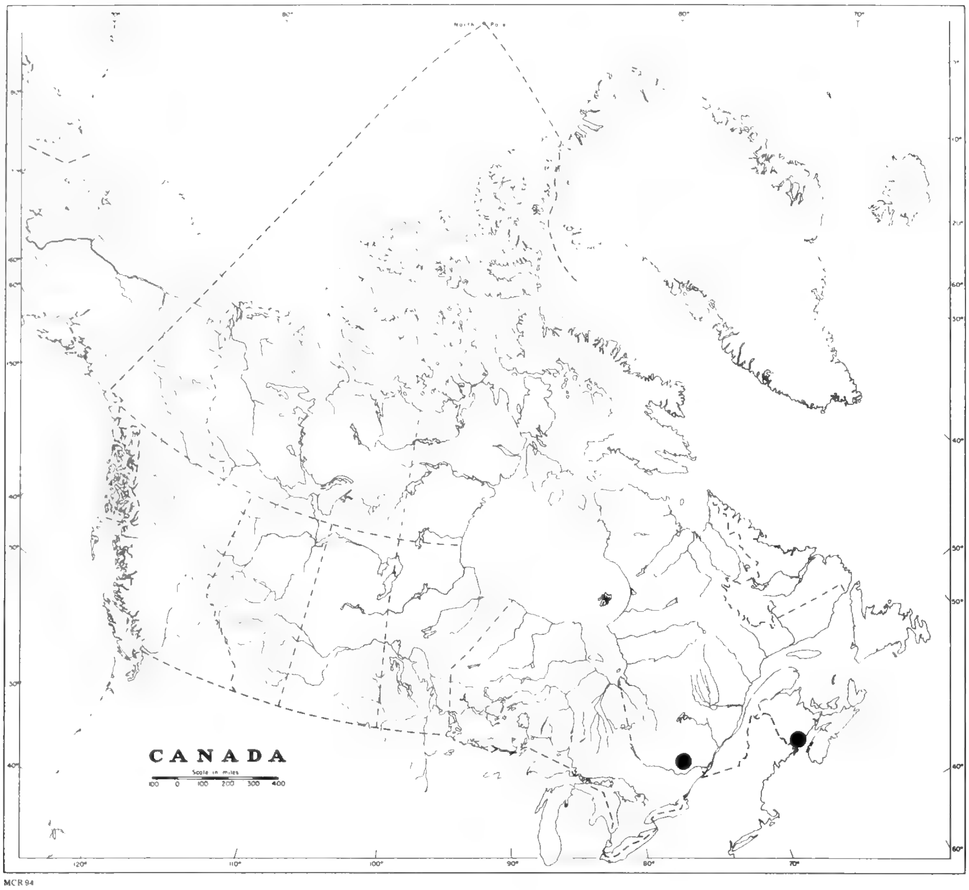

FIGURE 18: Map of the Canadian distribution of the pygmy smelt / éperlan nain - Osmerus spectrum. More research is needed to find if this species occurs in other lakes and whether it is being affected by acid rain.

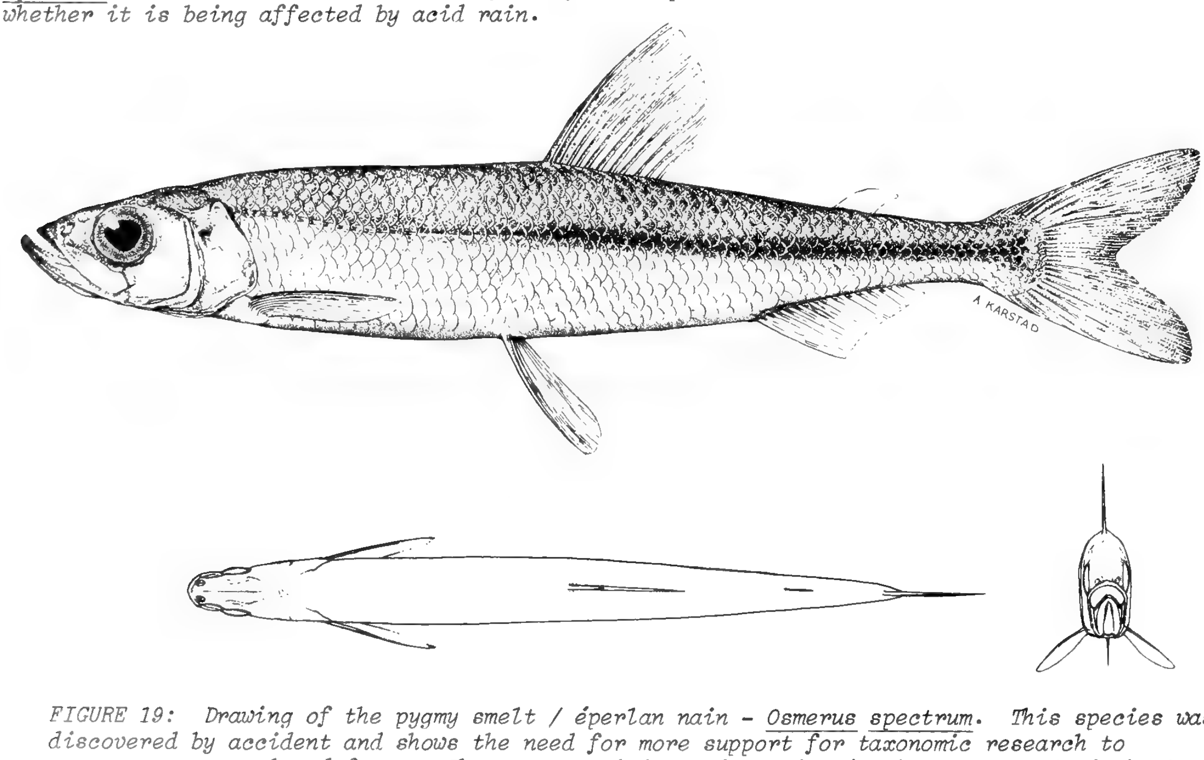

FIGURE 19: Drawing of the pygmy smelt / éperlan nain - Osmerus spectrum. This species was discovered by accident and shows the need for more support for taxonomic research to uncover our unexplored fauna. The pygmy smelt's maximum size is about 130 mm (5 inches), whereas its close relative, the rainbow smelt, reaches over 300 mm (one foot) in length. The pygmy smelt shows promise as a forage fish for land- locked salmon.

are needed to verify the identity of smelts in eastern Canadian lakes. It is not known whether elevated acidities of snow melt in spring threaten reproductive success.

Status elsewhere: Otherwise known only from United States where it has been identified in Green Lake, and Wilton Pond, Maine. Large and small smelts have also been reported from Lake Champlain and other lakes, but it is not known whether the small ones are pygmy smelt (Greene, 1930; Lanteigne and McAllister, 1983).

Taxonomic status: Lanteigne and McAllister (1983) show the pygmy smelt can be distinguished by gill rakers, slower growth, earlier maturity and different spawning times from the rainbow smelt. They concluded that the pygmy smelt is a distinct species, although closely related to the rainbow smelt, *Osmerus mordax*, which has both lacustrine and anadromous populations.

Distinguishing features: The pygmy differs significantly in smaller maximum length; smaller size at a given age; more gill rakers (mean 36.0, usually 34-36 in the pygmy, mean 32.8, usually 31-33 in freshwater rainbow smelt, and mean 29.4 usually 28-31 in anadromous rainbows); and fewer midlateral scales, (60) 61-65 (66) in the pygmy and (62) 63-70 in the rainbow smelt. In rainbow smelt the orbit diameter comprises 17-22% of the head, in the pygmies 23-30%. Spawning pygmies from Lac Heney (40 specimens) ranged from 68-79 mm SL and from Green Lake 71-82 mm standard length (Copeman, 1977), while in 11 other rainbow populations (1140 specimens), freshwater and anadromous spawners ranged from 105-223 mm, with a mean of 76 mm for dwarves and about 150 mm for rainbow smelt. Delisle (1969) found the largest Lac Heney pygmy was 125 mm in total length, the largest rainbow smelt 250 mm.

Habitat: Lac Heney is an oligotrophic lake about 10 km long with maximum depth about 33 m. The lake stratifies in summer with the thermoclime at about 3-4 metres depth. In mid-June the surface is 23°C, at 20 metres it is 6.6°C. Ice breakup is from 23 April to 1 May, and freezeup 8 to 28 December. The lake water is clear, Secchi disk readings vary between 3 and 6 m. Oxygen levels are high save in the depths over 30 m. The rainbow smelt tend to be restricted to the southern deep basin of the lake and in summer reside inside the 30 m depth isobath. The pygmies inhabit all of the lake including the habitat of the normal.

Biology: The following details are from Delisle (1969) and Legault and Delisle (1968). The pygmy smelt spawns during and after breakup from about 21 April to 10 May at temperature of between 4 and 8°C on sand and gravel beaches of the lake. Between 2,281 and 3,774 eggs 0.54 to 0.65 mm (preserved ovarian) in diameter are laid. (The rainbow smelt in the lake spawn before breakup from about 17 March to 12 April laying 24,820 to 79,630 eggs 0.80 to 0.95 mm in diameter, at 6-12 metres in depth at about 4°C; along the coasts of Canada rainbow smelts are anadromous, running up creeks and rivers to spawn in spring). The mean total lengths in mm of the different age classes of pygmies are: one-year-olds - 82, twos - 84, threes - 100, fours - 107, fives - 123. (At age four the rainbow smelts are about twice the length, 222 mm total length). Maturity in the pygmy smelt is reached at age two, in rainbow smelt at age three.

The pygmy smelt eats more plankton than the rainbow smelt, with copepods and cladocerans comprising the most common items. The rainbow smelt feed on a higher trophic level, consuming pygmy smelt as well as other fishes (smelt comprising about 50% of diet in winter), also Mysis and insects.

Pygmy smelts are infested by a microsporidian protozoan parasite, Glugea hertwigi, which results in massive mortality in spring time - at least two or three million (Legault and Delisle, 1967).

The young at least travel in schools. Pygmy smelt, unlike the rainbow smelt, are attracted to artificial light at night when near the surface and during the day they are found closest to the bottom.

Recommendations: 1) A survey be taken to determine whether the pygmy smelts are found in other lakes (a study of Canadian populations was begun in 1984 by Louise Lajoie at the University of Ottawa).

2) That Lac Heney be protected from developments which could cause the disappearance of the pygmy smelt.

3) That populations of the pygmy smelt be introduced into other suitable lakes, for example into Gatineau Park, taking care not to also introduce Glugea hertwigi, a microsporidian. Records should be published giving details of introduction.

4) pH levels should be observed at spawning time following snowmelt to ensure acidity levels are not lethal for eggs and larvae. For further details see Lanteigne and Cronin (1981).

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Campostoma anomalum (Rafinesque, 1820) - central stoneroller/roule-caillou (m.)

Minnows have no teeth in their jaws but this curious minnow has on its lower lip a sharp cartilaginous ridge with which it bites off mouthfuls of algae on which it feeds. The intestine is very long and is wound spirally about the gas bladder, the little baloon-like organ that gives fishes buoyancy. The long intestine doubtless helps in digesting algae, but why the gut is wound around the gas bladder, no one knows. The name stoneroller was bestowed because the male constructs nests of gravel by rolling the stones to the nest site using its snouth. The male's snout is protected by nuptual tubercles, hardened knobs on the skin.

We are fortunate in having this interesting minnow in Canadian waters. We still don't know to which subspecies it belongs. Hopefully, acid rain, to which it is sensitive, will not wipe it out, and it will survive to intrigue future generations.

Canadian status: Rare. The Canadian population is separated by about 150 km from the nearest U.S. population. The stoneroller is rare in the Niagara River and neither National Museums nor Ontario Ministry of Natural Resources surveys captured specimens in the Niagara watershed in 1979 (McKee and Parker, 1982). Found primarily in the North Thames River between Mitchell, Middlesex Co., to London and in creeks which flow into the North and main Thames River, all within a rectangle 25 by 50 km; but also in the Niagara River at and near Fort Erie. The range of the species appears to have expanded in Ontario over the last seven years. Conceivably this is related to eutrophication and subsequent increase in filamentous algae on the bottom although it avoids heavy mats of algae, or is possibly due to other factors suggested by McKee and Parker (1982). Locally it was quite abundant and population densities of 37 and 66 fish per 100 square metres have been estimated. Schools of more than 100 fish were not uncommon. Acid rainfall may threaten this species which avoids acidic waters (Lennon and Parker, 1960). Waters impounded by dams, such as the proposed Glengowen dam on the North Thames River, do not provide suitable habitat.

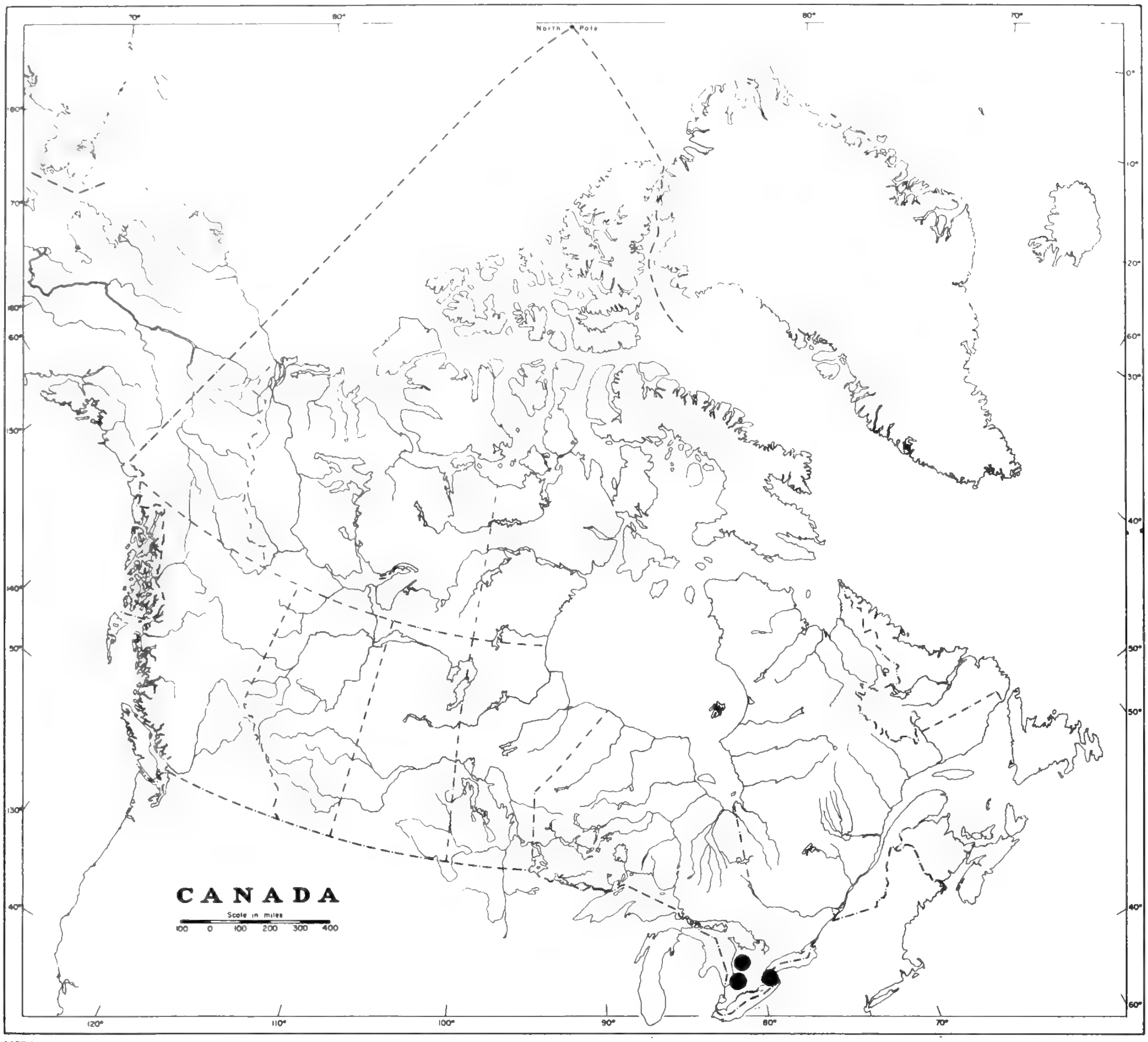

FIGURE 20: Map of the Canadian distribution of the central stoneroller / roule-caillou - Campostoma anomalum. The stoneroller, found in Canada by field work of the National Museum of Natural Sciences in 1972, demonstrating that even Ontario's waters are not yet well explored.

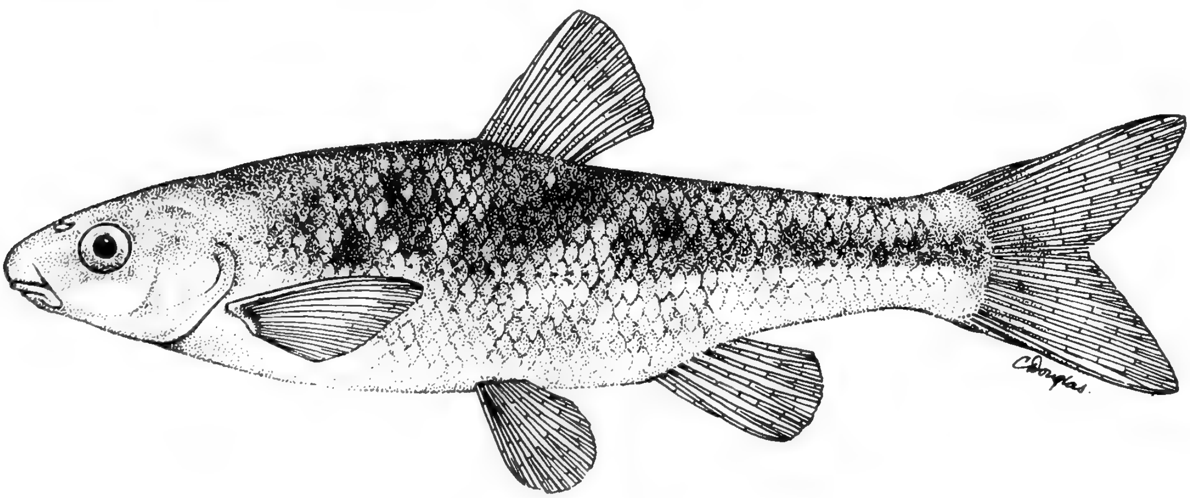

FIGURE 21: Drawing of the central stoneroller / roule-caillou - Campostoma anomalum, classified as a rare species in Canada.

Status elsewhere: Widespread and often locally abundant in the southern Great Lakes and Mississippi drainage basins in central and eastern United States with one population in Mexico, sporadic in Red River of North and on Great Plains (Burr, 1976) and considered threatened only in Louisiana (Miller, 1972; Burr *in* Lee *et al*., 1980).

Distinguishing features: Distinguished from other minnows in Canada by the presence of a prominent cartilaginous ridge on the lower jaw, separated by a groove from the lower lip. Additionally, the intestine is spirally wound about the gas bladder. Burr (1976) and Buth and Burr (1978) describe variation. Average adult size 70-230 mm in standard length.

Taxonomic status: A thorough analysis is needed to determine the names of the subspecies that apply to the different populations (Burr *in* Lee *et al*., 1980). Although morphologically the Thames River population appears most similar to *C. a. anomalum*, geographically it is closest to *C. a. pullum* (Gruchy, Bowen and Gruchy, 1973a).

Habitat: 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 large water weeds, particularly *Potamogeton pectinatus*, where water currents are slow. Large stonerollers are usually found in relatively deep riffles and pools (maximum depth about 1.5 m) while smaller fish are most 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.

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 some variation 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 oxygen fluctuations of 3 to 25 mg/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 (in Lee et al. 1980) indicated that stonerollers are relatively tolerant of variations in water quality.

Biology: 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 Lennon and Parker (1960). In September, young-of-the-year ranged from 2.3 to 3.9 cm in standard and from 0.2 to 1.0 grams in preserved weight, age 1+ fish ranged from 4.1 to 6.2 cm and from 1.3 to 4.4 grams, 2+ fish ranged from 5.5 to 8.7 cm and from 3.7 to 15.1 grams and 3+ fish ranged from 8.2 to 9.9 cm and from 15.2 to 22.0 grams. 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). Lennon and Parker (1960) found a maximum age of six years and a maximum length of 28.7 cm for stonerollers in North Carolina.

Little is known about reproduction in stonerollers in Ontario. Ten specimens collected in September 1979 were dissected and their gonads were examined. Only those longer than 8 cm standard length showed signs of gonad maturation and three out of seven examined from this size class still had small, undeveloped gonads. In Michigan, this species 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).

The stoneroller begins spawning in mid-April and continues spawning until early June over a temperature range of 14° to 24° C in New York (Miller, 1964) and 12° to 27° C in Illinois (Smith, 1935). E. Kott (pers. comm.) collected tuberculate males in early spring in the Thames River watershed, suggesting that this population spawns at about the same time as do populations in the northern states.

The spawning process has been described in detail by Langlois (1937) and Miller (1962, 1964). Males construct nests of gravel in both slow water and riffle areas. Males are territorial and guard the nests. Eggs are covered with sand and fine gravel during and after the spawning act. Stonerollers will also use nests of other minnows while other species may spawn over stoneroller nests (Miller, 1964). Among the minnows, the stoneroller exhibits the most extreme development of the nuptual tubercles (Hubbs and Cooper, 1936). Reed (1958) and Auer (1982) described the embryology and early larval stages of this species. Hatching requires 69 to 70 hours at 21 C.

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 percent of the gut content volume (range 0 to 90 percent). The foreguts of 86 percent 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 percent of the gut content volume (range 0 to 5 percent) and was present in only 29 percent of the specimens. Small amounts of microcrustaceans including ostracods and cladocerans were present in 19 percent of the specimens and accounted for about 0.1 percent of the gut content volume in each case. All foreguts contained sand or silt which composed an average of 76 percent of the volume (range 8 to 99.9 percent).

The subterminal mouth and cartilaginous lips of the stoneroller are morphological adaptations that likely aid in bottom feeding and the removal of encrusting algae from hard bottom. Like most herbivores, the stoneroller also has greatly elongated intestine and a black lining to its body cavity (peritoneum). It is probable that smallmouth bass and rock bass are the main predators on stonerollers in Canada.

Most stonerollers collected from Ontario in 1979 harboured to some degree the black-spot trematode, Uvulifer and infestations were heavy in some specimens. Berra and Au (1978) found that black-spot infestations are often higher 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.

This species is locally favoured in the United States, both as a food fish and as a bait fish. It is reputed to be one of the best bait minnow for bass, walleye, and catfish. It can be raised in bait production ponds and makes an interesting aquarium fish.

Protective measures taken: None.

Recommendations: We make the following recommendations on the stoneroller:

1) The effects of proposed dam construction within the range of the stoneroller should be critically evaluated and increases in eutrophication of the North Thames River watershed should be avoided.

2) Further studies to document the life history of the stoneroller in Canada should be implemented at universities.

3) The taxonomy of the species over its whole range requires study to find which subspecies are valid and what subspecies name should apply to the Canadian populations. Any moribund Canadian specimens from outside the North Thames drainage should be deposited in the National Museum of Natural Sciences, Ottawa, or a provincial museum.

4) Identification information should be made available to concerned agencies.

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Clinostomus elongatus (Kirtland, 1838) - redside dace/méné long (m.)

This feisty little species reaches a length of only 4 inches (100 mm), but captures flying insects by leaping. The large, upturned mouth is adapted to seizing food items from the surface or on the wing. The redside dace prefers clear, cool, flowing water with a gravel or stony bottom. It is sensitive to turbidity. This species is most abundant in streams with overhanging bushes and herbaceous plants, which probably foster the insects on which it feeds. Destruction of stream bush cover, increased turbidity from agricultural practices, and land development have probably been instrumental in the disappearance of many populations. Without their vital habitat, species disappear.

Canadian status: Threatened. Found only in gravel or stony-bottomed, clear streams flowing into western Lake Ontario in Ontario where it is much less common now than 30 years ago (Scott and Crossman, 1979), perhaps because of its sensitivity to turbidity, silting and clearance of bushes from stream shores, but recent records have been found in the

FIGURE 22: The redside dace, Clinostomus elongatus, prefers clear water with overhanging bushes or herbaceous plants, and silt-free bottoms, a habitat becoming rare in Ontario. Habitat photo.

Toronto-Hamilton area tributaries of Lake Ontario; the Irvine river, a tributary of the Grand River; the Saugeen River watershed of Lake Huron; and the Holland River system of Lake Simcoe (McKee and Parker, 1982). Collecting efforts in recent years in at least a dozen streams where they were formerly known, have been unsuccessful. Available information suggests severe population declines or extirpations. Sites where the redside dace no longer occurs have been affected by siltation, removal of stream edge cover, channelization and pollution (McKee and Parker, 1982).

Status elsewhere: Occurs elsewhere only in United States where it may be locally common but is overall rather rare; it has disappeared in recent years from many areas where it once occurred (Lee *et al.*, 1980). Threatened in Michigan (Miller, 1972), drastically reduced in Ohio (Trautman, 1957), and extirpated in Indiana (Lee *et al.* 1980). Coal mine, domestic and industrial pollution and agricultural practices caused demise of this species in many parts of Ohio (Trautman, 1957).

Distinguishing features: Characterized by the following combination of features from other Ontario minnows: base of pelvic fins located before dorsal fin; snout long and pointed, snout length exceeding orbit diameter; lining of body cavity silver; terminal upturned mouth with lower jaw projecting; lateral complete, with 63-70 scales; mouth barbels absent. Maximum size 100 mm total length in Ontario.

Habitat: In Ontario, the redside dace occurs in pools and slow-flowing sections of relatively small headwater streams which have both pool and riffle habitats. Stream widths at capture sites during the 1979 survey averaged about 5 m (range 1 to 10 m). Depths at collection sites were usually about 1 m, although specimens were captured in areas ranging between 0.3 and 2 m in depth. Schwartz and Norvell (1958) found redside dace in pools of small headwater streams having an average width of about 9 m and a depth of about 1 m. Trautman (1957) and Gilbert (*in* Lee *et al.*, 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

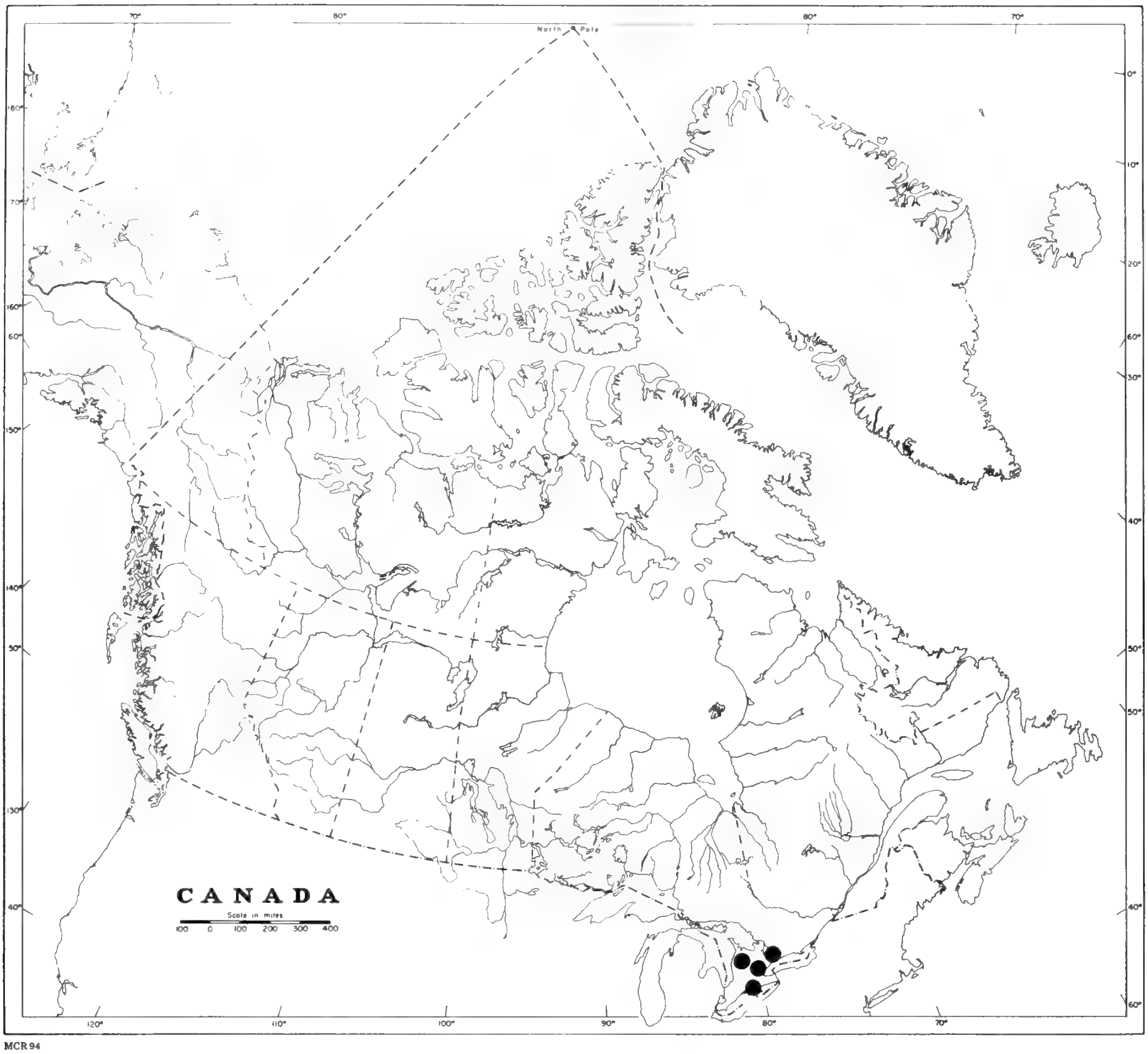

FIGURE 23: Map of the Canadian distribution of the redside dace / méné long - Clinostomus elongatus, a threatened species in Canada.

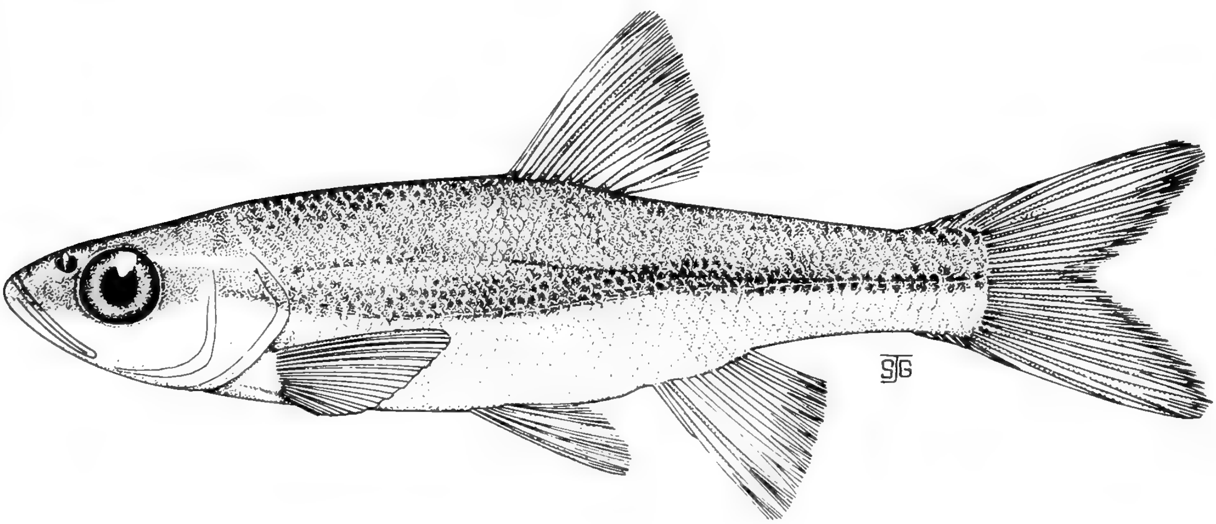

FIGURE 24: Drawing of the redside dace / méné long - Clinostomus elongatus. This feisty minnow, seldom 100 mm (4 inches) long, often leaps out of the water to catch its insect prey.

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 (in Lee et al., 1980) stated that this species occurs in rubble and gravel-bottomed streams.

The redside dace has stringent water quality requirements. It is usually found in relatively clear water in Ontario. Stream water was clear and colourless at most collection sites and clear and brown-tinged in streams with organic bottoms. Water was considered turbid (Secchi disc transparency about 0.3 m) at only two collection locations. This species prefers clear water and is apparently quite sensitive to turbidity (Trautman, 1957; Scott and Crossman, 1979).

Little is known of temperature and dissolved oxygen requirements of the redside dace. Temperature and dissolved oxygen levels at collection sites during this study ranged from 14 to 25°C and 4 to 11.5 mg/L, respectively, between mid-August and the end of September. Temperatures were usually less than 20°C and dissolved oxygen concentrations were usually at least 7 mg/L. Trautman (1957), Scott and Crossman (1979) and Gilbert (in Lee et al., 1980) reported that this species prefers cool temperatures. It is sensitive to domestic, agricultural and industrial pollution (Trautman, 1957).

Biology: Ages of 66 specimens of redside dace collected from mid-August to late September during the 1979 survey were determined by reading scales as described by Schwartz and Norvell (1958). Ages, ranges in standard lengths and preserved weights are as follows:

Age (years)	No. Specimens	Standard Length (mm)	Weight (grams)
0+	19	23 - 35	0.1 - 0.7
1+	10	35 - 45	0.6 - 1.4
2+ males	13	50 - 63	1.9 - 4.3
2+ females	13	48 - 67	1.9 - 4.9
3+ males	2	65 - 69	4.9 - 6.0
3+ females	9	63 - 78	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 79 mm (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 114 mm. The growth rate of this species generally decreases by a 50% increment annually (Schwartz and Norvell, 1958).

Gonads of 40 specimens collected in late summer, during this study, were examined. Most specimens of age 2+ have developing or well-developed gonads, while 1+ fish are immature. These data suggest that spawning occurs at age 3+ in Ontario, although some may spawn at age 2. The redside dace spawns during the latter half of May at water temperatures of 18°C or higher in New York (Koster, 1939). Spawning likely occurs at about the same time in Ontario.

The spawning process was described by Koster (1939). Spawning took place in a moderate current over fine gravel at a depth of about 3 to 8 cm at 18°C or higher. Eggs and milt were released over redds constructed by creek chub (Semotilus atromaculatus). Koster (1939) gave egg counts ranging from 409 to 1,971 per female. Larval development has not been described but Auer (1982) depicts a 23.3 mm juvenile.

Sexual dimorphism in the redside dace has been noted in previous studies (Koster, 1939; Trautman, 1957; Schwartz and Norvell, 1958; Scott and Crossman, 1979). Females captured during this study were generally larger than males of the same age. Males usually have proportionately larger pectoral fins than females. Body coloration is a more intense red 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, 1979).

Gut content analysis of 37 redside dace collected during this study indicates that this species feeds primarily at the surface. Insects accounted for about 96% of the average gut content. All specimens with food in their foregut had fed on insects. Adult Diptera were 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 bottom 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 consumed as the size of the fish increased. 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 were 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 mid-water and will occasionally 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.

Protective measures taken: None.

Recommendations: We make the following recommendations on the redside dace:

1) A natural history preserve should be set aside for this species by the Ontario government. It should encompass sufficient area to protect it from pollution, siltation or impoundments.

2) A study should be made to fill in aspects of its life history such as spawning time and habitat, unknown for Canadian populations.

3) Identification information should be made available to concerned agencies and to fishermen and bait dealers. Identification cards should be prepared for this purpose with one side devoted to recognition, the other side to its threatened status.

4) Existing suitable habitat should be protected from erosion due to human activities and livestock, and alteration of present gradient, flow regimes, and water quality. Stream bank restoration projects in damaged areas should be started with attention to suitable

riparian vegetation; a program should be started to encourage farmers to leave a band of natural vegetation along streams.

5) Moribund specimens should be preserved and sent to the National Museum of Natural Sciences, Ottawa or a provincial museum.

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Hybognathus argyritis Girard, 1856 - western silvery minnow/méné d'argent (m.).

This species was first described as new to science about 125 years ago from the Milk River, Montana, just south of where it occurs in Alberta. But only recently was it again realized that the western silvery minnow was a species distinct from the central silvery minnow. It is one of the few fishes adapted to turbid water, an adaptation not uncommon to fishes of the Missouri River basin.

Canadian Status: Rare. Found only in the South Saskatchewan River and Milk River, Alberta (Pflieger in Lee et al., 1980). Any increase in the already high rate of silt deposition, due to rechanneling of the river by man or by erosion on overgrazed areas could very well reduce this species to extinction in Canadian waters (Willock, 1968). For Canadian and U.S. range see map in W.L. Pflieger (in Lee et al., 1980). In view of changes in taxonomy of this species all purported records should be verified.

Status elsewhere: Occurs only in western United States in the Missouri and upper Mississippi where it was not listed as threatened or endangered (Miller, 1972). Found in North and South Dakota, Nebraska, and Missouri where it is generally less abundant than H. placitis.

Taxonomic status: Previous Canadian records have been referred to a Hybognathus nuchalis nuchalis Agassiz, 1855 (Willock, 1968; Scott and Crossman, 1979). But Pflieger (1971) showed that the form inhabiting the Missouri River and the Mississippi downstream from the Missouri mouth to Scott County, Missouri, to be a species, H. argyritis, distinct from the central silvery minnow, H. nuchalis nuchalis, which is found only in the Mississippi basin and Gulf Coast drainages and from H. n. regius found in the Great Lakes basin and the Atlantic slope of U.S. (the latter may itself be a distinct species). One collection in the National Museum from the Milk River, Alberta may be H. argyritis (fide B.W. Coad).

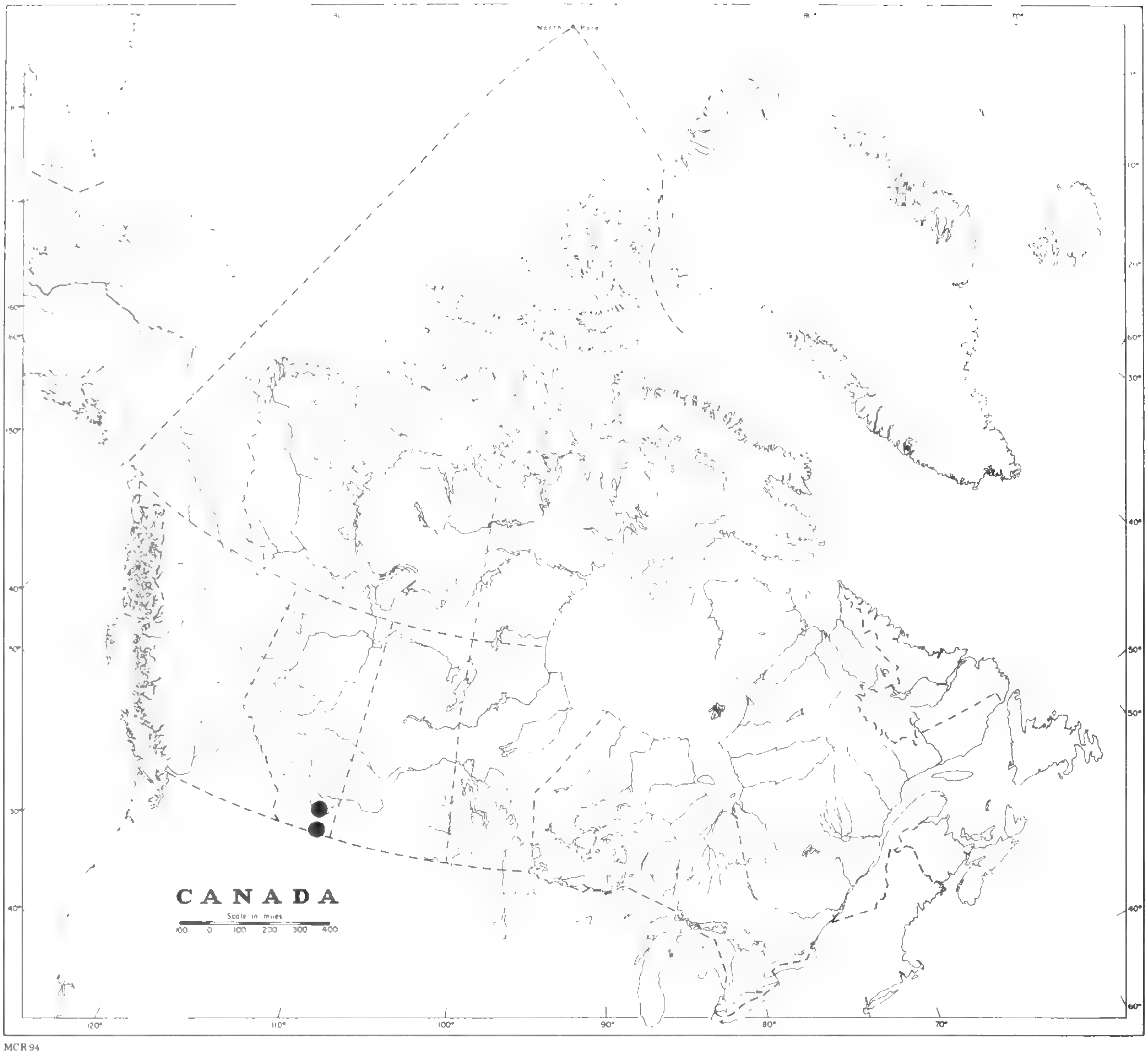

FIGURE 25: Map of the Canadian distribution of the western silvery minnow / méné d'argent - Hybognathus argyritis. The Canadian distribution of this minnow, closely related to the brassy minnow, is uncertain.

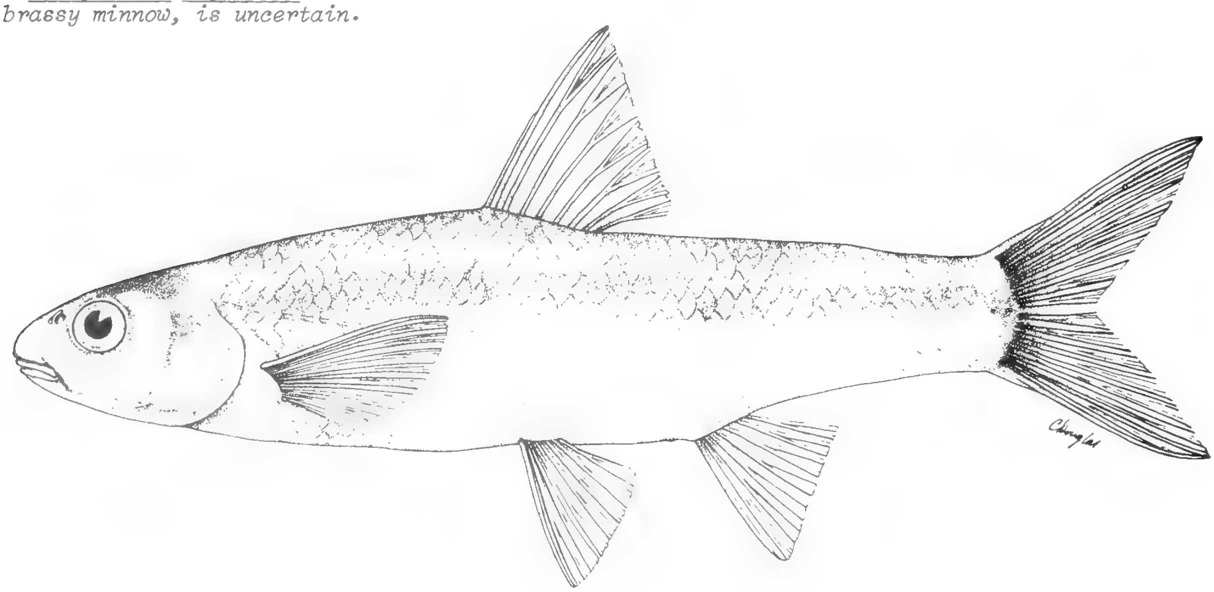

FIGURE 26: Drawing of the western silvery minnow / méné d'argent - Hybognathus argyritis, classified as rare in Canada.

Distinguishing features: Closely resembles the brassy minnow, *Hybognathus hankinsoni*. The brassy minnow is yellowish in colour and has about 20 radii (radiating grooves) on its scales, while the western silvery minnow is silvery and has about 10 radii on its scales.

Habitat: In the U.S. it is most abundant in backwaters and pools of large silty plains streams over silt or sand bottom (Pflieger, 1971; Pflieger *in* Lee *et al*., 1980). It is less abundant in creeks and impoundments. Brown (1971) reports it prefers large streams in Montana with depths of 60 to 150 cm on silt and sand bottoms. Willock (1969b) collected it in Alberta from turbid, even-flowing sections about one metre deep over mud or sand bottoms, with little current and temperatures 15.2 to 18.5°C.

Biology: Unknown in Canada. In Montana, Brown (1971) reports sexual maturity is attained after one year, and females between 50 and 90 mm in length produce 2000 - 7000 eggs each from May to August. Newly hatched fry are about 6 mm in length. One-year-olds are about 25 mm, two-year-olds 76 mm, three-year-olds 94 mm. The largest Montana specimen was 173 mm, and the maximum age was about 4 years. Feeds primarily on bottom ooze containing algae and minute animals. Probable forage for northern pike, sauger and channel catfish.

Protective measures taken: None.

Recommendations: 1) All purported records of this species should be verified.
2) A nature preserve for the Milk River Canyon as suggested by the Alberta Wilderness Association should be set up for the protection of this and other wildlife and plants and a status study instituted.

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Hybopsis storeriana (Kirtland, 1844) - silver chub/méné à grandes écailles (m.).

It was feared that this species disappeared from Canadian waters of Lake Erie along with the mayflies of the genus *Hexagenia* on which it fed. However, either collecting attempts were not made deep enough, 10 to 20 metres, or the population crashed and then rebounded as it adapted to alternate food such as insect larvae and *Gammarus*. It seems likely that low population levels of the silver chub are related to the "death" of Lake Erie, the enormous physical and biological changes that have overtaken this lake. These

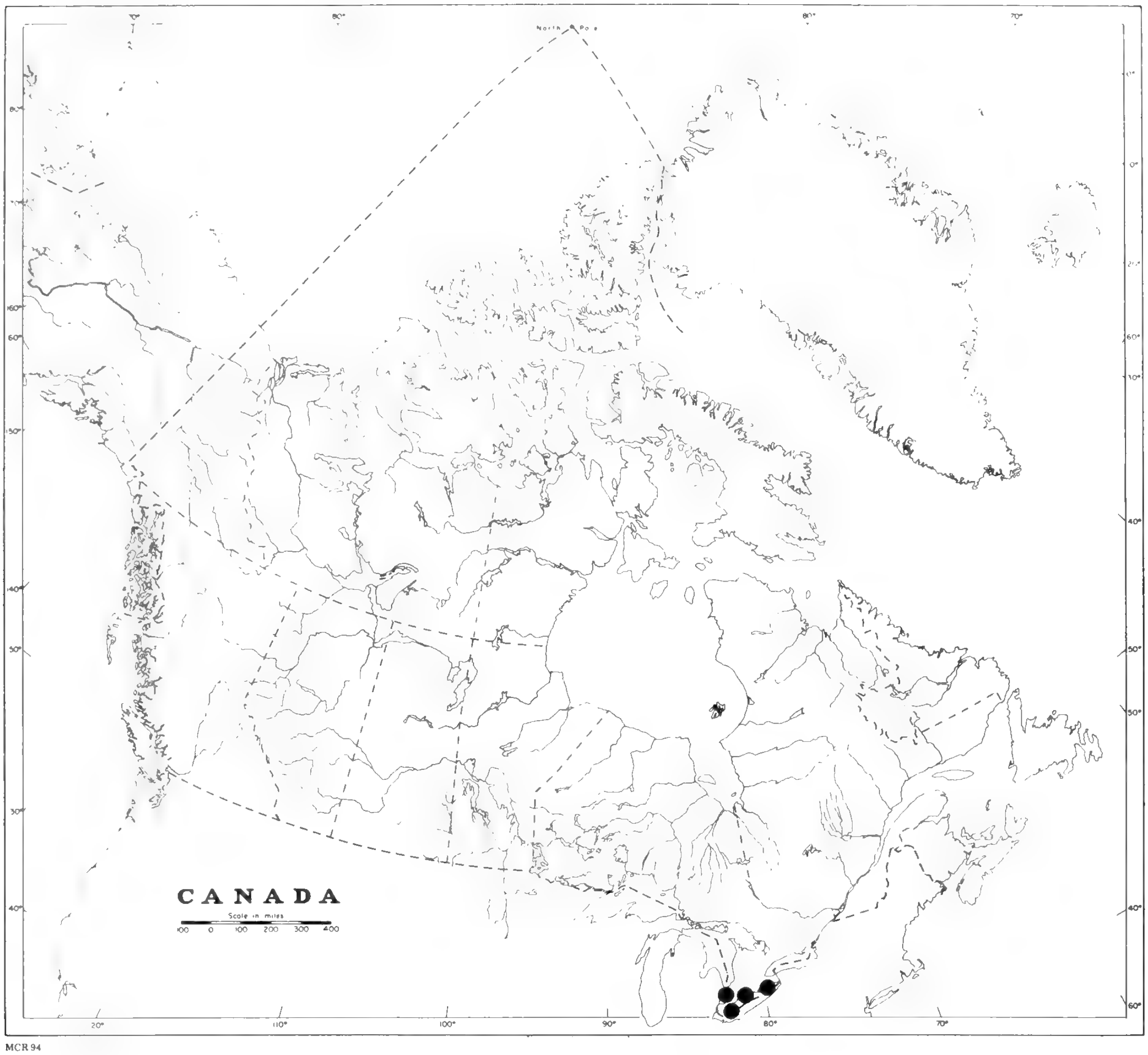

FIGURE 27: Map of the Canadian distribution of the silver chub / méné à grandes écailles - Hybopsis storeriana.

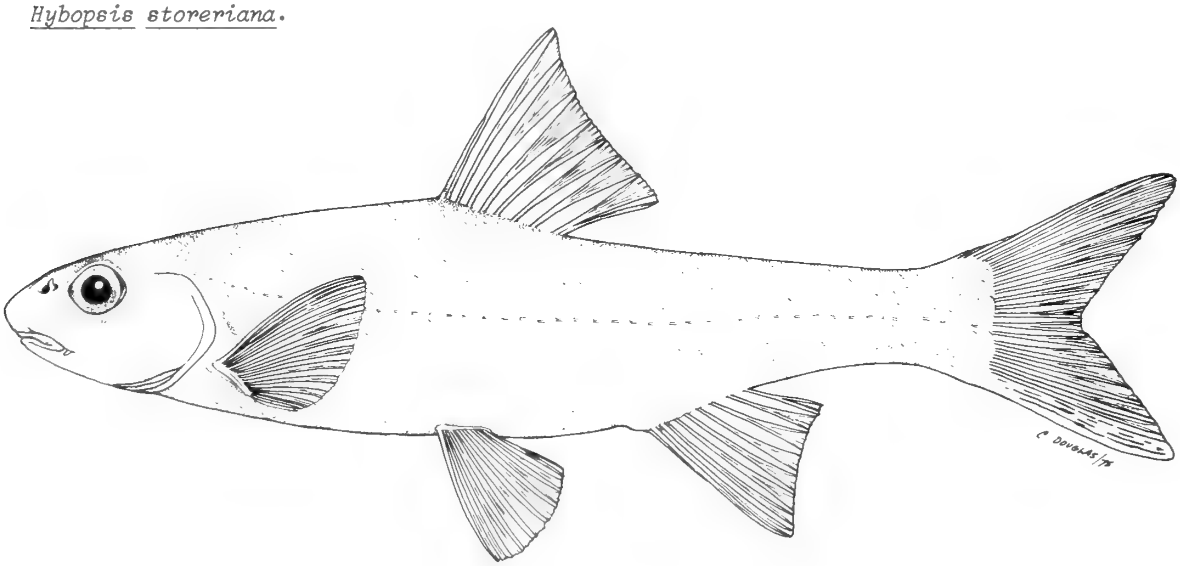

FIGURE 28: Drawing of the silver chub / méné à grandes écailles - Hybopsis storeriana. Pollution in Lake Erie forced this species to switch from its preferred food, mayfly nymphs, to scud and chironomids.

catastrophic changes include eutrophication, lethally low oxygen levels at certain depths and times of year, introduction of toxic chemicals, introduction of and great increase in numbers of the smelt, and introduction of the sea lamprey, documented by Smith (1968) and others.

Canadian status: Rare. Although common in the western basin of Lake Erie in the 1950's, efforts to obtain specimens with the co-operation of the Ontario Department of Lands and Forests and commercial fishermen in the late 1960's were in vain (Scott and Crossman, 1979), p. 421), as were efforts of the National Museum of Natural Sciences in southwestern Ontario 1971-74. However, the Ontario Ministry of Natural Resources recorded the species in 1979 from western Lake Erie and Lake St. Clair and it has been reported from the St. Clair River. Catch per unit effort suggest the relative abundance is low in the two lakes and less than 2% of fishes caught were silver chub. About 2.0 to 4.5 silver chub were trawled per hour in Lake Erie. The species thus occurs in very low numbers in the Great Lakes, relatively and absolutely. Although reported in the Assiniboine River and the Red River system north to St. Andrews Locks near Selkirk, in Manitoba, efforts by the National Museum of Natural Sciences to collect them there in 1970 were unsuccessful. However, K. Stewart collected specimens in the Red River at Winnipeg, 24 September 1981 (NMC84-0005).

Status elsewhere: Known elsewhere in the United States in the Lake Erie and Mississippi basins and eastern Gulf of Mexico drainages. It is regarded as threatened in Michigan and South Dakota (Miller, 1972), and endangered in Ohio.

Distinguishing features: Snout projecting considerably beyond mouth, a well-developed barbel at posterior end of maxillary nearly always present, 38-41 large deciduous lateral line scales, silvery sides without definite spots. The maximum length in Ohio is 231 mm (Trautman, 1957), in Canada 200 mm.

Habitat: The habitat and 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 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 movement into warmer water. 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 Ontario Ministry of Natural Resources in Lake St. Clair and Lake Erie are from waters under 10 metres 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 metres in depth. Capture depths of up to 20 metres have been recorded in Lake Erie (Woolman, 1895; Fish, 1932; and Trautman, 1957).

Bottom types at capture locations 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, gravely or sandy bottoms.

There is some indication that this species is intolerant of low dissolved oxygen levels. Kinney (1954) suggested that temporary hypoxic conditions created in the western basin of Lake Erie during 1953 by thermal stratification conditions have been recorded in the western basin of Lake Erie on several occasions (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°C for six to seven months of the year and above 21°C 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 within these levels. Silver chub have been captured in Lake St. Clair from waters ranging between 4 and 25°C.

Biology: 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 yo 145 mm in length, age 2+ from 110 to 155 mm and age 3+ from 145 to 170 mm in Lake Erie (Kinney, 1954). A collection of nine silver chub taken from Lake Erie near Hen Island by the Ontario Ministry of Natural Resources on July 12, 1978 averaged 70 mm in total length.

These specimens are believed to be 1+ fish. Specimens of silver chub captured in Lake St. Clair were of comparable size for age one and age two fish.

Silver chub taken during this study averaged 150 mm in total length. The longest Canadian specimen is approximately 200 mm in length. Trautman (1957) gave the maximum size for silver chub in Ohio as 231 mm in length and 170 grams in weight. Pflieger (1975) stated that in Missouri adult silver chub are commonly 90 to 140 mm in length and individuals above 150 mm in length were rare.

Too few specimens are available to determine growth rates in Canadian populations of this species. Kinney (1954) stated that 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 60 mm per year and in 2+ and 3+ silver chub the growth rate decreases to 25 mm and 15 mm, 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, 1979). Kinney (1954) reported that the silver chub spawns in late June and early August when water temperatures reach 18°C. Most spawning took place in waters above 21°C. Trautman (1957) found spawned out adults dead on Ohio beaches in June and July. Scott and Crossman (1979) 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 21, 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 were sexually mature.

The number of ripe eggs may be estimated by multiplying the ovary weight in grams by 746 and adding 365. 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) and Auer (1982) illustrates a tentatively identified silver chub larva. Larval silver chub have been taken in bottom trawls at depths of 18 to 20 m in Lake Erie (Scott and Crossman, 1979).

Food habits could not be determined for Canadian populations due to a lack of specimens. 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 consisted of Ephemeroptera nymphs, Hexagenia comprising more than 65% of those nymphs. Minor components of the stomach volume were small molluscs, Daphnia, Gammarus and small fish. Following the decline of Hexagenia populations in Lake Erie, during the 1950's, more chironomids and Gammarus were eaten (Scott and Crossman, 1979).

Parasites listed for the silver chub include Trematoda, Cestoda, Nematoda and Acanthocephala (Scott and Crossman, 1979).

The silver chub probably serves as food for several species of 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 as an excellent bait fish for walleye. Harlan and Speaker (1969) reported that in Iowa the silver chub was a popular bait fish and Jordan and Evermann (1908) regarded the silver chub as a superior baitfish 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.

Protective measures taken: None.

Recommendations: The following recommendations are made on the silver chub:

1) The Ontario Ministry of Natural Resources should monitor the species with the same gear used in the past so that population sizes and trends can be calculated. Spawning areas, times and nursery grounds of young should be identified.

2) Surveys should try to locate surviving populations in Manitoba.

3) Sampled specimens should be studied for growth, food, sexual maturity and parasites. Representative specimens should be deposited in the National Museum of Natural Sciences, Ottawa or a provincial museum.

4) Any efforts to return limnological conditions in lakes St. Clair and Erie, especially in regard to increasing oxygen levels, would benefit this species.

5) The impact of catch of bait dealers and fishermen on populations in Ontario should be estimated.

Hybopsis x-punctata Hubbs and Crowe, 1956 - gravel chub/gravelier (m.).

The gravel chub was collected twice in Ontario, the first time in 1928 and the last time in 1958. Despite search by the National Museum of Natural Sciences, Ontario Ministry of Natural Resources, and Beak Consultants Limited in the 1970's, surviving populations have not been found. It seems likely that the gravel chub has been extirpated in Canada.

Contributing factors to the loss of gravel chub from the Canadian fauna probably include siltation resulting from lack of cover on banks, and perhaps water quality.

Canadian status: Probably extirpated in Canada. Was known from the Thames River system at Muncy Indian Reserve in 1928 and in the Thames River near the University of Western Ontario where the last specimens were caught by D. Roseborough in August 1958 (Scott and Crossman, 1979). Surveys by C.G. Gruchy and Brad Parker in the Thames River from 1971-74 and in 1979 and the Ontario Ministry of Natural Resources in the early 1970's have failed to turn up surviving populations. The Thames population was about 300 km from the nearest American population. Water quality deterioration from agricultural and urban influences in the Thames River may have caused depletion or extirpation of the gravel chub populations.

Status elsewhere: Wide but spotty distribution in the northern Mississippi and southern Great Lakes Basin but extirpated from many localities where formerly found (Gilbert in Lee et al., 1980). Listed as endangered in Kansas (Platt, 1974), recommended for endangered status in Wisconsin (Anonymous, 1979) and reported as decreasing in abundance or extirpated in several sections of Ohio following siltation of sand and gravel bars.

Taxonomic status: Hubbs and Crowe (1956) assigned the northeastern Ohio basin and Ontario populations to the subspecies H. x-punctata trautmani, whose maximum standard length is 48 mm; another subspecies occurs to the west of the Mississippi River.

Distinguishing features: Snout projecting considerably beyond mouth, small conspicuous barbel near end of maxillary, 43-45 large scales in the complete lateral line, faint X- or Y-shaped spots on silvery sides.

Habitat: Pflieger (1975) reported that the gravel chub inhabits clear to moderately turbid streams with permanent flow and well-defined gravelly or rocky riffles. In the Ozark

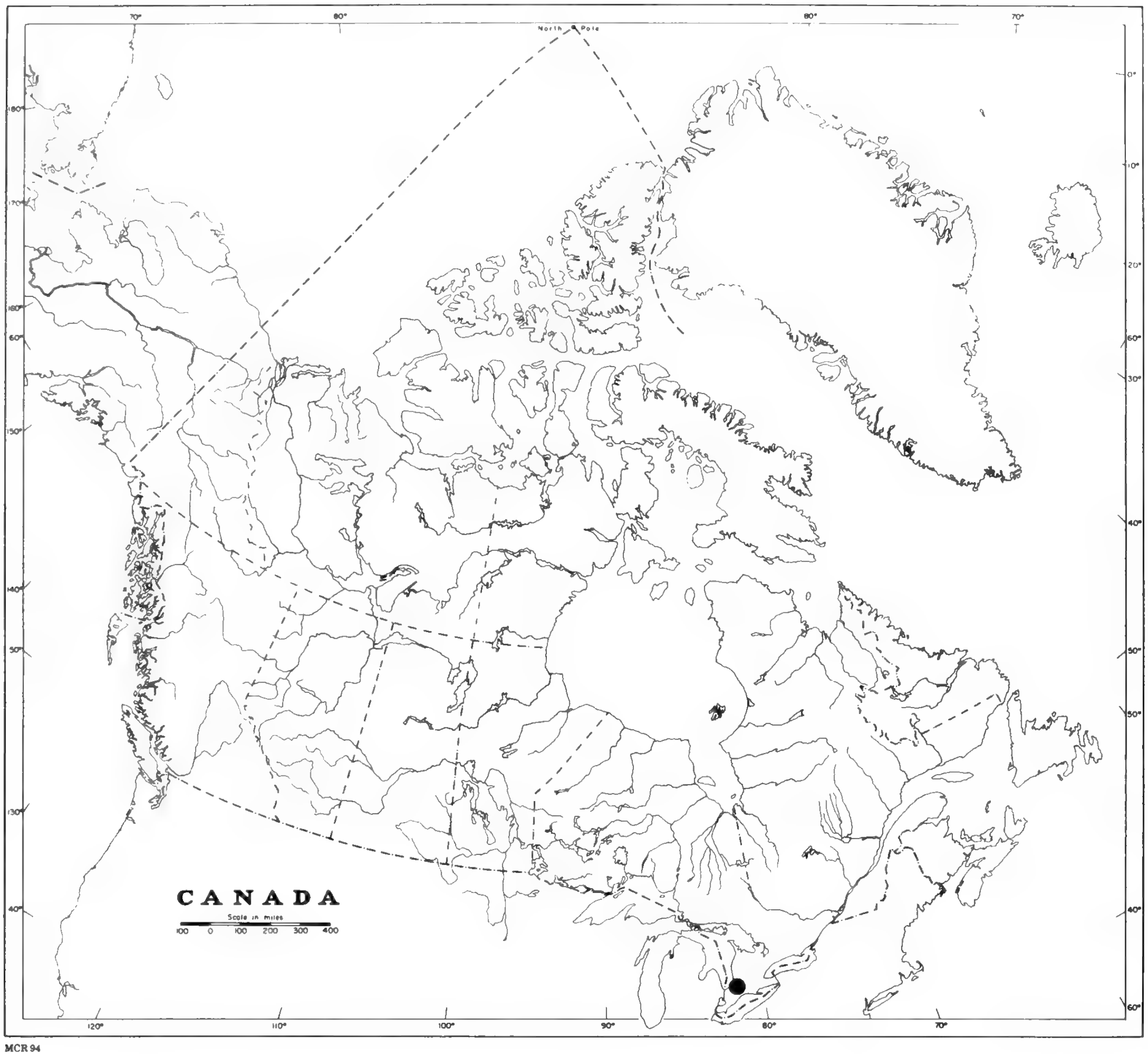

FIGURE 29: Map of the former Canadian distribution of the gravel chub / gravelier - Hybopsis x-punctata. Siltation from lack of plant cover on stream banks probably led to the disappearance of this species in Canada.

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 0.3 m and 1.3 m in the summer and 1.6 m and 2.0 m in winter.

This species also 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.

The Thames River, in areas of former capture, has a constant flow and is approximately 20 to 30 m in width and averages 1 to 3 m in depth; pool and riffle habitat predominate. The river bottom is composed of sand, rock and stone with areas of soft organic matter and silt. Siltation in the Thames River has caused the water to be quite turbid (white disc visible to less than 1 m). 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.

Biology: Gravel chub collected from the North Thames River ranged in length from 52 mm to 77 mm. Trautman (1957) reported that young-of-the-year in Ohio ranged between 28 and 65 mm in length; one-year-old fish between 40 and 70 mm; and breeding adults from 64 to 90 mm in length with a maximum of 102 mm. Considering the above growth data, it is probable that Ontario specimens were 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). Further data on reproduction are unavailable.

The gravel chub probably feeds on bottom 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 smallmouth bass, Micropterus dolomieui and rockbass, Ambloplites rupestris, which are common in the Thames River would feed on gravel chub if present. Scott and Crossman (1979) believed that the greatest importance of this species to man may be as an indicator of pollution due to its sensitivity to siltation.

Protective measures taken: None.

Recommendations: There is little chance that there are surviving Canadian populations, but on the chance there are:

1) Further efforts should be made to find them in suitable habitat.
2) Abatement of deterioration of water quality and siltation.
3) Establishment of a natural history reserve, and other measures should be considered if survivors are found.

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Notropis anogenus Forbes, 1885 - pugnose shiner/méné camus (m.)

The pugnose shiner has been found in Canada in three areas, Point Pelee and Rondeau Bay, both in Lake Erie and near Gananoque at the outlet of Lake Ontario. It was last collected in 1963. Despite search at all three known locations for the pugnose, none were captured, although possibly some may yet survive.

Canadian status: Endangered. Scott and Crossman (1979) concluded that its range has been diminishing in Ontario, due to its requirements for clear water, clean bottom, and extreme sensitivity to turbidity. Known in Ontario from only three localities: at the extreme outflow of Lake Ontario at Gananoque and in western Lake Erie in Rondeau Bay, and in ponds on the east side of Point Pelee, Lake Erie. It was last collected in Canada in 1963 in Rondeau Park despite search in 1979 at the three known localities, but we have just received a report of specimens being collected in the Old Ausable River in Pinery

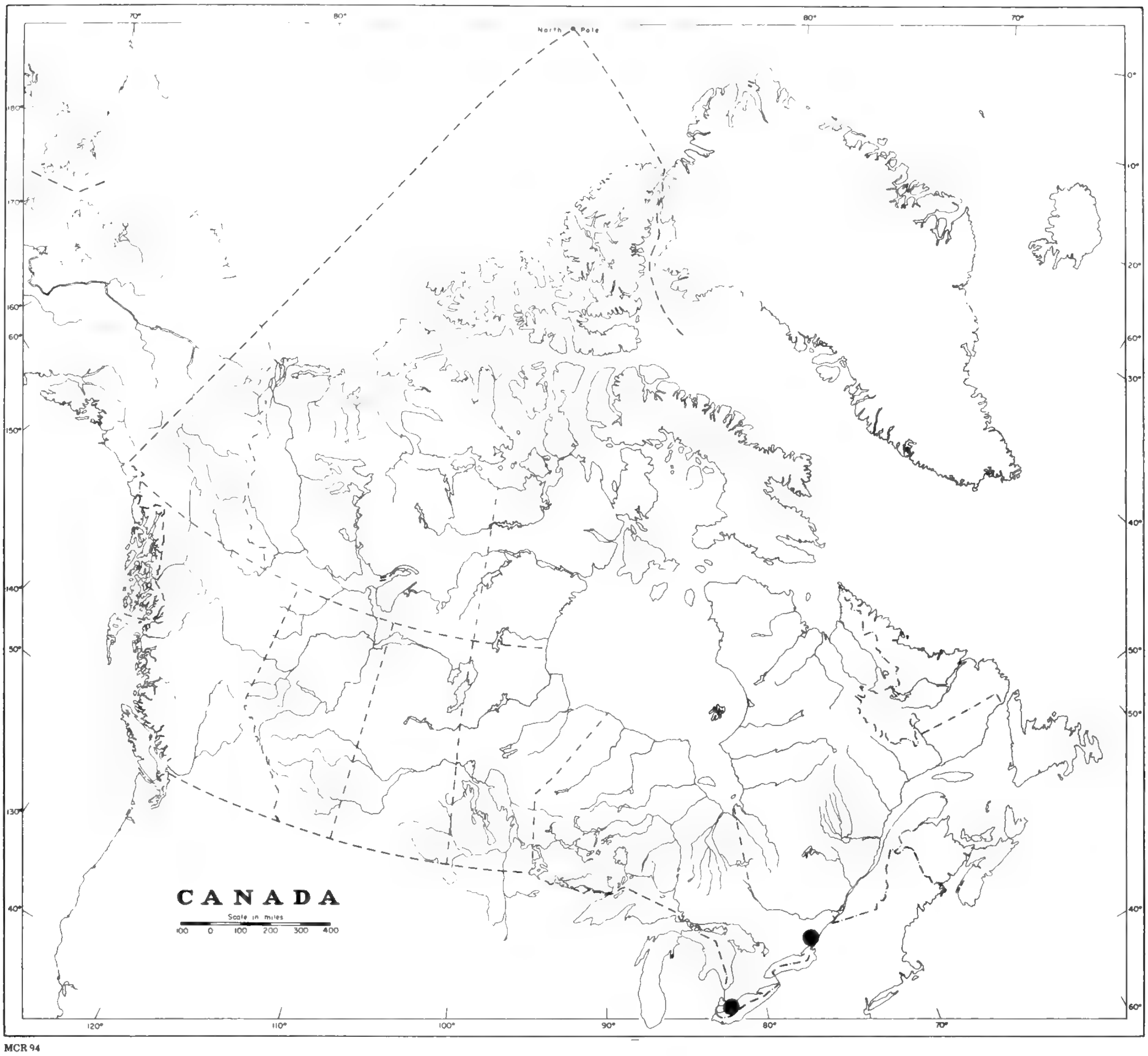

FIGURE 30: Map of the Canadian distribution of the pugnose shiner / méné camus - Notropis anogenus. Despite recent search, this species was last found in Canadian waters in 1963.

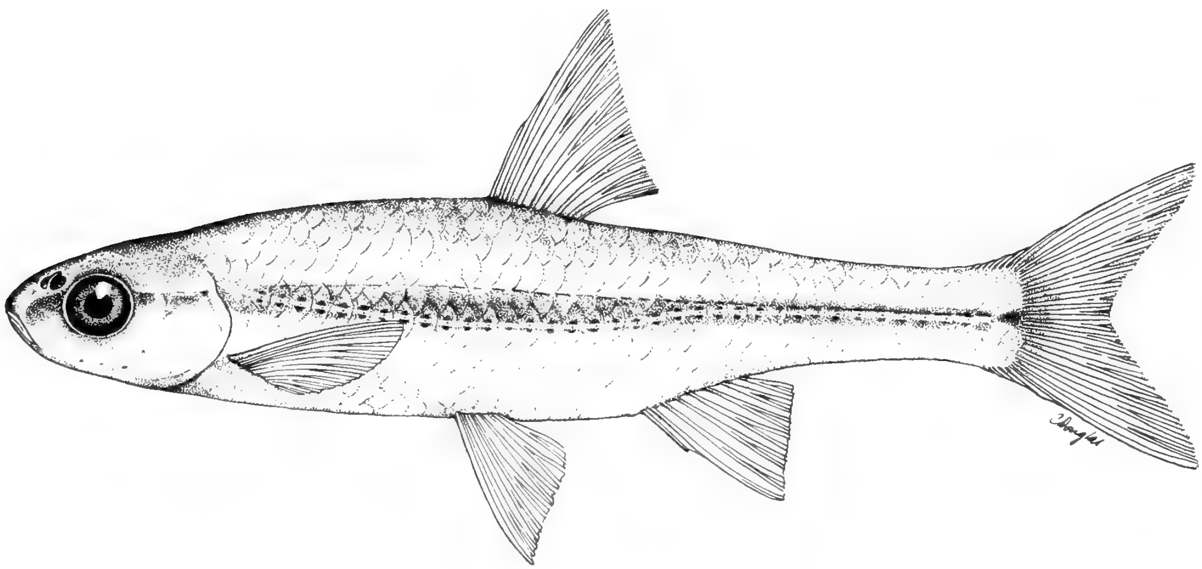

FIGURE 31: Drawing of the pugnose shiner / méné camus - Notropis anogenus. Deterioration in shoreline habitat and water quality in lakes Erie and Ontario has probably led to the decline of this species in Canada.

Provincial Park, Ontario by Erling Holm (in litt., 16 July 1982). The latter is the only known surviving population. Reports of this species occuring on the east side of Long Point, Lake Erie seem in error. Canadian populations are about 135 km from the nearest U.S. population.

Status elsewhere: Rare. Known elsewhere only in seven states of the U.S. from New York to North Dakota, all in the vicinity of the Great Lakes; it has disappeared from Ohio (Trautman, 1957). Protected as endangered in Wisconsin (Anonymous, 1979). Described by Bailey (1959), who provides a spot distribution map, as one of the rarest cyprinids in northern United States and southern Canada. He reported it to be extirpated in some areas due to increased turbidity from agricultural activities and reduction of aquatic vegetation. Generally rare and often missing from seemingly favourable habitat within its range (Gilbert in Lee et al., 1980).

Taxonomic status: Bailey (1959) reviewed taxonomy and Gilbert (1978b) listed type material.

Distinguishing features: Distinguished from all Ontario *Notropis* except *N. cornutus* by its black peritoneum. *N. cornutus* has 38-43 instead of 32-36 lateral line scales. Mouth small, almost vertical as in *N. emiliae* but dorsal rays 8 instead of 9. Ontario specimens were about 38-51 cm in total length.

Habitat: The habitat and biology of this species is virtually unknown. Trautman (1957) suggested that this species is usually found in clear, well-vegetated lakes and low gradient streams with sand, mud, and detrital bottoms.

In Canada, the pugnose shiner has been recorded from sheltered inshore ponds and protected bays near large water bodies. Substrates in these areas were usually composed of sand and detritus, but in Rondeau Harbour the bottom was predominantly clay. Each locality where the pugnose shiner has previously been captured is heavily vegetated; both emergent and submergent aquatic macrophytes are present. In our studies turbidity and silt were minimal at Point Pelee and Gananoque (a white disk was visible down to 1.5 meters); however, at Rondeau Harbour turbidity was much higher (disk visible to 0.3 meters). Water temperatures ranged from 15 to 18°C and dissolved oxygen ranged from 9 to 11 mg/L.

It is evident that specimens must be located before a definitive habitat preference can be specified.

Biology: Little has been published on the age and growth of this species. Trautman (1957) stated that adults ranged between 33 to 48 mm in length and Carlander (1969) gave the maximum length of this species as 56 mm total length.

Specimens from Ontario waters ranged in length from 38 to 51 mm total length. It is therefore deduced that specimens captured in Ontario were adults although ages were not determined.

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, 1979). 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 no specimens were available for dissection to determine stomach contents. Scott and Crossman (1979) 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.

Protective measures taken: None.

Recommendations: 1) A nature preserve should be set up to protect this species from lakeshore development.

2) A life history study should be instituted.

3) Identification cards should be prepared and sent to concerned agencies and individuals.

4) Any moribund specimens found should be deposited in the National Museum of Natural Sciences, Ottawa or a provincial museum.

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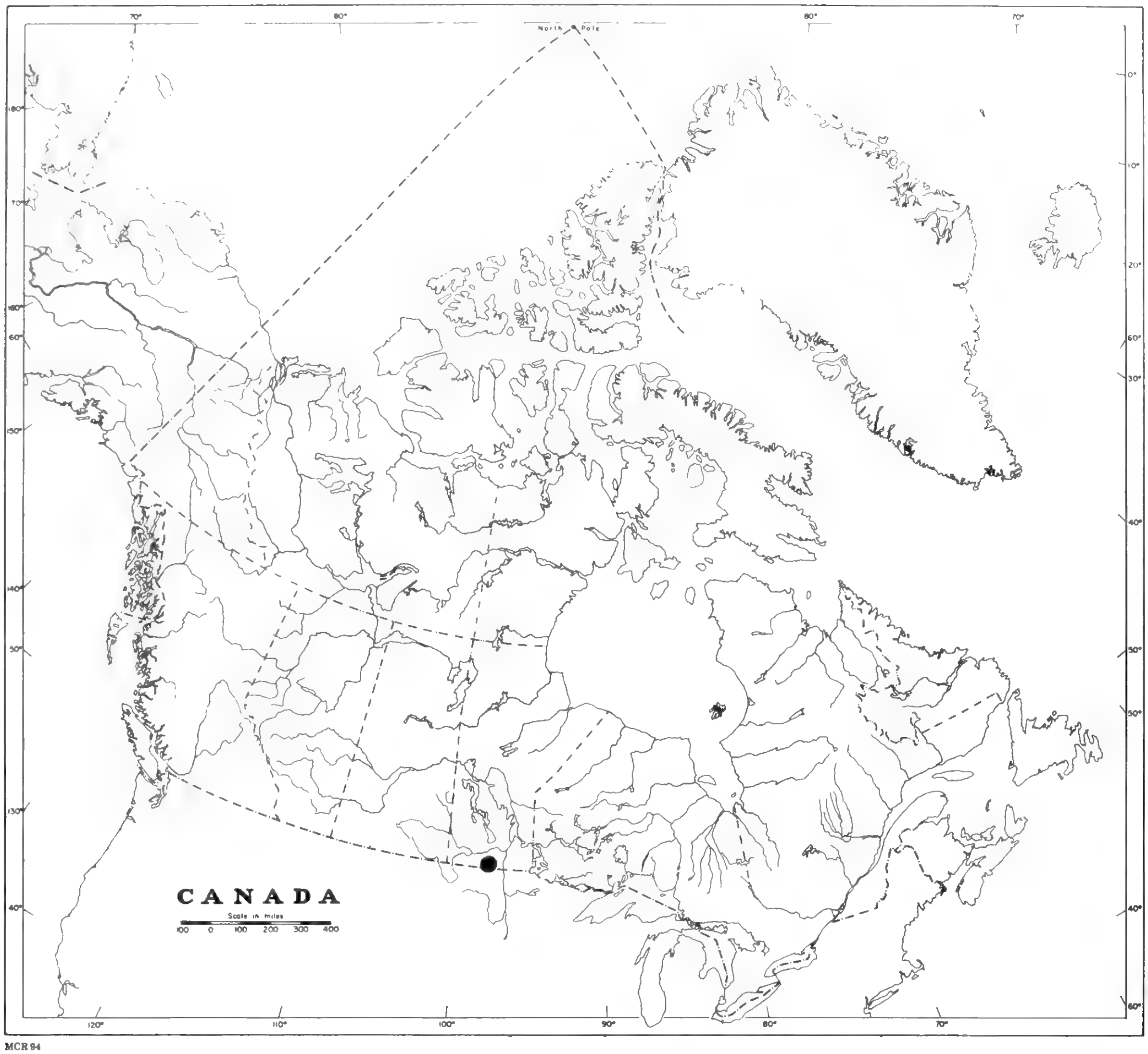

FIGURE 32: Map on the Canadian distribution of the bigmouth shiner / méné à grande bouche - Notropis dorsalis. The two 1969 Manitoba collections were the northernmost for the species.

FIGURE 33: Photograph of the pugnose minnow / petit-bec - Notropis emiliae, from Bear Creek in the Sydenham River system, Ontario.

Notropis dorsalis (Agassiz, 1854) - bigmouth shiner/méné à grande bouche (m.)

The bigmouth shiner occurs in shallow, open prairie-like streams with botton predominantly sand, often overlain with silt. First collected in Manitoba in 1968 at two sites, it has not been collected since. The Manitoba population is the northernmost for the species.

Canadian status: Rare. Tompkins (1983) has prepared a status report for COSEWIC. Known in Canada from 1968 collections in the Pembina River, 8 km upriver from the North Dakota border in Manitoba, and the Woody River, southern Manitoba (Fedoruk, 1970; Tompkins, 1983). These localities are over 120 km from the nearest U.S. record (Gilbert and Burgess in Lee et al., 1980). Crossman and McAllister (in press) questioned the report of this species from the Souris River, Manitoba. Fedoruk (1968) referred his specimens to the subspecies Notropis dorsalis dorsalis. Collecting in 1970 by C.G. Gruchy and T.A. Willock failed to reveal the presence of bigmouth shiner, but K.W. Stewart collected 25 in the Pembina River on September 17, 1983 (NMC 83-0760).

The proposed Garrison Diversion Project, which will divert water from the Missouri River into the Red River Basin, would probably have adverse affects on the quality and quantity of water in the Pembina River. There is also the potential for introduction of exotic species, diseases and parasites which may result in losses to bigmouth shiner populations (Tompkins, 1983). If the Garrison Project goes ahead, the status of bigmouth shiner in Canada should be changed to threatened or endangered. It is not tolerant of eutrophication.

Status elsewhere: Fairly widespread in central northern United States. Not listed as threatened or endangered in U.S. by Miller (1972) but Trautman (1957) considered continued expansion of the range of the silverjaw, Ericymba buccata, perhaps due to its tolerance to turbidity and toleration of pollution, will result in extirpation of the bigmouth shiner in Ohio and it is considered threatened in New York (Tompkins, 1983). Underhill (1957) reported it common in Minnesota including the Red River drainage and discussed its zoogeography and it was found in 11% of the collections from tributaries of the Red River in North Dakota (Tompkins, 1983).

Distinguishing features: Disinguished from other minnows of the genus *Notropis* by the large mouth extending below the front of pupil of the eye, the dark lateral band especially distinct on the posterior trunk and caudal penduncle, and a distinct mid-dorsal stripe. Underhill and Merrell (1959) dealt with intraspecific variation in Minnesota.

Habitat: Prefers small creeks (Underhill, 1957). Inhabits shallow, open, prairie-like streams with bottom predominantly sand, often overlain with silt, and with permanent flow (Gilbert and Burgess *in* Lee *et al*., 1980; Tompkins, 1983). Specimens in Manitoba were collected over bottoms of gravel, sand and shale with little vegetation. The bigmouth shiner's preference for sand and gravel bottoms may limit its distribution in Manitoba.

Biology: Feeds mainly on bottom insects but diet includes some bottom ooze and plant material (Gilbert and Burgess *in* Lee *et al*., 1980). Forms schools, sometimes with other species, or loose aggregations facing the current. Spawns from May to July in Illinois. Probably spawns in mid-water with eggs drifting downstream. Auer (1982) describes the larval stages and illustrates them. May live three years, occasionally four and reach 75 mm TL. Infestations of this species by the parasites *Neochinorhynchus rutili* and *Gyrodactylus planensis* were reported in Nebraska (Tompkins, 1983).

Protective measures taken: None.

Recommendations: 1) A natural history reserve with human disturbance minimized should be set up for its protection.

2) A study of its ecology, life history and population structure should be made.

3) Its distribution and abundance should be monitored and occurrence investigated in the Souris River.

4) Distribution and identification information should be made available to concerned agencies and individuals.

5) Any moribund specimens should be deposited in the National Museum of Natural Sciences, Ottawa or in a provincial museum.

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Notropis emiliae (Hay, 1881) - pugnose minnow/petit-bec (m.)

Like the pugnose shiner, the pugnose minnow is small, averaging 50 mm (2 inches) and has a small vertical mouth. However, it differs in having 9 rays instead of 8 supporting the dorsal fin and has a silvery instead of a black lining to its body cavity. Its preference for clear, slow-moving water with an abundance of vegetation, a habitat that is rapidly disappearing from southern Ontario, and its intolerance to turbidity and siltation, is probably related to its decline and rarity in Ontario waters. As with other species, unless its habitat is protected from deterioration, it will probably cease to survive.

Canadian status: Endangered. Known in Canada from only 10 localities. Was known in the Detroit River but has not been caught from the Canadian side since 1941. Also known from Lake St. Clair, and one locality in the Thames River where 7 were caught in 1968 (Scott and Crossman, 1979), one locality in the Grand River system, and from 7 localities in the North and East Sydenham rivers. Scott and Crossman (1979) considered it most unlikely that it would survive for long in Ontario because of its intolerance to turbid or muddy waters. Intensive surveys of previously known Ontario localities in 1979 revealed only 8 specimens. Catch-per-unit effort values were low, ranging from 0 to 3.3 specimens per 100 m^2 of area seined. The siltation of streams in southwestern Ontario may be detrimental to Canadian populations; it led to extirpation of pugnose minnow from many parts of its range in Ohio (Trautman, 1957).

Status elsewhere: Primarily now found in the Gulf states and the Mississippi Valley. Considered endangered in Missouri (Miller, 1972). Trautman (1957) reported it as drastically decreased in numbers since 1930, and that it appeared to be threatened with possible extirpation from Ohio waters, and (Van Meter and Trautman, 1970) as rare or extirpated in the Lake Erie watershed. See distribution map by Gilbert (*in* Lee *et al*., 1980).

Taxonomic status: This species has been placed in the monotypic genus *Opsopoeodus*. Gilbert and Bailey (1972) reduced *Opsopoeodus* to a subgenus of *Notropis*. But Camos and Hubbs (1973) disputed this action on the basis of chromosome form and number, and Gilbert (1978b) provided additional discussion of *Opsopoeodus*, type specimens and locality. The

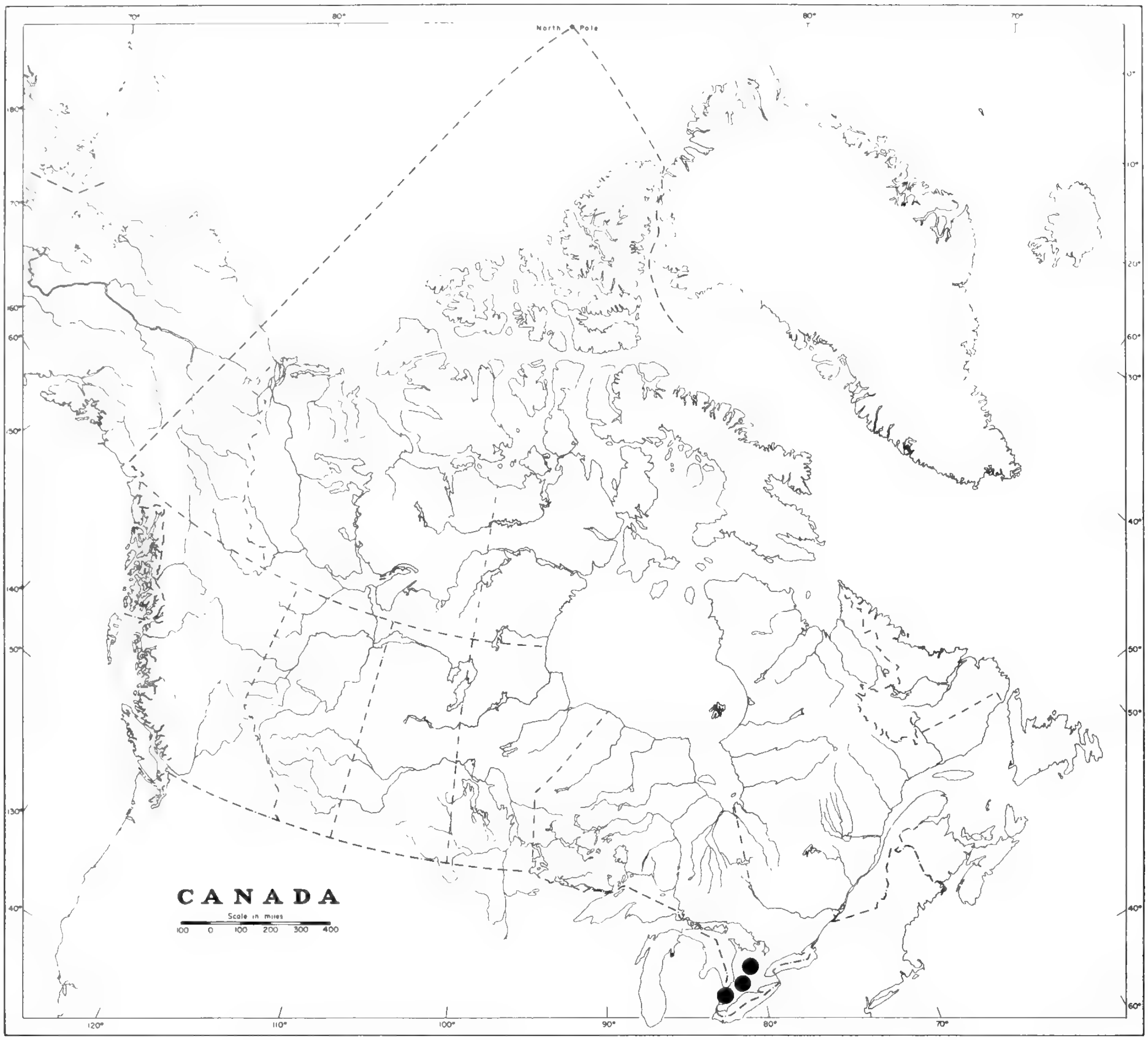

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FIGURE 34: Map of the Canadian distribution of the pugnose minnow / petit-bec - Notropis emiliae. Intensive surveys in 1979 turned up only 8 specimens.

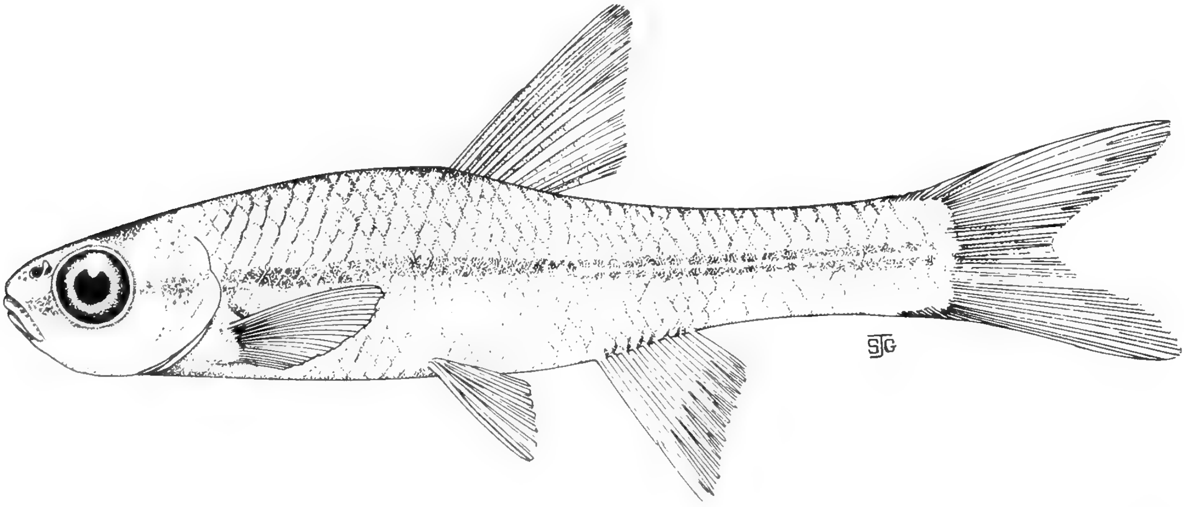

FIGURE 35: Drawing of the pugnose minnow / petit-bec - Notropis emiliae. This endangered species averages only 50 mm (2 inches) in length.

Ontario population belongs to the nominate subspecies, N. e. emiliae, according to Gilbert and Bailey (1972).

Distinguishing features: Distinguished from other Notropis by the very small and almost vertical mouth and the 9 instead of typically 8 dorsal rays.

Habitat: 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 0.02 m/km to approximately 0.2 m/km. Specimens were taken in pond-like, weedy embayments and along river edges. Capture sites had soft clay and silt bottoms in Mitchell Bay, Lake St. Clair. 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 1.5 m of water by encircling clumps of weeds with a seine.

High levels of suspended solids were evident at all capture locations during the 1979 survey. Secchi discs were visible only to a depth of 10 cm 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°C and dissolved oxygen concentrations were about 7 mg/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 extirpated 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.

Biology: 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. Validation of the scale method of age determination in this species requires a larger sample.

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

Age (years)	No. Specimens	Standard Length (mm)	Weight (grams)
1	2	29 - 32	0.24 - 0.29
2	5	34 - 37	0.57 - 0.73
3	1	46	1.19

In Ohio, young-of-the-year are 25 to 43 mm long, one-year old fish are 33 to 51 mm long, and adults are usually 38 to 58 mm long, with a maximum recorded length of 64 mm (Trautman, 1957).

Data on reproduction in this species are limited. Gilbert and Bailey (1972) stated that in Florida males are in spawning conditions from March to September and gravid females were captured from January to September. Gilbert and Bailey also mention that specimens in spawning condition were taken in late May in Arkansas. Forbes and Richardson (1920) 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 in Florida have been studied by Gilbert and Bailey (1972). 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 minnows examined, two had empty forguts, one contained unidentifiable material, and one contained 60 percent adult Diptera and 40 percent larval Trichoptera by volume. Scott and Crossman (1979) believed that the strongly up-turned mouth of the pugnose minnow suggests a mid-water or surface feeding habit.

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 trematode parasites of the pugnose minnow.

Protective measures taken: None.

Recommendations: 1) A nature reserve should be established for its protection in Ontario and guarded from siltation.

2) A study of its biology and population size should be made.

3) Identification cards should be made available to concerned agencies and persons.

4) Moribund specimens should be preserved and sent to the National Museum of Natural Sciences, Ottawa or a provincial museum.

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Notropis photogenis (Cope, 1864) - silver shiner/méné-miroir (m.)

The silver shiner, with its brilliant silver scales, streamlined form, and large size is one of Canada's more strikingly beautiful minnows. A vigorous swimmer, it lives in schools in medium to large streams with considerable currents, usually over hard bottoms.

Happily, there is some evidence that its range may be slightly expanding in Ontario; we do not know why. Fluctuations in population levels and ranges of some rare species may be related to weather cycles and spawning success, changes in water quality, or other factors.

Canadian status: Rare (COSEWIC status, April 1983). Known only from the middle reaches of the Grand River drainage and upper Thames river system near London, Ontario where it may be locally abundant. Dr. Edward Kott (in litt. 2 December 1983) wrote that he had collected silver shiner in Bronte Creek, a tributary to Lake Ontario between Toronto and Hamilton. In 1979 catches averaged 37 silver shiners per 100 square metres. Canadian populations are found about 300 km from the nearest U.S. populations. Evidence from collecting in 1979 and 1980 suggests that its range may be expanding in Ontario. The Ontario populations are at the northern fringe of the species range. As this manuscript was being completed, a master's thesis was submitted to accepted in the fall by the Biology Department of Carleton University, Ottawa by Mary E. Baldwin (30 June 1983) entitled Habitat use, distribution, life history, and interspecific associations of Notropis photogenis (silver shiner; Osteichthyes: Cyprinidae) in Canada, with comparisons with Notropis rubellus (rosyface shiner). The COSEWIC status report on this species is in press (Parker and McKee, 1984b).

Status elsewhere: Elsewhere occurs only in United States, throughout much of the upper Ohio basin of the Mississippi system (except western lowlands), and portions of the Upper Tennessee River watershed and the Lake Erie drainage of the Great Lakes Basin. Listed as threatened for Michigan by Miller (1972). Between 1920 and 1950 (Trautman, 1957) the species decreased markedly in number in many localities in Ohio, especially in areas where

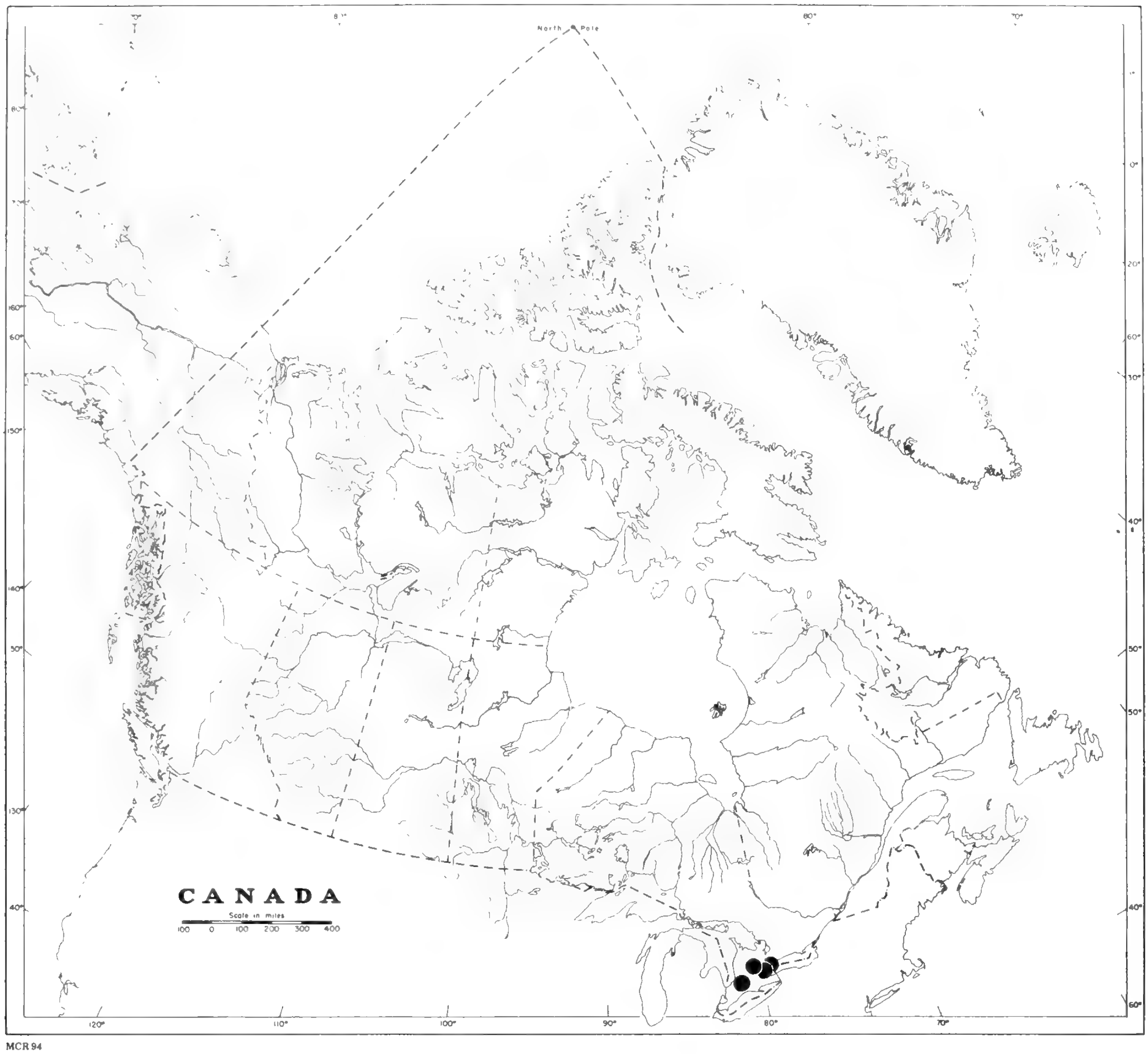

FIGURE 36: Map of the Canadian distribution of the silver shiner / méné-miroir - Notropis photogenis, which lives in schools in medium to large streams with considerable current over hard bottoms.

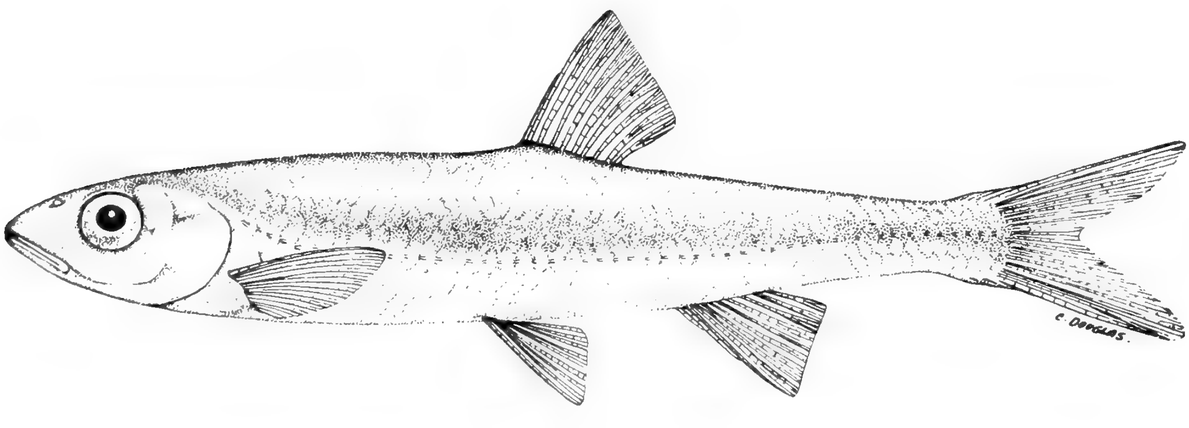

FIGURE 37: Drawings of the silver shiner / méné-miroir - Notropis photogenis. This rare species has brilliant silver scales and is a vigorous swimmer.

turbidity and siltation had increased greatly, and was uncommon to rare in Lake Erie tributaries (Gilbert *in* Lee *et al.*, 1980).

Taxonomic status: See Gilbert (1978b) regarding taxonomy and type specimens.

Distinguishing features: Distinguished from related species of *Notropis* with round scales and 9 or more anal rays by depth of body less than length of head, lack of a spot at the anterior base at the dorsal, origin of dorsal over insertion of pelvics, a crescentic spot medial to each nostril, a narrow, dense and clearly defined mid-dorsal stripe (orange in life, dark brown to black when preserved), and the striking mirror-like coloration of the body.

Habitat: The silver shiner inhabits medium-sized and large streams with considerable current (McKee and Parker, 1982; Trautman, 1957; Gruchy *et al.*, 1973b; Gilbert *in* Lee *et al.*, 1980). Stream widths at capture sites during the 1979 survey ranged from 5 to 100 m, but only two locations had widths of less than 30 m. Alternating pools and riffles characterized most sites. Large catches were also taken in moderate currents and eddies below dams. All specimens were taken in stream sections ranging between 20 and 100 cm in depth. Deeper waters were not sampled during this survey.

In the Grand River watershed, stream gradient may limit the distribution of the silver shiner. Over the range of this species in the Grand, Nith and Conestogo rivers, the average gradient is 1.4 m/km, 1.4 and 1.9, respectively. In the Thames River gradients ranged from 0.5-1.4 m/km. An abrupt drop in gradient to an average of less than 0.3 m/km in downstream sections of the Grand River beginning immediately below Brantford, corresponds with the downstream limit of the distribution of the silver shiner. An increase in gradient to 5.7 m/km through the Elora Gorge appears to impose an upstream limit to its range.

In Ontario, the silver shiner is found mainly over pebble and cobble bottoms with occasional boulders and areas of gravel, sand and silt. Trautman (1957), Gruchy *et al.*, (1973b), and Gilbert (*in* Lee *et al.*, 1980) noted that this species usually occurs over rocky bottoms. Catches of the silver shiner showed no apparent relationship with abundance of aquatic macrophytes.

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 while Gruchy et al. (1973b) found them in muddy to cloudy waters. However, Trautman (1957) noted that silver shiners preferred clear streams and Van Meter and Trautman (1970) observed they inhabit the least turbid Lake Erie tributaries. Dissolved oxygen and temperature levels in the Grand and Thames River watersheds ranged from 8.5 to 13 mg/L and to 20 to 23.5°C, respectively, in late summer during the 1979 survey.

Biology: 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.

Age-length determinations were carried out for 20 specimens collected in 1979. In August and September, young-of-the-year ranged from 35 to 59 mm standard length and 0.7 to 2.5 grams (preserved weight), 1+ fish were 55 to 77 mm and 2.1 to 4.9 grams, and 2+ fish were 87 to 98 mm and 6.7 to 12.5 g. Only one 3+ specimen (88 mm long, 9.1 grams) was examined, suggesting that most individuals have a life span of about 3 years. Gruchy et al (1973b) examined Grand River specimens and reported that juveniles were 32.5 to 54.5 mm in standard length and that adults were 57.0 to a maximum of 108.5 mm long in late July and early August. Trautman (1957) gave lengths of 38 to 61 mm for young-of-the-year silver shiners captured in October and lengths of 51 to 76 mm 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 55 mm long in standard length were examined, and three of these had maturing gonads. All specimens longer than 60 mm were mature. These observations suggest that a few may spawn at age 1 and most spawn at age 2. Gruchy et al. (1973b) stated that adults from the Grand River were 57 mm in standard length and longer while Trautman (1957) reported that adults in Ohio were usually longer than 69 mm. 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). Spawning probably occurs in June in Canada (McKee and Parker, 1982).

Gut content analysis of 36 specimens collected during the 1979 study indicates that the silver shiner is primarily a surface feeder. Insects comprised more that 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 quantities of immature aquatic insects in many specimens indicates that benthic organisms are also important in the diet. Smaller quantities of nematodes, microcrustaceans, hydrachnids, and filamentous algae were also found. Considerable variation was found in gut contents among specimens, indicating that the silver shiner is an opportunistic feeder. Gruchy et al. (1973b) 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 numbers 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 the 1979 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.

Many anglers favour this species as a bait minnow in the Grand River watershed, although it does not survive well in bait buckets.

Protective measures taken: None.

Recommendations: We make the following recommendations to ensure continued viable Canadian populations:

1) Ontario silver shiner populations should be monitored and documented. Voucher specimens from range extensions should be deposited in the National Museum of Natural Sciences, Ottawa or a provincial museum.

2) Proposed dam construction and other projects in the range of silver shiner should be evaluated in the light that lentic habitats created would probably extirpate populations.

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Rhinichthys cataractae ssp. - Nooky dace/naseux du Nooky (m.)

The little known Nooky dace of the Nooksack system of southwest B.C., inhabits moderate currents of riffles where it dines on nymphs of aquatic insects. It is unknown whether the Nooky dace represents a subspecies of the longnose dace, or a distinct species. Agricultural practices influencing water quality may pose problems for this species.

Canadian status: Rare. Confined to Bertram and Fishtrap creeks near Aldergrove, tributaries of the Nooksack River in southwestern British Columbia (Dr. J.D. McPhail, *in litt.*; McPhail, 1980b). A.E. Peden and G. Hughes found numerous specimens in the Nooksack River about 1978 and suggested agricultural practices and development of nearby gravel pits could cause problems.

Status elsewhere: Found only in western Washington in Puget Sound drainages and Pacific drainages of the Olympic Peninsula (see map in McPhail, 1980b). For range of other forms of the species see map by Gilbert and Shute (*in* Lee *et al.*, 1980).

Taxonomic status: An undescribed subspecies or species first recognized by J.D. McPhail (1967). Gilbert and Shute (*in* Lee *et al.*, 1980) report no comprehensive systematic studies of the species throughout its extensive range have yet been conducted. McPhail (1967, 1980b) and Bisson and Reimers (1977) discuss geographic variation of this form in western Washington.

Distinguishing features: This species or subspecies is distinguished from neighbouring *Rhinichthys cataractae* populations by a narrower caudal peduncle, fewer lateral line and caudal peduncular scales and by biochemical differences. The Chehalis form has 21-28 instead of 27-32 scales around the caudal peduncle and 50-61 instead of 58-75 lateral line scales (McPhail, 1980b).

Habitat: Lives in moderate currents of riffles (pers. comm. J.D. McPhail).

Biology: The Nooky dace spawns in April. The diet includes nymphs of benthic aquatic insects (pers. comm. J.D. McPhail).

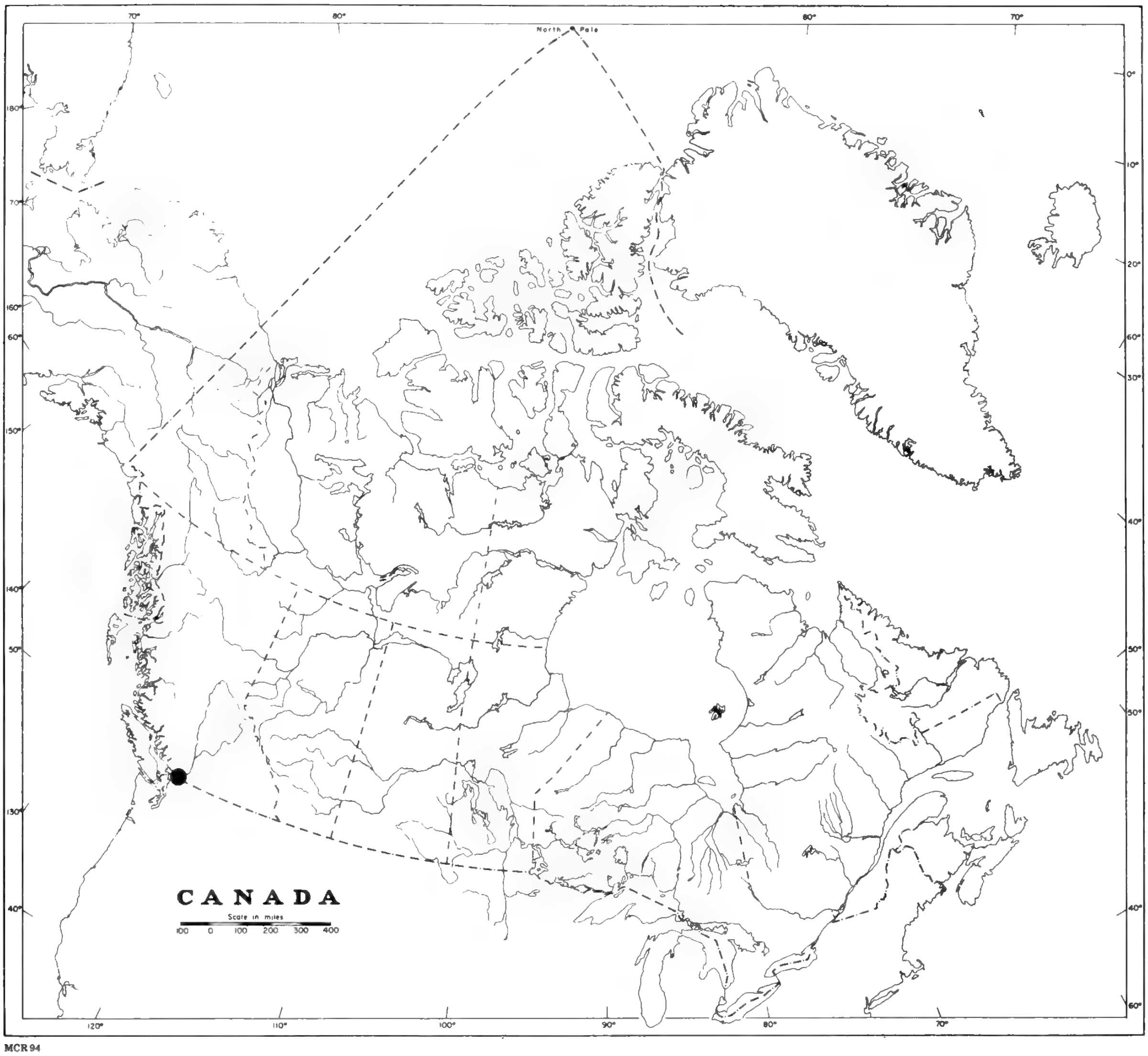

FIGURE 38: Map of the Canadian distribution of the Nooky longnose dace / naseux du Nooky - Rhinichthys cataractae ssp. This dace has not yet been given a scientific name and it is not known whether it is a distinct subspecies or a full species.

Protective measures taken: None.

Recommendations: 1) A taxonomic study should be instituted to describe this species or subspecies and give it a scientific name.

2) A life history and status study should be supported.

3) A nature preserve for its protection should be established.

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Rhinichthys cataractae smithi Nichols, 1916 - Banff longnose dace/Banff naseux de rapides (m.).

The Banff longnose dace is found only in the outflow of Cave and Basin Hotspring near Banff, Alberta. Aquarists have found that when tropical aquarium fish were planted in this hotspring they grew to a large size. As the effects of these later introductions on the dace are unknown, it would seem advisable to remove these fishes, although the small mosquitofish, *Gambusia affinis*, introduced for mosquito control in 1924, does not seem to have affected the dace.

Canadian status: Endangered. Population still surviving in 1981 near Banff, Alberta (pers. comm. Jacqueline Lanteigne), but the introduction of tropical aquarium fishes reported by McAllister (1969) and Nelson (1983) is a threat to their continued existence. Cichlids, mollies and longnose dace were observed in September 1980, but whether the dace were Banff longnose dace requires examination of specimens. Observations (by D.E.M.) in September 1984 suggest that the density of tropical fishes exceeds one per square metre and poses a serious threat to the dace through competition and predation on eggs and larvae.

Status elsewhere: Endemic to Canada, not known elsewhere. Named for Mr. Harlan I. Smith of the Victoria Memorial Museum, Ottawa (now called National Museums of Canada), who collected the types.

Taxonomic status: The taxonomic status of this subspecies requires re-evaluation in the light of modern taxonomic concepts. Dace were first reported in hot sulphur springs at Banff by Eigenmann (1894) as *Rhinichthys dulcis*. It was then described by Nichols (1916) from the hot spring at Cave and Basin, Banff, Alberta as a new subspecies, *Rhinichthys*

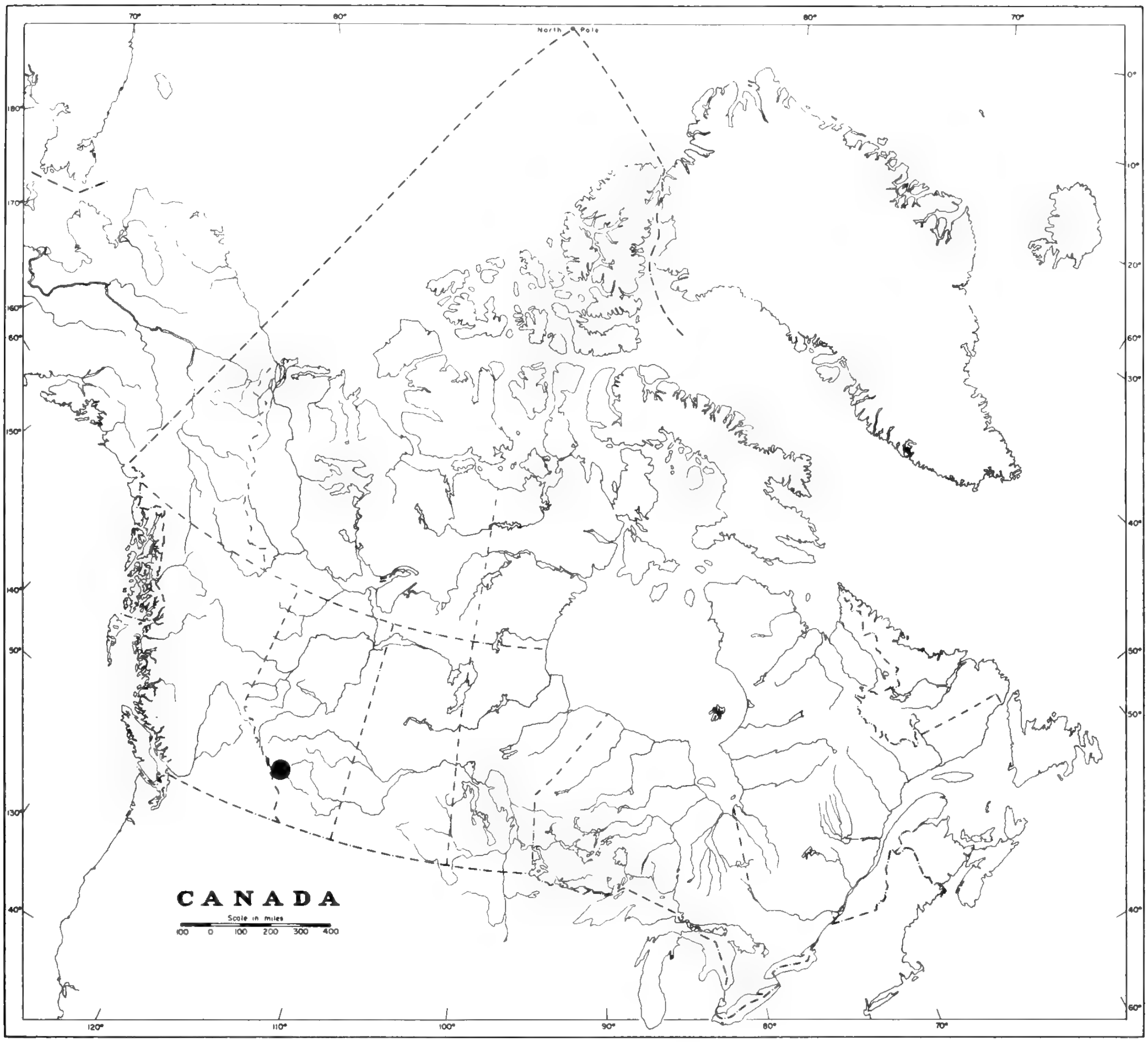

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FIGURE 39: Map of the Canadian distribution of the Banff longnose dace / Banff naseux de rapides - Rhinichthys cataractae smithi. The taxonomic status of this dace, known only from the outflow of Cave and Basin Hotspring near Banff, is under study by Claude Renaud and Don E. McAllister. Jacqueline Lanteigne has prepared a status report at the National Museum of Natural Sciences.

cataractae smithi. Gilbert and Shute (*in* Lee *et al*., 1980) report no comprehensive systematic studies of this species throughout its extensive range have yet been conducted. McPhail and Lindsey (1970) indicate that the species forms a series of geographic races whose subspecific status is in doubt. They reported northwestern Canadian populations have high vertebral counts 40-42, more than southeastern populations, 37-41. (Scott and Crossman, 1979). Bartnik (1972) identified Alouette River, B.C. specimens as *R. c. dulcis* (following Jordan and Evermann) and reported reproductive behavioural and colour differences between that population and those in Manitoba. These findings and preliminary meristic and morphometric studies lead us to suggest that B.C. populations are distinct from those east of the Continental Divide (including *R. c. smithi*) and, if they are to be recognized taxonomically, will require a new scientific name as *R. c. dulcis* were named from Nebraska, east of the divide.

Distinguishing features: Described as differing notably from *R. cataractae dulcis* in the fewere scales in the lateral line, 50-60 (Nichols, 1916). T.A. Willock (in Paetz and Nelson, 1970) gave the range of 56-59 (NMC 58-0226) for a collection from the same spring, while Bajkov (1926) gave counts of 58-64 for lakes in Jasper Park just to the north of Banff National Park (as *Agosia nubila*). Scott and Crossman (1979) described the species with 61-72 for Canada while McPhail and Lindsey (1970) reported 58-76 but usually more than 60 for northwestern Canada. Paetz and Nelson (1970) reported 59-73 in the Cypress Hills and 65-68 pored scales in the lateral line from the Red Deer River, Alberta, and Nelson (1966) 58-78 (mean 67.5) from the junction of the Red Deer and Blindman rivers, Alberta.

Habitat: This subspecies, unlike other subspecies which characteristically occur in clear, swift cool waters with gravel beds, is restricted to the outflow of Cave and Basin Hotspring (51°10'N, 115°35'W), 1.7 km southwest of Banff, tributary to the Bow River, Banff National Park, Alberta. The water temperature is 30°C where it exits from the outlet pipe, but about 26°C where the dace were collected 14 May 1971 in the swampy outlet. Vegetation is present on muddy bottom, the current is slight and water depth is 0-20 cm. See photo of habitat in McAllister (1969).

Biology: Nothing has been reported on the biology of this subspecies. For biology of other Canadian subspecies see Scott and Crossman (1979), McPhail and Lindsey (1970), and Paetz and Nelson (1970).

Protective measures taken: Some potential for protection is given by the location of the hotspring in a national park. Despite this park location the introduction of exotic fishes, potential competitors or predators, may threaten their continued existence.

Recommendations: 1) A taxonomic study should be made evaluating the taxonomic status of this subspecies. If the *R. c. smithi* proves to be a valid subspecies, then:
2) All introduced exotics except perhaps *Gambusia* should be removed from the hotspring.
3) A study of the biology and population structure should be undertaken.

[As this manuscript was being completed, a status report was being written by Jacqueline Lanteigne and a taxonomic study was being undertaken by Claude Renaud, University of Ottawa and National Museums of Natural Sciences].

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Rhinichthys osculus (Girard, 1857) - speckled dace/naseux moucheté (m.)

The speckled dace in B.C. provide a puzzle to science. There seem to be two morphological types occurring together. Are these two distinct species and if so which is the true speckled dace and which the new species? The description of Canada's fish fauna is far from complete and more support seems suggested for museums to complete our knowledge of classification of the Canadian fauna.

Canadian status: Classified as rare on the list of the Committee on the Status of Endangered Wildlife in Canada. Reported only from 120 km of the Kettle and Grandby rivers in the Columbia drainage of south central British Columbia at elevations below 1,000 m. (Peden and Hughes, MS, 1981; Peden, 1979), in a square roughly 60 by 60 km. Man-made changes pose the greatest potential threat.

Absence of dace below the town of Grand Forks may be related to the sewage plant, and continued monitoring of mining and logging activities which influence water quality is recommended (Peden and Hughes, MS). Peden and Hughes (1982) do not regard speckled dace as endangered in Canada, although there has probably been some reductions in numbers.

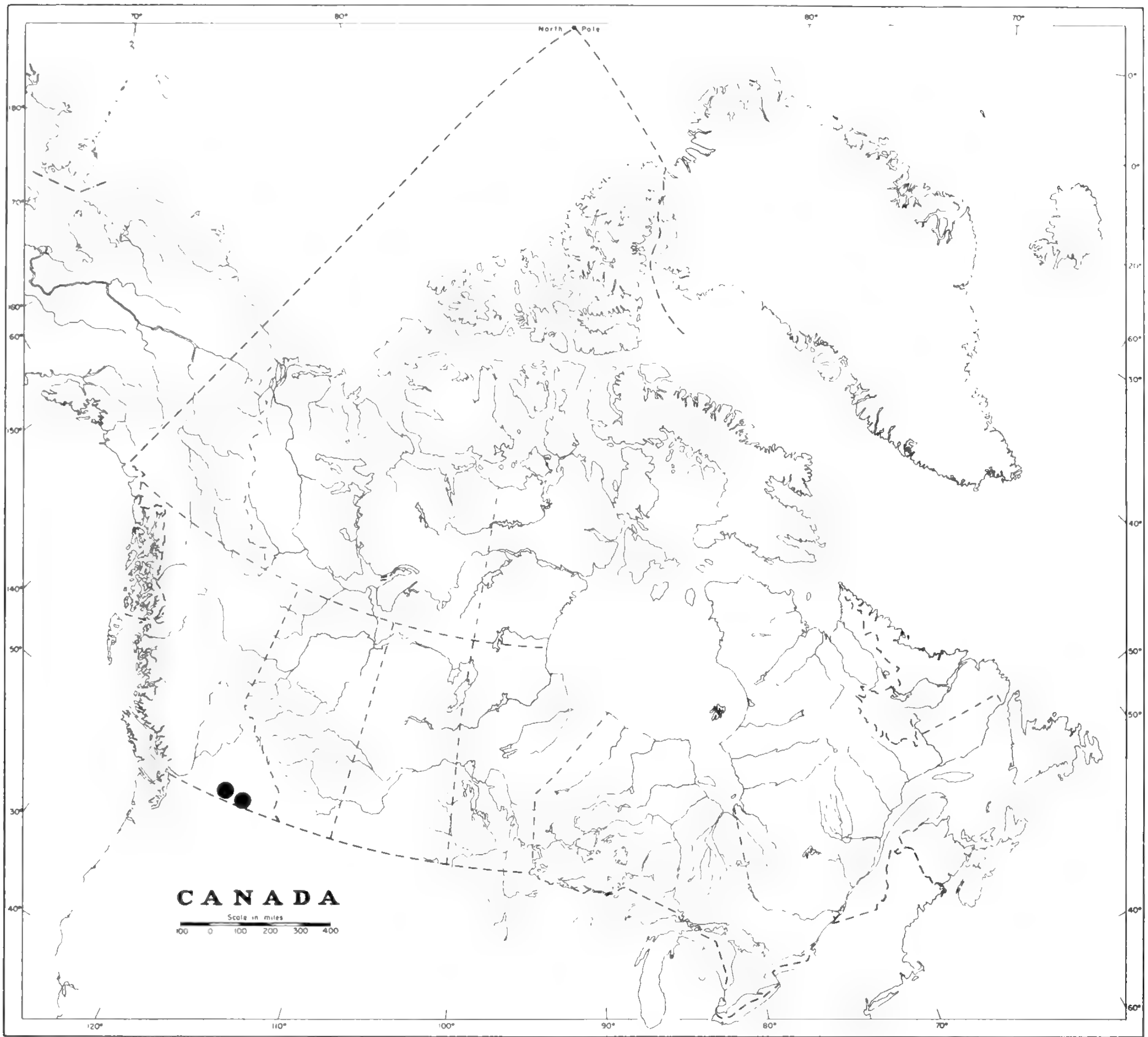

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FIGURE 40A: Map of the Canadian distribution of the speckled dace / naseux moucheté - Rhinichthys osculus. It appears that two forms are currently included under the name, speckled dace; which one is the true species and whether the other requires a new scientific name is not known at present.

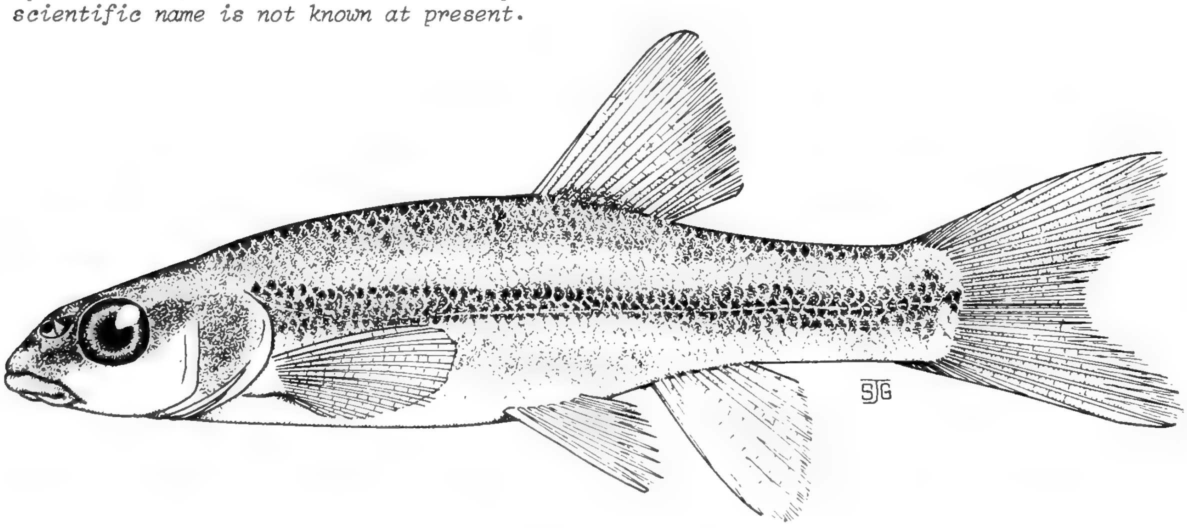

FIGURE 40B: Drawing of the speckled dace / naseux moucheté - Rhinichthys osculus.

Construction of dams would be detrimental as the species requires flowing water, but considered it rare. The COSEWIC status report on this species is in press (Peden and Hughes, 1984a).

Status elsewhere: The species ranges from Sonora, Mexico and the Colorado drainage in Arizona north to the Columbia system in B.C. (Wallace *in* Lee *et al.*, 1980). Five subspecies in the United States are recognized by the American Fisheries Society as endangered and two are threatened (Ono *et al.*, 1983). *R. osculus reliquus* from the Great Basin is extinct (Hubbs, Miller and Hubbs, 1974) and the Ash Meadows speckled dace, *Rhinichthys osculus nevadensis* was declared endangered under an emergency ruling (10 May 1982, Federal Register). However, the speckled dace as a species is/was the most ubiquitous freshwater fish in western U.S. (Hubbs, Miller and Hubbs, 1974).

Taxonomic status: Unpublished studies by J.D. McPhail (Peden and Hughes, MS, 1981) suggest possible sympatric populations of this and another *R. oculus*-like dace in adjoining regions of Washington State and Canadian populations could be allied to either of these two forms. Peden and Hughes (1979) found only a single morphological species of "*Rhinichthys osculus*" in 1978 in Canada, but field studies in mid-October 1979 revealed a second sympatric form (A.E. Peden, *in litt.* 24 October 1979). Preliminary studies in 1984 suggested the second species may be allied to *Rhinichthys umatilla*.

Distinguishing features: Distinguished from other *Rhinichthys* by the upper lip being protractile, that is having a groove freeing it from the snout, and the dark brown lining of the body cavity (peritoneum). Average adult size 45-80 mm in standard length.

Habitat: The following notes on Canadian habitat and biology are from Peden and Hughes (1979). Floods from melting snow occur in spring, but this flow is reduced to about 3% in autumn. In fall, the dace occur in shallows with clean sandy bottom or small stones with little vegetation or algae. Summer temperatures ranged from 14°C at higher elevations to 18°C at lower elevations. Except during runoff the water in the Kettle River is very clear. The current was moderate and depths were less than 0.5 m at most sites where small dace were collected, current was stronger (though moderate in between the rocks) and depths deeper than 0.5 m where dace larger than 40 mm standard length were collected. In U.S. the speckled dace inhabits cool flowing streams with rocky substrate, but it also occurs in large and small lakes, warm permanent and intermittent streams and the outflow of desert springs (Wallace *in* Lee *et al.*, 1980).

Biology: In stomachs of 79 out of 97 dace taken in October, 23% had filamentous algae, 32% insects, 26% had algae and insects, and 4% unidentifiable material in the gut. Most insects were ones taken below the surface. Females probably do not spawn until their second year. Young probably reach 25 mm standard length in October. The more common species associates are redside shiner, *Richardsonius balteatus*, largescale sucker, *Catostomus macrocheilus*, northern squawfish, *Ptychocheilus oregonensis* and slimy sculpin, *Cottus cognatus*. Information on population size, age and growth is lacking. Females between 50 and 79 mm in standard length contained 150 to slightly over 2,000 eggs. Presumably they spawn in July.

Recommendations: 1) Peden and Hughes (1981) recommended continued monitoring of water quality with attention to mining and logging activities.

2) The possibility of designation of a wilderness river was suggested.

3) Dam construction would be detrimental to the species.

4) The two forms require a full taxonomic investigation.

5) The species should be registered with all government departments concerned with land use so that appropriate conservation decisions are made.

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CATOSTOMIDAE

suckers — meuniers

Catostomus sp. - Salish sucker/meunier des Salish (m.)

Although fishes of Canada's west coast waters have been studied since 1836 when Sir John Richardson published *Fauna Boreali-Americana*, there are still, nearly 150 years later, undescribed species in our western waters. Among these is the Salish sucker found in the Salmon and Little Campbell rivers less than 50 km from Vancouver.

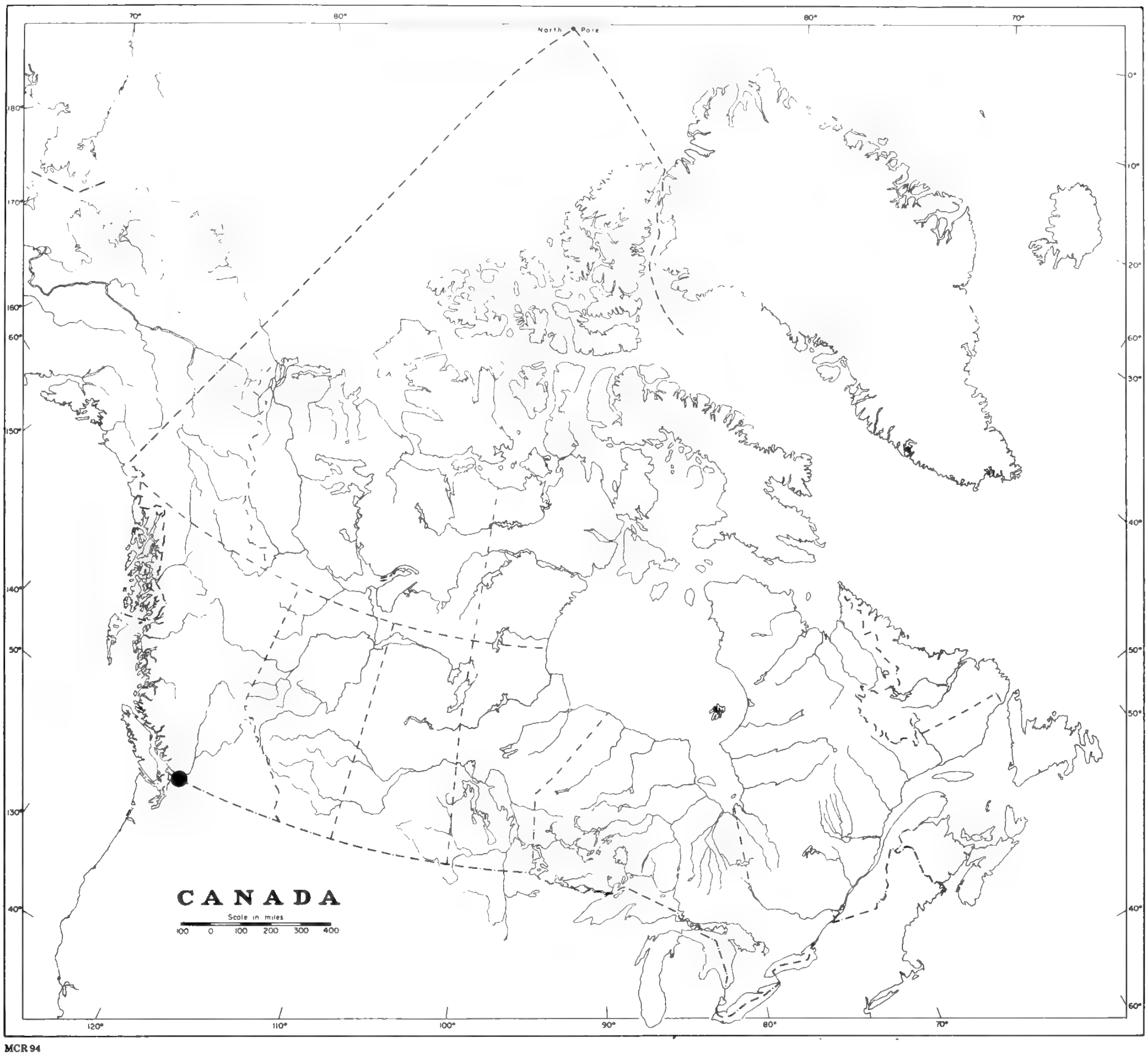

FIGURE 41: Map of the Canadian distribution of the Salish sucker / meunier des Salish - Catostomus sp. This sucker is part of the Chehalis fauna which was isolated from the Fraser Basin for about 200,000 years.

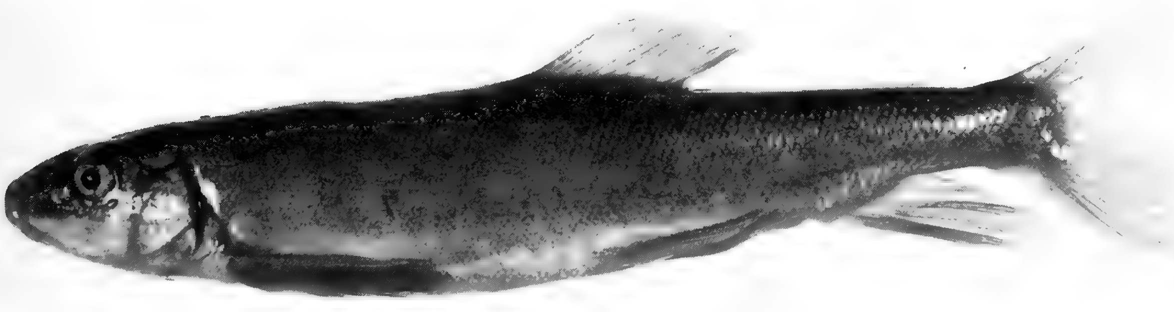

FIGURE 42: Photograph of the Salish sucker / meunier des Salish - Catostomus sp. It was feared that this species, endangered by urbanization, was already extirpated in Canada, but a small population was discovered in 1980. Photo courtesy of J.D. McPhail.

This species is highly sensitive to clearing and development. Until recently, it was feared that the species had been extirpated, but in 1980, a small population was rediscovered. Hopefully, a natural history reserve will be established to protect this small quiet-water bottom feeder.

Canadian distribution: Endangered. An undescribed form known in Canada only from the Salmon and Little Campbell rivers, southwesternmost British Columbia (*in litt*. Dr. J.D. McPhail). J.D. McPhail, A.E. Peden and G.W. Hughes were unable to find the species in recent years (Peden, *in litt*. October 1979), but McPhail rediscovered populations in 1980. Rapid urbanization of the lower mainland (McPhail, 1980b) endangers this species. As this manuscript was being completed, a status report on this species was being submitted by Dr. J.D. McPhail.

Status elsewhere: Probably endangered in western Washington and the Olympic Peninsula. It is part of the Chehalis fauna which was isolated from the Fraser for about 200,000 years.

Taxonomic status: An undescribed form (Dr. J.D. McPhail, *in litt*.). McPhail suggested the vernacular name Salish, after the original inhabitants of the land, in preference to the previous unofficial vernacular name, Campbell sucker.

Distinguishing features: Distinguished from *Catostomus catostomus* by fewer caudal peduncle and lateral line scales, smaller body size and relatively small mouth.

Habitat: Found in cold quiet waters of small streams in B.C. (pers. comm. J.D. McPhail).

Biology: A cold water form which spawns in March and April in the Little Campbell River (pers. comm. J.D. McPhail).

Protective measures taken: None.

Recommendations: 1) Habitat preservation through a natural history reserve is necessary to protect this species from clearing and development.

2) Support should be provided for early scientific description of this species.

Minytrema melanops (Rafinesque, 1820) - spotted sucker/meunier tacheté (m.)

The spotted sucker was first discovered in Canada in 1962 and was at that time thought to be a stray. However, sporadic occurrences since that time lead one to believe that there are small reproducing populations in southern Ontario. The populations are unlikely to increase until the turbidity, siltation and pollution, to which this species is sensitive, are reduced.

Canadian status: Rare (COSEWIC status, April 1983). Known only from Lake Erie off Point Pelee, Lake St. Clair, and the Sydenham and Thames rivers (tributaries of Lake St. Clair) in Ontario. Only ten specimens have been reported from Canadian waters, the last in 1977. Crossman and Ferguson (1963) suggested that the first Canadian specimen was a stray but new records imply that there may be one or more small reproducing populations. A commercial trap fisherman reported catching about 12 per year in Lake Erie. The Canadian populations are not disjunct from American populations. Turbidity and siltation are detrimental to this species. The COSEWIC status report on this species is in press (Parker and McKee, 1984c).

Status elsewhere: Known elsewhere only in United States where it is widespread in the Mississippi drainage and the Atlantic coastal plain. Considered threatened in Maryland by Miller (1972) but records for that state are questionable (*in litt*. R. Jenkins, 2 July 1979). Habitat destruction (turbidity and pollution) in Ohio appeared to be restricting it to the southern part of the state (Trautman, 1957) and it has disappeared from much of its range in Illinois (Gilbert and Burgess *in* Lee *et al*., 1980).

Dinstinctive features: Distinguished from other suckers in the family by the prominent spotted pattern with about 10 horizontal rows of dark pupil-sized spots, one per scale. Ontario specimens averaged 367 mm in total length; the largest one was 440 mm in total length.

Habitat: In Canada the spotted sucker has been captured in lakes and sluggish river environments. Trautman (1957) noted that this species had been captured in lakes, rivers, oxbows, sloughs and streams in Ohio. Elsewhere, it has been collected in many types of

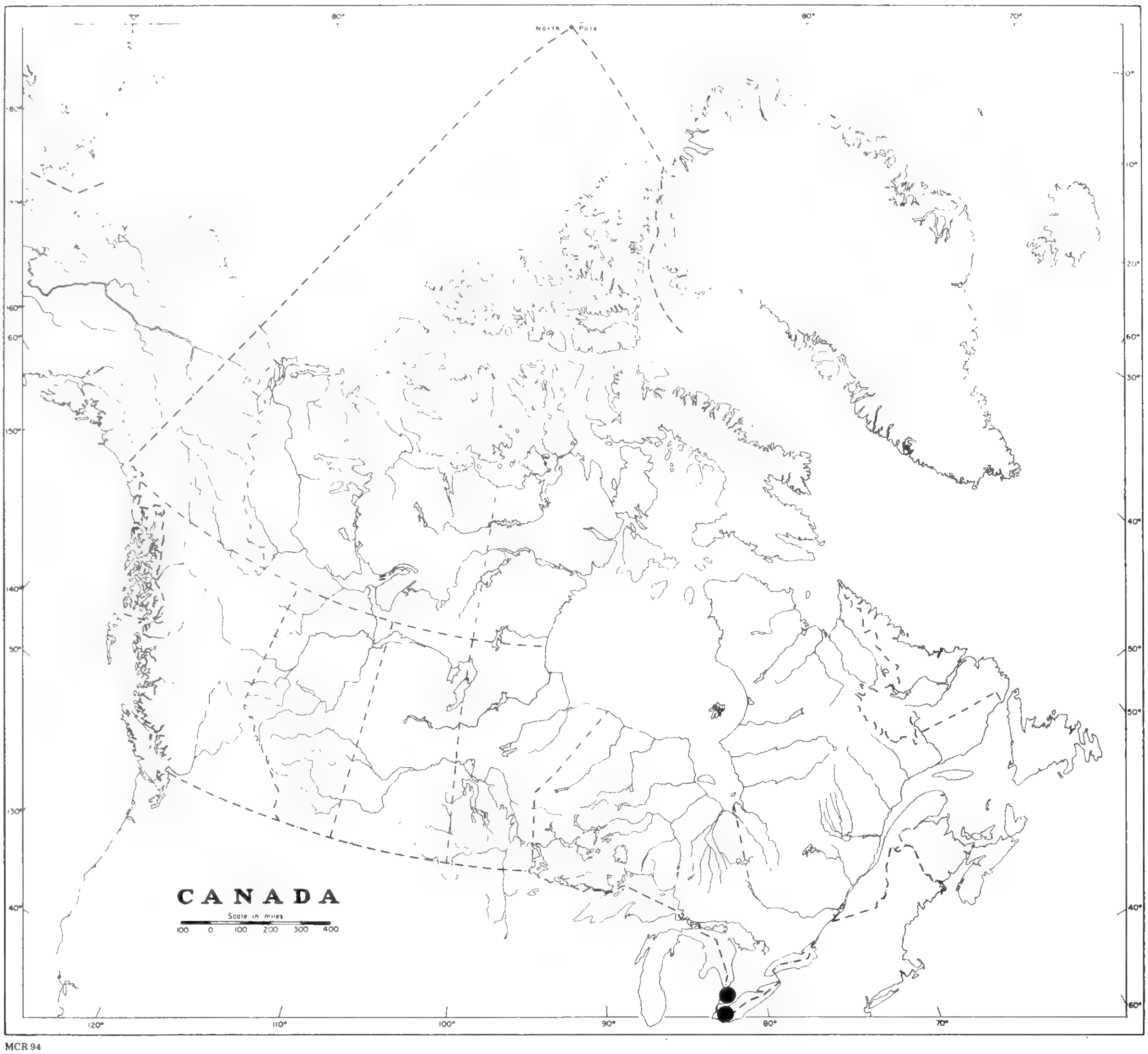

FIGURE 43: Map of the Canadian distribution of the spotted sucker / meunier tacheté - Minytrema melanops.

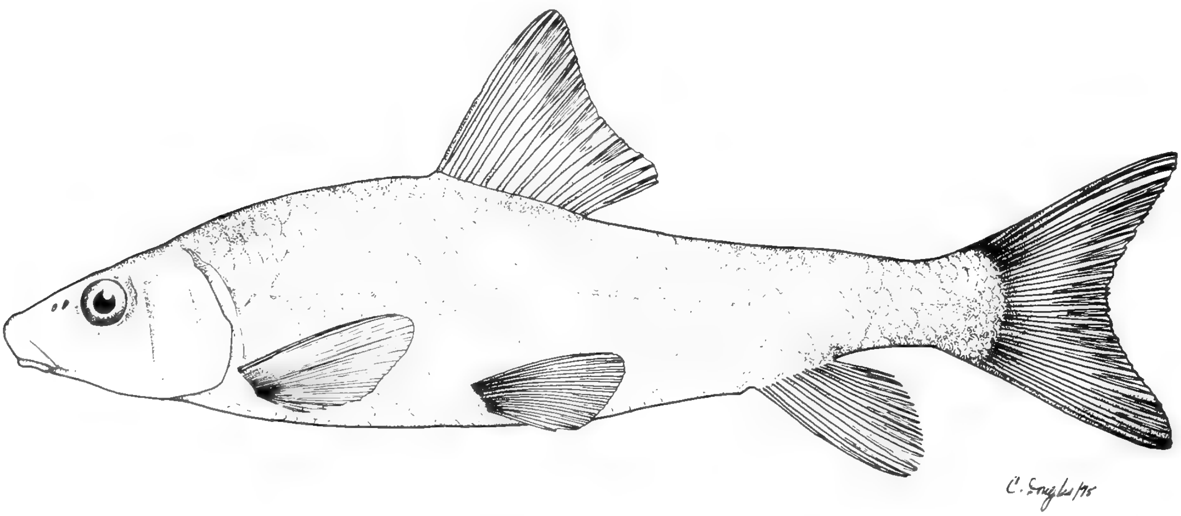

FIGURE 44: Drawing of the spotted sucker / meunier tacheté - Minytrema melanops. This species was first discovered in Canada in 1962 and it now appears that there is a small breeding population.

slow flowing water bodies from intermittent streams to large lakes and impoundments. (Douglas, 1974).

Bottom substrates at spotted sucker 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 in Lee et al., 1980). The spotted sucker has been reported from water bodies with dense aquatic macrophyte growths (Cross, 1967).

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 discs are visable at depths up to 45 cm. The spotted sucker is more tolerant to siltation than some other catostomids, especially if heavy siltation is only intermittent (Miller and Robinson, 1973). However, Trautman (1957) stated that this species was found in water bodies where siltation was extremely low. He suggested that the narrow gill openings in this species make it intolerant of 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 of watersheds along the 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, 1979). Ontario specimens averaged 367 mm in total length, considerably longer than that reported by Scott and Crossman. The smallest Canadian specimen was 275 mm in total length, the largest 440 mm in total length and weighed 1235 grams. Scales from two large specimens, 358 mm and 373 mm total length were aged at 7 and 8 years respectively. The maximum age reported for this species in populations from the Untied 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 51 to 102 mm. Adults ranged from 229 to 381 mm in length and weighed between 170 and 794 grams. The largest specimen from Ohio measured 450 mm in length and weighed 1361 grams. 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 155 mm the first year and average 290, 340, 410, and 440 mm at the end of succeeding years.

Age at maturity is not known for Canadian populations, but maturity is reached at 3 years of age in Missouri (Pflieger, 1975). Dwarf forms captured in Ohio are reported to mature at sizes as small as 150 mm (Trautman, 1957).

The spotted sucker spawns during late spring or early summer. Tuberculate males have been recorded in early June in Ohio (Trautman, 1957). Spawning runs have been observed in Georgia creeks and rivers as early as January. Spawning took place in waters ranging from 12 to 19°C. Spawning spotted sucker were observed in riffle areas over coarse limestone rubble where the water depth averaged 40 cm. The flow rate in the riffle area was estimated at 1.4 m^3/sec. Depressions behind large rocks were often used as spawning sites (McSwain and Gennings, 1972).

Spawning groups of spotted suckers observed in Georgia consisted of 3 individuals, two males and one female. An equal number of males and females were found on the spawning grounds. Spawning activity was described by McSwain and Gennings (1972). They observed semi-buoyant eggs drifting downstream after spawning acts. Observations suggested that males and females may spawn more than once. Spotted sucker eggs hatched within 7 to 12 days after fertilization (Jackson, 1957). Larval development was described by Hogue and Buckanan (1977) and White and Haag (1977), and described and illustrated by Auer (1982).

Breeding males have two dark lateral bands separated by a pinkish band along the midside, tubercules on the snout, anal fin and both lobes of the caudal fin.

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 - 15 mm in total length began feeding in midwater and at the surface on zooplankton and diatoms while the yolk was still present in the gut. At 25 to 30 mm total length the spotted sucker ceased to feed at mid-depths and were observed feeding over patches of sand. At approximately 50 mm total length they began feeding on bottom benthic organisms. Sand began appearing in the gut at this length. Specimens longer than 50 mm total length had feeding habits similar to adults.

Larvae up to 25 mm total length were observed by White and Haag (1977) feeding in shallow backwaters of creeks. Larval and juvenile spotted suckers usually feed over patches of sand mixed with organic debris and only rarely in areas where the substrate was mud or loose silt. White and Haag (1977) reported that adult spotted sucker feed individually or in loose aggregations in quiet waters, over clean sand bars, during the day. By volume, the largest percentage of particles in the stomach of adults were organic fragments and sand. Copepods, cladocerans, chironomids, and diatoms were identified as major food items. Molluscs have been mentioned by Miller and Robinson (1973), Harlan and Speaker (1969) 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 the larvae of 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 or 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 would be lumped with other rough fish and sold as mullet or used in agriculture.

Protective measures taken: None.

Recommendations: We make the following recommendations on the spotted sucker:

1) A population survey should be conducted by the Ontario Ministry of Natural Resources in conjunction with future fisheries surveys and commercial catch inspection programs. Moribund specimens should be preserved and deposited in the National Museum of Natural Sciences, Ottawa or a provincial museum.

2) A study should be implemented to identify spawning times, spawning areas and nurseries in Lake St. Clair and Lake Erie. Measures should be taken to protect these areas and important population centres.

3) Identification cards should be prepared and made available to concerned agencies and individuals. A provincial program would ensure that commercial fishermen knew the identity and rarity of this species.

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Moxostoma carinatum (Cope, 1870) - river redhorse/suceur ballot (m.).

The river redhorse prefers moderate to large rivers with swift flow, combining riffles, fast-flowing pools, with low turbidity and little siltation. It feeds on molluscs, crushing them with heavy, molar-like teeth located behind the gills. It has already disappeared from Michigan, most of Iowa, Kansas, Illinois, Indiana, and Pennsylvania due to turbidity, siltation and pollution. Canada still has populations in three regions and if we improve water quality, we are likely to continue to have our fauna enriched by this species. But a new threat, acid rain, harmful to the molluscs on which this species feeds, might prove to be the downfall of the river redhorse.

Canadian status: Rare (COSEWIC status, April 1983). The species is known from 3 widely separated localities: in southern Ontario in the Ausable and Grand rivers; Ottawa and Mississippi rivers near Ottawa; and in Quebec (Mongeau et al., 1974) near Montreal. Reproducing populations are known in the Mississippi River, Ontario where the river redhorse comprises only about 5% of all redhorse species, and in the Richelieu and Yamaska river basins in Québec where it is relatively rare in comparison to related species (J. Mongeau, pers. comm.). A reduction in the number of river redhorse at Packenham in the Mississippi River, Ontario was observed between 1977, 1979 and 1984 probably due to sport fishing. In 1984 a small population of perhaps 45 individuals was observed in the Mississippi between Blakeney and Almonte, Ontario by one of us (B.J.P.). Pollution limits occurrence in the Yamaska (Jenkins, 1970). The COSEWIC status report on this species is in press (Parker and McKee (1984d)).

Status elsewhere: For U.S. listed as usually uncommon or rare, occasionally common (Jenkins, in Lee et al., 1980). Listed as endangered in Kansas (Platt, 1974), threatened in Florida (Gilbert, 1978b), and in Missouri as nowhere abundant and having declined markedly over much of its range in the last century but with no changes in Missouri in the last 30 years (Pflieger, 1971). Apparently extirpated from Michigan, most of Iowa, Kansas, Illinois, Indiana and Pennsylvania (in litt. R. Jenkins, 2 July 1979).

Distinguishing features: Redhorses, genus Moxostoma, virtually always have fewer than 50 lateral line scales, and a 3-chambered gas bladder, unlike suckers of the genus Catostomus. Only one other redhorse in Canada, the copper redhorse, Moxostoma hubbsi, has heavy

FIGURE 45: Photograph of habitat of the river redhorse / suceur ballot - Moxostoma carinatum, the Mississippi River at Bleakney, Ontario.

molar-like pharyngeal teeth; the rest have slender, comb-like teeth. Caudal peduncle scales number about 12 in *M. carinatum* and 16 in *M. hubbsi*. Reaches 737 mm in length in Ohio and 617 mm total length in Ontario.

Habitat: 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. Occasionally 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 300 m long chute and a catch-pool below a 1 to 2 m high waterfall. Stream gradient is approximately 1.5 m/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 14.6 m^3/s in late summer to 142 m^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 2 cm 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 it is rarely captured in deeper waters or slow flowing sections with 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 (a white disk was visible to depths of about 1 m). 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 reductions 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 3 mg/L have been recorded (Ontario Ministry of the Environment, 1977). However, dissolved oxygen levels usually average 7 to 10 mg/L during summer months when water temperatures are highest.

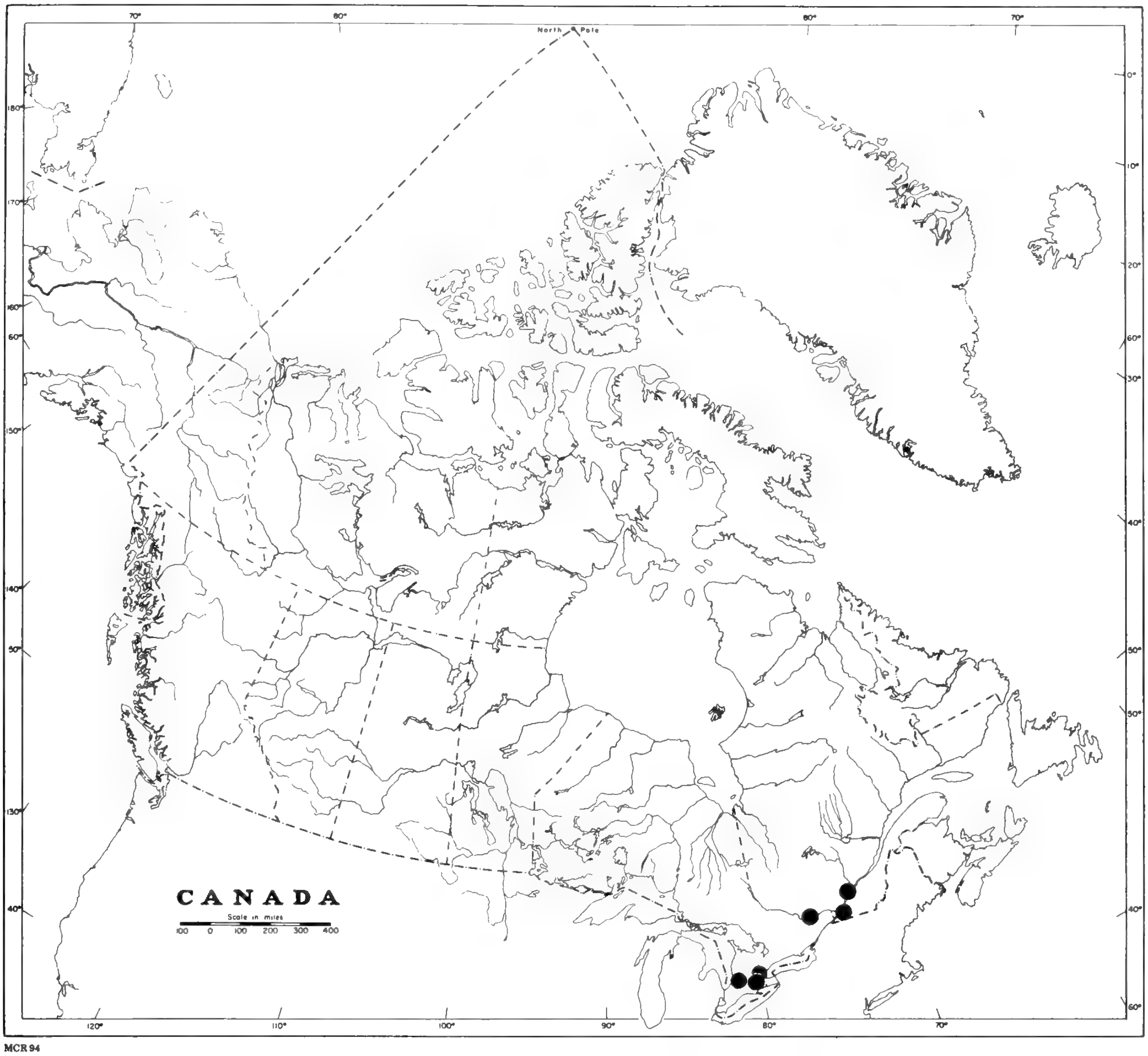

FIGURE 46: Map of the Canadian distribution of the river redhorse / suceur ballot - Moxostoma carinatum.

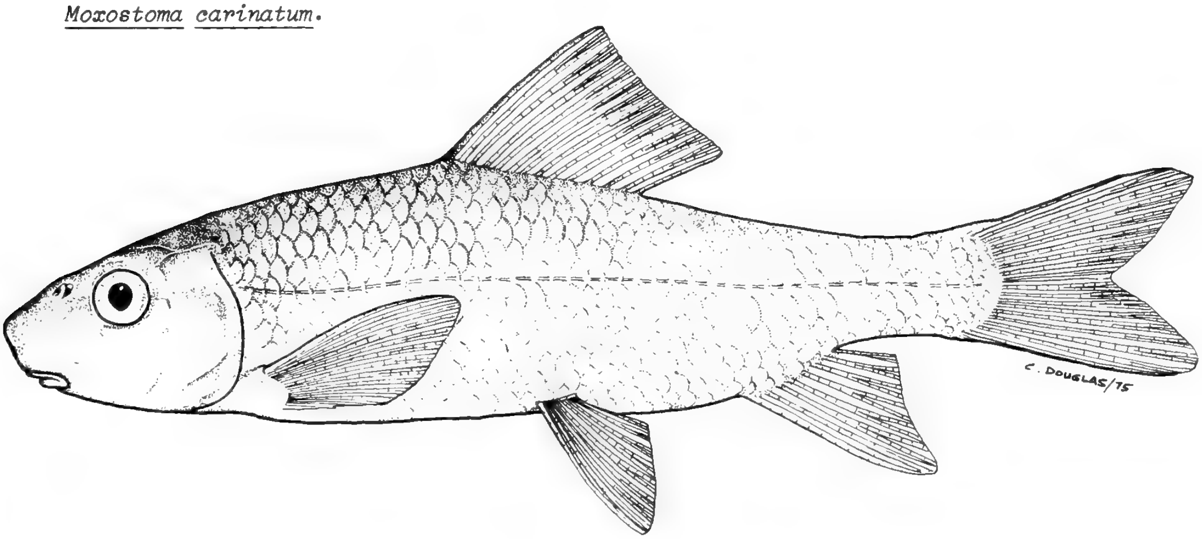

FIGURE 47: Drawing of the river redhorse / suceur ballot - Moxostoma carinatum. This rare species has disappeared from many parts of its range in the United States, but still survives at three localities in Canada.

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

Biology: Ten river redhorse collected in Ontario waters were aged using the scale method. Annual rings 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. Lengths calculated from scales for ten Ontario specimens at each age class are:

Standard Length

Age (years)	Calculated Size (mm)	Size Range (mm)	Yearly Size Increase (mm)
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	60
9	402	346-432	29
10	379	379	-
11	390	390	-
12	410	410	-
13	438	438	-
14	461	461	-

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 size calculated from scales for young-of-the-year river redhorse in Ontario was approximately 60 mm. Hackney et al. (1967) reported lengths of up to 100 mm for pond-raised young-of-the-year specimens captured in August and up to 161 mm for specimens captured in natural waters.

The largest specimen reported from Ontario waters was 617 mm in total length and weighed approximately 2814 grams (NMC 79-1981). This specimen was not aged. Trautman (1957) stated that the largest Ohio specimen was 737 mm in length and weighed 4761 grams. He also stated that Ohio River fishermen reported river redhorse weights up to 6272 grams, but this species usually ranged from 333 to 610 mm in length and 448 to 3136 grams 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 and 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°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 Museums of Canada had tubercule scars. Hackney et al. (1967) observed spawning river redhorse over gravel shoals in water from 0.15 to 1 m deep. Males constructed redds varying in size from 1.2 to 2.4 m in diameter and from 20 to 30 cm in depth. Hackney et al. (1967) 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. (1967) counted from 6078 to 23,085 eggs for individuals 450 to 560 mm in total length respectively. Eggs were relatively large, usually 3 to 4 mm in diameter during spawning. Larval development was described by Hackney et al. (1967) and Auer (1982) both described and illustrated larvae. Jenkins (1970) noted that males have large tubercules on the head and on the caudal and anal fins, females did not.

River redhorse feed extensively on bottom 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 and it was found that specimens of 100 to 150 mm in length fed primarily on chironomid larvae and pupae in about equal volumes. Food items found in specimens 200 to 250 mm long included chironomid larvae and pupae, Crustacea, Trichoptera and Coleoptera. The diet of specimens over 300 mm in length varied. The gut contents of specimens captured during 1977 in the Mississippi River, Ontario were composed mainly of snails (Gastropoda), approximately 80% by volume. Other food items that were present but in small quantities included larval insects (Trichoptera, Chironomidae), and Crustacea. The gut contents of 2 river redhorse specimens captured in 1979 contained Ephemeroptera nymphs, (30% by volume), crayfish (20%), Nematoda (20%), Trichoptera (10%) and insignificant amounts of Chironomidae and Gastropoda. 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.

This species is classed as a coarse fish by the Ontario Ministry of Natural Resources and therefore is 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 a cestode has been described from the intestinal tract of the river redhorse.

Protective measures taken: None.

Recommendations: The following recommendations are made concerning the preservation of river redhorse in Canada:

1) A survey should be carried out in Québec to determine population trends and obtain life history information. Control of pollution which limits distribution would be desirable.

2) A trap net, tagging and creel census study should be carried out on the Mississippi River to determine river redhorse populations and trends. Spawning and nursery grounds should be located and protected. Anglers should be educated to return this rare species to the water.

3) Taxonomic work should be supported to facilitate identification of this and other redhorse species. Redhorse specimens collected from rivers known to harbour the river redhorse should be sent to this museum facility.

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Moxostoma duquesnei (Le Sueur, 1817) - black redhorse/suceur noir (m.).

Impoundments, turbidity and siltation are detrimental to this species which survives only in southern Ontario. Surprisingly the bow and arrow may pose a threat to the upper Grand River populations. Bow fishermen find it difficult to distinguish this species from the carp which they seek, when they are submerged in water. Consequently, a number of black redhorse are killed and left on the banks. Some dams planned in the range of the black redhorse may threaten individual populations.

Canadian status: Endangered. Formerly known in Catfish Creek, Elgin County, Ontario, but not collected there since 1938 despite repeated efforts, and in Cedar Creek, tributary of Grand River between Paris and Princeton, Oxford County where it was last taken in 1928. Specimens were recently taken at two localities in the Nith River, a tributary of the Grand river, Lake Erie drainage as well as in the Grand River itself. A specimen was captured in

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FIGURE 48: Map of the Canadian distribution of the black redhorse / suceur noir – Moxostoma duquesnei. This species has disappeared from two localities from which it was known in Ontario before 1939. It is classed as endangered.

Belgrave Creek, Maitland river system, Lake Huron drainage in Huron County in 1973. The Grand River supports a small breeding population. Here black redhorse fingerlings are only one tenth as common as the golden redhorse which itself is not a common species. Grand River populations appear to differ from other populations in higher (a mean count 47.7 for 15 adults) lateral line counts. The only identified spawning grounds for the Grand River population may be threatened by the planned West Montrose dam. A dam has also been proposed for the Nith River north of Ayr, the only other area where spawning may occur in the Grand River system. These dams would reduce suitable spawning areas.

Status elsewhere: Listed as threatened in West Virginia (Miller, 1972) and becoming rare in many areas (Kott, Jenkins and Humphreys, 1979), but as often common in U.S. by Jenkins (*in* Lee *et al*., 1980).

Distinguishing features: Differs from other redhorses except the golden redhorse, *M. erythrurum* by the sooty caudal fin; distinguished from *M. erythrurum*, the species it most closely resembles, by the lateral line scale count of 45-48 instead of 39-44 and 16-20 instead of 13-16 predorsal scales. Attains a length of 439 mm in U.S. and 375 mm in standard length in Canada.

Habitat: The black redhorse inhabits moderate-sized (flow of 15 to 20 cubic metres per second), cool, clear streams with sand, gravel and bedrock bottoms where siltation is minimal. Typically, the stream is composed of riffle and pool habitats with a moderate flow (Trautman, 1957; Moore, 1957; 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 and had 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; Scott and Crossman, 1979).

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).

Biology: 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:

Calculated Standard Length

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 in standard length and 419 mm fork length (WLU 6268). Trautman (1957) listed the largest Ohio specimen as 439 mm long and 1019 grams. Maximum age was given as 10 years by Bowman (1959).

Data from growth rate calculations suggest that there is rapid growth in young-of-the-year black redhorse (0 + up to 85 mm standard length) followed by decreased but constant growth in 1 +, 2 + and 3 + fish (1 +, 2 +, 3 + fish growth increment 58 mm per year). After the black redhorse reaches age 4 +, growth rate decreases in each successive year perhaps due to attainment of sexual maturity as suggested by Bowen (1959) in Missouri.

The black redhorse spawns during late spring (E. Kott, pers. comm.). 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 eggs of 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. Auer (1982) described larval development and illustrated a larva.

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 emptied. Signs of gonad development begin again in August and continue through the fall. By October, the eggs are quite large and can easily be counted. Testes also greatly increase in size. Insufficient data are available for the period from December to spring. 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.

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 observations of Jenkins (1970). However, in the populations studied by Bowman (1970) males developed a light pink mid-lateral band. In males, tubercules 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 sucking 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.

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 occurrence). Other food items are cladocerans 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 opportunism 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 carpio). 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 redhorses are mistaken for carp by bow fishermen, and then are left to rot along the river's edge. To a lesser extent, redhorse are also susceptible to rod fishermen who are seeking carp. The black redhorse is easily taken by hook and line using worms. Redhorses would be most susceptible to this fishery before and after spawning is completed.

Northern pike, (Esox lucius) and snapping turtles, (Chelydra) have been observed feeding on black redhorses which have been caught in gill nets. Pike are believed to prey on most species of suckers (Scott and Crossman, 1979). 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 (Moxostoma erythrurum), shorthead redhorse, (M. macrolepidotum) and possibly the greater redhorse (Moxostoma valenciennesi), likely compete for food with the black redhorse, particularly during early life history stages.

Protective measures taken: None.

Recommendations: The following recommendations are suggested to protect the black redhorse:

1) A portion of the Nith River system should be protected as a natural history preserve to ensure continued existence of this species and other typical elements of biota (Kott, Jenkins and Humphreys, 1979).

2) Taxonomic work should be supported to improve identification of this and other redhorse species. Redhorse specimens collected by the Ontario Ministry of Natural Resources from the Grand, Thames, and Maitland river basins should be identified at this facility.

3) Measures should be taken to avoid or reduce effects of dam construction in the Thames and Grand river watersheds. Measures should be taken to avoid depletion of this species by bow fishermen.

4) Moribund specimens should be preserved and donated to the National Museum of Natural Sciences, Ottawa or a provincial museum.

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Moxostoma hubbsi (Legendre, 1942) - copper redhorse/suceur cuivré (m.).

The copper redhorse is unique to Quebec. If we do not protect it from organic and other forms of pollution it will disappear forever. Like the river redhorse it has molar-like teeth behind the gills which are adapted to crush the small clams and snails on which it feeds. As acid water is inimical to molluscs on which it feeds, acid rain may pose a threat to the copper redhorse.

Canadian status: Threatened. Known only from Quebec where it has been reported from Rivière des Mille-Iles, Lac Saint Pierre and Lac St. Louis of the Fleuve Saint-Laurent, Lac des Deux-Montagnes of the Ottawa River near Montréal, the Rivière Richelieu and the Rivière Yamaska system including Rivière Noire, and the Chambly basin (see map by Massé, 1977). Extensive sampling in the Ottawa River near Ottawa by the University of Ottawa failed to turn up specimens. Pollution reduces hope of its continued survival.

Status elsewhere: Known only from Canada.

Distinguishing features: Redhorses, genus Moxostoma, virtually always have fewer than 50 lateral line scales and a 3-chambered gas bladder, unlike Catostomus. Only one other redhorse in Canada, the river redhorse, Moxostoma carinatum, has heavy molar-like

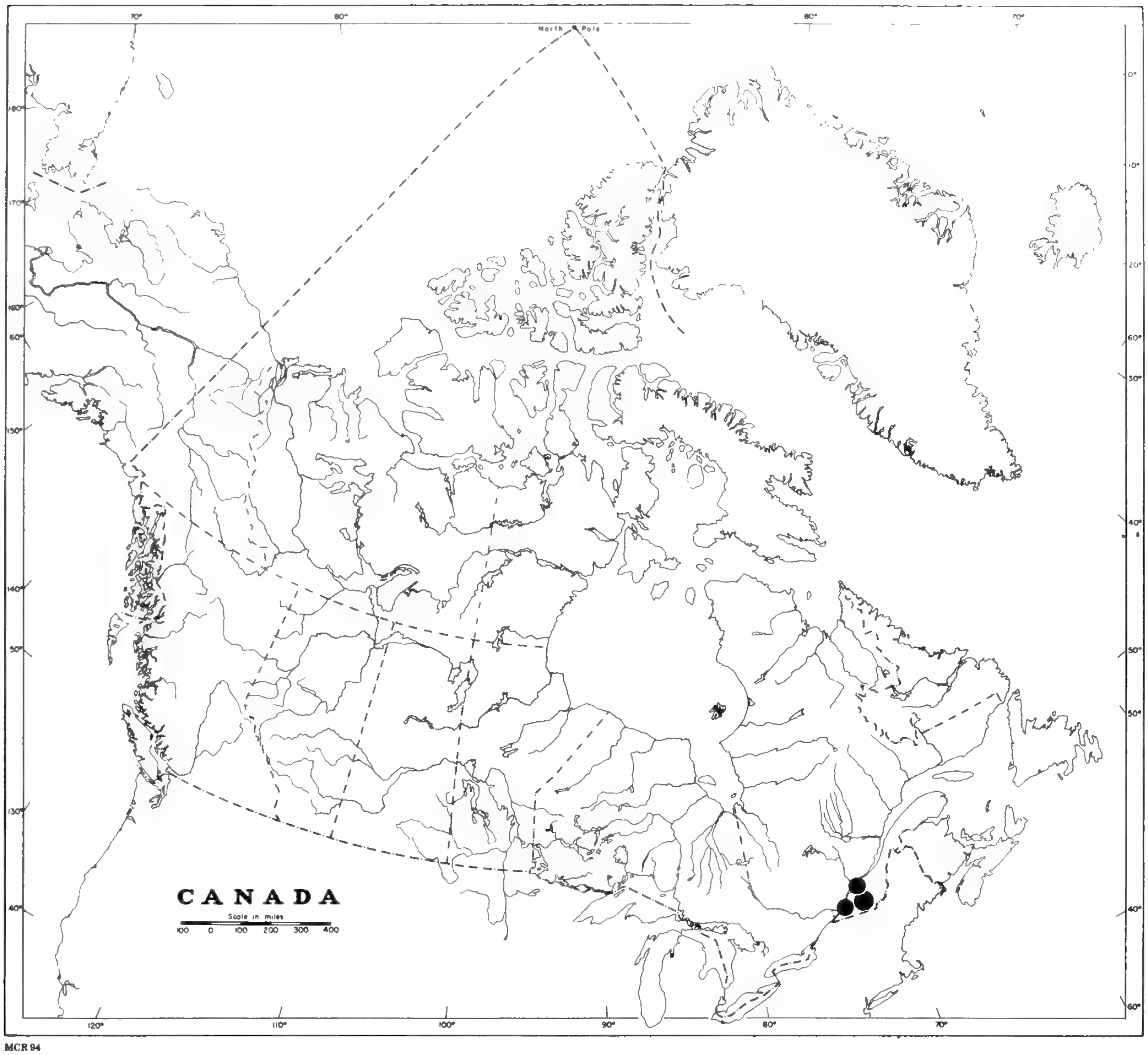

FIGURE 49: Map of the Canadian distribution of the copper redhorse / suceur cuivré - Moxostoma hubbsi. Sensitive to organic pollution, urbanization and industrialization in the Montreal area may pose a threat to this species.

pharyngeal teeth; the other species have slender comb-like teeth. Caudal peduncle scales number about 12 in _M. carinatum_ and 16 in _M. hubbsi_.

Habitat: Indications from the Rivière Kamouraska are that it is more sensitive to organic pollution than the shorthead redhorse, _Moxostoma macrolepidotum_, and the silver redhorse, _Moxostoma anisurum_. One of the cleaner rivers of the district, the Rivière Richelieu, supports a fair population. The copper redhorse inhabits the St. Lawrence and its warmer tributaries, avoiding cooler waters which do not reach 15.5°C in summer. Most captures were from deeper rivers, over 4.5 metres in depth.

Biology: The following information is drawn from Massé (1977). The copper redhorse is confined to an area within 100 km of Montréal in southern Québec. Between 1942 and 1973 only 164 specimens were captured. These comprised only about 2.8% of specimens of all species of sucker captured.

The copper redhorse commonly attains a weight of 3 kg and one specimen weighed 5.67 kg and measured 698 mm in total length. Almost nothing has been published on age, growth, food or spawning requirements, but it has been reported to have a life span of 12 to 15 years and indirect evidence suggests that it spawns in mid-June in swift waters (Ono, Williams and Wagner, 1983). The massive pharyngeal teeth suggest a mollusc diet, and Jenkins _in_ Lee _et al_. (1980) lists bivalves, gastropods and insect larvae from one or two stomachs examined.

While surveys have shown that the copper redhorse is slightly more widespread than was previously realized, it is nowhere very common. Massé (1977) points out that urbanization and industrialization of the region to which it is confined, expose it to a long-term but real danger of extinction.

Protective measures taken: None.

Recommendations: 1) A nature preserve, free from organic pollution, ought to be set up for this unique Canadian endemic species which would include spawning, nursery and adult foraging areas.

2) Acidity of the water, molluscan and copper redhorse population levels should be monitored.

3) A detailed study of its habitat and life history should be inaugurated and a population estimate be made.

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ICTALURIDAE

catfishes barbottes

Noturus miurus Jordan, 1877 - brindled madtom/chat-fou tacheté (m.)

The madtoms are small catfishes which receive the appelation "mad" because of their hyperactive seemingly inane swimming behavior. The streaked coloration gave birth to the "brindled" handle for this species. One of the relatives of the brindled madtom is apparently even madder, for it is called the furious madtom!

The brindled madtom, which usually feeds at night, is protected from predators, to some degree, by sharp saw-toothed pectoral spines and an associated poison gland. Persons picking up this species may be surprised by an unexpected sharp prick followed by the sensation of a bee-like sting.

Recent surveys have failed to reveal this curious species in Canada and if it still survives, population levels must be extremely low.

Canadian status: Endangered. Known in Canada only from Sydenham River east of Sarnia, tributaries of Lake Erie, and the Niagara River, Ontario. Surveys using a variety of capture methods and day and night sampling in 1979 failed to reveal the continued presence of this species and it is likely that population levels are extremely low if still surviving. It was last collected in 1976. Canadian populations are not disjunct from those in the U.S.

Status elsewhere: Widespread in eastern United States from lakes Erie and Ontario, Ohio and Mississippi basins, and central Gulf coast drainages (Rhode in Lee et al., 1980) and not reported as threatened or endangered for any state by Miller (1972). Listed as rare in Kansas by Platt (1974). Van Meter and Trautman (1970) report it as formerly numerous in

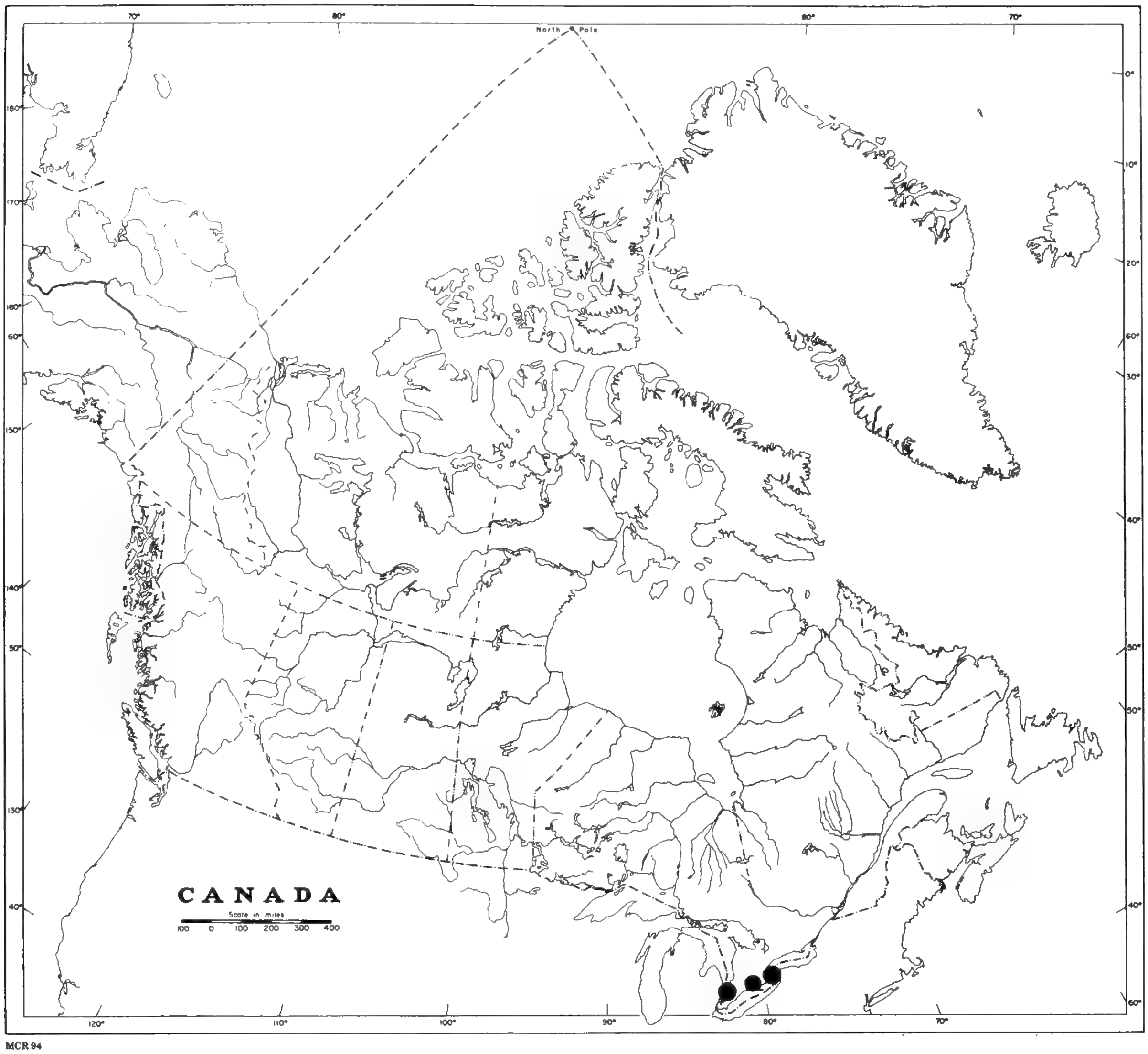

FIGURE 50: Map of the Canadian distribution of the brindled madtom / chat-fou tacheté - Noturus miurus. Surveys in 1979 using a variety of collecting gear in the day and during the night, failed to locate specimens at previously known localities.

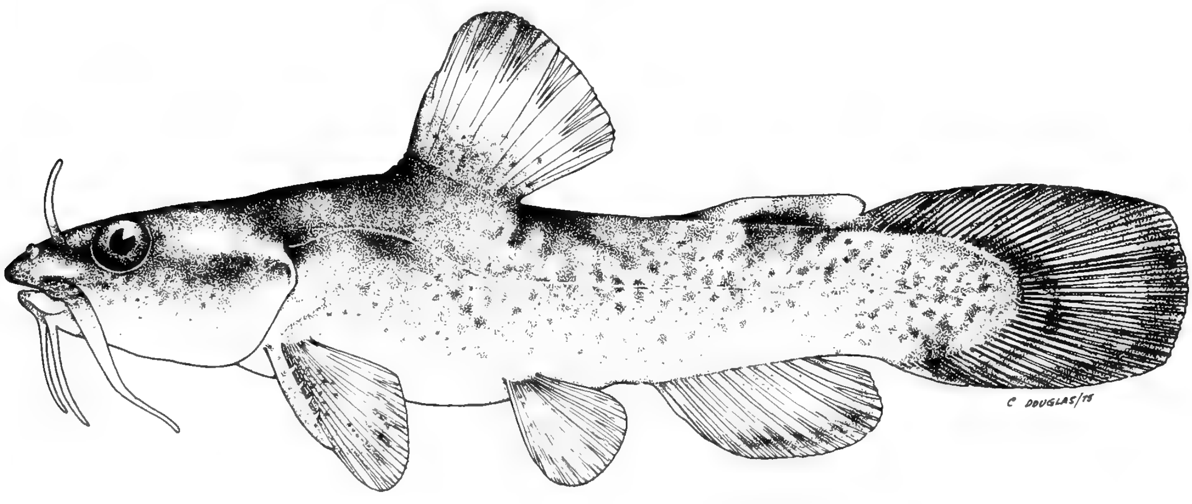

FIGURE 51: Drawing of the brindled madtom / chat-fou tacheté - Noturus miurus. The long-based adipose in front of the tail and the dark-coloured saddles on the sides characterize this species which reaches 87 mm (3 ½ inches) in Canada.

the western basin of Lake Erie and in many tributaries of southeastern Lake Michigan and northwestern Ohio.

Distinguishing features: Distinguished from other catfishes by the long and low (instead of tab-like) adipose fin, body pale with conspicuous dark saddles and bars, upper jaw extending beyond lower, and strong barbs on pectoral spines. Largest Canadian specimen is 87 mm and U.S. 132 mm in total length.

Habitat: In Canada the brindled madtom has been captured in lake, river and stream environments. Scott and Crossman (1979) reported that specimens taken in Ontario were from clear, fast flowing streams with gravel bottoms. Collections made during the 1970s extended known habits by including shallow lake environments over detrital and sand bottoms, and moderate to low 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 (1957) 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. Aside from a few in riffles, adults were taken consistently in mud-bottomed pools, the young are sometimes taken in riffles but also with adults in pools in Mill Creek, Illinois (Burr and Mayden, 1982).

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 detritus 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.

Biology: Little information has been published on the age and growth of the brindled madtom in Canada. Bowen (1980) described age determination in Ohio using 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. Burr and Mayden (1982) found males matured in their third summer, females in their first or second summer. 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 males and females 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. In Illinois nest preparation began in May and mates guarding eggs were found in June (Burr and Mayden, 1982). Scott and Crossman (1979) 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, 1979). Three-day-old larvae ranged from 10.0 to 11.0 mm in total length, 24-day-old larvae 15.4 to 17.5 mm. Auer (1982) described and illustrated larvae of about 15 mm.

Hybrids occur between the brindled madtom and the tadpole madtom, Noturus gyrinus and slender madtom, Noturus exilis (Trautman, 1957; Taylor, 1969).

Bowen (1980) has conducted food habit studies over a 12 month period and suggested 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 trichopterans. In Illinois Burr and Mayden (1982) found mostly dipteran larvae, mayfly naiads, stonefly larvae and isopods in brindled madtom stomachs. Scott and Crossman (1979) suggest that madtoms are nocturnal in habit; and Bowen reported that the majority of brindled madtoms captured during his study were caught 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, 1979).

Hoffman (1967) lists only four parasitic 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). Mill Creek, Illinois specimens were frequently (59%) parasitized by encysted nematodes. The following parasites have been recorded for the brindled madtom: monogenetic and digenetic trematodes, cestodes, nematodes, leeches and Copepoda (Bangham and Hunter, 1939; Bowen, 1980; Hoffman, 1967).

Protective measures taken: None.

Recommendations: The following suggestions are made concerning the brindled madtom:

1) Identification cards should be made available to concerned agencies.

2) Ontario Ministry of Natural Resources should incorporate some night sampling into lake and field surveys, especially in southern Ontario.

3) Should investigate several specimens, a study to determine population and life history parameters should be initiated and protective measures investigated.

4) Moribund specimen should be preserved for study and transferred to the National Museum of Natural Sciences, Ottawa or a provincial museum.

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CYPRINODONTIDAE

killifishes | cyprinodontes

Fundulus notatus (Rafinesque, 1820) - blackstripe topminnow/fondule rayé (m.).

Standing on a bridge over a slow, ready river in the Sydenham drainage of Ontario, you may see small fishes rippling the surface of the water. If, as they swim closer, you see a gleaming opalescent spot on top of the head you will have seen blackstripe topminnows. The flat-topped head and tiny upturned mouth of these fish is adapted to feeding on small animals just under or on the surface film. They have a special sensory system on the head which can detect the presence and direction of wavelets from a struggling insect on the surface film, and help guide them to their prey.

Known in Canada only from the Sydenham River system, it likes the slow current of creeks or rivers. Reeds or other aquatic plants in its preferred habitat provide cover when threatened by a minnow-eating fish or bird.

Canadian status: Rare. First reported for Canada by Gruchy, Bowen and Gruchy (1973a). Known in Canada only from the North Sydenham River watershed in Lambton and Kent counties, primarily in Black and Bear creeks where it occupies a very small range. It has been caught as recently as 1979 and the populations appear to be self-sustaining with adults and young present, although in low numbers. Livestock destruction of aquatic vegetation and bank cover limit available habitat area in Black Creek. Maximum density observed was 10 to 15 individuals per 100 square meters. Canadian populations are disjunct, being separated by about 200 km from the nearest United States population.

Status elsewhere: In U.S. occurs on the Gulf slope, from Mobile Bay drainage in western Alabama west to San Antonio Bay drainage, Texas; Mississippi Valley north to Indiana, southern Wisconsin, and Lake Michigan and Lake Erie drainages from Wisconsin to Ohio (Shute, *in* Lee *et al*., 1980). Despite greater tolerance to turbid waters than *Fundulus diaphanus*, *Fundulus notatus* has decreased markedly in abundance in the sections of the Maumee River drainage in Ohio which showed the greatest increases in turbidity from 1925 to 1950 (Trautman, 1957). Usually common but never collected in large numbers (Shute *in* Lee *et al*., 1980).

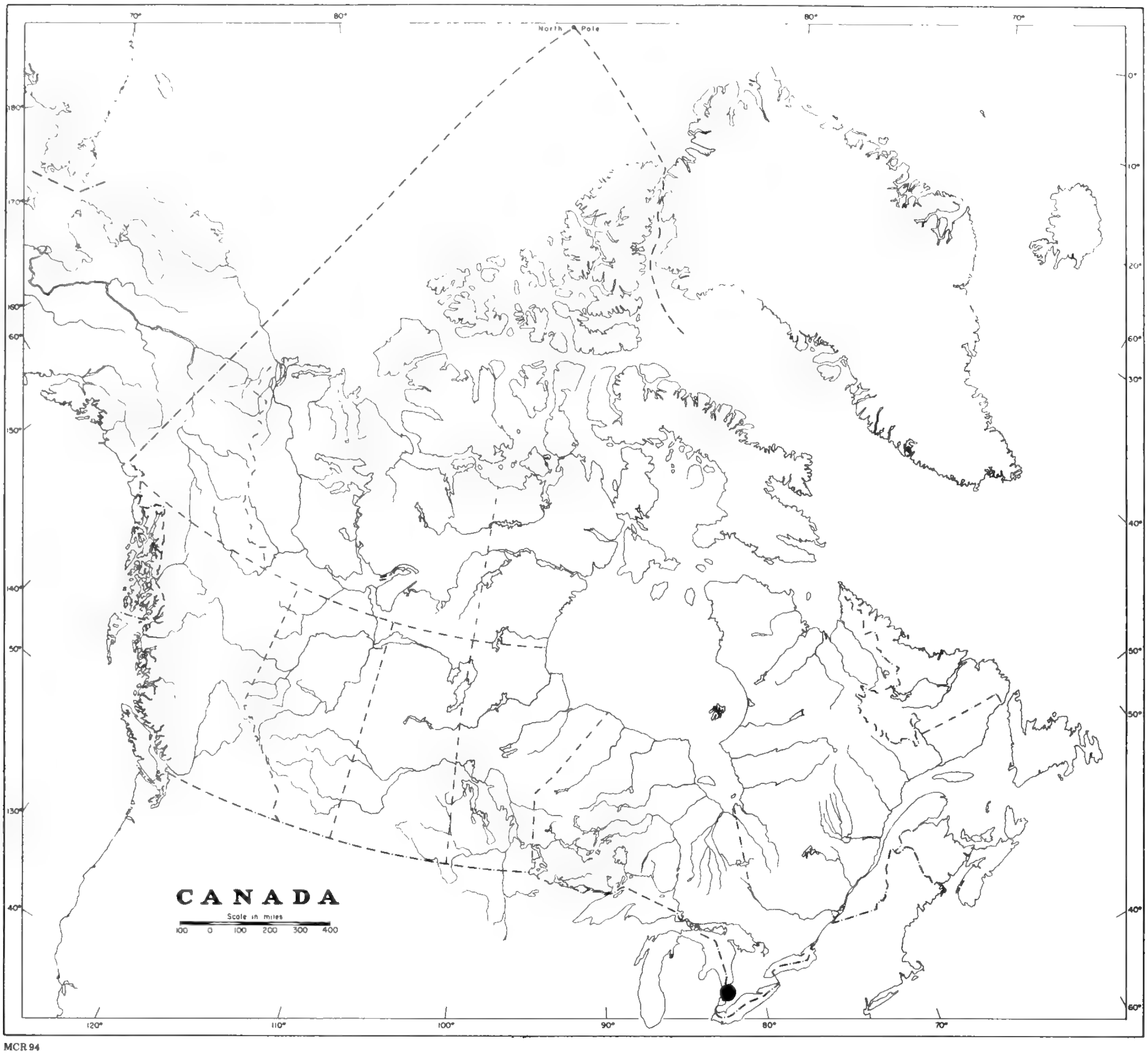

FIGURE 52: Map of the Canadian distribution of the blackstripe topminnow / fondule rayé - Fundulus notatus. Known in Canada only in the Sydenham River system.

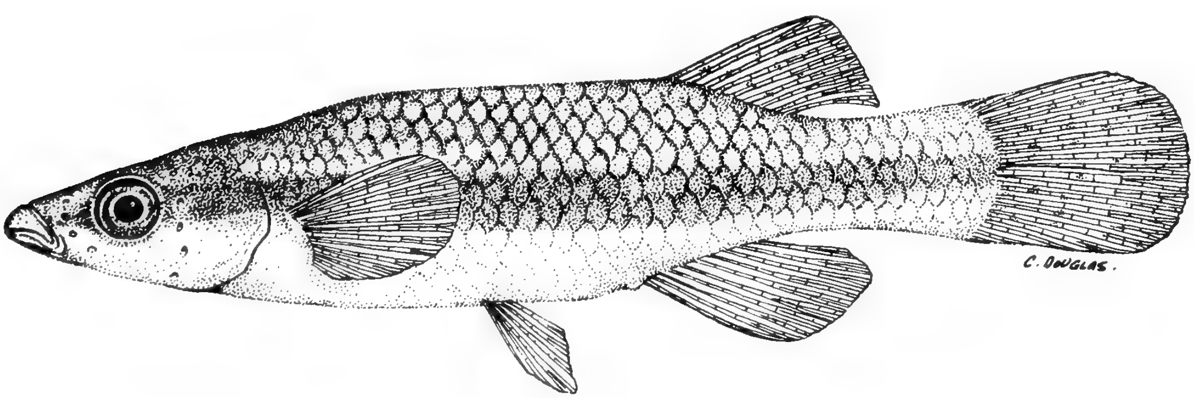

FIGURE 53: Drawing of the blackstripe topminnow / fondule rayé - Fundulus notatus. In life, this topminnow possesses a gleaming opalescent spot on top of its head; this may be seen as it feeds just under the surface of the water.

Taxonomic status: Regarded by Hubbs and Burnside (1972) as belonging to a distinct genus, *Zygonectes*.

Distinguishing features: Distinguished from the banded killifish, *Fundulus diaphanus*, by the long horizontal black stripe, instead of a series of short vertical bars. It also has 32-35 instead of 40-55 lateral line scales and 8-9 instead of 12-15 dorsal rays. Average total length 50-70 mm, maximum 74 mm in U.S., the largest Canadian specimen was 50 mm in standard length. An opalescent spot on top of the head makes the blackstripe topminnow readily identifiable in life, but it disappears after death.

Habitat: In Ontario the blackstripe minnow occurs in sluggish permanent and intermittent creeks and rivers. Stream gradients in the North Sydenham River watershed range from 0.2 m/km to over 6 m/km. This species was found in permanent flowing waters with gradients less than 0.7 m/km or 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 later summer. Water flow is virtually absent between these pools. Trautman (1957), and Shute (*in* Lee *et al*., 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 bank cover and aquatic vegetation 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 (*Sagittaria latifolia*), or spatterdock (*Nuphar*).

The species exhibits an apparent tolerance to a wide range in water quality. Erosion of fine clay soils 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 (in Lee et al., 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.

Summer 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 8.6 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).

Biology: 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 (in Lee et al., 1980) summarized available biological information. 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 15 to 32 mm while 1+ fish ranged from 38 to 50 mm and 2+ fish ranged from 41 to 51 mm in length. The largest fish captured in 1979 was 51 mm in standard length and weighed 2.34 grams (preserved weight). The maximum age of Ontario specimens examined 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 reduced growth rate is reported from 1+ and 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 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 30 adhesive eggs are extruded and fertilized one at a time, and are 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 dimorphism is quite apparent in the blackstripe topminnow. Differences exist in fin shape, fin marking, and body coloration. The male exhibits dark vertical 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. Coloration and fin shape are related to sex recognition, display, and the reproductive act. A full description of reproductive 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 (more than 50% by volume, 100% by frequency of occurrence), indicating that surface feeding is important to this species. 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) similarly 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 predators of *F. notatus* 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 annularis*) 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 copepods of the genus *Lernaea* infested 2 of 16 blackstripe topminnows examined from the 1979 survey. Hoffman (1967) listed Cestoda, Nematoda and Acanthocephala as parasites of this species, and Shira (1913), as cited by Hart and Fuller (1974), found this species was parasitized by larvae (glochidia) of freshwater mussels (Unionidae).

Protective measures taken: None.

Recommendations: The following recommendations are made concerning the blackstripe topminnow:

1) A natural history preserve should be established for this species.

2) Destruction of stream bank cover by livestock in headwaters of Black Creek should be investigated by the St. Clair Conservation authority.

3) Seepage from oil wells into Black Creek in the vicinity of Oil Springs should be curtailed, especially as this is a surface feeding species.

4) The range of the blackstripe topminnow should be taken into consideration in resource and development plans for the North Sydenham system.

5) The Ontario Ministry of Natural Resources should monitor known and seek new populations of blackstripe topminnows. Voucher specimens of new populations should be deposited for study in the National Museum of Natural Sciences, Ottawa or a provincial museum.

6) Identification cards should be made available to concerned agencies and individuals.

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COTTIDAE

sculpins chabots

Cottus confusus Bailey and Bond, 1963 - shorthead sculpin/chabot à tête courte (m.).

The shorthead sculpin may be considered by some an ugly, dull-coloured, squat, big-mouthed fish, a potential predator on eggs of sportfish with which we could just as well do without. However, we see in this species a sturdy fishlet of character, adapted to live in rivers often cold and turbulent, which instead deserves our admiration and respect. Trout and charrs often feed on freshwater sculpins, including we suspect, this species and the sea shorthead sculpin is known to feed on blackflies. So it does have a role to play in relation to man, although it needs none to our way of thinking, to justify its right to survive.

Surviving in Canada only in the Flathead River of southeasternmost B.C., open pit coal mining and clear cut logging may threaten its continued existence.

Canadian status: Threatened (Committee on Status of Endangered Wildlife in Canada, April 1984). Occurs only in the Flathead River in southeasternmost British Columbia. The Sage Creek Coal Development in the Flathead Valley (Schneider, 1975) is a potential threat to the continued existence of this species in Canada and planned clear cut logging with resultant changes in turbidity, temperature and flow may cause problems. Cottus confusus is likely to be at risk from habitat destruction if coal mining commences along Cabin Creek, especially if Howell Creek is diverted into the Flathead River further upstream than at present, and these populations may move downstream when flow rates are minimal and be subjected to possible pollution from the coal mine (Hughes and Peden, 1984). Hughes and Peden (1984) sampled less than 1% of available, apparently suitable habitat in the lower

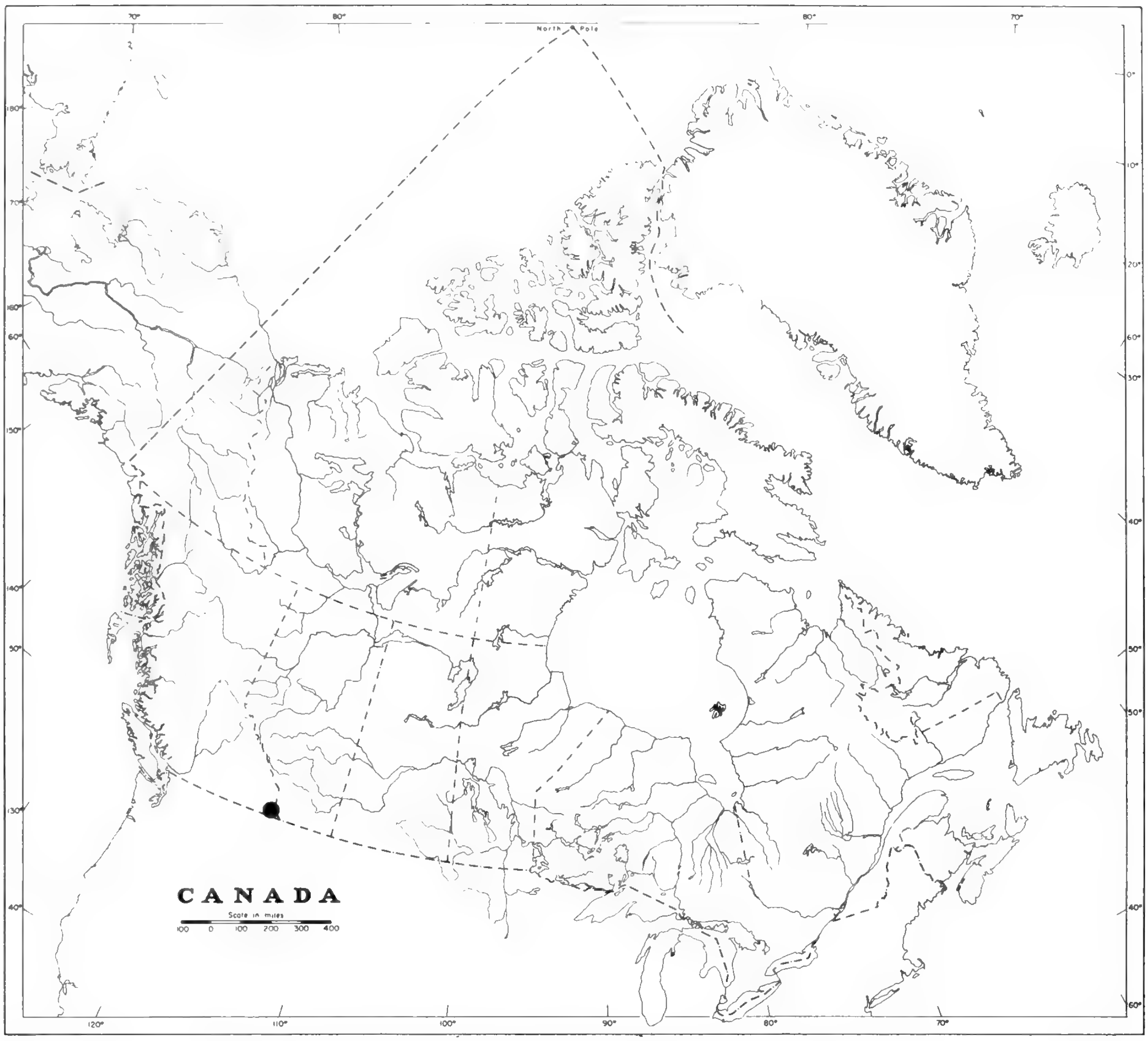

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FIGURE 54: Map of the Canadian distribution of the shorthead sculpin / chabot à tête courte - Cottus confusus. Open pit coal mining and clear-cut logging threaten this species in British Columbia.

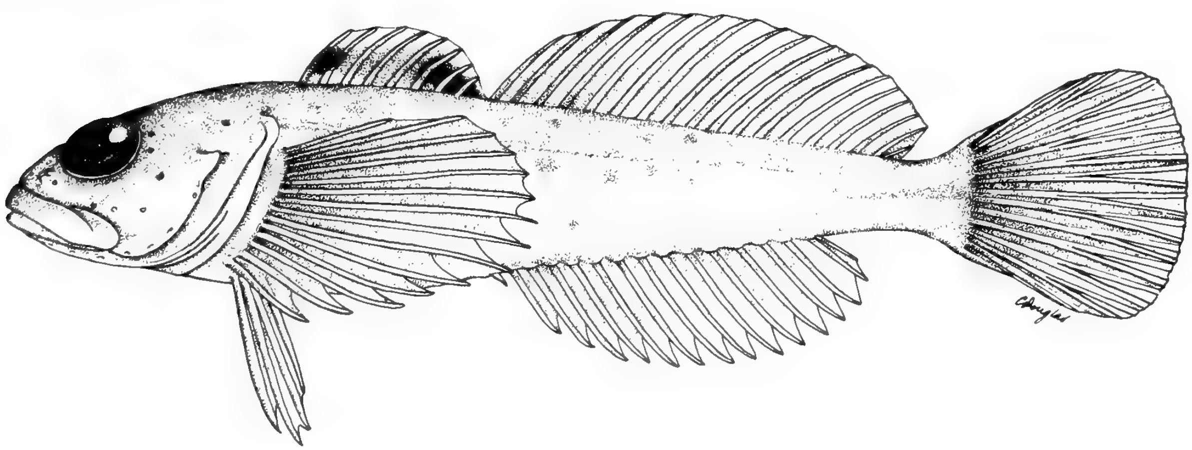

FIGURE 55: Drawing of the shorthead sculpin / chabot à tête courte - Cottus confusus. This threatened species lives in riffles of streams and rivers with cold summer temperatures.

Flathead River, B.C. and it is possible that the Canadian population is well in excess of 40,000. But few very small shorthead sculpin were captured. For map and species account of Canadian and American distribution see D.A. Cannamela and K.W. Gasser, in D.S. Lee et al. (1980) and Peden and Hughes (1982, 1984). The COSEWIC status report on this species is in press (Peden and Hughes, 1984b).

Status elsewhere: Known elsewhere only in parts of Washington, Oregon, Idaho and Montana where it chiefly occurs in riffles of small cold streams, but sometimes in large rivers (Bailey and Bond, 1963). Considered threatened in Montana (Miller, 1972), but abundant in the Big Lost River, Idaho (Johnson, Cannamela and Gasser, 1983).

Distinguishing features: May be distinguished from the only other sculpin with which it is sympatric in B.C., the slimy sculpin, Cottus cognatus, by the presence of palatine teeth, 2 instead of 1 coronal pores, well instead of poorly developed head papillae 12-14 instead of 10-12 anal rays, and 15-17 instead of 12-15 pectoral rays. Attains 122 mm in standard and 147 mm in total length.

Habitat: Occurs in riffles of streams and rivers with cold summer temperatures, usually further upstream than Cottus cognatus. Peden and Hughes (1982) reported it to be most abundant in areas of stones where the bottom was not sedimented and there was a slow current, not necessarily in riffles, and at temperatures of 13-17°C. Johnson, Cannamela and Gasser (1983) reported it in streams with widths 1.5-4.5 m, in pools and riffles with depths 0.1-1.0 m, on bottom of cobbles, boulders, gravel, pebbles and sand in Idaho.

Biology: Unknown in Canada. Matures at age of two or three years. Spawns in mid-April in Idaho laying eggs on undersides of rocks. Feeds on aquatic insect larvae and occasionally other sculpins or their eggs (Lee et al., 1980). Peden and Hughes (1982) found a preponderance of insects in stomachs with fish remains (23.4 mm TL) in one stomach. Johnson, Cannamela and Gasser (1983) found Trichoptera, Ephemeroptera and Plecoptera to be the most important foods in Idaho, with some Hemiptera, Diptera and Cottus confusus; it was a bottom rather than a drift feeder. In B.C., Hughes and Peden (1984) found that females 1 year old averaged 48.6 mm SL, males 64.4 mm SL, and a 2 year old female was 71.4 mm SL, larger than those reported in the Big Lost River, Idaho. Males outnumbered females 74 to 49 in their samples.

Protective measures taken: None.

Recommendations: 1) Creation of reserve protected from effects of logging, open pit coal mining and other harmful influences, with regular monitoring of conditions. Educate resource persons about the limited distribution of *Cottus confusus*.

2) A study of life history and population structure be inaugurated.

3) No work on this species should be given credence unless voucher specimens and other pertinent data are submitted to experienced taxonomists and deposited in collections as field workers and even fishery biologists have confused the identity of this species and *Cottus cognatus*.

4) Moribund specimens should be deposited in the National Museum of Natural Sciences, Ottawa or a provincial museum.

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STICHAEIDAE

pricklebacks — sticheés

Allolumpenus hypochromus Hubbs and Schultz, 1932 - Y-prickleback/lompénie i-grec (f.)

Ascertaining the status of a species within the constraints of a lake or a river, is easier than evaluating a little-known species in the vastness of the sea. If surveys reveal it to be rare, is it rare only because we have not properly sampled its true habitat? Have we not used the appropriate collecting method, or is it really rare? Some species previously rare in collections were found to be locally common when explorations were made in the right habitat with effective methods such as scuba gear.

Rare marine fishes also raise the question as to what protective or remedial measures can be taken. And the only reply can be to find out more about them so that appropriate action can be taken. But it should not be forgotten that aquatic natural history preserves have just as great a role to play in the sea as on the land.

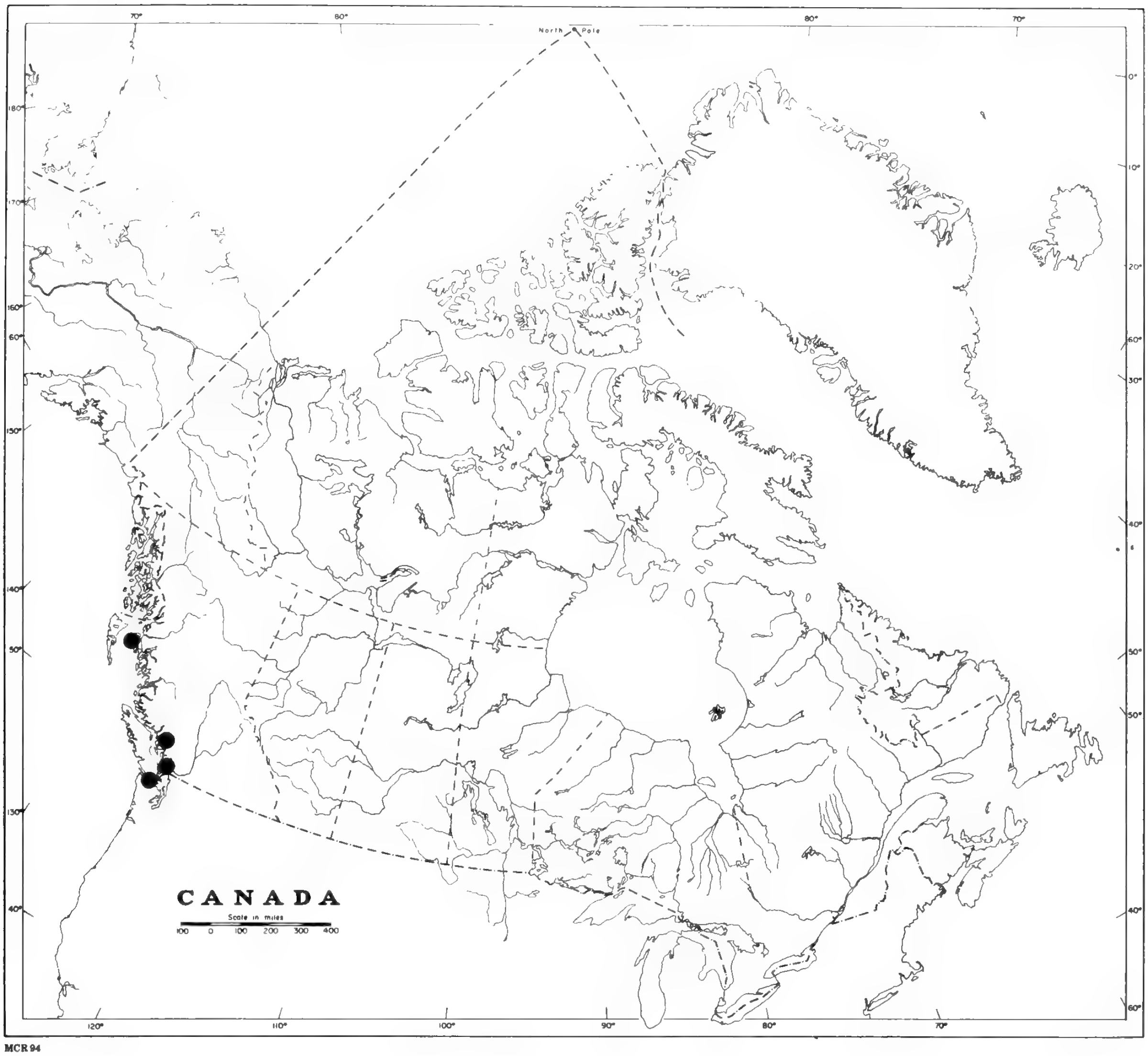

FIGURE 56: Map of the world distribution of the Y-prickleback / lompénie i-grec – Allolumpenus hypochromis. This species is known only in Canada where it has been recorded at less than half a dozen localities.

In view of our ignorance about the Y-prickleback, our first recommendation must be to institute a study on its range, habitat, habits, biology and population size.

Canadian status: Rare. Known only from Malcom Island; Departure Bay; Baker Passage; and Saanich Inlet, southern British Columbia (Hart, 1973).

Status elsewhere: Known only from Canada.

Distinguishing features: United gill membranes joined to isthmus, Y-shaped markings on sides, spots along base of dorsal fin, long pelvic fins, dorsal with about 45 spines and anal fin with one spine and 31 rays.

Habitat: Unknown.

Biology: Unknown.

Protective measures taken: None.

Recommendations: 1) A survey be made to determine its range, habitat, and life history and population structure.

2) If necessary a nature reserve can be created for its protection.

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GASTEROSTEIDAE

sticklebacks épinoches

Gasterosteus sp. - giant stickleback/épinoche géante (f.).

Many in their youth have seen the green-blue threespine stickleback in the sea or neighbouring streams, or even kept them in an aquarium, hoping to watch the male construct and guard a nest for its eggs and young. In Mayer Lake in the Queen Charlotte Islands of B.C., is a large, black, long-spined relative of this species, the giant stickleback.

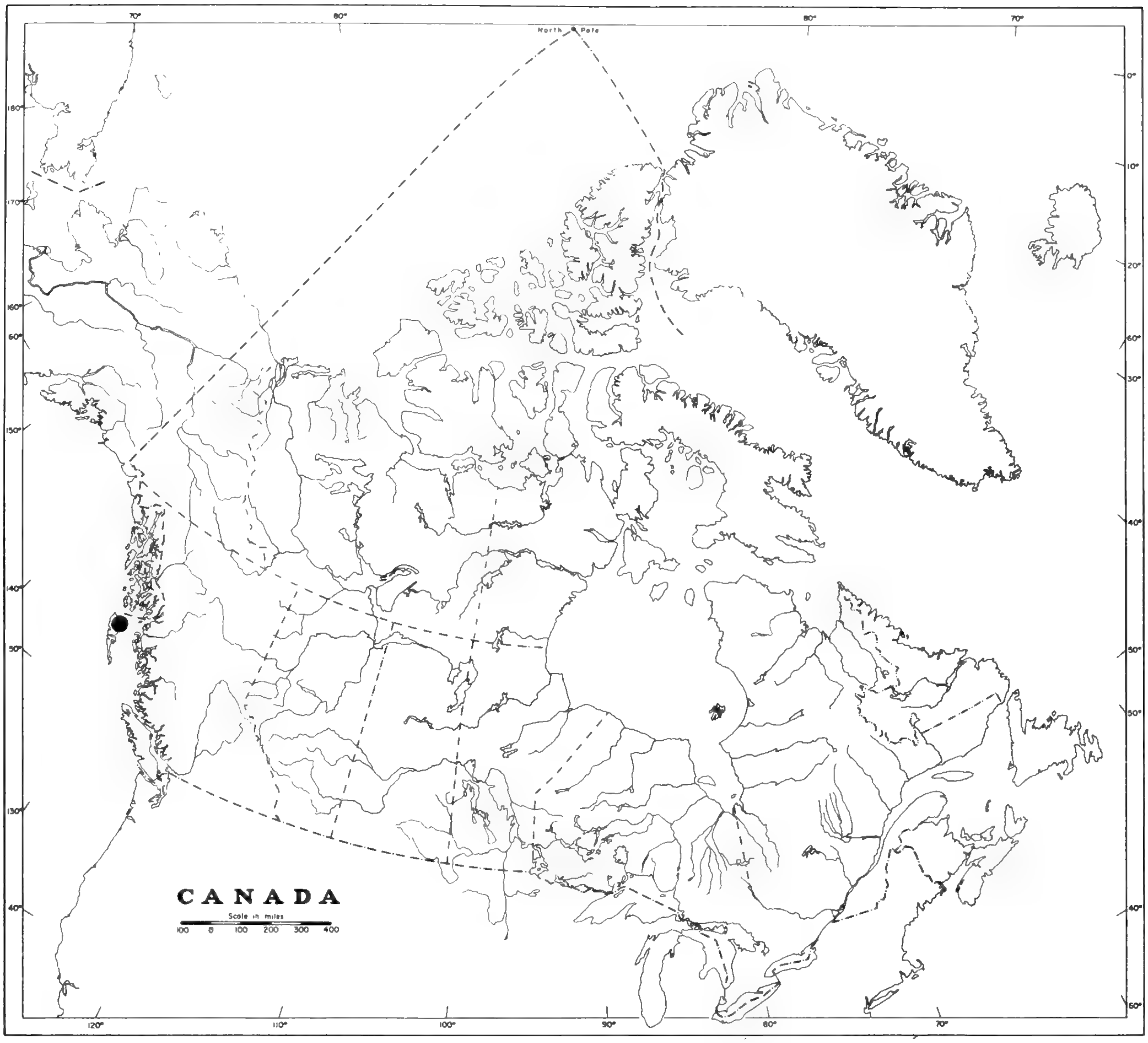

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FIGURE 57: Map of the world distribution of the giant stickleback - épinoche géante - Gasterosteus sp. This species is known only in Canada. Fortunately, the British Columbia government has created a nature preserve for this species.

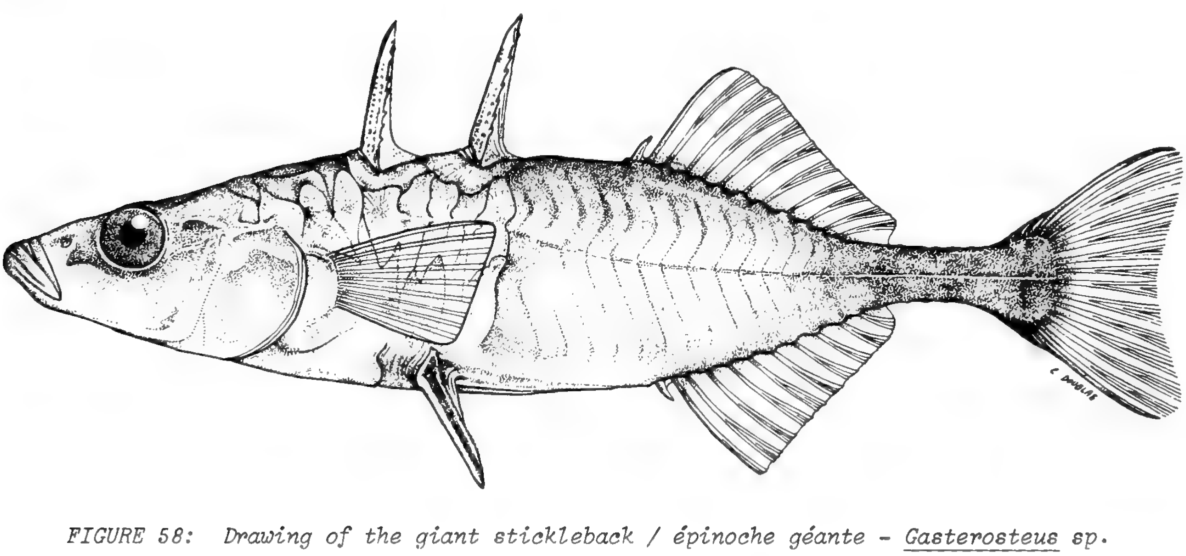

FIGURE 58: Drawing of the giant stickleback / épinoche géante - Gasterosteus sp.

Fortunately, the B.C. provincial government has established a natural history preserve for the giant stickleback, the first preserve intended to protect a fish in Canada. The government is to be commended for this action.

Geologists, but not biologists argue that the Charlottes were covered by ice during the last glaciation. Did the giant stickleback survive and evolve from the threespine stickleback in an area free of glacial ice on the Charlottes or did it evolve rapidly after the glacial ice melted? Hopefully, further study will answer these and other questions about the giant stickleback.

Canadian status: Classified as rare by the Committee on the Status of Endangered Wildlife in Canada in 1980. The giant stickleback is known in Mayer Lake, Graham Island (53° 40'N, 130° 02'W), the Queen Charlotte Islands, British Columbia (Moodie, 1972; Moodie and Reimchen, 1973; Moodie, 1979). A tentative guess places the population at a few hundred thousand. The population appears stable.

The Mayer Lake population does not appear to be under any immediate threat but this may change if densities of cutthroat trout decline due to the increased pressure of angling. Trout densities should therefore be monitored as this predator is important in maintaining the phenotype of the giant stickleback and in excluding the threespine stickleback, *G. aculeatus* from the habitat of the giant stickleback (G.E.E. Moodie, *in litt*. 18 October 1979).

In lakes such as Boulton Lake in the Queen Charlottes other stickleback specimens show a tendancy towards loss of 1-3 dorsal spines and lack lateral plates. A two-spined form with a tendancy to lack plates is also found on Texada Island, southern British Columbia which has been studied by Dr. J.D. McPhail (not to be confused with the black stickleback of Washington state) and a giant black stickleback (unknown whether related to the Charlotte form) occurs in northern Vancouver Island and near Prince Rupert, which may also deserve protection (J.D. McPhail *in litt*., 3 June 1976), but similarity of other in pigmentation populations is probably due to convergence (Moodie, *op. cit*.). The COSEWIC status reports on this species and on the Charlotte unarmoured stickleback are in press (Moodie, 1984; Reimchen, 1984).

Status elsewhere: Not known outside of Canada.

Taxonomic status: The population in Mayer Lake proper appears to meet all the criteria of a biologically defined species (Moodie and Reimchen, 1973). See also discussions on taxonomy of the genus by Moodie (1976a, 1973b) and Bell (1977). Normal, *leiurus*-type threespine sticklebacks are found in the three tributary streams. The two kinds of sticklebacks differ in size, colour and in 6 meristic and morphometric characteristics as well as in behavior and habitat. Presumed hybrids are occasionally found. There are a number of distinctive threespine stickleback populations on Graham Island and these are under taxonomic study by Dr. T.E. Reimchen.

Distinguishing features: The *leiurus* form of the threespine stickleback, *Gasterosteus aculeatus*, is the only stickleback which comes in contact with the giant stickleback. The giant stickleback can be distinguished from the *leiurus* threespine by its black colour as opposed to silvery or light with dark bars, by usually having 19-25 gill rakers instead of 13-18, and usually 6-9 lateral plates on the sides of the body instead of 3-5, and long pelvic spines 4.3 - 6.1 times in standard length instead of 6.2 to 8.0 times. The giant stickleback lacks the keel on the caudal peduncle and plates on the posterior half of the body found in the *trachurus* anadromous threespine sticklebacks found around the coast of the Queen Charlottes. Gold Creek *leiurus* stickleback have a mean plate count of 5.8 as opposed to 6.9 in giant stickleback from the lake. The giant stickleback reaches a maximum length of 116 mm (T.E. Reimchen, *in litt.*, 29 August 1984), in Mayer Lake.

Habitat: Inhabits the limnetic zone of Mayer Lake, avoiding stream mouths and apparently not entering either the three inlets or the outlet stream connected to the lake. Mayer Lake is 12 km long with mean length less than 800 m, a maximum depth of less than 9 m, and an altitude of 22.5 m. It flows into Mayer River which zigzags eastward into Hecate Strait. Lake water is stained a very dark brown, the bottom is mainly sand and pebbles, with scattered water lilies, *Nuphar luteum*; a water moss, *Fontinalis*; and a reed, *Isoetes*. About 20% of the littoral zone is without vegetation. Nests are built near vegetation, on sandy, gently sloping substrate in the littoral zone (Moodie and Reimchen, 1973).

Biology: Mean egg number per stickleback is 257 (Moodie, 1972). Egg number is a function of standard length, egg production equals -393.3 plus 72.2 times the standard length in mm. Mean clutch size in nests was 773. Each male probably completes 5 or fewer breeding cycles during the season which starts in May and lasts about 90 days. Each cycle of about 18 days includes 1 day to build the nest and court the females, an estimated 9 days of incubation, and 8 days to care for the fry. Males and probably females are mature at the age of 2. Female giant stickleback feed in the limnetic zone on zooplankton, the males inhabit shallow littoral waters (T.E. Reimchen, 29 August 1984, *in litt*.).

Protective measures taken: Under the British Columbia Ecological Reserves Act, Drizzle Lake was established as an ecological reserve 9 August 1973 by R. Williams, Minister of Land and Forests on the recommendation of Dr. Alex Peden.

Recommendations: 1) Public information program to bring awareness of this species.
2) Prohibition of introduction of any other species.
3) Monitoring of population of cutthroat trout which excludes the related threespine stickleback from the Lake.
4) Forbidding of lake fertilization programs in bodies of water containing unique sticklebacks.
5) Moribund specimens should be deposited in the National Museum of Natural Sciences, Ottawa, or a provincial museum.

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PERCIDAE

perches | perches

Stizostedion vitreum glaucum Hubbs, 1926 - blue pike or blue walleye/doré bleu (m.).

The enormous changes in the physical and biological environment of Lake Erie wiped out this distinctive subspecies, the blue walleye. Perhaps ten or fifteen thousand years were necessary for the evolution of the blue walleye.

An extinct species or subspecies is gone forever. The complex set of genes on its chromosomes that so subtly adapted it to its natural environment that the subspecies could never be restructured by artificial breeding.

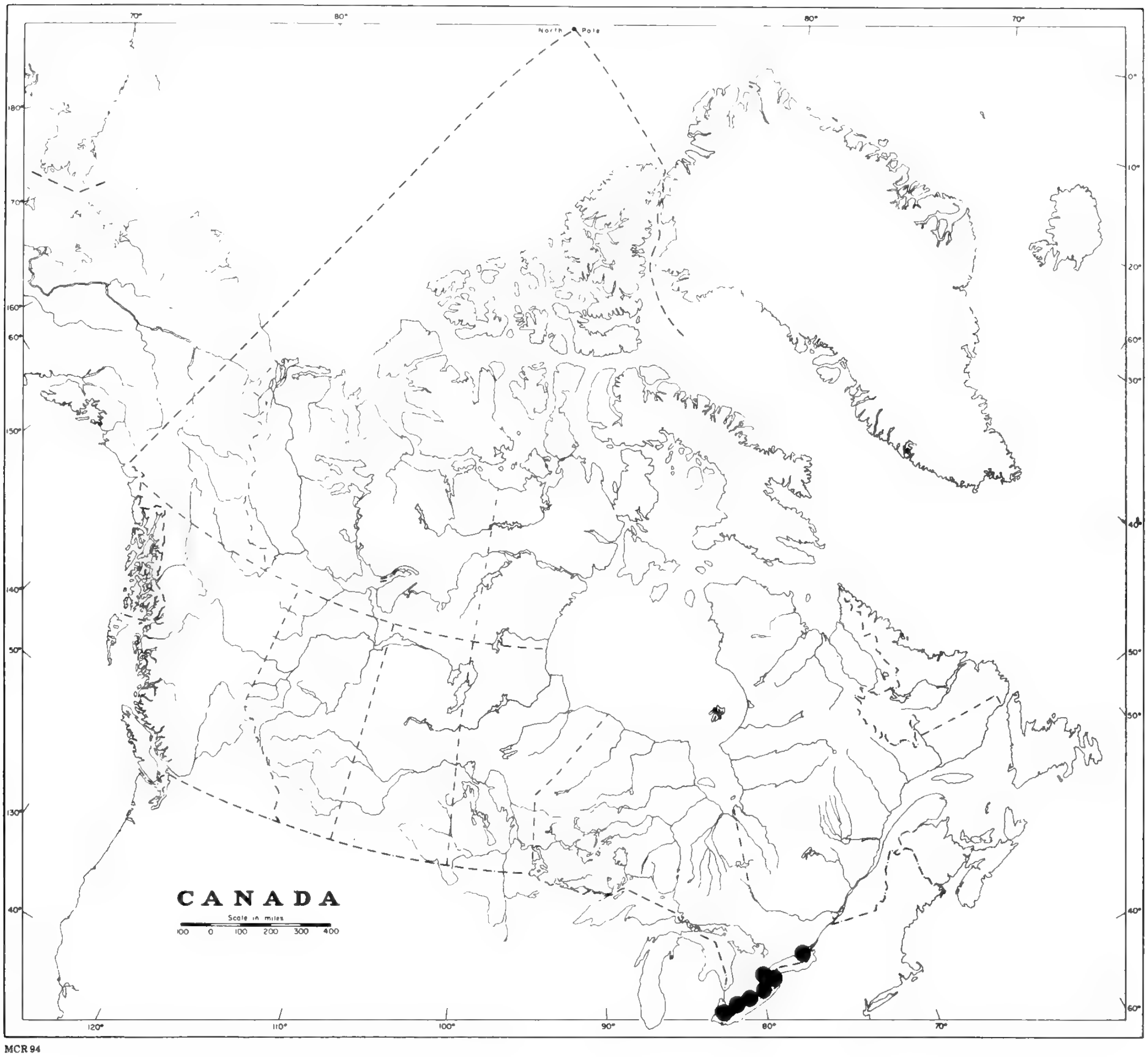

FIGURE 59: Map of the former Canadian distribution of the blue walleye / doré bleu - Stizostedion vitreum glaucum; the blue walleye is extinct.

Canadian status: Extinct. Died with Lake Erie, the precise causes unknown, but which probably included pollution, oxygen depletion, exploitation by commercial and sport fishermen, and introduction of non-native species.

Status elsewhere: Extinct, although classified as endangered for the United States by Williams and Finnley (1977) who listed it for lakes Erie and Ontario. Ono, Williams and Wagner (1983) regarded all populations extinct: central and eastern Lake Erie, the Niagara River, and western and southern Lake Ontario. Canada has signed a Convention on international trade in endangered species of wild flora and fauna which classified this species as endangered, but placed a reservation against it. The last blue pike in fishery landings was seen in 1965.

Distinguishing features: From sauger, *Stizostedion canadense*, the blue walleye is distinguished by the large blotch at the end of the spinous dorsal instead of a row of dark spots, usually 3 long instead of usually 5 short pyloric caeca, and 5-7 instead of 3-4 dark saddles on back; from the yellow walleye, *Stizostedion vitreum vitreum*, by the blue instead of brassy colour, eyes larger and higher and space between the eyes narrower.

Habitat: The following details are from Trautman (1957). The blue walleye inhabited the open deeper and clearer waters of Lake Erie with the largest populations in the eastern two-thirds of the lake. It was absent or present only as strays in shallow turbid waters.

Biology: Spawning usually took place in shallow water in May. Auer (1982) provided some information and depicts some stages of larval development of yellow walleye and blue pike. It grew more slowly and attained a smaller maximum size than the yellow walleye. Adults were 200-260 mm and weighed 0.23 to 3.3 kg. It fed largely on other fishes including yellow perch, rainbow smelt, troutperch and minnows, especially the emerald shiner. In summer large numbers of mayflies were consumed (Scott, 1967), but due to pollution, mayflies disappeared from the lake in the 1950's. The blue pike supported a significant sport fishery, as recently as the 1950's, as well as a commercial fishery.

Protective measures taken: None.

Recommendations: Save other fishes before it's too late.

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OTHER POSSIBLE CANDIDATES FOR RARE OR THREATENED STATUS

This lists other species whose status deserves investigation. Concern has even been expressed over some of the species of lampreys (Vladykov, 1973).

PETROMYZONTIDAE

Lampetra macrostoma Beamish, 1982 - lake lamprey/lamproie à grand disque (f). A parasitic lamprey known only in Lake Cowichan and nearby. Mesachie Lake, Vancouver Island, British Columbia (Beamish, 1982).

SALMONIDAE

Coregonus (Leucichthys) sp. - spring cisco/cisco de printemps (m.). A spring spawning cisco related to lake cisco, Coregonus artedii and sympatric with fall spawners was reported in Lac des Ecorces, Ottawa River basin, Québec by Pariseau, Dumont and Migneault (1983).

Prosopium coulteri (Eigenmann and Eigenmann, 1892) - pygmy whitefish/ménomini pygmée (f.). There are two known "giant" populations of pygmy whitefish (J.D. McPhail, in litt., 3 June 1976; McPhail, 1980b).

OSMERIDAE

Spirinchus thaleichthys (Ayres, 1860) - longfin smelt/éperlan d'hiver. A neotenous form known only in Harrison and Pitt lakes, southwestern B.C. (J.D. McPhail, in litt., 3 June 1976; McPhail, 1980b).

ESOCIDAE

Esox americanus vermiculatus Le Sueur, 1846 - grass pickerel/brochet vermiculé (m.). Ontario (Maher, 1970). Population in Black Creek tributary of the Niagara River, Ontario was verified in 1979 (B. Parker, in litt.)

CYPRINIDAE

Couesius plumbeus - Liard dace/méné de Liard (m.). British Columbia in Liard Hotsprings, Liard River on Alaska Highway. An unpublished doctoral thesis has concluded that this is the most distinctive population of the species.

CATOSTOMIDAE

Catostomus catostomus lacustris Bajkov, 1927 - chinook sucker/meunier chinook. Rare, possibly threatened. Bajkov (1927) named this species from Annette, Patricia, Beauvert and Pyramid lakes in Jasper National Park, Alberta but subsequent authors synonymized it. Camus and McAllister (1984) restudied topotypic material and concluded that at least the Pyramid Lake population was probably subspecifically distinct on the basis of gill raker counts. It has been reported subspecifically that mountain whitefish are now the dominant fish in the lake although Rawson (1950) reported that longnose sucker comprised 75% and mountain whitefish 22% from 1939 to 1945; this suggests a decline in the sucker population.

Erimyzon sucetta (Lacépède, 1803) - lake chubsucker/sueet du lac (m.). Ontario (Maher, 1970).

Ictiobus cyprinellus (Valenciennes, 1844) - bigmouth buffalo/buffalo à grande bouche (m.). Saskatchewan, Manitoba, Ontario (Maher, 1970).

Moxostoma erythrurum (Rafinesque, 1818) - golden redhorse/suceur doré (m.). Ontario (Maher, 1970). Collected sporadically in Sydenham River, Ontario in 1979 (B. Parker, in litt.).

CENTRARCHIDAE

Lepomis megalotis (Rafinesque, 1820) longear sunfish/crapet à longues oreilles (m.). Quebec, Ontario (Maher, 1970).

Lepomis cyanellus Rafinesque, 1819 - green sunfish/crapet vert (m.). Ontario (Maher, 1970).

PERCIDAE

Ammocrypata pellucida (Baird, 1863) - eastern sand darter/dard de sable (m.). Ontario (Van Meter and Trautman, 1970).

Etheostoma microperca Jordan and Gilbert, 1888 - least darter/petit dard (m.). Ontario (Maher, 1970).

Percina copelandi (Jordan, 1877) - channel darter/dard gris (m.). Quebec (McAllister and Coad, 1974), Ontario (Maher, 1970).

COTTIDAE

Cottus aleuticus Gilbert, 1895 - coastrange sculpin - chabot côtier. The population of pelagic dwarf sculpins in Cultus Lake, southwestern B.C. deserves protection (McPhail, 1980b).

ANARCHICHADIDAE

Anarhichas orientalis Pallas, 1814 - Bering wolffish/loup de Bering (m.). Rare. Known in Arctic Canada only from Bathurst Inlet, Northwest Territories. Elsewhere known from Alaska to Japan.

LUMPENIDAE

Acantholumpenus mackayi (Gilbert, 1895) - blackline prickle-back/terrasier à six lignes (m.). Rare. Known only in Tuktoyaktuk Harbour and Liverpool Bay, Northwest Territories in the western Arctic. Elsewhere known from Alaska to Japan.

AGONIDAE

Ocella impi Gruchy, 1970 - pixie poacher/agone lutin (m.). Rare. Known from Skonun River mouth, Graham Island, British Columbia and nowhere else in the world (Gruchy, 1970; Hart, 1973).

Gasterosteus sp. - stickleback/épinoche - A sympatric pair of sticklebacks, one pelagic and one benthic, inhabits Paxton Lake, south of Vananda, northern Texada Island, B.C. (Larsen, 1976). These and other sympatric pairs occurring in several British Columbia lakes (McPhail, 1980a) deserve investigation. Reimchen (1982 and 1984) recommended the status of rare for endemic populations characterized by major loss of spines and lateral plates and a tolerance to naturally acidic waters; these occur in *Sphagnum* dominated lowlands of the Queen Charlotte Islands, British Columbia. This form, which we call the Charlotte unarmoured stickleback, was granted the status of rare by COSEWIC in April 1983; the COSEWIC status report on this form is in press (Reimchen, 1984).

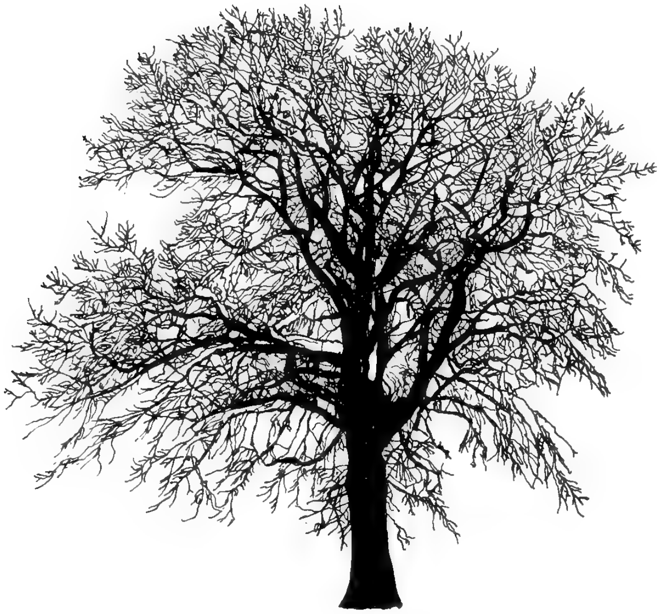

FIGURE 60: Plant a tree for tomorrow.

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APPENDIX 1

STATUS OF RARE, THREATENED, ENDANGERED OR EXTINCT FISH IN CANADA

Status indicated is recommended by a report (Report, date), approved by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, date), or is provisionally recommended by the COSEWIC Subcommittee on Fish and Marine Mammals (Provisional).

		Canada	World
1	Acipenser brevirostrum Le Sueur shortnose sturgeon/esturgeon à museau court (m.)	Rare (COSEWIC, April 1980)	Endangered
2	Polyodon spathula (Walbaum) paddlefish/spatulaire (m.)	Extirpated (Report, 1984)	Declining; threatened endangered in some states
3	Lepisosteus oculatus Winchell spotted gar/lépisosté tacheté (m.)	Rare (COSEWIC, April 1983)	Satisfactory except endangered in Ohio
4	Sardinops sagax caerulea Pacific sardine/sardine du Pacifique (f.)	Rare (Provisional)	Depleted
5	*Salvelinus fontinalis timagamiensis aurora charr/omble de fontaine "aurora" (f.)	Endangered. Natural populations extirpated, but brood stock surviving (Provisional)	Same

* Endemic to Canada, found in no other country.

		Canada	World
6	*Coregonus sp. Squanga whitefish/corégone du Squanga (m.)	Threatened (Provisional, report pending)	Same
7	*Coregonus sp. Opeongo whitefish/corégone d'Opeongo (m.)	Endangered (Provisional)	Same
8	*Coregonus canadensis Scott Acadian whitefish/corégone d'Acadie (m.)	Endangered (COSEWIC, April, 1984)	Same
9	Coregonus hoyi (Gill) bloater/cisco de fumage (m.)	Secure (?) (Report, 1984)	Rare. Michigan Lake Huron fishery closed
10	Coregonus johannae (Wagner) deepwater cisco/cisco de profondeur (m.)	Extinct (Report, 1984)	Extinct
11	Coregonus kiyi (Koelz) kiyi/cisco kiyi (m.)	Secure. Extirpated or rare except Lake Superior (Report, 1984)	Fishing closures and catch quotas in Michigan, netting effort restrictions in Minnesota. Extirpated from most of range but survives in Lake Superior

* Endemic to Canada, found in no other country.

		Canada	World
12	Coregonus nigripinnis blackfin cisco/cisco à nageoires noires (m.)	Extirpated everywhere except Lake Nipigon	Extirpated in United States
13	Coregonus reighardi (Koelz) shortnose cisco/cisco à museau court (m.)	Rare (Report, 1984)	Considered extinct by Illinois, Indiana, Wisconsin, Minnesota and New York, endangered by Michigan, and under consideration as endangered by United States Fish and Wildlife Service
14	Osmerus spectrum Cope pygmy smelt/éperlan nain (m.)	Rare (Report, 1983)	Rare
15	Campostoma anomalum (Rafinesque) central stoneroller/roule-caillou (m.)	Rare (Report, 1983)	Satisfactory except Louisiana
16	Clinostomus elongatus (Kirtland) redside dace/méné long (m.)	Threatened (Report, 1981)	Rare to extirpated in different states
17	Hybognathus argyritis Girard western silvery minnow/ méné d'argent	Rare (Provisional)	Satisfactory
18	Hybopsis storeriana (Kirtland) silver chub/méné à grandes écailles (m.)	Endangered (Report, 1982)	Satisfactory or threatened in Michigan and South Dakota

		Canada	World
19	Hybopsis x-punctata Hubbs and Crowe gravel chub/gravelier (m.)	Extirpated (Report, 1982)	Depleted, endangered or extirpated in different states
20	Notropis anogenus Forbes pugnose shiner/méné camus (m.)	Endangered (Report, 1982)	Rare, endangered or extirpated in different states
21	Notropis dorsalis (Agassiz) bigmouth shiner/méné à grande bouche (m.)	Rare (Report, 1983)	Satisfactory
22	Notropis emiliae (Hay) pugnose minnow/petit-bec (m.)	Endangered (Report, 1982)	Depleted, rare, endangered or extirpated in different states
23	Notropis photogenis (Cope) silver shiner/méné-miroir (m.)	Rare (COSEWIC, April 1983)	Satisfactory, depleted or threatened in different states
24	Rhinichthys cataractae sp. Nooky dace/naseaux du Nooky (m.)	Rare (Provisional)	Rare
25	*Rhinichthys cataractae smithi Nichols Banff longnose dace/Banff naseaux de rapides (m.)	Endangered (Report, 1982)	Same

		Canada	World
26	Rhinichthys osculus (Girard) speckled dace/naseaux moucheté (m.)	Rare (COSEWIC, April 1980)	Satisfactory in some subspecies but 2 subspecies threatened and 5 subspecies endangered
27	Catostomus sp. Salish sucker/meunier des Salish (m.)	Endangered (Report, 1983)	Rare
28	Minytrema melanops (Rafinesque) spotted sucker/meunier tacheté (m.)	Rare (COSEWIC, April 1983)	Satisfactory except Maryland and Ohio
29	Moxostoma carinatum (Cope) river redhorse/suceur ballot (m.)	Rare (COSEWIC, April 1983)	Depleted to endangered, or extirpated in different states
30	Moxostoma duquesnei (Le Sueur) black redhorse/suceur noir (m.)	Endangered (Report, 1980 provisional)	Satisfactory, depleted or threatened in different states
31	*Moxostoma hubbsi (Legendre) copper redhorse/suceur cuivré (m.)	Threatened (Provisional)	Same

* Endemic to Canada, found in no other country.

		Canada	World
32	Noturus miurus Jordan brindled madtom/chat-fou tacheté (m.)	Endangered (Report, 1982)	Satisfactory, depleted or rare in different states
33	Fundulus notatus (Rafinesque) blackstripe topminnow/fondule rayé (m.)	Endangered (Report, 1983)	Satisfactory or depleted in different states
34	Cottus confusus Bailey and Bond shorthead sculpin/chabot à tête courte (m.)	Threatened (COSEWIC, April 1984)	Satisfactory in some states but threatened in Montana
35	*Allolumpenus hypochromis Hubbs & Schultz Y-prickleback/lompénie i-grec (f.)	Rare (Provisional)	Same
36	*Gasterosteus sp. giant stickleback/épinoche géante (f.)	Rare (COSEWIC, 1980)	Same
37	*Gasterosteus aculeatus Charlotte unarmoured stickleback	Rare (COSEWIC, April 1983)	Same
38	Stizostedion vitreum glaucum Hubbs blue walleye/doré bleu (m.)	Extinct	Extinct

* Endemic to Canada, found in no other country.

APPENDIX 2

SOME CONSERVATION ORGANIZATIONS IN CANADA

Canadian Coalition on Acid Rain, 2171 Queen Street East, Toronto, Ontario M4E 1E6

Canadian Nature Federation, 75 Albert Street, Ottawa, Ontario K1P 6G1

Canadian Wildlife Federation, 1673 Carling Avenue, Ottawa, Ontario K2A 1C4

Federation of Ontario Naturalists, 1262 Don Mills Road, Toronto, Ontario

Pollution Probe, University of Toronto, Toronto, Ontario M5S 1A1

Save Our Streams, 355 Lesmill Road, Don Mills, Ontario M3B 2W8

World Wildlife Fund Canada, 60 Claire Avenue West, Suite 201, Toronto, Ontario M4T 1N5

ADDENDUM

A recent publication enables us to provide the following information as this paper goes to press:

The following is summarized from: Hughes, G.W. and A.E. Peden. 1983. A preliminary report on the status of two Canadian populations of spotted dace (*Rhinichthys* sp.) during 1983. Typed report to COSEWIC Subcommittee on Fishes and Marine Mammals, December 1983.

Two distinctive populations, both endangered and possibly similar to *Rhinichthys umatilla* Gilbert and Evermann. The Otter Creek population between Otter Lake and the Tulameen River is very small, perhaps less than 50 individuals. Its scale counts are fairly distant and scarcely overlapping with those of *R. osculus* in the Kettle River; the Otter Creek specimen scale counts are even more distant from spotted dace in the Kettle River.

Kettle River spotted dace are known in Canada only from the lower Kettle River, B.C. downstream of waterfalls at Cascade, and the population is quite small. Centroids of counts are equidistant from centroids for B.C. *R. falcatus* and Kettle River *R. osculus*.

Taxonomic research is vitally needed to correctly name these two populations. Because of their very small population sizes they can be very easily extirpated.

Columbia drainage dams planned by the U.S. Army Corps of Engineers threaten survival of the spotted dace (A.E. Peden, *in litt.*, 15 October 1984).

"If life on earth were to survive, not a single man, plant, bird or animal must be allowed to lose its life except through some great necessity of life itself. And in the losing all men should join in with every plant and animal and bird to praise it and mourn its passing as that of something infinitely precious that had given life the service for which it had been conceived and rendered itself well."

Laurens van der Post. A far off place. 1974. Clarke, Irwin and Company Ltd., Toronto. 311 pp.

RECENT SYLLOGEUS TITLES / TITRES RÉCENTS DANS LA COLLECTION SYLLOGEUS

No. 39 Russell, D.A. and G. Rice (ed.) (1982)
K-TEC II: CRETACEOUS-TERTIARY EXTINCTIONS AND POSSIBLE TERRESTRIAL AND EXTRA-TERRESTRIAL CAUSES. 151 p.

No. 40 Fournier, Judith A. and Colin D. Levings (1982)
POLYCHAETES RECORDED NEAR TWO PULP MILLS ON THE NORTH COAST OF BRITISH COLUMBIA: A PRELIMINARY TAXONOMIC AND ECOLOGICAL ACCOUNT. 91 p.

No. 41 Bélanger-Steigerwald, Michèle and/et Don E. McAllister (1982)
LIST OF THE CANADIAN MARINE FISH SPECIES IN THE NATIONAL MUSEUM OF NATURAL SCIENCES, NATIONAL MUSEUMS OF CANADA / LISTE DES ESPÈCES DE POISSONS MARINS DU CANADA AU MUSÉE NATIONAL DES SCIENCES NATURELLES, MUSÉES NATIONAUX DU CANADA. 30 p.

No. 42 Shih, Chang-tai, and/et Diana R. Laubitz (1983)
SURVEY OF INVERTEBRATE ZOOLOGISTS IN CANADA - 1982 / RÉPERTOIRE DES ZOOLOGISTES DES INVERTÉBRÉS AU CANADA - 1982. 93 p.

No. 43 Ouellet, Henri et Michel Gosselin (1983)
LES NOMS FRANÇAIS DES OISEAUX D'AMÉRIQUE DU NORD. 36 p.

No. 44 Faber, Daniel J., editor (1983)
PROCEEDINGS OF 1981 WORKSHOP ON CARE AND MAINTENANCE OF NATURAL HISTORY COLLECTIONS. 196 p.

No. 45 Lanteigne, J. and D.E. McAllister (1983)
THE PYGMY SMELT, *OSMERUS SPECTRUM* COPE, 1870, A FORGOTTEN SIBLING SPECIES OF EASTERN NORTH AMERICAN FISH. 32 p.

No. 46 Frank, Peter G. (1983)
A CHECKLIST AND BIBLIOGRAPHY OF THE SIPUNCULA FROM CANADIAN AND ADJACENT WATERS. 47 p.

No. 47 Ireland, Robert R. and Linda M. Ley (in press)
TYPE SPECIMENS OF BRYOPHYTES IN THE NATIONAL MUSEUM OF NATURAL SCIENCES, NATIONAL MUSEUMS OF CANADA.

No. 48 Bouchard, André, Denis Barabé, Madeleine Dumais, et/and Stuart Hay (1983)
LES PLANTES VASCULAIRES RARES DU QUÉBEC. / THE RARE VASCULAR PLANTS OF QUÉBEC. 79, 75 p.

No. 49 Harington, C.R., editor (1983)
CLIMATIC CHANGE IN CANADA 3. 343 p.

No. 50 Hinds, Harold R. (1983)
THE RARE VASCULAR PLANTS OF NEW BRUNSWICK. / LES PLANTES VASCULAIRES RARE DU NOUVEAU-BRUNSWICK. 38, 41 p.

No. 51 Harington, C.R., editor (in press)
CLIMATIC CHANGE IN CANADA 4.

No. 52 Hunter, J.G., S.T. Leach, D.E. McAllister and M.B. Steigerwald (1984)
A DISTRIBUTIONAL ATLAS OF RECORDS OF THE MARINE FISHES OF ARCTIC CANADA IN THE NATIONAL MUSEUMS OF CANADA AND ARCTIC BIOLOGICAL STATION. 35 p.

No. 53 Russell, D.A. (1984)
A CHECK LIST OF THE FAMILIES AND GENERA OF NORTH AMERICAN DINOSAURS. 35 p.

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