

ANNOTATED LIST OF THE FISHES OF THE LAKE ONTARIO WATERSHED

by

E. J. CROSSMAN
Department of Ichthyology and Herpetology
Royal Ontario Museum
Toronto, Ontario M5S 2C6

and

HARRY D. VAN METER
Great Lakes Fishery Laboratory
U. S. Fish and Wildlife Service
Sandusky, Ohio 44870

TECHNICAL REPORT NO. 36

**Great Lakes Fishery Commission
1451 Green Road
Ann Arbor, Michigan 48105**

June 1979

CONTENTS

Abstract	1
Introduction	1
Annotated list of fishes	7
Petromyzontidae-lampreys	7
Acipenseridae-sturgeons	8
Lepisosteidae-gars	8
Amiidae - bowfins	8
Anguillidae-freshwater eels	8
Clupeidae-herrings	8
Hiodontidae - mooneyes	9
Salmonidae-ciscoes, whitefishes, salmon and trout	9
Osmeridae-smelts	11
Umbridae-mudminnows	11
Esocidae-pikes	11
Cyprinidae-minnows and carps	11
Catostomidae - suckers	14
Ictaluridae-freshwater catfishes	15
Aphredoderidae - pirate perches	16
Percopsidae - trout-perches	16
Gadidae - codfishes	17
Cyprinodontidae - killifishes	17
Atherinidae - silversides	17
Gasterosteidae - sticklebacks	17
Percichthyidae-temperate basses	17
Centrarchidae-sunfishes	18
Percidae-perches	19
Sciaenidae - drums	20
Cottidae-sculpins	20
Acknowledgments2 1
References2 1

ANNOTATED LIST OF THE FISHES OF THE LAKE ONTARIO WATERSHED¹

by

E. J. Crossman and Harry D. Van Meter²

ABSTRACT

This annotated list of the fishes of Lake Ontario and its watershed is based on published distribution records, museum collections, and reports of fish surveys that confirm the occurrence of fish species dating back to the 1850's. It includes 130 forms (129 spp. + the hybrid splake), 20 of which have disappeared or are extremely rare today. Considering species present only in the lake proper, 64 were reported in 1929, and 51 of those remained in 1972-73 (13 having disappeared). Seventeen species and the splake are fishes not known to have occurred in the lake in 1929 or were introduced since then. A list of 86 references pertinent to the study of the fish fauna of the watershed is given. The present list, started in 1972, includes some information from as late as 1976.

INTRODUCTION

This annotated list of fishes of the Lake Ontario watershed is based on published distribution records, collections of the Royal Ontario Museum (Toronto), and fishery survey data recorded by Canadian and United States agencies in the 1970's. Most of the recent collections were made during the 1972-73 International Field Year for the Great Lakes (IFYGL), in which the participants were the New York Department of Environmental Conservation, Ontario Ministry of Natural Resources, Royal Ontario Museum, U.S. Fish and Wildlife Service, and Alfred (New York) University. Collectively, more than 260 survey trips were made to inshore and offshore locations throughout the lake, and to tributaries along the north shore.

The Lake Ontario basin, which covers an estimated 56,000 square km, encompasses the incoming Niagara River and numerous other lakes and streams that empty into the lake before it discharges into the St. Lawrence River (Fig. 1). As elsewhere in the Great Lakes, Lake Ontario and its tributary waters have sustained a great variety of fish through the years. We have authenticated the presence, at some time during the

1 Contribution 540, Great Lakes Fishery Laboratory, U.S. Fish and Wildlife Service, Ann Arbor, Michigan 48105

2 Present address: Division of Fishery Ecology Research, U.S. Fish and Wildlife Service, Washington, D.C. 20240.

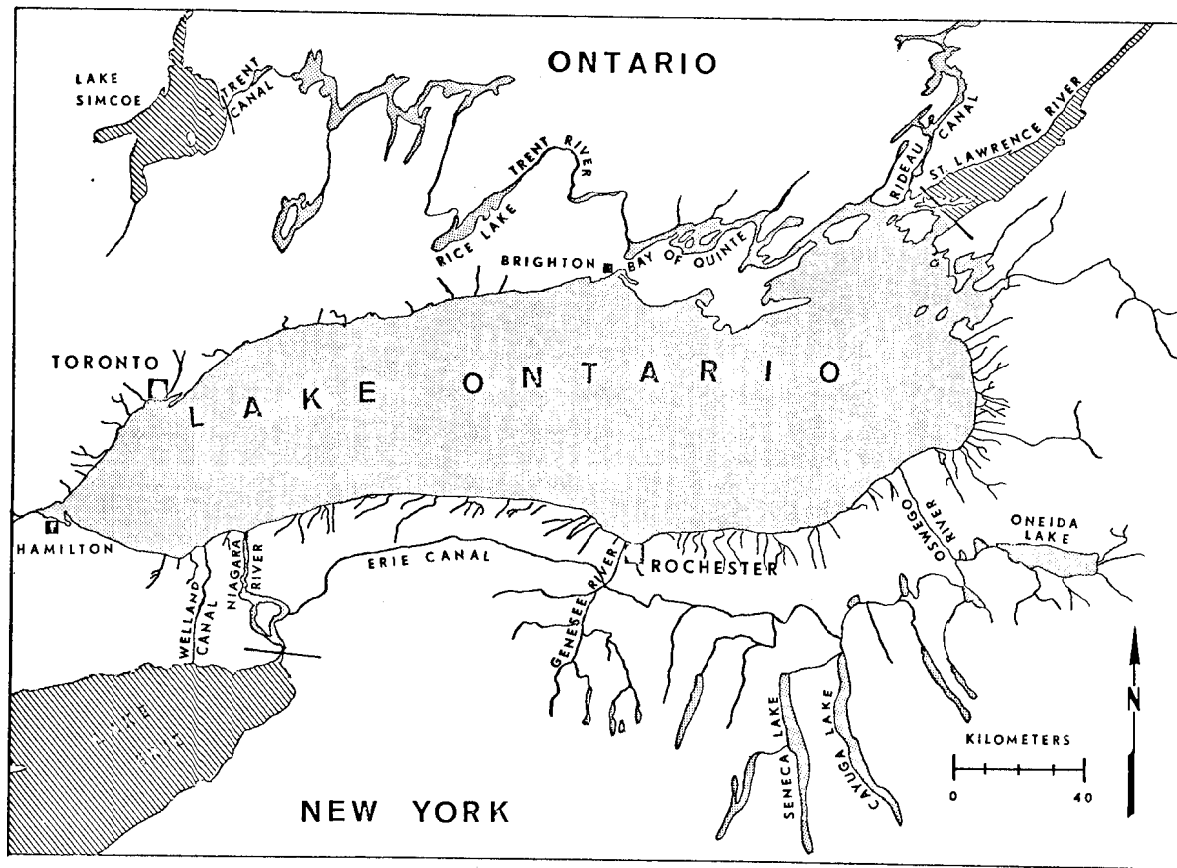


Figure 1.

approximately 125-year period from 1850, of 129 species and the hybrid splake, representing 25 families and 61 genera.

The 68 species designated by an asterisk are those collected in the lake proper by survey teams in the 1970's. The 20 species marked by a dagger are those formerly present in the watershed but now absent, or considered to be extremely- rare. The latter group includes several native species, as well as some exotics that failed to become established.

Common and scientific names, which follow Bailey et al (1970), are given in Table 1 (pp. 3-5) together with the page on which each appears in the text. The species are listed in alphabetical order of common name in the table, and by scientific name, in taxonomic order, in the annotated list.

Table 1. Fishes of the Lake Ontario watershed including those collected from the lake in 1972-75 (*), and those once present but now absent or extremely rare (†). Listed in alphabetical order of common name.

Common name	Scientific name	Page
Alewife*	<i>Alosa pseudoharengus</i> (Wilson)	8
American brook lamprey	<i>Lampetra lamottei</i> (LeSueur)	
American eel*	<i>Anguilla rostrata</i> (LeSueur)	8
American shad†	<i>Alosa sapidissima</i> (Wilson)	8
Atlantic salmon†	<i>Salmo salar</i> Linnaeus	10
Banded killifish*	<i>Fundulus disphanus</i> (LeSueur)	17
Bigeye chub†	<i>Hybopsis amblops</i> (Rafinesque)	12
Bigmouth shiner?	<i>Notropis dorsalis</i> (Agassiz)	13
Black bullhead*	<i>Ictalurus melas</i> (Rafinesque)	15
Black crappie*	<i>Pomoxis nigromaculatus</i> (LeSueur)	19
Blackchin shiner	<i>Notropis heterodon</i> (Cope)	13
Blackfin cisco†	<i>Coregonus nigripinnis</i> (Gill)	9
Blacknose dace*	<i>Rhinichthys atratulus</i> (Hermann)	14
Blacknose shiner	<i>Notropis heterolepis</i> Eigenmann and Eigenmann	13
Blackside darter	<i>Percina maculata</i> (Girard)	20
Bloater*	<i>Coregonus hoyi</i> (Gill)	9
Bluegill*	<i>Lepomis macrochirus</i> Rafinesque	18
Blue pike†	<i>Stizostedion vitreum glaucum</i> Hubbs	20
Bluntnose minnow*	<i>Pimephales notatus</i> (Rafinesque)	14
Bowfin*	<i>Amia calva</i> Linnaeus	8
Brassy minnow	<i>Hybognathus hankinsoni</i> Hubbs	12
Bridle shiner	<i>Notropis bifrenatus</i> (Cope)	13
Brindled madtom	<i>Noturus miurus</i> Jordan	16
Brook silverside*	<i>Labidesthes sicculus</i> (Cope)	17
Brook stickleback	<i>Culaea inconstans</i> (Kirtland)	17
Brook trout*	<i>Salvelinus fontinalis</i> (Mitchill)	10
Brown bullhead*	<i>Ictalurus nebulosus</i> (LeSueur)	16
Brown trout*	<i>Salmo trutta</i> Linnaeus	10
Burbot*	<i>Lota lota</i> (Linnaeus)	17
carp*	<i>Cyprinus carpio</i> Linnaeus	12
Central mudminnow*	<i>Umbra limi</i> (Kirtland)	11
Chain pickerel	<i>Esox niger</i> LeSueur	11
Channel catfish*	<i>Ictalurus punctatus</i> (Rafinesque)	16
Channel darter	<i>Percina copelandi</i> (Jordan)	20
Chinook salmon*	<i>Oncorhynchus tshawytscha</i> (Walbaum)	10

Table 1. (continued)

Common name	Scientific name	Page
Cisco or lake herring*	<i>Coregonus artedii</i> LeSueur	9
Coho salmon*	<i>Oncorhynchus kisutch</i> (Walbaum)	10
Common shiner*	<i>Notropis cornutus</i> (Mitchill)	13
Creek chub*	<i>Semotilus atromaculatus</i> (Mitchill)	14
Creek chubsucker	<i>Erimyzon oblongus</i> (Mitchill)	15
Cutlips minnow	<i>Exoglossum maxillingua</i> (LeSueur)	12
Eastern sand darter†	<i>Ammocrypta pellucida</i> (Putnam)	19
Emerald shiner*	<i>Notropis atherinoides</i> Rafinesque	13
Fallfish	<i>Semotilus corpora/is</i> (Mitchill)	14
Fantail darter*	<i>Etheostoma flabellare</i> Rafinesque	19
Fathead minnow*	<i>Pimephales promelas</i> Rafinesque	14
Finescale dace	<i>Phoxinus neogaeus</i> Cope	
Fourhorn sculpin*	<i>Myoxocephalus quadricornis</i> (Linnaeus)	21
Freshwater drum*	<i>Aplodinotus grunniens</i> Rafinesque	20
Gizzard shad*	<i>Dorosoma cepedianum</i> (LeSueur)	9
Golden shiner*	<i>Notemigonus crysoleucas</i> (Mitchill)	12
Goldfish*	<i>Carassius auratus</i> (Linnaeus)	12
Grass pickerel	<i>Esox americanus vermiculatus</i> LeSueur	11
Greater redhorse	<i>Moxostoma valenciennesi</i> Jordan	15
Greenside darter	<i>Etheostoma blennioides</i> Rafinesque	19
Green sunfish	<i>Lepomis cyanellus</i> Rafinesque	18
Hornyhead chub	<i>Nocomis biguttatus</i> (Kirtland)	12
Iowa darter	<i>Etheostoma exile</i> (Girard)	19
Johnny darter*	<i>Etheostoma nigrum</i> Rafinesque	19
Kiyi†	<i>Coregonus kiyi</i> (Koelz)	9
Kokanee	<i>Oncorhynchus nerka</i> (Walbaum)	10
Lake chub*	<i>Comesius plumbeus</i> (Agassiz)	12
Lake chubsuckert	<i>Erimyzon sucetta</i> (Lacépède)	15
Lake sturgeon	<i>Acipenser fulvescens</i> Rafinesque	8
Lake trout	<i>Salvelinus namaycush</i> (Walbaum)	10
Lake whitefish*	<i>Coregonus clupeaformis</i> (Mitchill)	9
Largemouth bass*	<i>Micropterus salmoides</i> (Lacepede)	18
Least darter	<i>Etheostoma microperca</i> Jordan and Gilbert	19
Logperch*	<i>Percina caprodes</i> (Rafinesque)	19
Longear sunfish	<i>Lepomis megalotis</i> (Rafinesque)	18
Longnose dace*	<i>Rhinichthys cararactae</i> (Valenciennes)	14
Longnose gar*	<i>Lepisosteus osseus</i> (Linnaeus)	8
Longnose sucker*	<i>Catostomus catostomus</i> (Forster)	15
Margined madtom†	<i>Noturus insignis</i> (Richardson)	16
Mimic shiner*	<i>Notropis volucellus</i> (Cope)	14
Mooneye	<i>Hiodon tergisus</i> LeSueur	9
Mottled sculpin*	<i>Cottus bairdi</i> Girard	20
Muskellunge*	<i>Esox masquinongy</i> Mitchill	11
Ninespine stickleback	<i>Pungitius pungitius</i> (Linnaeus)	17
Northern brook lamprey†	<i>Ichthyomyzon fossor</i> Reighard and Cummins	7
Northern hogsucker	<i>Hypentelium nigricans</i> (LeSueur)	15
Northern pike*	<i>Esox lucius</i> Linnaeus	11
Northern redbelly dace	<i>Phoxinus eos</i> (Cope)	14
Pearl dace	<i>Semotilus margarita</i> (Cope)	14
Pirate perch?	<i>Aphredoderus sayanus</i> (Gilliams)	16
Pugnose shiner	<i>Notropis anogenus</i> Forbes	13
Pumpkinseed*	<i>Lepomis gibbosus</i> (Linnaeus)	18
Quillback*	<i>Carpiodes cyprinus</i> (LeSueur)	14
Rainbow darter*	<i>Etheostoma caeruleum</i> Storer	19

Table 1. (continued)

Common name	Scientific name	Page
Rainbow smelt*	<i>Osmerus mordax</i> (Mitchill)	11
Rainbow trout*	<i>Salmo gairdneri</i> Richardson	10
Redfin shiner†	<i>Notropis umbratilis</i> (Girard)	14
Redside dace	<i>Clinostomus elongatus</i> (Kirtland)	12
River chub	<i>Nocomis micropogon</i> (Cope)	12
Rock bass*	<i>Ambloplites rupestris</i> (Rafinesque)	18
Rosyface shiner	<i>Notropis rubellus</i> (Agassiz)	13
Round whitefish*	<i>Prosopium cylindraceum</i> (Pallas)	10
Sand shiner	<i>Notropis stramineus</i> (Cope)	14
Satinfin shiner†	<i>Notropis analostanus</i> (Girard)	13
Sauger	<i>Stizostedion canadense</i> (Smith)	20
Sea lamprey*	<i>Petromyzon marinus</i> Linnaeus	7
Shorthead redhorse*	<i>Moxostoma macrolepidotum</i> (LeSueur)	15
Shortnose cisco†	<i>Coregonus reighardi</i> (Koelz)	10
Silver chub†	<i>Hybopsis storeriana</i> (Kirtland)	12
Silver lamprey	<i>Ichthyomyzon unicuspis</i> Hubbs and Trautman	7
Silver redhorse*	<i>Moxostoma anisurum</i> (Rafinesque)	15
Silvery minnow*	<i>Hybognathus nuchalis</i> Agassiz	12
Slimy sculpin*	<i>Cottus cognatus</i> Richardson	20
Smallmouth bass*	<i>Micropterus dolomieu</i> Lacépède	18
Splake*	<i>Salvelinus fontinalis</i> x <i>S. namaycush</i>	10
Spoonhead sculpin†	<i>Cottus ricei</i> (Nelson)	21
Spotfin shiner*	<i>Notropis spilopterus</i> (Cope)	14
Spottail shiner*	<i>Notropis hudsonius</i> (Clinton)	13
Stonecat*	<i>Noturus flavus</i> Rafinesque	16
Stoneroller	<i>Camptostoma anomalum</i> (Rafinesque)	11
Striped bass†	<i>Morone saxatilis</i> (Walbaum)	18
Striped shiner	<i>Notropis chrysocephalus</i> (Rafinesque)	13
Swallowtail shiner†	<i>Notropis procne</i> (Cope)	13
Tadpole madtom*	<i>Noturus gyrinus</i> (Mitchill)	16
Tessellated darter	<i>Etheostoma olmstedii</i> Storer	19
Threespine stickleback*	<i>Gasterosteus aculeatus</i> Linnaeus	17
Tonguetied minnow?	<i>Exoglossum laurae</i> (Hubbs)	12
Trout-perch	<i>Percopsis omiscomaycus</i> (Walbaum)	16
Walleye*	<i>Stizostedion vitreum vitreum</i> (Mitchill)	20
White bass*	<i>Morone chrysops</i> (Rafinesque)	17
White crappie*	<i>Pomoxis annularis</i> Rafinesque	18
White perch*	<i>Morone americana</i> (Gmelin)	17
White sucker*	<i>Catostomus commersoni</i> (Lacépède)	15
Yellow bullhead	<i>Ictalurus natalis</i> (LeSueur)	16
Yellow perch*	<i>Perca flavescens</i> (Mitchill)	19

Changes in species occurrence in Lake Ontario in the last 50 years can be identified by comparing 68 species collected from the lake proper in the 1970's (asterisked) with the last extensive, published list from the 1920's (Dymond et al. 1929). The older list shows 64 species in the lake, of which 51 are known still to be present; the following 13 were not collected from the lake in 1972-75: lake sturgeon, American shad, mooneye, kiyi, shortnose cisco, lake trout, blackchin shiner, blacknose shiner, sand

shiner, brook stickleback, ninespine stickleback, sauger, and blue pike. Four of these-American shad, kiyi, shortnose cisco, and blue pike-are forms known to have become extinct in the lake since 1929. Two others-lake sturgeon and lake trout-are present today but are scarce. The lake sturgeon is no longer considered to be reproducing in the lake, and the lake trout occurs only as the result of recent introductions. Mooneye, brook stickleback, ninespine stickleback, and sauger have always been rare in the lake and may no longer occur or may simply be so sparse that they escaped capture during the recent surveys. The three minnows in question-blackchin shiner, blacknose shiner, and sand shiner-were common to abundant in Burlington Bay in 1927. These species must now be absent or extremely rare, to have eluded the numerous seine collections made in that area during the 1972-73 survey.

We consider these losses in the lake's ichthyofauna serious, even though the number is not large. In the 46-year period from 1929 to 1975, the lake has in essence lost at least three native species (in addition to the loss of the Atlantic salmon during the last century) and an introduced species, the American shad. The other nine species, most of which were native, are also probably lost. Christie (1973) published lists of species extinct before and after 1900. Whillans (1977) gave the earliest known record and changes in abundance over the years for various species known to have occurred in Toronto Bay and Burlington Bay.

The 18 fishes collected from the lake proper during 1972-75 that were not reported in 1927 are as follows: coho salmon, chinook salmon, rainbow trout, brown trout, splake, brook trout, rainbow smelt, silvery minnow, mimic shiner, fathead minnow, quillback, black bullhead, brook silverside, white perch, smallmouth bass, white crappie, rainbow darter, and mottled sculpin. A few of these species may have been present in 1929, but not collected or identified. Others are recent invaders (e.g., white perch), the result of direct introductions elsewhere (e.g., rainbow smelt), or of introductions into the lake or its tributaries (e.g., coho salmon, chinook salmon, rainbow trout, brown trout, and splake).

Omitted from the annotated list are several species whose "occurrence" was listed in early records, but has since been discounted because of misidentification or changes in taxonomic nomenclature. The following names are in this category:

Chrosomus erythrogaster Rafinesque-redbelly dace. Earlier records for the Lake Ontario watershed using this name are the result of a nomenclatorial problem and actually refer to what is now known as *Phoxinus eos* (Cope), the northern redbelly dace. *Phoxinus* (= *Chrosomus*) *erythrogaster* (Rafinesque), the southern redbelly dace, is a more southerly form and apparently was never present.

Notropis blennioides - straw-colored minnow. Many records list a small common minnow by this name which refers to what we now know as *Notropis stramineus* (Cope), the sand shiner. The species known as *Notropis blennioides* (Girard), the river shiner, occurs no closer than in a tributary of Lake Michigan, and that record is in doubt.

Notropis whipplii - silver-fin minnow, or satinfin minnow. Satinfin

minnow is still an unofficial alternate common name for *N. stramineus* (Cope), the sand shiner. Most older records using the scientific name *N. whipplii* actually refer to *N. stramineus* and not to *N. whipplei* (Girard), the steelcolor shiner (the steelcolor shiner does not occur in the Lake Ontario basin). Misuse in the past of the common name satinfin "shiner" may explain the erroneous presence in some lists of records of *N. analostanus* in southern tributaries of Lake Ontario.

Moxostoma spp. All distribution records of redhorses, genus *Moxostoma*, in the literature before the 1930's are suspect and are almost impossible to assign to a present species. Historically the forms were greatly confused. *Moxostoma duquesnei* and *M. erythrurum* have been recorded at one time or another but such records are now considered errors of identification, since most authentic statements of their distribution do not include the Ontario watershed.

In the annotated list of fishes of the Lake Ontario watershed that follows, we offer brief comments on distribution and abundance, habitat preference, and biological or economic status of the species where appropriate. The list of selected references that follows includes the literature cited and certain less well-known materials concerning the fishes of the lake.

ANNOTATED LIST OF FISHES

Including those collected from the lake in 1972-75 (*), and those once present but now absent or extremely rare (†).

PETROMYZONTIDAE-LAMPREYS

Ichthyomyzon fossor Reighard and Cummins - northern brook lamprey†
An early record listed for the lake. Possibly present in a few scattered tributary creeks. Nonparasitic.

Ichthyomyzon unicuspis Hubbs and Trautman-silver lamprey
A limited number of specimens have been recorded from the lake and several tributaries before 1970; occurrence has remained low and distribution local. Adults are parasitic.

Lampetra lamottei (LeSueur)-American brook lamprey
Common to abundant in recent years in many rivers and creeks. This nonparasitic species is most often observed during spring spawning activities in shallow, gravelly riffle areas.

Petromyzon marinus Linnaeus-sea lamprey*
Common and widespread in the watershed. Attempts are under way to control this parasite by chemical treatment of larval nursery areas.

ACIPENSERIDAE-STURGEONS

Acipenser fulvescens Rafinesque-lake sturgeon

Once abundant in the lake (especially in the eastern outlet basin) and commercially valuable; however, stocks were largely depleted by 1900. Still occasionally taken but mostly in the eastern outlet basin. Doubtful whether a reproducing population occurs in the lake itself.

LEPISOSTEIDAE - GARS

Lepisosteus osseus (Linnaeus)-longnose gar*

Inhabits weedy areas of the shallower bays and larger sluggish streams where it is moderately common. Whillans (1977) mentioned that two species of gars had been reported from Toronto Bay. These may have been based on the distinctly different color pattern of the young and adult of this species. Practically worthless as a food or game fish.

AMIIDAE-BOWFINS

Amia calva Linnaeus-bowfin*

Numbers have declined in recent years in the southern part of the system, but are increasing in the Bay of Quinte. Usually confined to the shallower, vegetated bays and marshes. Has little food value.

ANGUILLIDAE-FRESHWATER EELS

Anguilla rostrata (Lesueur) - American eel*

Common, particularly in nearshore waters of the eastern basin. Its flesh is esteemed, either fresh or smoked, and it has considerable market value in the commercial fishery.

CLUPEIDAE-HERRINGS

Alosa pseudoharengus (Wilson)-alewife*

A marine species that became landlocked many years ago. Heavy annual mortalities known at least since the 1890's. Now widespread and abundant throughout the lake and larger tributary streams. Used as forage by introduced salmonids and other piscivores. Continues to be subject to mass mortalities in late winter and spring.

Alosa sapidissima (Wilson)-American shad †

A few specimens recorded as late as the 1920's from a remnant lake population. First stocked in 1870; now considered extinct,

Dorosoma cepedianum (Lesueur) - gizzard shad*

Common to abundant in the shallower areas of the lake and larger streams; fluctuates in abundance from year to year. Numbers have increased tremendously since 1972 in certain areas of the lake.

HIODONTIDAE-MOONEYES

Hiodon tergisus LeSueur - mooneye

Rare. May occur sparingly in the lake and larger tributaries. Those present in the Bay of Quinte are probably strays from the Trent River population. A bony fish with little value as food or sport.

SALMONIDAE-CISCOES, WHITEFISHES,
SALMONS AND TROUTS

Coregonus artedii Lesueur - cisco or lake herring*

Formerly abundant in the lake; record production was 5 million pounds, in 1889. Now rare to uncommon; a continual decrease in population endangers its very existence. Present in numerous inland lakes.

Coregonus clupeaformis (Mitchill)-lake whitefish*

Taken commercially for many years; however, its numbers have decreased significantly in recent years and it is now considered reduced and endangered. Typically found in shallow to moderate depths of the eastern basin and in some inland lakes.

Coregonus hoyi (Gill)--bloater*

Last known record was in 1972, off Port Credit, Ontario. Todd (1978) listed it as extinct or too rare to be rehabilitated. Smallest of the ciscoes.

Coregonus kiyi (Koelz)-kiyi †

Formerly common in deeper waters of the western basin of the lake. Last known record off Oswego, New York, in 1964 (Todd 1978). Now considered extinct.

Coregonus nigripinnis (Gill) - blackfin cisco †

Records in earlier years from deeper waters of the lake are in doubt. Todd (1978) considered the name used for the specimens on which the records for blackfin cisco in the lake were based to be involved in the synonymy of *C. zenithicus*. He claimed that there is no valid record for either species for Lake Ontario. Now extinct, if it existed in the lake in the past.

- Coregonus reighardi* (Koelz)-shortnose cisco †
Once common and widespread, and until the late 1930's an important commercial species in the lake. Last known record September 1964, off Rochester, New York (Todd 1978). Now considered extinct in the system.
- Oncorhynchus kisutch* (Walbaum) - coho salmon*
Repeated introductions from 1873 to 1933 were unsuccessful. However, adults resulting from annual fingerling plants since 1968 now support a sport fishery in the lake and adjacent streams, and a limited commercial catch from the lake.
- Oncorhynchus nerka* (Walbaum)-kokanee
Introductions in United States and Canadian waters of the lake from 1950 to 1970 were unsuccessful. Incidental plants are being continued in some New York tributary lakes to provide a limited sport fishery.
- Oncorhynchus tshawytscha* (Walbaum)&chinook salmon*
Introduced on numerous occasions from 1874 to 1925 without becoming established. Annual hatchery plants of fingerlings since 1969 are providing an increasingly important sport fishery.
- Prosopium cylindraceum* (Pallas)-round whitefish*
Reduced in numbers and probably endangered, but still taken regularly in the shallower depths on the north shore, east of Brighton, Ontario.
- Salmo gairdneri* Richardson-rainbow trout*
Widely distributed in numerous lakes and streams throughout the watershed, providing an extensive sport fishery. Hatchery plantings supplement natural reproduction in the more heavily fished waters. Lake-run rainbow trout are known as steelheads. So-called "golden" or palamino trout taken in the system are a genetic color variant of this species.
- Salmo salar* Linnaeus-Atlantic salmon †
Once abundant in the lake, this native fish became extinct before the turn of the century. Reintroduction in the United States and Canadian tributary waters from 1947 to 1970 have failed to re-establish a population. Restoration efforts are continuing.
- Salmo trutta* Linnaeus-brown trout*
Inhabits the lake and larger coldwater streams of moderate elevation. Natural reproduction is supplemented with hatchery stock in some areas. Annual plantings since 1973 sustain an increasingly important sport fishery.
- Salvelinus fontinalis* (Mitchill)-brook trout*
A favorite sport fish that is native to the watershed, occurring in the colder, spring-fed streams of higher elevations.
- Salvelinus fontinalis* X *Salvelinus namaycush*-splake*
This hybrid was produced by selective breeding and recently introduced into the lake as part of a rehabilitation program. Not abundant.

Salvelinus namaycush (Walbaum)-lake trout

A native fish commercially important before becoming extinct. Apparently no reproducing population exists, and lake trout now present originate from hatchery-reared stock.

OSMERIDAE-SMELTS

Osmerus mordax (Mitchill)-rainbow smelt*

Origin in drainage system is controversial. Rare until the mid-1940's, but population has since become abundant enough to support commercial and recreational fisheries.

UMBRIDAE-MUDMINNONS

Umbra limi (Kirtland) - central mudminnow*

Avoids the open lake but occurs locally in sheltered bays and probably in most small, muddy, weedy tributaries of low elevation.

ESOCIDAE-PIKES

Esox americanus vermiculatus Leseur - grass pickerel

Occurs in both north and south shore tributaries of the eastern and western portions of the drainage basin, where it is local and not abundant. Prefers weed beds over mud bottom of lowland streams, but is occasionally taken in shallower bays of the lake. Not significant as a food or sport fish.

Esox lucius Linnaeus-northern pike*

The most abundant member of the pike family, widely distributed throughout the watershed. Prefers weedy shallows of bay areas in the lake. Important food and sport fish.

Esox masquinongy Mitchill-muskellunge*

Primarily confined to the shallower bays (especially Bay of Quinte and Cape Vincent) and larger tributary streams, including the Niagara River. A highly prized sport fish.

Esox niger LeSueur - chain pickerel

An inhabitant of the southern part of the drainage system. Locally common in weedy areas of sluggish streams. Rarely found in the lake.

CYPRINIDAE-MINNONS AND CARPS

Camptostoma anomalum (Rafinesque)-stoneroller

Largely restricted to south shore waters of the drainage system; prefers clear, gravelly streams of low elevation. Occurs sparingly in the Niagara River and the lake.

- Carassius auratus* (Linnaeus)-goldfish*
 Locally established in moderate numbers in bays and larger streams near their confluences with the lake. Has little value.
- Clinostomus elongatus* (Kirtland)-redside dace
 Moderately common in a few streams along the western end of the north shore but more general in the southern portion of the drainage system. Inhabits the clearer, colder waters.
- Couesius plumbeus* (Agassiz)--lake chub*
 Primarily a lake fish but also occurs in the larger and more sluggish streams. Uncommon.
- Cyprinus carpio* Linnaeus-carp*
 Widespread in the drainage basin since its introduction in the 1880's. Now most common along the shore area of the lake and in the larger streams; supports a modest commercial fishery. Carp-goldfish hybrids are frequently taken.
- Exoglossum laurae* (Hubbs) - tonguetied minnow †
 Extremely rare if present. An early record from the Genesee River system probably was an immigrant from another drainage.
- Exoglossum maxillingua* (Lesueur) - cutlips minnow
 Locally common in some southern and eastern tributaries, including Cayuga Lake. Prefers clear, silt-free streams with moderate current.
- Hybognathus hankinsoni* Hubbs-brassy minnow
 Occurs in many north shore streams, but considered rare in south shore tributaries. Usually confined to bog waters of upland tributaries. Not taken in the lake.
- Hybognathus nuchalis* Agassiz-silvery minnow*
 Restricted somewhat to the lowland tributaries in isolated localities of the extreme eastern portion of the system. Inhabits the larger streams with mud bottoms and little current, and a few bays of the lake.
- Hybopsis amblops* (Rafinesque)-bigeye chub?
 Early records from a few southern tributaries of the western sector of the lake. Prefers small streams with sandy or gravel bottoms. Rare, if present.
- Hybopsis storeriana* (Kirtland)-silver chub †
 Collected in the late 1890's from isolated localities along southern shore of the lake. Rare, if present. Prefers large, silted rivers and, to a lesser extent, lakes.
- Nocomis biguttatus* (Kirtland) - hornyhead chub
 Rare in the lake. Confined to south shore streams of moderate current in the western basin.
- Nocomis micropogon* (Cope)-river chub
 Uncommon, though recorded from a few north and south shore streams in the western basin. Prefers clear, moderate-sized streams with gravelly bottoms and little vegetation.
- Notemigonus crysoleucas* (Mitchill)-golden shiner*
 Common in well-protected areas of the lake, and in the more sluggish streams. A popular bait minnow.

- Notropis analostanus* (Girard)--satinfin shiner †
Extremely rare, if present. Occurrence restricted to some early records in a few south shore tributaries of the eastern basin of the lake. (See notes on *N. whipplii* in the Introduction).
- Notropis anogenus* Forbes-pugnose shiner
Uncommon and isolated. Occurs in the extreme eastern portion of the outlet basin. Early records from the southern shore of the lake and the Oswego River system. Prefers clear, weedy lakes and clear, quiet streams.
- Notropis atherinoides* Rafinesque-emerald shiner*
Most abundant minnow in the lake; also taken in the larger tributary streams. A favorite bait of anglers.
- Notropis bifrenatus* (Cope)-bridle shiner
Locally common in shallow bays and lowland streams with muddy bottoms. On the north shore, found only from the Bay of Quinte eastward. Has limited value as a bait minnow.
- Notropis chrysocephalus* (Rafinesque)-striped shiner
Occurs in lowland streams and shoreline areas of the lake. Locally common in some waters in weedy areas over mud bottoms. Separation of this form from *N. cornutus* is unclear for northern populations in the system.
- Notropis cornutus* (Mitchill) - common shiner*
A predominant fish of the region. Common to abundant in the lake and tributaries, adapting easily to a diversified habitat.
- Notropis dorsalis* (Agassiz)-bigmouth shiner †
Early records restricted it to Oneida Lake and a tributary of the Genesee River. Rare, if present.
- Notropis heterodon* (Cope)-blackchin shiner
Uncommon in the southern part of the system, although frequently taken in north shore tributaries. Inhabits clear, weedy bays of the lake and larger streams.
- Notropis heterolepis* Eigenmann and Eigenmann-blacknose shiner
Widely distributed in north shore areas of the drainage basin. Apparently less abundant in New York waters. Most prevalent in weedy and sandy shallows of lakes.
- Notropis hudsonius* (Clinton)-spottail shiner*
Common to abundant in protected bays of the lake and near mouths of larger streams. An important bait and forage minnow.
- Notropis procne* (Cope)-swallowtail shiner †
Rare if present. Specimens said to have been collected many years ago, from an Oswego River tributary, are presumed to have entered the river through a connecting canal. Never reported elsewhere in the drainage basin.
- Notropis rubellus* (Agassiz) - rosyface shiner
Present, though uncommon, in isolated tributaries throughout the system. Prefers the warmer waters of lower sections of larger streams, but intolerant of turbidity. Rare in the lake.

- Notropis spilopterus* (Cope) - spotfin shiner*
Widely distributed but uncommon; prefers rivers rather than lakes.
- Notropis stramineus* (Cope)-sand shiner
Present in the southern zone of the lake and larger rivers with sandy bottoms. Apparently restricted to tributaries along the north shore.
- Notropis umbratilis* (Girard) - redfin shiner †
A few early records from tributary streams in the western sector along the south shore of the lake. Does not occur in the Ontario portion of the system. Rare, if still present.
- Notropis volucellus* (Cope)-mimic shiner*
Uncommon. Inhabits still water and the small lowland creeks that provide marshy habitat.
- Phoxinus eos* (Cope) - northern redbelly dace
Occurs more commonly northward in the system; prefers upland lakes, bogs, and sluggish streams. A hybrid of this species and *P. neogaeus* has been recorded from the lake.
- Phoxinus neogaeus* Cope-finescale dace
Frequents the more upland lakes and bogs of the drainage system. Common wherever this type of habitat occurs in the basin.
- Pimephales notatus* (Rafinesque)-bluntnose minnow*
Common to abundant in most stream systems and in the shallower waters of the lake. An important forage resource.
- Pimephales promelas* Rafinesque-fathead minnow*
Generally distributed throughout the drainage system, though not abundant. Prefers swampy habitats. An important bait minnow.
- Rhinichthys atratulus* (Hermann) - blacknose dace*
Widespread and abundant throughout the watershed. Inhabits the small, clear streams with gravel and rubble bottoms-particularly the so-called trout waters.
- Rhinichthys cataractae* (Valenciennes)-longnose dace*
Widely distributed throughout the system, but possibly more common in north shore than in south shore tributaries. Inhabits swiftly flowing gravel or bouldery streams.
- Semotilus atromaculatus* (Mitchill&creek chub*
Abundant in small clear streams throughout the watershed. Occasionally taken in protected bays of the lake. Commonly used as bait.
- Semotilus corporalis* (Mitchill) - fallfish
Well represented in the eastern portion of the drainage system, frequenting larger streams with mud and gravel bottoms. Occasionally taken in the lake. Largest of the native minnows.
- Semotilus margarita* (Cope&pearl dace
Not abundant, but occurs in many small coldwater streams throughout the drainage basin. Rarely taken in the lake.

CATOSTOMIDAE-SUCKERS

- Carpiodes cyprinus* (Lesueur) - quillback*
Uncommon and apparently absent, or at least unreported, from

north shore tributaries. Occasional records from the lake and larger rivers could be strays from Lake Erie, since no young are known to have been collected.

Catostomus catostomus (Forster)--longnose sucker*

Frequents the larger and cooler tributary waters of the eastern basin. Said by Whillans (1977) to have been identified from the vicinity of Toronto Bay in the early 1900's. Locally common in some areas, but not as prevalent as the white sucker.

Catostomus commersoni (Lacépède)—white sucker*

Most abundant sucker, with a widespread distribution in the watershed. Present around the lake and in coldwater and warmwater streams alike. Adults have limited value as food, and the young are important as bait and forage.

Erimyzon oblongus (Mitchill) - creek chubsucker

Early records of occurrence in eastern tributaries in New York, and more recently in the Salmon River. Does not occur along the north shore and is uncommon if present in the lake. Prefers the more sluggish streams of moderate size.

Erimyzon sucetta (Lacépède)—lake chubsucker †

Uncommon, if still present. A few records of occurrence in early years along the southern shore of the lake and in several tributaries. Never taken in the Ontario part of the system. Early records of this and the previous species are confusing because the name *E. sucetta oblongus* was commonly assigned to this species.

Hypentelium nigricans (LeSueur) - northern hogsucker

Generally restricted to small, clear tributaries of the western portion of the watershed. Prefers waters with strong current and hard bottom but has been recorded from the lake. Uncommon.

Moxostoma anisurum (Rafinesque)-silver redhorse*

Well represented throughout the watershed, including the lake, though never in abundance. Prefers the larger and warmer tributary streams.

Moxostoma macrolepidotum (Lesueur) - shorthead redhorse*

Most common of the redhorses. Abundant in the lake and most streams. More northerly distribution than reported in earlier years. Has some commercial food value.

Moxostoma valenciennesi Jordan-greater redhorse

Recorded from the lake in earlier years (as *M. rubriques*) but numbers have since decreased. Now rare, but occurs in the Niagara River and some northern tributaries of the lake.

ICTALURIDAE-FRESHWATER CATFISHES

Ictalurus melas (Rafinesque)--black bullhead*

Records previously limited to a few New York tributaries of the lake. Now known to occur at least in the western portion of the north shore. Specimens from the northern part of the drainage

possibly not separated from *I. nebulosus* before 1974. Whillans (1977) recorded it as taken near Toronto in 1927. Inhabits the more turbid waters.

Ictalurus natalis (LeSueur)-yellow bullhead

Uncommon to rare, though present in the warmer, heavily vegetated bays of the lake and larger streams-particularly in the eastern part of the system.

Ictalurus nebulosus (Lesueur) - brown bullhead*

Widely distributed throughout the watershed. Dominant member of the catfish family. Especially abundant in the eastern end of the lake. Has considerable sport and commercial importance.

Ictalurus punctatus (Rafinesque) - channel catfish*

Widespread and relatively common along the shore zone of the lake and near the mouths of larger tributaries. A food and sport species.

Noturus flavus Rafinesque - stonecat*

Present in the lake and larger streams; prefers the shallower rocky areas. Common and widely distributed.

Noturus gyrinus (Mitchill)-tadpole madtom*

Uncommon but occurs throughout the system. Usually restricted to weedy areas of mud-bottom waters of the lake and its tributaries.

Noturus insignis (Richardson)-margined madtom †

Rare, if not extinct. A few early records from small tributary streams of the Oswego River. Probably emigrated from another drainage system connected to the Oswego by a canal. A recent record from a tributary of the Ottawa River, however, could indicate the presence of isolated populations in the extreme eastern part of the watershed.

Noturus miurus Jordan-brindled madtom

Rare. Never reported from the lake but does occur in the Niagara River. There is an early record from Oneida Lake of the Oswego River system.

APHREDODERIDAE - PIRATE PERCHES

Aphredoderus sayanus (Gilliams) - pirate perch †

A few early records from isolated areas in the Oswego River system. Extremely rare, if present.

PERCOPSIDAE - TROUT-PERCHES

Percopsis omiscomaycus (Walbaum) - trout-perch

Moderately common. Essentially a lake fish, but also occurs in larger tributaries with sluggish current and mud bottom. Has some value as a forage fish.

GADIDAE - CODFISHES

Lota lota (Linnaeus)-burbot*

Uncommon to rare in the lake, but occurs over the entire watershed. Numbers greatly reduced in recent years.

CYPRINODONTIDAE-KILLIFISHES

Fundulus diaphanus (LeSueur) - banded killifish*

Present throughout the system but rarely seen in large numbers. Commonly observed feeding on the surface in shallow, weedy bays of the lake and large sluggish streams. Has some forage value where abundant.

ATHERINIDAE-SILVERSIDES

Labidesthes sicculus (Cope)--brook silverside*

A common surface swimmer taken in open water or in clear, shallow water above beds along the lake shore and in larger tributaries. Moderately important as forage.

GASTEROSTEIDAE - STICKLEBACKS

Culaea inconstans (Kirtland)-brook stickleback

Widely distributed but uncommon. Prefers shallow, weedy bays of lakes and smaller streams of low elevation.

Gasterosteus aculeatus Linnaeus-threespine stickleback*

The most abundant stickleback throughout the watershed. Commonly taken in weed beds over rocky areas near the lake shore, but also taken considerable distances offshore and in most streams.

Pungitius pungitius (Linnaeus) - ninespine stickleback

Rare. Occurrence believed restricted to a few well-protected bays along the south shore of the lake and colder tributary streams. Moves only short distances up tributary streams.

PERCICHTHYIDAE-TEMPERATE BASSES

Morone americana (Gmelin)-white perch*

First reported in the lake about 1950; probably entered through canals (Scott and Christie 1963). Now widely distributed and abundant throughout the lake and larger streams. Valued as a sport and commercial fish.

Morone chrysops (Rafinesque)--white bass*

Uncommon, and numbers declining in recent years. Prefers deep,

quiet waters over sand and gravel bottoms in the lake but also occurs in larger streams.

Morone saxatilis (Walbaum) - striped bass †

There is an 1878 record of the introduction of 140 fingerlings in the lake; only one recovery was reported. Whillans (1977) cited this 1878 introduction as in the Genesee River, about six miles from the lake. He listed three recaptures including one each in Niagara River, Burlington Bay, and Sackett's Harbor. Essentially a coastal game fish whose northern range extends to the lower reaches of the St. Lawrence River.

CENTRARCHIDAE-SUNFISHES

Ambloplites rupestris (Rafinesque)-rock bass*

Widely distributed and abundant along rocky shores of the lake and in lowland tributary streams. Valued as a sport and commercial fish.

Lepomis cyanellus Rafinesque-green sunfish

Rare. Early records of a few collections from isolated tributary streams of eastern and western New York. Primarily confined to smaller creeks and ponds in the southern part of the basin, but now known from Canadian tributaries of western Lake Ontario.

Lepomis gibbosus (Linnaeus) - pumpkinseed*

The most abundant and widely distributed sunfish in the watershed. Prefers clear, cool waters in weedy areas over sand and gravel bottoms. Has considerable commercial value and often taken by anglers.

Lepomis machrochirus Rafinesque-bluegill*

Uncommon. It inhabits the warmer, weedy areas of protected bays and slow-flowing streams. Well established in numerous small inland lakes and ponds. It enters both the commercial and sport fisheries.

Lepomis megalotis (Rafinesque)-longear sunfish

Rare. Records of occurrence are restricted to the southern portion of the drainage system.

Micropterus dolomieu Lacepede-smallmouth bass*

Common to abundant in the watershed. Sizable populations occur in the lake around rocky shoals. Considered the most popular game fish of the region.

Micropterus salmoides (Lacepede) - largemouth bass*

Less common than the smallmouth bass, though adapted to a wide range of habitats. Widely introduced and established in warmer lakes and ponds throughout the basin.

Pomoxis annularis Rafinesque-white crappie*

Rare. Several records of specimens taken from protected bays of the lake and near the mouths of larger streams along the south shore.

Pomoxis nigromaculatus (Lesueur) - black crappie*

Formerly abundant and still commonly taken in the Bay of Quinte. Occurs elsewhere in shallow bays and sluggish streams; prefers weedy areas. A commercial and sport fish of some importance.

PERCIDAE-PERCHES

Ammocrypta pellucida (Putnam)-eastern sand darter †

Extremely rare, if present. Reported from only a few scattered localities in the southern part of the watershed. Inhabits sandy bottoms of larger streams and inland lakes.

Etheostoma blennioides Rafinesque-greenside darter

Uncommon but present in a few lowland tributary streams along the south shore of the western basin.

Etheostoma caeruleum Storer-rainbow darter*

Uncommon. Primarily a stream fish; its presence is restricted to cool, fast-flowing waters with gravelly bottoms.

Etheostoma exile (Girard)-Iowa darter

Range is extensive; moderately common in weedy habitats of the shallower lakes and streams.

Etheostoma flabellare Rafinesque-fantail darter*

Uncommon, though present in most of the watershed. Prefers smaller streams with rocky bottoms. Occasionally taken in bays of the lake.

Etheostoma microperca Jordan and Gilbert-least darter

Scarce. A few early collections from western basin tributaries, including Burlington Bay in 1962 (Whillans 1977). Inhabits quiet, weedy parts of slow-moving streams. Smallest of the darters.

Etheostoma nigrum Rafinesque-Johnny darter*

Most abundant darter in the region. Commonly taken in lakes and streams in a variety of habitats. A forage species.

Etheostoma olmstedi Storer-tessellated darter

Primarily confined to the southern part of the drainage basin. However, the taxonomic status of this form (particularly in Canada) is still uncertain. Cole (1967) considered all populations in New York waters of Lake Ontario and the St. Lawrence River to be intergrades of two subspecies of *E. olmstedi*. Earlier records often listed *E. nigrum* or *E. nigrum olmstedi*.

Perca flavescens (Mitchill)-yellow perch*

Essentially a lake fish that has been of major importance to the sport and commercial fishery for many years. Present throughout the system but locally most abundant along the shore of the eastern basin.

Percina caprodes (Rafinesque)-logperch*

Widely distributed in lakes and streams. Prefers open-lake shoals and

shallow gravelly streams with moderate current. Largest of the darters.

Percina copelandi (Jordan&channel darter

Rare. Primarily a southern species that has been collected in the New York portion of the eastern basin and in several tributary streams.

Percina maculata (Girard) - blackside darter

Uncommon. Never recorded in Ontario waters of the watershed. Range is confined to the southwestern part of the basin, in shallower, rapid streams flowing over rubble or bedrock.

Stizostedion canadense (Smith)-sauger

Formerly collected in the lake though never abundant. Said by Whillans (1977) to have been abundant in Burlington Bay in the mid 1800's. Currently rare, if present, but reportedly still taken in some inland lakes and rivers of the region.

Stizostedion vitreum vitreum (Mitchill&walleye*

Common and commercially important during the 1950's in the eastern half of the lake. Now greatly reduced in numbers in the lake, it still remains an important game fish in many inland lakes and rivers throughout the watershed.

Stizostedion vitreum glaucum Hubbs-blue pike †

Extinct. Commercially important and a sport fish at least until the late 1940's, being caught from the deeper waters of the lake and in the lower Niagara River. Population thought by some to be expatriate, originating from nonspawning individuals coming down from Lake Erie (Christie 1974).

SCIAENIDAE - DRUMS

Aplodinotus grunniens Rafinesque-freshwater drum*

Uncommon. More numerous in the eastern basin in Canada (particularly Bay of Quinte), but in the western basin in New York. Prefers mud-bottom waters of shallow lakes and large rivers. Has limited commercial value.

COTTIDAE-SCULPINS

Cottus bairdi Girard-mottled sculpin*

Moderately common in small, rapidly flowing streams with rubble bottoms. Less common in bay areas of the lake. Provides forage for trout.

Cottus cognatus Richardson-slimy sculpin*

Relatively common in both the shallower and deeper waters of the lake and in a few rocky streams.

Cottus ricei (Nelson)-spoonhead sculpin †

Rare. Reported to occur in the deeper waters of the lake and in a few large rivers, but there is no authentic record from the lake.

Myoxocephalus quadricornis (Linnaeus) - fourhorn sculpin*

Formerly common in the deeper areas of the lake. Declined sharply in the 1950's (Christie 1974), and now considered extremely rare and endangered. Largest of the Great Lakes sculpins. (Listed in earlier records as *Triglopsis thompsoni* or *M. quadricornis thompsoni*-deepwater sculpin.)

ACKNOWLEDGMENTS

We are grateful for the cooperation of many associates who participated in surveys on Lake Ontario during 1972-7.5. Special thanks go to Thomas Eckert, New York Department of Environmental Conservation, and Peter Buerschaper and Eldon Smith, Royal Ontario Museum, for assisting in the collection and identification of specimens. Cheryl Goodchild, Royal Ontario Museum, and Marilyn Tremper, Great Lakes Fishery Laboratory, U.S. Fish and Wildlife Service (FWS), assisted in the literature search. W.B. Scott and J.W. Christie provided considerable helpful input and assistance in the early stages of the manuscript. The considerable effort of FWS editors is acknowledged.

REFERENCES

Includes those cited and others of use in any reference to the fishes of Lake Ontario.

AGASSIZ, J. L. R.

1856. On some young gar-pikes from Lake Ontario. Proc. Boston Soc. Nat. Hist. 6:47-48. Also published in Am. J. Sci. 2d Ser. 23:284-285.

ALLIN, A. E.

1940. The vertebrate fauna of Darlington Township, Durham County, Ontario. Trans. R. Can. Inst. No. 49, 23(1):83-118.

ANONYMOUS

1964. A prospectus for investigations of the Great Lakes fishery. Great Lakes Fish. Comm. Doc. 64-10. 51 pp.

1965. Lake Ontario cruise-Vessel Namaycush. July-August, 1965. Catch summary. Ontario Department Lands and Forests. 4 pp. Unpubl. manuscr.).

1966. The Ontario Federation of Anglers and Hunters big fish contest-1966. Prize winning list. 5 pp. (Mimeo.).

1969. Fish tug trawls off Toronto Harbour. Ont. Dep. Lands For. Newsl. 22(40):30.

BAILEY, R. M., J. E. FITCH, E. S. HERALD, E. A. LACHNER, C. C. LINDSEY, C. R. ROBINS, and W. B. SCOTT.

1970. A list of common and scientific names of fishes from the United States and Canada. Am. Fish. Soc. Spec. Publ. 6. 3d ed. 149 pp.

BEAN, T. H.

1902. Food and game fishes of New York. N.Y. For. Fish Game Comm. 7th. Annu. Rep. (1901):251-460.

1903. Catalogue of the fishes of New York. N.Y. State Mus. Bull. 60. 784 pp.

- BIDGOOD, B. F., and A. H. BERST.
 1967. Phenotypic characteristics of rainbow trout in the Great Lakes. J. Fish. Res. Board Can. 24(4):887-892.
- CHRISTIE, W. J.
 1958. The present general condition of the eastern Lake Ontario fisheries. Ontario Department Lands and Forests. 7 pp. (Unpubl. Manuscr.).
 1963. Effects of artificial propagation and the weather on recruitment in the Lake Ontario whitefish fishery. J. Fish. Res. Board Can. 20(3):597-646.
 1972. Lake Ontario: effects of exploitation, introductions, and eutrophication on the salmonid community. J. Fish. Res. Board Can. 29(6):913-929.
 1973. A review of the changes in the fish species composition of Lake Ontario. Great Lakes Fish. Comm. Tech. Rep. 23. 65 pp.
 1974. Changes in the species composition of the Great Lakes. J. Fish. Res. Board Can. 31(5):827-854.
- COBB, J. N.
 1898. The fisheries of Lake Ontario in 1897. N.Y. For. Fish Game Comm. 3d Annu. Rep. (1897):205-221.
- COLE, C. F.
 1967. A study of the eastern Johnny darter, *Etheostoma olmstedii* Storer (Teleostei, Percidae). Chesapeake Sci. 8(1):28-51.
- DYMOND, J. R.
 1928. Some factors affecting the production of lake trout (*Chistivomer namaycush*) in Lake Ontario. Univ. Toronto Stud. Biol. Ser. 31, Publ. Ont. Fish. Res. Lab. 33:27-41.
- DYMOND, J. R., J. L. HART, and A. L. PRITCHARD.
 1929. The fishes of the Canadian waters of Lake Ontario. Univ. Toronto Stud. Biol. Ser. 33, Publ. Ont. Fish. Res. Lab. 37:1-35.
- EVERMANN, B. W., and W. C. KENDALL.
 1901. Notes on the fishes of Lake Ontario. N.Y. For. Fish Game Comm. 6th Annu. Rep. (1900):479-488.
 1902. Notes on the fishes of Lake Ontario. U.S. Comm. Fish. Rep. (1901) 27:209-216.
- FOTHERGILL, C.
 1934. Notes on the natural history of eastern Canada, 1816-1837. Trans. R. Can. Inst. 20(1):141-168.
- GREELEY, J. R.
 1927. Fishes of the Genesee Region with annotated list. Pages 47-66 in A biological survey of the Genesee River system. N.Y. Conserv. Dep. Suppl. 16th Annu. Rep. (1926).
 1928. Fishes of the Oswego watershed with annotated list. Pages 84-107 in A biological survey of the Oswego River system. N.Y. Conserv. Dep. Suppl. 17th Annu. Rep. (1927).
 1929. Fishes of the Erie-Niagara watershed with annotated list. Pages 150-179 in A biological survey of the Erie-Niagara system. N.Y. Conserv. Dep. Suppl. 18th Annu. Rep. (1928).
 1940a. Fishes of the watershed with annotated list. Pages 42-81 in A biological survey of the Lake Ontario watershed. N.Y. Conserv. Dep. Biol. Surv. 16, Suppl. 29th Annu. Rep. (1939).
 1940b. Conservation of the smallmouth black bass resource of the Lake Ontario-St. Lawrence region. N.Y. Conserv. Dep. Biol. Surv. 10 pp.
- GREELEY, J. R., and S. C. BISHOP.
 1932. Fishes of the area with annotated list. Pages 54-92 in A biological survey of the Oswegatchie and Black River systems. N.Y. Conserv. Dep. Biol. Surv. 6, Suppl. 21st Annu. Rep. (1931).
- GREEN, S.
 1874. Shad in Lake Ontario. For. Stream 2:292.
- HANKINSON, T. L.
 1923. The creek fish of western New York. Copeia No. 115:29-34.

- HANKINSON, T. L., and C. L. HUBBS.
 1922. The establishment of smelt in Great Lakes waters. *Copeia* No. 109:57-59.
- HARKNESS, W. J. K., and J. R. DYMOND.
 1937. Fishes collected in King Township, June 15-25, 1937. *Ont. Fish. Res. Lab.* 4 pp. (Unpubl. manuscr.).
- HARKNESS, W. J. K., and W. E. RICKER.
 1929. A preliminary study of some trout waters of Ontario. *Trans. Am. Fish. Soc.* 59:256-267.
- HART, J. L.
 1930. The spawning and early life history of the whitefish, *Coregonus clupeaformis* (Mitchill), in the Bay of Quinte, Ontario. *Contrib. Can. Biol. Fish.* 6(7):165-214.
- HOWE, C. E.
 1913. Life zones. Pages 91-99 in J. R. Faull ed. *The natural history of the Toronto region.* Canadian Inst., Toronto.
- HUBBS, C. L.
 1926. A check list of the fishes of the Great Lakes and tributary waters with nomenclatorial notes and analytical keys. *Univ. Mich. Mus. Zool. Misc. Publ.* 15. 77 pp.
- HUBBS, C. L., and D. E. S. BROWN.
 1929. Materials for a distributional study of Ontario fishes. *Trans. R. Can. Inst.* 17(1): 1-56.
- HUBBS, C. L., and K. F. LAGLER.
 1964. Fishes of the Great Lakes region. *Univ. Mich. Press, Ann Arbor.* 213 pp.
- JORDAN, D. S., and W. F. THOMPSON.
 1911. Description of a new species of deep-water sculpin (*Triglopsis ontariensis*) from Lake Ontario, with notes on related species. *Proc. U.S. Nat. Mus.* 38(1728):75-78.
- KOELZ, W.
 1924. Two new species of cisco from the Great Lakes. *Univ. Mich. Occas. Pap. Mus. Zool.* 146. 8 pp.
- LAPWORTH, E. D.
 1956. The effect of fry plantings on whitefish production in eastern Lake Ontario. *J. Fish. Res. Board Can.* 13(4):547-558.
- LEVERETT, F., and F. B. TAYLOR.
 1910. Outline history of the Great Lakes. *Mich. Acad. Sci. Rep.* 12:19-42.
- MacKAY, H. H.
 1930. Pollution problems in Ontario. *Trans. Am. Fish. Soc.* 60:297-305.
 1963. Fishes of Ontario. Ontario Department Lands and Forests. Bryant Press. Toronto. 300 pp.
- MacKAY, H. H., and E. MacGILLIVRAY.
 1949. Recent investigations on the sea lamprey, *Petromyzon marinus*, in Ontario. *Trans. Am. Fish. Soc.* 76(1946): 148-159.
- MacNAB, J. D., and R. A. HESTER.
 1976. Operation doorstep angling. Vol. 1. The fishery resource. Ontario Ministry Natural Resources, Toronto. 175 pp.
- MASON, E. J. R.
 1933. Smelts in Lake Ontario. *Copeia* 1933(1):34.
- MATHER, F. A.
 1881. Fishes which can live in both salt and fresh water. *Trans. Fish. Cult. Assoc.* 10:65-75.
- McCRIMMON, H. R.
 1948. Collection from Duffin Creek. Ontario Ontario Department Lands and Forests. 1 pp. (Unpubl. manuscr.).
 1950. The reintroduction of Atlantic salmon into tributary streams of Lake Ontario. *Trans. Am. Fish. Soc.* 78(1948): 128-132.
- MUMA, A. R.
 1958. Collection of fish in the Upper Niagara River and tributaries. Ontario Department Lands and Forests, Toronto. 4 pp. (Unpubl. manuscr.).

- NASH, C. W.
 1908. Check list of the fishes of Ontario. Pages 7-122 in Vertebrates of Ontario. Ont. Dep. Educ. L. K. Cameron, Toronto.
 1913. Fishes of the Toronto region. Chap. 19, pages 249-271 in J. R. Faull ed. The natural history of the Toronto region. Canadian Inst., Toronto.
- OUCHTON, J. P.
 1930a. Game fish of the Trent Canal system. R. Ont. Mus. 11 pp. (Unpubl. manuscr.).
 1930b. Report of a trip up the Trent River system. R. Ont. Mus. 8 pp. (Unpubl. manuscr.).
- PARSONS, J. W.
 1973. History of salmon in the Great Lakes, 1850-1970. Bur. Sport Fish and Wildl. Pap. 68. 80 pp.
- PARSONS, J. W., T. N. TODD, and S. L. EMERY.
 1975. The status of some endemic fishes of the Great Lakes based upon changes in abundance. U.S. Fish and Wildl. Service, Great Lakes Fishery Laboratory, Ann Arbor, Mich. 6 pp. (Mimeo.).
- PRITCHARD, A. L.
 1928. A preliminary study of the Genus *Leucichthys* in the Canadian waters of Lake Ontario. Univ. Toronto Stud. Biol. Ser. 31, Publ. Ont. Fish. Res. Lab. 32:7-25.
 1929. The alewife (*Pomolobus pseudoharengus*) in Lake Ontario. Univ. Toronto Stud. Biol. Ser. 33. Publ. Ont. Fish. Res. Lab. 38:37-54.
 1930. Spawning habits and fry of the cisco (*Leucichthys artedi*) in Lake Ontario. Contrib. Can. Biol. Fish. N.S., 6(9):227-240.
 1931. Taxonomic and life history studies of the ciscoes of Lake Ontario. Univ. Toronto Stud. Biol. Ser. 35, Publ. Ont. Fish. Res. Lab. 41:1-78.
- RADFORTH, I.
 1944. Some considerations on the distribution of fishes in Ontario. R. Ont. Mus. Zool. Contrib. 25. 116 pp.
- ROBERTSON, J. R., editor.
 1934. The diary of Mrs. John Graves Simcoe, wife of the first Lieutenant-Governor of the Province of Upper Canada, 179 1-6. Ontario Publishing Co., Ltd., Toronto. 440 pp.
- ROBSON, J. J.
 1878. California salmon in Lake Ontario. For. Stream 10:482.
- SCOTT, W. B.
 1956. The smelt in Ontario. R. Ont. Mus. Div. Zool. Paleontol. 7 pp.
 1967. Freshwater fishes of eastern Canada. 2nd ed. Univ. Toronto Press. 137 pp.
- SCOTT, W. B., and E. J. CROSSMAN.
 1973. Freshwater fishes of Canada. Fish. Res. Board Can. Bull. 184. 966 pp.
- SCOTT, W. B., and F. E. J. FRY.
 1947. Fluctuations in abundance of freshwater fish with particular reference to the whitefish in Lake Ontario. Ontario Department Lands and Forests. 5 pp. (Mimeo.).
- SCOTT, W. B., and W. J. CHRISTIE.
 1963. The invasion of the lower Great Lakes by the white perch, *Roccus americanus* (Gmelin). J. Fish. Res. Board Can. 20(5): 1189-1195.
- SMITH, H. M.
 1892. Report on the investigation of the fisheries of Lake Ontario. U.S. Fish Comm. Bull. 10(1890):177-215.
 1899. Acclimatization of Pacific salmon in the Great Lakes. Rev. Int. Peche Piscicult. 3:9-10.
- SMYTH, D. W.
 1799. A short topographical description of His Majesty's Province of Upper Canada, in North America. W. Faden, London. 164 pp.
- SNYDER, J. P.
 1932. Tagged smallmouth black bass in Lake Ontario, N.Y. Trans. Am. Fish. Soc. 62:380-381.
- SPEIRS, J. M.
 1954. Lake Ontario bibliography. Ontario Department Lands and Forests, Toronto. 11 pp. (Mimeo.).

- STONE, F. L.
 1948. A study of the taxonomy of the blue and yellow pike-perches (*Stizostedion*) of Lake Erie and Lake Ontario. Ph.D thesis. Univ. Rochester. 164 pp.
- STONE, U. B.
 1947. A study of the deep-water cisco fishery of Lake Ontario with particular reference to the bloater, *Leucichthys hoyi* (Gill). Trans. Am. Fish. Soc. 74(1944):230-249.
- STONE, U. B., D. G. PASKO, and R. M. ROECKER.
 1954. A study of Lake Ontario-St. Lawrence River smallmouth bass. N.Y. Fish Game J. 1(1):1-26.
- TEDLA, S., and C. H. FERNANDO.
 1969. Observations on the seasonal changes of the parasitic fauna of yellow perch (*Perca flavescens*) from the Bay of Quinte, Lake Ontario. J. Fish. Res. Board Can. 26(4):833-843.
- TODD, T. N.
 1978. Revised status of Great Lakes coregonines. February 1978. Great Lakes Fishery Laboratory, Ann Arbor, Mich. 2 pp. (Mimeo.).
- WELLS, L.
 1969. Fishery survey of U.S. waters of Lake Ontario. Pages 51-57 in Limnological survey of Lake Ontario, 1964. Great Lakes Fish. Comm. Tech. Rep. 14.
- WERNER, W. H. R.
 no date. Commercial fishing in Ontario. Ontario Department Lands and Forests, Toronto. 3 pp. (Unpubl. manuscr.).
- WHILLANS, T. H.
 1977. Fish community transformations within the lower Great Lakes, Univ. Toronto, Inst. Environ. Stud., MSc diss. 328 pp.
- WILMOT, S.
 1882. Introduction of California salmon into Ontario, with remarks on the disappearance of marine salmon from that province. U.S. Fish Comm. Bull. 1(1881):347-349.
- WRIGHT, A. H.
 1918a. Fish succession in the water courses of Lake Ontario. Copeia No. 53: 10.
 1918b. Fish succession in some Lake Ontario tributaries. Sci. Mon. (Dec.):535-544.
- WRIGHT, R. R.
 1892. Preliminary report on the fish and fisheries of Ontario. Ont. Game Fish Comm. Report of the Commissioner. (1891):419-476.