AN ATLAS OF MICHIGAN FISHES

WITH

KEYS AND ILLUSTRATIONS FOR THEIR IDENTIFICATION

BY

REEVE M. BAILEY, WILLIAM C. LATTA, AND GERALD R. SMITH

MISCELLANEOUS PUBLICATIONS

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Albert, J.S. 2001. Species diversity and phylogenetic systematics of American knifefishes (Gymnotiformes, Teleostei). *Misc. Publ. Mus. Zool., Univ. Michigan*, No. 190, pp. i-vi, 1-127, 50 figs.

Nussbaum, R.A. & C.J. Raxworthy. 2000. Systematic revision of the genus *Paroedura* Günther (Reptilia: Squamata: Gekkonidae), with the description of five new species. *Misc. Publ. Mus. Zool., Univ. Michigan,* No. 189, pp. i-iv, 1-26, 12 figs., 7 tables.

Storer, R.W. 2000. The metazoan parasite fauna of grebes (Aves: Podicipediformes) and its relationship to the birds' biology. *Misc. Publ. Mus. Zool., Univ. Michigan,* No. 188, pp. i-iv, 1-90, 9 figs., 7 tables.

Nussbaum, R.A. & M.E. Pfrender. 1998. Revision of the African caecilian genus *Schistometopum* Parker (Amphibia: Gymnophiona: Caeciliidae). *Misc. Publ. Mus. Zool., Univ. Michigan,* No. 187, pp. i-iv, 1-32, 15 figs., 15 tables, 4 color plates.

Nussbaum, R.A., C.J. Raxworthy & O. Pronk. 1998. The ghost geckos of Madagascar: a further revision of the Malagasy leaf-toed geckos (Reptilia, Squamata, Gekkonidae). *Misc. Publ. Mus. Zool., Univ. Michigan,* No. 186, pp. i-iv, 1-26, 25 figs., 5 tables.

RECENT *OCCASIONAL PAPERS*

Garrison, R.W., N. von Ellenrieder & M.F. O'Brien. 2003. An annotated list of the name-bearing types of species-group names in Odonata preserved in the University of Michigan Museum of Zoology. *Occ. Pap. Mus. Zool., Univ. Michigan,* No. 736, 73 pp.

Ng, H.H. & J.S. Sparks. 2003. The ariid catfishes (Teleostei: Siluriforms: Ariidae) of Madagascar, with the description of two new species. *Occ. Pap. Mus. Zool., Univ. Michigan,* No. 735, 21 pp., 11 figs., 1 table.

Ng, H.H. 2003. *Arius verrucosus*, a new speices of freshwater ariid catfish (Teleostei: Ariidae) from the Mekong River. *Occ. Pap. Mus. Zool., Univ. Michigan,* No. 734, 14 pp., 6 figs., 1 table.

Norris, S.M. 2001. Osteology of the southwestern darters, *Etheostoma* (*Oligocephalus*) (Teleostei, Percidae)-with comparison to other North American percid fishes. *Occ. Pap. Mus. Zool., Univ. Michigan,* No. 733, 44 pp., 18 figs.

Ng, H.H. & W.J. Rainboth. 2001. A review of the sisorid catfish genus *Oreoglanis* (Siluriformes: Sisoridae) with descriptions of four new species. *Occ. Pap. Mus. Zool., Univ. Michigan,* No. 732, 34 pp., 13 figs., 3 tables.

Collette, B.B. 2001. *Opsanus dichrostomus*, a new toadfish (Teleostei: Batrachoididae) from the western Caribbean Sea and southern Gulf of Mexico. *Occ. Pap. Mus. Zool., Univ. Michigan,* No. 731, 16 pp., 5 figs.

Fink, W.L. & A. Machado-Allison. 2001. *Serrasalmus hastatus*, a new species of piranha from Brazil, with comments on *Serrasalmus altuvei* and *Serrasalmus compressus* (Teleostei: Characiformes). *Occ. Pap. Mus. Zool., Univ. Michigan,* No. 730, 18 pp., 16 figs.

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COVER ILLUSTRATION – *Salvelinus fontinalis*, brook trout – by John Megahan

MISCELLANEOUS PUBLICATIONS
MUSEUM OF ZOOLOGY, UNIVERSITY OF MICHIGAN, NO. 192

An Atlas of Michigan Fishes
with
Keys and Illustrations for their Identification

by

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Ann Arbor, August 6, 2004

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INTRODUCTION

The State of Michigan geographically dominates the Great Lakes watershed which encompasses the largest system of freshwater lakes in the world. Michigan's shoreline extends for 3,288 miles, longer than any state except Alaska. It has over 35,000 inland lakes one-tenth of an acre or larger and more than 200 rivers with a total length of 36,350 miles (Wolfson 1987). Coon (1999) listed 172 extant species of fish present in the Great Lakes and their tributaries. (Seven more occur in the St. Lawrence River and its tributaries). Of the 172 species, 153 are found in Michigan waters.

Since 1919 the University of Michigan Museum of Zoology (UMMZ) has systematically collected and catalogued Michigan fishes. During these years the State of Michigan Department of Natural Resources (MDNR) and federal agencies have provided specimens to the UMMZ in the context of their studies of environmental health, angling, or commercial harvest. Early distribution maps were compiled by UMMZ, but were not readily available for use outside of the Museum. At present, with environmental concerns being addressed at the ecosystem level, it has become essential that the distribution and abundance of fishes be known for planning and management. This information will enhance land-use planning from the community to the state level. Distribution patterns in relation to global warming and other environmental disturbances can be considered, the influence of past geologic and climatic changes can be studied, and management plans for rare, threatened and endangered species can be made. The impact of immigrant and introduced fishes can also be assessed. Our objectives in this atlas are to provide detailed digital distribution maps by species for Michigan fishes with explicit keys and illustrations for their identification.

An enormous amount of valuable information exists describing present and historical patterns of fish distributions in Michigan. Although these data were collected for diverse purposes and appear in various formats, Geographic Information Systems software provides a means for comprehensive compilation. The tools are now available for visualizing and analyzing species distributions for this large data base of 174,519 georeferenced records. The data come from MDNR (approximately 63,000 records, 5000 sites, dating from 1923), UMMZ (35,000 records, 4700 sites, dating from 1874), United States Geological Survey, Great Lakes Science Center (USGS/GLSC) (34,000 records, 4600 sites, dating from 1958), United States Fish and Wildlife Service (USFWS) (33,000 records, 4100 sites, dating from 1947), Michigan Rivers Inventory (MRI) (8000 records, 546 sites, dating from 1937), University of Michigan Center for Great Lakes and Aquatic Science (UM/CGLAS) (1,400 records, 100 sites, dating from 1982), and miscellaneous sources (600 records, 600 sites, dating from 1923). The MRI collections were made by Drs. Paul W. Seelbach and Michael J. Wiley and students from the UM School of Natural Resources and Environment combined with collections made mostly on large rivers by the MDNR. The UM (CGLAS) collections were made by Dr. David J. Jude.

METHODS

Data Preparation

Background maps are modified from existing federal and state data for state and county boundaries and watersheds. Fish records from the collaborating institutions are compiled into one data set, with most collection/capture information preserved, so that any user of the data can access more information about each record. In most cases, the data are in electronic format; in other cases, data are digitized from existing maps or entered from written records. Most records are georeferenced either by latitude/longitude or by the one-square-mile Public Land Survey System units, or by Great Lakes ten minute statistical grid squares (see below). In other cases, data are georeferenced by on-screen digitizing (using pre-existing data layers), by locating sites on published maps, or by looking up locations in gazetteers. These references include the United States Geographic Names Information System (U.S. Geological Survey 1999) and the Michigan Lake Inventory (Humphreys and Green 1962). To clarify what locations were in the original data and which were georeferenced by the authors, this information is included in the electronic form of the data.

Hybrids and unidentified specimens are excluded from all data sets. In the UMMZ collections, the identification of species has been painstakingly addressed and voucher specimens are available for almost all records. However, in the other collections identification of species is usually accepted but, in most cases, voucher specimens for verification of identity are not available.

Digital data sources

All maps are in a Universal Transverse Mercator (UTM) projection, zone 16, North American Datum of 1927 (NAD 1927). All maps were made using Arc Map Version 8.2 and ArcView Version 3.1 (ESRI, Inc.). ArcInfo Version 7.2.1 was used in some cases to edit and re-project coverages (ESRI, Inc.).

County boundaries: USGS 1:100,000 Digital Line Graph (DLG) data were used.

Major and minor watershed boundaries: The source is Michigan Department of Environmental Quality watershed boundary data re-projected

from decimal degrees to UTM, zone 16 (NAD 1927). Several modifications were made. The watershed coverage was clipped in ArcView to conform to the state boundary. Small sections near the Ohio and Wisconsin borders were added based on the state boundary, and the larger islands from the county boundary map were added.

State watershed divide: The state watershed divide was created in ArcInfo by selecting and copying arcs from the major watershed coverage. This delineation indicates which Great Lake each watershed feeds.

Hydrography: USGS 1:200,000 DLG data were used.

Fish collections: These were mapped using their location according to either latitude/longitude or to the Public Land Survey System (PLSS). In the former case, the latitude and longitude in decimal degrees were used as x and y coordinates in an event theme. In the latter case, each point was placed at the calculated center of the section in which the collection occurred, and location is therefore accurate to within approximately 0.7 mile. Points were mapped using the PLSS ArcView point coverage ("mitrs") created by Jennifer Kotanchik and maintained by the School of Natural Resources and Environment, University of Michigan. This coverage was reprojected to decimal degrees in ArcView. The Animal Movement Extension in ArcView was used to generate x,y coordinates for these centroids. These data were then used as a look-up table to generate x, y coordinates for the fish collection sites. These data were combined with sites already in geographic projection, and all points were then added as an event theme. In some records for lakes Michigan and Superior the 10 minute by 10 minute statistical grid square was the only location information. In these instances each point was placed in the center of the grid square. The coordinates for these center points were taken from the point coverage statistical_grid_10_min_points.shp created by Shannon Brines, and obtained from the State of Michigan's Center for Geographic Information. They were then reprojected in ArcView to the UTM projection. The published sources of fish distribution information referred to in the creation of this atlas are listed under REFERENCES.

In the keys, meristic or other characters are often expressed in the following form: (55) 57 to 63 (64); roughly 90% of counts will fall between 57 and 63 and the extremes of variation, 55 and 64, are given in parentheses. A glossary is provided for help in interpretation of the technical nomenclature and other concepts (p. 210).

DISTRIBUTION OF FISHES

The names, common and scientific, for Michigan fishes and the distribution map number for each species are given on pages 5-8. For help in analysis of the distribution maps five figures are presented: Figure 1 shows Michigan counties, Figure 2 identifies the major watersheds in the state, Figure 3 shows all fish collection sites by counties, Figure 4 all sites by watersheds, and Figure 5 principal rivers.

In 2002, Bailey and Smith published the latest revision of the names of Michigan fishes. The names presented here to identify the distribution maps generally follow the revision. Since the last printing of this checklist (1991) two species have been deleted and four added. The blackfin cisco (*Coregonus nigripinnis*) is believed by some to be a variation of the lake herring (*Coregonus artedi*). The western mosquitofish (*Gambusia affinis*), introduced in 1941 to control mosquitoes, survived briefly but is probably no longer present in the state. As noted in the annotation below, the skipjack herring (*Alosa chrysochloris*) has entered Lake Michigan by canal, the ghost shiner (*Notropis buchanani*) has been found in southeastern Michigan, the western sand darter (*Ammocrypta clara*) has been discovered to inhabit the Menominee River, and the ruffe (*Gymnocephalus cernuus*) is an inadvertent introduction. In addition to the species deletions and additions, several taxonomic nomenclature changes have been made. In phylogenetic sequence the annotations are as follows:

Alosa chrysochloris, skipjack herring. This Mississippi River fish is occasionally caught in Lake Michigan, being a rare invader through the Chicago Drainage Canal.

Margariscus nachtriebi, northern pearl dace. Previously treated as a subspecies of *M. margarita*, a larger scaled form that ranges from southern New York and Vermont to Virginia. Hubbs (1926:31-33) diagnosed *Margariscus* and showed that it comprised several nominal forms which he assigned to *nachtriebi*. These differed in scale size from the typical *margarita*, but he contended that differences between the two were bridged by intermediates from near the south shore of Lake Ontario. The notable difference in lateral-line scale counts between *nachtriebi* and *margarita* were pointed out by Bailey and Allum (1962:37) and by Smith (1986:157), who assigned these taxa to the related genus *Semotilus*. In New York, Smith mapped the two forms as allopatric. He gave no indication of intergradation. It seems appropriate to regard *nachtriebi* and *margarita* as distinct species, an option suggested as possible by McPhail and Lindsey (1970:231).

Notropis amblops, bigeye chub. The status of the species in Michigan has been changed from endangered to extirpated. Extensive sampling since 1978 in the drainages where this fish historically occurred has not revealed its presence (Latta, 1998c).

*Notropis buchanani,*ghost shiner. This species appears to have spread from Ontario (Jude and Hensler, 2001). The recent Michigan and Ontario records of ghost shiner are remote from the established distribution of the species (Gilbert 1980:243). It is therefore interpreted as an introduction into Great Lakes waters.

Rhinichthys obtusus, western blacknose dace. Formerly ranked as a subspecies of *R. atratulus*, these two forms were found to be allopatric and distinct in New York (Smith, 1986:147), where they had apparently diverged into separate species during Pleistocene separation in eastern and Mississippian refugia. Matthews *et*

al. (1982) discussed character differences, reported limited mixing of forms in Meadow Creek, Virginia, and noted their inability to separate consistently between subspecies *meleagris* and *obtusus*. Jenkins and Burkhead (1994:296) united these sister taxa and showed that the correct name is *obtusus*. Etnier and Starnes (1994) also discussed the problem.

Catostomus commersonii, white sucker. The 1999 International Code of Zoological Nomenclature has clarified the disputed spelling of patronyms for species-group names ending in –i or –ii by ruling that original spelling shall prevail. The endings of four Michigan fish names are thus corrected from *i* to *ii* in *Catostomus commersonii*, *Prosopium coulterii*, *Cottus bairdii,* and *Myoxocephalus thompsonii*.

Erimyzon claviformis, western creek chubsucker. Hubbs (1930a) reviewed *Erimyzon* and recognized three species and six total forms. Recent authors mostly agree, though the distinction of *E. oblongus connectens* from *E. oblongus*, and the validity of *E. s. kennerlii* have been questioned. It is now evident that the distribution of *E. oblongus* is disjunct (Etnier and Starnes, 1994:272; Wall and Gilbert, 1980:397-398), with a substantial hiatus between eastern (*oblongus*) and western (*claviformis*) populations. The forms differ notably in size (to 375mm TL in *oblongus*; to about 178 mm, rarely 229 mm, in *claviformis*) and in dorsal-fin ray counts (11 to 14, usually 12 in *oblongus*, 9 to 11, usually 10 in *claviformis*). We recommend that the two forms be ranked as allopatric species.

Ictiobus cyprinellus, bigmouth buffalo and *I. niger*, black buffalo. These species were formerly thought to be native to Great Lakes waters. The early basis of the occurrence of *I. cyprinellus* in Lake Erie was given by Hubbs (1930a:11), from a specimen in the Harvard Museum of Comparative Zoology said to have been collected by Kirtland from Rockport, Ohio, in November 1854. But there is no Rockport, Ohio. A cataloging error is apparent; there is a Rockport in Ohio County, Kentucky on the Green River in an area well populated by *I. cyprinellus*. About 1920, introductions of *I. cyprinellus* were made by the federal government in western Lake Erie and Sandusky Bay (Trautman, 1981:408). These were successful and the species soon spread into Pennsylvania, Ontario, and Michigan, at least as far as the Saginaw Bay drainage. Hubbs (1926:20) reported *Ictiobus urus* [=*I. niger*] from lagoons about the southern end of Lake Michigan, where he thought it likely they were introduced. The Chicago Drainage Canal would afford access to this area. Hubbs (1930b:427) later reported *I. niger* as far north in Lake Michigan as Black Lake, near Holland. More recent records from Saginaw Bay and Lake St. Clair probably represent introductions from unknown sources. We discount the report of *Ictiobus bubalus* and *I. niger* by Hubbs (1930a:11, 13; 1930b:427) from Homer, Calhoun Co., Michigan as probable market specimens mailed to the Museum of Comparative Zoology. The area around Homer has been heavily collected and no species of *Ictiobus* lives anywhere near.

Esox lucius x E. masquinongy, tiger muskellunge. This hybrid was formerly stocked in Michigan.

C*oregonus nigripinnis,* blackfin cisco. This fish, now extinct from Lake Michigan (the type locality) and Lake Huron, is removed from the list of Michigan fishes as a probable synonym of *C. artedi*, the lake herring (RMB, WCL).

Coregonus hoyi, bloater. The author of *C. hoyi* is corrected from (Gill) to (Milner).

Salmo salar, Atlantic salmon. In 1972-82 the MDNR planted over 25,000 Atlantic salmon in tributaries to the Great Lakes in an effort to establish a reproducing population. They were not successful. However, plants in some large inland lakes in the state have created temporary fisheries. In recent years, the Lake Superior State University Aquatics Laboratory at Sault Ste Marie and the MDNR have been stocking Atlantic salmon smolts in the St. Mary's River and Torch Lake. (In 2001, about 36,000 fish were stocked in St. Mary's River and 31,000 fish in Torch Lake). The sport fishing is substantial, but again there is no evidence that the species is self sustaining.

Salvelinus fontinalis x S. namaycush, splake. This hybrid is commonly stocked to provide a sport fishery. In 2001, approximately 358,000 smolts were planted in lakes Michigan, Huron, and Superior as well as in many inland lakes.

Salvelinus namaycush, siscowet. This name is applied to a stock of lake trout characterized by a high content of body fat, living in deep water of Lake Superior. Although genetically identifiable, it is not uniformly recognized as a species.

Fundulidae. This family has been carved from the Cyprinodontidae.

Atherinopsidae, New World silversides. Dyer and Chernoff (1996) have split the Atherinidae into several families; most of the New World species belong to their Atherinopsidae.

Moronidae. Striped basses. This small family was formerly in the Percichthyidae; the name striped basses is more appropriate than temperate basses.

Lepomis peltastes, northern longear sunfish. This dwarf stock, long treated as a subspecies of *L. megalotis,* is here regarded as a full species. *L. peltastes,* ranges from the Great Lakes drainage of western New York, southern Ontario and northern Ohio and Indiana, the Lower Peninsula of Michigan to eastern Wisconsin; in addition it was at least formerly present in a few scattered localities in the Mississippi basin in Wisconsin, Minnesota, Iowa, and northeastern Illinois. *Lepomis megalotis* occurs in these states only in eastern and southern Illinois, where Smith (1979:242) found no evidence of intergradation with *peltastes*. In Ohio, Trautman (1981:591) noted differences between *peltastes* and *megalotis* "so great as to suggest that these two may be incipient species rather than well-marked subspecies. The area of intergradation, if any, lies in a narrow band along the Lake Erie-Ohio River divide." Trautman (1981:589-594) recorded size of *peltastes* as 2.1"-4.0" [T.L.], largest 4.8", weight 2 oz.; of *megalotis* 2.5"-7.0", largest 9.3", weight 10 oz. Trautman (1981:109) also noted differences in the configuration and pigmentation of the opercular flaps in adults. Other differences include scale size, lateral line (33) 35-37 (39) in *peltastes*, (36) 39-44 (46) in *megalotis*, and pectoral rays, usually 13 in *peltastes*, (13) 14 (15) in *megalotis*.

Ammocrypta clara, western sand darter. This addition to the Michigan fauna is from the Menominee River, Menominee County, adjacent to Wisconsin; first discovered in 1993 by Stan Kowton, who collected specimens that had passed through turbines at the Grand Rapids Power Plant. We collected additional specimens a short distance below the dam in 1996.

Etheostoma flabellare, fantail darter. The barred fantail darter (*E. f. flabellare*) occurs in Michigan only in the Lower Peninsula; the striped fantail darter (*E. f. lineolatum*), commonly regarded as a distinct subspecies, occurs only in the south central part of the Upper Peninsula.

Gymnocephalus cernuus, ruffe**.** An addition to the state list, this native to Europe and Asia was first found in 1986 in the Duluth-Superior Harbor, Lake Superior (Anonymous 2000). It was undoubtedly brought there in ship ballast (perhaps from a Baltic seaport). By 1991, it had spread to the Black and Ontonagon rivers, Gogebic and Ontonagon counties in Michigan's Upper Peninsula, and by 1995, probably through an independent introduction, to Alpena in Lake Huron in the Lower Peninsula. In 2002, it was found in Little Bay de Noc, northern Lake Michigan, probably also brought there in ballast.

Sander canadensis, sauger, and *S. vitreus,* walleye. *Sander* has priority over *Stizostedion* for the sauger and walleye and replaces that time-honored name (Kottelat, 1997:173). Since *Sander* is masculine, the adjectival species names are corrected: *canadense* becomes *canadensis* and *vitreum* becomes *vitreus*. The name blue pike was applied to a genetically identifiable stock of *Sander* from lakes Erie and Ontario before its catastrophic extinction in the 1960's. Authorities disagree as to whether it was a distinct species (*glaucus*), a subspecies of the walleye, or a color phase of the walleye. In 2002, at the Meeting of the American Society of Ichthyologists and Herpetologists, C. A. Stepien, M. M. Coburn, T. M. Cavender, and C. D. Taylor concluded, from molecular and morphological analyses, that the blue pike was a distinct species. Confirmed Michigan records are wanting, although commercial fishermen reported collecting blue pike in Michigan waters.

There are 26 fishes present in Michigan waters as a result of direct or indirect intervention of humans (Table 1). The first non-native species introduced into Michigan that was able to establish a reproducing population was the goldfish in 1878 (Latta, 1974). It was followed by the carp in 1879.

Michigan's Endangered Species Act of 1974 (Act 203) requires the listing of endangered and threatened fishes every 2 years. The current list, recognized in 1999, contains eight endangered species, seven threatened species, and nine extirpated or extinct species (Table 2). A committee of six experts from the state recommends species for the lists. Because of environmental perturbations and variabilities, and the difficulties in measuring the distribution and abundance of fishes in a large geographical area such as Michigan, the lists of fishes are dynamic. The process is described in Latta, 1998c.

In addition to the distribution maps for the fishes of Michigan, this atlas provides a description of the 28 families of fishes and detailed keys to the genera and species. Also presented here are line drawings of each species with notation of one or more characteristics, pigment and/or morphology, which will help identify the species in the field. Distribution patterns will help with identification. Although the volume of data used to create the distribution maps for these 153 species was great there will undoubtedly be future corrections and additions. Use of the maps will reveal the corrections needed.

The fish locality data, project metadata, and maps are available over the internet at the State of Michigan Center for Geographic Information web site. The fish locality data and metadata can be accessed at http://www.mcgi.state.mi.us/mgdl/?rel=thext&action=thmname&cid=8&cat=Fish+Atlas under "Plant and animal locations."

LIST OF MICHIGAN FISHES

Family and species name	Common name	Species page number
Petromyzontidae	**Lampreys**	
Ichthyomyzon castaneus Girard	chestnut lamprey	56
Ichthyomyzon fossor Reighard & Cummins	northern brook lamprey	57
Ichthyomyzon unicuspis Hubbs & Trautman	silver lamprey	58
Lampetra appendix (DeKay)	American brook lamprey	59
Petromyzon marinus Linnaeus	sea lamprey	60
Acipenseridae	**Sturgeons**	
Acipenser fulvescens Rafinesque	lake sturgeon	61
Polyodontidae	**Paddlefishes**	
Polyodon spathula (Walbaum)	paddlefish	62
Lepisosteidae	**Gars**	
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Amiidae	**Bowfins**	
Amia calva Linnaeus	bowfin	65
Hiodontidae	**Mooneyes**	
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Anguillidae	**Freshwater eels**	
Anguilla rostrata (Lesueur)	American eel	67
Clupeidae	**Herrings**	
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Alosa pseudoharengus (Wilson)	alewife	69
Dorosoma cepedianum (Lesueur)	gizzard shad	70
Cyprinidae	**Carps and minnows**	
Campostoma anomalum pullum (Agassiz)	central stoneroller	71
Carassius auratus (Linnaeus)	goldfish	72
Clinostomus elongatus (Kirtland)	redside dace	73
Couesius plumbeus (Agassiz)	lake chub	74
Cyprinella spiloptera (Cope)	spotfin shiner	75
Cyprinus carpio Linnaeus	common carp	76
Hybognathus hankinsoni Hubbs	brassy minnow	77
Luxilus chrysocephalus Rafinesque	striped shiner	78
Luxilus cornutus (Mitchill)	common shiner	79
Lythrurus umbratilis (Girard)	redfin shiner	80
Macrhybopsis storeriana (Kirtland)	silver chub	81
Margariscus nachtriebi (Cox)	northern pearl dace	82
Nocomis biguttatus (Kirtland)	hornyhead chub	83
Nocomis micropogon (Cope)	river chub	84
Notemigonus crysoleucas (Mitchill)	golden shiner	85
Notropis amblops (Rafinesque)	bigeye chub	86
Notropis anogenus Forbes	pugnose shiner	87
Notropis atherinoides Rafinesque	emerald shiner	88
Notropis buccatus (Cope)	silverjaw minnow	89
Notropis buchanani Meek	ghost shiner	90
Notropis chalybaeus (Cope)	ironcolor shiner	91
Notropis dorsalis (Agassiz)	bigmouth shiner	92
Notropis heterodon (Cope)	blackchin shiner	93
Notropis heterolepis Eigenmann & Eigenmann	blacknose shine	94
Notropis hudsonius (Clinton)	spottail shiner	95
Notropis photogenis (Cope)	silver shiner	96
Notropis rubellus (Agassiz)	rosyface shiner	97
Notropis stramineus (Cope)	sand shiner	98
Notropis texanus (Girard)	weed shiner	99

Table 1. List of the 26 non-native fishes in Michigan present as the result of direct or indirect intervention of humans.

Scientific name	Common name
Petromyzon marinus	sea lamprey
Anguilla rostrata	American eel
Alosa chrysochloris	skipjack herring
Alosa pseudoharengus	alewife
Carassius auratus	goldfish
Cyprinus carpio	common carp
Notropis buchanani	ghost shiner
Phenacobius mirabilis	suckermouth minnow
Misgurnus anguillicaudatus	Oriental weatherfish
Ictiobus cyprinellus	bigmouth buffalo
Ictiobus niger	black buffalo
Noturus insignis	margined madtom
Osmerus mordax	rainbow smelt
Oncorhynchus gorbuscha	pink salmon
Oncorhynchus kisutch	coho salmon
Oncorhynchus mykiss	rainbow trout
Oncorhynchus tshawytscha	Chinook salmon
Salmo salar	Atlantic salmon
Salmo trutta	brown trout
Gasterosteus aculeatus	threespine stickelback
Morone americana	white perch
Lepomis humilis	orangespotted sunfish
Lepomis microlophus	redear sunfish
Gymnocephalus cernuus	ruffe
Neogobius melanostomus	round goby
Proterorhinus marmoratus	tubenose goby

Table 2. List of Michigan fishes recognized in 1999 as endangered, threatened, extirpated, or extinct as a partial requirement of Michigan Legislative Act 203.

Scientific name	Common name
Endangered	
Clinostomus elongatus	redside dace
Notropis photogenis	silver shiner
Opsopoeodus emiliae emiliae	pugnose minnow
Phoxinus erythrogaster	southern redbelly dace
Erimyzon claviformis	western creek chubsucker
Noturus stigmosus	northern madtom
Percina copelandi	channel darter
Percina shumardi	river darter
Threatened	
Acipenser fulvescens	lake sturgeon
Hiodon tergisus	mooneye
Moxostoma carinatum	river redhorse
Coregonus artedi	lake herring
Coregonus zenithicus	shortjaw cisco
Ammocrypta pellucida	eastern sand darter
Sander canadensis	sauger
Extirpated	
Polyodon spathula	paddlefish
Notropis amblops	bigeye chub
Notropis chalybaeus	ironcolor shiner
Notropis texanus	weed shiner
Thymallus arcticus	Arctic grayling
Extinct	
Coregonus johannae	deepwater cisco
Coregonus nigripinnis	blackfin cisco[1]
Coregonus reighardi	shortnose cisco
Sander glaucus	blue pike[2]

[1]Not recognized taxonomically in this report.
[2]Of questionable occurrence in Michigan.

Figure 1. Counties in Michigan.

Figure 2. Major watersheds in Michigan.

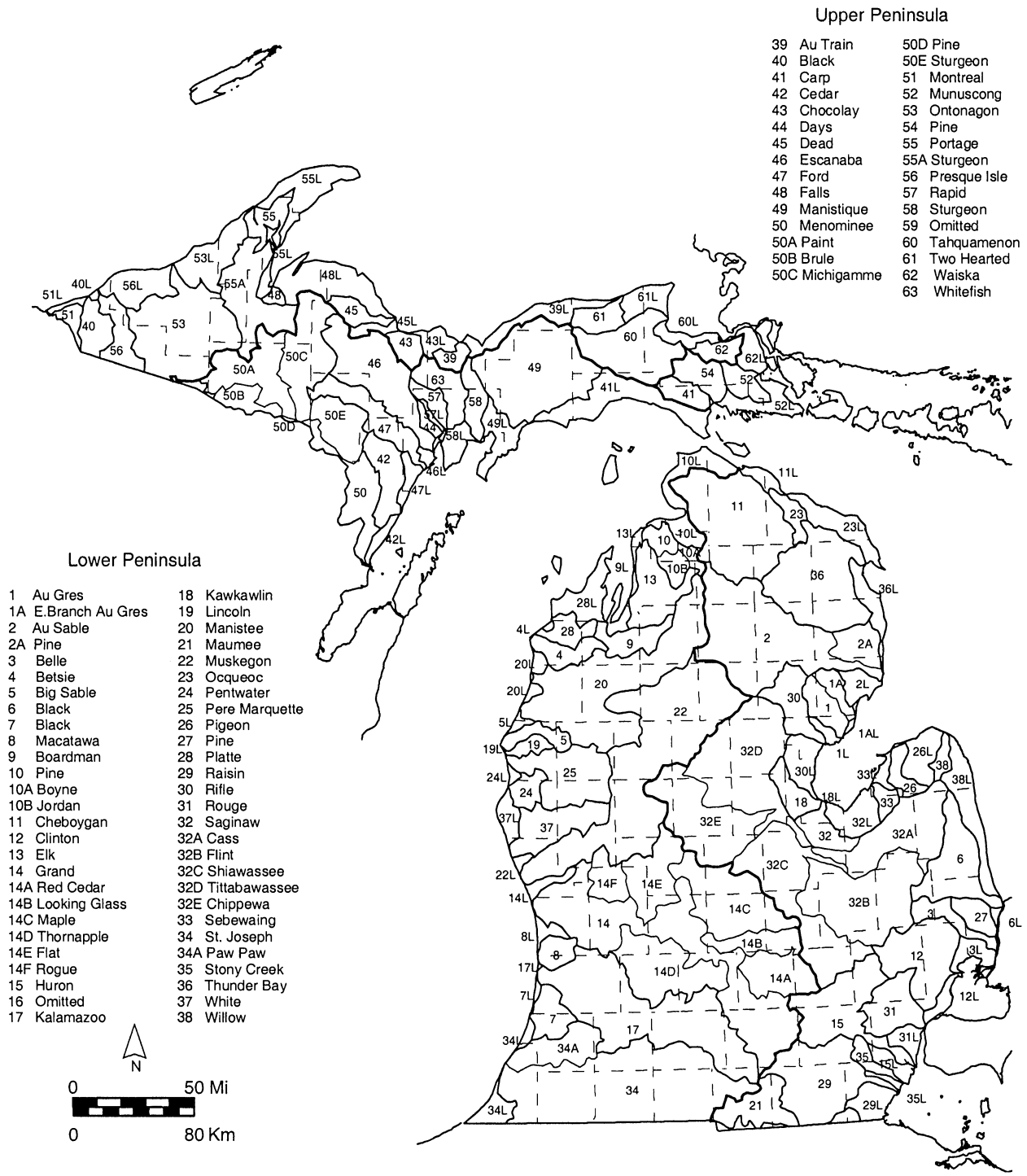


Figure 3. Fish collection sites by county.

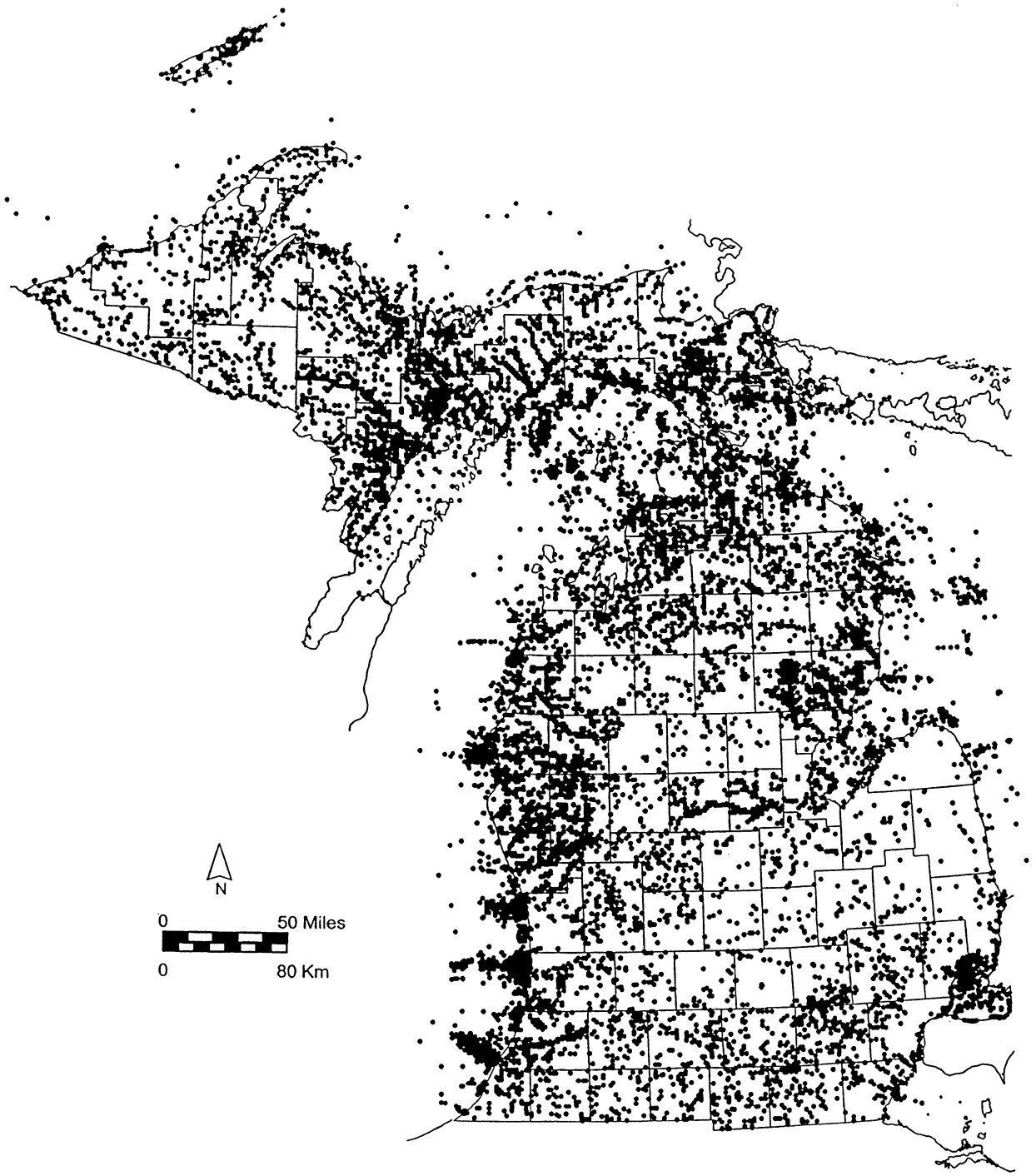


Figure 4. Fish collection sites by watershed.

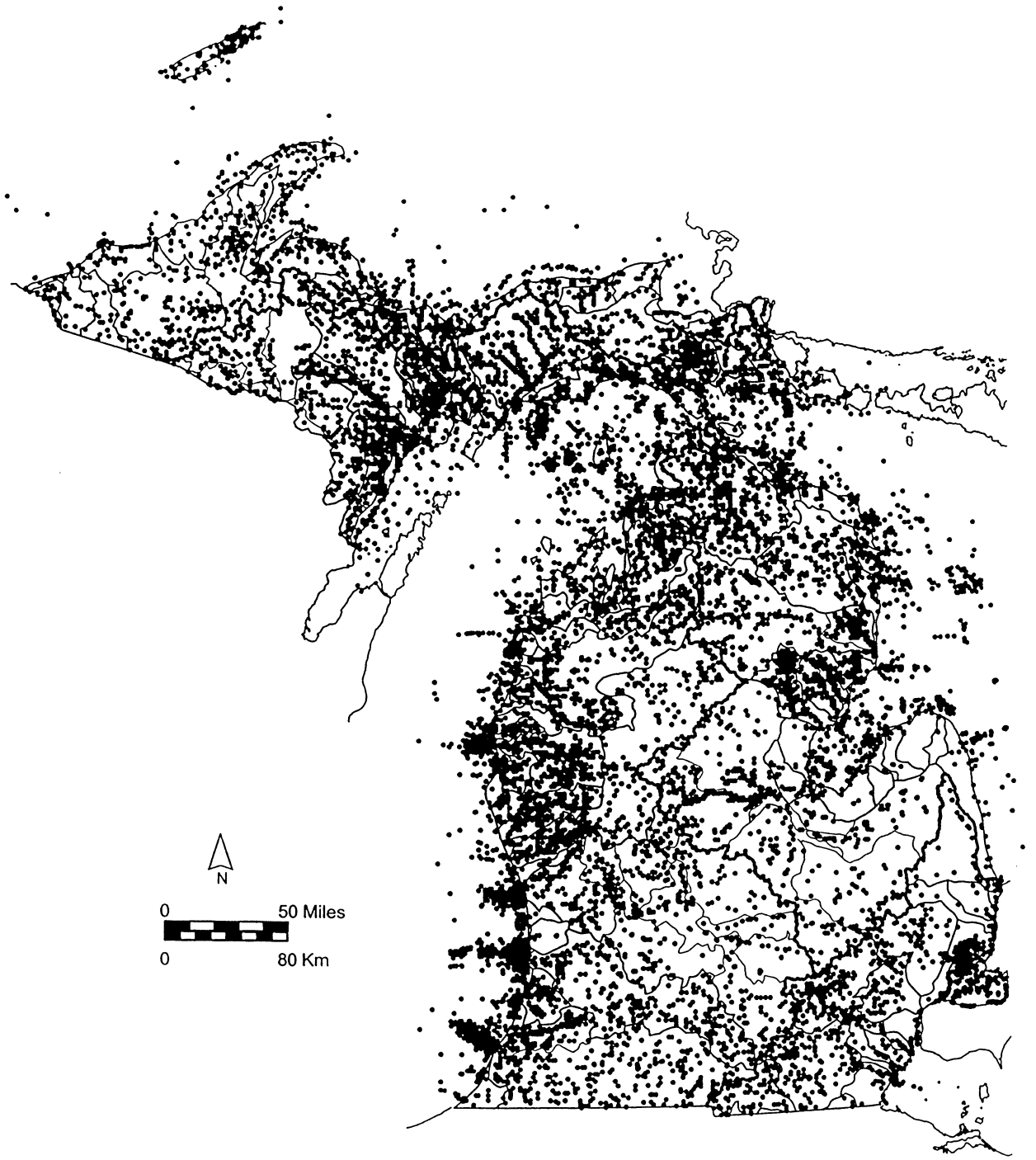
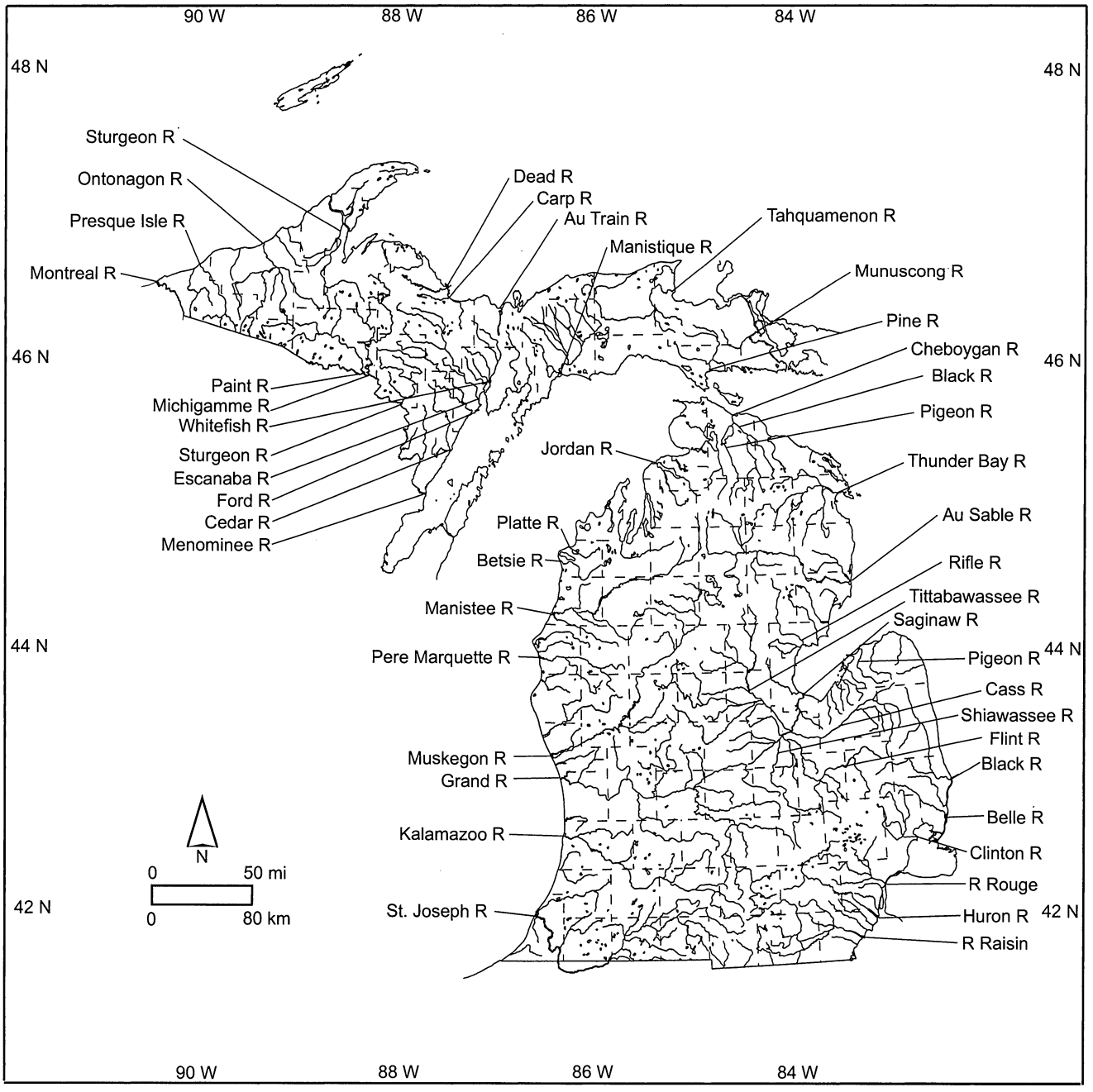


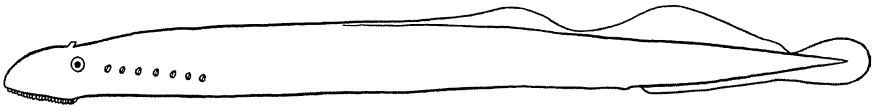
Figure 5. Principal rivers in Michigan.



FAMILIES OF MICHIGAN FISHES

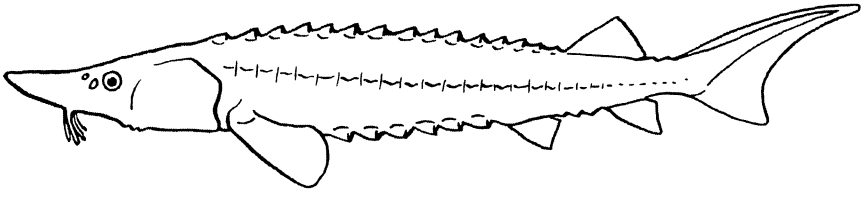
PETROMYZONTIDAE (lampreys). Body eel-like; mouth a sucking disc without jaws; no paired fins; no scales; nostril single and median; seven external gill openings on each side.

Four native species and one canal invader (see keys on p. 27).



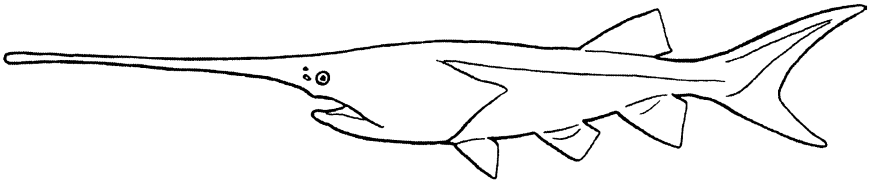
ACIPENSERIDAE (sturgeons). Body with five rows of bony plates; caudal fin notably heterocercal; mouth ventral, protrusible; conical snout with two pairs of elongate barbels.

One species, *Acipenser fulvescens* Rafinesque, 1817--lake sturgeon (p. 61).



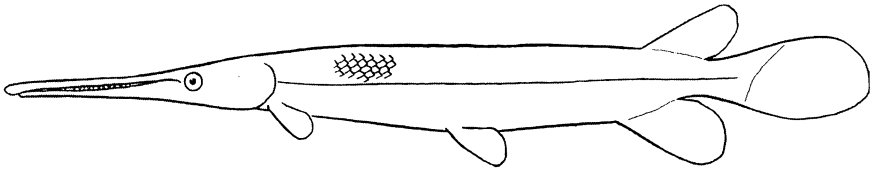
POLYODONTIDAE (paddlefishes). Snout prolonged, flat, paddle-shaped, with a pair of minute barbels below, a short distance in front of mouth; caudal fin strongly heterocercal; head very long, body mostly smooth with few small rhombic scales posteriorly; teeth feeble or absent; gillrakers long and numerous.

One extirpated species, *Polyodon spathula* (Walbaum, 1792)--paddlefish (p. 62).



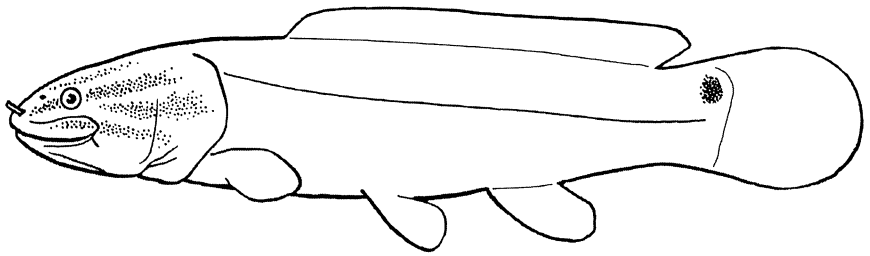
LEPISOSTEIDAE (gars). Body elongate, sheathed with thick, diamond-shaped (rhombic) scales; snout and jaws extended into a strong flattened beak armed with numerous sharp conical teeth; caudal fin abbreviate heterocercal, dorsal and anal fins short, opposed, and well back on body, pelvic fin abdominal, pectoral fin placed low on side.

Two species (see key on p. 27-28).



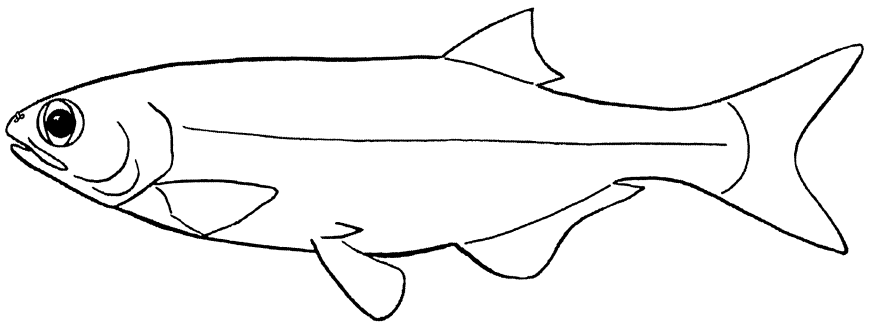
AMIIDAE (bowfins). Single dorsal fin long; scales cycloid; a bony plate between lower jaw bones; caudal fin abbreviate heterocercal.

One species, *Amia calva* Linnaeus, 1766--bowfin (p. 65).



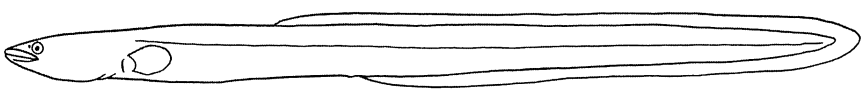
HIODONTIDAE (mooneyes). Body compressed, herring-like, midline of belly keeled but without spiny scutes; eye large; mouth well toothed; lateral line present; large silvery cycloid scales; head naked; no adipose fin, a single short dorsal fin.

One species, *Hiodon tergisus* Lesueur, 1818--mooneye (p. 66).



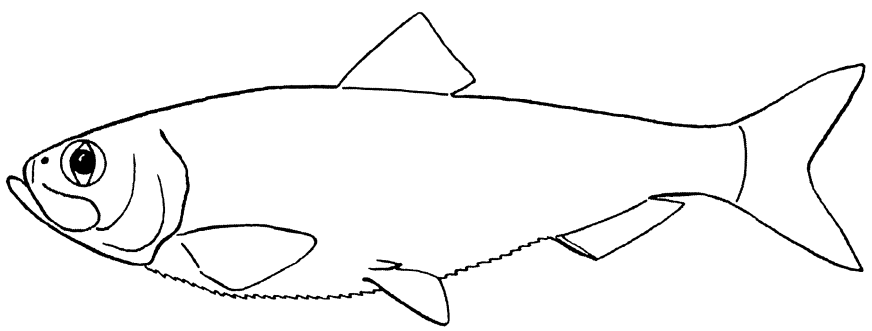
ANGUILLIDAE (freshwater eels). Body anguilliform; pectoral fins present, pelvic fins absent; mouth terminal, jaws well toothed; scales small, imbedded and linear; median fins continuous.

One introduced species, *Anguilla rostrata* Lesueur, 1817--American eel (p. 67).



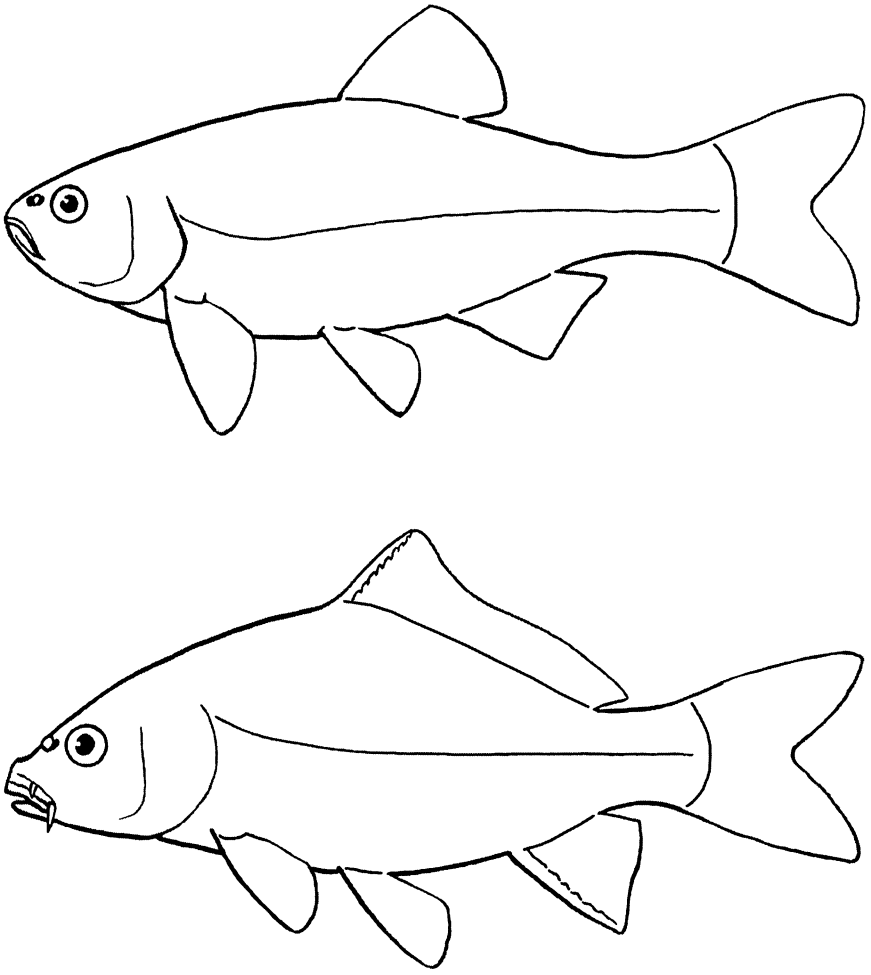
CLUPEIDAE (herrings). Body compressed; no adipose fin; thin cycloid scales on body, head naked, midline of belly with spiny scutes (sawbelly); no lateral line; gill rakers numerous and long.

One native species and two recent canal invaders (see key p. 28).



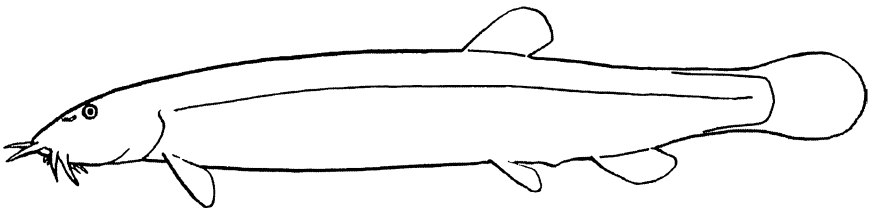
CYPRINIDAE (carps and minnows). Head scaleless, body scales cycloid; mouth without teeth, lips usually thin; no adipose fin, dorsal fin single, with nine or fewer soft rays in native minnows, but long and with a serrate spine in introduced carp and goldfish; pharyngeal arch falciform with one to three short rows of teeth, the lesser with 0 to 2, the longer with (3) 4-5 (6) teeth; pectoral fin with first ray simple, origin of anal fin much closer to pelvic base than to caudal base except in carp and goldfish (which have a long dorsal fin), principal caudal fin rays typically 19; barbels 0, 2, or 4.

Forty species, of which four are introduced (see keys p. 28-38).



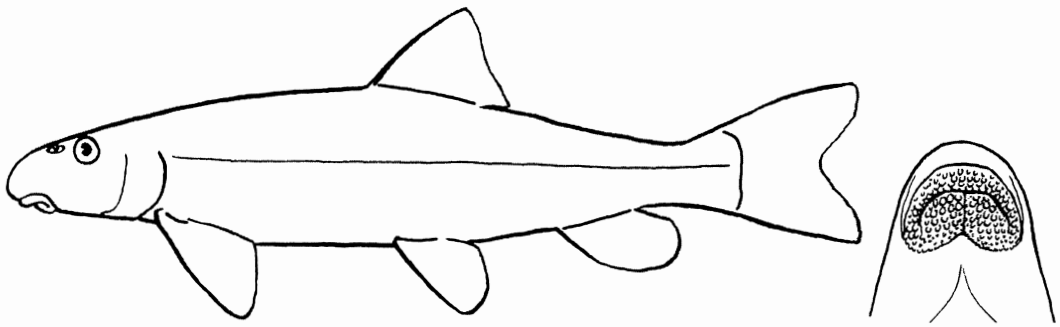
COBITIDAE (loaches). Body eel-like with cycloid scales and round caudal fin; subterminal mouth surrounded by five pairs of short barbels; short fins without spines.

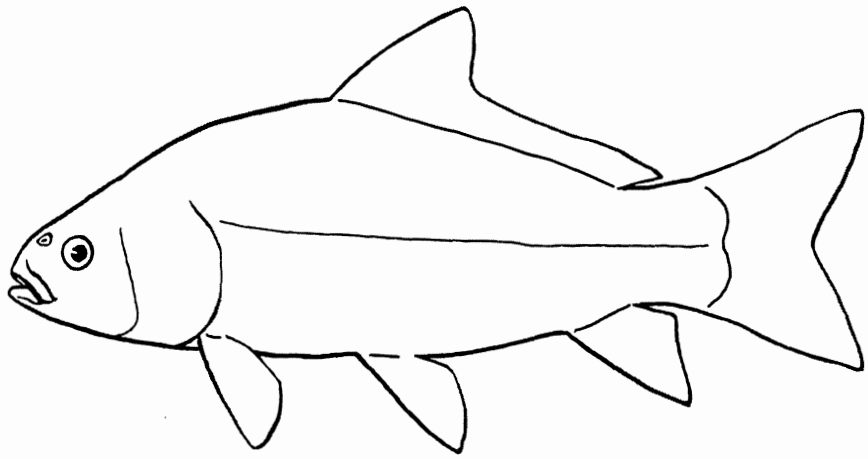
One introduced species, *Misgurnus anguillicaudatus* (Cantor, 1842)--Oriental weatherfish (p. 111).



CATOSTOMIDAE (suckers). Head scaleless, body scales cycloid; mouth without teeth, usually inferior, lips usually thick and fleshy, most often with papillae or plicae, no barbels; no adipose fin, dorsal fin single, without spine, with (9) 10 or, usually, more rays; pharyngeal arch falciform, long, with a single comb-like row of many teeth; anterior two pectoral rays unbranched; origin of anal fin about equidistant from base of pelvic fin and caudal fin base or, usually, nearer caudal; principal caudal fin rays 18.

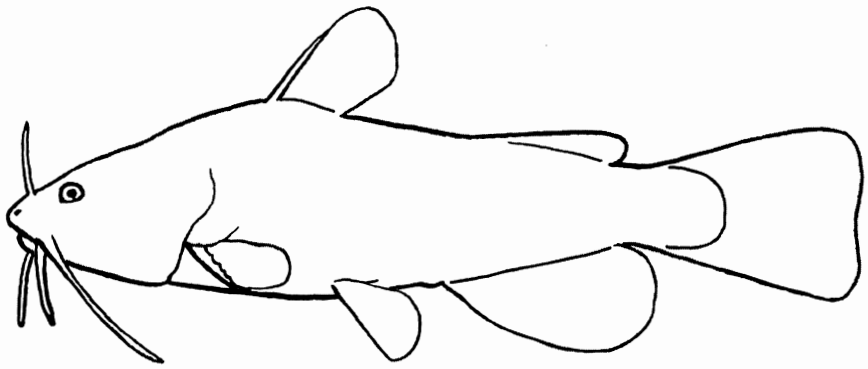
Thirteen native and two introduced species (see keys p. 38-40).





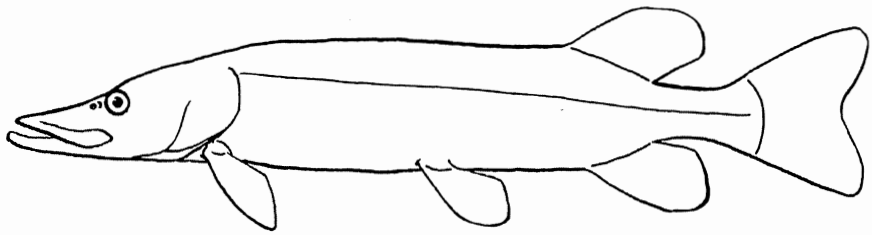
ICTALURIDAE (bullhead catfishes). No scales; adipose fin present; four pairs of barbels on head (including a pair of nasal barbels); stout spines at origin of dorsal and pectoral fins.

Nine native and one introduced species (see keys, p. 41-42).



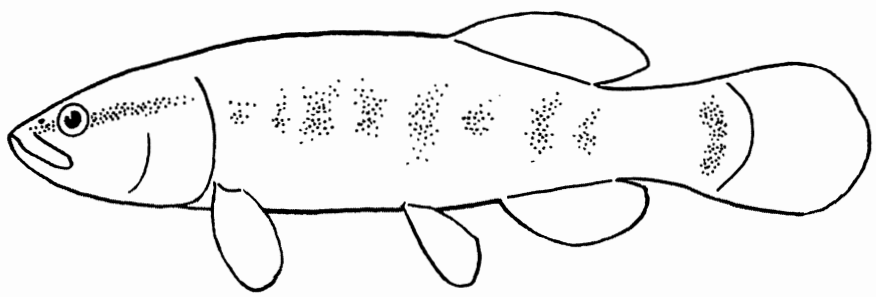
ESOCIDAE (pikes). Body elongate, terete; single opposed dorsal and anal fins placed well back; snout duck-like; caudal fin forked; head and body with cycloid scales; pelvic fin abdominal, with 8 to 13 rays; canine teeth present; branchiostegal rays 11 to 19.

Three species (see key p. 43).



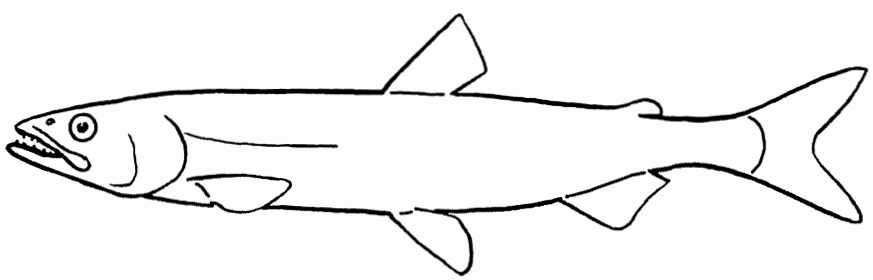
UMBRIDAE (mudminnows). Body terete; head and body with cycloid scales; single dorsal fin usually with 13 to 15 soft rays, no adipose fin, caudal fin rounded, pelvic fin abdominal, usually with six soft rays; teeth villiform; head blunt, mouth terminal, premaxillae not protractile; no lateral line; branchiostegal rays six.

One species, *Umbra limi* (Kirtland, 1840)--central mudminnow (p. 140).



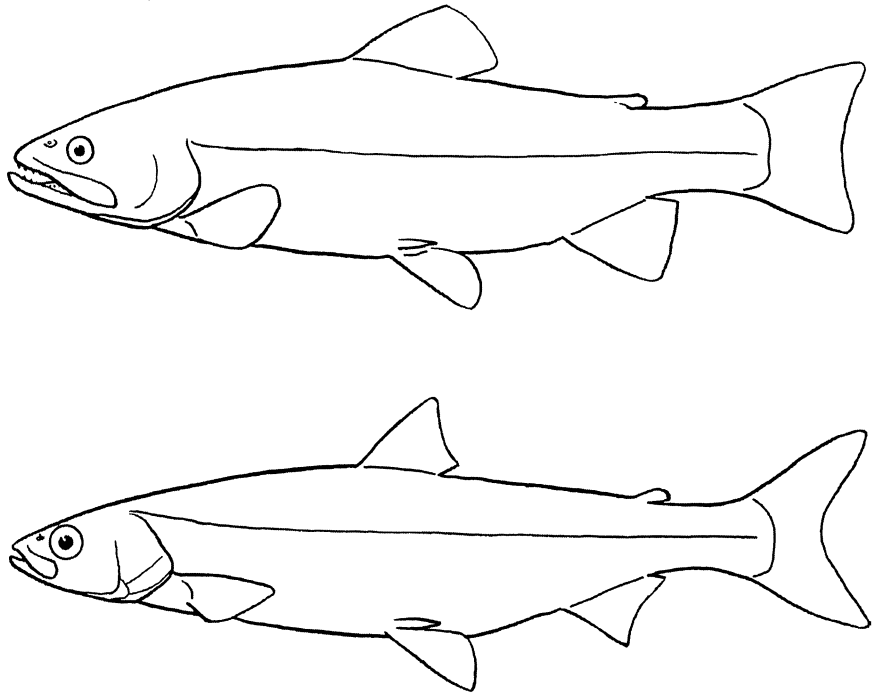
OSMERIDAE (smelts). Body slender, compressed; a single soft-rayed dorsal fin, adipose fin present; trout-like but lacks pelvic axillary process; no scales on head, those on body cycloid, of moderate size; mouth large, with strong teeth (some fang-like); pyloric caeca few or absent.

One introduced species, *Osmerus mordax* (Mitchill, 1814)--rainbow smelt (p. 141).



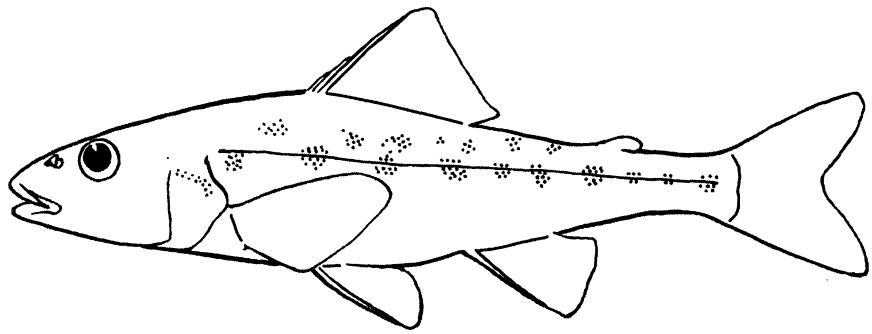
SALMONIDAE (trouts). Body terete to moderately compressed; a single soft-rayed dorsal fin, adipose fin present; pelvic axillary process well developed; scales on body cycloid, moderate to very small, no scales on head; mouth small to large, dentition variable, from none to strong canines; pyloric caeca present, usually numerous.

Eighteen species, six introduced and three extirpated or extinct (see keys, p. 43-46).



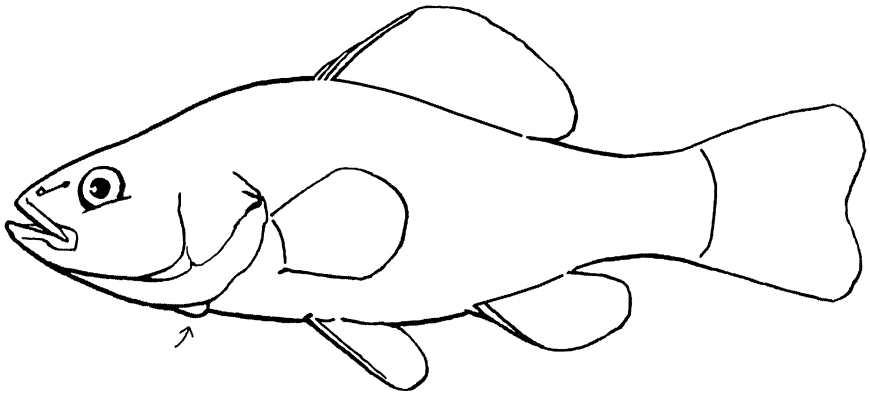
PERCOPSIDAE (trout-perches). Body slender with moderate-sized ctenoid scales; jaws with villiform teeth, no teeth on vomer or palatine; head naked, provided with enlarged sensory chambers; lachrymal and preopercle entire; nostrils narrowly separated; adipose fin present; lateral line complete; caudal fin deeply forked; genital aperture and anus near anal fin; dorsal fin with one or two weak spines anteriorly, anal fin with a single slender spine, pelvic-fin rays usually eight.

One species, *Percopsis omiscomaycus* (Walbaum, 1792)--trout-perch. (p. 160).



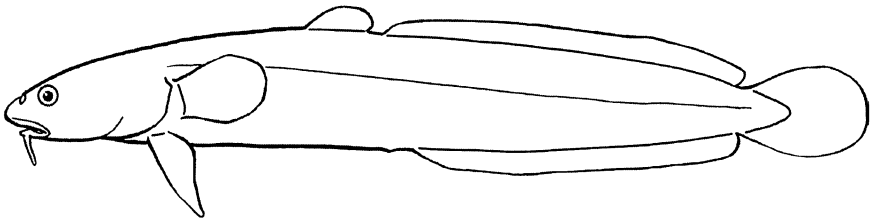
APHREDODERIDAE (pirate perches). Body oblong, heavy forward; jaws, vomer and palatine with villiform teeth; head with many ctenoid scales and several series of small sensory papillae; lachrymal and preopercle serrate; nostrils well separated, the anterior in a short tube; no adipose fin; lateral line wanting or developed only anteriorly; caudal fin truncate; genital aperture and anus in normal position in young, migrating forward to throat in adult; dorsal fin with three (rarely four in Michigan) and anal fin with two or three strong spines, pelvic-fin rays usually seven.

One species, *Aphredoderus sayanus* (Gilliams, 1824)--pirate perch (p. 161).



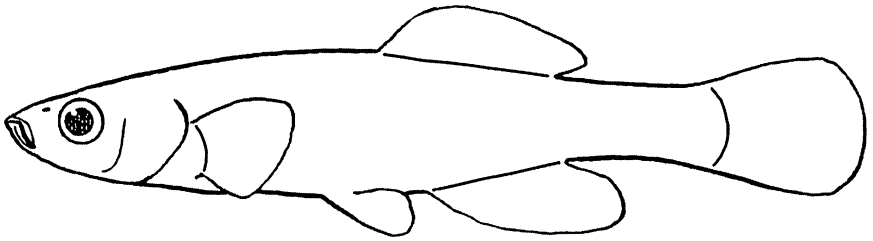
GADIDAE (cods). All fins without spines; dorsal fins one, two, or three (two in *Lota*), anal fins one or two (one in *Lota*); body elongate, head broad and depressed, back half of body compressed; opposed second dorsal and anal fins very long, caudal fin isocercal, pelvic fin jugular, with seven rays; scales minute, imbedded, cycloid; mouth large, snout slightly projecting, premaxillae and vomer with broad bands of villiform teeth; chin with a well developed median barbel; branchiostegal rays seven.

One species, *Lota lota* (Linnaeus, 1858)--burbot (p. 162).



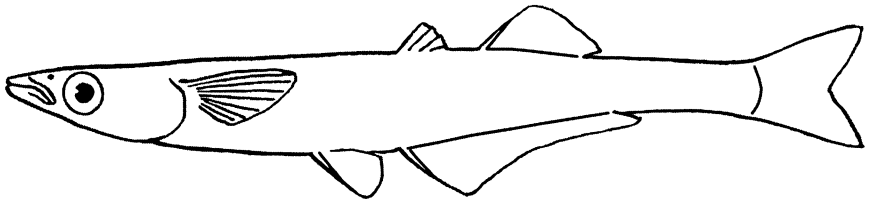
FUNDULIDAE (killifishes). Head and body with usually large cycloid scales; single short dorsal fin, rays soft; premaxillae protractile, mouth superior or terminal, jaws with villiform teeth; pelvic fin abdominal, usually with six rays, no adipose fin, caudal fin truncate or rounded; no lateral line; gill membranes separate and free from isthmus; color pattern sexually dimorphic.

Three species (see key p.47).



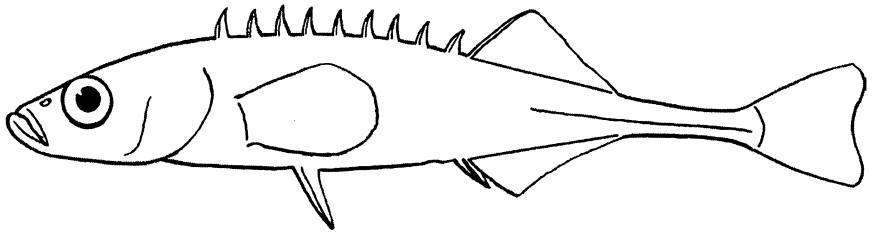
ATHERINOPSIDAE (New World silversides). Body elongate, terete; head and body with numerous small cycloid scales and a silver lateral stripe; mouth terminal, protractile, produced to form a beak; jaws with villiform teeth; two separated dorsal fins, the first with four frail spines, its origin slightly behind anal-fin origin, second dorsal fin short, caudal fin forked, anal fin long, with one weak spine, pectoral fin placed high on side, pelvic fin abdominal, with one spine and five branched rays.

One species, *Labidesthes sicculus* (Cope, 1865)--brook silverside (p. 166).



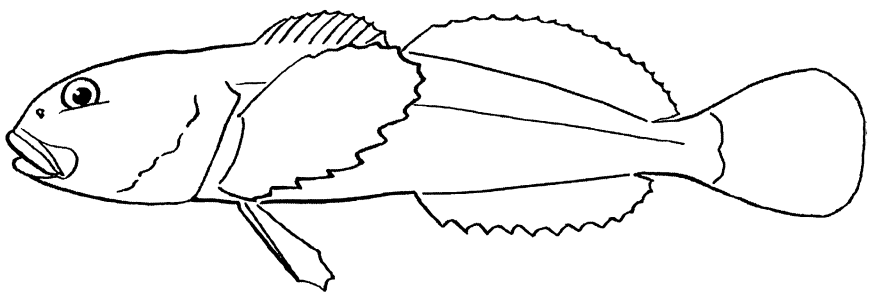
GASTEROSTEIDAE (sticklebacks). A series of free dorsal spines, (2) 3 to 10 (12), (15 in extralimital species) in number; body elongate and compressed, caudal peduncle slender, naked or with strong bony plates on side; caudal fin shallowly forked to truncate, anal fin with a single strong spine, pectoral fin on side, pelvic fin (rarely absent) thoracic, with a strong spine and one or two weak soft rays; caudal peduncle in some species with a prominent lateral keel that may be armed with bony plates; mouth terminal, jaws with strong teeth, premaxillae protractile.

Two native and one introduced species (see key p. 47).



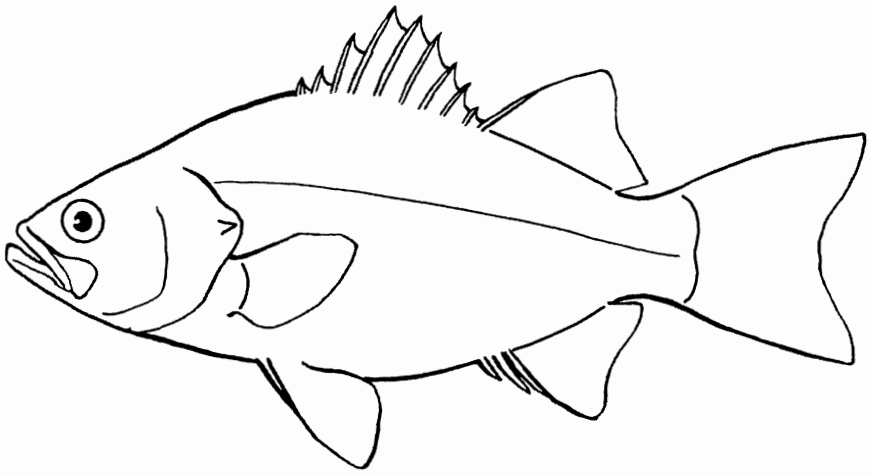
COTTIDAE (sculpins). A strong bony stay from third infraorbital bone that extends across cheek to angle of preopercle (often hidden by skin); head large and depressed, mouth terminal, eyes superolateral; pectoral fin expansive, tilted forward; head and body naked or with small prickles; preopercle with one or more serrae; two dorsal fins separate, contiguous, or narrowly conjoined, first dorsal fin with slender flexible spines, second dorsal fin and anal fin without spines, the rays usually unbranched, pelvic fin thoracic, with a slender hidden spine and usually three or four soft rays; lateral line present, often incomplete.

Four species (see key p. 48).



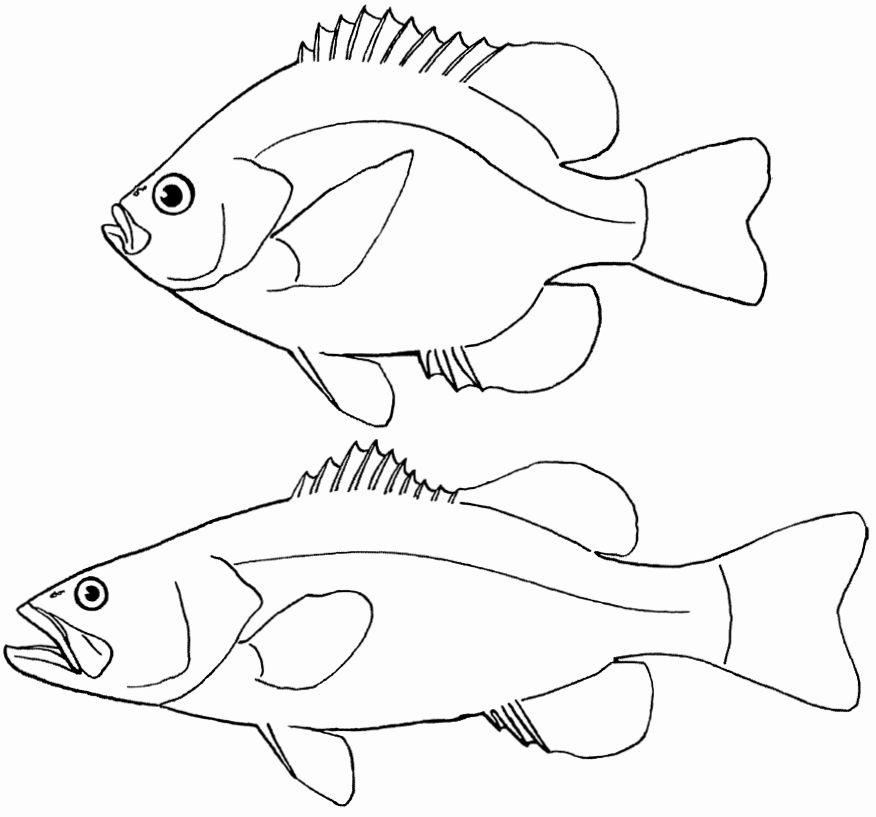
MORONIDAE (striped basses). Compressed deep-bodied perciform fishes with two separate or narrowly conjoined dorsal fins, the first spinous, second usually with a spine and 11 to 14 soft rays, a shallowly forked caudal fin, anal fin with three spines and 8 to 13 soft rays, pelvic fin with a spine and five soft rays; a developed opercular spine; scales on head and body ctenoid; preopercle serrate; pseudobranchium present; subocular shelf well developed.

Two species: one native, one a canal invader (see key, p. 49).



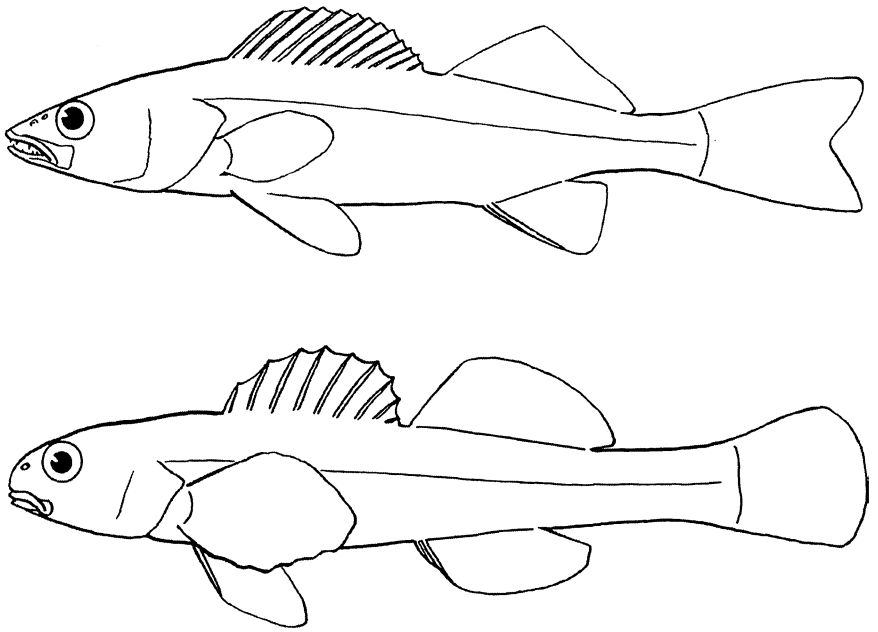
CENTRARCHIDAE (sunfishes). Terete to compressed and moderately deep-bodied perciform fishes; single dorsal fin comprised of a sometimes nearly separate anterior part with 6 to 14 spines and usually 10 to 16 soft rays, caudal fin shallowly notched (may be rounded in extralimital forms), anal fin with (2) 3 to 8 spines and 9 to 19 soft rays, pelvic fin thoracic, consistently with a spine and five soft rays; branchiostegal rays six or seven; lateral line usually complete, scales on head and body ctenoid; preopercle and lachrymal entire or serrate; opercle ends in one or two flat lobes, sometimes flexible, no marginal spine; pseudobranchium rudimentary; no subocular shelf.

Twelve species (two introduced). (see keys p. 49-51).



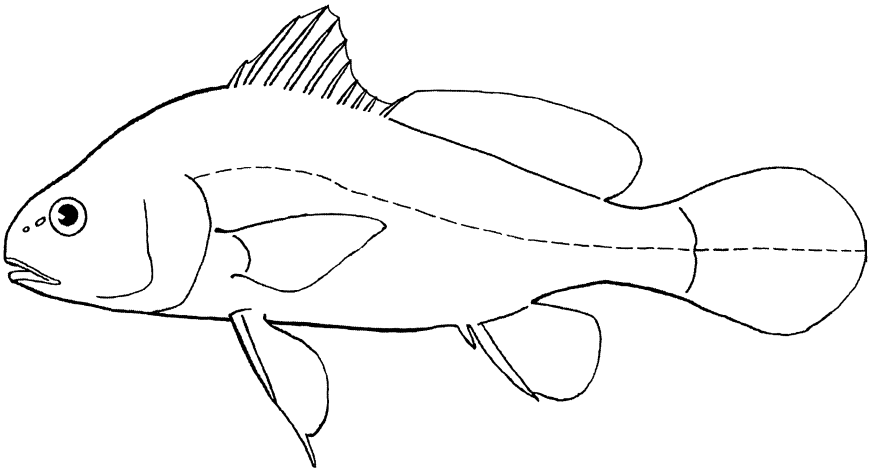
PERCIDAE (perches). Terete, usually elongate perciform fishes with two dorsal fins that may be narrowly separated, contiguous, or (in *Gymnocephalus*) broadly conjoined, the first fin spinous, the second with soft rays, caudal fin forked, truncate, or rounded, anal fin with one or two spines and 7 to 13 soft rays, pelvic fin consistently with a spine and five soft rays; lateral line most often complete, but incomplete in some darters, occasionally absent; branchiostegal rays 5 to 7; scales ctenoid, the head sometimes naked; body scalation reduced in *Ammocrypta*; preopercle and lachrymal serrate or entire; opercle usually ends in a sharp spine; no subocular shelf.

Seventeen native species and one ballast-tank intruder (see keys p. 51-54).



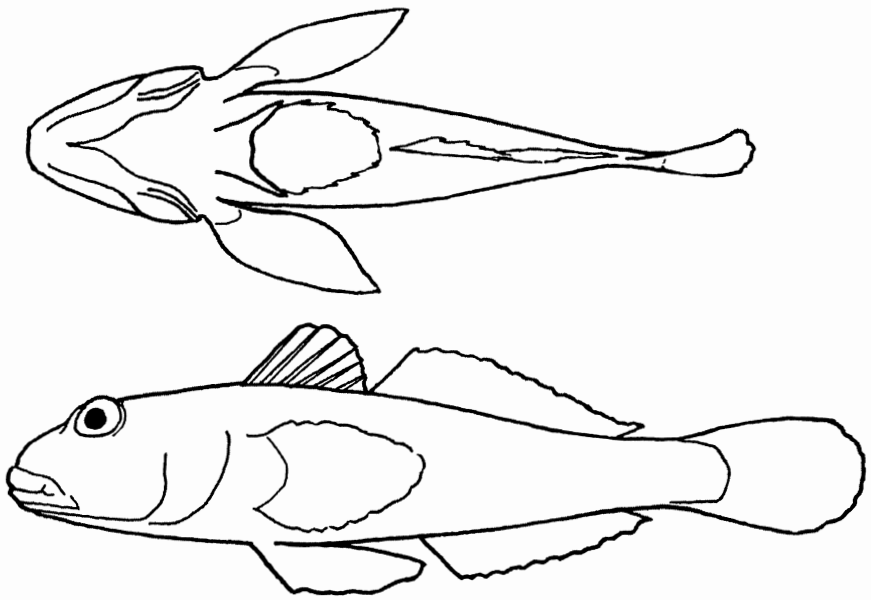
SCIAENIDAE (drums). Body compressed and deep, with a highly arched lateral line that extends to the end of the rhombic caudal fin; dorsal fins two, the first usually with nine spines, the second long with one spine and about 30 or 31 soft rays, anal fin with two strong spines, one short, the second long and stout, and about seven soft rays, pelvic fin with a spine and five soft rays; head and body with ctenoid scales; snout blunt, mouth almost horizontal, with sharp teeth; pharyngeal bones form upper and lower grinding plates equipped with molariform teeth; otoliths large, inscribed with a deep groove.

One species, *Aplodinotus grunniens* Rafinesque, 1819-- freshwater drum (p. 207).



GOBIIDAE (gobies). Perhaps the largest family of fishes, most gobies live in coastal waters of the tropics and subtropics. Nevertheless, two species from the Black Sea have in recent years been transferred by ballast waters into the Great Lakes and established flourishing populations. Gobies are structurally diverse, most are small. No lateral line; protractile premaxillae; sharp teeth, mouth usually terminal; two dorsal fins, the first in our species with six flexible spines; a similar thin flexible spine at front of second dorsal and anal fins, caudal fin rounded or lanceolate, pelvic fin below pectoral fin with one spine and five soft rays, the paired spines connected by a transverse membrane, the fins fused to form a disc-like cup that is free from the belly; gill membranes joined to isthmus; in our species ctenoid scales present on body and head.

Two introduced species (see key p. 55).



KEYS TO MICHIGAN FISHES*

Key to Michigan Genera of Petromyzontidae

1a. Dorsal fin single, sometimes emarginate but never divided into two distinct fins. Myomeres between last gill aperture and vent 47 to 56.....*Ichthyomyzon* (See key to species p. 27).

1b. Dorsal fin divided by a deep notch or space to form two distinct fins. Myomeres between last gill aperture and vent 63 to 76.....2

2a. Buccal funnel with rows of well-developed horny teeth that radiate outward toward the disc margin. Myomeres usually 65 to 76, mean about 70. Adults parasitic, the disc if expanded as wide as body; total length commonly 300 to 600 mm or more.....*Petromyzon* (One species, sea lamprey, *P. marinus* Linnaeus, 1758); an invader by canal, *Great Lakes and major tributaries).* (p. 60).

2b. Buccal funnel with weak teeth in clusters, not in radiating rows. Myomeres usually 63 to 70, mean about 67. Adult not parasitic, the disc if expanded somewhat narrower than body; total length typically less than 200 mm, exceptionally to nearly 300 mm.....*Lampetra* (One Michigan species, American brook lamprey, *L. appendix* (DeKay, 1842); *nearly statewide except Isle Royale).* (p. 59).

Key to Michigan Species of *Ichthyomyzon* (Petromyzontidae)

1a. Nonparasitic; adult with the digestive tract nonfunctional; teeth of the buccal funnel few and small. Length of oral disc less than 5.4% of total length; length of snout less than 6.9% of total length. Teeth in lateral rows 1 to 5, rarely 6. Maximum total length about 150 mm. *Statewide except Isle Royale*.....northern brook lamprey, *I. fossor* Reighard and Cummins, 1916 (p. 57).

1b. Parasitic on other fishes; adult with the digestive tract functional and with a wide lumen; teeth of the buccal funnel numerous, in radiating series, well developed. Length of oral disc more than 5.5 (usually at least 6.5) % of total length; length of snout more than 7% of total length. Teeth in lateral rows 5 (rarely) to 11. Maximum total length about 330 mm.....2

2a. Circumoral teeth with rare exceptions all unicuspid, but from the Lake Superior drainage 24 specimens have 0 to 6 bicuspid circumoral teeth, mean 2.4. Teeth in lateral rows 5 to 8, 7 or fewer in 92%. Teeth in anterior row 2 to 4, 2 or 3 in 79%. Supraoral cusps usually 1 or 2, but 3 or 4 in about 4%. Transverse lingual lamina usually moderately to strongly bilobed (Hubbs and Trautman, 1937:33, fig. 3). *Statewide except Isle Royale, but rare in Lake Michigan drainage*.....silver lamprey, *I. unicuspis* Hubbs and Trautman, 1937 (p. 58).

2b. Circumoral teeth in part (1 to 11, usually 6 to 8) bicuspid. Teeth in lateral rows 6 to 11, 8 or more in 87%. Teeth in anterior row 3 to 5, 4 or 5 in 96%. Supraoral cusps usually 2, but 3 in about 38%. Transverse lingual lamina usually linear or weakly bilobed (Hubbs and Trautman, 1937:33, fig. 3). *Lake Michigan drainage*.....chestnut lamprey, *I. castaneus* Girard, 1858 (p. 56).

Key to Great Lakes species of *Lepisosteus* (Lepisosteidae)

1a. Snout long and slender, "beaklike"; least width (in fish over 50 mm SL) 13 to 25.5 times in its length. *Lower Peninsula of Michigan*.....longnose gar, *L. osseus* (Linnaeus, 1758) (p. 64).

1b. Snout shorter and broader; least width (in fish over 50 mm SL) 4.5 to 11 times in its length.....2

*Prepared by Reeve M. Bailey

2a. Lateral-line scales (59) 60 to 63 (65). Predorsal scales (50) 52 or 53 (55). Anterior part of body and head usually without dark spots (but in clear water spots may be present). *Hypothetical in Michigan. Occurs in southern Green Bay, Wisconsin, about 40 km. from Michigan*.....shortnose gar, *L. platostomus* Rafinesque, 1820

2b. Lateral-line scales 53 to 59, mean 56.1. Predorsal scales 45 to 54, mean 48.2. Anterior part of body and head with dark spots and blotches. *Southern third of Lower Peninsula in Lake Michigan drainage; known also from Lake Erie drainage in Ohio*.....spotted gar, *L. oculatus* Winchell, 1864 (p. 63).

Key to Michigan Species of Clupeidae

1a. Posterior ray of dorsal fin prolonged into a prominent filament (except in young). Dorsal-fin origin behind pelvic-fin insertion; anal-fin rays 25 to 36, the fin base nearly twice as long as dorsal-fin base. Snout bluntly rounded; mouth subterminal, tip of lower jaw far below center of eye. Maxilla does not extend to below front of pupil. Gill rakers very long, numerous (more than 200). Stomach gizzard-like. Predorsal midline naked. *Lower Peninsula; Green Bay drainage in Upper Peninsula*.....gizzard shad, *Dorosoma cepedianum* (Lesueur, 1818) (p. 70).

1b. Posterior ray of dorsal fin not filamentous. Dorsal-fin origin in advance of pelvic-fin insertion. Anal-fin rays 17 to 21, the fin base equal to or scarcely greater than dorsal-fin base. Snout profile flattened; lower jaw protruding, its tip at level of center of eye. Maxilla extends almost to below center of eye or beyond. Gill rakers long, fewer than 50 on lower limb or first arch. Stomach not gizzard-like. Predorsal midline scaled.....*Alosa*...2

2a. Gill rakers on lower limb of first arch 18 to 24, the number not increasing with age. Lower jaw strongly projecting, extending to or almost to dorsal profile of head; its upper margin rises gradually to form a broadly obtuse angle. Teeth on lower jaw strong, persistent; those on tongue acute, in two to four series. Scales (difficult to count) 51 to 60. Vertebrae 53 to 55. *Not established in Michigan, but an occasional vagrant from the Mississippi River enters Lake Michigan via the Chicago Drainage Canal*.....skipjack herring, *A. chrysochloris* (Rafinesque, 1820) (p. 68).

2b. Gill rakers on lower limb of first arch more than 30, increasing with age especially until 100 mm SL, 38 to 44 in adult. Lower jaw included or projecting little, not extending into dorsal profile of head; its upper margin rises abruptly to form a strong shoulder. Teeth on lower jaw feeble; those on tongue granular, in a single median series. Scales 42 to 50. Vertebrae 46 to 50. *Statewide (not known from Isle Royale), especially in proximity to Great Lakes; introduced via Welland Canal*.....alewife, *A. pseudoharengus* (Wilson, 1811) (p. 69).

Key to Michigan Genera of Cyprinidae
[Excludes Eurasian genera except *Carassius* and *Cyprinus*]

1a. Dorsal fin long (more than 16 principal rays), with a strong serrate spine at lead edge. Anal fin short, with a strong serrate spine and 5 (occasionally 6) branched rays, the origin about equidistant or (usually) nearer caudal fin base than pelvic-fin insertion.....Cyprininae . . . 2[1]

1b. Dorsal fin short, usually with 8 or 9 nonspinous rays. Anal fin longer, without spine, principal soft rays typically 7 to 14, the origin much closer to pelvic-fin insertion than to caudal-fin base. .....Leuciscinae . . . 3[2]

2a. Upper jaw with 2 long fleshy barbels on each side (except in small young). Lateral-line scales 35 to 38 (body sometimes scaleless or imperfectly scaled). Gill rakers on anterior arch 21 to 27. Pharyngeal teeth in 2 to 4 rows, usually 1, 1 or 2, 3–3, 1 or 2, 1, those of the main row molariform, always 3. Total vertebrae (including 4 Weberian vertebrae) 36 to 38.....*Cyprinus*
(One species in Michigan, common carp, *C. carpio* Linnaeus, 1758; *introduced; widespread in Lower Peninsula; rare in Upper Peninsula; not on Isle Royale).* (p. 76).

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[1]Hybrids between carp and goldfish are common in and near Lake Erie. They are intermediate in characters and usually have two short barbels. Meristic data for these two species and hybrids in Michigan are given in Table 3.

[2]Pharyngeal tooth counts and principal anal-fin ray counts for Michigan cyprinids in this subfamily are given in Tables 4 and 5.

Table 3. Meristic counts for the goldfish (*Carassius auratus*), carp (*Cyprinus carpio*), and hybrids from Michigan waters.

Species	**Meristic counts**														
	Pharyngeal teeth														Number
	0,4-4,0	0,4-4,1	1,4-4,1	2,4-4,1	1,4-4,2	2,4-4,2	1,1,4,-4,1,1	1,3-4,1	1,1,3,-3,1,1	1,1,3-3,2,1	1,2,3,-3,2,1	1,2,3,-3,2,1,1	1,2,3,-3,1,1	1,2,1,3-3,2,1,1	1,1,1,3-3,1,1	
C. auratus	26														26
Hybrids	1	2	16	2	4	2	1	2							30
C. carpio									14	2	5	1	1	1	2	26

	Total vertebrae									Number
	30	31	32	33	34	35	36	37	38	
C. auratus	15									15
Hybrids			1	5	17	4				27
C. carpio							2	12	11	25

	Anal-fin rays				Number
	1,4	1,5	1,6	1,7	
C. auratus		19	1		20
Hybrids		27	1	1	29
C. carpio	1	18			19

2b. Upper jaw without barbels. Lateral-line scales 26 to 29. Gill rakers on anterior arch 37 to 43. Pharyngeal teeth always in a single row, 4–4, with grinding surface but not molariform. Total vertebrae 30.....*Carassius* (One species in Michigan, goldfish, *C. auratus* (Linnaeus, 1758); *introduced; scattered records in southern Lower Peninsula, common in Lake Erie drainage).* (p. 72).

3a. Abdomen behind pelvic fins with a fleshy median keel over which the scales do not pass. Anal-fin rays 11 to 14 (very rarely 10), the fin falcate. Lateral line notably decurved. Pharyngeal teeth usually in a single row, 5–5, with serrate edges. An opercular canal.....*Notemigonus* (One Michigan species, golden shiner, *N. crysoleucas* (Mitchill, 1814); *statewide*). (p. 85).

3b. Abdomen behind pelvic fins without median keel and usually fully scaled. Anal rays variable, usually 12 or fewer except in *Lythrurus* (9 or fewer in most species). Lateral line little decurved. Pharyngeal teeth in one or two rows, not 5–5 except in three species that have 8 anal rays; teeth rarely serrate. No opercular canal.....4

4a. Cartilaginous ridge of lower jaw prominent, and separated by a groove from the fleshy lower lip. Intestine very long, spirally looped about the swimbladder. Gill rakers on first arch 26 to 35 [Burr and Smith, 1976:522, *Copeia*], moderately long and slender. .....*Campostoma* (One Michigan species, central stoneroller, *C. anomalum pullum* (Agassiz, 1854); perhaps a full species; *southern two thirds of Lower Peninsula*). (p. 71).

4b. Cartilaginous ridge of lower jaw, if present, less prominent, and not separated by a definite groove from lower lip. Gill rakers on first arch fewer than 17, short.....5

5a. Upper jaw not protractile, not separated from snout by a groove. Distance between lower ends of gill clefts greater than half interorbital space. Scales rather small, 56 to 72 in the complete lateral line; scale radii present in all fields. [Maxilla with a slender barbel at its posterior end. Pharyngeal teeth 2, 4–4, 2.].....*Rhinichthys* (Two Michigan species, see separate key, p. 38).

5b. Upper jaw protractile, separated from snout by a groove. Distance between lower ends of gill clefts less than half interorbital space except in *Phenacobius* (which has fewer scales and lacks a barbel). Scale size variable, fewer than 52 in lateral line in most genera, but more in several which differ (a) in having an incomplete lateral line, (b) in lacking scale radii in the lateral fields, or (c) in number of teeth in main row.....6

6a. Scales smaller, 51 or more (rarely 48 to 50) in lateral series and 20 or more (rarely 18 or 19) around caudal peduncle. Pharyngeal teeth in main row 5–4 or 5–5 except in rare variants, but normally 4–4 in *Couesius* (which has 60 or more lateral-line scales).....7

6b. Scales larger, 50 or fewer in lateral line and 17 (rarely 18) or fewer around caudal peduncle. Pharyngeal teeth in main row usually 4–4 except in rare variants, but normally 5–5 in *Opsopoeodus* (which has fewer than 40 lateral-line scales).....11

7a. A black spot near base of anterior dorsal-fin rays. Breeding males with several greatly enlarged nuptial tubercles on side of head and without bright red on body or fin bases; no rows of modified tubercles below pectoral-fin base. A triangular flaplike barbel in groove above upper lip in advance of posterior end, this often undeveloped in young and juveniles. [Pharyngeal teeth usually 2, 5–4, 2; lateral line complete, with 50 to 64 scales; anal rays usually 8.].....*Semotilus* (One Michigan species, creek chub, *S. atromaculatus* Mitchill (1818); *statewide*). (p. 110).

7b. No black spot at base of anterior dorsal-fin rays. Breeding males without much enlarged tubercles on head but with rows of comblike tubercles below pectoral-fin base; bright red on side of body or on paired-fin bases. Barbel, if present, flaplike as in *Semotilus* (*Margariscus*) or threadlike, at end of maxilla in *Couesius*.....8

8a. A threadlike barbel at or scarcely in advance of end of maxilla. Pharyngeal teeth usually 2, 4–4, 2. [Lateral line complete, with 60 to 76 scales; anal rays 8.].....*Couesius* (One Michigan species, lake chub, *C. plumbeus* (Agassiz, 1850); *Upper Peninsula; shores of upper Great Lakes*). (p. 74).

8b. Barbel usually absent, if present, flaplike, triangular, lying in groove above maxilla well in advance of its end. Pharyngeal teeth in main row 5–4 or 5–5.....9

9a. Anal rays 9. Mouth large, maxilla extends to front of pupil. Snout sharp, lower jaw longer.....*Clinostomus* (One Michigan species, redside dace, *C. elongatus* (Kirtland, 1840): *native and rare in southeastern counties; introduced and common in Presque Isle River, Upper Peninsula*). (p. 73).

9b. Anal rays 8. Mouth smaller, maxilla does not extend beyond front of eye. Snout blunt, rounded, the jaws equal or the upper longer.....10

10a. Lateral line complete, the scales somewhat larger, usually 60 to 78. Scales with radii present only in the posterior field. A triangular, flaplike barbel usually present in groove above upper lip just in advance of posterior end of maxilla (often absent in juveniles and occasionally in adult).....*Margariscus* (One Michigan species, northern pearl dace, *M. nachtriebi* (Cox, 1896); *Upper Peninsula and Lower Peninsula north of Saginaw Bay and south to Grand River*). (p. 82).

10b. Lateral line incomplete, lateral scales very small, about 65 to 90. Scales with radii developed in all fields. No barbel.....*Phoxinus* (Three Michigan species, see separate key, p. 37).

11a. Lower lip thick, rugose, with a fleshy projection on each side that is partly separated from mandible by a deep groove. Gill clefts widely separated by a distance about equal to or greater than interorbital space. Eyes superolateral. [Pharyngeal teeth 4–4. Anal rays usually 7. Mouth inferior, suckerlike.].....*Phenacobius* (One Michigan species, suckermouth minnow, *P. mirabilis* (Girard, 1856); *Lake Erie drainage in Lenawee and Monroe counties).* (p. 102).

11b. Lower lip normal, not suckerlike. Gill clefts narrowly separated by a distance less than half interorbital space. Eyes not superolateral except in *Notropis dorsalis*.....12

12a. Principal dorsal rays 9. Mouth small and steeply inclined. Pharyngeal teeth usually 5–5, with serrate edges. [Anal rays 8.].....*Opsopoeodus* (One Michigan species, pugnose minnow, *O. e. emiliae* Hay, 1881); *rare, extreme southeastern Michigan*). (p. 101).

12b. Principal dorsal rays normally 8. Mouth larger and less steeply inclined except in *Notropis anogenus.* Pharyngeal teeth in one or two rows, those of major row 4–4 (except in rare variants), infrequently with serrate edges except in *Notropis anogenus* and *Cyprinella spiloptera*.....13

13a. Predorsal area somewhat broad and flattened, the scales crowded, much smaller than those on rest of body, in about 27 to 34 rows. Second (rudimentary) ray of dorsal fin short and stout, separated from first principal ray by a membrane (best developed in adult male). Nuptial tubercles large, those of head and body confined to a cluster on front of snout and (in *P. promelas*) chin. [Anal rays 7, pharyngeal teeth 4–4, with grinding surface but no hooks; peritoneum black; intestine greater than twice body length.].....*Pimephales* (Two Michigan species, see separate key, p. 38).

13b. Predorsal scales neither greatly crowded nor notably smaller than elsewhere on body (except in *Luxilus cornutus* and *Lythrurus,* which have 8 or more anal rays and 2, 4–4, 2 teeth). Second (rudimentary) ray of dorsal slender and closely adherent to first principal ray. Nuptial organs not confined to a cluster of enlarged tubercles on front of snout and chin.....14

14a. Terminal maxillary barbel present.....15

14b No maxillary barbel.....17

15a. Mouth somewhat oblique, subterminal. Anal rays 7.....*Nocomis* (Two Michigan species, see separate key, p. 37).

15b. Mouth horizontal, inferior. Anal rays 8.....16

16a. Silvery, no dark lateral stripe; lower lobe of caudal fin with distinctive white margin. Length to about 250 mm SL. Dorsal-fin origin in advance of pelvic insertion.....*Macrhybopsis* (One Michigan species, silver chub, *M. storeriana* (Kirtland, 1845); *rare, lakes St. Clair and Erie*). (p. 81).

16b. Not silvery; with an axial dark lateral stripe; lower lobe of caudal fin without distinctive white margin. Length to about 75 mm SL. Dorsal-fin origin above pelvic insertion.....*Notropis* (in part) (See key to *Notropis*, p. 32-34).

17a. Intestine elongate, more than twice SL, coiled. Peritoneum black, visible through abdominal wall in preserved specimens. Pharyngeal teeth 4–4, with well developed grinding surface but no hooks. [Anal rays 8. Body brassy in life.].....*Hybognathus* (One Michigan species, brassy minnow, *H. hankinsoni* Hubbs, 1929; *widespread but absent from Isle Royale and southern two or three tiers of counties*). (p. 77).

17b. Intestine short, less than twice SL, in a single S-shaped loop. Peritoneum silvery or sometimes dusky (especially in *Luxilus*), not visible through abdominal wall. Pharyngeal teeth in one or two rows, without grinding surfaces, but at least some with terminal hooks.....18

18a. A black blotch on posterior dorsal rays; a dark lengthwise streak on intergular membrane; lateral scales with distinctive dark crosshatching. Pharyngeal teeth usually 1, 4–4, 1, some usually with serrations. [Anal rays usually 8. Mouth somewhat oblique, subterminal.].....*Cyprinella* (One Michigan species, spotfin shiner, *C. spiloptera* (Cope, 1867); *Lower Peninsula, but infrequent in northeastern counties*). (p. 75).

18b. Posterior dorsal rays without black blotch; no dark streak on intergular membrane; lateral scales lack notable dark crosshatching. Pharyngeal teeth variable, if 1, 4–4, 1 they are not serrate.....19

19a. A black spot at base of anterior dorsal fin rays. Scales notably small and crowded in dorsolateral area, lateral-line scales (39) 41 to 47. [Anal rays (10) 11 or 12. Dorsal-fin origin behind pelvic-fin insertion. Pharyngeal teeth 2, 4–4, 2. Body decidedly compressed, the lateral line somewhat decurved anteriorly.].....*Lythrurus* (One Michigan species, redfin shiner, *L. umbratilis* (Girard, 1856); *southern two thirds of Lower Peninsula, chiefly in eastern drainages).* (p. 80.).

19b. No dark spot at base of anterior dorsal-fin rays. Scales not notably small in dorsolateral area (but predorsal scales crowded in *Luxilus cornutus*), lateral-line scales usually 40 or fewer (rarely 41 in *Luxilus cornutus* and *Notropis atherinoides*).....20

20a. Anal rays usually 9 (often 8, rarely 10). Lateral scales anteriorly greatly elevated. Body deep, larger, attain over 150 mm SL. [Dorsal-fin origin above or slightly in advance of pelvic-fin insertion. Pharyngeal teeth 2, 4-4, 2].....*Luxilus* (Two Michigan species, see separate key, p. 37).

20b. Anal rays rarely 9, usually 7 or 8 or 10 or more. Lateral scales scarcely elevated (except in *Notropis volucellus, N. buchanani,* and *N. heterolepis*). Body slender, smaller, few species exceed 100 mm SL.....*Notropis* (in part) (Fifteen Michigan species, see separate key, p. 32-34.)

Key to Michigan Species of *Notropis* (Cyprinidae)

1a. Anal rays 10 or 11 (rarely 9 or 12). Dorsal-fin origin above or usually behind pelvic-fin insertion. Mouth terminal. [Pharyngeal teeth 2, 4-4, 2. No barbel.].....2

1b. Anal rays 7 or 8 (6 or 9 in rare variants). Dorsal-fin origin above or usually in front of pelvic-fin insertion. Mouth usually somewhat subinferior, the upper lip longer, but very oblique and terminal in *N. anogenus*. [Pharyngeal teeth usually 4-4 or 1, 4-4, 1, but mostly 2, 4-4, 2 in *N. chalybaeus, N. hudsonius,* and *N. texanus*].....4

2a. Pelvic rays 9. A pair of prominent dark crescents between nostrils; median predorsal dark streak intense, clearly defined. Dorsal-fin origin above or slightly behind pelvic-fin insertion. Length to about 117 mm SL (130 mm TL). *Southeastern counties: Hillsdale, Livingston, Monroe, and Washtenaw*.....silver shiner, *N. photogenis* (Cope, 1865) (p. 96).

2b. Pelvic rays 8 (rarely 9). No prominent crescents between nostrils; median predorsal dark streak diffuse, not clearly defined. Dorsal-fin origin decidedly behind pelvic-fin insertion. Maximum length to about 93 mm SL (102 mm TL).....3

3a. No red pigment on snout or around pectoral-fin base. Snout blunter and body deeper and more compressed. Length to 93 mm (SL). Breeding males with tubercles on pectoral ray 1; rays 2 through about 10 with small tubercles arranged bi- or tri-serially, 6-16 per ray segment. Pectoral rays usually 15 or 16. Gill rakers on first arch 10-13, longer. *Most often on shores of Great Lakes or in large inland lakes or large rivers; statewide*.....emerald shiner, *N. atherinoides* Rafinesque, 1818 (p. 88).

3b. Breeding males with red pigment on snout and around pectoral-fin base. Snout sharper, body more slender and less compressed. Length to 72 mm (SL). Breeding males lack tubercles on pectoral ray 1; rays 2 through about 6 to 8 with 1 large tubercle per ray segment, uniserial. Pectoral rays usually 13 or 14. Gill rakers on first arch 7-10, short. *Usually on gravel riffle areas of small streams and rivers; throughout Lower Peninsula; in Upper Peninsula only in St. Marys River and in Green Bay drainage*.....rosyface shiner, *N. rubellus* (Agassiz, 1850) (p. 97).

4a. Anal rays 7.....5

4b. Anal rays usually 8 (commonly 7 in *N. buccatus,* rarely 7 in other species).....7

5a. Side of head and lower jaw with enlarged sensory chambers. Eyes superolateral. Snout length greater than eye. Mouth almost horizontal, extends to below posterior nostril. [Pharyngeal teeth 1, 4-4, 1]. *Southeastern counties*: *Hillsdale, Lenawee, Monroe, St. Clair, and Washtenaw*.....silverjaw minnow, *N. buccatus* (Cope, 1865) (p. 89).

5b. Side of head and lower jaw without enlarged sensory chambers. Eyes lateral. Snout length about equal to eye. Mouth somewhat oblique, extends to below anterior border of eye.....6

6a. A black lateral stripe that extends forward onto snout and invades upper and lower lips. Scales in row below lateral line often edged with melanophores. Posterior three anal rays often bordered with melanophores. Pharyngeal teeth usually 2, 4-4, 2. *Formerly Kalamazoo, Grand, and Saginaw river basins; now perhaps extirpated from Michigan*.....weed shiner, *N. texanus* (Girard, 1856) (p. 99).

6b. No black lateral stripe (a dusky stripe on caudal peduncle); anterior lateral-line scales each with double dark specks or dashes. Chin pale or with few scattered melanophores. Pharyngeal teeth 4-4. *Statewide except for Isle Royale; rare in western third of Upper Peninsula*.....sand shiner, *N. stramineus* (Cope, 1865) (p. 98).

7a. Barbel present at end of maxilla. [Mouth inferior, horizontal. Pharyngeal teeth 1, 4-4, 1]. *Formerly Hillsdale, Lenawee, Monroe, Washtenaw, and Wayne counties in southeastern Michigan; now perhaps extirpated from Michigan*.....bigeye chub, *N. amblops* (Rafinesque, 1820) (p. 86).

7b. No barbel.....8

8a. A well-developed black lateral stripe.....9

8b. No well-developed black lateral stripe.....12

9a. Mouth very small, steeply oblique. Peritoneum black. Pharyngeal teeth 4-4, the edges serrate. *Lower Peninsula; rare and spotty*.....pugnose shiner, *N. anogenus* Forbes, 1885 (p. 87).

9b. Mouth of moderate size, moderately to little oblique. Peritoneum silvery. Pharyngeal teeth with edges entire (except in *N. heterodon* which has teeth 1, 4-4, 1).....10

10a. Black lateral stripe involves lower lip, chin dark. Lateral stripe not forming series of dark crescents. Lateral line usually incomplete. Pharyngeal teeth in two rows.....11

10b. Black lateral stripe does not involve lower lip, chin white. Lateral stripe broken into series of dark crescents. Lateral line usually complete. Lateral scales of trunk somewhat elevated, as in *N. volucellus.* Pharyngeal teeth 4-4. *Statewide*.....blacknose shiner, *N. heterolepis* Eigenmann and Eigenmann, 1893 (p. 94).

11a. Lateral dark stripe sharply delimited. Breast naked. Inside of mouth commonly blackened with melanophores. Pharyngeal teeth 2, 4-4, 2, entire. *Formerly Branch, Calhoun, Cass, and St. Joseph counties in St. Joseph River basin; now perhaps extirpated from Michigan*.....ironcolor shiner, *N. chalybaeus* (Cope, 1869) (p. 91).

11b. Lower edge of lateral stripe irregular, zigzag. Breast scaled. Inside of mouth not blackened. Pharyngeal teeth 1, 4-4, 1, a few with edges serrate. *Statewide except for Isle Royale*.....blackchin shiner, *N. heterodon* (Cope, 1865) (p. 93).

12a. A prominent black spot at base of caudal fin. Pharyngeal teeth usually 2, 4-4, 2, but lesser row often with a single tooth on one or both sides. Maximum SL about 115 mm. *Statewide, especially common in and near Great Lakes*.....spottail shiner, *N. hudsonius* (Clinton, 1824) (p. 95).

12b. No prominent black spot at base of caudal fin. Pharyngeal teeth typically 1, 4-4, 1 or 4-4. Maximum SL about 70mm.....13

13a. Lateral scales of trunk elevated, much deeper than long. Eyes lateral. Mouth somewhat oblique, small. Snout blunt, its length about equal to eye. A dark spot anterior to origin of anal fin. Body not notably silvery. Pharyngeal teeth 4-4.....14

13b. Lateral scales of trunk rounded behind, not elevated. Eyes superolateral. Mouth almost horizontal. Snout produced, its length greater than eye. No black spot in front of anal fin. Body silvery. Pharyngeal teeth 1, 4-4, 1.....15

14a. Infraorbital canal complete. Fins lower and less falcate; length of depressed dorsal 21.9 to 23.8 % of SL; of depressed anal 16.7 to 19.8 % of SL; pelvic does not reach or barely reaches anal fin. Well pigmented: side with melanophores anteriorly, a well-developed dusky stripe on peduncle, and usually a small triangular spot at caudal base; dorsolateral area with darkened scale borders; middorsal streak weakly developed or absent. Peritoneum speckled or blotched with melanophores. Larger, to at least 64 mm SL. *Statewide except for a few counties in the western Upper Peninsula*.....mimic shiner, *N. volucellus* (Cope, 1865) (p. 100).

14b. Infraorbital canal absent or rudimentary. Fins higher and more falcate; length of depressed dorsal 24.5 to 27.9 % of SL; of depressed anal 19.5 to 22.9 % of SL; pelvic reaches or exceeds origin of anal (except in ripe females). Pallid: few or no melanophores in lateral stripe, at caudal base, or in dorsolateral area; middorsal streak usually undeveloped. Peritoneum silvery or with few melanophores. Smaller, to 41 mm SL. *Confined to southeastern counties near lakes Erie and St. Clair, where probably spreading*.....ghost shiner, *N. buchanani* Meek, 1896 (p. 90).

15a. Side of head and lower jaw without enlarged sensory chambers. Middorsal streak dark and well defined before and behind dorsal fin. Mouth large, extends to below anterior border of eye. *West-central counties in Lake Michigan drainage of Lower Peninsula; Baraga and Houghton counties in Lake Superior drainage in Upper Peninsula*.....bigmouth shiner, *N. dorsalis* (Agassiz, 1854) (p. 92).

15b. Side of head and lower jaw with enlarged sensory chambers. Middorsal streak present but ill defined and diffuse. Mouth small, extends to below posterior nostril. [Anal rays usually 8 but often 7.] *Southeastern counties: Hillsdale, Lenawee, Monroe, St. Clair, and Washtenaw*.....silverjaw minnow, *N. buccatus* (Cope, 1865) (p. 89).

Table 4. Pharyngeal tooth counts of Michigan Cyprinidae[1].

Species	Tooth counts (recorded left - right)										Other	Number
	2,5-4,2	2,4-4,2	2,4-4,1	1,4-4,2	1,4-4,1	1,4-4,0	0,4-4,1	0,5-5,0	0,5-4,0	0,4-4,0		
Campostoma a. pullum										35		35
Clinostomus elongatus	23										2,5-5,2=2 2,5-4,3=1	26
Couesius plumbeus		19	2	2	1						2,4-3,2=1	25
Cyprinella spiloptera					27		1					28
Hybognathus hankinsoni									2	23		25
Luxilus chrysocephalus		24	1									25
Luxilus cornutus		25										25
Lythrurus umbratilis		24	1									25
Macrhybopsis storeriana					24						1,5-4,1=1	25
Margariscus nachtriebi	19	5									1,5-4,2=1	25
Nocomis biguttatus					26	2	1					29
Nocomis micropogon										38		38
Notemigonus crysoleucas								26	5		0,6-5,0=1	32
Notropis amblops					24		1					25
Notropis anogenus										25		25
Notropis atherinoides		25										25
Notropis buccatus					24		1					25
Notropis buchanani									1	24		25
Notropis chalybaeus		24		1								25
Notropis dorsalis					16	5	3			1		25
Notropis heterodon					25							25
Notropis heterolepis										30		30
Notropis hudsonius		23	3	4								30
Notropis photogenis		24	1									25
Notropis rubellus		25										25
Notropis stramineus										25		25
Notropis texanus		18	3	4								25
Notropis volucellus										25		25
Opsopoeodus e. emiliae								48	3			51
Phenacobius mirabilis										25		25
Phoxinus eos								49	7			56
Phoxinus erythrogaster								23	2			25
Phoxinus neogaeus	25										2,5-4,1=1	26
Pimephales notatus									2	38		40
Pimephales promelas										25		25
Rhinichthys cataractae		25										25
Rhinichthys obtusus		43									2,4-3,1=1	44
Semotilus atromaculatus	57	5									2,5-4,1=1 1,5-4,1=1	64

[1]The 1129 counts here tabulated are plotted by frequency distribution. The counts emphasize five modes (2,5-4,2; 2,4-4,2; 1,4-4,1; 0,5-5,0; and 0,4-4,0). Of 38 species, 13 reveal no variation from the mode in the sample counted, and in 32 species at least 88 percent of counts are at the mode for their species. More significant variation, in 19 to 36 percent of counts, is noted in six species with maximum deviation in *Notropis texanus* 28 and *N. dorsalis* 36 percent. Overall 92.8 percent of counts are at the mode for their species. Deviant counts are more frequent in the lesser row of teeth, involving loss or rarely gain of a tooth. A small number of errors may be introduced due to failure to detect scars of lesser row teeth; this rarely if ever happens in teeth of the major row. Most counts are from Michigan fish. However, because of limited specimens those of *Macrhybopsis storeriana*, *Notropis chalybaeus*, and *Phenacobius mirabilis* are supplemented by material from adjacent areas. The counts for *Opsopoeodus e. emiliae* are from Gilbert and Bailey, 1972.

Table 5. Principal anal-fin ray counts (last ray double at base) for Michigan Cyprinidae in percentage frequencies.

Species	Anal-fin rays									Number	Mean of counts
	6	7	8	9	10	11	12	13	14		
Campostoma a. pullum	1.6	98.4								126	7.0
Clinostomus elongatus			1.0	84.0	15.0					100	9.1
Couesius plumbeus		1.2	95.7	3.1						161	8.0
Cyprinella spiloptera		0.8	97.7	1.5						133	8.0
Hybognathus hankinsoni		9.2	89.4	1.4						142	7.9
Luxilus chrysocephalus			7.9	88.5	3.6					165	9.0
Luxilus cornutus			11.3	87.4	1.3					151	8.9
Lythrurus umbratilis					2.9	50.7	44.9	1.5		136	11.4
Margariscus nachtriebi		3.0	94.0	3.0						133	8.0
Nocomis biguttatus		0.8	99.2							124	7.0
Nocomis micropogon		0.8	95.9	3.3						122	7.0
Notemigonus crysoleucas					0.5	22.8	58.9	15.8	2.0	202	12.0
Notropis amblops		1.7	97.4	0.9						116	8.0
Notropis anogenus		1.9	98.1							106	8.0
Notropis atherinoides				1.8	40.6	48.5	9.1			165	10.6
Notropis buccatus		34.3	65.0	0.7						140	7.7
Notropis buchanani		4.2	95.8							72	8.0
*Notropis chalybaeus**		4.3	90.6	5.0						139	8.0
Notropis dorsalis		9.7	86.7	3.5						113	7.9
Notropis heterodon		4.1	93.1	2.7						146	8.0
Notropis heterolepis		7.8	88.8	3.4						179	8.0
Notropis hudsonius		3.1	93.7	3.1						127	8.0
Notropis photogenis				5.1	78.6	16.2				117	10.1
Notropis rubellus				11.1	73.1	14.8	0.9			108	10.1
Notropis stramineus	2.8	96.4	0.8							249	7.0
Notropis texanus	1.2	97.0	1.8							169	7.0
Notropis volucellus		1.3	95.5	2.9			0.3			314	8.0
*Opsopoeodus e. emiliae**		1.0	98.0	1.0						100	8.0
*Phenacobius mirabilis**	6.0	92.0	2.0							100	7.0
Phoxinus eos		6.1	87.8	6.1						100	8.0
Phoxinus erythrogaster		1.1	98.9							90	8.0
Phoxinus neogaeus		3.8	94.3	1.9						106	8.0
Pimephales notatus	1.7	98.3								115	7.0
Pimephales promelas	0.8	99.2								119	7.0
Rhinichthys cataractae	2.1	97.9								146	7.0
Rhinichthys obtusus	0.9	99.1								111	7.0
Semotilus atromaculatus		2.8	96.5	0.7						141	8.0

*Because of few available Michigan specimens, counts of *Macrhybopsis storeriana*, *Notropis chalybaeus*, *Opsopoeodus e. emiliae*, and *Phenacobius mirabilis* include some from adjacent areas.

Key to Michigan Species of *Nocomis* (Cyprinidae)

1a. A large circular dark spot at base of caudal fin. Caudal fin usually red, especially bright in juveniles. Suborbital (preorbital) width (least distance from orbit to suborbital margin) narrower, usually contained 2.1 or more times in postorbital length of head in fish less than 100 mm SL, 2.0 or more times in larger fish. Nuptial male with enlarged tubercles (or scars) on top of head extending well behind eye; a bright red spot behind eye. Pharyngeal teeth typically 1, 4-4,1; occasionally with a tooth of lesser row absent. *Throughout Lower Peninsula and western half of Upper Peninsula but not on Isle Royale...* ....hornyhead chub, *N. biguttatus* (Kirtland, 1840) (p. 83).

1b. Spot at base of caudal fin, if present, indistinct, not round. Caudal fin not red. Suborbital wider, usually contained 1.8 to 2.2 times in postorbital length of head in fish less than 100 mm SL, 2.0 or fewer times in larger fish. Nuptial male with enlarged tubercles on top of head confined to snout and interorbital area; no red spot behind eye. Pharyngeal teeth consistently 4-4. *Much of the Lower Peninsula but absent from northwestern counties from Manistee to Cheboygan*..... .....river chub, *N. micropogon* (Cope, 1865) (p. 84).

Key to Michigan Species of *Luxilus*[1] (Cyprinidae)

1a. Anterior dorsolateral scales (17)18-24(26). Circumferential scales 30-35(37). Sum of anterior dorsolateral and circumferential scale counts (48)50-57(61). Parallel stripes on anterior dorsolateral part of back absent. Pigment usually lacking on gular area and most of chin. *Statewide except Isle Roy ale*.....common shiner, *L. cornutus* (Mitchill, 1817) (p. 79).

1b. Anterior dorsolateral scales (13)14-17(19). Circumferential scales (23)26-29(32). Sum of anterior dorsolateral and circumferential scale counts (38)40-45(48). Parallel stripes on anterior dorsolateral part of back present, crooked. Pigment usually present on chin and adjacent part of gular area. *Southern third of Lower Peninsula*.....striped shiner, *L. chrysocephalus* Rafinesque,1820 (p. 78).

Key to Michigan Species of *Phoxinus*[2] (Cyprinidae)

1a. A single midlateral dark stripe. Angle of mouth extends to below anterior border of eye or pupil. Basicaudal spot abruptly darker and narrower than axial stripe. Ventrolateral surface usually heavily peppered with melanophores. Intestine short, with a single S-shaped loop. Pharyngeal teeth usually 2,5–4,2; the grinding surfaces small. *Formerly as far south as Oakland County, now restricted to northern two-thirds of the Lower Peninsula, the Upper Peninsula, and Isle Royale.* .....finescale dace, *P. neogaeus* Cope, 1867 (p. 105).

1b. Two lateral dark stripes well defined in adult (one only in young). Angle of mouth to below posterior nostril; does not reach eye. Basicaudal spot scarcely or not narrower and only slightly darker than axial stripe. Ventrolateral surface usually immaculate, may be red in life. Intestine long, with two or more loops or coils. Pharyngeal teeth usually 5–5, rarely a tooth in lesser row; grinding surfaces large.....2

2a. Mouth steeper, about 45-50° with horizontal, almost straight. Upper lip above lower edge of pupil. Basicaudal spot not partially separated from axial stripe by a constriction. Lateral line very short, at most extends to about two-thirds length of pectoral fin. *Almost statewide, but not known from southern tier of counties; common northward*.....northern redbelly dace, *P. eos* (Cope, 1862) (p. 103).

2b. Mouth less oblique, about 30-35° with horizontal, gently curved. Upper lip usually below lower edge of pupil. Basicaudal spot usually partially separated from axial stripe by a constriction, especially in adults. Lateral line longer, in adults extends beyond middle of pectoral, exceeds pectoral fin in 80 percent, and at most reaches to below origin of dorsal fin. *Lenawee, Monroe, and Washtenaw counties, southeastern Michigan; known to persist only in Lenawee County*.....southern redbelly dace, *P. erythrogaster* (Rafinesque, 1820) (p. 104).

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[1]Data largely from Gilbert, 1964; those for *L. cornutus* utilize St. Lawrence drainage material; those for *chrysocephalus* are for the nominal subspecies.

[2]See comparative study by Phillips (1969).

Key to Michigan Species of *Pimephales* (Cyprinidae)

1a. Mouth terminal or nearly so, oblique, about 45° angle with horizontal; upper lip at lower level of pupil. Lateral line incomplete, usually terminates below front of dorsal fin, with 8 to 21 pored scales. Body chubby, depth about one-fourth SL. Gill rakers of moderate length, 13 to 16 on anterior arch. Spot at base of caudal fin small, ill defined. Nuptial male without barbel-like papilla at end of maxilla. Nuptial tubercles on head in male usually more than 16, some on lower jaw. *Statewide*.....fathead minnow, *P. promelas* Rafinesque, 1820 (p. 107).

1b. Mouth subterminal, nearly horizontal, angle much less than 30°; upper lip at lower level of orbit. Lateral line complete. Body elongate, depth about one-fifth SL. Gill rakers short, 7 to 9 on anterior arch. Dark spot at caudal fin base prominent. Nuptial male with barbel-like papilla at end of maxilla. Nuptial tubercles on head in male usually 16, none on lower jaw. *Statewide except not known from Isle Royale*.....bluntnose minnow, *P. notatus* (Rafinesque, 1820) (p. 106).

Key to Michigan Species of *Rhinichthys* (Cyprinidae)

1a. Upper jaw scarcely exceeds lower jaw; mouth somewhat oblique. Lower lip as viewed from below of uniform width throughout. Dorsal origin equidistant from base of caudal and a point behind anterior margin of orbit, usually behind middle of pupil. Eye lateral, larger. Lateral dark stripe rather sharply defined below. Many dark scales scattered over body. *Statewide except Isle Royale*.....western blacknose dace, *R. obtusus* Agassiz, 1854 (p. 109).

1b. Upper jaw greatly exceeds lower jaw; the nearly horizontal mouth shark-like in appearance. Lower lip as viewed from below widest posteriorly, tapered notably to its junction with mandibular ramus. Dorsal origin equidistant from base of caudal and a point anterior to rear edge of pupil, usually in front of orbit. Eye superolateral, smaller. Lateral dark stripe fades gradually both above and below. Few or no scattered dark scales on body. *Upper Peninsula (including Isle Royale); northern Lower Peninsula south to Montcalm County; shores of lakes Huron and Michigan*.....longnose dace, *R. cataractae* (Valenciennes, 1842) (p. 108).

Key to Michigan Genera of Catostomidae

1a. Dorsal fin with more than 22 principal rays. Supraorbital bone present. Body deeper, usually more than one third SL.....2

1b. Dorsal fin with 17 or fewer principal rays. No supraorbital bone except in *Minytrema*. Body more slender, depth usually less than one third SL.....3

2a. Anal-fin rays usually 8 or 9, occasionally 7 or 10. Cheek shallow and shortened, distance from eye to lower posterior angle of preopercle about three-fourths that to upper end of gill cleft. Subopercle broadest at middle, semicircular. Anterior fontanelle absent or rudimentary. Color drab or gray.....*Ictiobus* (Two species, see separate key, p. 40).

2b. Anal-fin rays usually 7, rarely 6 or 8. Cheek deep and long, eye equidistant from angle of preopercle and upper end of gill cleft. Subopercle broadest below its middle, subtriangular. Anterior fontanelle well developed. Silvery fishes, often with a golden sheen.....*Carpiodes* (One Michigan species, quillback, *C. cyprinus* (Lesueur, 1817); *much of Lower Peninsula; mostly in large rivers and lakes*). (p. 112).

3a. Lateral line with 55 or more scales. Anterior scales on side much smaller than those on caudal peduncle. Circumpeduncle scales 16 (rarely) to 29.....*Catostomus* (Two species, see separate key, p. 39)

3b. Lateral-line scales (or lateral scales) 50 or fewer. Anterior scales on side not smaller than those on caudal peduncle. Circumpeduncle scales usually 12 to 16.....4

4a. Supraorbital bone present. Side marked with several horizontal rows of dark spots, one per scale (not developed in young, which have a dusky distal margin on the weakly falcate dorsal fin). Two or three infraorbital bones broad, half to two-thirds diameter of eye, as in *Erimyzon*. [Lateral line feebly developed. Dorsal-fin rays usually 12. Juveniles with a midlateral series of five or six large blotches].....*Minytrema*
(One species, spotted sucker, *M. melanops* (Rafinesque, 1820); *southern third of Lower Peninsula and Roscommon County, where perhaps introduced*). (p. 120).

4b. No supraorbital bone. Side not marked with rows of dark spots. Three or four infraorbitals, narrow (except in *Erimyzon*), less than half diameter of eye.....5

5a. No lateral line. Mouth small and subterminal, somewhat oblique. Color pattern consisting of a broad lateral stripe in young that may be broken into vertical bars or blotches in adults.....*Erimyzon*
(Two species, see separate key, p. 39).

5b. Lateral line well developed, mouth inferior, horizontal.....6

6a. Head depressed between eyes, interorbital area concave. Lips heavily papillose. Dorsal-fin rays usually 11. Swimbladder with two chambers. Body with a series of oblique crossbands.....*Hypentelium*
(One Michigan species, northern hog sucker, *H. nigricans* (Lesueur, 1817); *Lower Peninsula north to Au Sable River; Upper Peninsula, Green Bay drainage*). (p. 117).

6b. Head not depressed between eyes, interorbital area flat or convex. Lips plicate or papillo-plicate. Dorsal-fin rays usually 12 to 17. Swimbladder with three chambers. Body without oblique crossbands.....*Moxostoma*
(Six species, see separate key, p. 40).

Key to Michigan species of *Catostomus* (Catostomidae)

1a. Scales larger: lateral-line rows fewer than 75; caudal peduncle rows (16) 17-20. Snout blunt, projecting little or not at all beyond upper lip; lower lip does not extend back as far as nostril. Head deeper than broad. Dorsal-fin rays (10) 11-12 (13); anterior rays when depressed fail by a wide margin to equal posterior rays. Adults without red lateral stripe. Peritoneum silvery. *Statewide*.....white sucker, *C. commersonii* (Lacepède, 1803) (p. 114).

1b. Scales smaller: lateral-line rows more than 80; caudal peduncle rows 25-29. Snout long, projects well beyond upper lip; lower lip more flaring, extends back at least to narial flap. Head depressed, broader than deep. Dorsal-fin rays (8) 10 (11); anterior rays when depressed almost reach or exceed posterior rays. Adults with a broad red lateral stripe, especially evident in breeding fish. Peritoneum black. *Upper Peninsula; northern Lower Peninsula, especially in or near Great Lakes; south in lakes Michigan and Huron*.....longnose sucker, *C. catostomus* (Forster, 1773) (p. 113).

Key to Michigan species of *Erimyzon* (Catostomidae)

1a. Lateral scale rows (34) 35-38. Dorsal-fin rays 11-12 (13). Dark lateral stripe continuous throughout life, but often indistinct in adults, in which it may form faint crossbands. Larger, SL to at least 386 mm (often more than 200). *Southern half of Lower Peninsula; introduced in Crawford County*.....lake chubsucker, *Erimyzon sucetta* (Lacepède, 1803) (p. 116).

1b. Lateral scale rows 39-44 (45). Dorsal-fin rays (9) 10 (11). Dark lateral stripe continuous in juveniles but broken into a series of partly connected blotches in adults. Smaller, SL to about 180 mm. *Formerly southern tier of counties, now rare or extirpated*.....western creek chubsucker, *Erimyzon claviformis* (Girard, 1856) (p. 115).

Key to Michigan species of *Ictiobus* (Catostomidae)

1a. Mouth large, oblique, terminal; upper lip about level with lower margin of orbit; upper jaw about as long as snout. Lips thin, only faintly striate. Lower pharyngeal arch thin, more than twice as high as wide. *Introduced; Lake Erie to lower Saginaw River; spreading*.....bigmouth buffalo, *I. cyprinellus* (Valenciennes,1844) (p. 118).

1b. Mouth small, little oblique, inferior; upper lip far below lower margin of orbit; upper jaw distinctly shorter than snout. Lips fuller, more or less coarsely striate. Lower pharyngeal arch heavier, about as wide as high. *Introduced; southern Lake Michigan and from Saginaw Bay to Lake St. Clair*.....black buffalo, *I. niger* (Rafinesque, 1819) (p. 119).

Key to Michigan Species of *Moxostoma* (Catostomidae)

1a. Caudal fin in life slate colored or olive (not bright red). Upper-body scales without dark spot at base.....2

1b. Caudal fin bright red in living adults. Body scales on upper parts each with a dark spot at base.....4

2a. Dorsal-fin rays (13) 14-16 (17); fin base about equal to distance from dorsal fin to occiput. Plicae of lips broken by transverse ridges or creases into papilla-like elements; halves of lower lip form an acute angle. Dorsal fin margin gently convex. Body silvery. [Lateral-line scales usually 39-43]. *Statewide except Isle Royale* .....silver redhorse, *M. anisurum* (Rafinesque, 1820) (p. 121).

2b. Dorsal-fin rays (12) 13 (14); fin base shorter than distance from dorsal fin to occiput. Plicae of lips not broken into papilla-like elements. Dorsal-fin margin straight or somewhat falcate.....3

3a. Lateral-line scales smaller (43) 44-47 (49). Pelvic-fin rays 9-10, most often 10 on one or both sides. Breast scales of adults partly embedded, much smaller than anterior belly scales. Breeding males lack enlarged tubercles on head. Predorsal scales (14) 16-18 (20). Caudal peduncle depth usually 8.5 to 9.9% of SL. Vertebrae (43) 44-45 (47), including 4 in Weberian apparatus. Color darker. *Southern half of Lower Peninsula*.....black redhorse, *M. duquesnei* (Lesueur, 1817) (p. 123).

3b. Lateral-line scales larger (39) 40-42 (43). Pelvic-fin rays typically 9 on each side. Breast scales of adults exposed, not notably smaller than anterior belly scales. Breeding males with enlarged tubercles on head. Predorsal scales (12) 14-16 (17). Caudal-peduncle depth usually 10.0-11.4% of SL. Total vertebrae (39) 41-42 (43). Color more yellowish. *Menominee County, Upper Peninsula; southern two thirds of Lower Peninsula*.....golden redhorse, *M. erythrurum* (Rafinesque, 1818) (p. 124).

4a. Dorsal-fin margin falcate (concave). Mouth small, lips plicate or with some papillae near corners or posterior edge. Posterior margin of lower lip straight or forming a very shallow angle. Head subconical, short, (18) 19-22 (24)% of SL in fish greater than 150 mm SL. [Pharyngeal arch light, lower teeth compressed. Head tubercles of breeding male minute, concentrated dorsally]. *Most of Michigan except Isle Royale*.....shorthead redhorse, *M. macrolepidotum* (Lesueur, 1817) (p. 125).

4b. Dorsal-fin margin straight or slightly convex. Mouth large, lips plicate, the posterior margins forming a moderate angle. Head large, (21) 22-27% of SL in fish less than 200 mm, 23 to 25% of SL at larger sizes.....5

5a. Scale rows around caudal peduncle (15) 16 (17). Pharyngeal arch light, lower teeth comb-like, well compressed, not molarlike. *Lake Michigan drainage in Upper Peninsula; Lower Peninsula*.....greater redhorse, *M. valenciennesi* (Jordan, 1885) (p. 126).

5b. Scale rows around caudal peduncle 12 (14). Pharyngeal arch stout; lower teeth large, not compressed, 6 to 8 on lower half of arch with flattened grinding surfaces. *Large rivers of Lake Michigan drainage north to Muskegon River*.....river redhorse, *M. carinatum* (Cope, 1870) (p. 122).

Key to Michigan Genera of Ictaluridae

1a. Jaws equal or the upper protruding; mouth of moderate width. Pectoral spine varied, not as in 1b. Preoperculomandibular canals separate, the pores 10 or 11. Anterior nasal pore located medial to anterior nostril. Premaxillary tooth band a transverse or curved bar (except in *Noturus flavus*). 2

1b. Lower jaw projecting; head notably depressed anteriorly and mouth very wide. Pectoral spine strong, almost straight, anterior and posterior edges equally armed with well-developed serrae. Preoperculomandibular canals joined in a median pore on chin, the pores 12 on each side (including median pore). Anterior nasal pore located at edge of lip, well in front of anterior nostril. Premaxillary tooth band with a broad backward projection on each side, the posterior border smoothly curved. [Adipose fin large, free from caudal. Anal fin with 12 to 16 rays. Attains a weight of over 100 pounds (45 kg). Vertebrae (including 5 in Weberian complex) 50 to 52.].....*Pylodictis*
(One species, flathead catfish, *P. olivaris* (Rafinesque, 1818) *in large rivers in Lake Michigan drainage from Manistee to St. Joseph; reported from Saginaw River*). (p. 136).

2a. Adipose fin with posterior margin free, not fused or continuous with caudal fin. Gill rakers 11 to 21. Size large, all species may exceed 300 mm TL.....3

2b. Adipose fin a low, keel-like fleshy ridge which is fused or continuous with caudal fin (nearly free in *N. stigmosus*). Gill rakers 3 to 10. Size small, usually less than 200 mm TL (except in *N. flavus* which may attain a total length of about 310 mm).....*Noturus*
(Five Michigan species, see separate key, p. 42).

3a. Caudal fin deeply forked. Anal rays 24 or more (including rudiments). Upper jaw projects beyond lower. Supraoccipital bone produced backward to join with anterior process from dorsal fin supports. Vertebrae (including 5 in Weberian complex) 47 to 51.....*Ictalurus*
(One Michigan species, channel catfish, *I. punctatus* (Rafinesque, 1818); *Lower Peninsula; rare in Upper Peninsula)*. (p. 130).

3b. Caudal fin more or less truncate or rounded behind, not deeply forked. Anal rays 17 to 27. Jaws nearly equal in anterior extent. Supraoccipital bone produced backward, but fails to join anterior process from dorsal-fin supports.....*Ameiurus*
(Three Michigan species, see separate key, p. 41).

Key to Michigan Species of *Ameiurus*

1a. Chin barbels white, rarely faintly dusky. Caudal fin rounded behind. Anal-fin rays (24) 25 or 26 (27); base length of fin 3.3 to 3.7 in SL, the distal margin almost straight. [Gill rakers on first arch usually 14 to 16]. *Throughout Lower Peninsula; Menominee County in Upper Peninsula* .....yellow bullhead, *A. natalis* (Lesueur, 1819) (p. 128).

1b. Chin barbels dusky or black. Caudal fin slightly emarginate or truncate behind. Anal-fin rays (17) 18 to 22 (24); base length of fin 4.0 to 4.6 in SL, the distal margin broadly rounded.....2

2a. Pectoral spine smooth or only weakly roughened posteriorly. Gill rakers on first arch (14) 15 to 19 (21). Anterior edge of supraethmoid bone a broad (see figure) shallow depression with divergent cornua that lack mesial processes. Distal two thirds of anal fin with interradial membranes notably darker than rays. Adults with the belly usually yellow. *Statewide except for Isle Royale*.....black bullhead, *A. melas* (Rafinesque, 1820) (p. 127).

2b. Pectoral spine with strong posterior serrae. Gill rakers on first arch 11 to 14. Anterior edge of supraethmoid bone with a narrow median subcircular notch (see figure) between processes of the cornua. Dark pigment on anal fin usually densest on membranes near their margin, in spots that form an obscure bar near base of fin, or more or less mottled; the rays and membranes about equally pigmented. Adults with the belly usually whitish. *Statewide except for Isle Royale*.....
.....brown bullhead, *A. nebulosus* (Lesueur, 1819) (p. 129).

Key to Michigan Species of *Noturus* (Ictaluridae)

1a. Pectoral spine curved, scimitar-like, long, with serrae on both anterior and posterior edges; anterior serrae numerous, much the smaller; posterior serrae large, about as long as diameter of spine shaft, recurved toward spine base (except 1 to 3 at proximal end). Color pattern of dark blotches or saddles on body and fins. (Subgenus *Rabida*).....2

1b. Pectoral spine straight or gently curved, without anterior serrae but in some with a few distal recurved hooks or steps; posterior serrae, if present, shorter, not recurved. Color pattern usually dark, without prominent blotches or saddles on body.....3

2a. Dorsal fin with a distal jet-black blotch; dark bar on adipose fin extends to fin margin; no midcaudal crescentic bar (a submarginal dark band is present); no pair of light spots near dorsal-fin base. One internasal pore, mean 1.05 (anterior ends of infraorbital and supraorbital canals connected). Caudal fin rays (54) 57 to 65. Free vertebrae 32 to 37. *Southeastern Michigan in drainages of lakes St. Clair and Erie*.....brindled madtom, *N. miurus* Jordan, 1877 (p. 134).

2b. Dorsal fin with a brownish or dusky bar but no jet-black blotch; dark bar on adipose fin does not extend to distal margin; a midcaudal crescentic brown bar in addition to a submarginal caudal band; a pair of large light spots typically enclosed in dark saddle just anterior to dorsal-fin base. Typically two internasal pores (anterior ends of infraorbital and supraorbital canals distinct). Caudal rays (47) 49 to 53 (56). Free vertebrae 31 to 35. *Southeastern Michigan in Lake St. Clair, Detroit River, and Huron River*.....northern madtom, *N. stigmosus* Taylor, 1969 (p. 135).

3a. Premaxillary tooth patch rectangular, with long posterior projections from lateral corners. Ossified pectoral radials never fused. Dorsal-spine length stepped in predorsal length 4.5 to 8.0, mean 5.7. Size larger, maximum SL at least 240 mm. [Ventral surface, pelvic fin, upper and lower margins of caudal peduncle and caudal fin, and margins of adipose and anal fins immaculate. Lower jaw included. Free vertebrae 37 to 41]. (Subgenus *Noturus*). *Lower Peninsula north to Au Sable River of Lake Huron and Muskegon River of Lake Michigan*.....stonecat, *N. flavus* Rafinesque, 1818 (p. 131).

3b. Premaxillary tooth patch rectangular, without long posterior projections from lateral corners. Pectoral radials typically fused. Dorsal spine length 2.0 to 4.6 in predorsal length. Smaller, maximum SL 134 mm. (Subgenus *Schilbeodes*).....4

4a. Jaws subequal. Pectoral spine nonserrated, with deep grooves. Head not depressed, body short and chubby. Pelvic-fin rays usually 8, often 9, mean 8.16. Preoperculomandibular pores usually 10, mean 10.19. Free vertebrae 32 to 37, mean 34.3. Maximum SL 105 mm. Fins, barbels, and upper body nearly uniformly pigmented, with a dark gray axial streak; lower surfaces lighter. *Lower Peninsula; southern Upper Peninsula north to Iron County*.....tadpole madtom, *N. gyrinus* (Mitchill, 1817) (p. 132).

4b. Lower jaw included. Pectoral spine long, scarcely curved, with up to 9 short, erect serrae posteriorly, these smaller with age. Head depressed, body slender. Pelvic rays usually 9, mean 9.08. Preoperculomandibular pores usually 11, mean 10.98. Free vertebrae 37 to 42, mean 38.9. Maximum SL 134 mm. Margins of pectoral, anal, dorsal, and caudal fins commonly dusky or black, narrowly edged with light. *Introduced and established in landlocked Clark Lake, Gogebic County, Upper Peninsula; native to Atlantic costal drainages where normally a river species*.....margined madtom, *N. insignis* (Richardson, 1836) (p. 133).

Key to Michigan Species of *Esox* (Esocidae)

1a. Cheek and opercle fully scaled. Mandibular pores typically 4 on each side, rarely 3 or 5 on one side; infraorbital canal usually divided into three sections; no extrascapular canal. Branchiostegal rays usually 12, often 11 or 13. Scale rows on body fewer than 115. Dusky teardrop slanted downward and backward. Pelvic rays usually 8 to 10. Vertebrae 48 to 52 (n=21). Largest Michigan specimen 335 mm SL (ca. 15.5 in. TL). [Body with oblique dark crossbands and often an irregular light stripe at midside]. *Southern half of Lower Peninsula*.....grass pickerel, *E. americanus vermiculatus* Lesueur, 1846 (p. 137).

1b. Lower half of opercle naked. Mandibular pores 5 or more on each side (rarely 4 on one side only); infraorbital canal continuous, usually with 8 to 10 pores; extrascapular canal present, forked, with 3 pores. Branchiostegal rays usually 14 (rarely 13) to 19. Scale rows on body usually more than 115. Teardrop, if present, usually vertical. Pelvic rays usually 10 to 13. Vertebrae 59 or more. Attain a length of more than a meter.....2

2a. Lower half of cheek scaled. Mandibular pores usually 5, large. Branchiostegal rays usually 14 to 16. Scale rows on body usually fewer than 135. Young with oblique green cross bands; larger fish with many oval light spots on head and body. Vertebrae 59 to 63(n=22). *Statewide*.....northern pike, *E. lucius* Linnaeus, 1758 (p. 138).

2b. Lower half of cheek naked. Mandibular pores 6 to 9, small. Branchiostegal rays usually 17 to 19. Scale rows on body usually more than 135. Body color variable: unmarked, with vertical rows of dark spots on a light background, or with dark cross bars. Vertebrae 64 to 68 (n=10). *Discontinuous: Upper Peninsula, especially in west; northern Lower Peninsula; southeastern Lower Peninsula, most commonly in Lake St. Clair and Detroit River*.....muskellunge, *E. masquinongy* Mitchill, 1824 (p. 139).

Key to Michigan Genera of Salmonidae

1a. Scales of moderate size: those in the row above lateral line fewer than 100; rows above lateral line 12 or fewer. Teeth in jaws small or absent. Mouth small or of moderate size, maxilla does not extend behind middle of eye. Parietals in broad contact in median line of skull.....2

1b. Scales small: those in the row above lateral line more than 100; rows above lateral line 18 or more. Teeth in both jaws strong. Mouth large, maxilla extends to back of pupil or beyond (except in juveniles). Parietals widely separated by supraoccipital. Trout and salmon, subfamily Salmoninae.....4

2a. Dorsal fin long, with 17 to 24 rays, the anterior half unbranched; basal length contained less than twice in predorsal length. Maxilla with small teeth. Body with small dark spots. Pyloric caeca 13 to 21. [Juveniles with parr marks. Lateral-line scales 77 to 98]. Graylings, subfamily Thymallinae.....*Thymallus* (Formerly one Michigan species, Arctic grayling, *T. arcticus* (Pallas, 1776); *Upper Peninsula and northern Lower Peninsula; now extirpated from Michigan*). (p. 159).

2b. Dorsal fin short, with 15 or fewer rays, only one to three unbranched; basal length usually contained more than three times in predorsal length. Maxilla toothless. Body without dark spots. Pyloric caeca 23 or more except in *Prosopium coulterii* (15-23) which has fewer than 70 scales in lateral line. Whitefishes, subfamily Coregoninae.....3

3a. A single flap between the nostrils. Juveniles with a series of parr marks. Gill rakers on first branchial arch 13 to 20. Transparent eyelid with a ventroposterior notch below back of pupil. Body subterete. Basibranchial plate present.....*Prosopium*
(See key to species, p. 46.)

3b. Two flaps between the nostrils. No parr marks. Gill rakers on first branchial arch 24 or more. Transparent eyelid without ventroposterior notch. Body usually moderately compressed. No basibranchial plate.....*Coregonus*
(See key to species, p. 44-45.)

4a. Body and dorsal fin with dark spots. Scales larger, those in row above lateral line fewer than 170. Vomer flat, toothed anteriorly, teeth extending back on shaft in a double or zigzag series. Lead edge of pelvic and anal fins not white (except sometimes at tip).....5

4b. Body and dorsal fin often marbled but without dark spots; pale light spots or markings of gray, white, red or orange often present. Scales not obvious, small, those in row above lateral line more than 175. Vomer with trough-like, toothless shaft, teeth confined to head of bone. Lead edges of pelvic and anal fins white.....chars, *Salvelinus* (See key to species, p. 46).

5a. Caudal fin with few or no dark spots. Pelvic-fin rays usually 9 (8) on one or both sides. Adipose fin without a dark margin; principal anal rays 12 or fewer. Second infraorbital bone bladelike.....*Salmo* (See key to species, p. 46).

5b. Caudal fin with some dark spots at SL 150 mm. or above, heavily spotted at larger sizes. Pelvic-fin rays usually 10, rarely 9 or 11. Adipose fin with a black margin or principal anal-fin rays 13 or more. Second infraorbital bone thin and tubular.....*Oncorhynchus* (See key to species, p. 45-46).

Key to Michigan Species of *Coregonus* (Salmonidae)

1a. Premaxillae inclined downward and backward (retrorse), mouth subterminal, the upper jaw longer; snout blunt and rounded. Dorsal fin farther forward, the predorsal length subequal to distance from dorsal origin to adipose fin. Gill rakers on anterior arch (24) 26-29 (31), 28 or fewer in 85%. Size larger, to 7 kg (=15 lbs) or more, commonly SL more than 500 mm. *Great Lakes and a few deep inland lakes*.....lake whitefish, *C. clupeaformis* (Mitchill, 1818) (p. 143).

1b. Premaxillae inclined forward (antrorse), mouth terminal or the lower jaw protruding; snout not blunt and rounded. Dorsal fin farther back, predorsal length much greater than distance from dorsal origin to adipose fin. Gill rakers on anterior arch (31) 33 or more in more than 90% except in *C. johannae* (see 2a below). Size smaller, maximum SL 447 mm.....2

2a. Gill rakers on anterior arch (25) 27-33 (36), 33 or fewer in over 90%. [Pectoral fin long, ratio: pectoral-pelvic distance/pectoral fin length (PP/P) usually 1.5-1.8. Lightly pigmented. Maximum SL 332 mm]. *Formerly in deep waters of lakes Michigan and Huron; now regarded as extinct* (last capture date August 1952).....deepwater cisco, *C. johannae* (Wagner, 1910) (p. 145).

2b. Gill rakers (31) 33-62 (66), 33 or more in over 90% of all stocks, rarely 33 except in *C. reighardi*.....3

3a. Gill rakers on anterior arch (31) 33-43 (50), except usually 44 to 47 in *kiyi* from Lake Ontario (*orientalis*), and in *hoyi*.....4

3b. Gill rakers (38) 44-62 (66).....8

4a. Lower jaw longer than upper.....5

4b. Lower jaw equal to or shorter than upper.....7

5a. Lower jaw usually with symphyseal knob; mandible frail. Small, SL usually less than 250 mm, maximum 277 (L. Ontario). Maxilla seldom immaculate. Gill rakers often as many as 44 to 47.....6

5b. Lower jaw without symphyseal knob; mandible well developed. Larger, commonly attains SL of 300 mm or more, maximum 386 mm. Maxilla usually immaculate. Gill rakers usually 33-43. This is the longjaw (*alpenae*) of Koelz, from lakes Huron and Michigan (recorded also in Lake Erie), now regarded as a variant of the shortjaw cisco, *C. zenithicus*, but with the lower jaw slightly projecting.....shortjaw cisco, *C. zenithicus* (Jordan & Evermann, 1909) (in part) (p. 148).

6a. Body shape in lateral view ovate (greatest depth ahead of dorsal fin). Pectoral fin longer, usually contained 1.3 to 1.7 times in pectoral-pelvic distance (but 1.7 to 2.0 in Lake Ontario). Pigment on premaxilla heavy. Lateral-line scales usually 73 to 87. Eye larger. Spawns in October. *Deep water in lake Superior; formerly in lakes Michigan, Huron, and Ontario*.....kiyi, *C. kiyi* (Koelz, 1921) (p. 146).

6b. Body shape in lateral view elliptical (greatest depth at dorsal origin). Pectoral fin shorter, usually contained 1.6 to 2.0 times in pectoral-pelvic distance. Pigment on premaxilla light. Lateral-line scales usually 61 to 81. Eye smaller. Spawns in spring. *Deep water in lakes Nipigon, Superior, Michigan, Huron, and Ontario*.....bloater, *C. hoyi* (Milner, 1874) (p. 144).

7a. Gill rakers usually 33-38. Pectoral fin usually contained 2.0-2.2 times in pectoral-pelvic distance. Snout and maxilla relatively short. Small, maximum SL 320 mm. *Lakes Michigan, Huron, and Ontario, now perhaps extinct*.....shortnose cisco, *C. reighardi* (Koelz, 1924) (p. 147).

7b. Gill rakers usually 36-43. Pectoral fin usually contained 2.0 – 2.5 in pectoral-pelvic distance. Snout and maxilla longer, usually contained 3.4 – 3.7 and 2.4 – 2. 6 times in head length. Mandible usually immaculate. Maximum SL 386. *Lakes Nipigon, Superior, Michigan, Huron, and Erie; now extirpated from much of range*.....shortjaw cisco, *C. zenithicus* (Jordan & Evermann, 1909) (p. 148).

8a. Gill rakers (38) 44-52 (55). Pectoral-fin length contained in pectoral-pelvic distance (1.6) 1.8 – 2.3 (2.6) times. *Great Lakes; statewide in scattered deep inland lakes*.....cisco or lake herring, *C. artedi* Lesueur, 1818 (p. 142).

8b. Gill rakers 54-62 (66). Pectoral-fin length contained in pectoral-pelvic distance (1.4) 1.5 – 1.8 (1.9) times. *Lake Nipigon and a few adjacent Ontario lakes; not in Michigan unless C. hubbsi* (Koelz, 1929) *from Ives Lake, Marquette Co. is this species*.....Nipigon cisco, *C. nipigon* (Koelz, 1925).

Key to Michigan Species of *Oncorhynchus* (Salmonidae)

1a. Principal anal-fin rays 12 or fewer; length of anal-fin base about equal to depth of caudal peduncle. Adipose fin with a black edge, with or without a narrow break and often with one or a few dark spots. Adults commonly with a broad red lateral stripe, not visible in silvery adults (steelheads). [Gill rakers on first arch 17 to 22]. *Introduced; widely established in cold waters including Great Lakes*.....rainbow trout, *O. mykiss* (Walbaum, 1792) (p. 151).

1b. Principal anal-fin rays 14 or more (rarely 12, frequently 13); length of anal-fin base much greater than depth of caudal peduncle. Adipose fin usually without a black edge, unpigmented, uniformly dusted with melanophores or with a black tip. No lateral red stripe (except in breeding males of *O. kisutch*)..... 2

2a. No parr marks. Gill rakers on first arch usually 29 to 32. Adults with dark spots on back and caudal fin, the largest as large as eye. Posterior adipose eyelid well developed, extends half way to posterior margin of pupil. *Introduced; primarily Lake Superior and tributaries; also northern lakes Michigan and Huron*.....pink salmon, *O. gorbuscha* (Walbaum, 1792) (p. 149).

2b. Parr marks present, at least in juveniles, extend well above and below midside. Gill rakers on first arch usually 19 to 23. Dark spots on back and caudal fin small and irregular, the largest about size of pupil. Posterior adipose eyelid little developed, does not extend half way to margin of pupil.....3

3a. Caudal fin of large fish with dark spots on both upper and lower lobes. Anal fin scarcely falcate, the anterior rays much exceeded by posterior rays in the depressed fin; clear anterior edge not followed by dark pigment. Gums of lower jaw often blackened in adult. Adipose fin blackened in distal third but usually with a clear anterior window. Parr marks broader, usually as wide as or wider than light interspaces. *Introduced; Great Lakes and lower courses of major tributaries*.....Chinook salmon, *O. tshawytscha* (Walbaum, 1792) (p. 152).

3b. Caudal fin of large fish with dark spots confined to upper lobe. Anal fin falcate, the anterior rays almost as long as posterior rays when depressed; clear anterior edge followed by dark pigment. Gums of lower jaw in adult usually gray or dusky in Michigan waters (light in marine fish). Adipose fin uniformly dusted with melanophores. Parr marks narrower and higher, much exceeded by the light interspaces. *Introduced; Great Lakes and tributaries*.....coho salmon, *O. kisutch* (Walbaum, 1792) (p. 150).

Key to Michigan Species of *Prosopium* (Salmonidae)

1a. Lateral-line scales (55) 56 to 66 (70); scales around body (31) 33 to 37 (40); scales around caudal peduncle (16) 18 to 20. Vertebrae 52 to 54. Pyloric caeca 15 to 23. Pelvic-fin rays 9 or 10 (11). Small, maximum total length about 153 mm (Lake Superior) or 200 mm (Alaska). *Lake Superior*.....pygmy whitefish, *P. coulterii* (Eigenmann & Eigenmann, 1892) (p. 153).

1b. Lateral-line scales (80) 83 to 96 (100); scales around body (40) 42 to 46 (47); scales around caudal peduncle 22 to 25. Vertebrae 59 to 63. Pyloric caeca 87 to 117. Pelvic-fin rays (10) 11 (12). Large, maximum weight formerly about 6 pounds (2.7kg). *Shore waters of Great Lakes (except Erie) especially northerly; rare in inland rivers, except the Au Sable*.....round whitefish, *P. cylindraceum* (Pallas, 1784) (p. 154).

Key to Michigan Species of *Salmo* (Salmonidae)

1a. Scale rows around caudal peduncle 45 to 49. Lateral-line scales 109 to 121. Adipose fin smaller, not orange in life. Vomerine teeth few, not extending far back on shaft. Caudal fin deeply forked in juveniles, somewhat truncated in adults. Mouth smaller, maxilla extends to below center of orbit in young, increases with age but does not exceed orbit except in adults. *Not established in Michigan. Currently stocked in St. Marys River and Torch Lake; sport catch significant*.....Atlantic salmon, *S. salar* Linnaeus, 1758 (p. 155).

1b. Scale rows around caudal peduncle 53-61. Lateral-line scales 120 to 130. Adipose fin larger, orange or with orange spots in young and half grown. Vomerine teeth numerous, large, extending far back on shaft. Caudal fin always less deeply forked than in salmon of the same size. Mouth larger, maxilla extends to below back margin of orbit in large young, increases with age, and is decidedly larger in adults. *Introduced and established widely in cold waters (no records from Isle Royale)*.....brown trout, *S. trutta* Linnaeus, 1758 (p. 156).

Key to Michigan Species of *Salvelinus* (Salmonidae)

1a. Caudal fin truncate or shallowly forked. Adults with blue halos surrounding red spots on side; in breeding male lower side and fins brilliant red. Anal and pelvic fins brightly colored, with sharply contrasting white lead edges followed by black. Dorsal-fin origin closer to snout tip than to caudal-fin base. Basibranchial (hyoid) teeth usually lacking. Vertebrae 58 to 62. Pyloric caeca 23 to 55, usually fewer than 50. Size smaller, record 6.6 kg (14.5 lb), infrequently over TL 500 mm. Parr marks wider than interspaces. *Statewide in cold waters; originally in Jordan River in the Lower Peninsula and in Upper Peninsula*.....brook trout, *S. fontinalis* (Mitchill, 1814) (p. 157).

1b. Caudal fin deeply forked. Adults with light spots, lower fins may be reddish but body lacks gaudy red and blue of brook trout. Dorsal-fin origin closer to caudal-fin base than to snout. Basibranchial (hyoid) teeth present. Vertebrae 61 to 69. Pyloric caeca 93 or more, usually 120 to 180. Size large; record 46.3 kg (102 lbs), TL 126 cm (49.5 in). Parr marks of juveniles narrower than interspaces. *Large deep lakes, especially Great Lakes*.....lake trout, *S. namaycush* (Walbaum, 1792) (p. 158).

Key to Michigan Species of *Fundulus* (Fundulidae)

1a. Origin of dorsal fin in advance of that of anal fin, much nearer back of head than caudal base. Dorsal-fin rays usually 11 to 13. Body with dark vertical bands in both sexes, those of male broader, subequal in width to the silvery interspaces; those of female much narrower than interspaces. Lateral scale rows usually 40 to 44. *Southern Michigan and the Lake Michigan and Lake Huron drainages of the Upper Peninsula*.....western banded killifish, *F. diaphanus menona* Jordan & Copeland, 1877 (p. 163).

1b. Origin of dorsal fin behind vertical from that of anal fin, much nearer caudal base than back of head. Dorsal-fin rays 7 to 9. Body without vertical dark bands except in males of *F. dispar.* Lateral scale rows usually 33 to 35.....2

2a. No dark teardrop below eye. Midside with a broad dark stripe, its borders zigzag with vertical extensions, especially in males, the lower edge straight in females. Dorsal-fin rays usually 8 or 9. Slender, depth 4.0 to 5.3 in SL. *Southern three tiers of counties in Lower Michigan*.....blackstripe topminnow, *F. notatus* (Rafinesque, 1820) (p. 165).

2b. A prominent black teardrop downward and backward from eye. Males with about 10 to 16 narrow vertical bars superimposed on longitudinal rows of dark spots at scale centers; females with about 10 horizontal stripes that lie between scale rows. Dorsal-fin rays usually 7, often 8. Body more compressed, depth 3.3 to 4.1 in SL. *Lake Michigan drainage north to Barry County*.....starhead topminnow, *F. dispar* (Agassiz, 1854) (p. 164).

Key to Great Lakes Species of Gasterosteidae

1a. The two halves of pelvic girdle in broad contact, forming a long, median posterior process. Dorsal spines infrequently 4, the anterior spines not widely separated from spine at origin of soft-dorsal fin. Pelvic rays I, 1(pelvic girdle occasionally absent).....2

1b. The halves of pelvic girdle forming a pair of well-separated lateral, posterior processes. Dorsal spines usually 4 (rarely 5), the first longer than eye; anterior 3 (or 4) spines grouped, remote from spine at origin of soft-dorsal fin. Pelvic rays I, 2. [Body naked, without plates or scales. Anal spine below dorsal soft ray 3 or 4. Gill membranes fused to isthmus.] *Hypothetical in Michigan. Introduced, presumably in ballast water, and established in Lake Superior drainage near Thunder Bay, and at Marathon, Ontario*.....fourspine stickleback, *Apeltes quadracus* (Mitchill, 1815).

2a. Dorsal spines 5 (rarely 4) to 12, entire, subequal in length, short (about equal to pupil), equally spaced, alternately divergent to left or right. Gill membranes broadly united, forming a free fold across isthmus. Anal-spine origin below last dorsal spine or first dorsal soft ray. Body naked or with small plates in caudal keel. Pelvic spine entire, about equal to or shorter than eye.....3

2b. Dorsal spines usually 3 (very rarely 2 or 4), strongly serrate and bases expanded, the first two much longer and well forward of third (longest equal to or greater than eye), median. Gill membranes fused to isthmus. Anal-spine origin below base of dorsal soft ray 4 to 6. Body with series of elevated, lateral bony plates that posteriorly form supporting ribs for pronounced caudal keel. Pelvic spine serrate, much longer than eye. *Recently* (about 1980*) introduced presumably from ballast-water transfers from the Atlantic Ocean and now widely distributed in upper Great Lakes. An imperfectly plated freshwater form (termed* cuvieri *or* leiurus*) occurs naturally in the Lake Ontario basin but this is not the form now found in the upper lakes (e.g., Michigan)*.....threespine stickleback, *Gasterosteus aculeatus* Linnaeus, 1758 (p. 168).

3a. Dorsal spines (8) 9 or 10 (12). Caudal peduncle very slender, much broader than deep, usually provided with lateral keels. Caudal fin shallowly lunate. Pelvic process broad, triangular; no median keel behind. *Deep cold lakes; shores of upper Great Lakes and adjacent areas*.....ninespine stickleback, *Pungitius pungitius* (Linnaeus, 1758) (p. 169).

3b. Dorsal spines usually 5, vary from 4 to 7. Caudal peduncle slender, nearly round, lacking lateral keels. Caudal fin truncate or rounded. Pelvic process slender, spinelike, followed by a median fleshy keel. *Statewide*.....brook stickleback, *Culaea inconstans* (Kirtland, 1841) (p. 167).

Key to the Michigan Species of Cottidae

1a. Gill membranes free from isthmus, joined in a deeply angled, free fold. Upper two preopercular spines directed backward, the second somewhat downward. Dorsal fins widely separated. No pores at front of lower jaw. Mouth large, U-shaped, the chin protruding. Pelvic-fin soft rays usually three, the last longest. Dorsal soft rays usually 12 or 13. *Deep waters of lakes Huron, Michigan, and Superior*.....deepwater sculpin, *Myoxocephalus thompsonii* (Girard, 1851) (p. 173).

1b. Gill membranes fused to isthmus. Second preopercular spine directed downward. Dorsal fins conjoined, contiguous, or narrowly separated. One or two pores near symphysis of lower jaw. Mouth smaller, crescent-shaped as viewed from below, lower jaw does not protrude. Pelvic-fin soft rays three or four, the second or third (not last) longest. Dorsal-fin soft rays 15 to 18..... *Cottus*...2

2a. A single median pore at front of lower jaw. Lateral line complete in adults. Upper preopercular spine long, sickle-shaped, directed upward or even somewhat forward. Body and top of head with many prickles. Caudal peduncle slender, depth 4.7 to 5.9 percent of SL. Head more depressed, truncate [tapered] as viewed from above. [Pelvic-fin rays I, 4; palatine toothless]..... *Great Lakes shores, including Isle Royale, often in deep water; south to Green Bay and off Ottawa County in Lake Michigan and to Iosco County in Lake Huron; rare*..... .....spoonhead sculpin, *C. ricei* (Nelson, 1876) (p. 172).

2b. A pair of separated pores at front of lower jaw (very rarely united). Lateral line incomplete, usually ending below second dorsal fin. Upper preopercular spine shorter, curved but directed backward and somewhat upward. Prickles, if present, confined to area mesial to pectoral fin. Caudal peduncle deeper, 6.2 to 9.2 (usually at least 7.0) percent of SL. Head deeper, broadly rounded as viewed from above.....3

3a. Pelvic-fin rays usually I, 4, the second and third soft rays subequal or the third ray longer; fourth ray typically well developed. Anal fin farther back: last anal ray below or scarcely in advance of last dorsal soft ray; caudal peduncle length 10.8 to 14.7 (usually 14 or less) percent of SL; distance from chin to anal-fin origin 58.0 to 62.1 percent of SL. Caudal-peduncle length 4.0 to 5.2 times in distance from chin to anal-fin origin. Last two elements of soft dorsal and anal fins (counted as the last ray) typically closely approximated (i.e., with a single basal support). Dorsal-fin soft rays modally 17 or 18 (often 16); anal-fin rays usually 12 to 14. Interradial membranes of anal fin less deeply notched. Palatine usually with teeth, sometimes in a broad band but often in a single short row of 2 to 12 teeth; occasionally toothless. *Statewide except in lake plains of Saginaw-Bay drainage*.....mottled sculpin, *C. bairdii* Girard, 1850 (p. 170).

3b. Pelvic-fin rays usually I, 3 in our area[1], the second soft ray longer; if four rays are present, the fourth is usually slender and short, scarcely half the third ray. Anal fin more advanced: last anal ray well forward of last dorsal soft ray; caudal peduncle length 13.6 to 19.5 (usually 15 or more) percent of SL; distance from chin to anal origin 56.1 to 59 percent of SL. Caudal-peduncle length 3.1 to 3.8 times in distance from chin to anal origin. Last two elements of soft-dorsal and anal fins (counted as the last ray) typically well separated (i.e., each with its own basal support). Dorsal-fin soft rays (13) 15 or 16; anal-fin rays (9) 10 to 12 (13). Interradial membranes of anal fin deeply notched. Palatine commonly toothless, but often with a few (usually 1 to 6; rarely up to 12) teeth.....*Great Lakes (Superior, Michigan, and Huron) often in deep water; Upper Peninsula; northern Lower Peninsula south to Ogemaw and Oceana counties (avoiding Muskegon River drainage)*.....slimy sculpin, *C. cognatus* Richardson, 1836 (p. 171).

[1]The pelvic-ray structure and count as here given for *cognatus* is useful and rather consistent in the Great Lakes area and elsewhere in the East, but breaks down as a species distinction in the West and Northwest. For example, Alaskan populations usually have four developed pelvic-fin rays.

Key to Michigan Species of *Morone* (Moronidae)

1a. Anal spines graduated, the second much shorter than third and scarcely thicker; anal soft rays (11) 12 (13). Second dorsal rays (including spine) (13) 14 or 15. Scales around caudal peduncle (23) 24 to 26 (27). Lateral-line scales (51) 52 to 56 (57). Lower jaw protrudes beyond upper. Basihyal teeth present, usually in two patches, sometimes united with age. Body in half-grown and adults with horizontal dark stripes. *Most common in southern half of Lower Peninsula from Saginaw Bay and tributaries south to Lake Erie; also southern Lake Michigan, and in Green Bay. Scattered records in Lake Superior and in northern Lower Peninsula may not represent established populations*.....white bass, *M. chrysops* (Rafinesque, 1820) (p. 175).

1b. Second and third anal spines subequal in length, the second only slightly shorter but much thicker; anal soft rays (8) 9 or 10. Second-dorsal rays (including spine) (12) 13 (14). Scales around caudal peduncle (20) 21 (22). Lateral-line scales usually 47 to 49. Jaws equal in forward extent. No basihyal teeth. Body without horizontal dark stripes. *Introduced by canal connections and dispersal from Atlantic Coast, reaching Lake Erie in 1953. Now common from Lake Erie to Saginaw Bay and tributaries and dispersing rapidly; reports from as far as Green Bay*.....white perch, *M. americana* (Gmelin, 1798) (p. 174).

Key to Michigan Genera of Centrarchidae

1a. Anal spines typically 3 (rarely 2 or 4). Dorsal spines usually 10. Branchiostegal rays 6.....2

1b. Anal spines modally 6 (rarely 5 or 7). Dorsal spines never 10. Branchiostegal rays 6 (*Ambloplites*) or 7 (*Pomoxis*).....3

2a. Body subterete, elongate. Scales small, 9 to 20 rows on cheek and 58 to 81 on lateral line. Opercle emarginate. Vertebrae usually 15 + 17 = 32.....*Micropterus*
(See key to species, p. 50).

2b. Body moderately compressed, oblong. Scales larger, in 3 to 9 rows on cheek and usually 33 to 50 in lateral line. Opercle rounded behind (emarginate in small young) or produced into a flexible flap. Vertebrae usually 12 + 17 or 18 = 29 or 30.....*Lepomis*
(See key to species, p. 49-50).

3a. Dorsal-fin spines 11 or 12, soft rays 10 or 11. Base of anal fin contained 1.7 to 2.0 in dorsal base. Gill rakers moderately strong, short, fewer than 15. Ectopterygoid teeth present; glossohyal teeth in a single patch. Preopercle weakly crenate. Subocular bar oblique. Vertebrae usually 13 + 18 = 31.....*Ambloplites*
(One Michigan species, rock bass, *A. rupestris* (Rafinesque, 1817); *statewide except Isle Royale)*. (p. 176).

3b. Dorsal-fin spines (5) 6 to 8, soft rays 14 to 17. Basal lengths of anal and dorsal fins subequal. Gill rakers long and slender, more than 25. No ectopterygoid teeth; glossohyal teeth in two patches. Preopercle finely serrate. No subocular dark bar. Vertebrae usually 14+18 or 19 = 32 or 33.....*Pomoxis*
(See key to species, p. 51).

Key to Michigan Species of *Lepomis* (Centrarchidae)

1a. Tongue, ectopterygoid, and entopterygoid toothed. Supramaxilla well developed, its length greater than breadth of maxilla. *Southern half of Lower Peninsula* .....warmouth, *L. gulosus* (Cuvier, 1829) (p. 179).

1b. No teeth on tongue, ectopterygoid, or entopterygoid. Supramaxilla reduced or wanting, its length much less than breadth of maxilla.....2

2a. Opercle (not including membrane) stiff to its margin; not fimbriate along posterior edge.....3

2b. Opercle produced into a thin, flexible projection lying within the opercular membrane; often more or less fimbriate or ragged posteriorly.....5

3a. Pectoral fin short and broadly rounded; about 4 in SL. Anal fin with a light margin. Gill rakers moderately long and slender, the longest if depressed extends to base of second (third in young) raker below. Opercle broadly margined with light, without scarlet in life. Supramaxilla about two-thirds breadth of maxilla. Inferior pharyngeal bone elongate, external margin straight, teeth rather sharp. Palatine teeth fairly well developed. *Lower Peninsula; scattered stations in Upper Peninsula where probably introduced*..... .....green sunfish, *L. cyanellus* Rafinesque, 1819 (p. 177).

3b. Pectoral fin long and pointed, 2.7 to 3.3 in SL. Anal fin without light margin. Gill rakers short and stout, the longest if depressed extends to base of first (second in young) raker below. Opercular edge dark, often with a scarlet spot or margin. Supramaxilla about one-third breadth of maxilla. Inferior pharyngeal bone broad and heavy, the external margin a sigmoid curve, teeth blunt. Palatine teeth normally absent (often a single tooth developed).....4

4a. A small semicircular scarlet spot on a dark opercular margin. Pectoral fin shorter, about 3.0 to 3.3 in SL in adult. Form more gibbous and subcircular. Lateral-line scales (36) 38 to 44 (47). Soft dorsal and anal fins spotted or mottled. Opercle stiff to its margin. *Statewide*....pumpkinseed, *L. gibbosus* (Linnaeus, 1758) (p. 178).

4b. Opercle broadly margined with scarlet. Pectoral fin longer, about 2.7 to 3.0 in SL in adult. Form more rhomboidal. Lateral-line scales [in Michigan] (34) 35 to 38 (39). Soft dorsal and anal fins not mottled or spotted. Opercle somewhat flexible near margin in adult. *Introduced; southern three tiers of counties*.....redear sunfish, *L. microlophus* (G□nther, 1859) (p. 182).

5a. Gill rakers short and stout, knoblike, the longest when depressed does not extend beyond first raker below (except in young). Longest anal spine usually 1.8 to 2.4 (1.4 or more in young) in distance from insertion of pelvic fin to origin of anal fin. Pectoral fin short, obovate. Caudal vertebrae typically 18. *Lower Peninsula*.....northern longear sunfish, *L. peltastes* Cope, 1870 (p. 183).

5b. Gill rakers rather long and slender, the longest when depressed extends to base of second raker below (third in young). Longest anal spine usually 1.0 to 1.8 in distance from insertion of pelvic fin to origin of anal fin (1.0 to 1.4 in young). Pectoral fin moderate to long. Caudal vertebrae typically 17.....6

6a. Opercle extends little into membranous flap, its flexible margin entire; opercular membrane broadly margined with light. Anal fin III, 7 to 9. No dark blotch on posterior dorsal rays. Palatine teeth present. Sensory cavities of head well developed, the supraorbital canals wider than interspace. *Recent invader in southeastern Michigan* (*Monroe, Washtenaw, and Wayne counties*); *surviving but apparently not spreading*.....orangespotted sunfish, *L. humilis* (Girard, 1858) (p. 180).

6b. Opercle extends almost to membranous margin, its edge fimbriate; opercular membrane dark to its margin. Anal fin III, 10 to 12. A dark blotch on median part of posterior dorsal rays. Palatine teeth absent. Sensory cavities of head not enlarged, the supraorbital canals much narrower than interspace. *Lower Peninsula; less common in Upper Peninsula, where perhaps introduced*..... .....bluegill, *L. macrochirus* Rafinesque, 1819 (p. 181).

Key to Michigan species of *Micropterus* (Centrarchidae)

1a. Outline of spinous dorsal fin a gentle curve, shortest spine at emargination more than half as long as the longest. Anal and soft dorsal fins with scales on membranes near base. Scales 68 to 81 along lateral line and 14 to 18 on cheek from eye to angle of preopercle. Pattern consists principally of vertical dark bars, becoming obscured with age; young with base of caudal fin yellow followed by a marked dark band, the edge of fin immaculate. Pyloric caeca mostly unbranched. Mouth smaller, maxilla does not exceed eye in adult. *Statewide except Isle Royale*.....smallmouth bass, *M. dolomieu* Lacepède, 1802 (p. 184).

1b. Outline of spinous dorsal fin angulate, shortest spine at emargination less than half as long as longest. Anal and soft dorsal fins normally without scales on membranes near base. Scales 58 to 69 along lateral line and 9 to 12 on cheek from eye to angle of preopercle. Pattern consists chiefly of a rather regular longitudinal dark stripe on side; young without marked band on caudal fin. Most pyloric caeca branched at base. Mouth larger; maxilla exceeds eye in adult. *Statewide except Isle Royale; perhaps introduced in Upper Peninsula*.....largemouth bass, *M. salmoides* (Lacepède, 1802) (p. 185).

Key to species of *Pomoxis* (Centrarchidae)

1a Dorsal-fin spines usually 6 (rarely 5 or 7); soft rays 14 or 15. Dorsal-fin base much shorter than distance from origin of dorsal to posterior margin of eye (58 to 65 percent of predorsal length). Caudal vertebrae typically 18. Mouth moderately oblique. Dark markings on body are arranged in irregular vertical cross bands. *Southern two-thirds of Lower Peninsula, north to Mason and Alcona counties; mostly near the Great Lakes; one Upper Peninsula record in Iron Lake, Iron County, where introduced*.....white crappie, *P. annularis* Rafinesque, 1818 (p. 186).

1b. Dorsal-fin spines usually 7 but commonly 8; soft rays 14 to 20. Dorsal-fin base equal to or greater than distance from origin of dorsal to posterior margin of eye (73 to 81 percent of predorsal length). Caudal vertebrae typically 19. Mouth strongly oblique. Dark markings on body more irregular and mottled, not forming vertical cross bands. *Most of Lower Peninsula (except northern tip); scattered in western half of Upper Peninsula where perhaps introduced; one record on Isle Royale*.....black crappie, *P. nigromaculatus* (Lesueur, 1829) (p. 187).

Key to Michigan Genera of Percidae

1a. Preopercle strongly serrate. Branchiostegal rays 7 (occasionally 8). No distinct urogenital papilla. Supraoccipital crest high. Fishes of medium to large size.....2

1b. Preopercle not strongly serrate. Branchiostegal rays usually 6, infrequently 5, rarely 7. Genital papilla prominent. Supraoccipital crest weak or absent. Slender fishes of small size (maximum TL, about 170 mm; most species maximum SL less than 110 mm). Darters, Etheostomatinae.....4

2a. Spinous and soft dorsal fins broadly connected. Head scaleless, with much enlarged sensory chambers. Mouth small, extends to about front of eye. Lateral-line scales larger than those above and below, fewer than 40. Preopercular spines in part very large. [Anal-fin rays II, 6 or 7, the spines strong, longer than soft rays. Body without series of dark crossbands. Adults attain a TL of 250 mm, usually 13 to 18 cm.].....*Gymnocephalus*
(One species introduced from Europe via ballast tanks, ruffe, *G. cernuus* (Linnaeus, 1758); *in western Lake Superior and in Lake Huron near Alpena; spreading).* (p. 199).

2b. Dorsal fins separate or contiguous. Head without enlarged sensory chambers, usually partly scaled. Mouth larger, extends beyond front of eye. Lateral-line scales not enlarged, more than 50. Preopercular spines small and numerous, comb-like.....3

3a. Strong canine teeth on jaws and palatine. Pelvic fins widely separated (interspace equal to breadth of fin base). Body slender and subterete. Anal-fin rays II, 12 or 13. Pseudobranchium well developed. (Long known as *Stizostedion*).....*Sander*
(Two Michigan species, see separate key, p. 54).

3b. No canine teeth. Pelvic fins close together. Body rather deep and compressed, crossed by about 7 prominent vertical dark bands. Anal-fin rays II, 6 to 8. Pseudobranchium rudimentary.....*Perca*
(One Michigan species, yellow perch, *P. flavescens* (Mitchill, 1814); *statewide*). (p. 200).

4a. Spinous and soft-dorsal fins separated by a space about equal to diameter of eye. Breast and belly scaleless, body elsewhere imperfectly scaled. Body in life translucent. Lateral line complete, cephalic canals uninterrupted. Anal spine single, flexible. Premaxilla protractile. [Vomer and palatine toothless. Body slender, depth 7 to 9 in SL].....*Ammocrypta*
(Two Michigan species, see separate key, p. 52).

4b. Spinous and soft-dorsal fins usually contiguous, or nearly so (narrowly separated in *P. copelandi*). Breast and/or belly usually with scales. Body opaque, often well patterned or brightly colored. Lateral line and cephalic canals variously complete or interrupted. Anal spines typically two except in *E. nigrum* and sometimes in *E. microperca*, usually stiff.....5

5a. Interpelvic space and midline of belly with a series of enlarged, specialized ctenoid scales; modified scales sometimes reduced and occasionally of normal size in females or even absent, but at least one enlarged scale typically present. Anal fin large, about equal to or larger than soft-dorsal fin (somewhat smaller in *P. caprodes*). Body usually more slender and terete, the lateral-line and cephalic canals uninterrupted. [Pelvic fins widely separated, the interspace nearly or quite as great as base of fin. Vertebrae 38 to 46.].....*Percina*
(Four Michigan species, see separate key, p. 54).

5b. Breast, interpelvic space, and belly variously naked or covered with normal scales, but never with a median series of enlarged and modified scales. Anal fin usually smaller than soft dorsal fin. Body usually deeper and more compressed. [Pelvic fins separated by a space that varies from nearly as wide as pelvic base to less than half that distance. Lateral line, infraorbital canal, and supratemporal canal complete or incomplete. Vertebrae 32 to 42. Body frequently with bright colors].....*Etheostoma*
(Seven Michigan taxa, see separate key, p. 52-53).

Key to Michigan Species of *Ammocrypta* (Percidae)

1a. Upper part of opercle a sharply pointed, posterior spine. Anal-fin origin slightly in advance of second dorsal-fin origin; snout tip to anal-fin origin 59.2 to 61.7% of SL. Transverse scale rows (counted from second dorsal-fin origin downward and backward at an angle of 45 degrees to anal-fin base) (3) 4-7 (12). Side and top of snout, upper lip, and subopercular area rather uniformly stippled with dark. Pelvic fin unpigmented. Preoperculomandibular pores usually 8. Vertebrae (38) 39-40 (42). *Menominee River drainage, Upper Michigan*.....western sand darter, *A. clara* Jordan and Meek, 1885 (p. 188).

1b. Upper part of opercle a rounded, non-spinous lobe. Anal-fin origin below second dorsal-fin origin; snout tip to anal-fin origin 61.8 to 65.7% of SL. Transverse scale rows (6) 8-14 (16). Side and top of snout with bold, contrasting markings: a black bridle on upper lip, black stripe above and black blotch below nostril, clear suborbital area. Pelvic fin of male dusky. Preoperculomandibular pores usually 10, commonly 9 or 11. Vertebrae (42) 43-44 (45). *Southeastern Michigan in Lake Erie, Lake St. Clair, and St. Clair River tributaries*.....eastern sand darter, *A. pellucida* (Putnam, 1863) (p. 189).

Key to Michigan Species of *Etheostoma* (Percidae)

1a. Lateral line with at least 11 pored scales; lateral scales 37 (usually at least 40) or more. Preoperculomandibular pores usually 10, often 9 in *E. nigrum*; infraorbital canal complete or incomplete, with 6 or more pores. Branchiostegal rays usually 6 (occasionally 5 in *E. zonale*). All species attain a SL of 60 mm or more.....2

1b. Lateral line absent or with no more than 3 pored scales; lateral scales 30 to 36, usually 32 to 34. Preoperculomandibular pores usually 6; infraorbital pores usually 2 or 3. Branchiostegal rays usually 5. Smallest Michigan fish; maximum SL 37 mm. [Anal spines 1 or 2. Dorsal spines 5 to 8, usually 6. Pelvic fin of breeding male tuberculate, long, with red-orange color]. (Subgenus *Microperca*). *Statewide except for Isle Royale and the eastern Upper Peninsula*.....
.....least darter, *E. microperca* Jordan and Gilbert, 1888 (p. 195).

2a. Lateral line complete (or with no more than 4 unpored scales). Dorsal saddles or cross bands 6 or 7. Snout blunt.....3

2b. Lateral line incomplete, with 8 or more unpored scales. Dorsal saddles or crossbands, if evident, usually 8 or more. Snout moderately sharp.....5

3a. Gill membranes broadly conjoined to form a gentle curve or a strongly obtuse angle. Pelvic fins widely spaced, the interspace about three-fourths of fin base. Spinous dorsal fin green distally with a series of dark red blotches at base. Anal spines 2, the first stiff. Dorsal spines usually 10 to 14. Supratemporal canal complete. Genital papilla of female a long tube. (Subgenus *Etheostoma*).....4

3b. Gill membranes separate, the junction forms an acute angle. Pelvic fins close together, the interspace less than two-thirds of fin base. Spinous dorsal fin not brightly colored, often with a dark anterior spot. Anal spine 1, flexible. Dorsal spines usually 8 or 9, infrequently 10. Supratemporal canal interrupted. Genital papilla of female broad, flat, and bilobed. [Premaxilla protractile, separated from snout by a deep groove.] (Subgenus *Boleosoma*). *Statewide except Isle Royale*.....johnny darter, *E. nigrum* Rafinesque, 1820 (p. 196).

4a. Maxilla adnate to preorbital (lachrymal) bone. Premaxilla separated from the bulbous snout by a deep groove. Breast naked. Anal-fin rays II, 8 or 9. Lateral-line scales usually 56 to 65: caudal peduncle scale rows 20 to 22. Larger, maximum SL over 100 mm. Dorsal spines usually 12 to 14, dorsal soft rays 13 to 16. A series of 7 or 8 V-shaped lateral blotches. *Southern half of the Lower Peninsula, mostly but not exclusively, in eastern drainages*.....greenside darter, *E. blennioides* Rafinesque,1819 (p. 190).

4b. Maxilla free from preorbital bone. Premaxillary frenum present. Breast partly or wholly invested with exposed ctenoid scales. Anal-fin rays II, 6 or 7. Lateral-line scales 43 to 47; caudal peduncle scale rows 16 to 19. Smaller, maximum SL 65 mm. Dorsal spines usually 10 to 12, dorsal soft rays usually 11 or 12. A series of 8 or 9 green lateral cross bars. *Green Bay drainage of Menominee County, Upper Peninsula*.....banded darter, *E. zonale* (Cope, 1868) (p. 198).

5a. Gill membranes separate or narrowly united, the junction forms an acute angle. Scales present on opercle; present or absent on cheek, nape, and breast. Dorsal spines usually 8 or more, long, not modified as in 5b. Caudal fin truncate. No black humeral spot. Adults, especially males, gaudily colored on body and fins with red, orange, and blue. (Subgenus *Oligocephalus*).....7

5b. Gill membranes broadly united over isthmus to form a gentle curve or obtuse angle. No scales on opercle, cheek, nape, breast, or prepectoral area. Dorsal spines usually 7 or 8, short (fin much lower than soft dorsal fin); in breeding males the spine tips are expanded and bear fleshy orange pads used in egg cleaning. Caudal fin rounded, with many narrow cross bands. A prominent black humeral spot. No bright colors. (Subgenus *Catonotus*).....fantail darter, *E. flabellare* Rafinesque, 1819. Two subspecies occur in Michigan.....6

6a. Body pattern dominated by a series of about 12 vertical dark crossbands. *Southern two-thirds of Lower Peninsula*.....barred fantail darter, *E. f. flabellare* Rafinesque, 1819 (p. 193).

6b. Body crossbands usually evident but dominated by superimposed horizontal rows of spots and dashes. *South central Upper Peninsula*.....striped fantail darter, *E. f. lineolatum* (Agassiz, 1854) (p. 194).

7a. Cheek well scaled. Supratemporal canal usually incomplete, pores 2-2. Dorsal spines usually 8 or 9 (7 to11). Lateral line gently arched upward anteriorly, with 18 to 34 pored scales; unpored scales in lateral series 27 to 42; scale rows 52 to 67. *Statewide*.....Iowa darter, *E. exile* (Girard, 1859) (p. 192).

7b. Cheek naked or with a few imbedded scales behind eye. Supratemporal canal usually complete, with 3 pores. Dorsal spines usually 9 to 11 (8 to 12). Lateral line almost straight, with 23 to 31 pored scales; unpored scales in lateral series 8 to 24; scale rows 37 to 50.....8

8a. Infraorbital canal complete, pores usually 8. Pectoral rays (12) 13 (14). Adult male with a red blotch on anal fin. Gill membranes narrowly connected. Cross bands from anal-fin origin to caudal fin 6 or 7, narrow. Unpored scales in lateral series usually 15 or more. *Lower Peninsula excluding some northwestern areas*.....rainbow darter, *E. caeruleum* Storer, 1845 (p. 191).

8b. Infraorbital canal incomplete, pores 2 to 4+4=6 to 8. Pectoral rays usually (10) 11 or 12. Adult male without red on anal fin. Gill membranes not connected. Cross bands from anal-fin origin to caudal fin usually 4 or 5, broad. Unpored scales in lateral series usually 14 or fewer. *Southeastern Michigan in Lake Erie drainage*.....orangethroat darter, *E. spectabile* (Agassiz, 1854) (p. 197).

Key to Michigan Species of *Percina* (Percidae)

1a. Interorbital space broad, more or less depressed. Snout forms a conical fleshy protuberance that projects beyond upper jaw. Body with many (14 to 18) narrow crossbands that extend from back to mid or lower side. Mouth small, maxilla does not reach front of eye. Nape scaleless. [Lateral-line scales more than 75. A prominent basicaudal spot. Large, SL to over 100 mm]. (Subgenus *Percina*). *Statewide*.....northern logperch, *P. caprodes semifasciata* (De Kay, 1842) (p. 201).

1b. Interorbital space neither especially broad nor depressed. Snout does not project beyond upper jaw. Body crossbands, if present, fewer, confined to side. Maxilla extends to beyond front of eye. Nape at least partly scaled.....2

2a. Premaxillary frenum wide. Dorsal-fin spines (12) 13 to 15. Transverse scale rows (from anal-fin origin upward and forward to dorsal-fin base) 17 to 23. [A series of 6 to 9 large, oval lateral blotches, often confluent. SL to 80 mm.] (Subgenus *Alvordius*). *Lower Peninsula; Lake Michigan drainage of central and eastern Upper Peninsula with one record in Lake Superior drainage of Marquette County*.....blackside darter, *P. maculata* (Girard, 1859) (p. 203).

2b. Premaxilla protractile or the frenum very narrow. Dorsal-fin spines (9) 10 or 11 (12). Transverse scale rows 13 to 17. Pattern either of a dark midlateral stripe, a series of confluent blotches, or about 8 to 15 vertical dark bars.....3

3a. Snout blunt, separated by a deep groove from premaxilla. Scales around the slender caudal peduncle 16 to 18. Dorsal soft rays (10) 11 or 12 (14); anal soft rays (7) 8 or 9 (10). Side with a dark stripe or series of confluent blotches. First dorsal fin in adult male with a broad dark band near base and a narrow dark band at or near fin margin. Anal fin of male not elevated. SL to 60 mm. (Subgenus *Cottogaster*). *Lake Erie to Cheboygan River along eastern edge of Lower Peninsula, entering lower courses of larger tributaries*.....channel darter, *P. copelandi* (Jordan, 1877) (p. 202).

3b. Snout pointed, with a narrow frenum or separated by a shallow groove from premaxilla. Scales around caudal peduncle 20 to 25. Dorsal soft rays (11) 13 or 14 (16); anal soft rays (10) 11 (13). Side with 8 to 15 vertically elongate discrete bars. First dorsal fin with a small dark spot at anterior base and a larger posterior blotch. Adult male with anal fin greatly elevated, the rays reaching caudal fin; seasonally with tubercles on lower fins and caudal fin. SL to 65 mm. [Belly largely scaleless, especially in females; the specialized midventral series sometimes absent or reduced to a single interpelvic scale]. (Subgenus *Imostoma*). *Lake Erie to Lake Huron at mouth of Au Sable River, inshore waters and lower courses of major tributaries*.....river darter, *P. shumardi* (Girard, 1859) (p. 204).

Key to Michigan Species of *Sander* (formerly *Stizostedion*) (Percidae)

1a. Lower lobe of caudal fin not tipped with white. Spinous dorsal fin with clear-cut black spots (except in young), but without a large black blotch near base of posterior spines. Second-dorsal fin rays (18) 19 or 20 (22). Cheek usually well scaled. Pyloric caeca 3 to 9 (usually 5), each shorter than stomach. Back with 3 or 4 dark saddles, these expanded laterally to form 3 prominent oblong blotches, one below each dorsal fin and a smaller one on caudal peduncle. Vertebrae usually 43 to 45. *Great Lakes and lower Muskegon River; now rare. Not known from Isle Royale*.....sauger, *S. canadensis* (Smith, 1834) (p. 205).

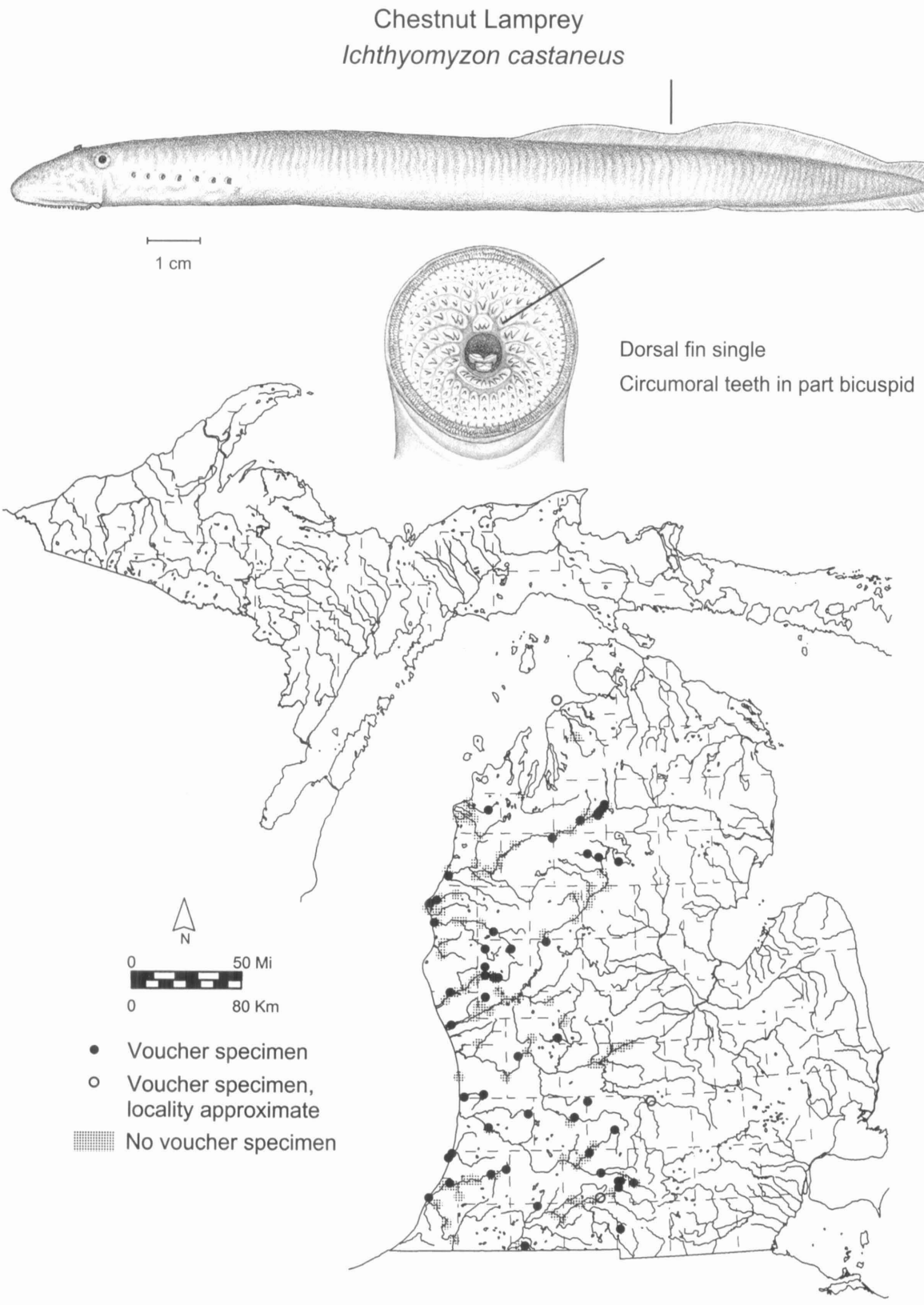
1b. Lower lobe of caudal fin with a milk-white tip. Spinous dorsal fin without clearly defined black spots; a large black blotch near base of posterior spines. Second dorsal-fin rays (20) 21 or 22. Cheek usually with few scales. Pyloric caeca 3, each about as long as stomach. Back crossed with 6 or 7 dark saddles. Vertebrae (42) 45 to 48 (50). *Statewide including Isle Royale. Usually in large rivers and lakes*.....walleye, *S. vitreus* (Mitchill, 1818) (p. 206).

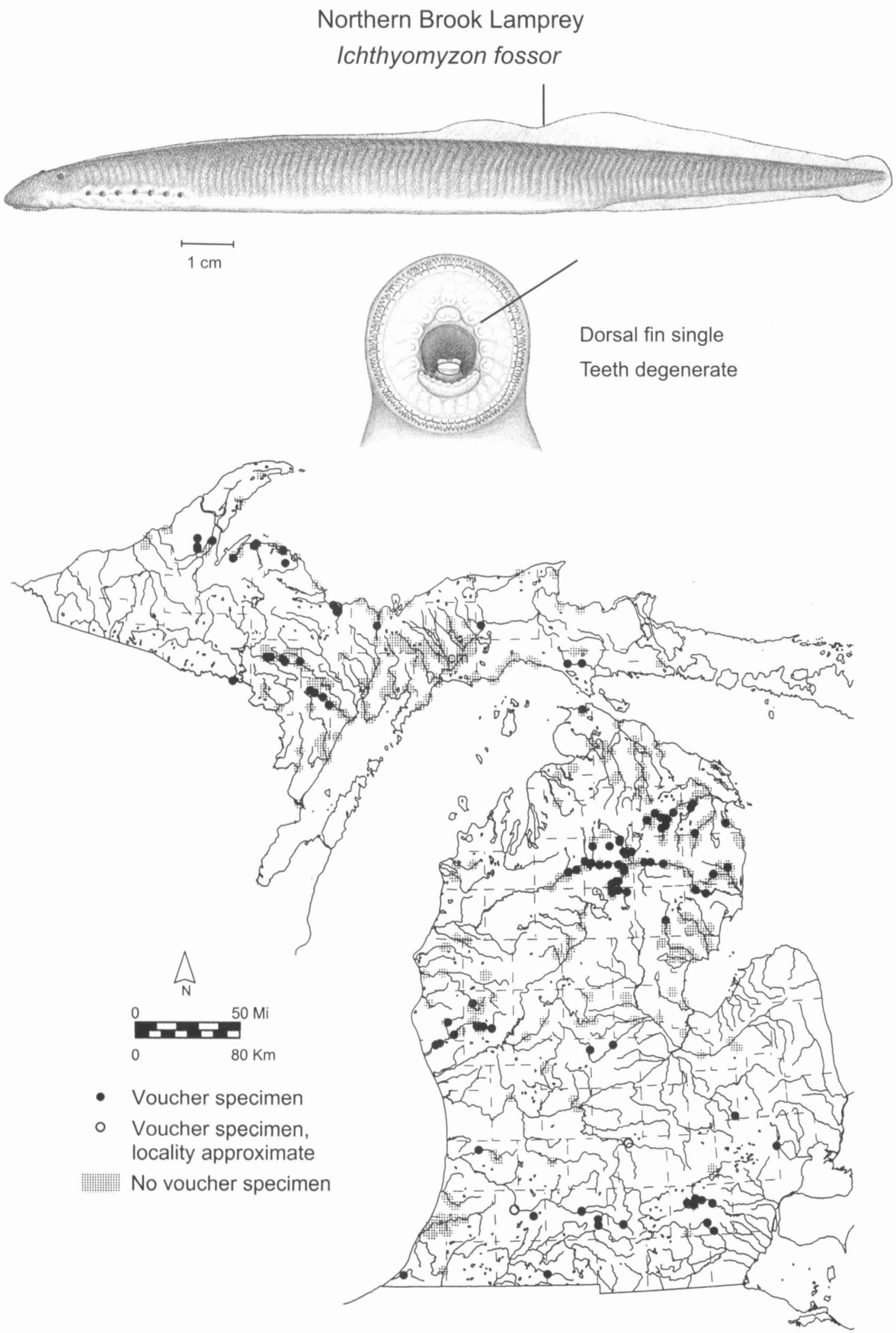
Key to Michigan Species of Gobiidae

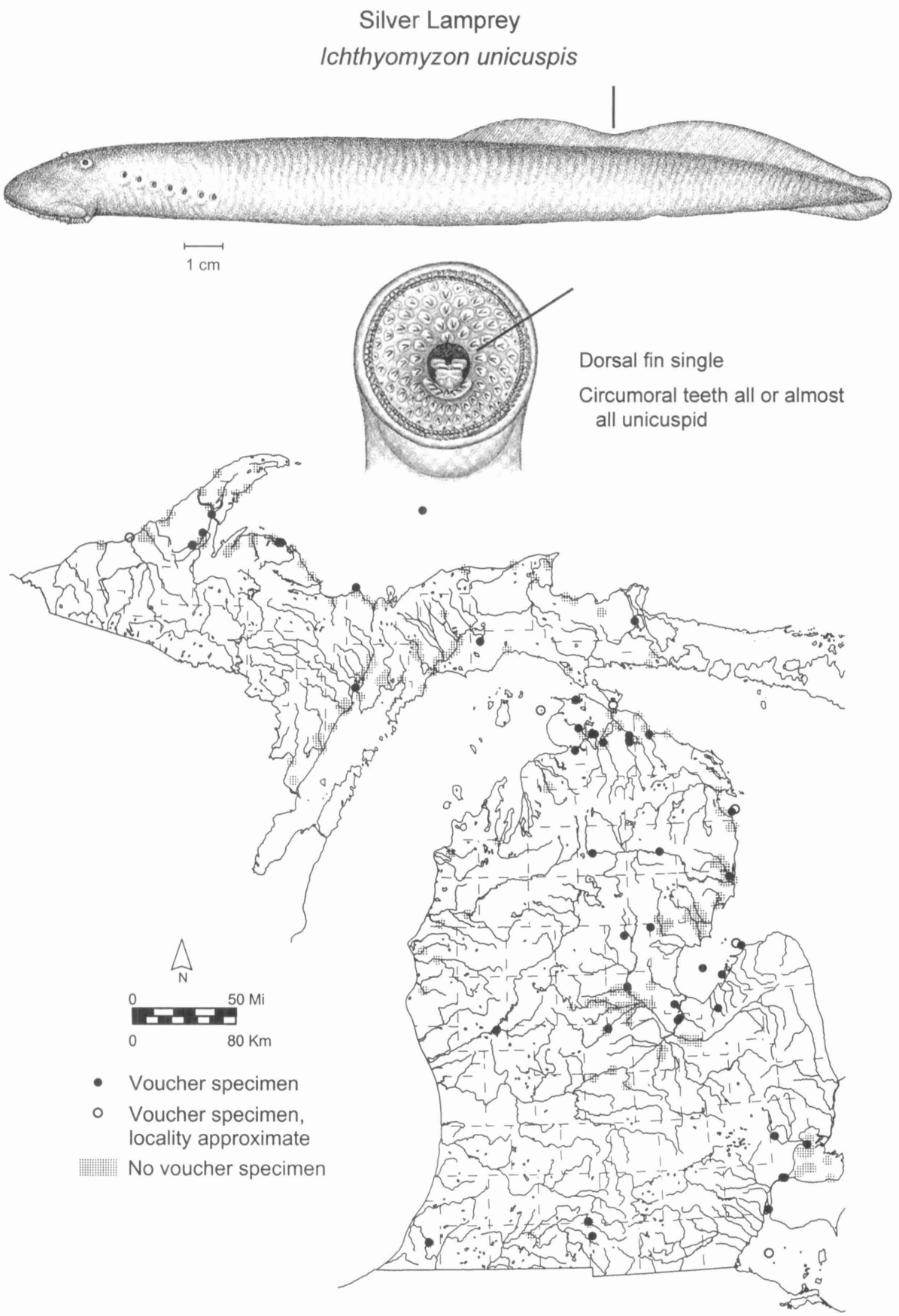
1a. Anterior nostril produced as a long barbel-like tubule that overhangs mouth. A diffuse dusky spot often present on anterior dorsal spines, but no intense black blotch posteriorly. No dark spot at base of upper pectoral-fin rays; this fin and caudal fin with irregular cross bars. Anal fin with 6 to 8 dark cross bars. Pectoral-fin rays 14 to 16, usually 15. Scale rows usually 42 to 47. *St. Clair River to Lake Erie; first noticed in 1990, probably introduced from Black Sea via ballast water*.....tubenose goby, *Proterorhinus marmoratus* (Pallas, 1814) (p. 209).

1b. Anterior nostril in a short tube that does not reach the upper lip. An intense usually oval black blotch at posterior end of first dorsal fin. A small black spot at base of upper pectoral-fin rays; this fin and caudal fin without crossbars. Anal fin dusted with melanophores but without cross bars. Pectoral-fin rays 18 or 19. Scale rows usually 48 to 55. *Introduced probably from the Black Sea, via ballast water. First noticed in southeast Michigan in 1990 but dispersing rapidly, probably from multiple introductions. Now common from Lake Erie to tributaries to Saginaw Bay, but also reported as established near Chicago, Milwaukee, Cleveland, Green Bay, in the Duluth- Superior Harbor of Lake Superior and elsewhere*.....round goby, *Neogobius melanostomus* (Pallas, 1814) (p. 208).

FISH DISTRIBUTION MAPS AND ILLUSTRATIONS

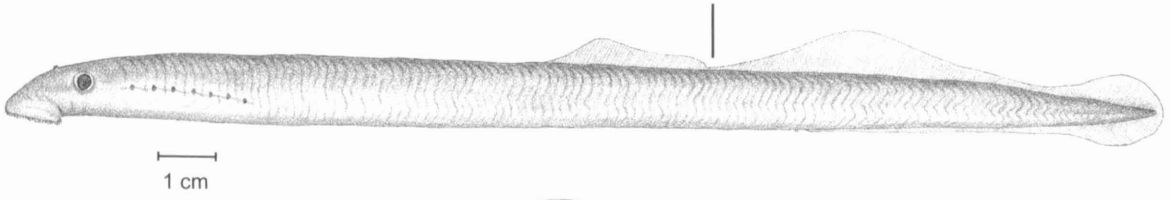



Northern Brook Lamprey
Ichthyomyzon fossor
1 cm
Dorsal fin single
Teeth degenerate
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

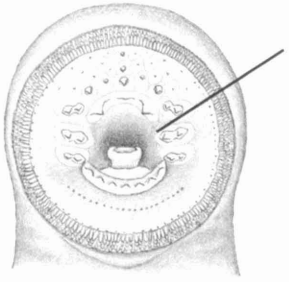

Silver Lamprey
Ichthyomyzon unicuspis
1 cm
Dorsal fin single
Circumoral teeth all or almost all unicuspid
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

American Brook Lamprey

Lampetra appendix

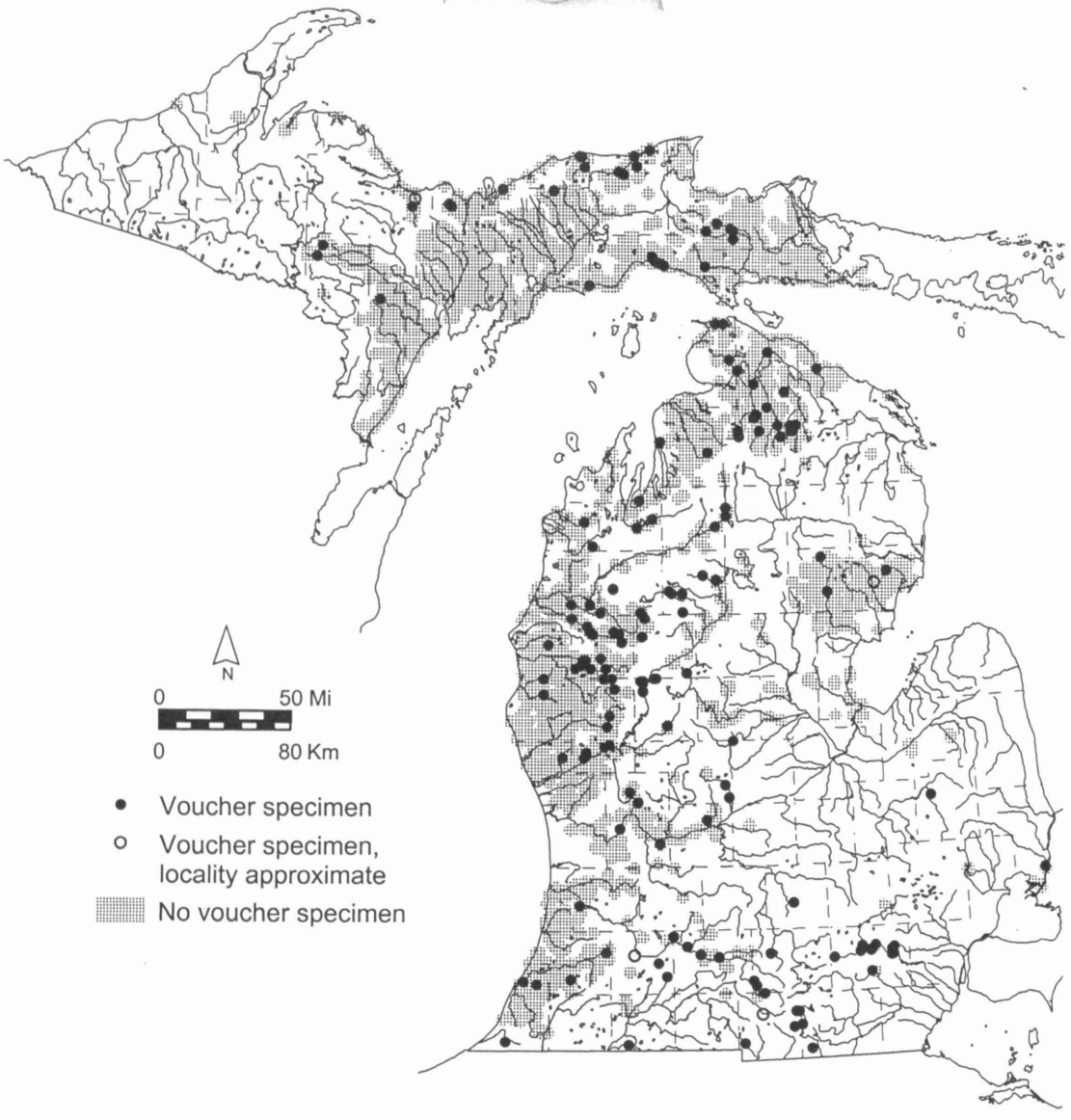


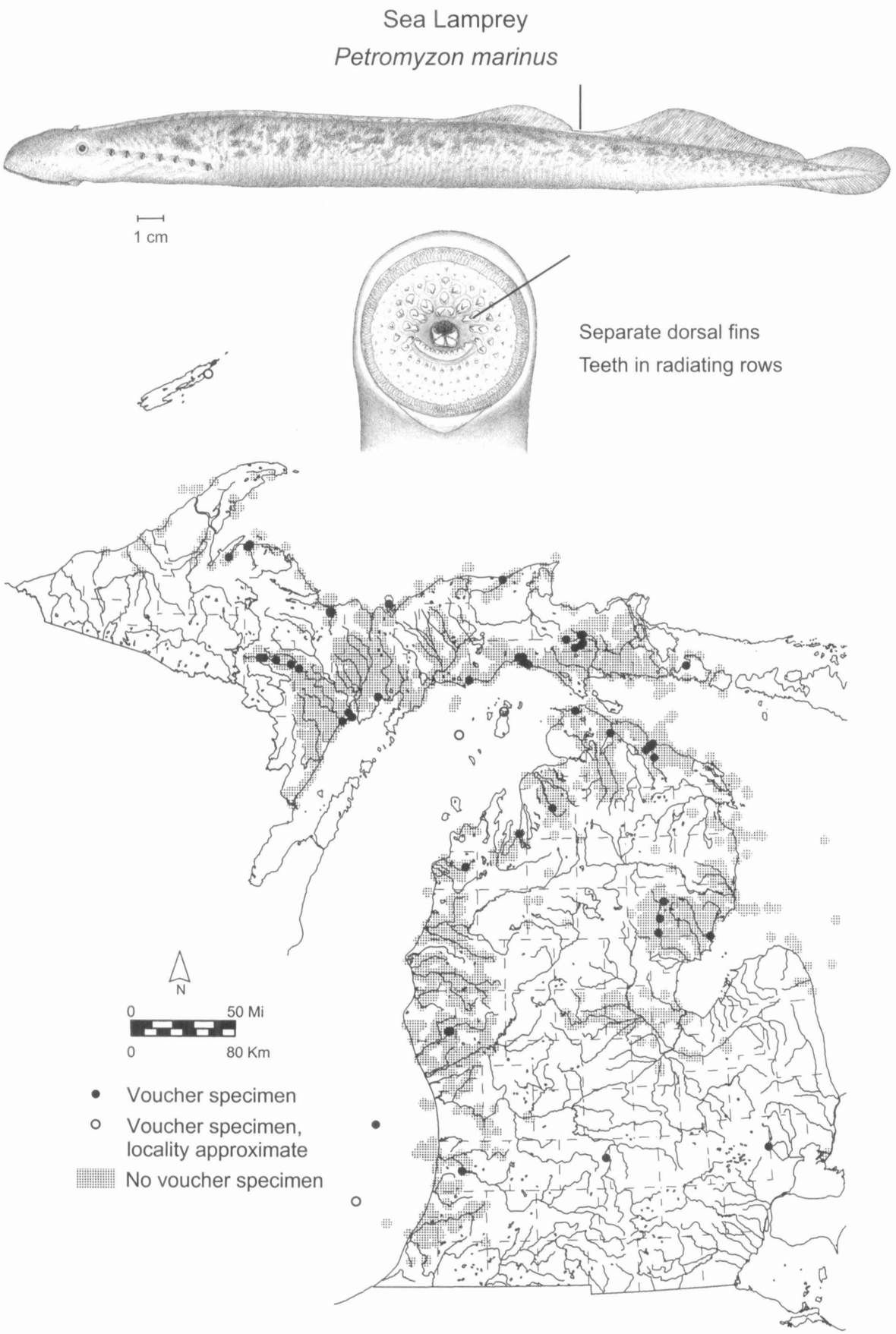
1 cm



Two distinct dorsal fins

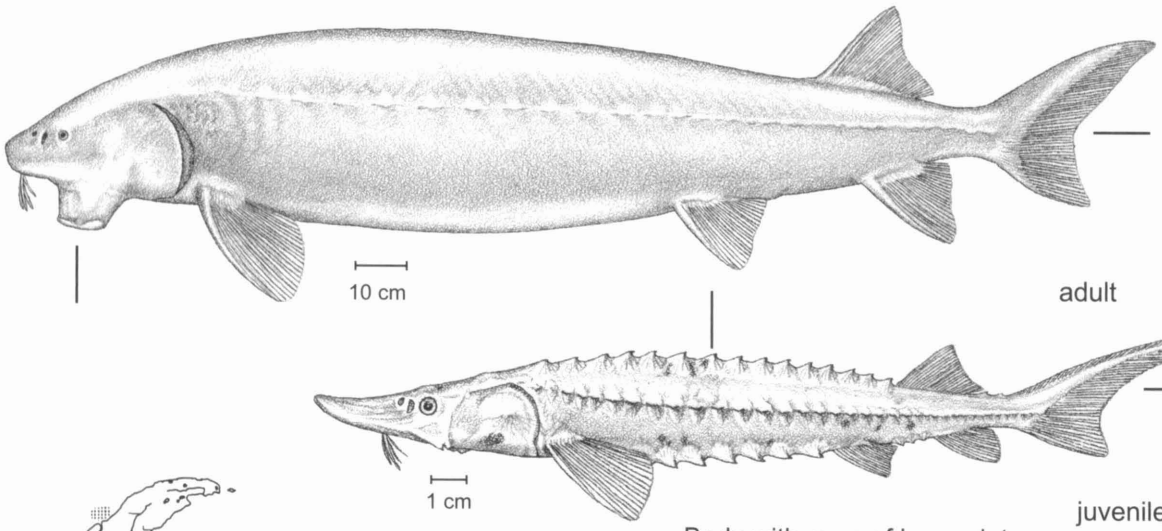
Teeth not in radiating series




Sea Lamprey
Petromyzon marinus
1 cm
Separate dorsal fins
Teeth in radiating rows
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

Lake Sturgeon

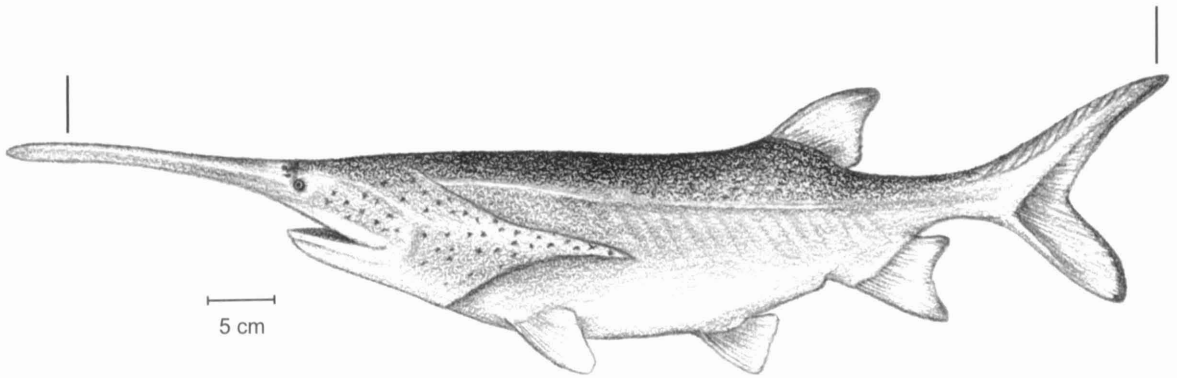
Acipenser fulvescens



Body with rows of bony plates
Tail heterocercal
Ventral protrusible mouth

Paddlefish

Polyodon spathula

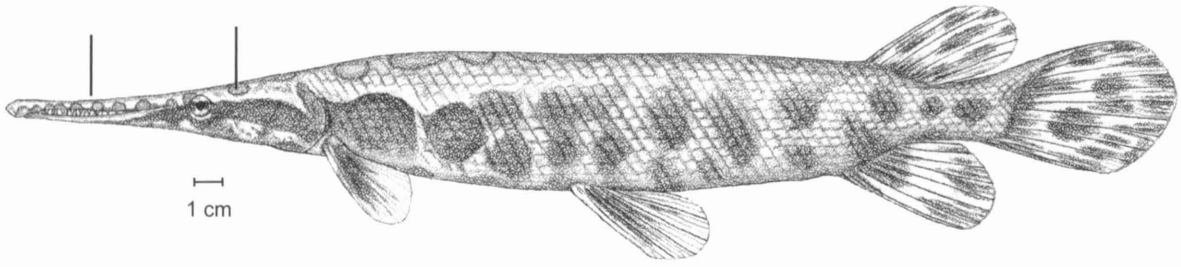


Snout prolonged, paddle-shaped

Tail heterocercal

Spotted Gar

Lepisosteus oculatus



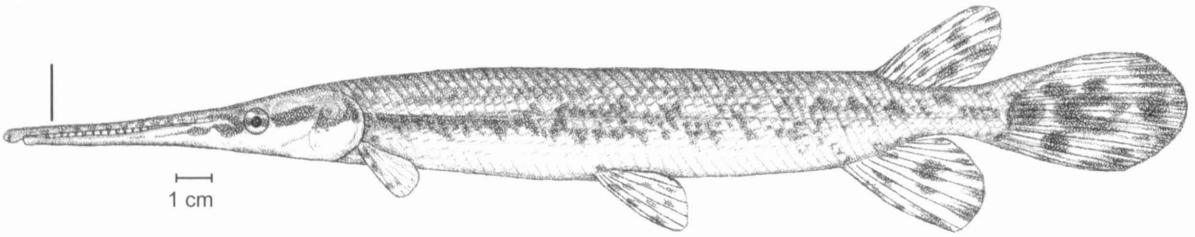
Snout beaklike, short and broad

Head spotted

Scales rhomboid

Longnose Gar

Lepisosteus osseus



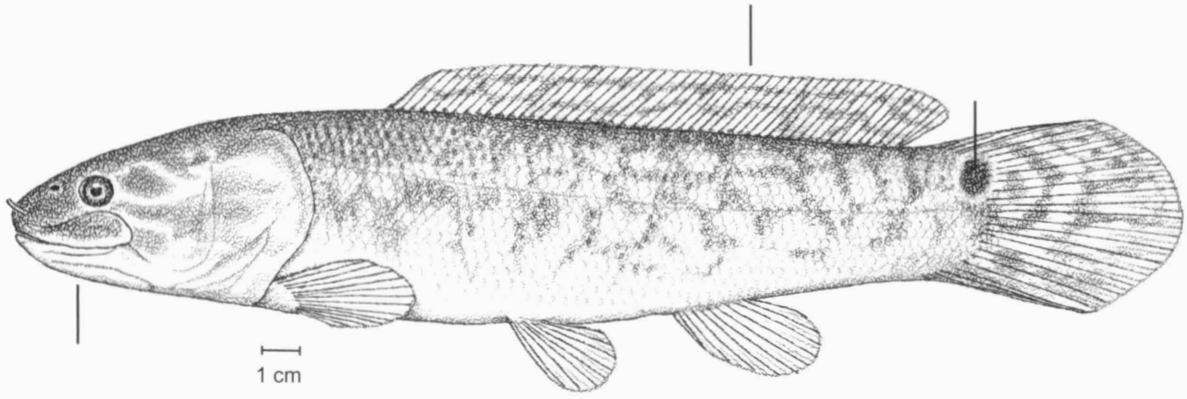
Snout beaklike, long and narrow

Head not spotted

Scales rhomboid

Bowfin

Amia calva



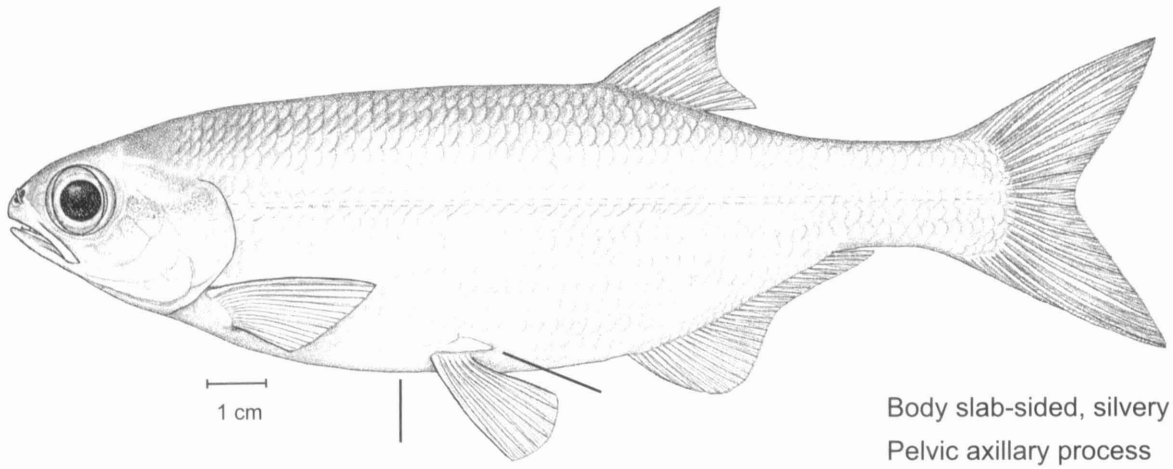
Long dorsal fin

Large gular plate

Black spot at caudal base

Mooneye

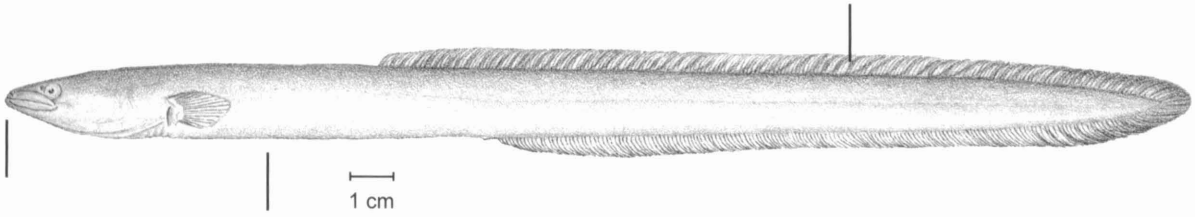
Hiodon tergisus



Body slab-sided, silvery
Pelvic axillary process
Midventral keel
Lateral line distinct
Mouth strongly toothed

American Eel

Anguilla rostrata



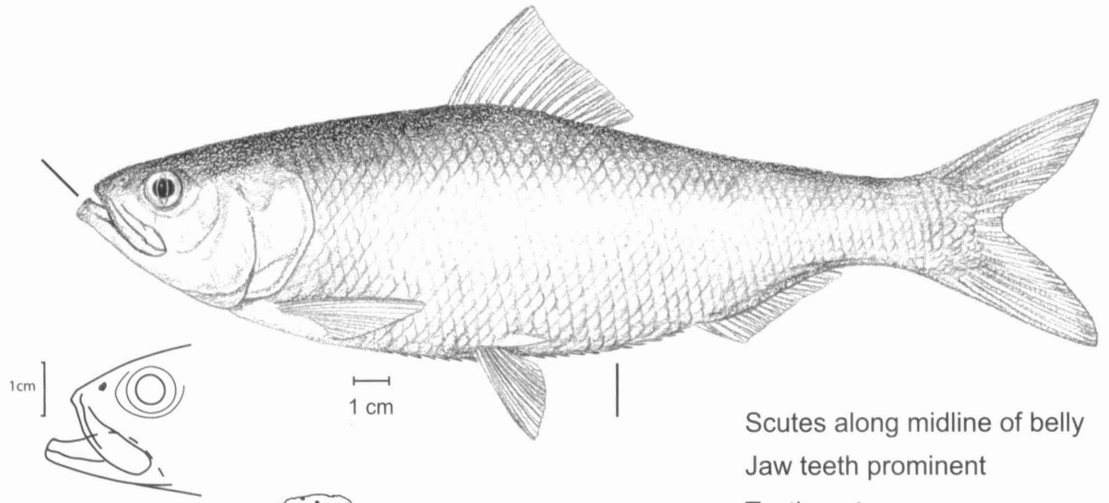
Dorsal, caudal, and anal fins continuous

No pelvic fins

Jaws present

Skipjack Herring

Alosa chrysochloris

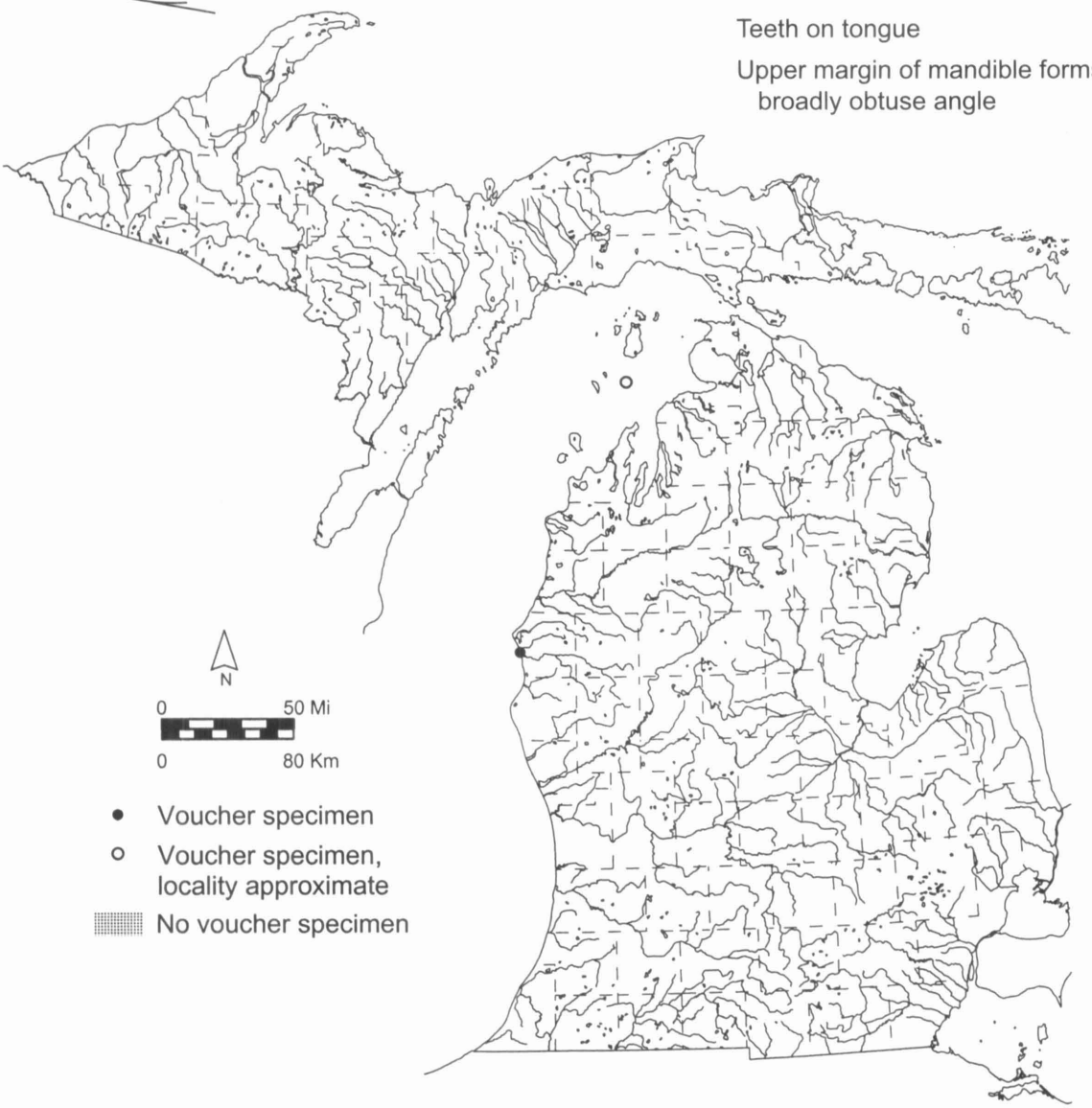


Scutes along midline of belly

Jaw teeth prominent

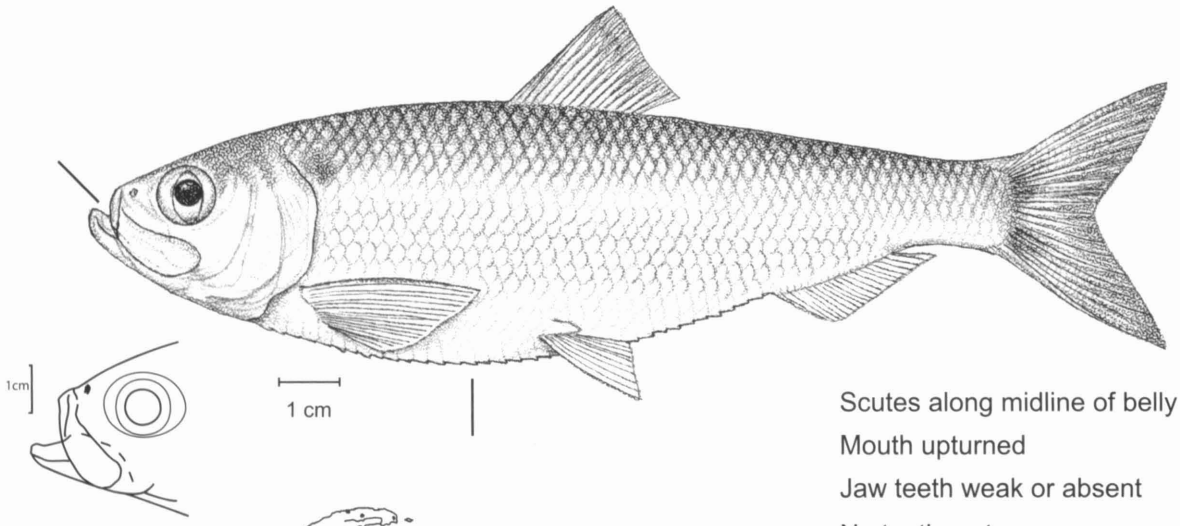
Teeth on tongue

Upper margin of mandible forms a broadly obtuse angle



Alewife

Alosa pseudoharengus



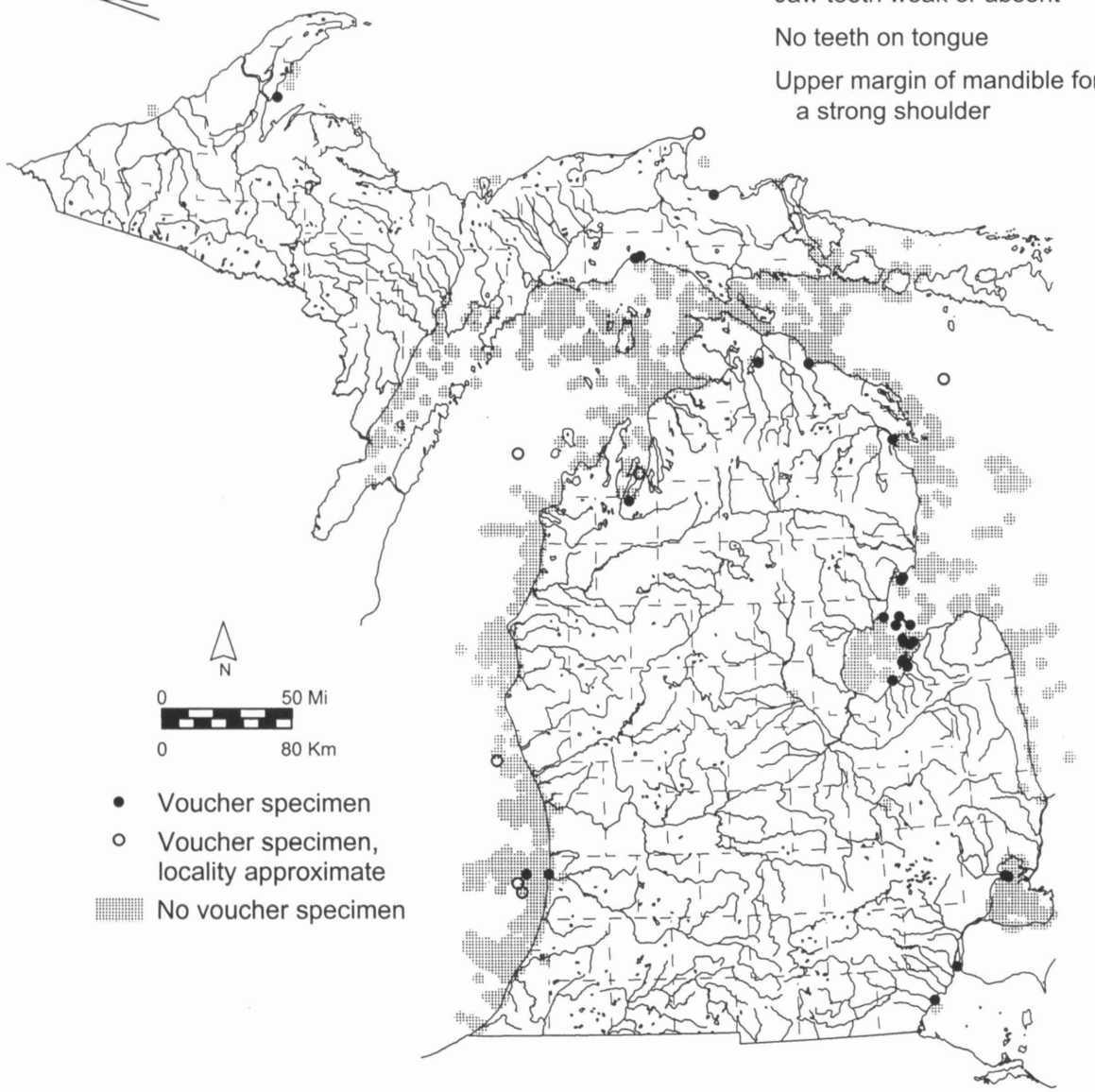
Scutes along midline of belly

Mouth upturned

Jaw teeth weak or absent

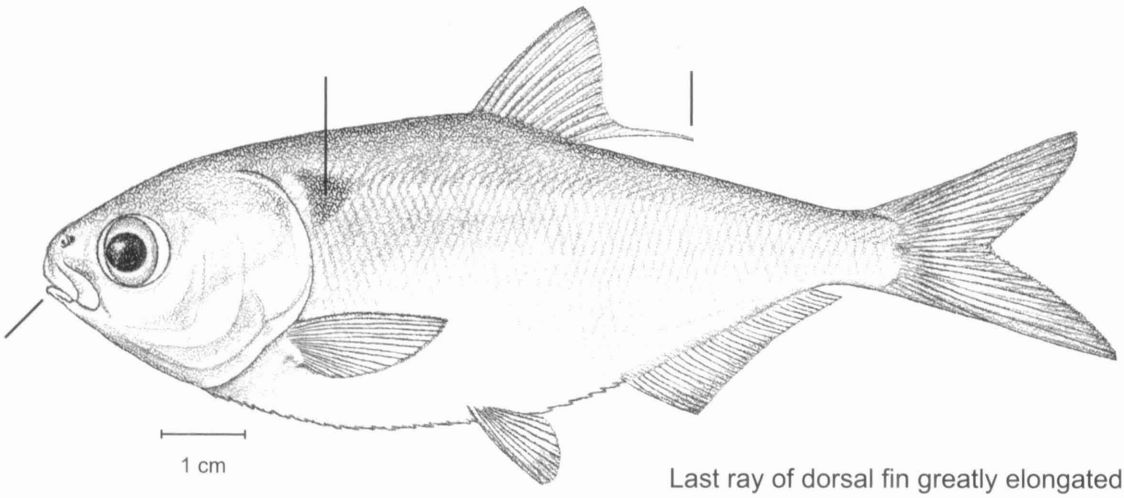
No teeth on tongue

Upper margin of mandible forms a strong shoulder



Gizzard Shad

Dorosoma cepedianum



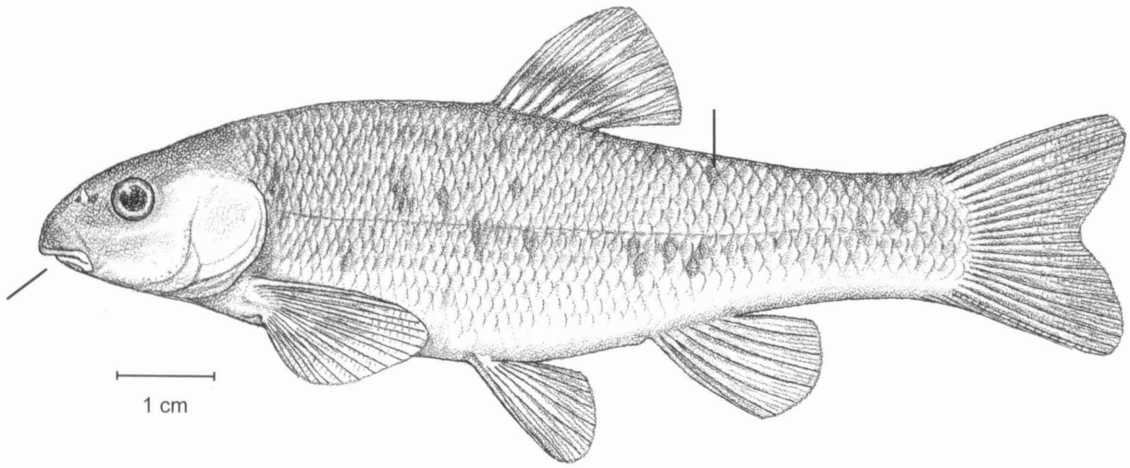
Last ray of dorsal fin greatly elongated

Mouth subterminal

Dusky spot behind gill cleft (may be absent)

Central Stoneroller

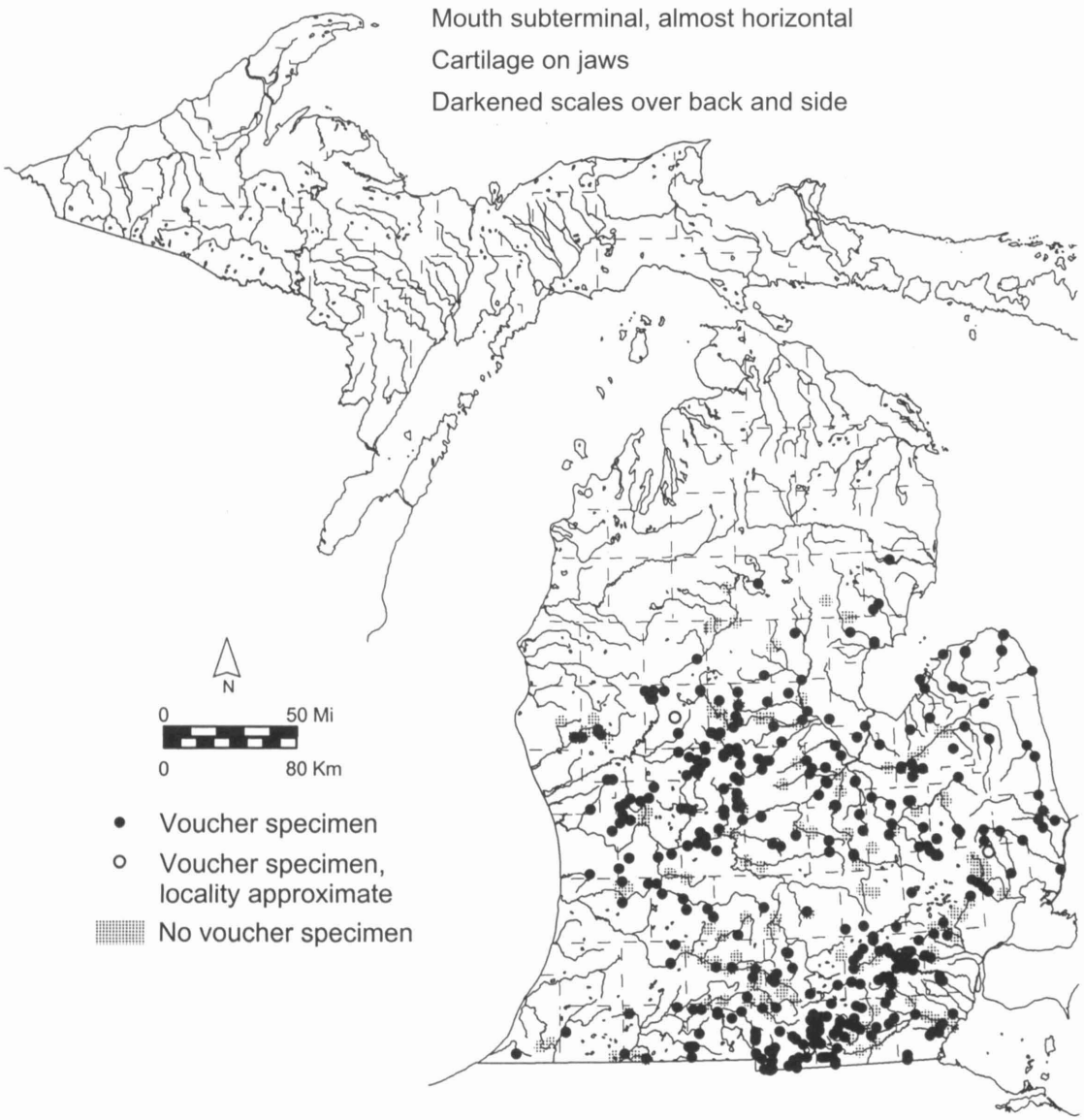
Campostoma anomalum pullum

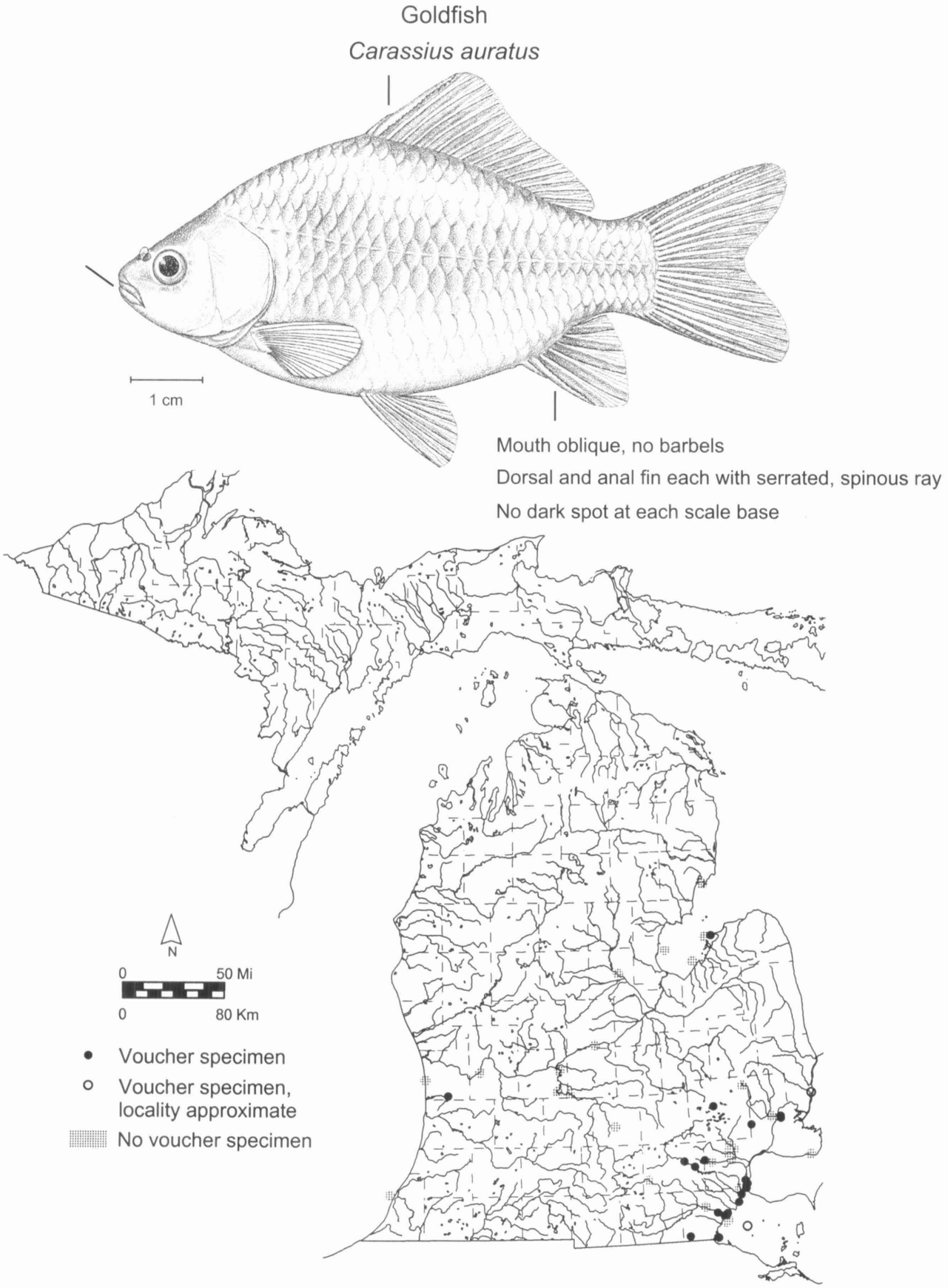


Mouth subterminal, almost horizontal

Cartilage on jaws

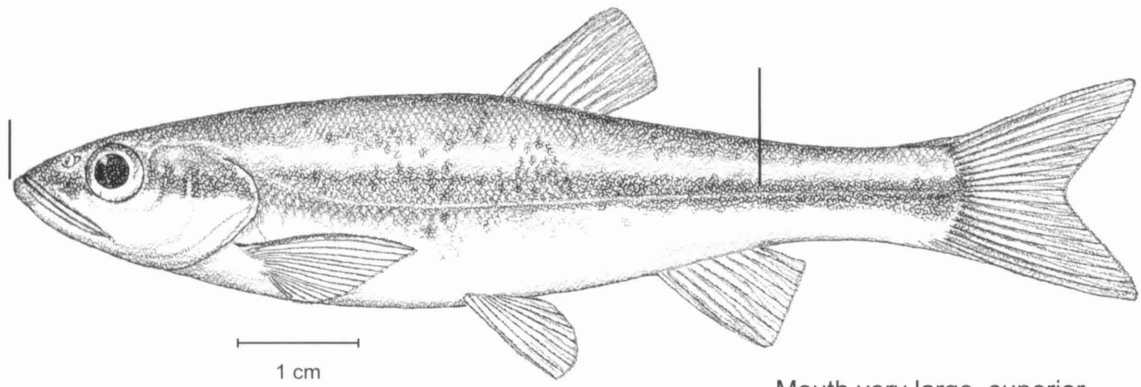
Darkened scales over back and side




Goldfish
Carassius auratus
1 cm
Mouth oblique, no barbels
Dorsal and anal fin each with serrated, spinous ray
No dark spot at each scale base
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

Redside Dace

Clinostomus elongatus

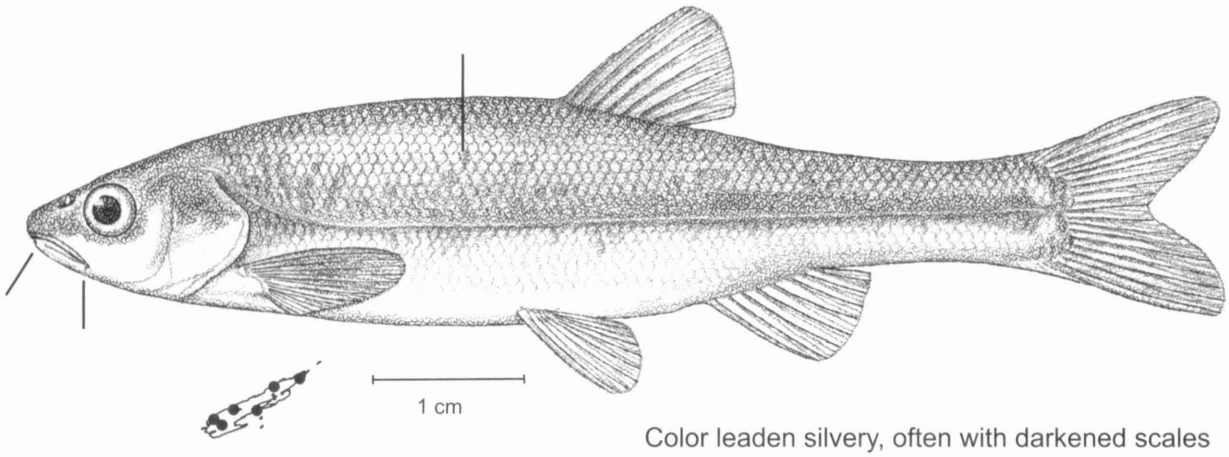


Mouth very large, superior

Adults with scarlet on side

Lake Chub

Couesius plumbeus

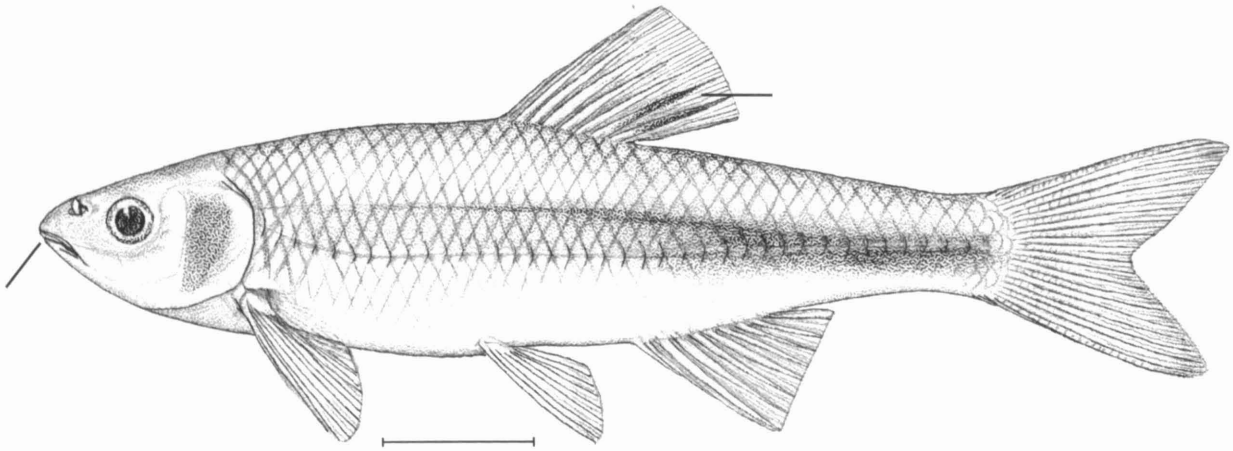


Color leaden silvery, often with darkened scales

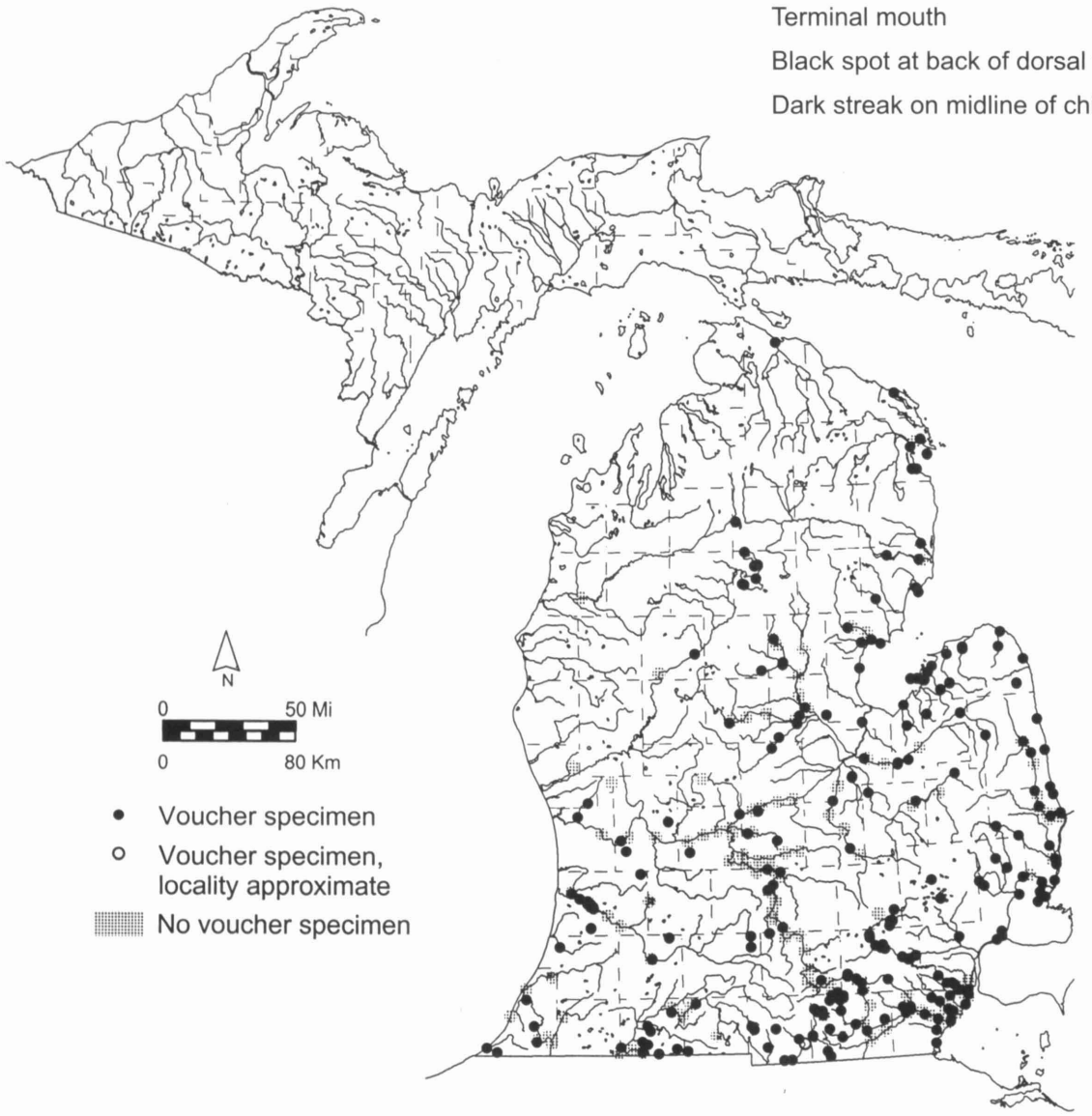
Mouth medium, subterminal

Well-developed thread-like barbel at corner of mouth

Spotfin Shiner
Cyprinella spiloptera

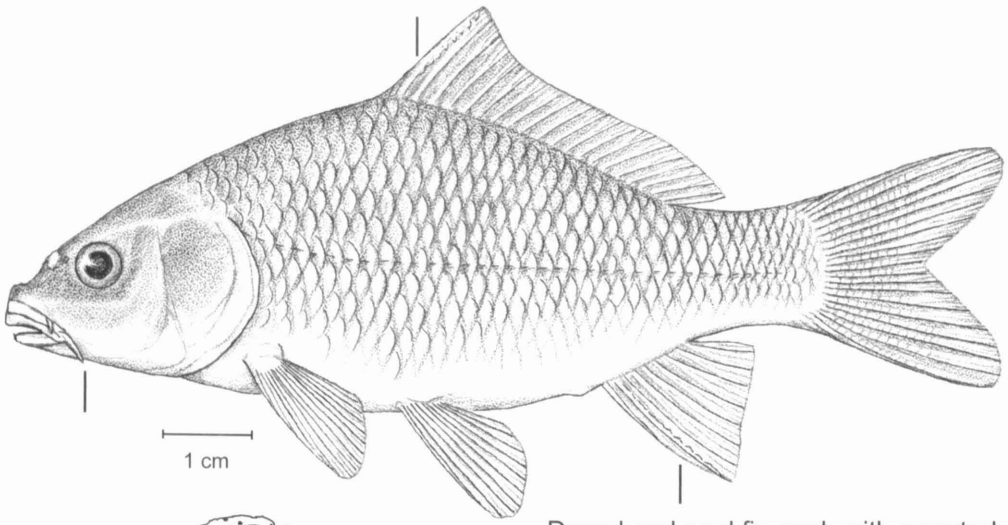


Body deep, color bluish-silvery
Terminal mouth
Black spot at back of dorsal fin
Dark streak on midline of chin



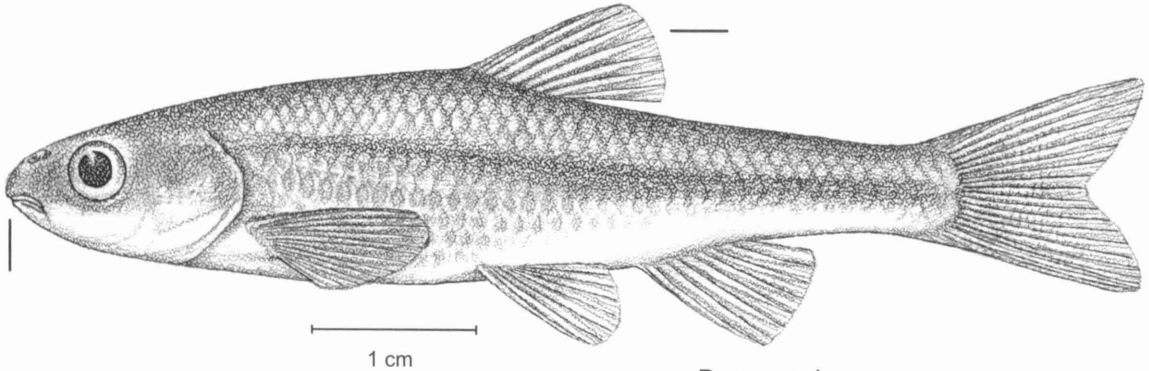
Common Carp

Cyprinus carpio

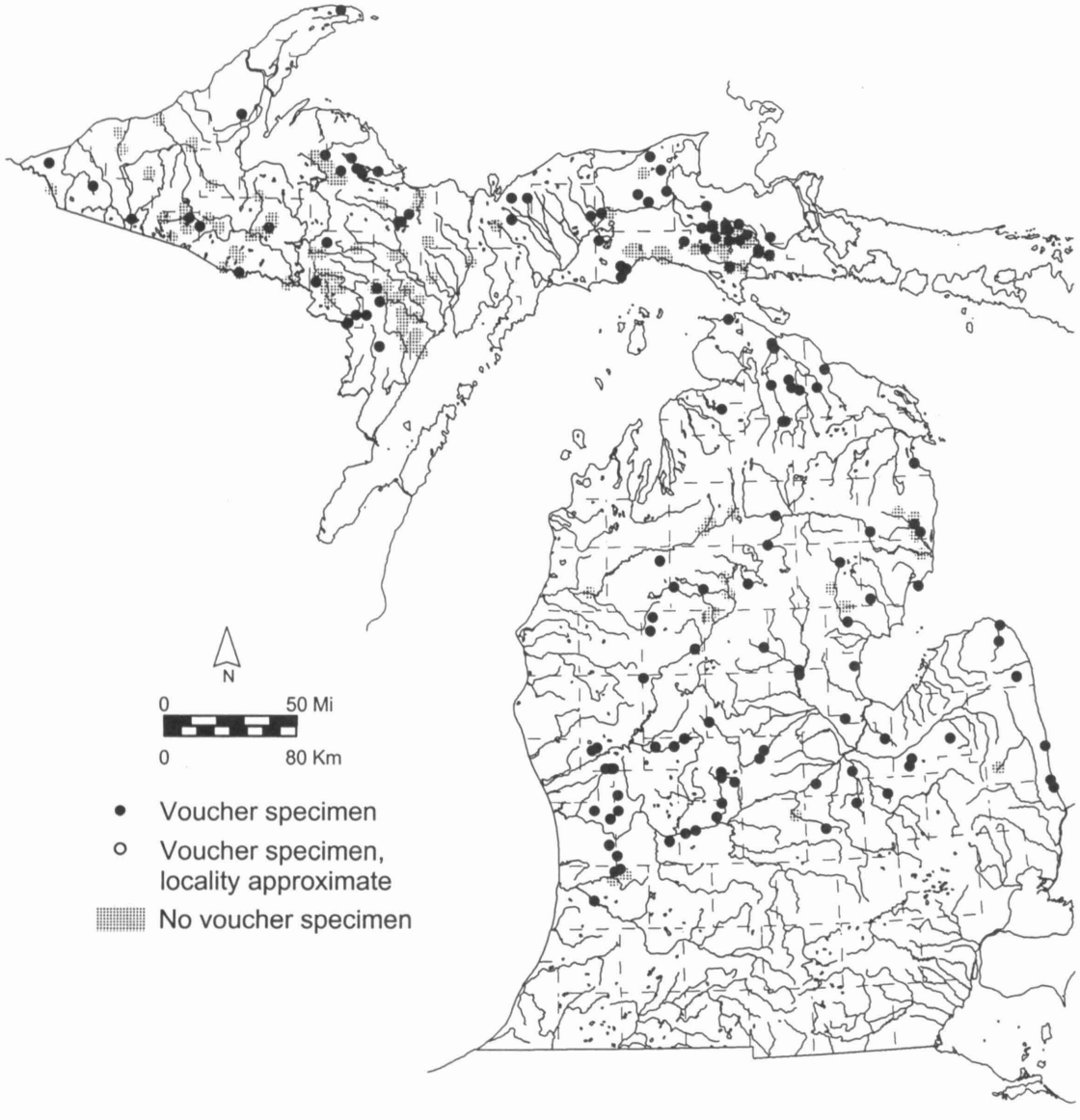


Dorsal and anal fin each with serrated, spinous ray
Mouth almost horizontal, with two fleshy barbels
Dark spot at scale bases

Brassy Minnow
Hybognathus hankinsoni

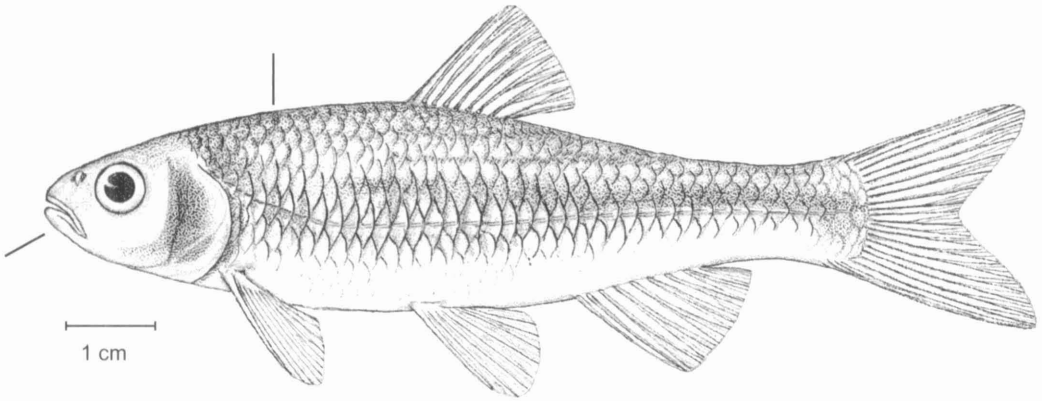


Brassy color
Dorsal fin rounded
Mouth small, subterminal, gape short

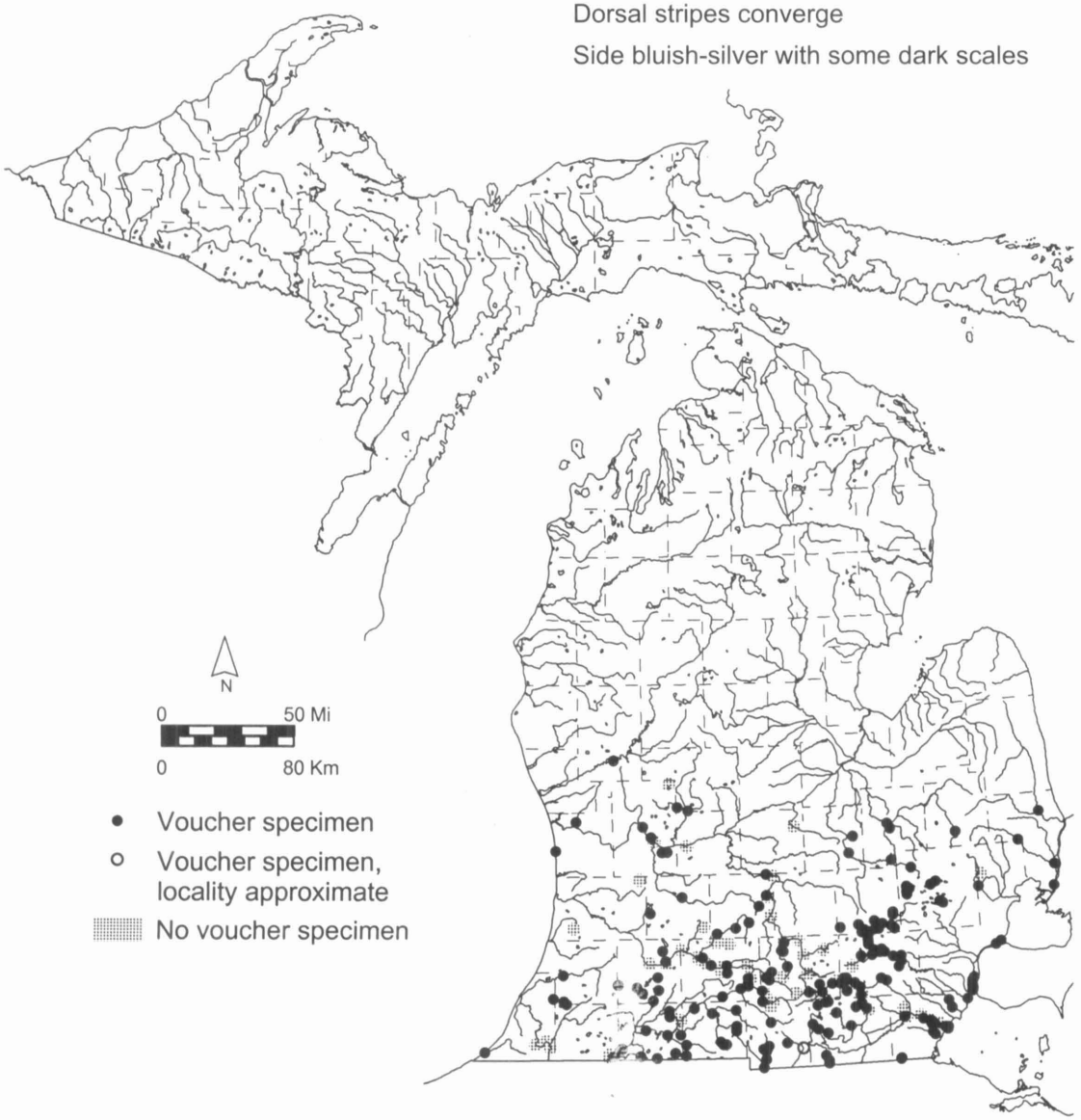


Striped Shiner

Luxilus chrysocephalus

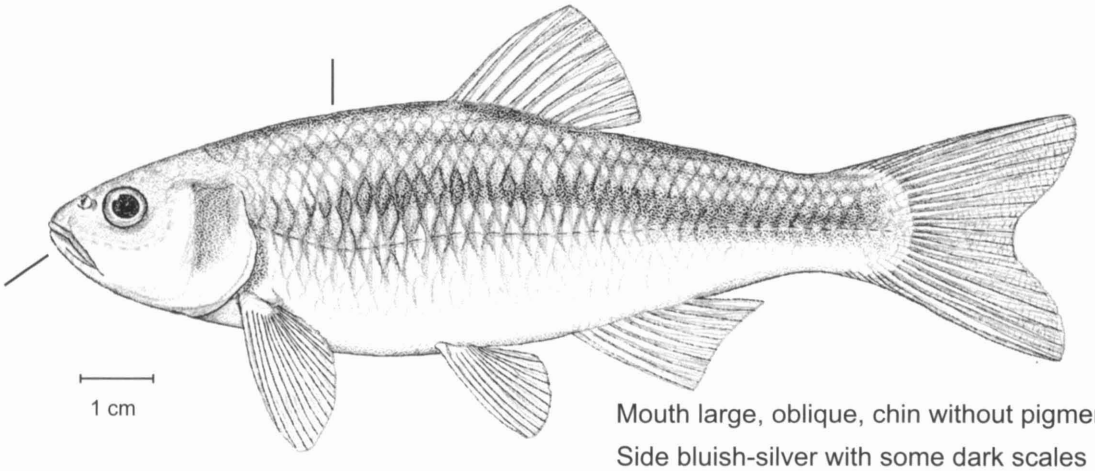


Mouth large, oblique, chin with pigment
Predorsal scales large (14-17), lateral scales deep
Dorsal stripes converge
Side bluish-silver with some dark scales

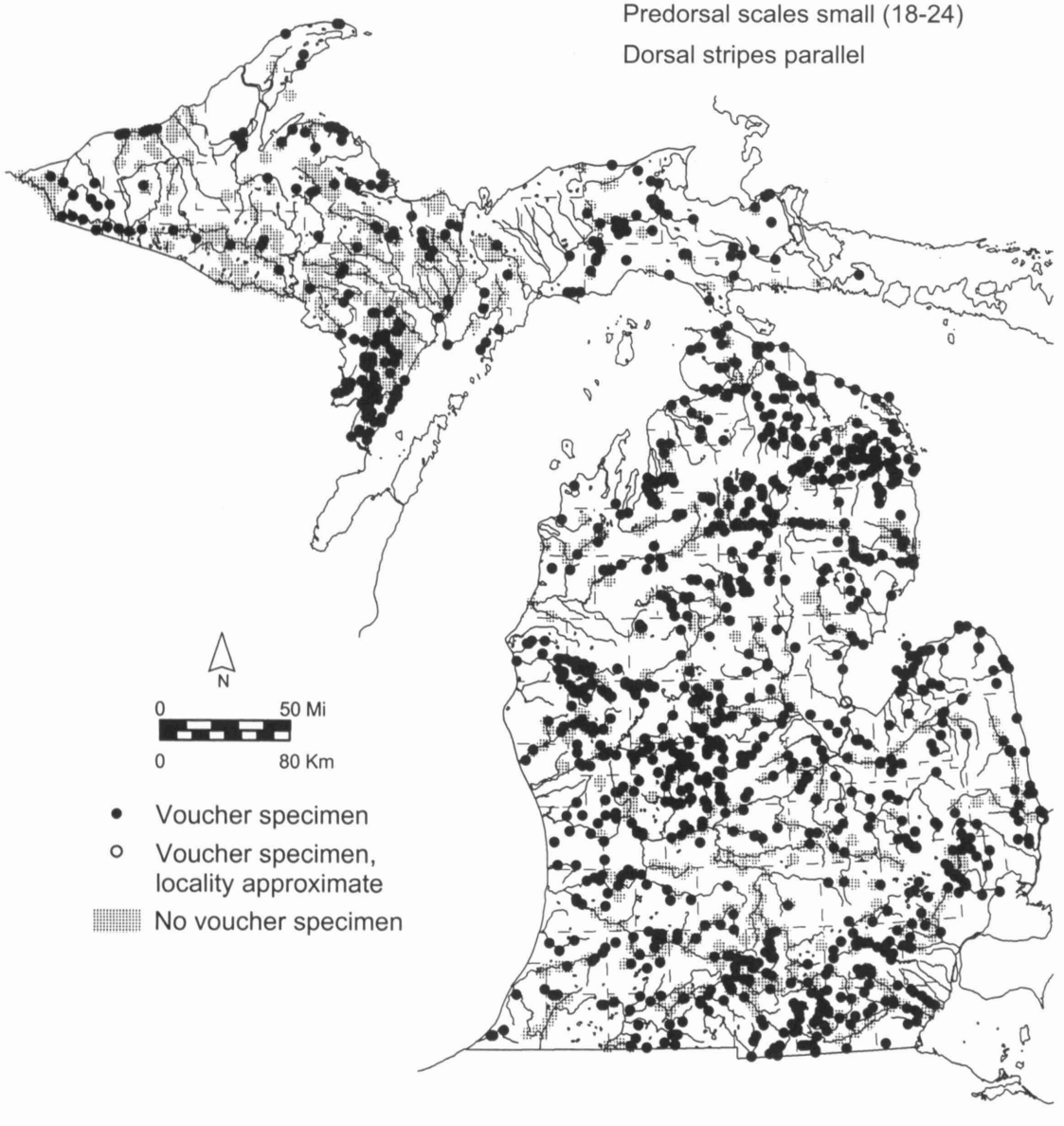


Common Shiner

Luxilus cornutus

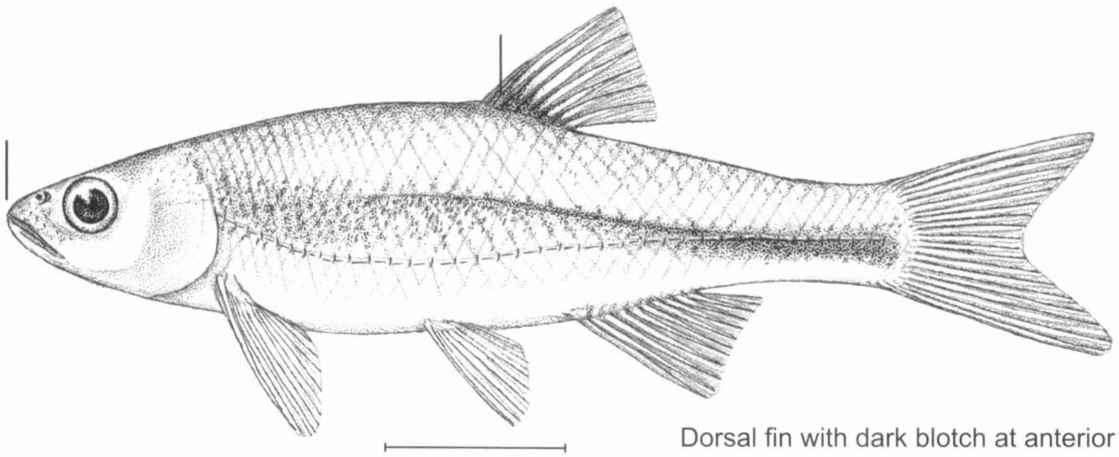


Mouth large, oblique, chin without pigment
Side bluish-silver with some dark scales
Predorsal scales small (18-24)
Dorsal stripes parallel



Redfin Shiner

Lythrurus umbratilis

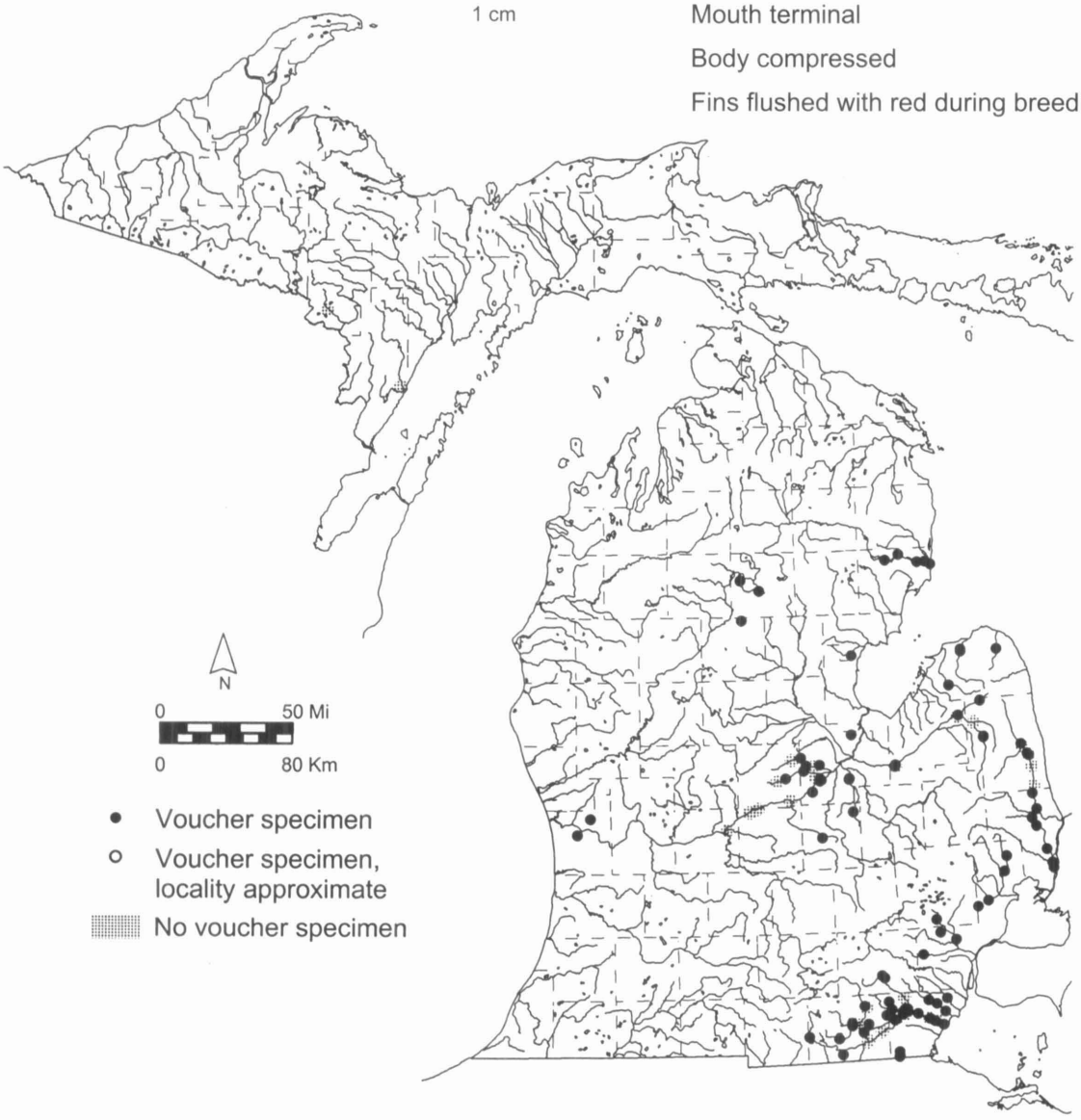


Dorsal fin with dark blotch at anterior base

Mouth terminal

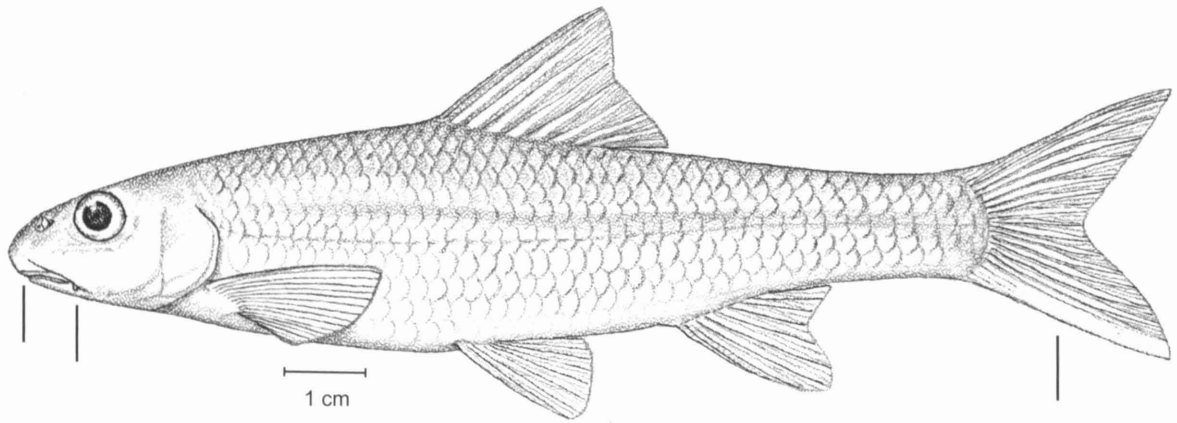
Body compressed

Fins flushed with red during breeding



Silver Chub

Macrhybopsis storeriana



Mouth small and overhung by snout

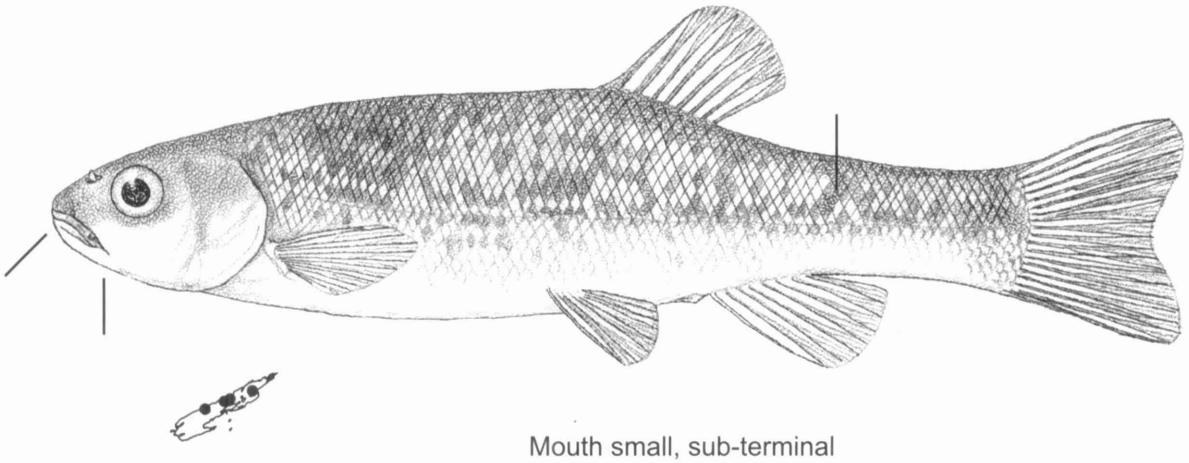
Terminal barbel

Ventral edge of caudal fin milk-white

Coloration silvery

Northern Pearl Dace

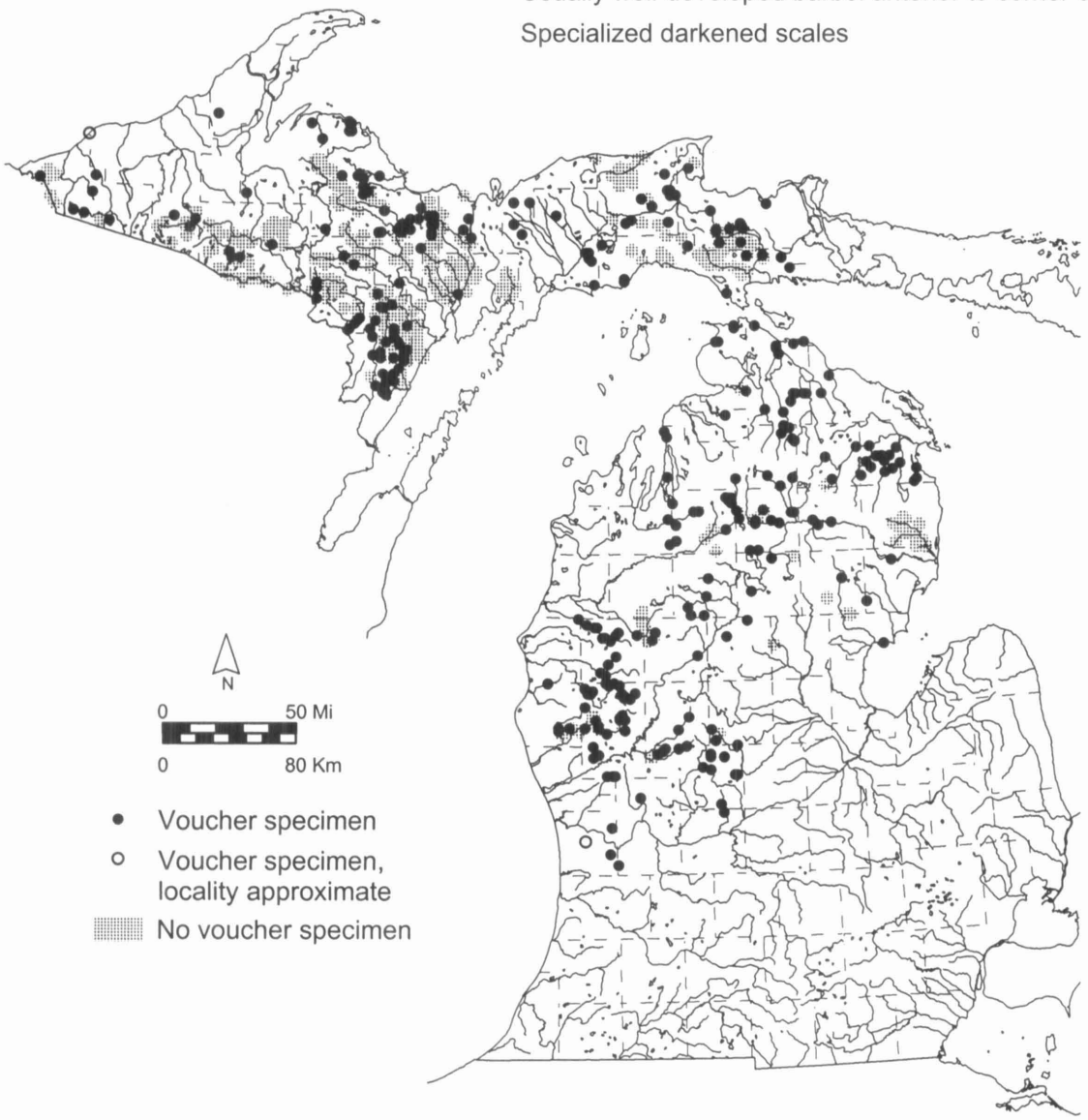
Margariscus nachtriebi



Mouth small, sub-terminal

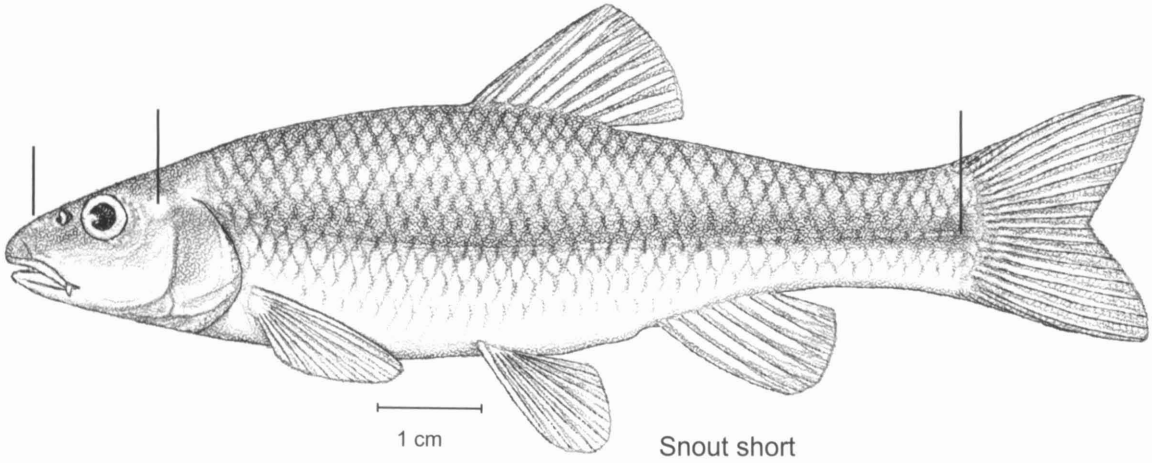
Usually well-developed barbel anterior to corner of mouth

Specialized darkened scales



Hornyhead Chub

Nocomis biguttatus



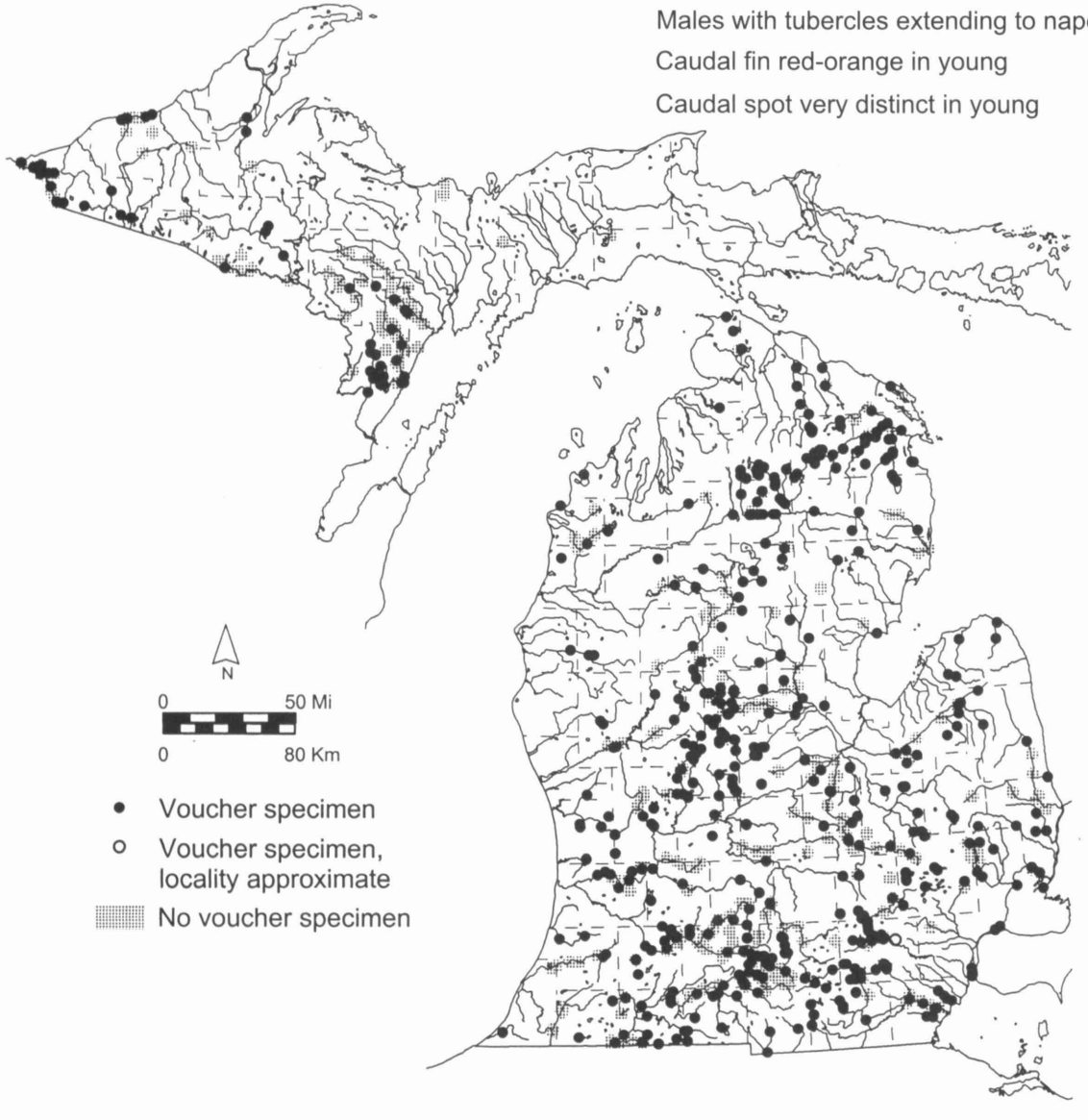
Snout short

Breeding adults with squarish red spot behind eye

Males with tubercles extending to nape

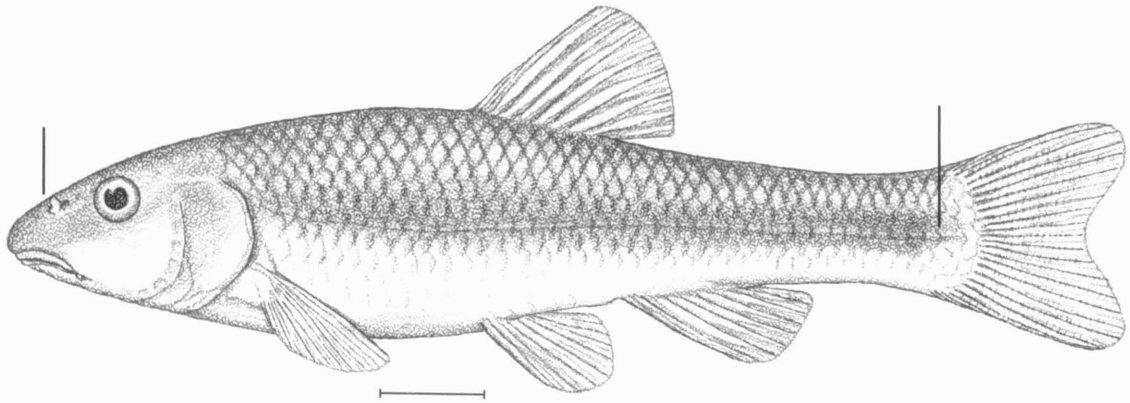
Caudal fin red-orange in young

Caudal spot very distinct in young



River Chub

Nocomis micropogon

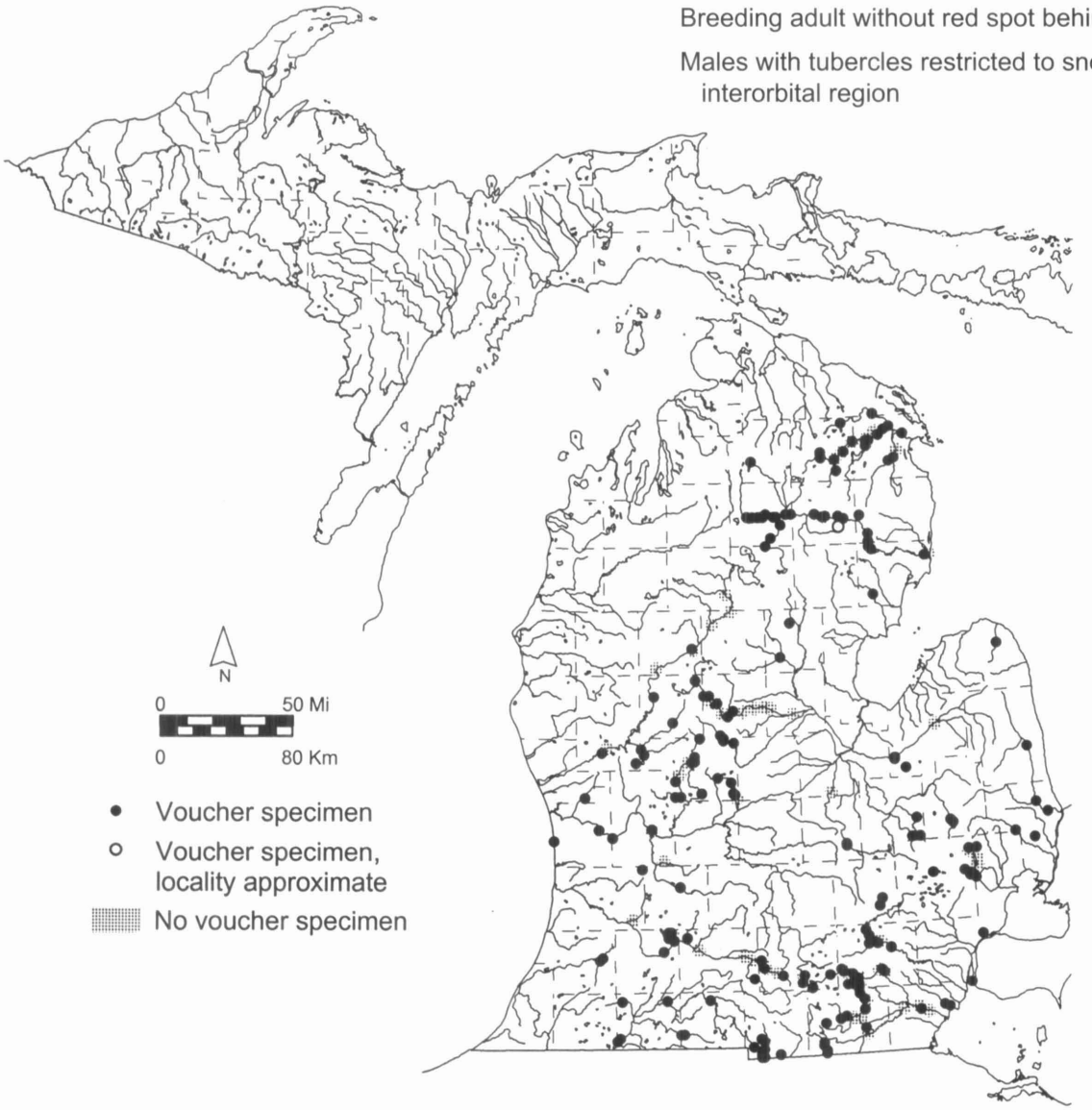


Snout long

Caudal spot not prominent

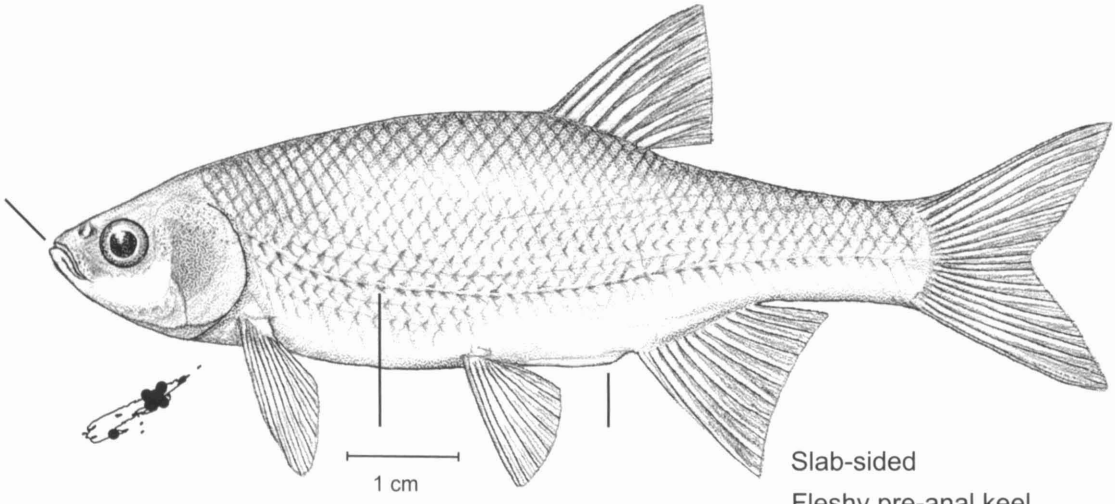
Breeding adult without red spot behind eye

Males with tubercles restricted to snout and interorbital region

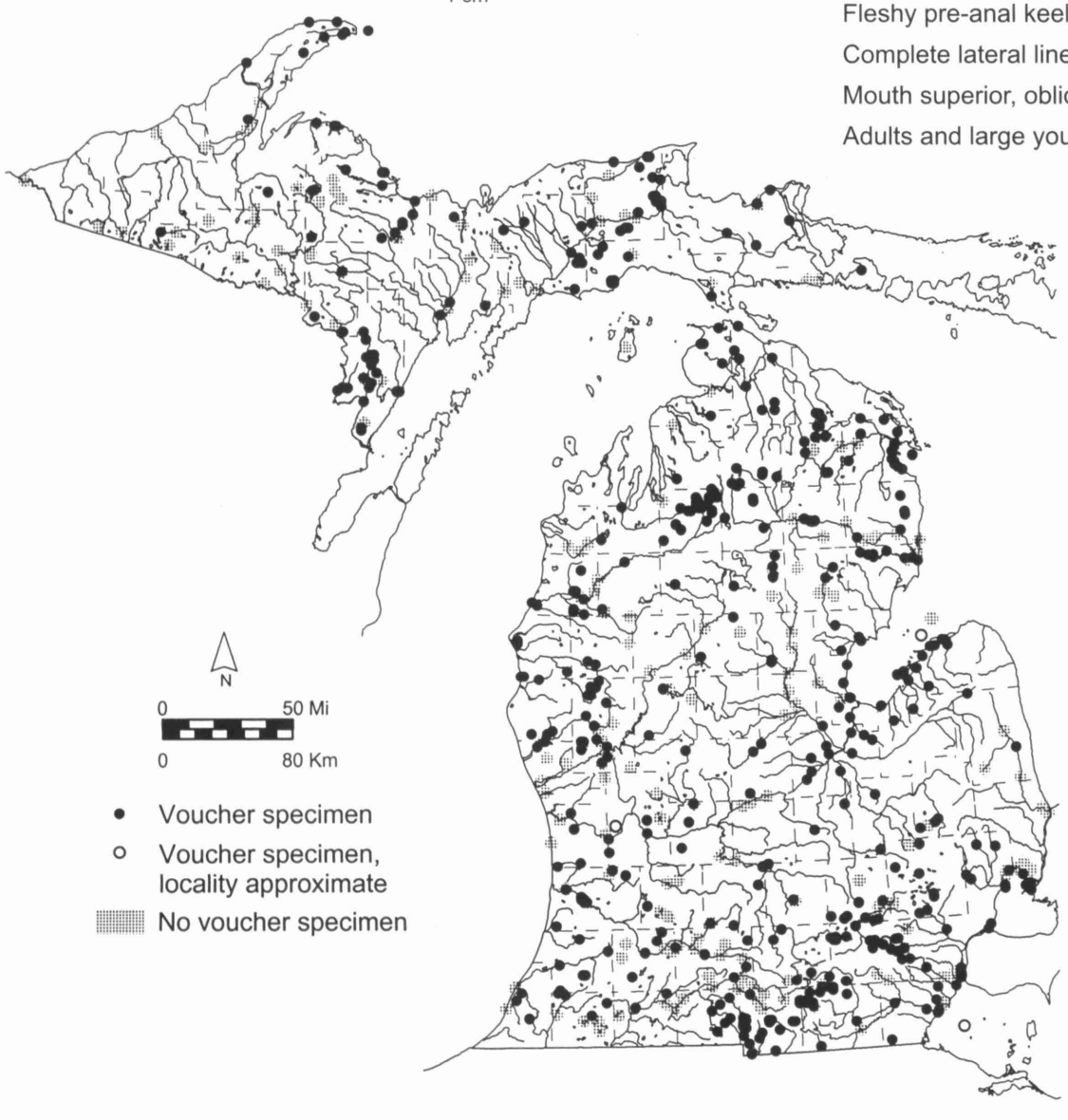


Golden Shiner

Notemigonus crysoleucas

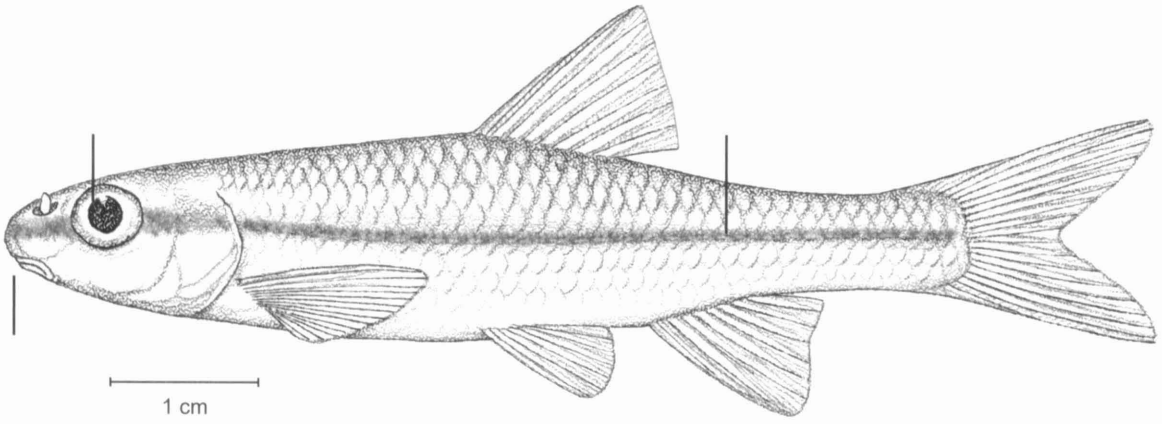


Slab-sided
Fleshy pre-anal keel
Complete lateral line, greatly decurved
Mouth superior, oblique
Adults and large young golden-yellow



Bigeye Chub

Notropis amblops



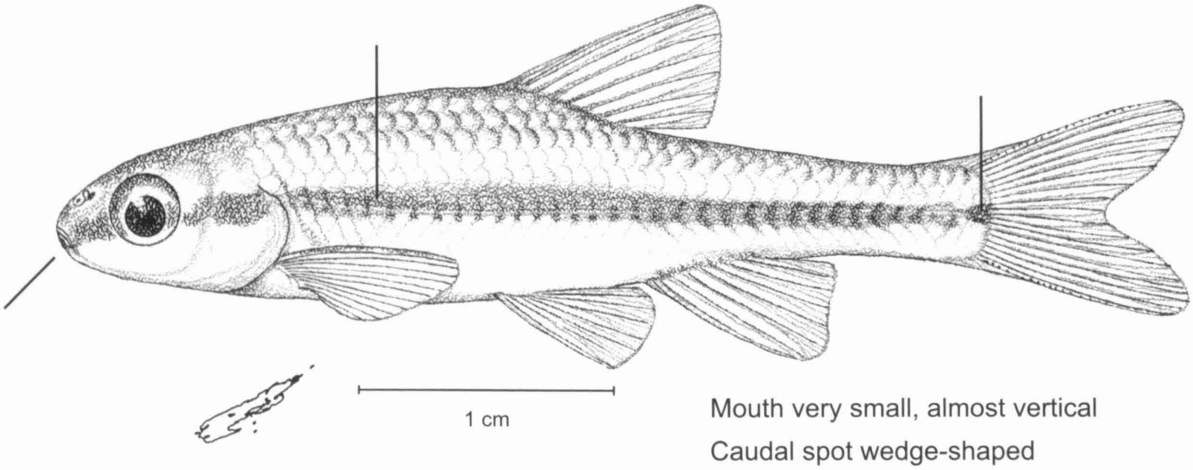
Eye large

Mouth small, overhung by snout

Bold, black lateral stripe, as wide as eye, encircles snout and continues along side to tail

Pugnose Shiner

Notropis anogenus

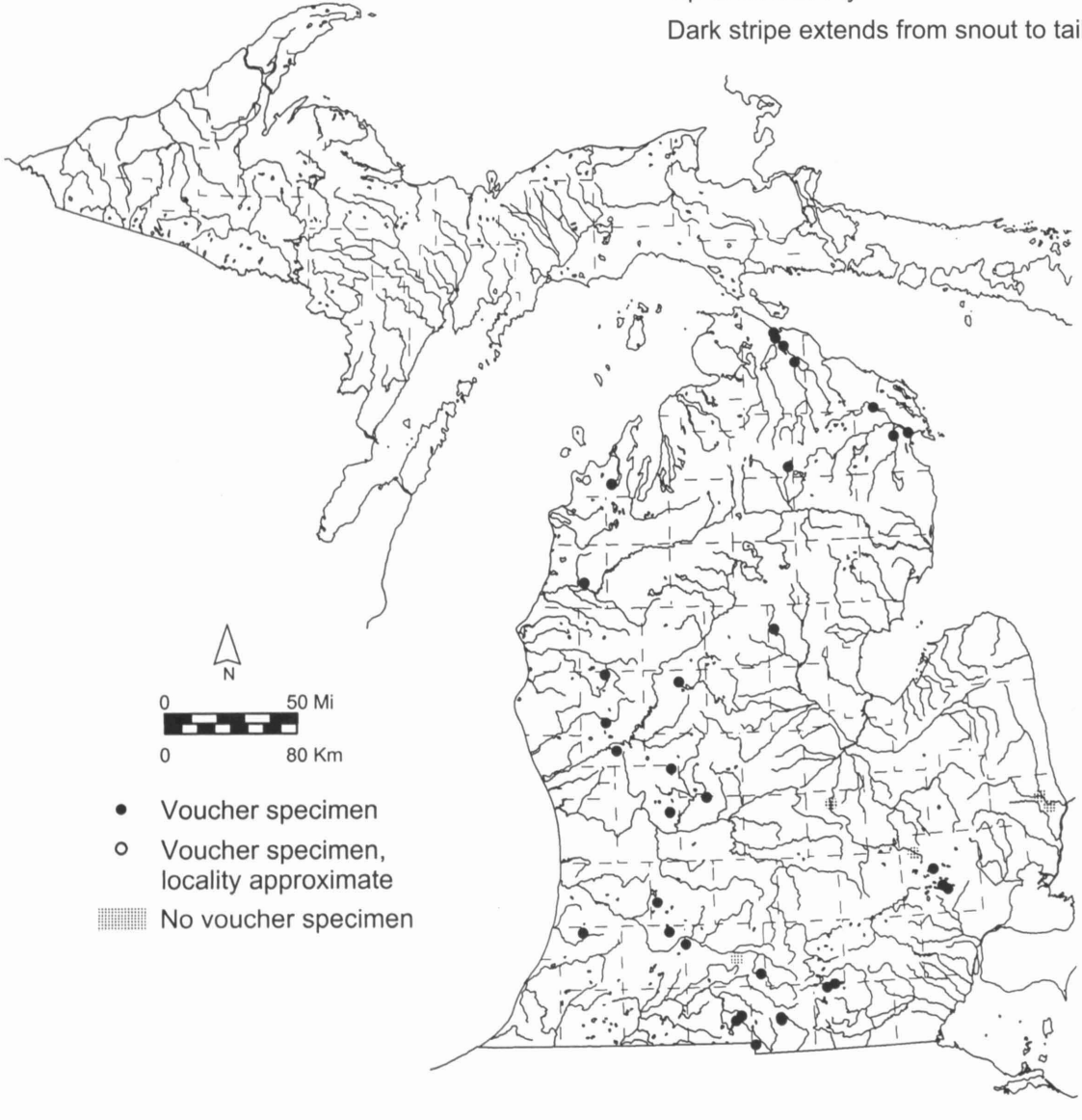


Mouth very small, almost vertical

Caudal spot wedge-shaped

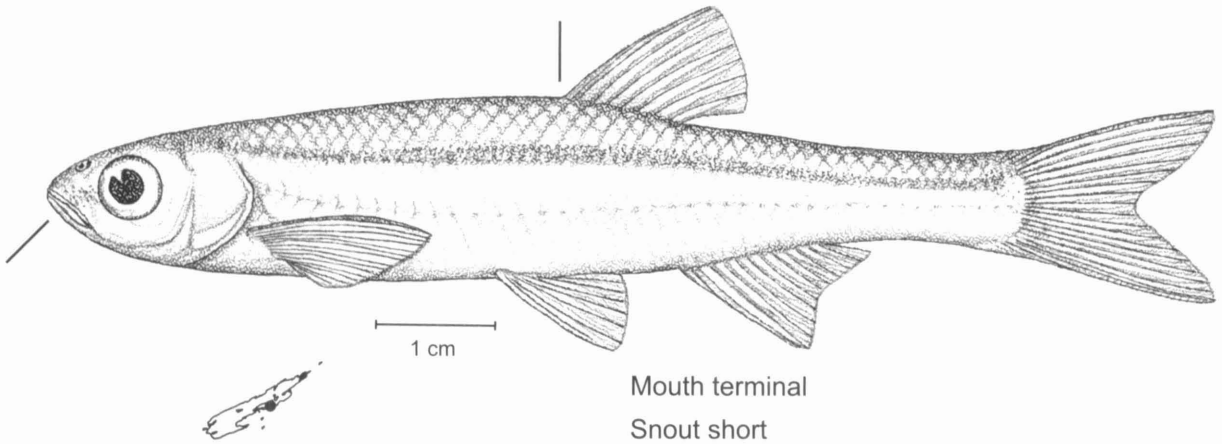
Tip of chin dusky

Dark stripe extends from snout to tail



Emerald Shiner

Notropis atherinoides

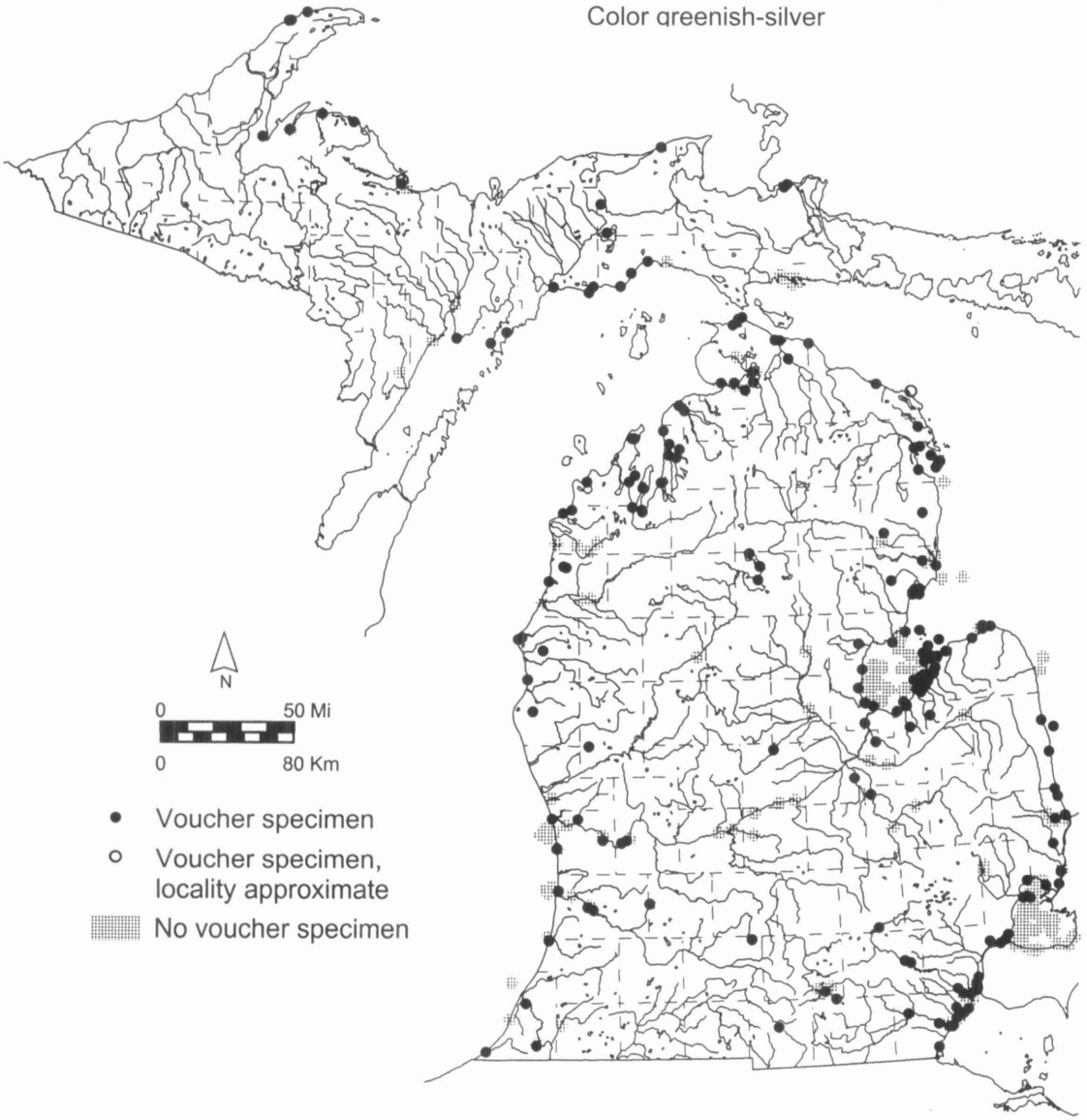


Mouth terminal

Snout short

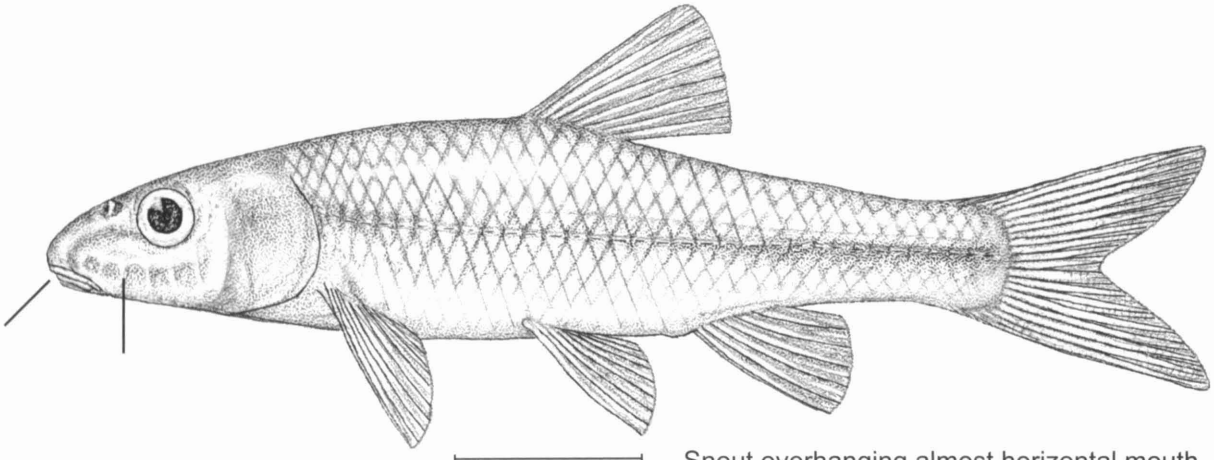
Dorsal fin origin well behind origin of pelvic

Color greenish-silver



Silverjaw Minnow

Notropis buccatus

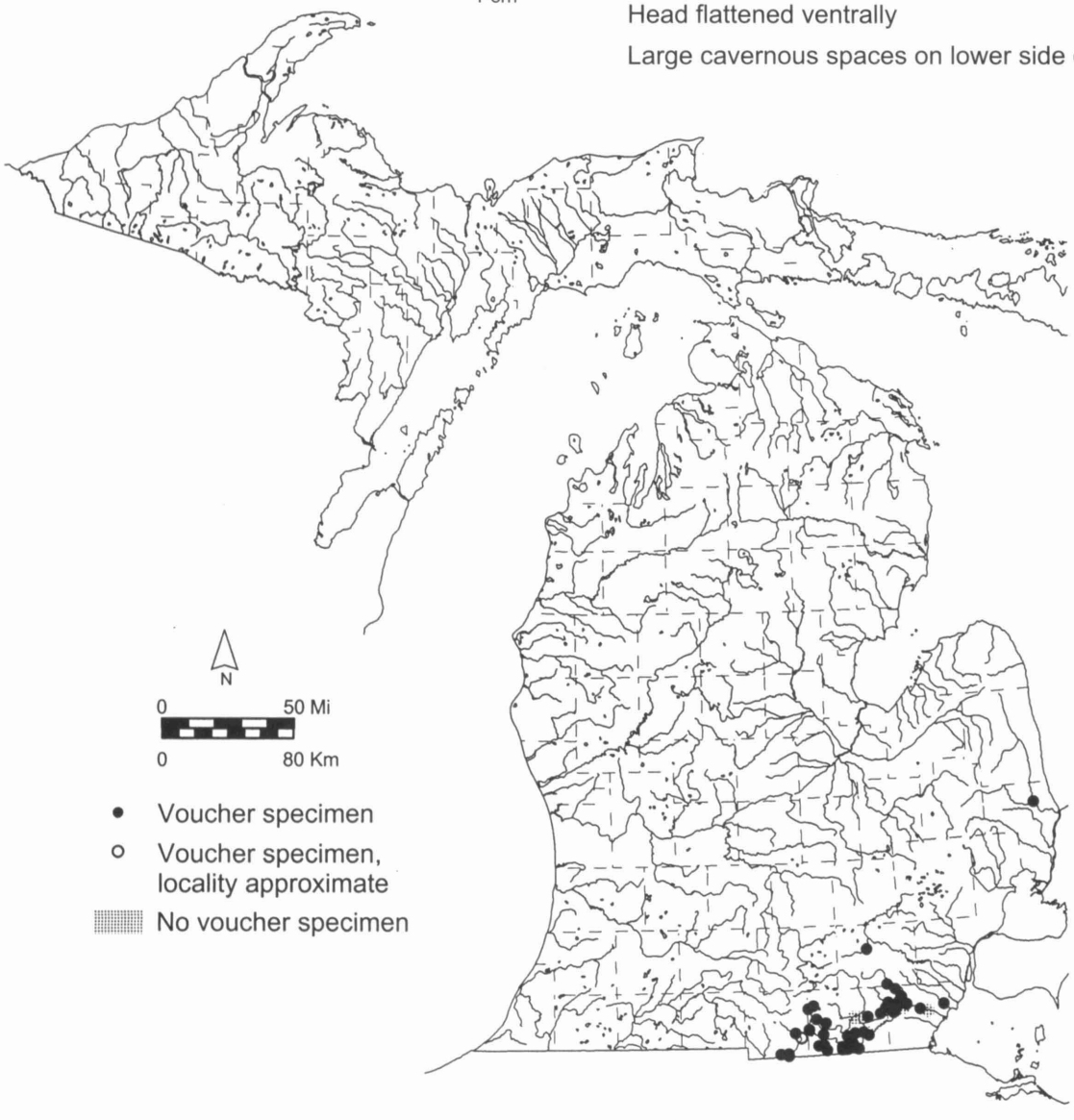


1 cm

Snout overhanging almost horizontal mouth

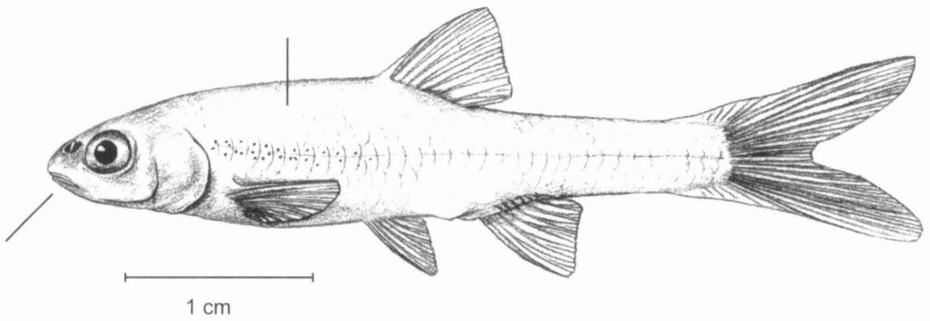
Head flattened ventrally

Large cavernous spaces on lower side of head



Ghost Shiner

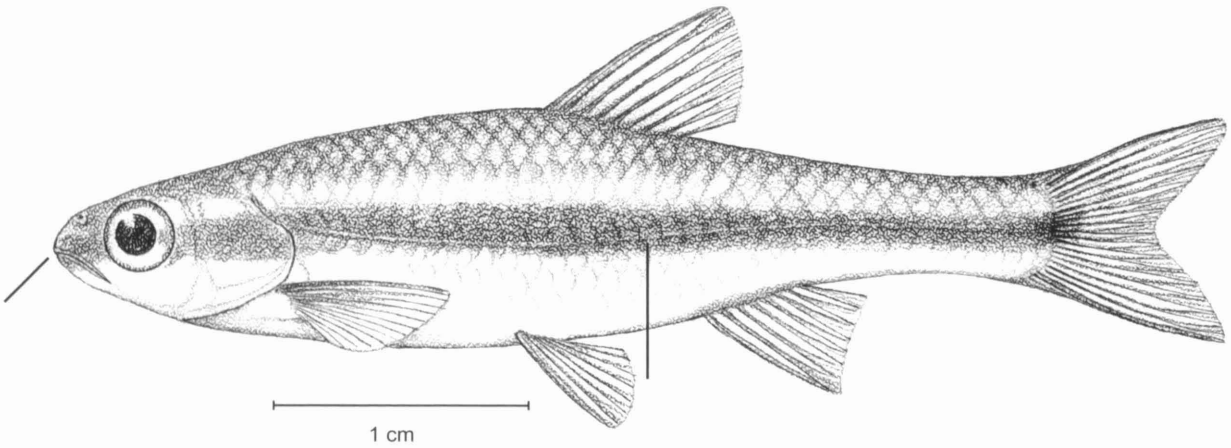
Notropis buchanani



Milky white color
Pigmentation lacking
Mouth small
Much like *N. volucellus*

Ironcolor Shiner

Notropis chalybaeus

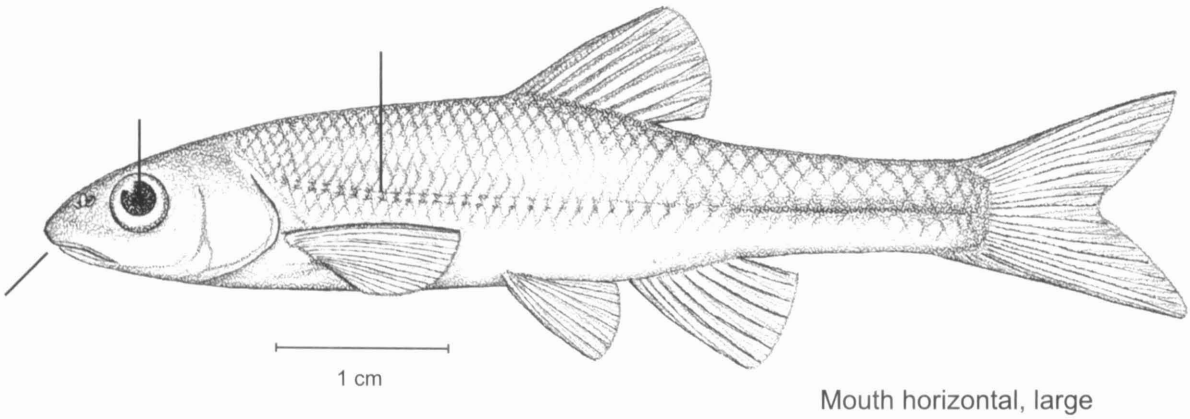


Black pigment around and inside mouth

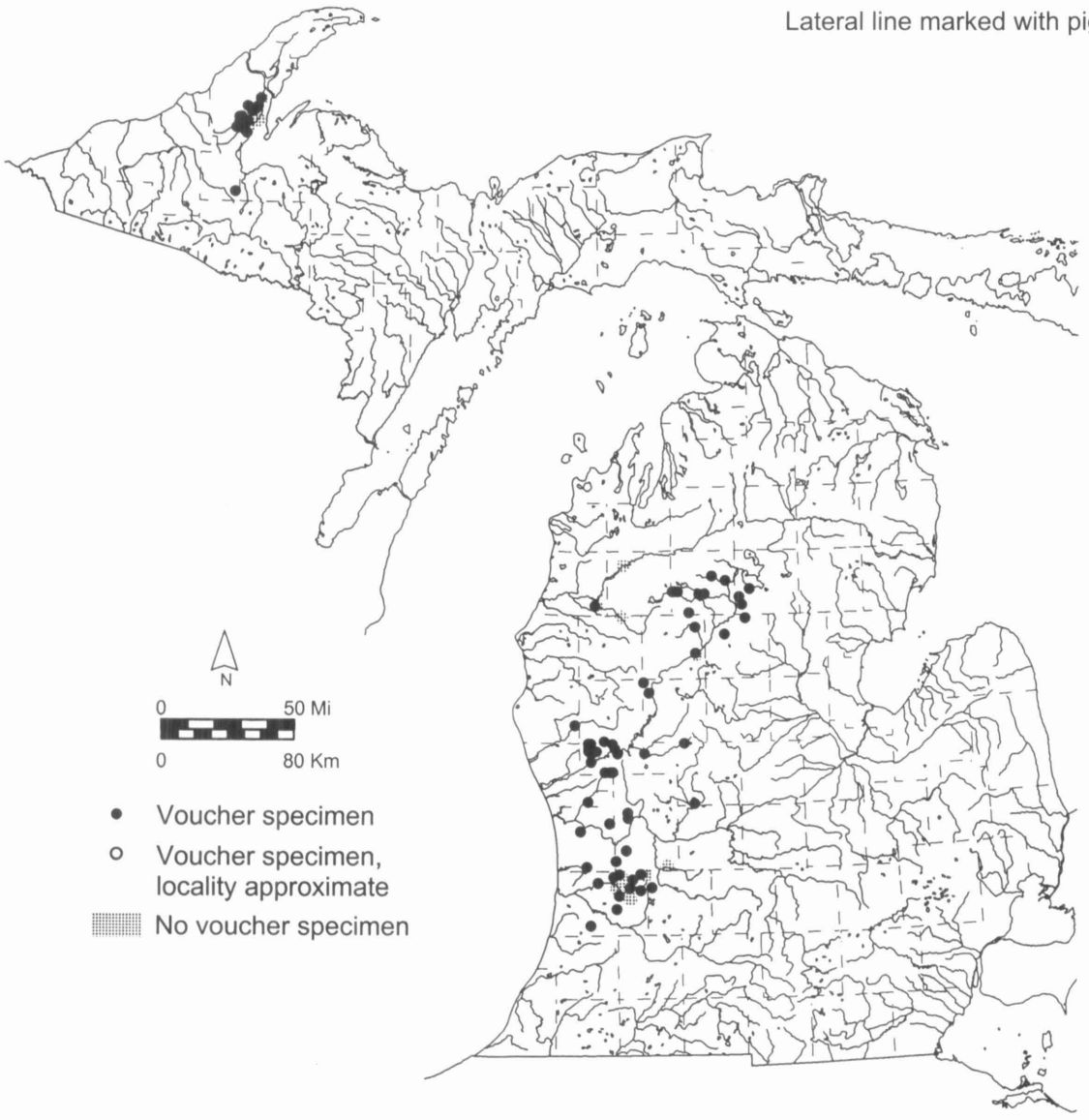
Black lateral stripe sharply demarcated below

Bigmouth Shiner

Notropis dorsalis

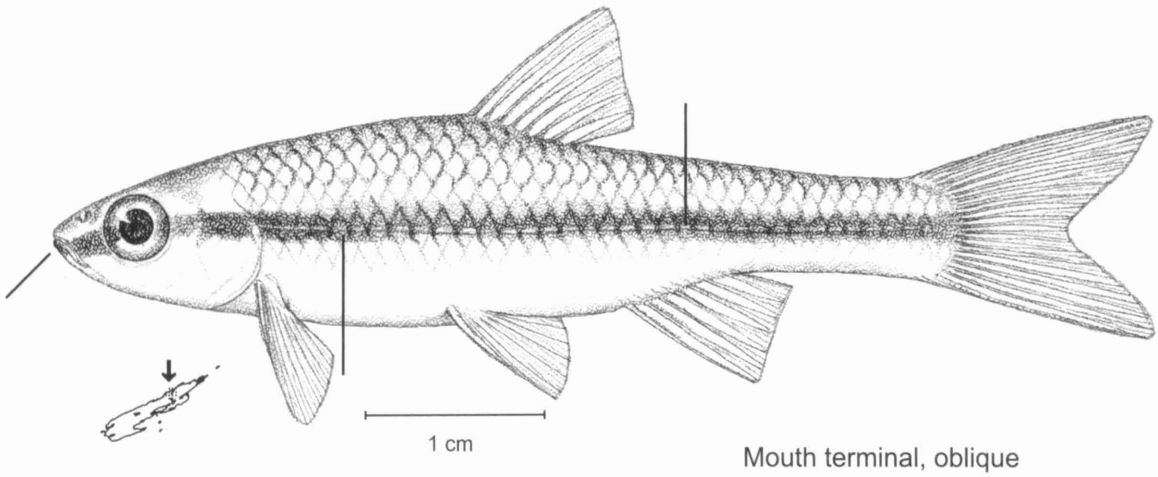


Mouth horizontal, large
Head flattened ventrally
Eyes dorsolateral
Lateral line marked with pigment



Blackchin Shiner

Notropis heterodon

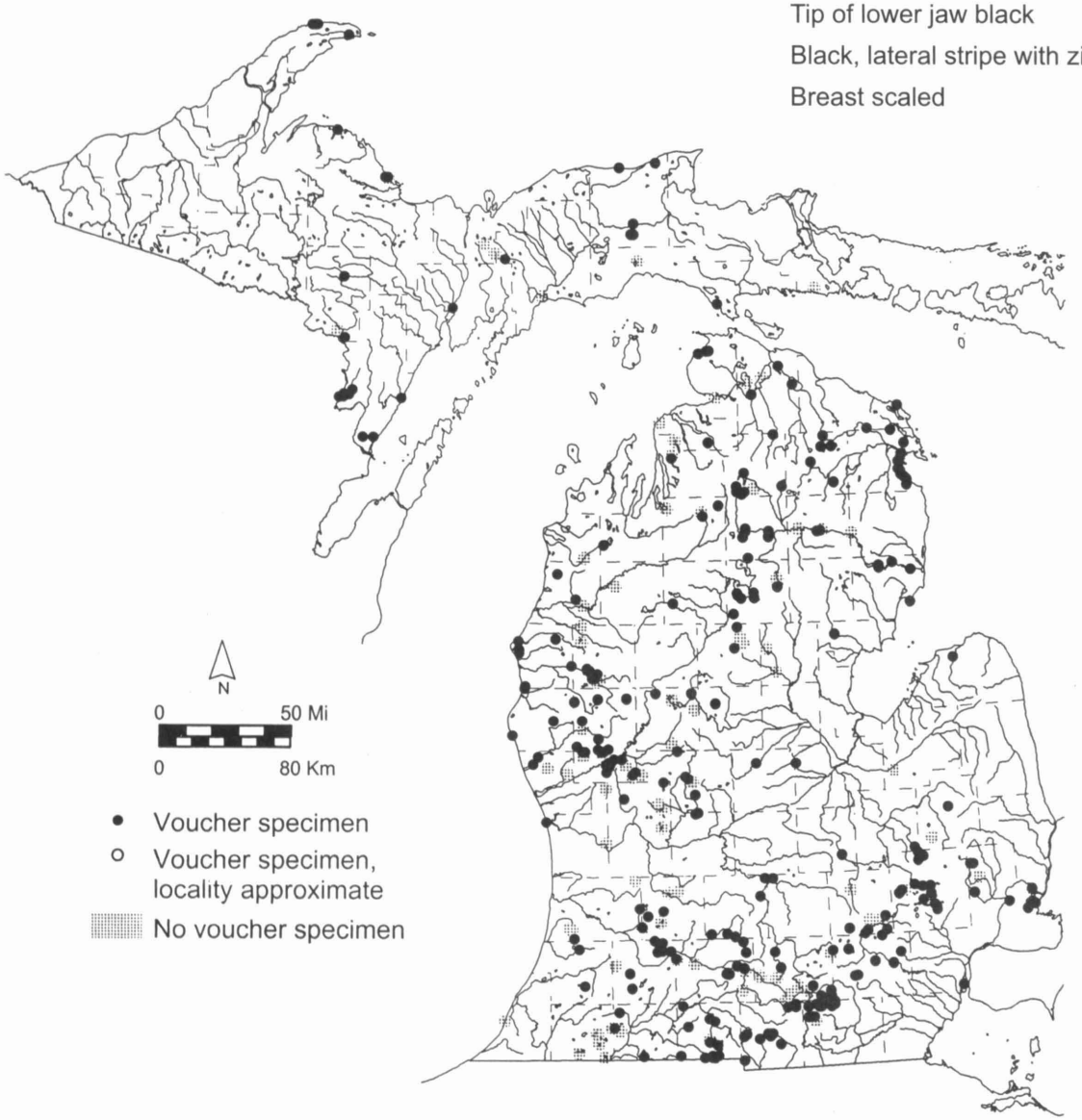


Mouth terminal, oblique

Tip of lower jaw black

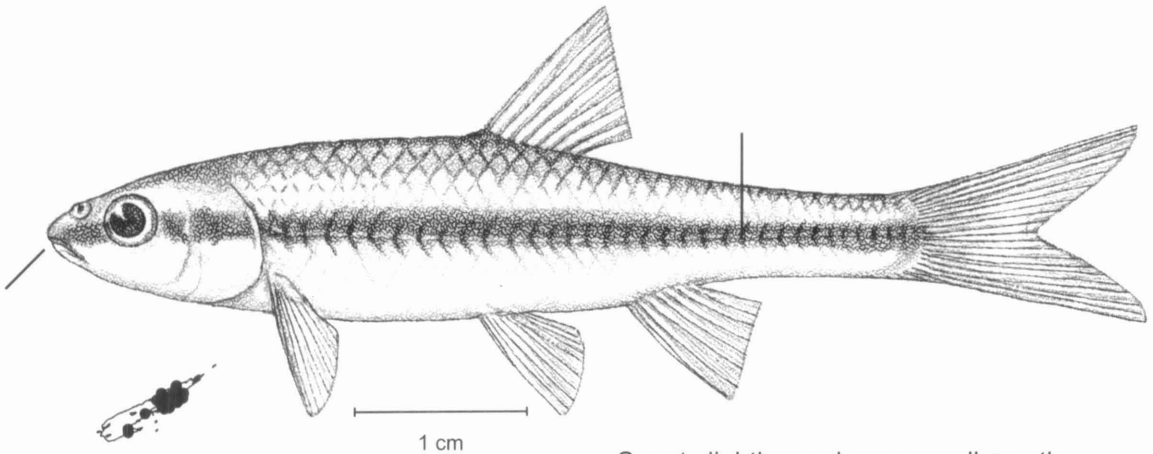
Black, lateral stripe with zig-zag edges

Breast scaled



Blacknose Shiner

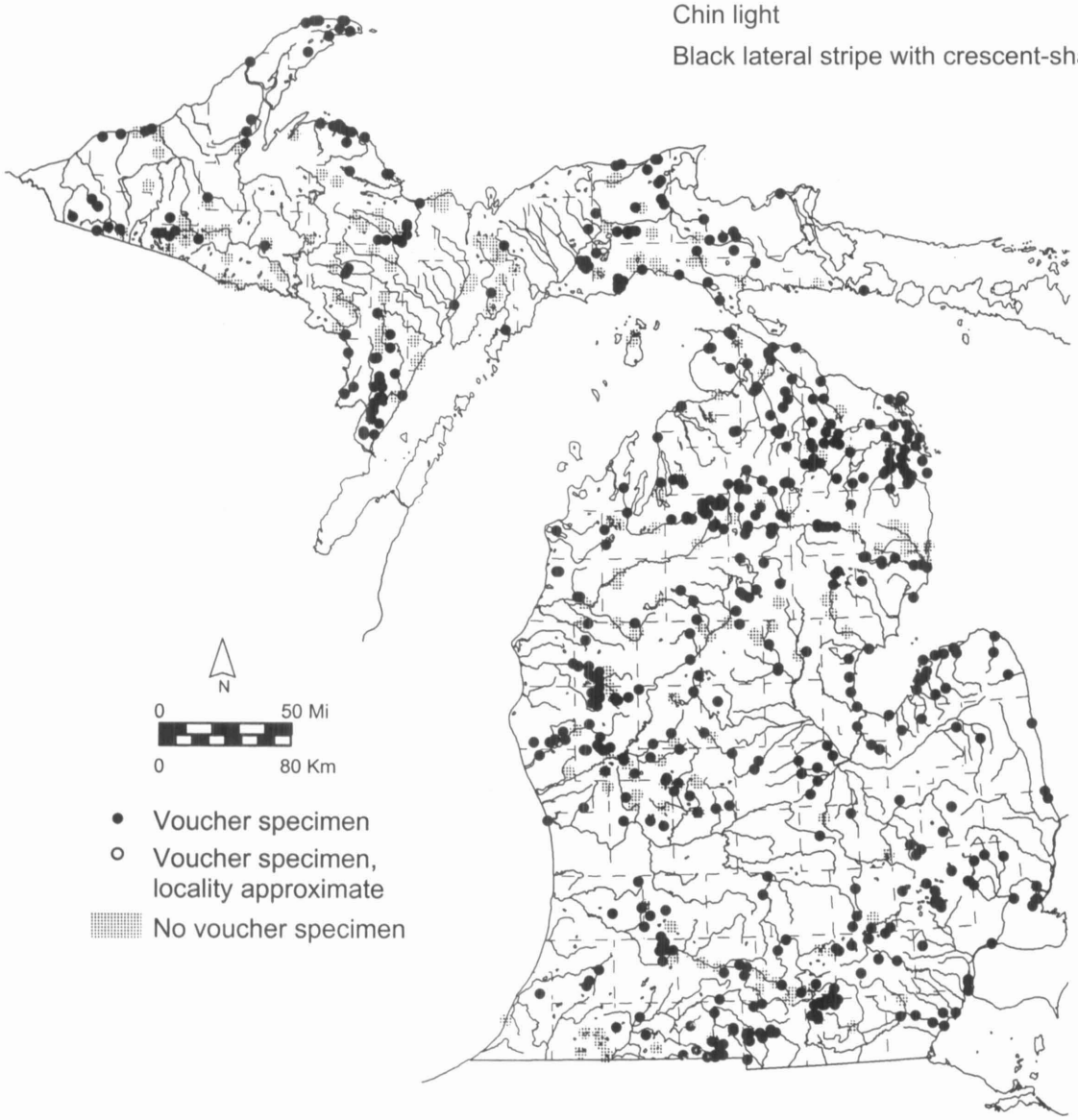
Notropis heterolepis



Snout slightly overhangs small mouth

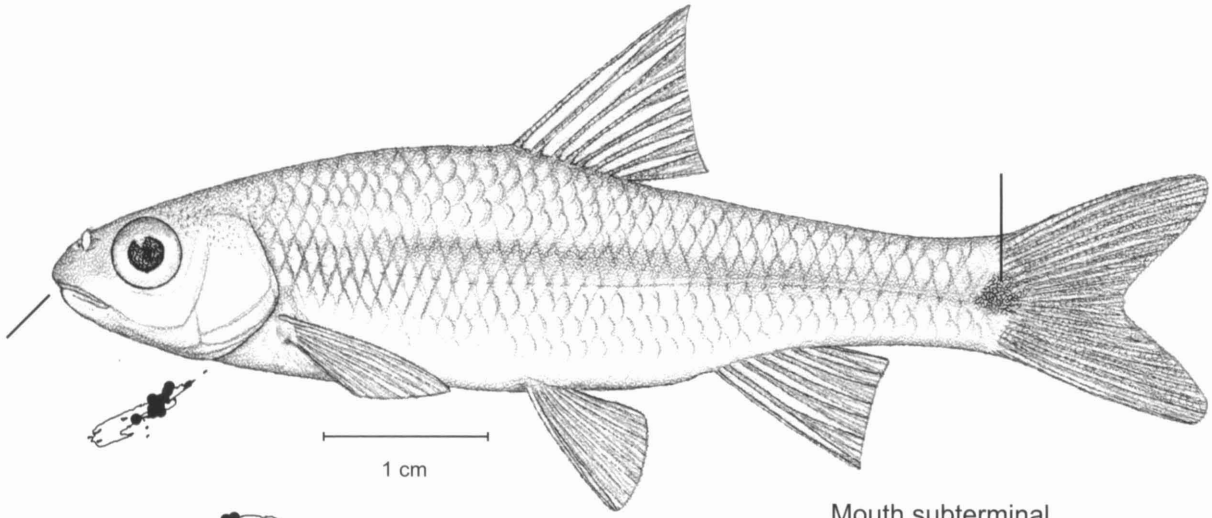
Chin light

Black lateral stripe with crescent-shaped bars

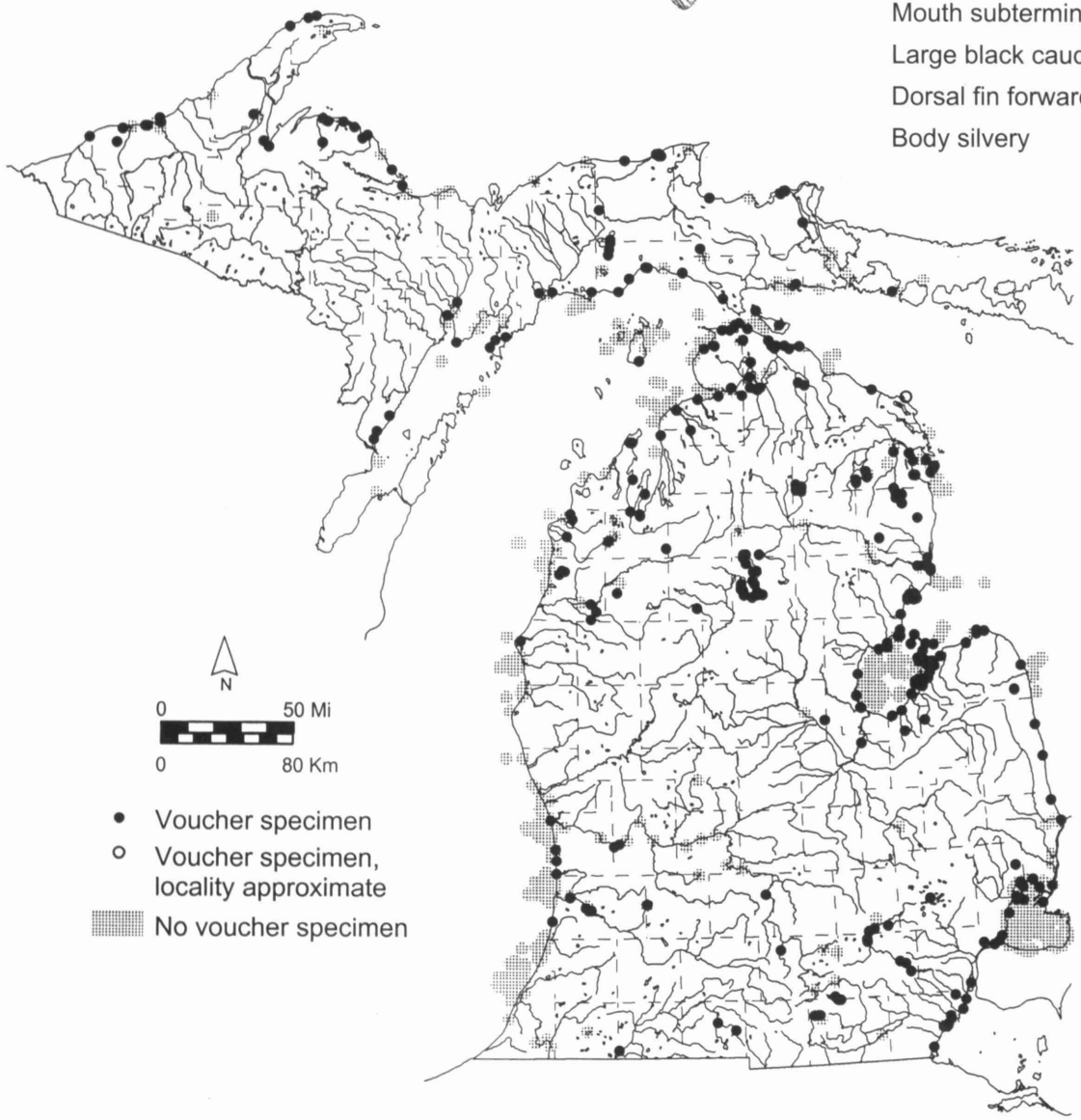


Spottail Shiner

Notropis hudsonius

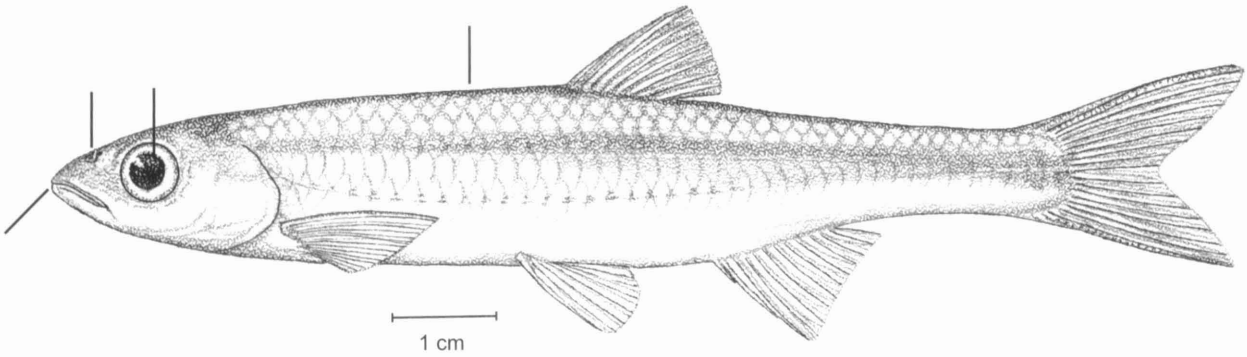


Mouth subterminal
Large black caudal spot
Dorsal fin forward and falcate
Body silvery



Silver Shiner

Notropis photogenis



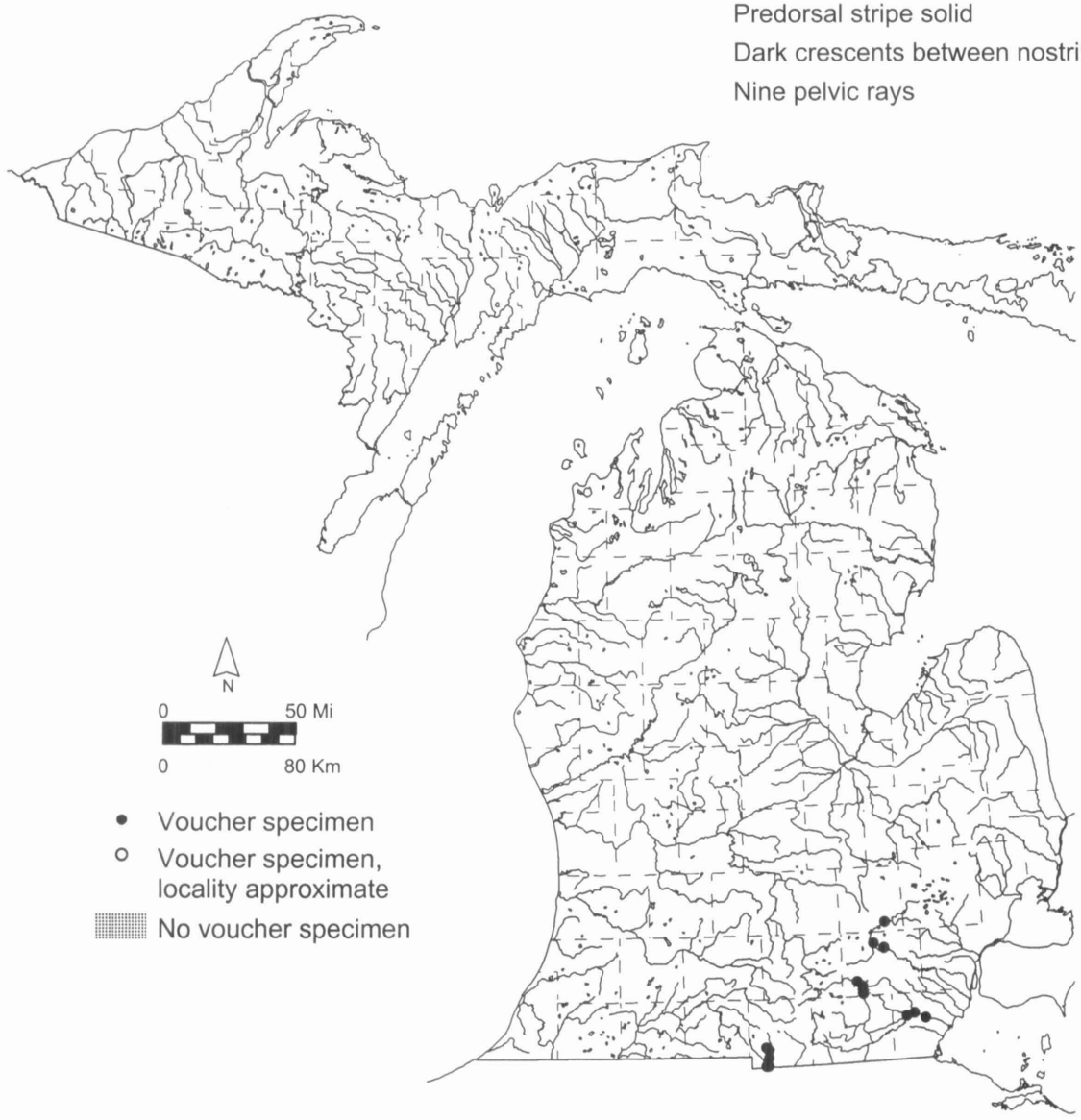
Mouth terminal, snout pointed

Eye large

Predorsal stripe solid

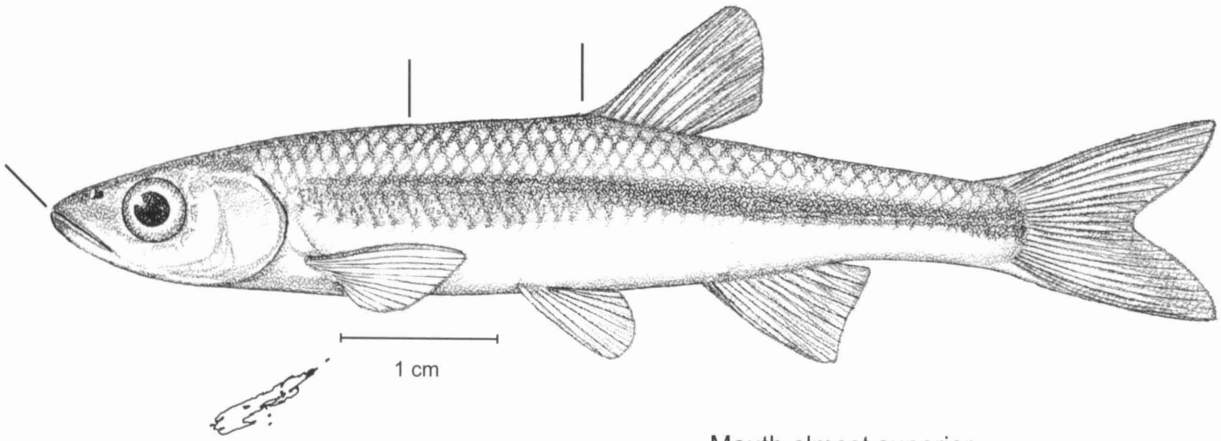
Dark crescents between nostrils

Nine pelvic rays

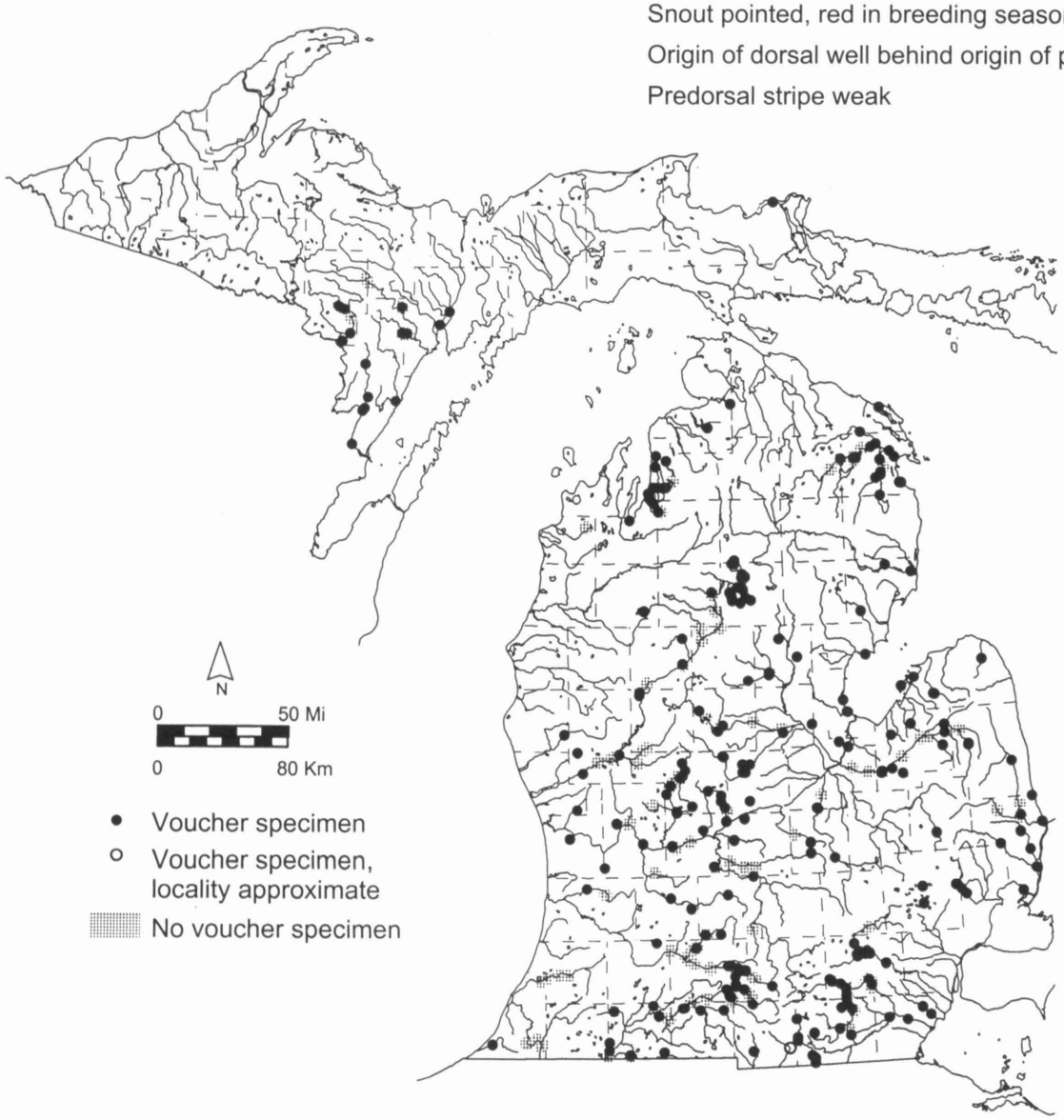


Rosyface Shiner

Notropis rubellus

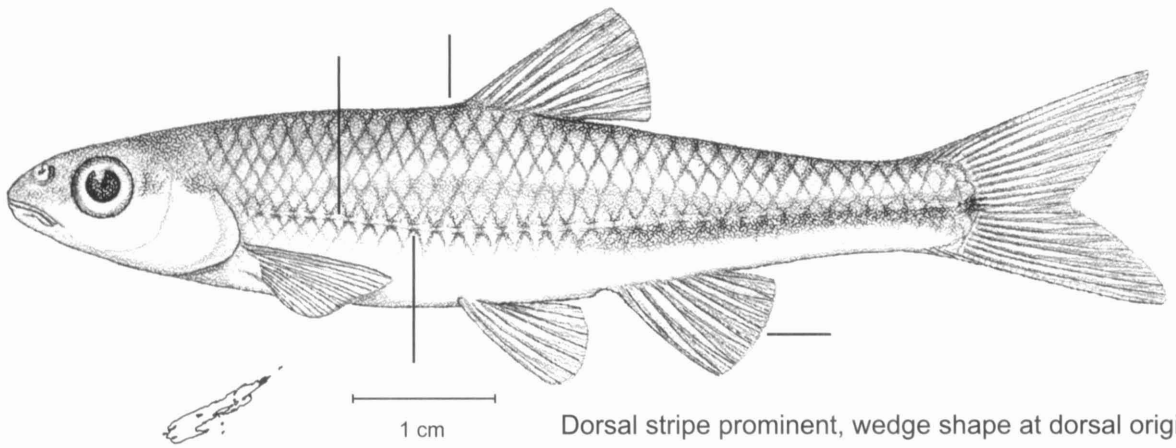


Mouth almost superior
Snout pointed, red in breeding season
Origin of dorsal well behind origin of pelvic
Predorsal stripe weak

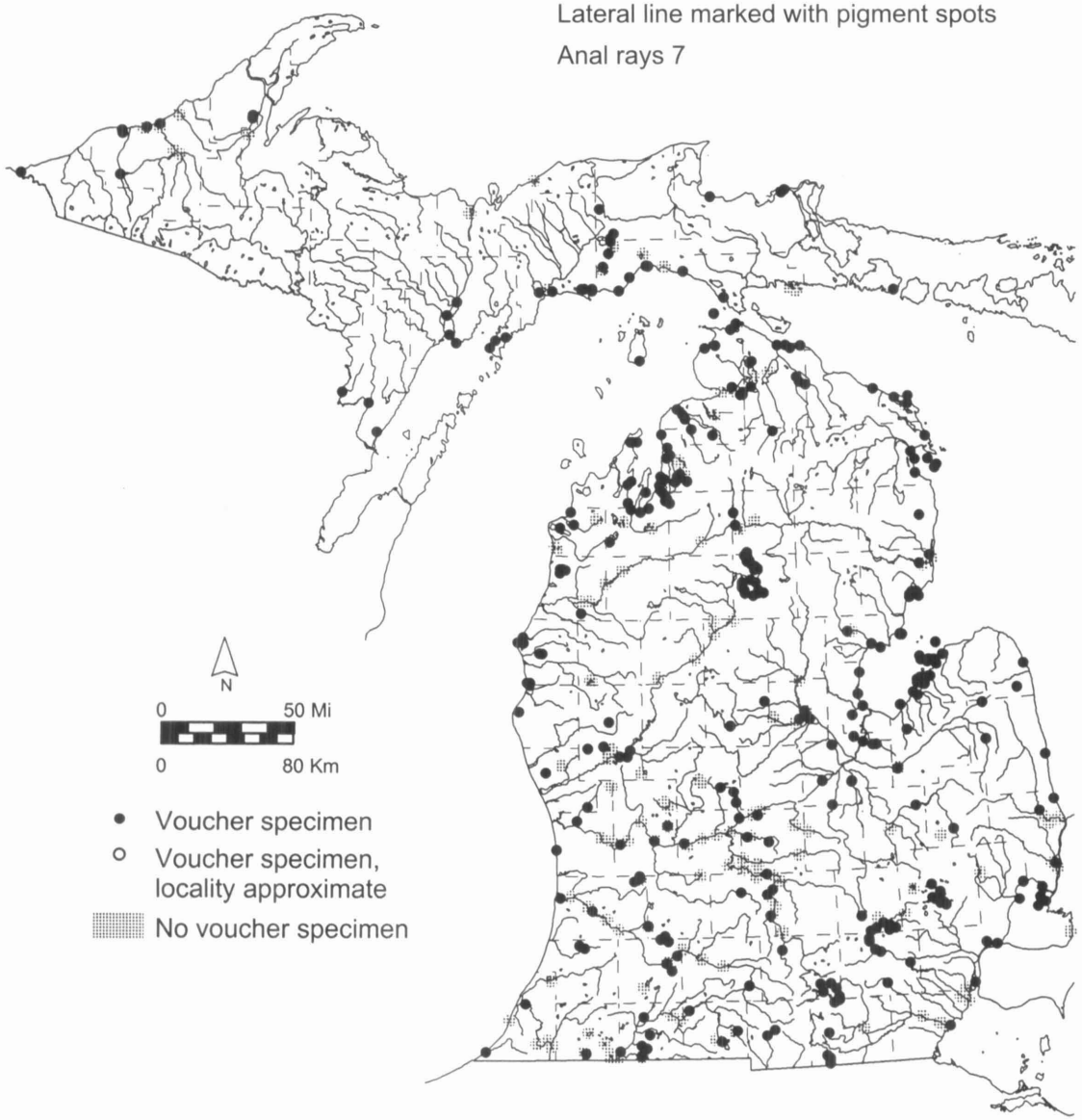


Sand Shiner

Notropis stramineus

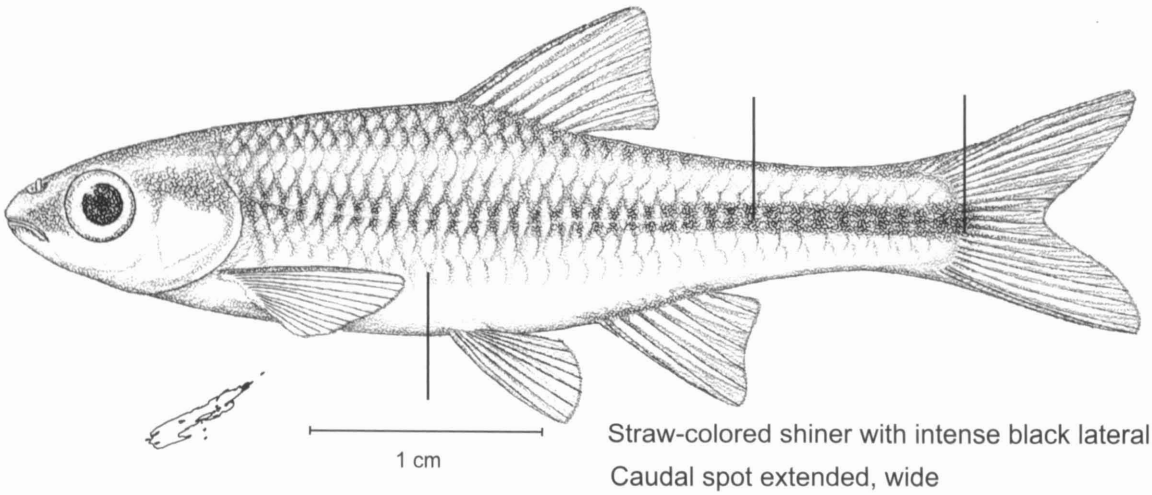


Dorsal stripe prominent, wedge shape at dorsal origin
Lateral line scale's height less than two times width
Lateral line marked with pigment spots
Anal rays 7

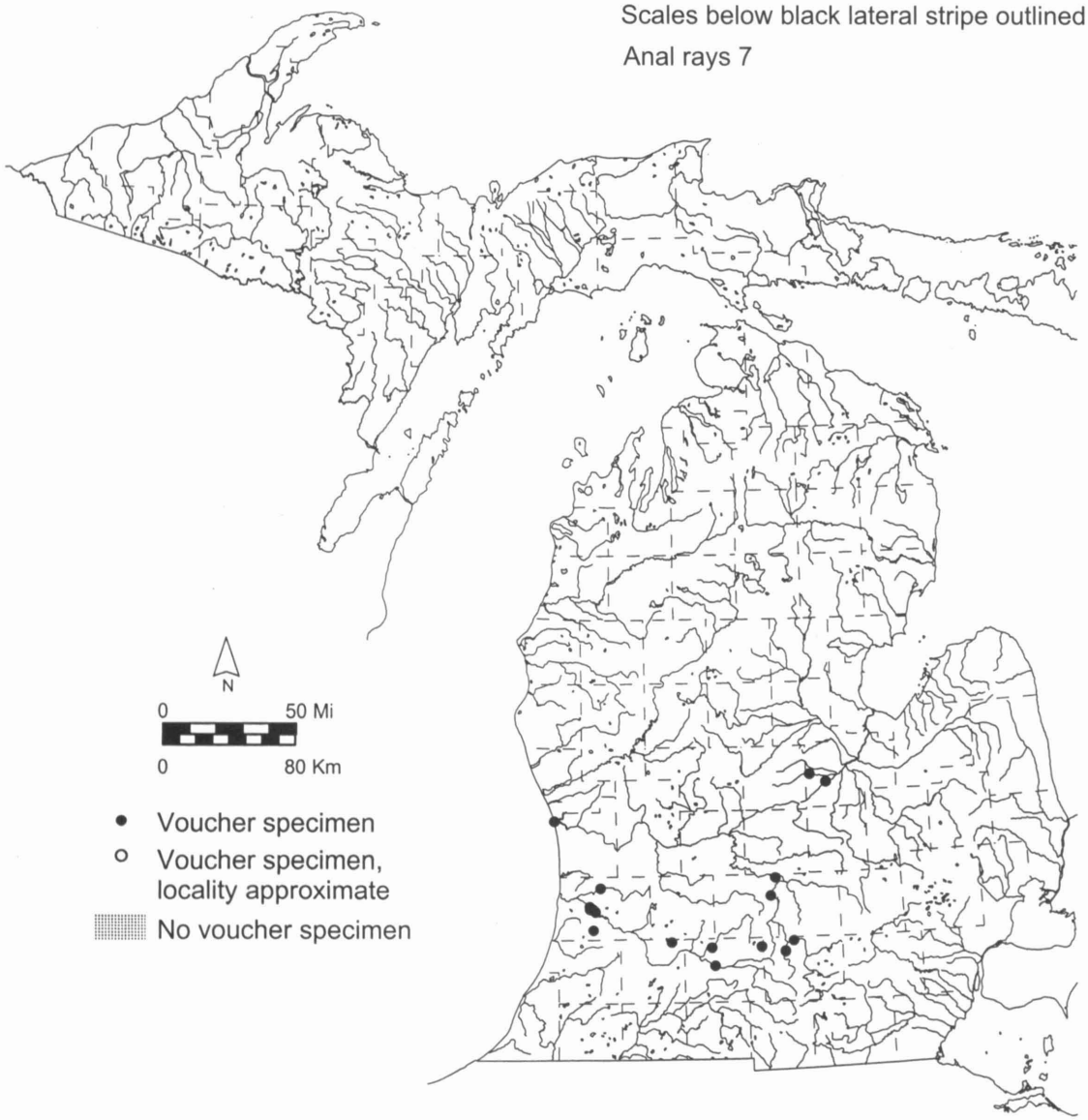


Weed Shiner

Notropis texanus

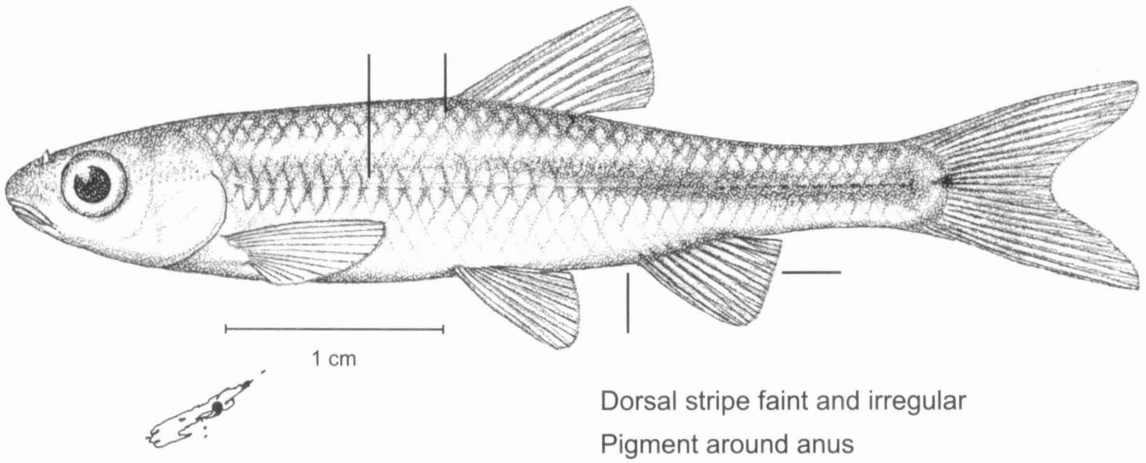


Straw-colored shiner with intense black lateral stripe
Caudal spot extended, wide
Scales below black lateral stripe outlined with pigment
Anal rays 7



Mimic Shiner

Notropis volucellus



Dorsal stripe faint and irregular

Pigment around anus

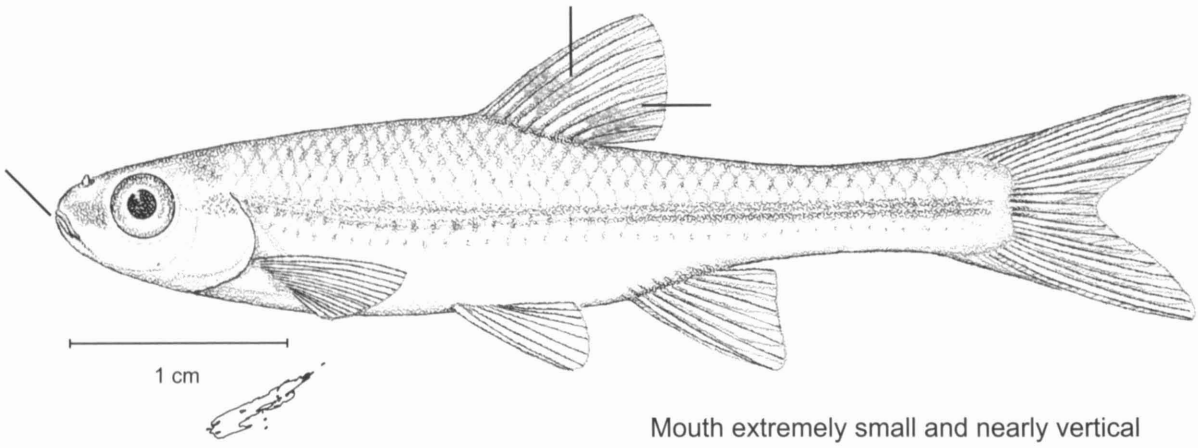
Lateral line scales high, more than two times width

Lateral line not well marked with pigment spots

Anal rays 8

Pugnose Minnow

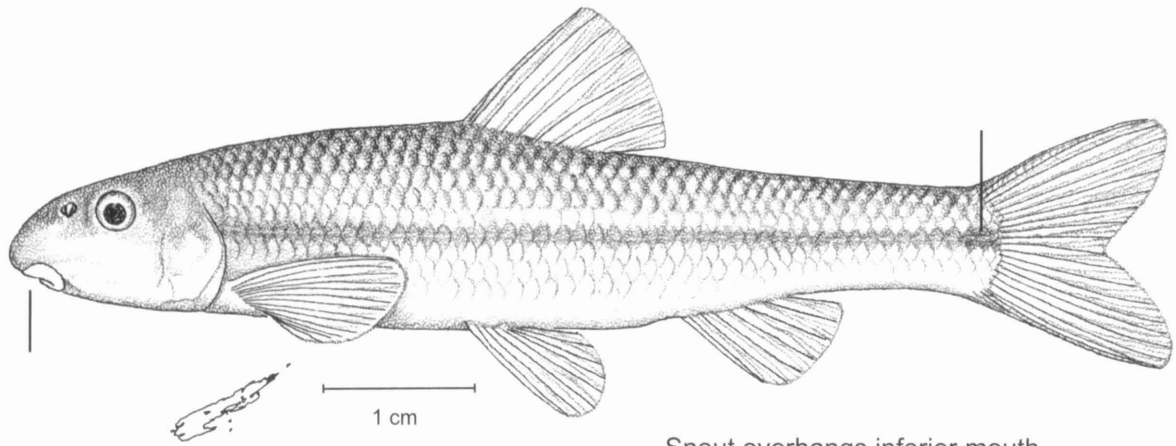
Opsopoeodus emiliae emiliae



Mouth extremely small and nearly vertical
Adult with two dark areas on dorsal fin
Dorsal rays 9

Suckermouth Minnow

Phenacobius mirabilis

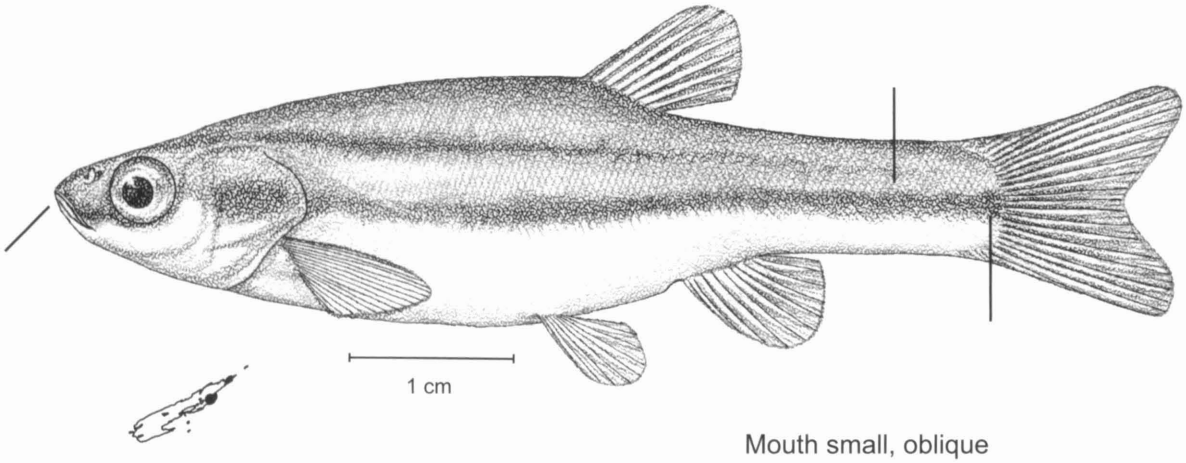


Snout overhangs inferior mouth

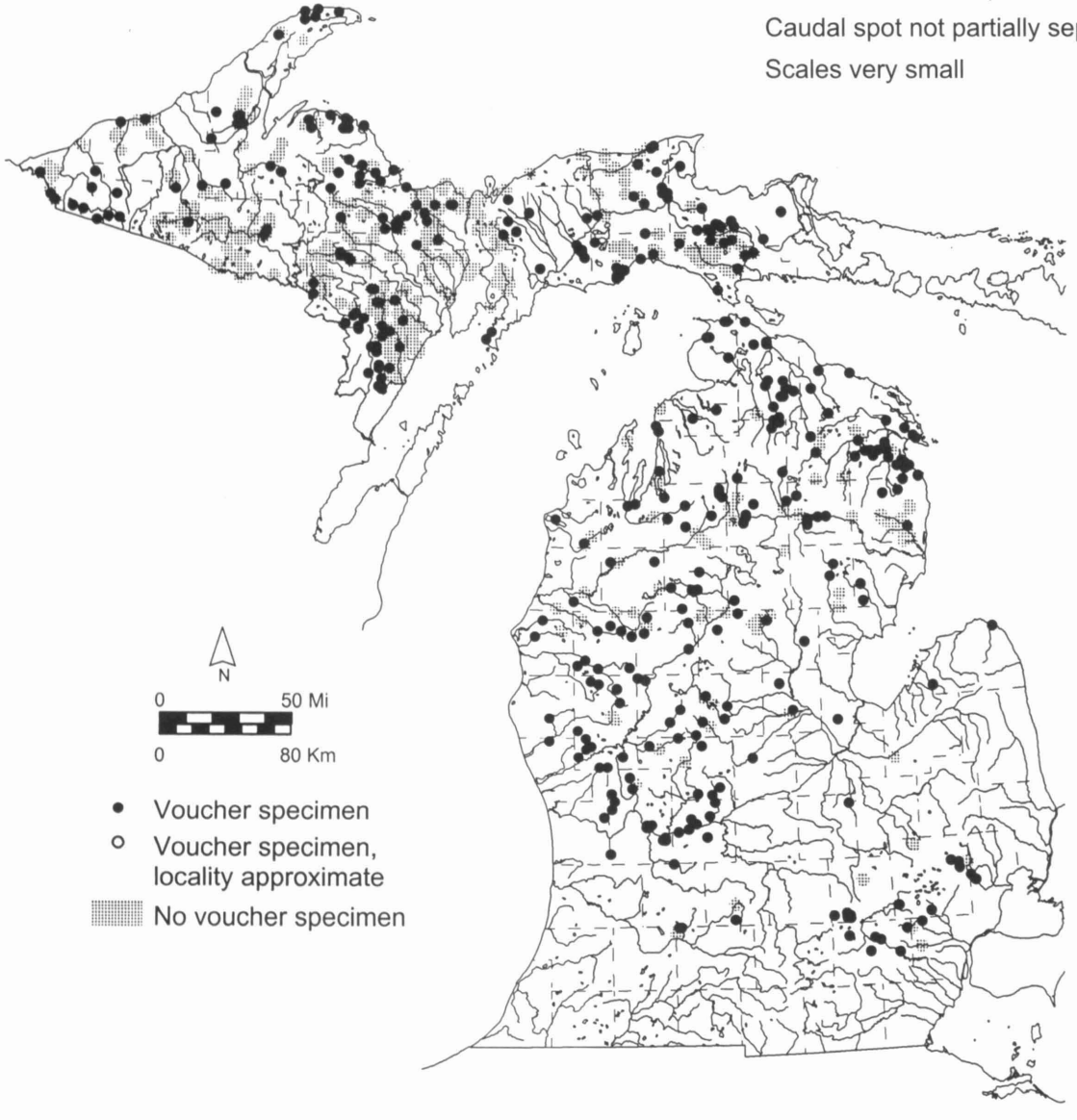
Lips fleshy, form lobes

Prominent caudal spot

Northern Redbelly Dace
Phoxinus eos

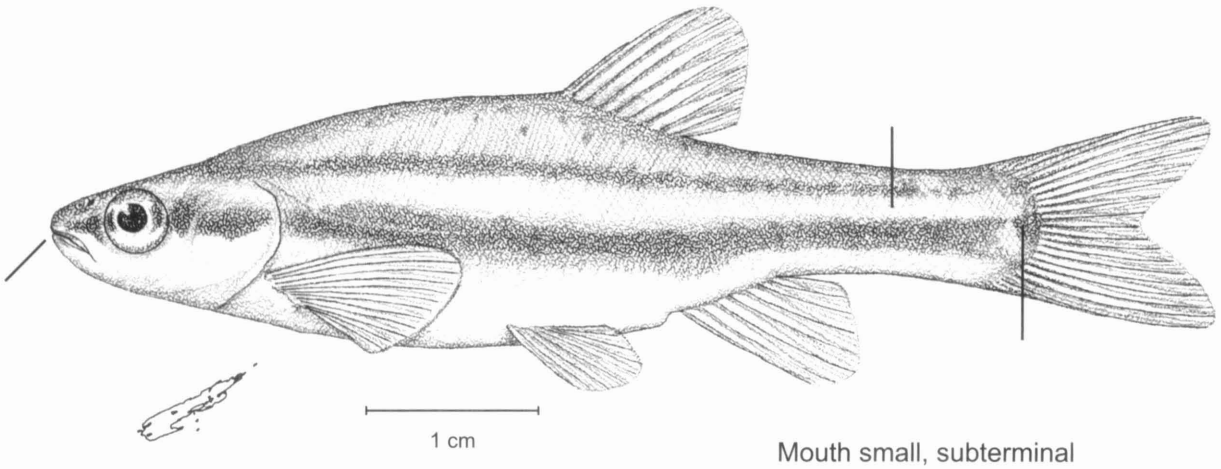


Mouth small, oblique
Two dark lateral stripes in adult
Caudal spot not partially separated
Scales very small



Southern Redbelly Dace

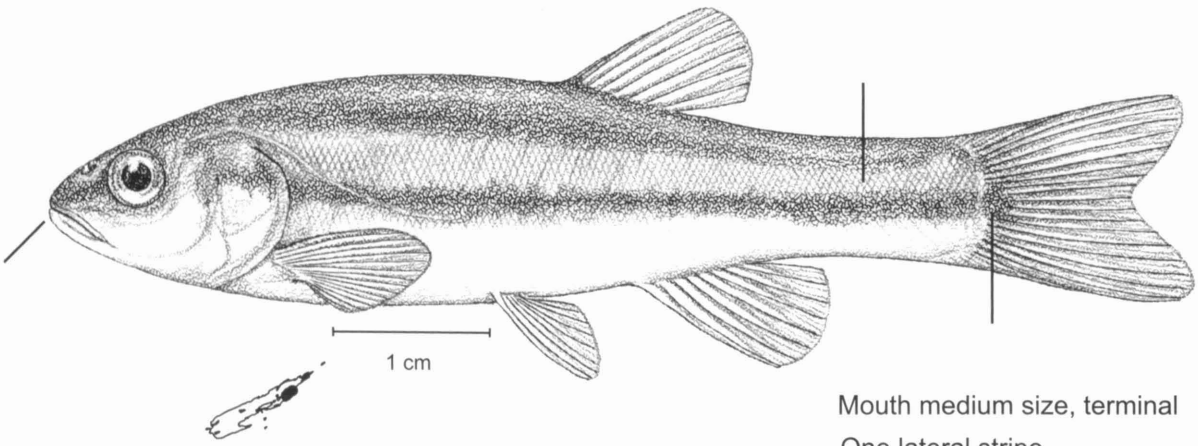
Phoxinus erythrogaster



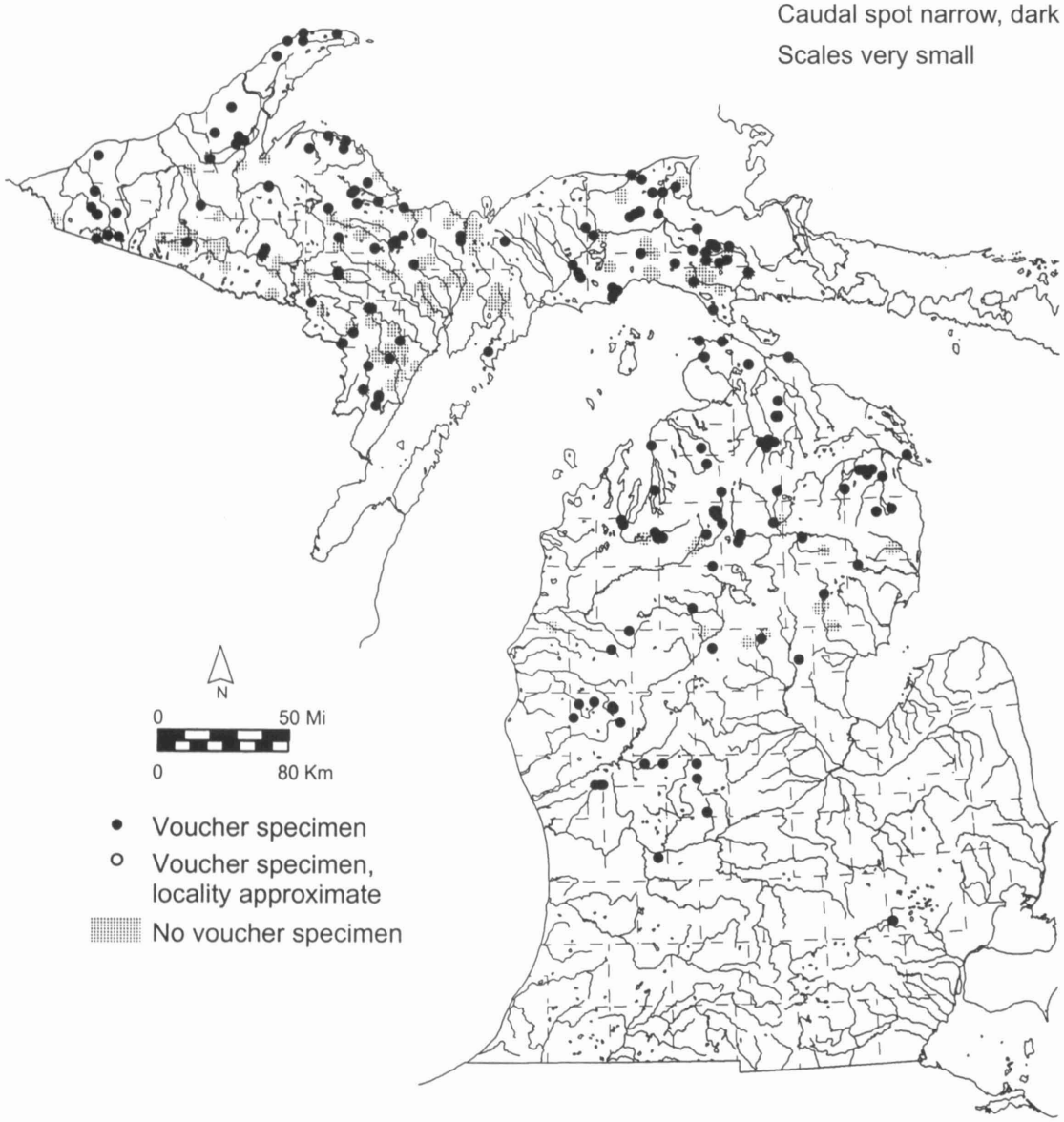
Mouth small, subterminal
Two dark lateral stripes in adult
Caudal spot partially separated
Scales very small

Finescale Dace

Phoxinus neogaeus

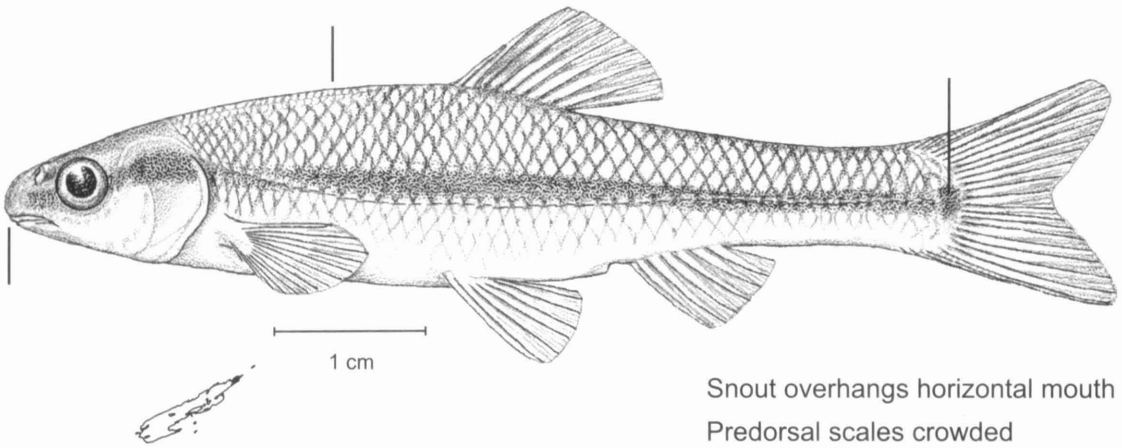


Mouth medium size, terminal
One lateral stripe
Caudal spot narrow, dark
Scales very small



Bluntnose Minnow

Pimephales notatus



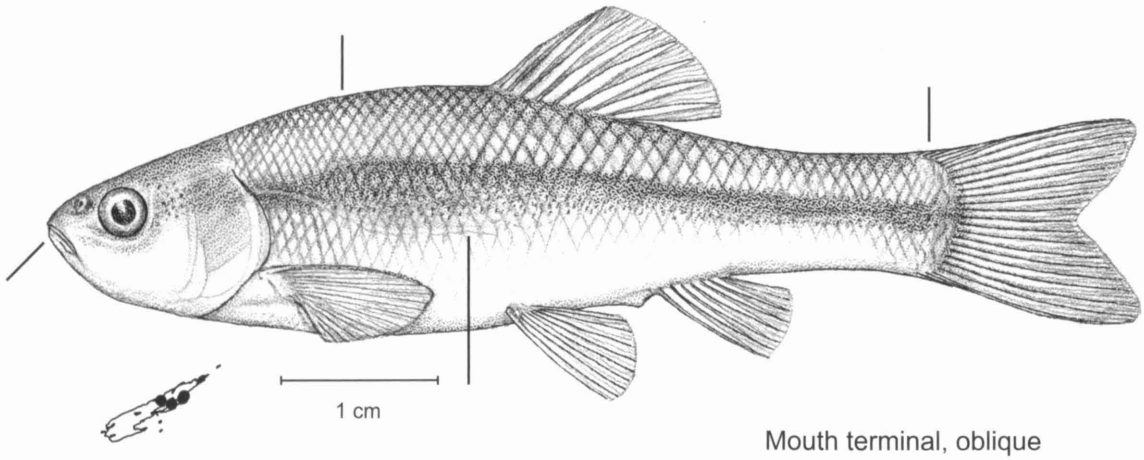
Snout overhangs horizontal mouth

Predorsal scales crowded

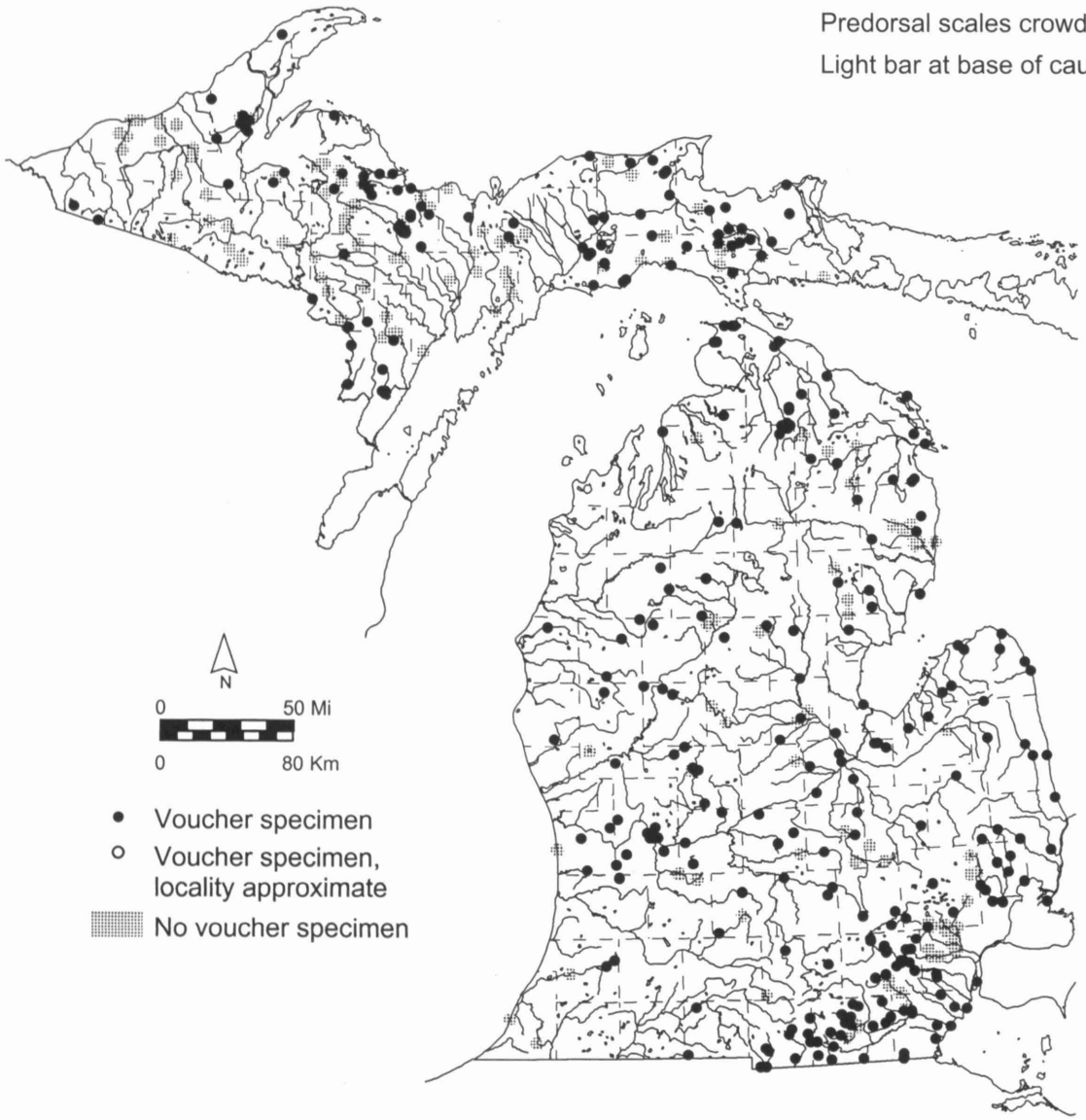
Caudal spot conspicuous

Fathead Minnow

Pimephales promelas

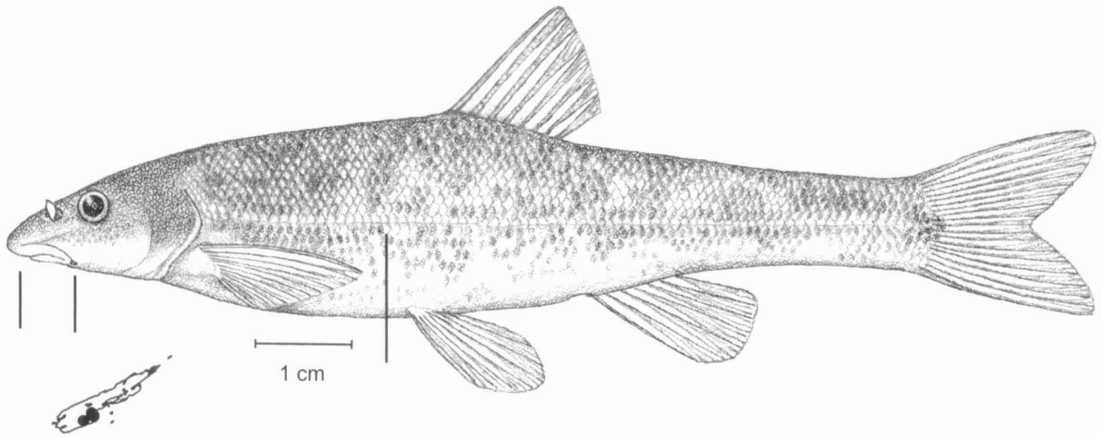


Mouth terminal, oblique
Lateral line incomplete
Predorsal scales crowded
Light bar at base of caudal fin



Longnose Dace

Rhinichthys cataractae



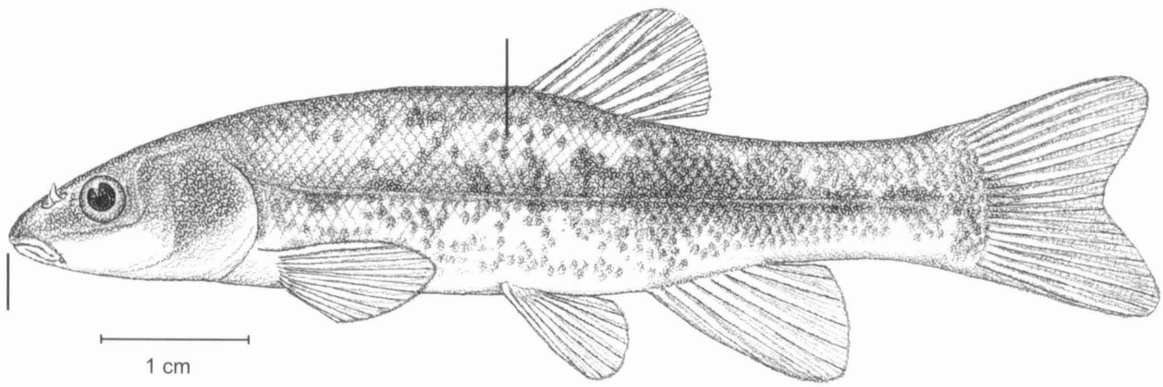
Snout projecting far beyond almost horizontal mouth

Barbel present

Dusky lateral stripe poorly defined or absent

Western Blacknose Dace

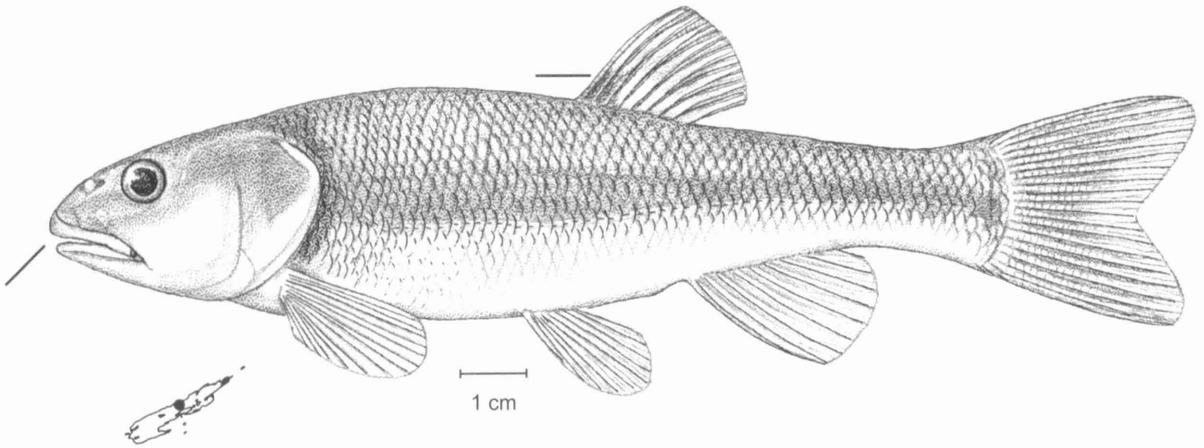
Rhinichthys obtusus



Snout scarcely projecting beyond subterminal mouth
Upper jaw not protractile
Barbel present
Many dusky scales scattered over back and side
Dark lateral stripe contrasts with silvery side

Creek Chub

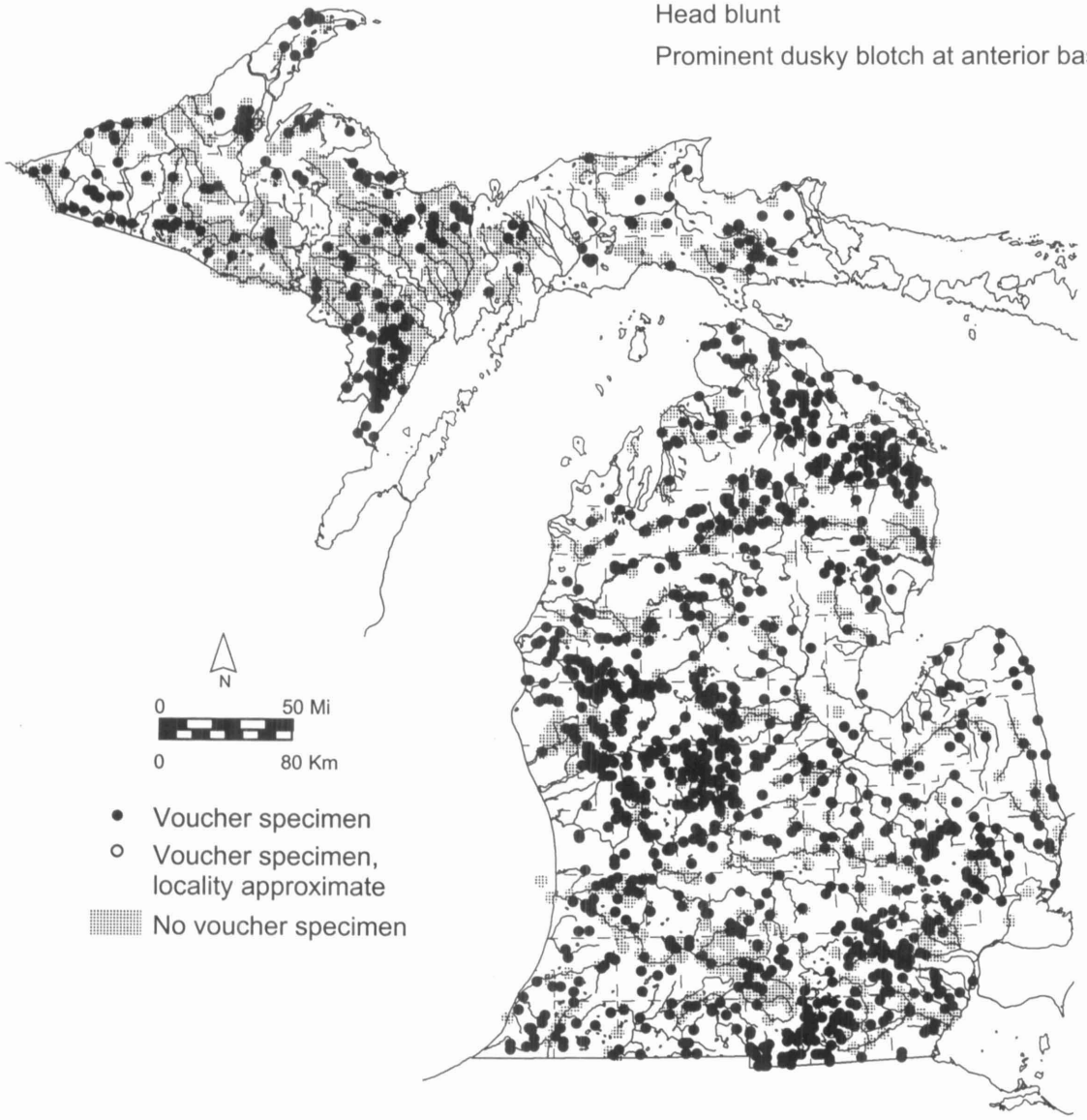
Semotilus atromaculatus



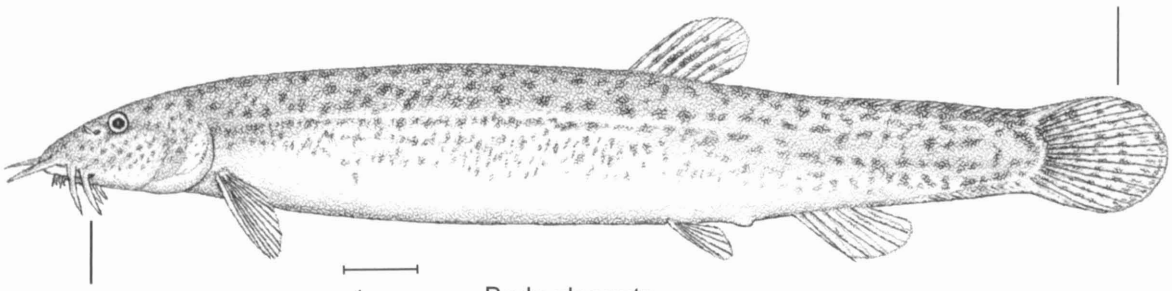
Mouth large, terminal

Head blunt

Prominent dusky blotch at anterior base of dorsal fin



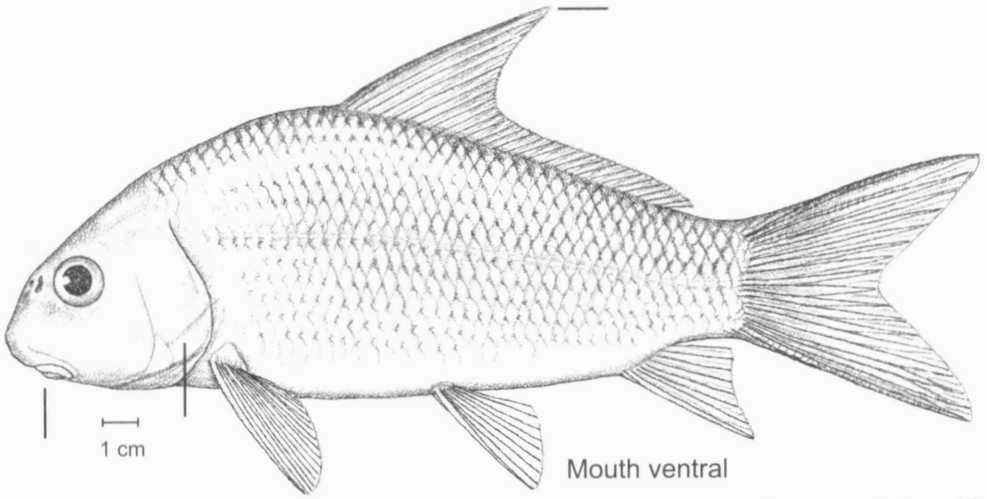
Oriental Weatherfish
Misgurnus anguillicaudatus



Body elongate
Five pairs of barbels around mouth
Caudal fin round

Quillback

Carpiodes cyprinus



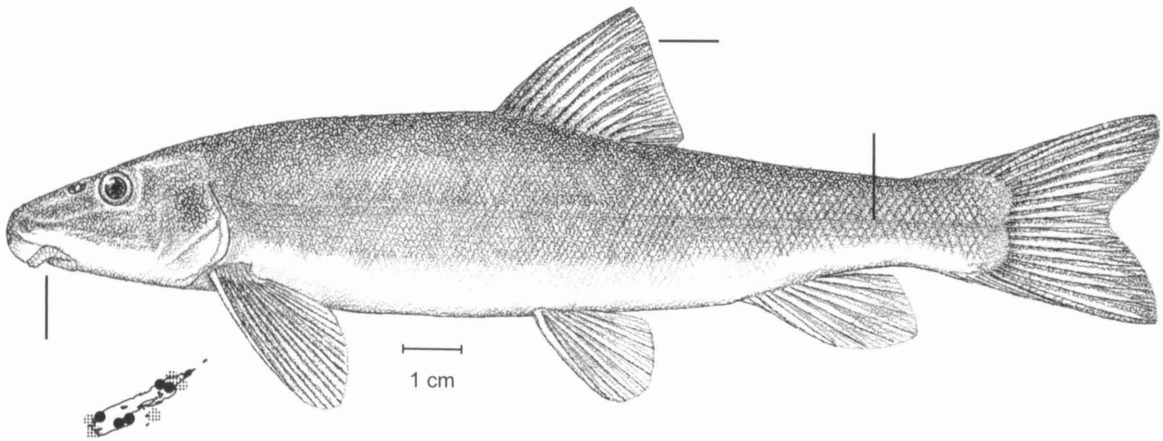
Mouth ventral

Anterior rays of depressed dorsal fin longer than one-half dorsal fin base

Subopercle subtriangular

Longnose Sucker

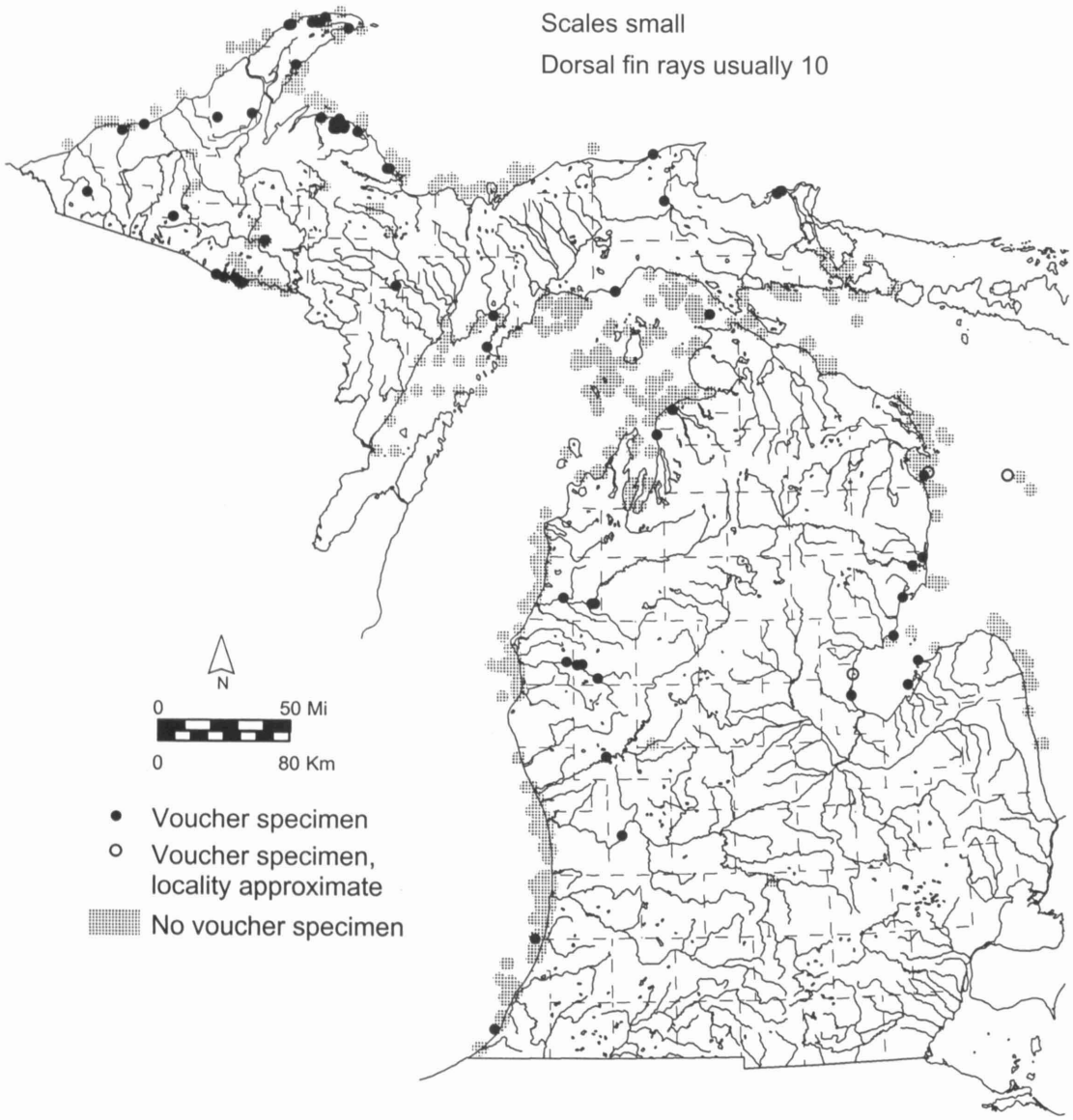
Catostomus catostomus



Bulbous snout projects far beyond upper lip

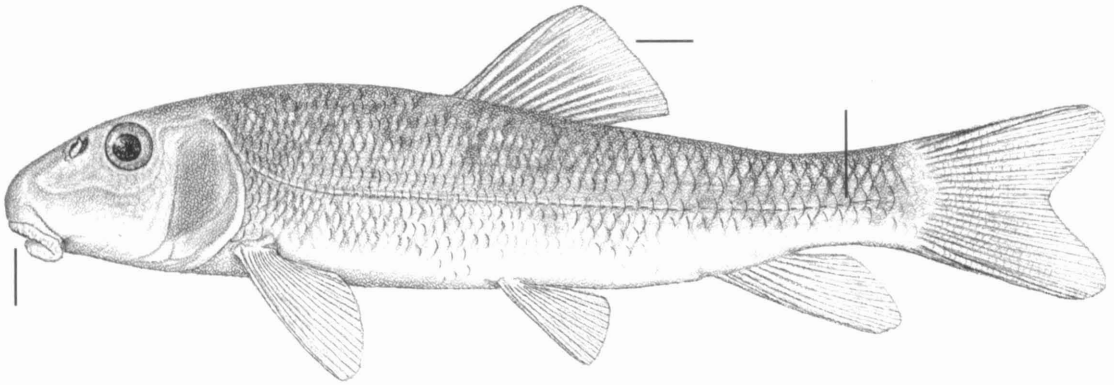
Scales small

Dorsal fin rays usually 10



White Sucker

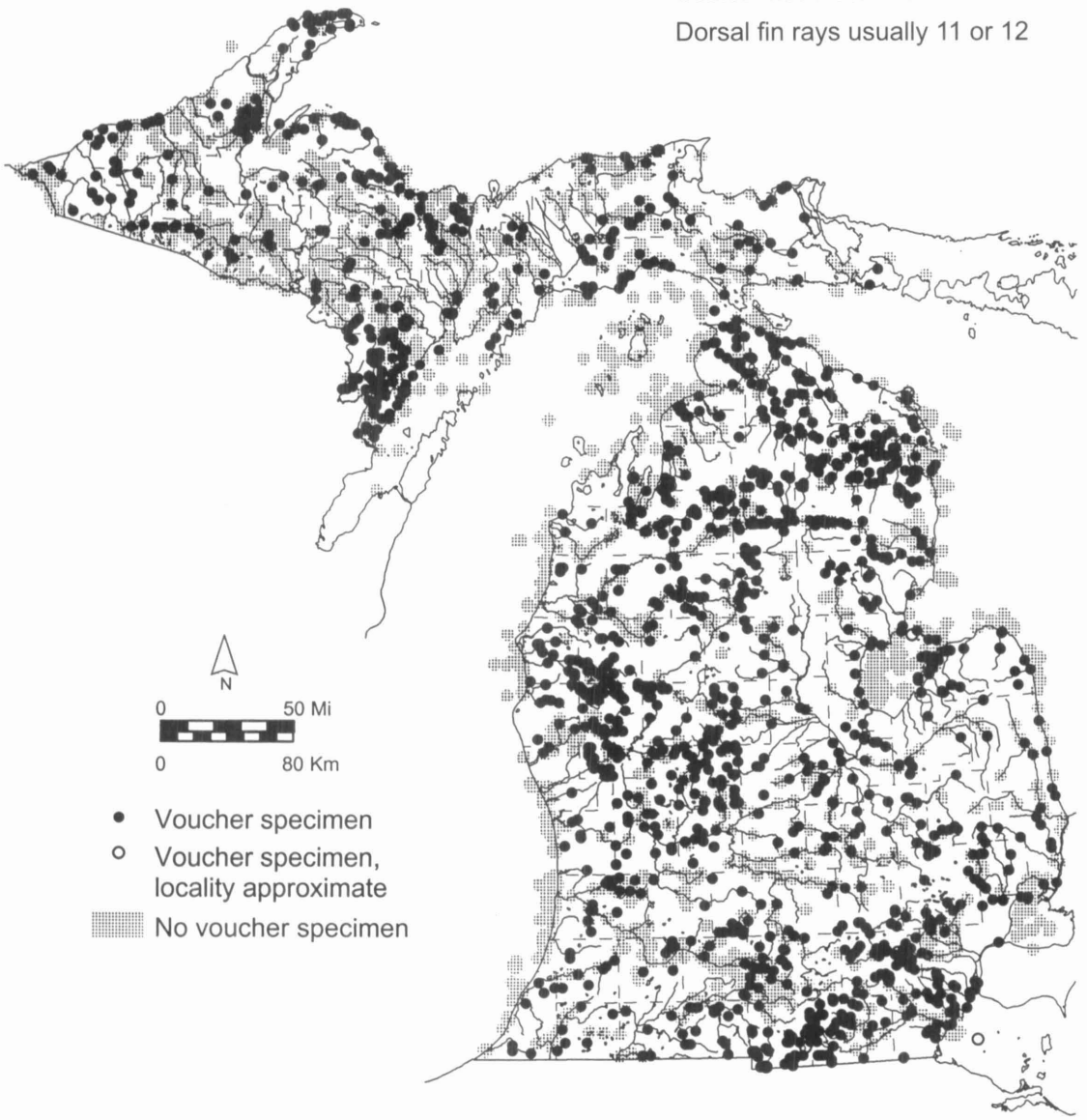
Catostomus commersonii



Rounded snout projects only slightly or not at all beyond tip of upper lip

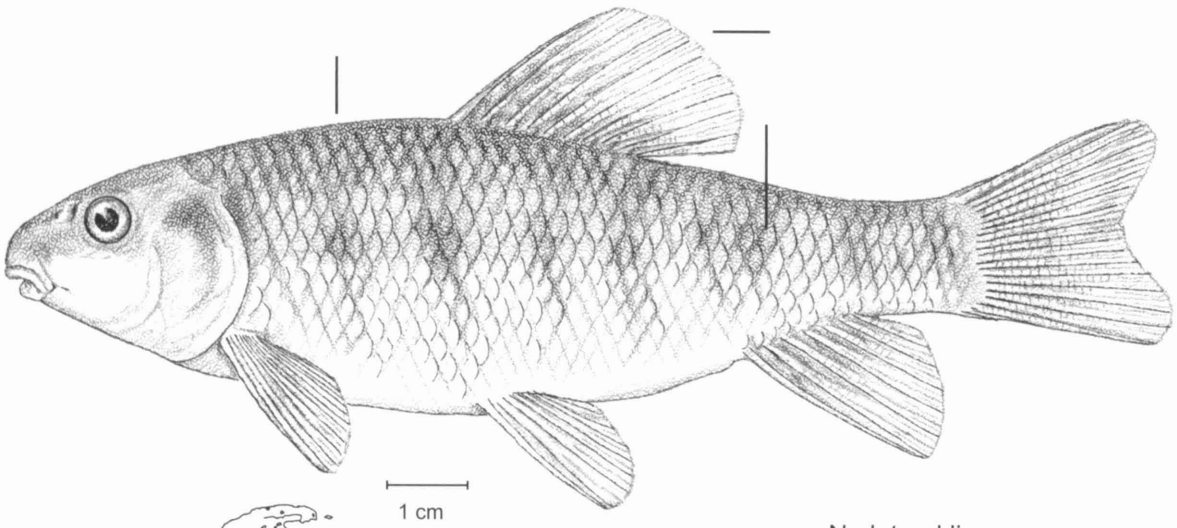
Scales moderate in size

Dorsal fin rays usually 11 or 12



Western Creek Chubsucker

Erimyzon claviformis



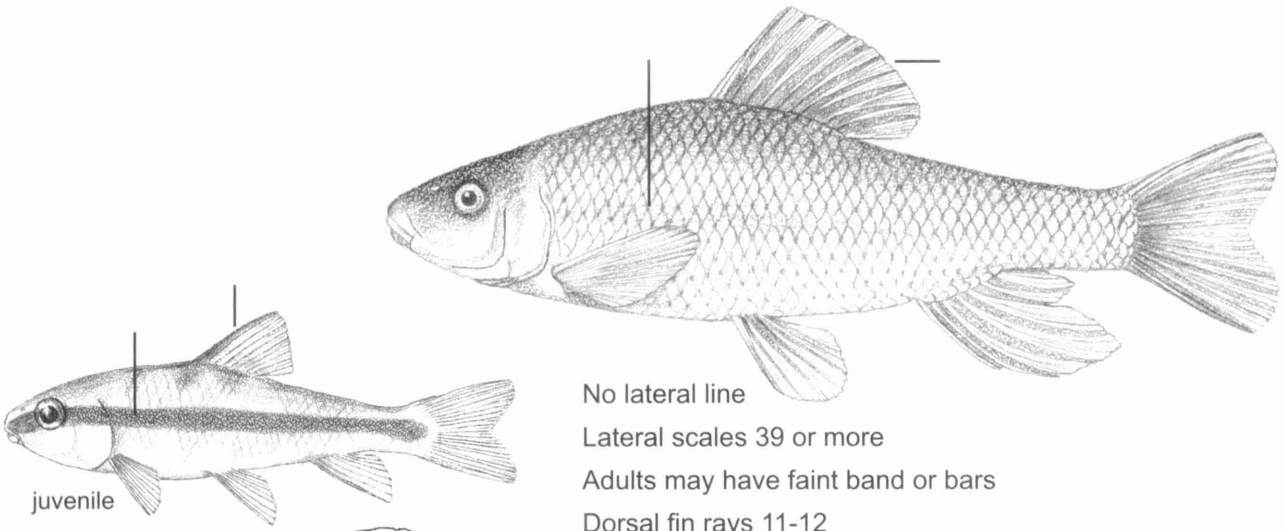
No lateral line

Lateral scales 39 or more

Five to eight blotches along side with saddle band above each

Dorsal fin rays usually 10

Lake Chubsucker
Erimyzon sucetta



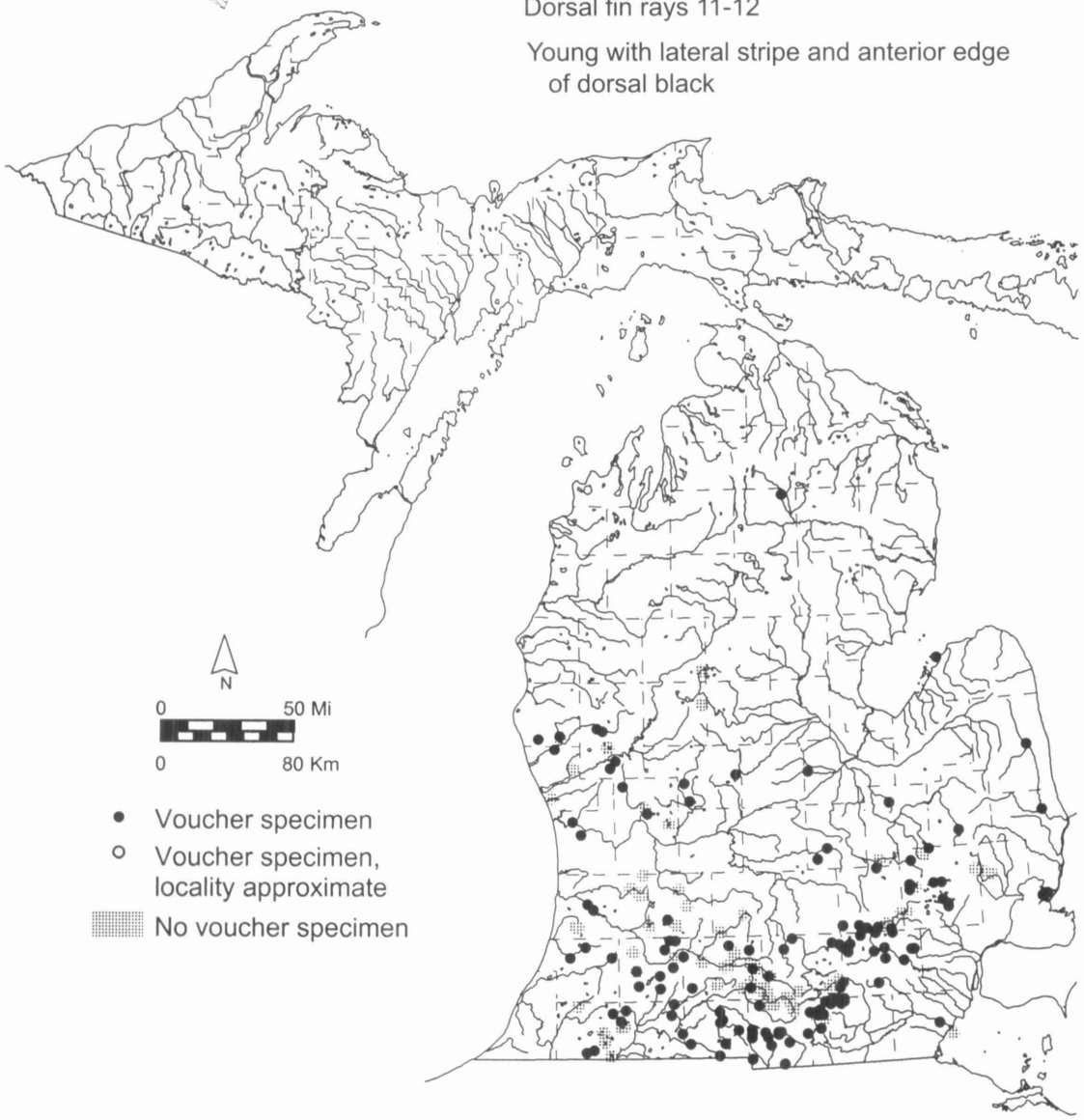
No lateral line

Lateral scales 39 or more

Adults may have faint band or bars

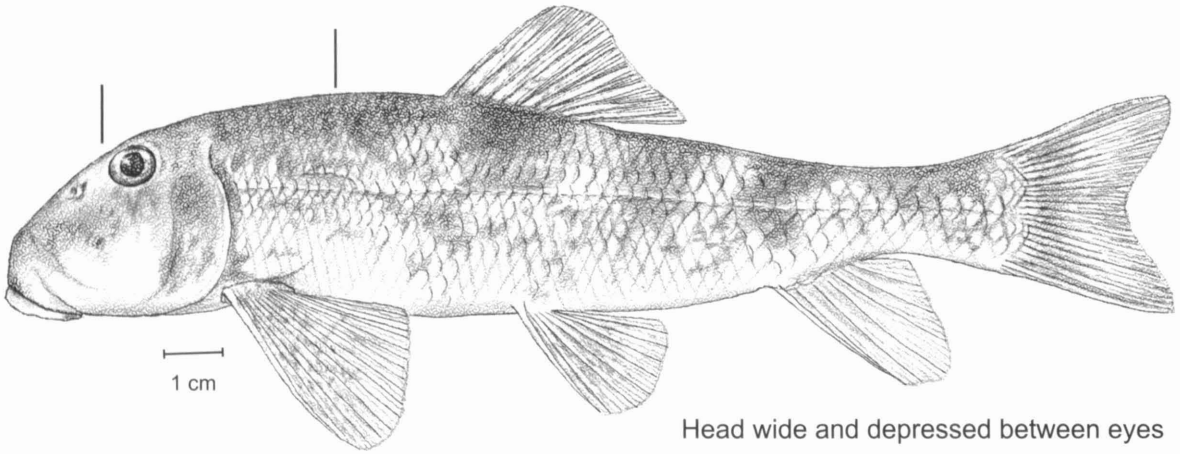
Dorsal fin rays 11-12

Young with lateral stripe and anterior edge of dorsal black

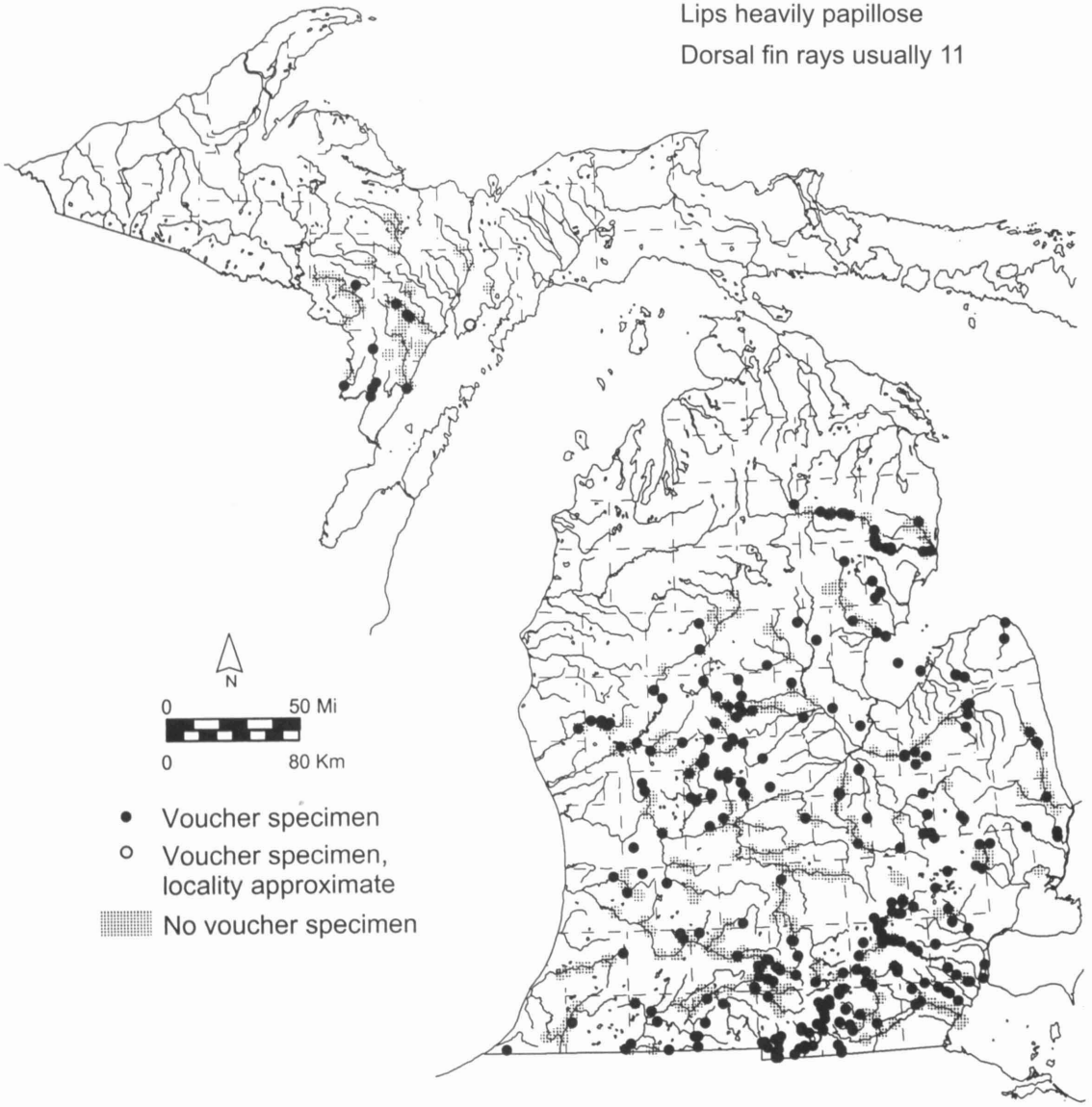


Northern Hog Sucker

Hypentelium nigricans

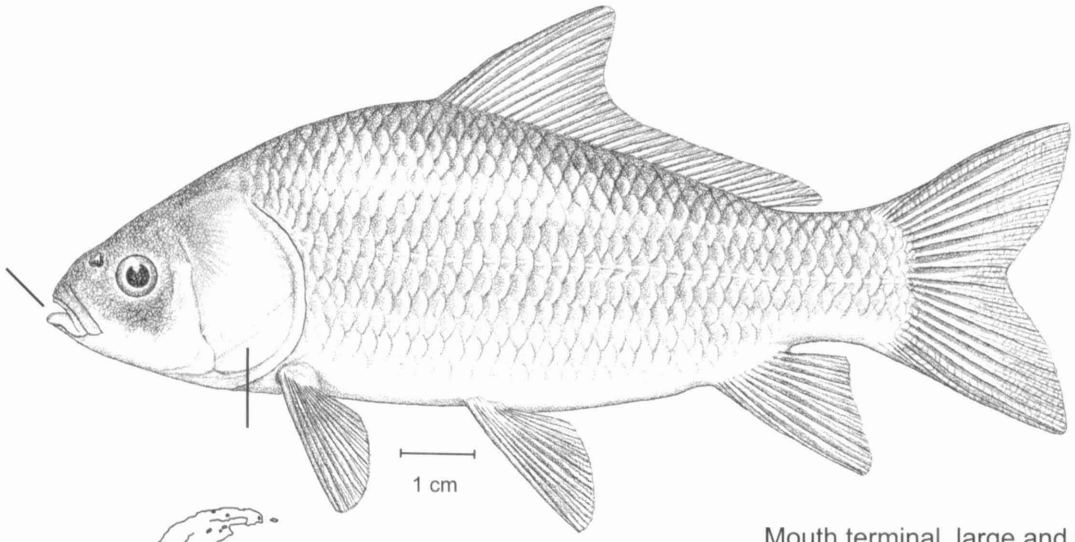


Head wide and depressed between eyes
Four to six dark saddle bands on body
Lips heavily papillose
Dorsal fin rays usually 11



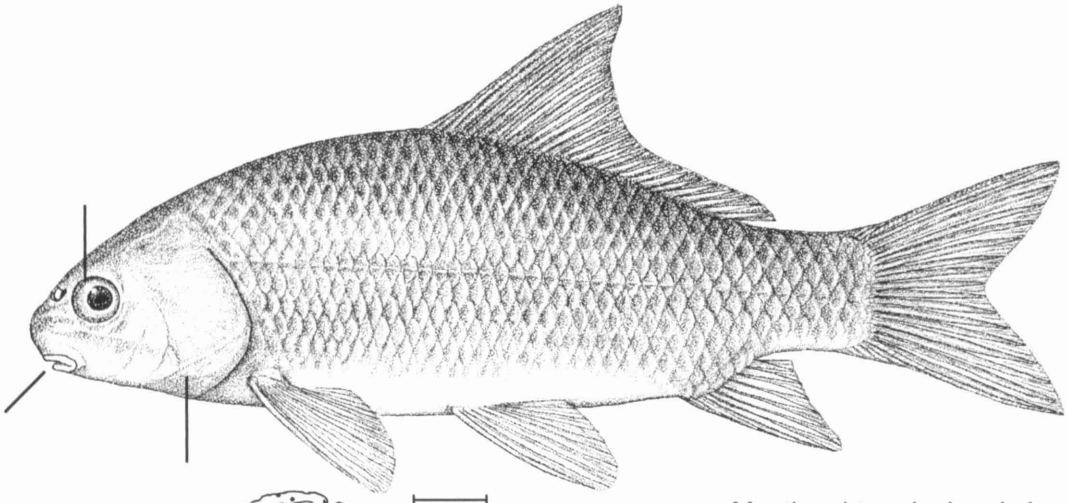
Bigmouth Buffalo

Ictiobus cyprinellus

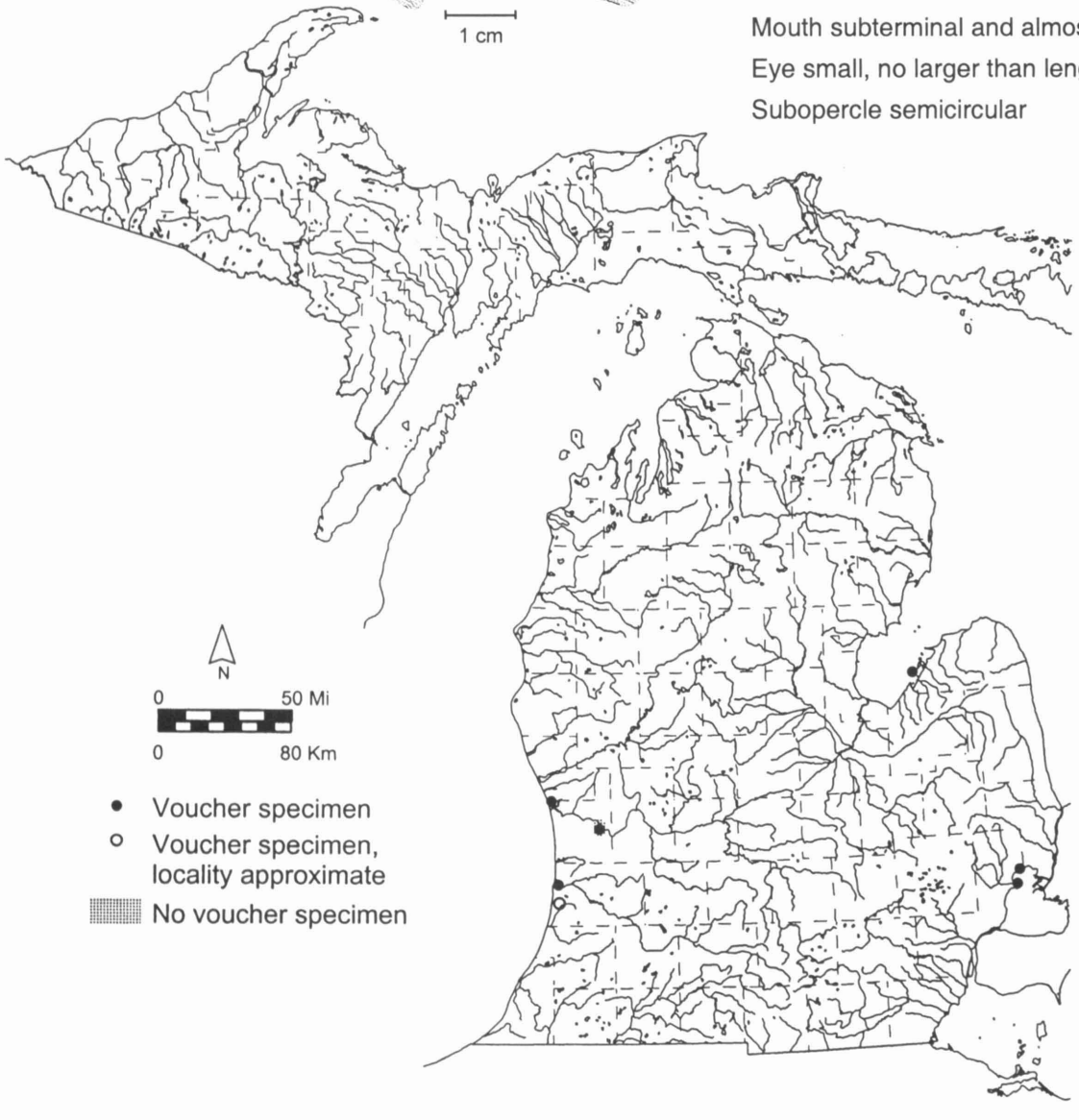


Mouth terminal, large and oblique
Lips thin
Subopercle semicircular

Black Buffalo
Ictiobus niger

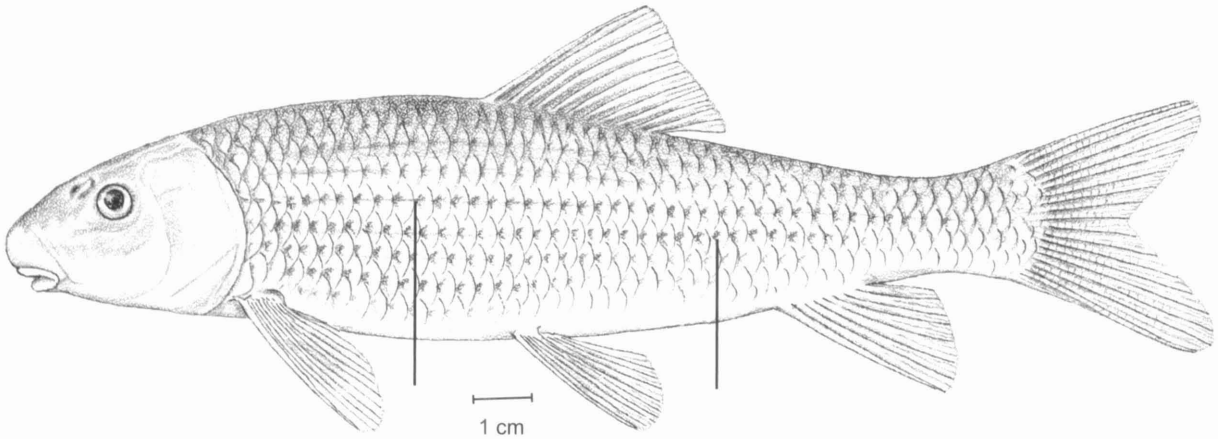


Mouth subterminal and almost horizontal
Eye small, no larger than length of upper jaw
Subopercle semicircular



Spotted Sucker

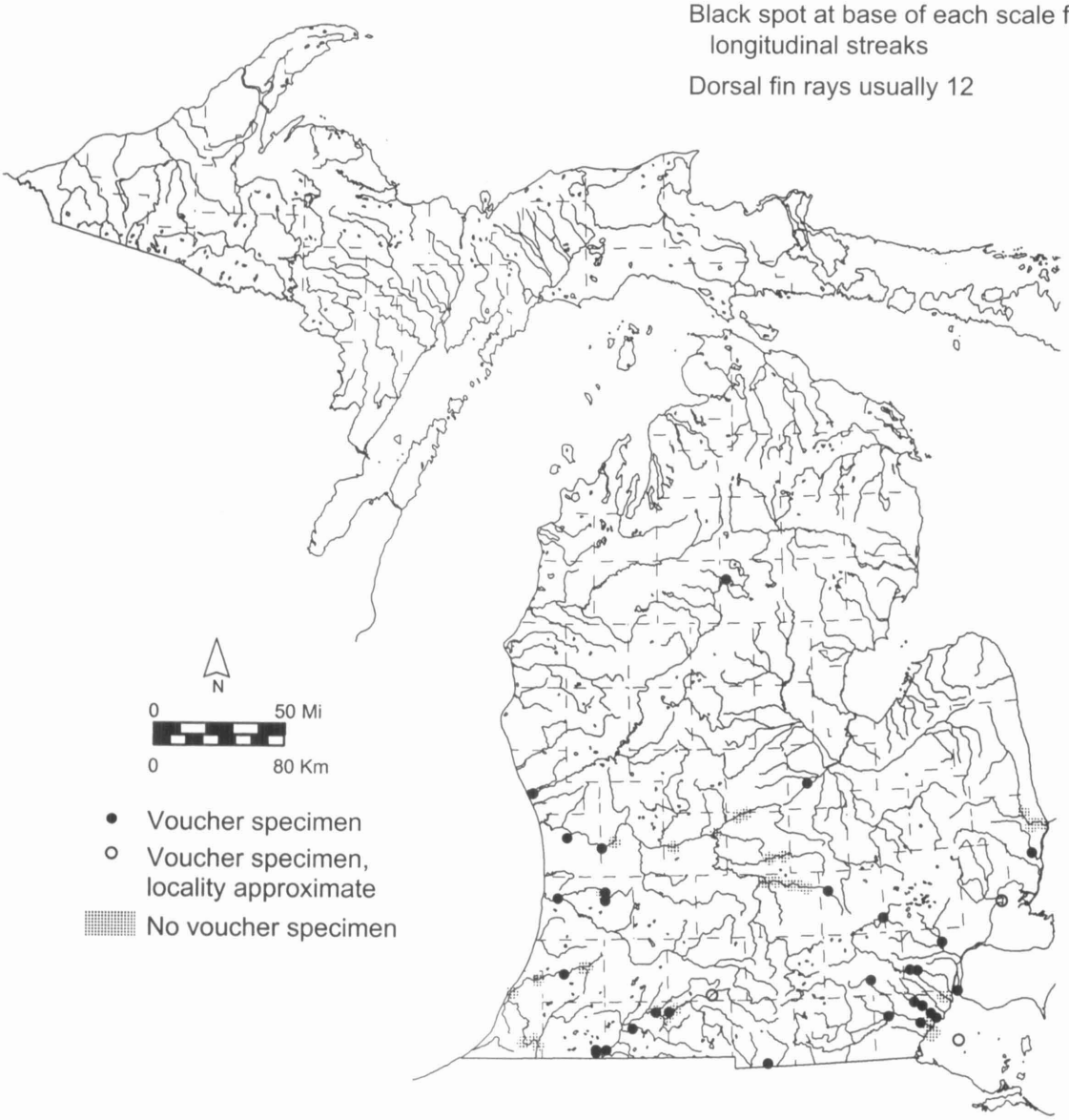
Minytrema melanops



Lateral line weak

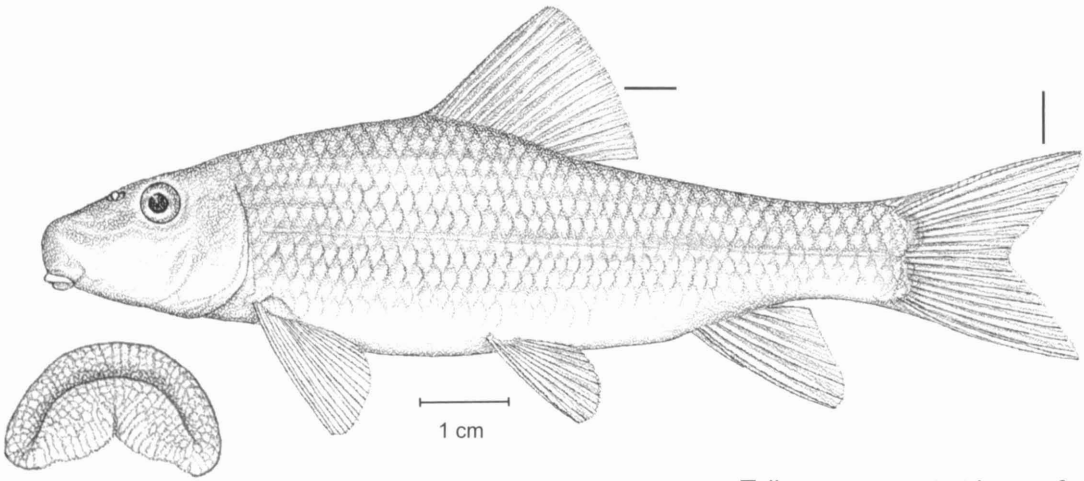
Black spot at base of each scale forming longitudinal streaks

Dorsal fin rays usually 12



Silver Redhorse

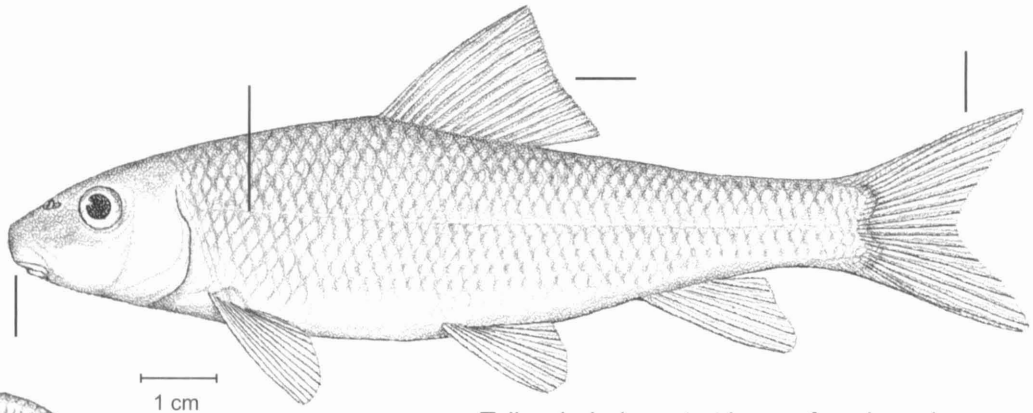
Moxostoma anisurum

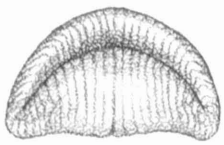


Tail gray, no spot at base of each scale
Lower lip full, broken into papillae
Dorsal fin rounded, rays 14 - 17

River Redhorse

Moxostoma carinatum

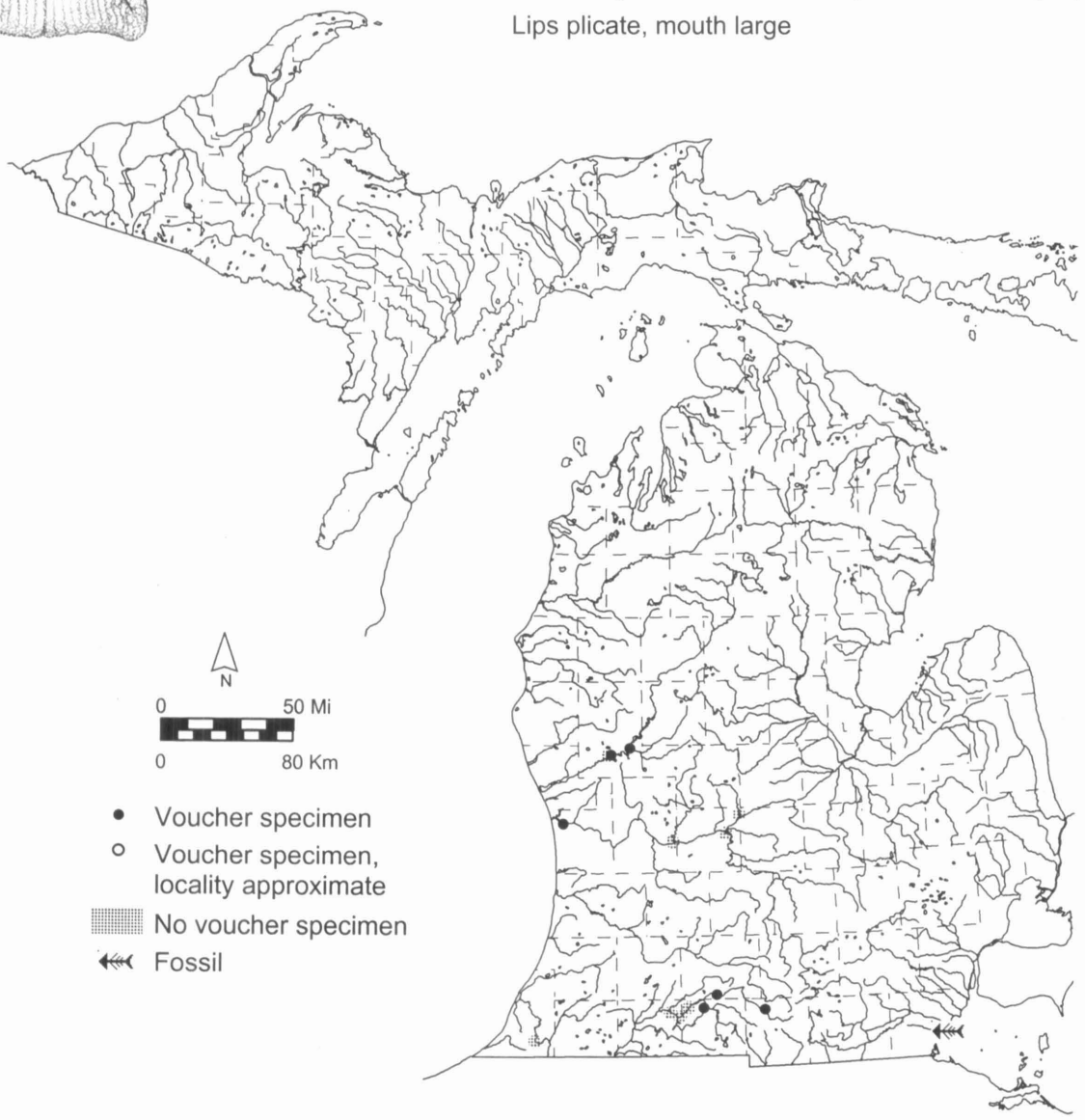




Tail red, dark spot at base of each scale

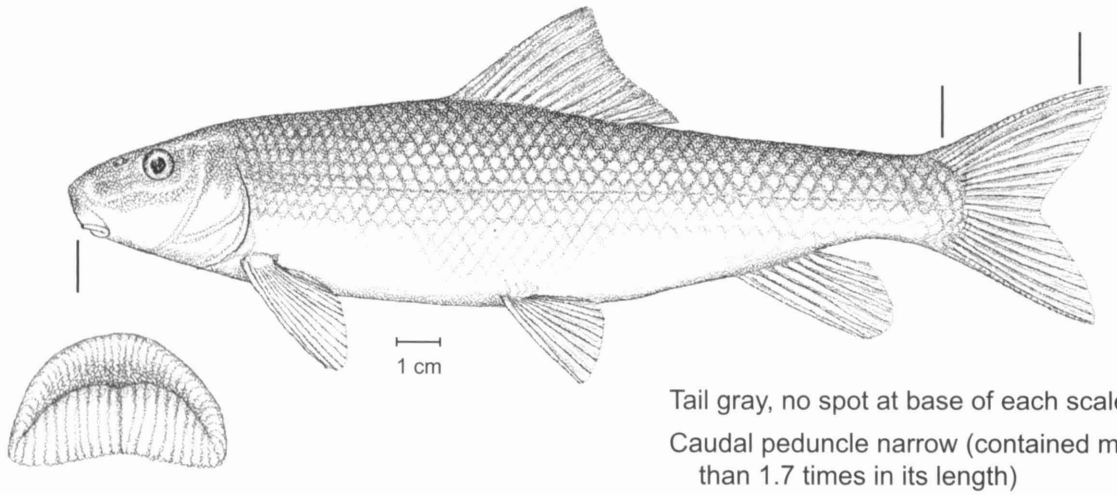
Distal edge of dorsal fin weakly concave to slightly convex

Lips plicate, mouth large



Black Redhorse

Moxostoma duquesnei

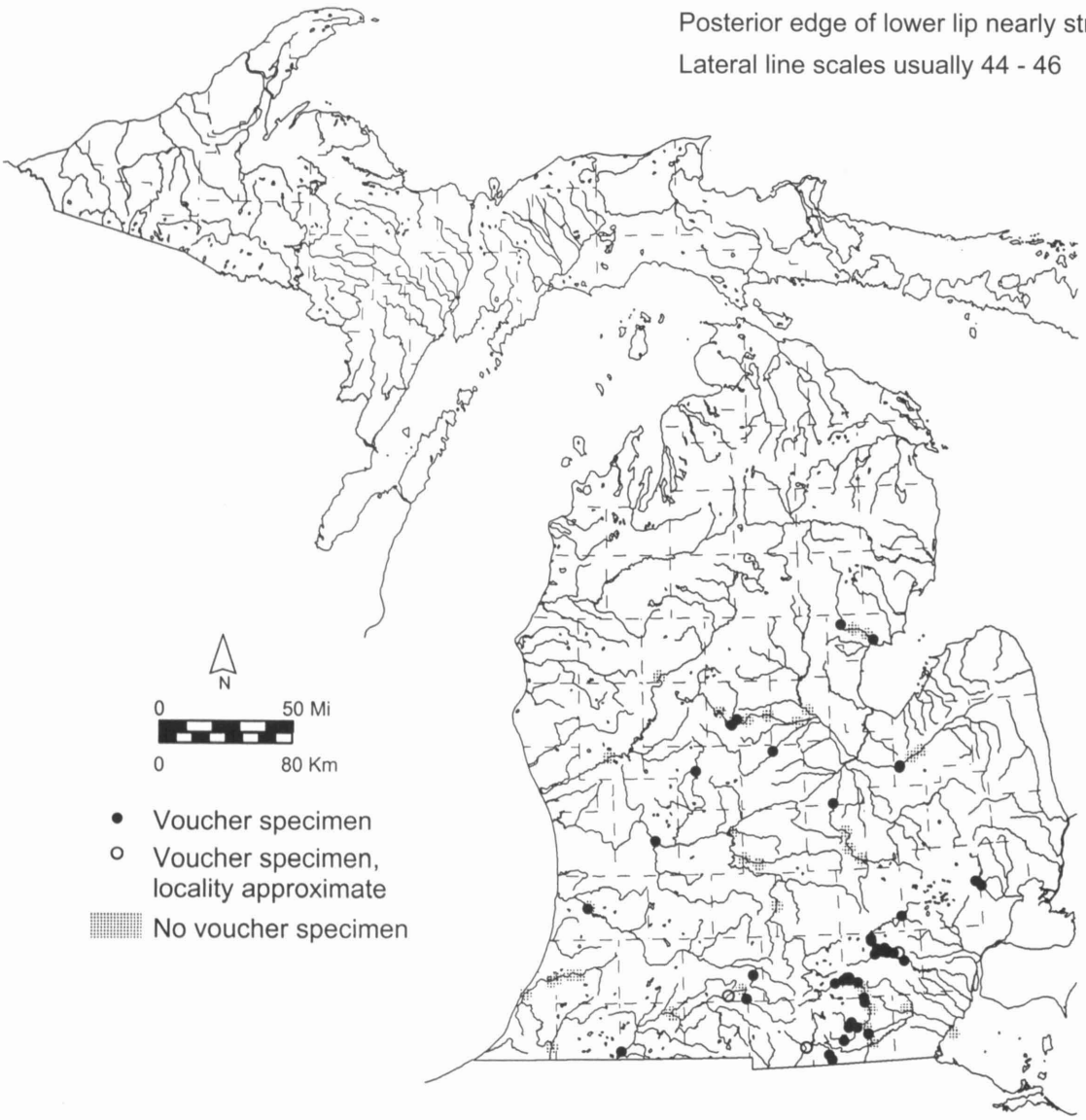


Tail gray, no spot at base of each scale

Caudal peduncle narrow (contained more than 1.7 times in its length)

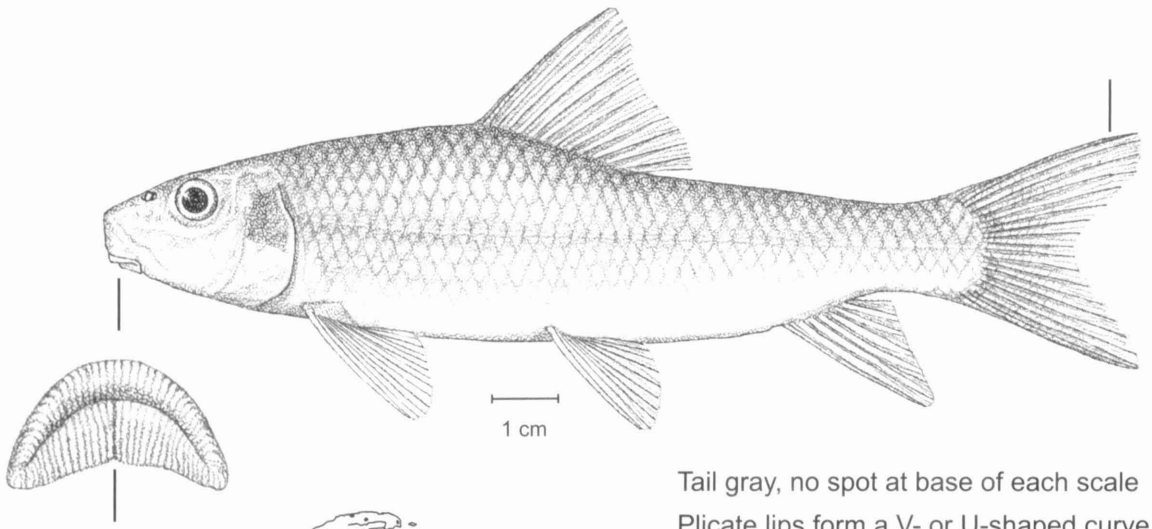
Posterior edge of lower lip nearly straight

Lateral line scales usually 44 - 46



Golden Redhorse

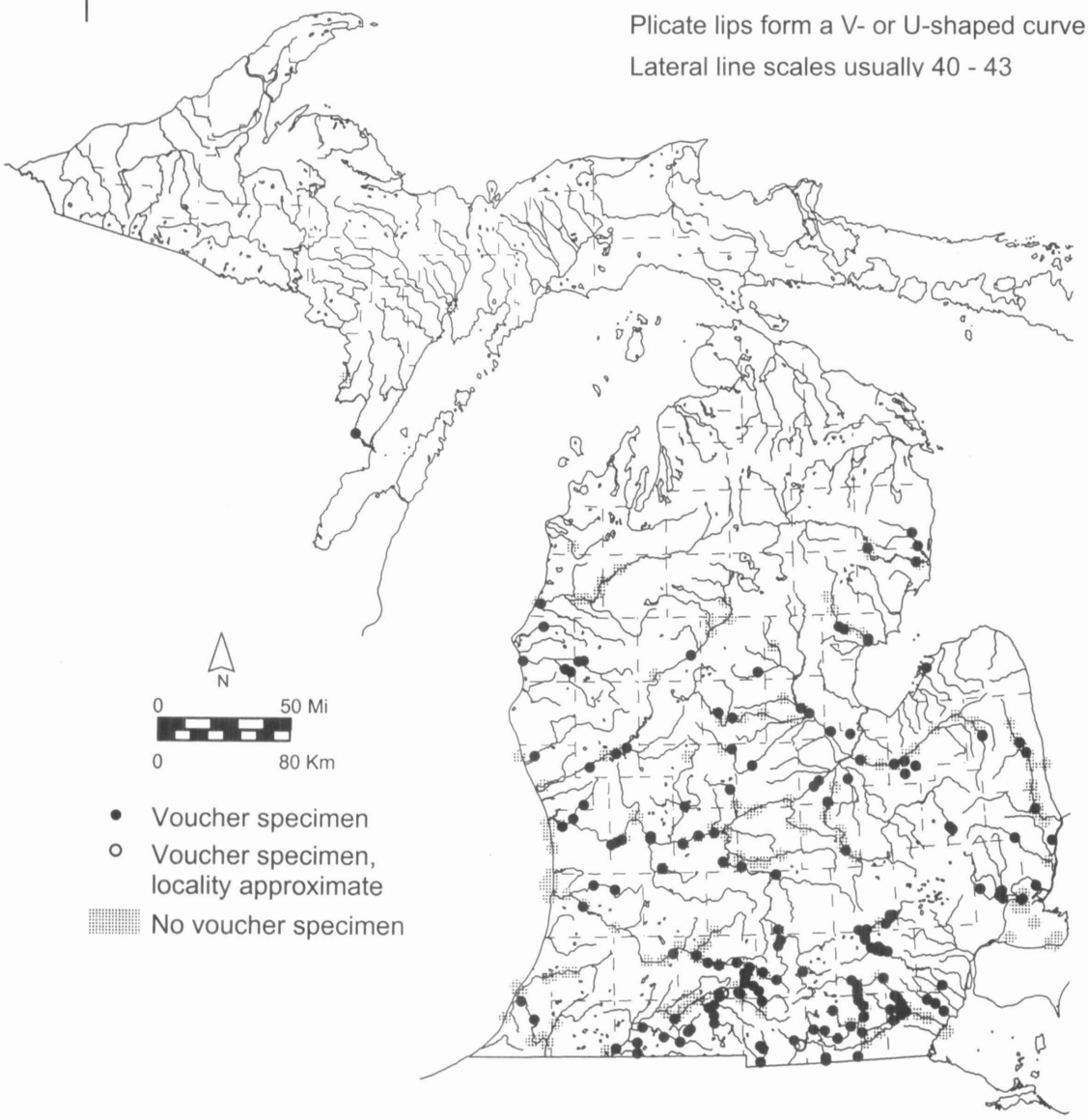
Moxostoma erythrurum



Tail gray, no spot at base of each scale

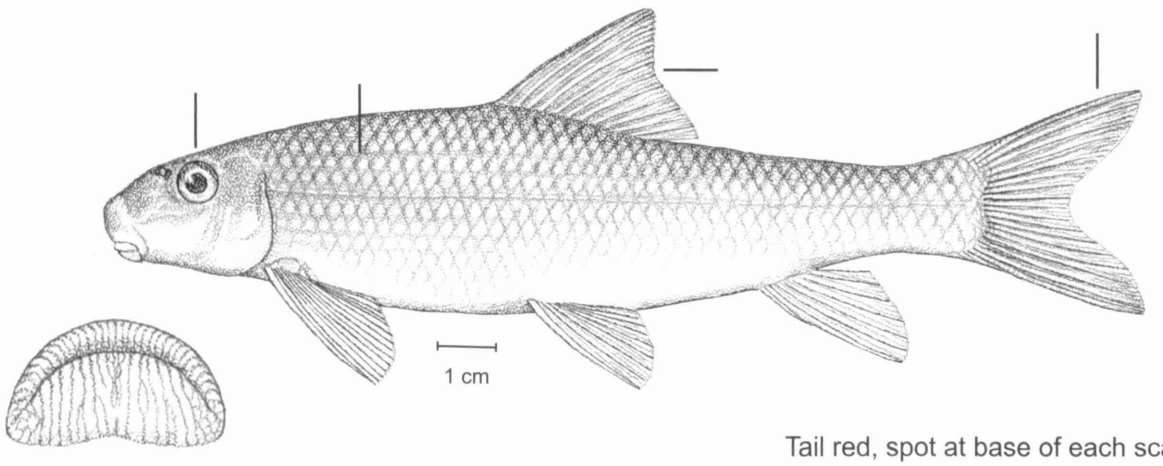
Plicate lips form a V- or U-shaped curve posteriorly

Lateral line scales usually 40 - 43



Shorthead Redhorse

Moxostoma macrolepidotum



Tail red, spot at base of each scale

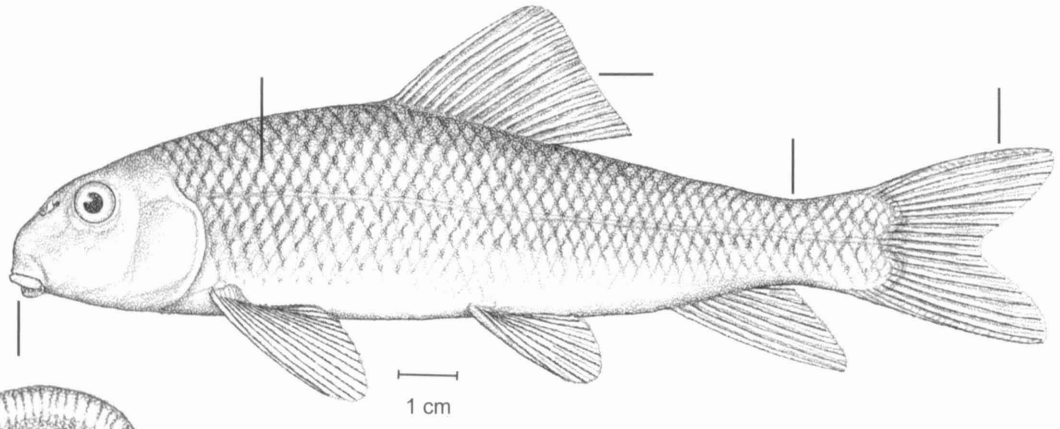
Head short, mouth small

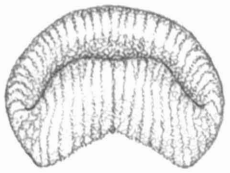
Falcate dorsal fin

Plicate lips, form a straight line posteriorly

Greater Redhorse

Moxostoma valenciennesi



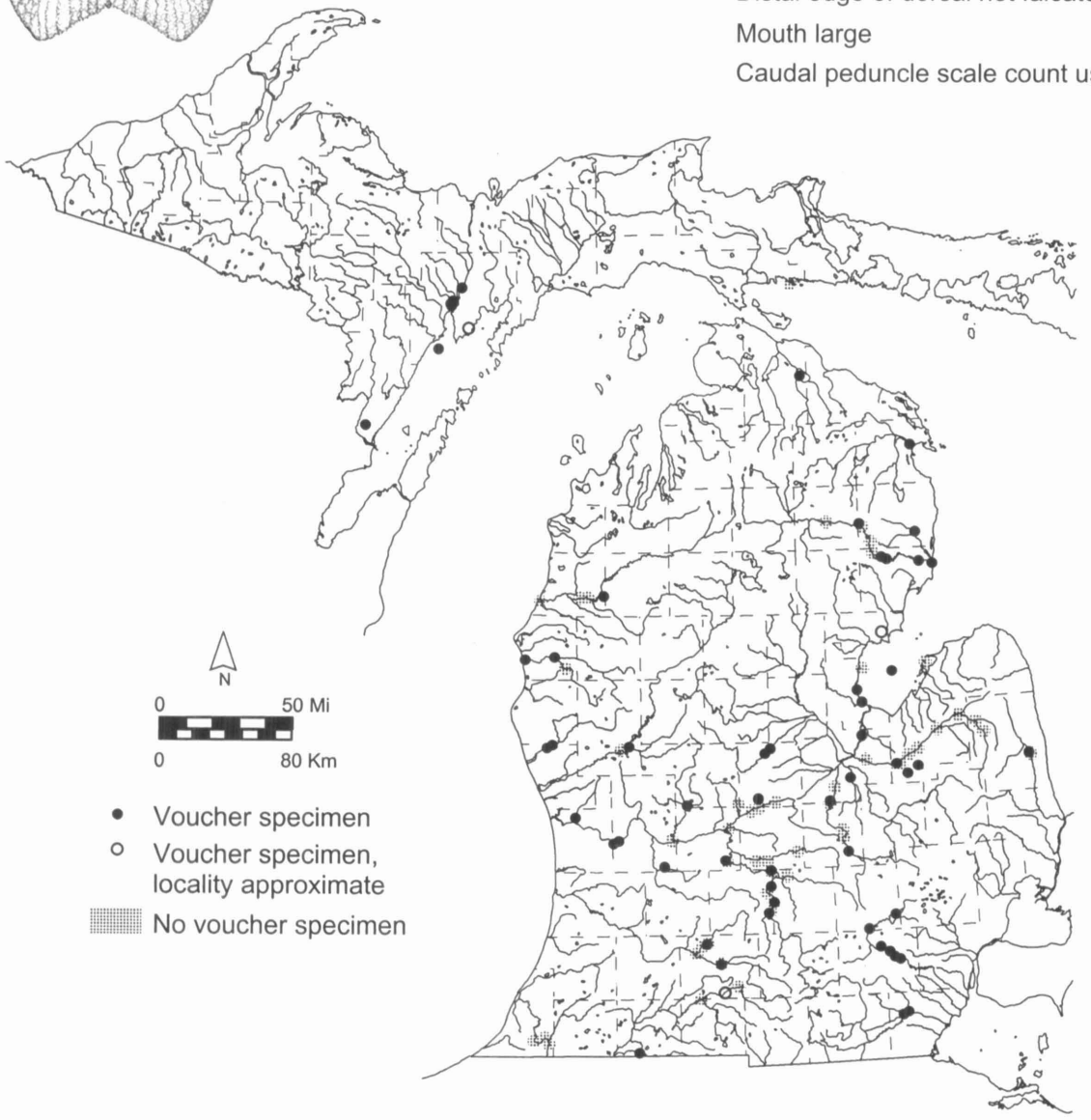


Tail red, spot at base of each scale

Distal edge of dorsal not falcate

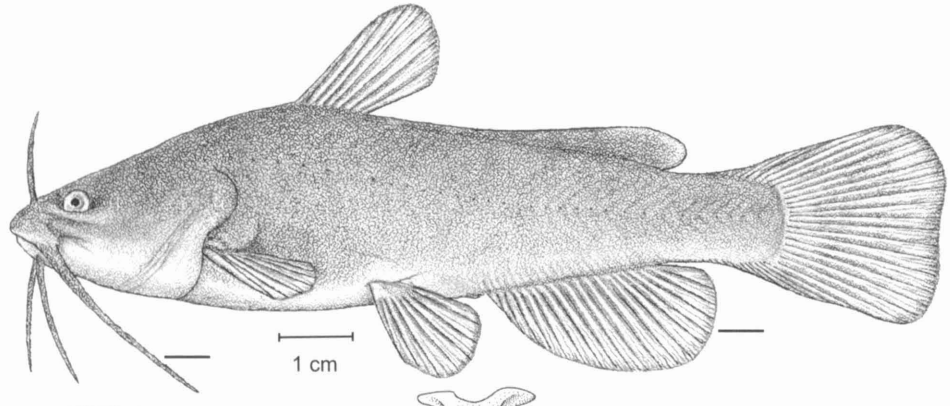
Mouth large

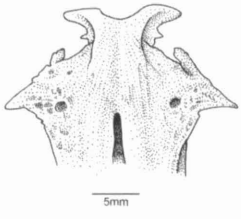
Caudal peduncle scale count usually 16



Black Bullhead

Ameiurus melas





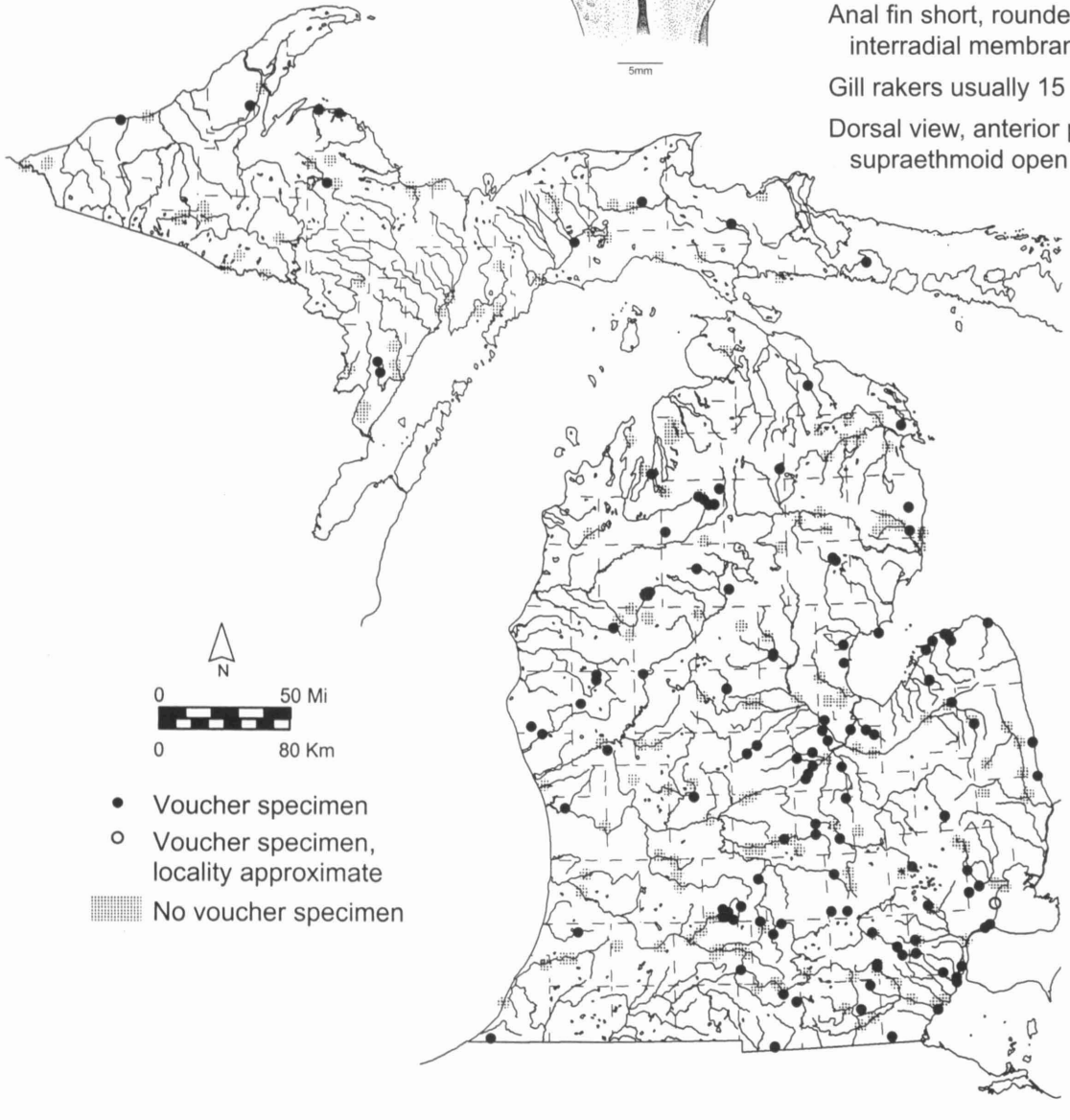
Chin barbels dark

Pectoral spine weakly serrated

Anal fin short, rounded, with dark interradial membranes

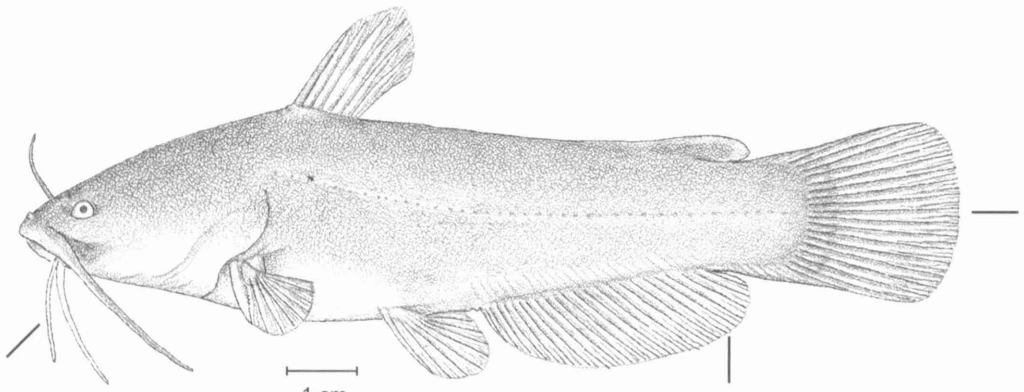
Gill rakers usually 15 - 19

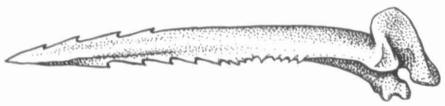
Dorsal view, anterior profile of cranium, supraethmoid open

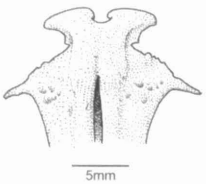


Yellow Bullhead

Ameiurus natalis





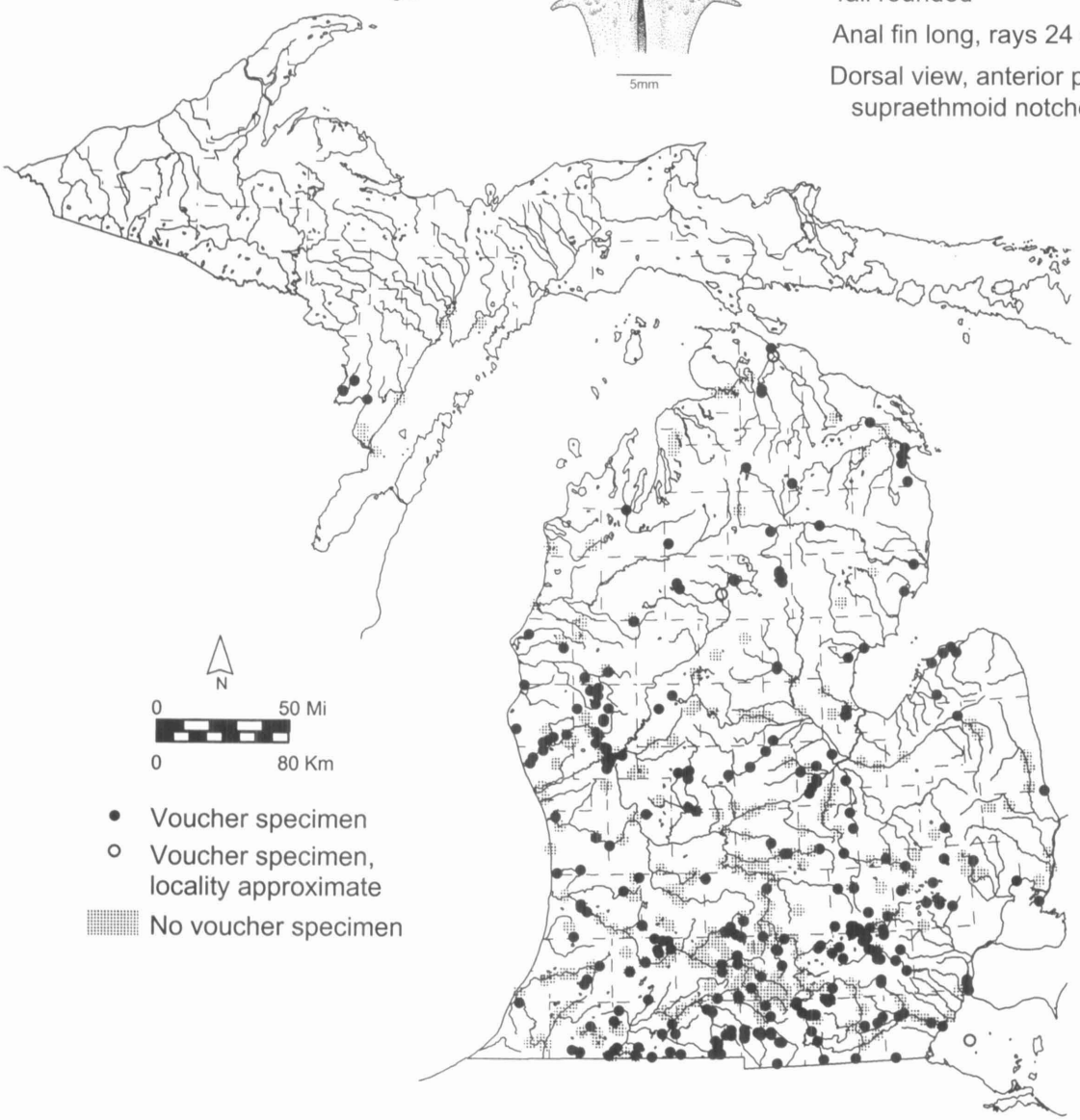


Chin barbels whitish or yellowish

Tail rounded

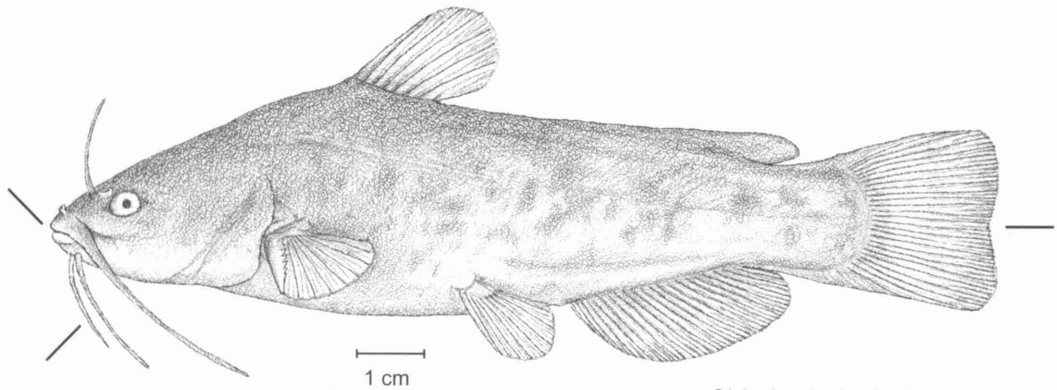
Anal fin long, rays 24 or more

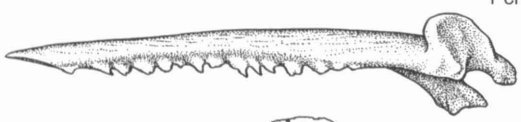
Dorsal view, anterior profile of cranium, supraethmoid notched

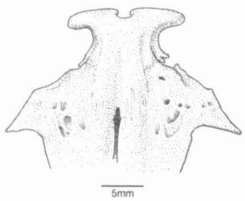


Brown Bullhead

Ameiurus nebulosus







Chin barbels dark

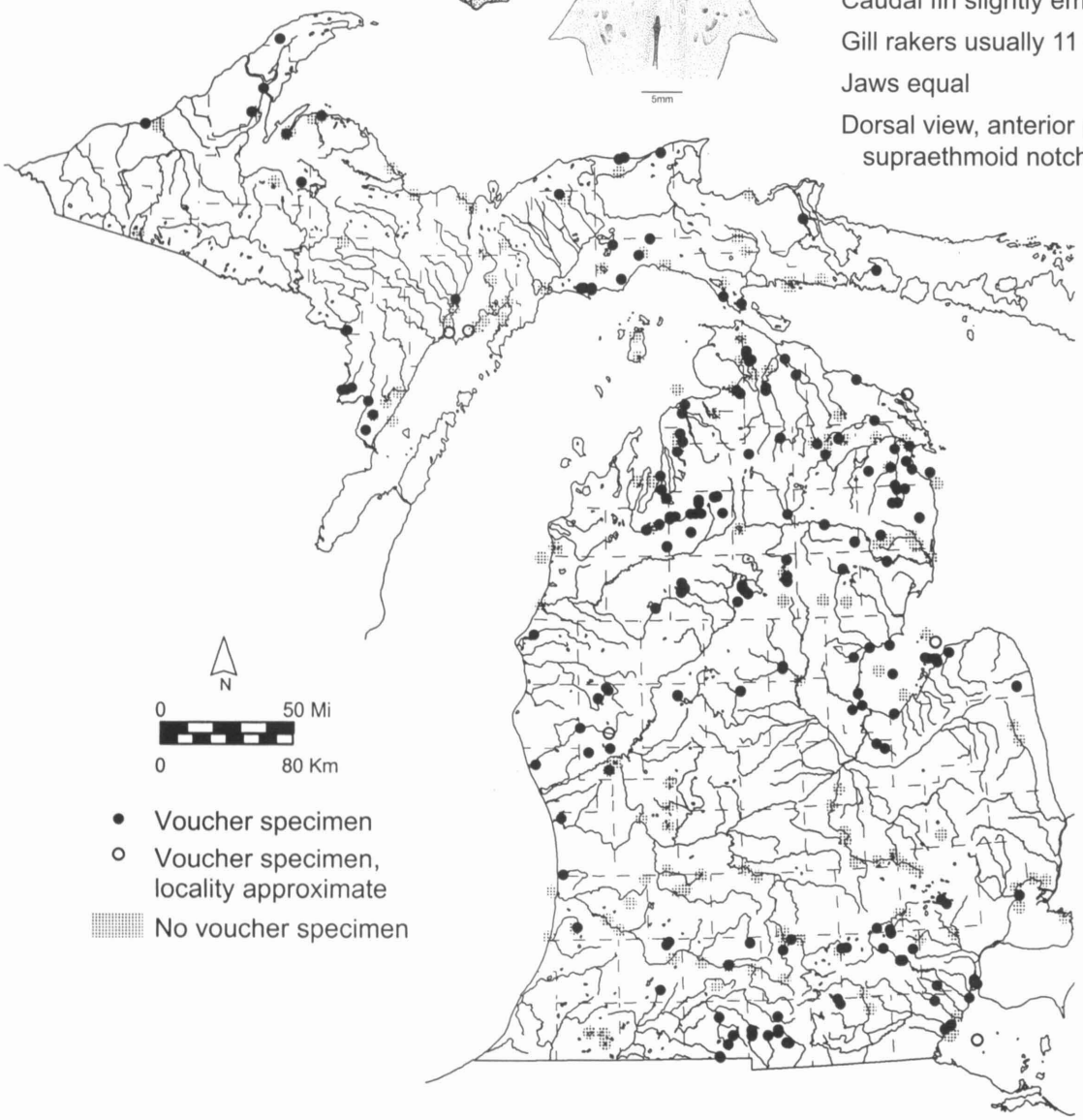
Pectoral spine sharply serrated

Caudal fin slightly emarginate

Gill rakers usually 11 - 14

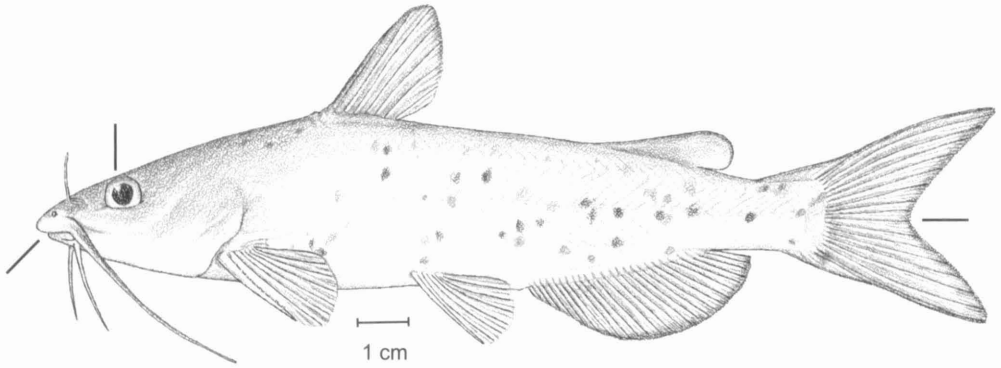
Jaws equal

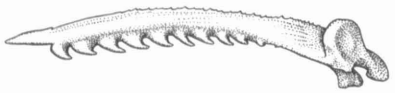
Dorsal view, anterior profile of cranium, supraethmoid notched



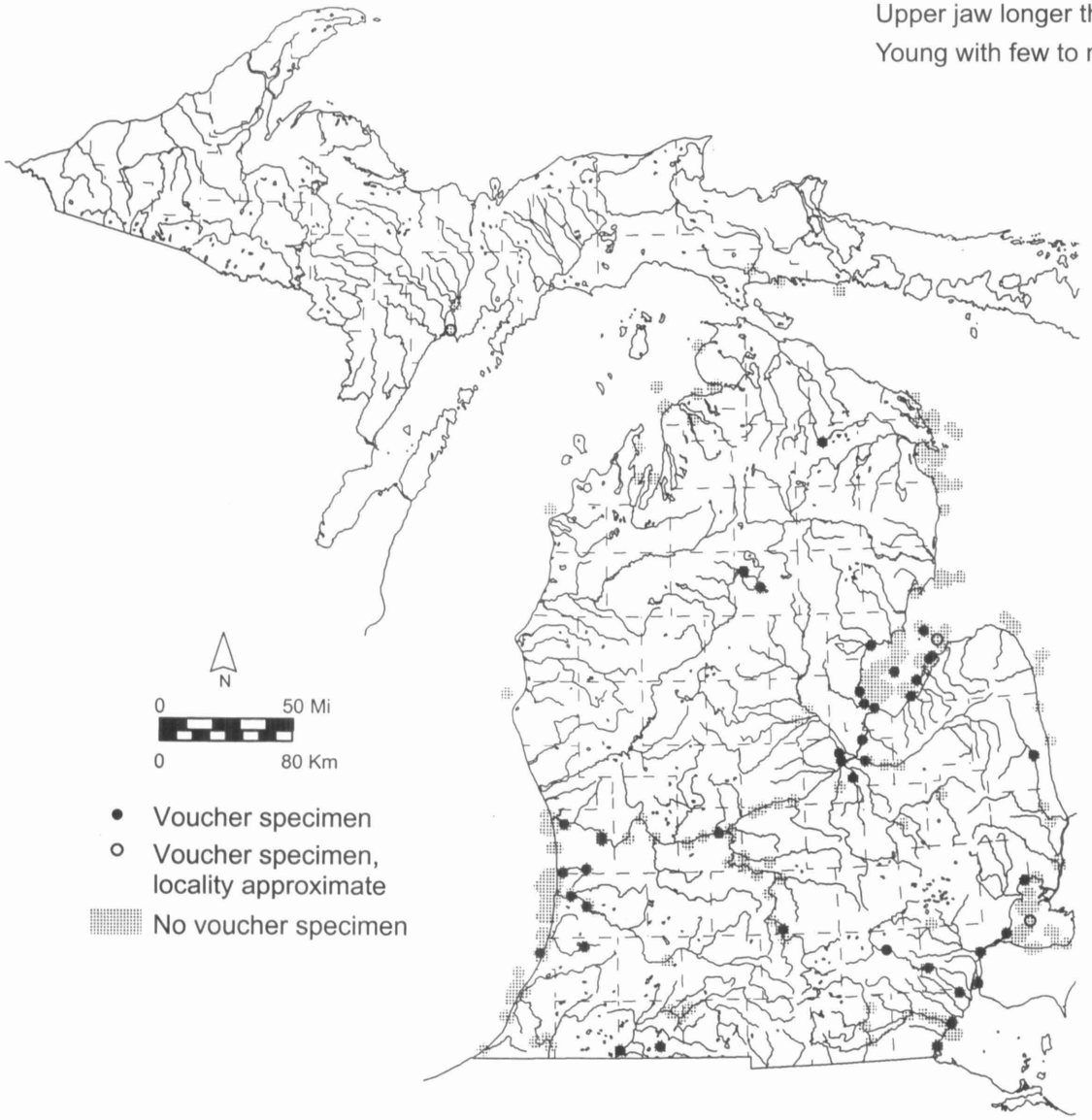
Channel Catfish

Ictalurus punctatus



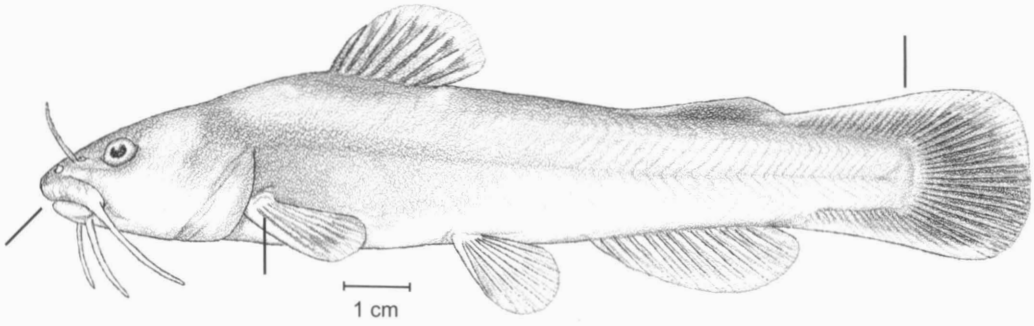


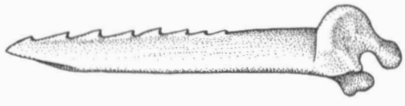
Tail deeply forked
Eyes in dorsal half of head
Upper jaw longer than lower
Young with few to many body spots



Stonecat

Noturus flavus

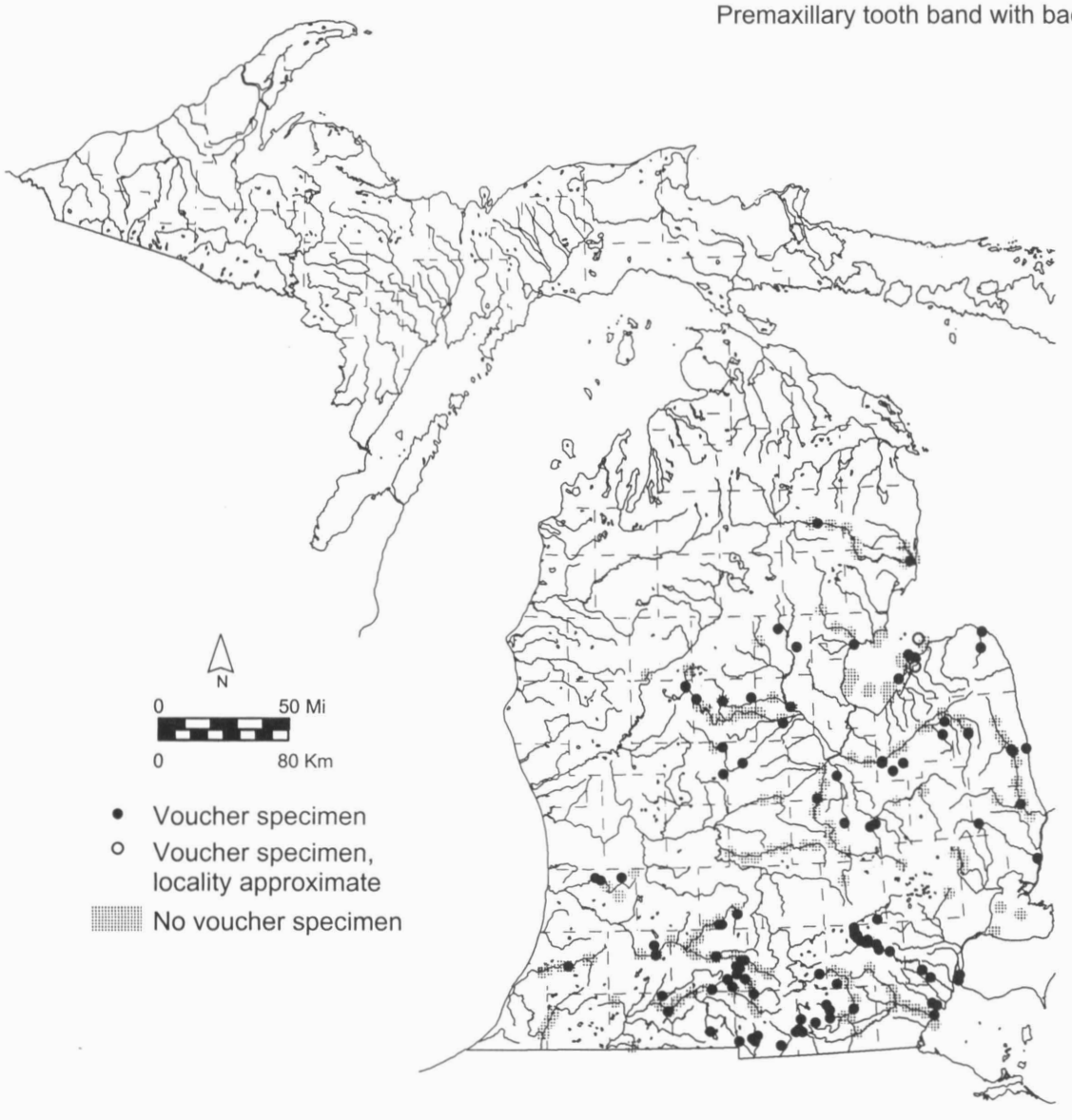


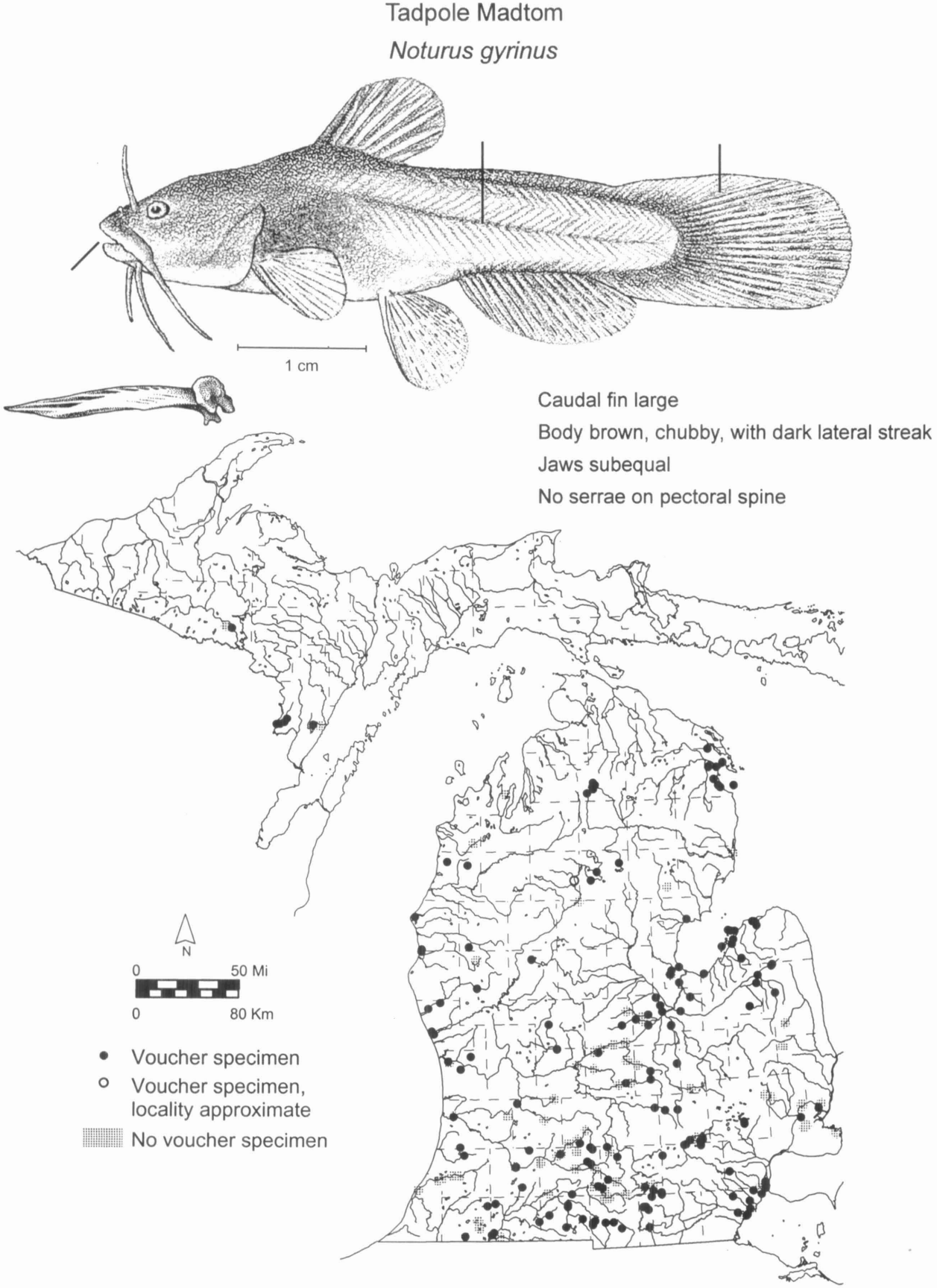


Upper jaw longer than lower jaw

Fins with light edges

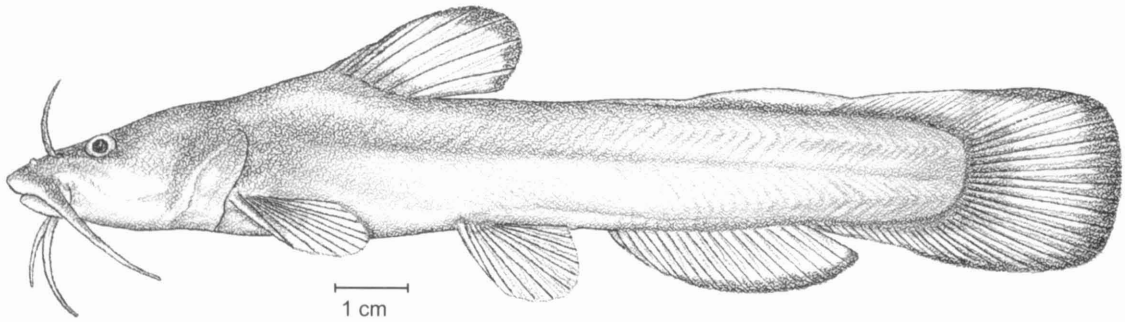
Premaxillary tooth band with backward extensions



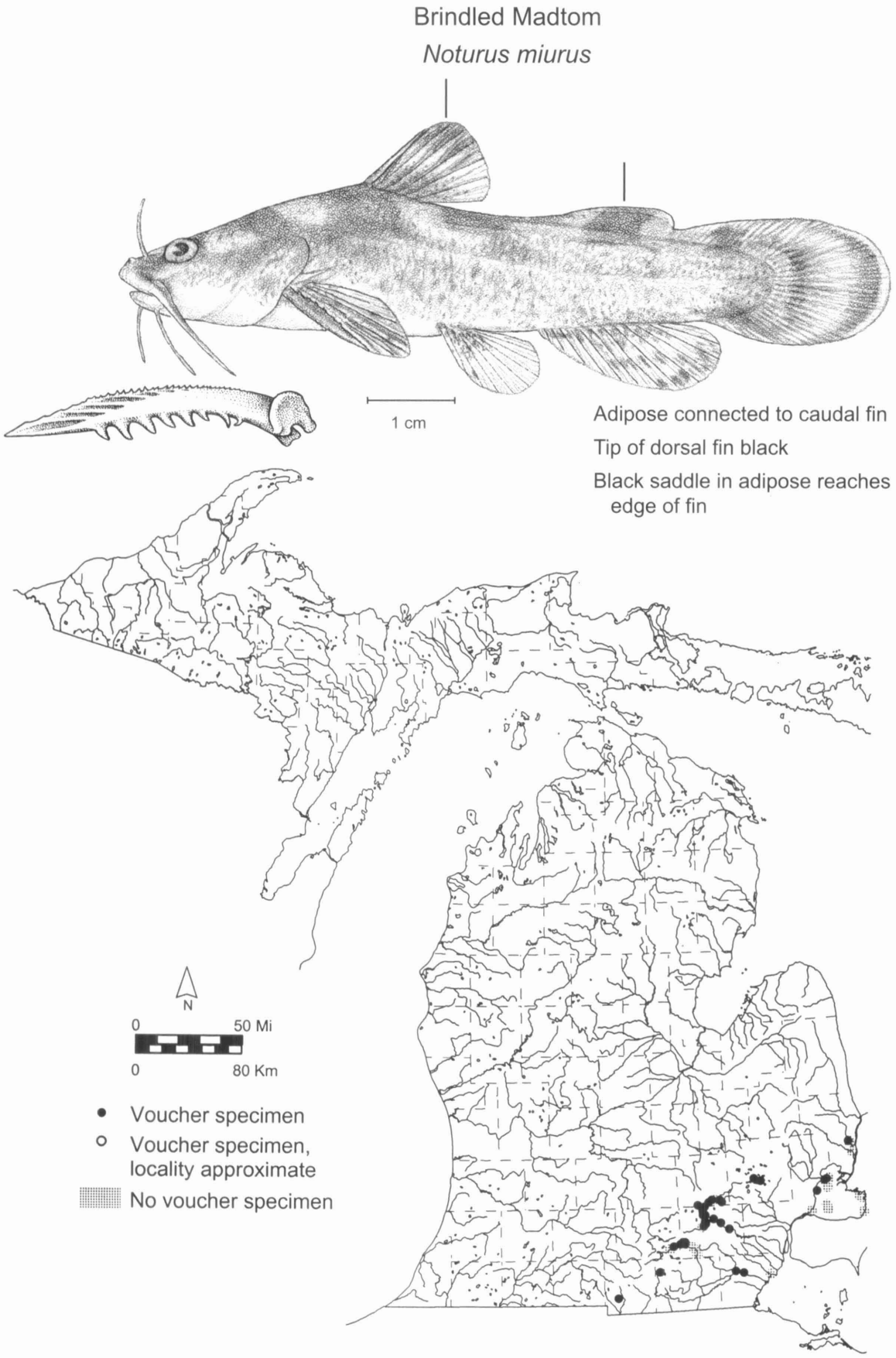

Tadpole Madtom
Noturus gyrinus
1 cm
Caudal fin large
Body brown, chubby, with dark lateral streak
Jaws subequal
No serrae on pectoral spine
N
0
50 Mi
0
80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

Margined Madtom

Noturus insignis

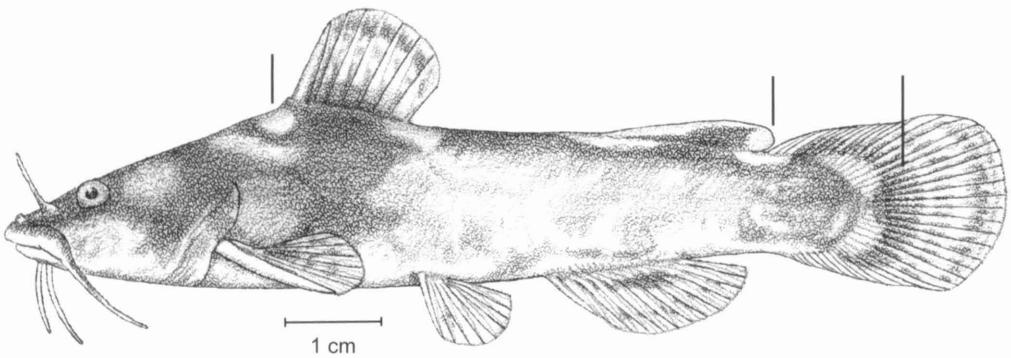


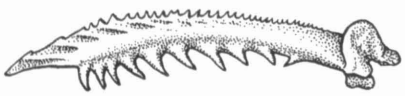
No blotches or saddles
Fins dark edged


Brindled Madtom
Noturus miurus
1 cm
Adipose connected to caudal fin
Tip of dorsal fin black
Black saddle in adipose reaches edge of fin
N
0
50 Mi
0
80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

Northern Madtom

Noturus stigmosus





Adipose separated from caudal fin by acute notch

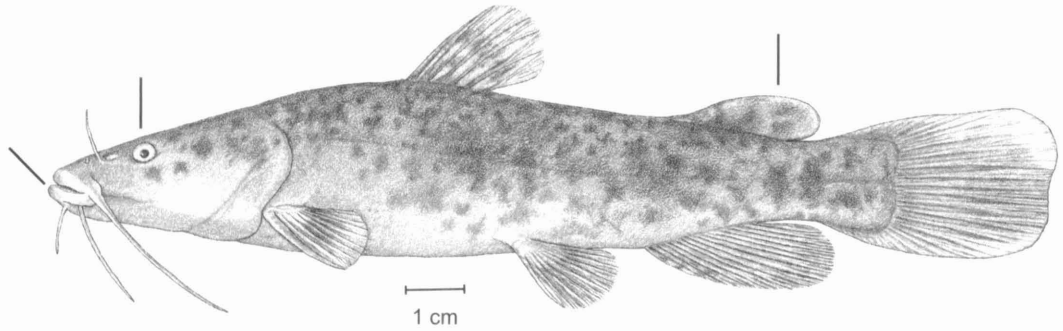
Paired light spots before dorsal

Strong midcaudal crescentic bar

Black saddle in adipose does not reach edge of fin

Flathead Catfish

Pylodictis olivaris



Lower jaw projects

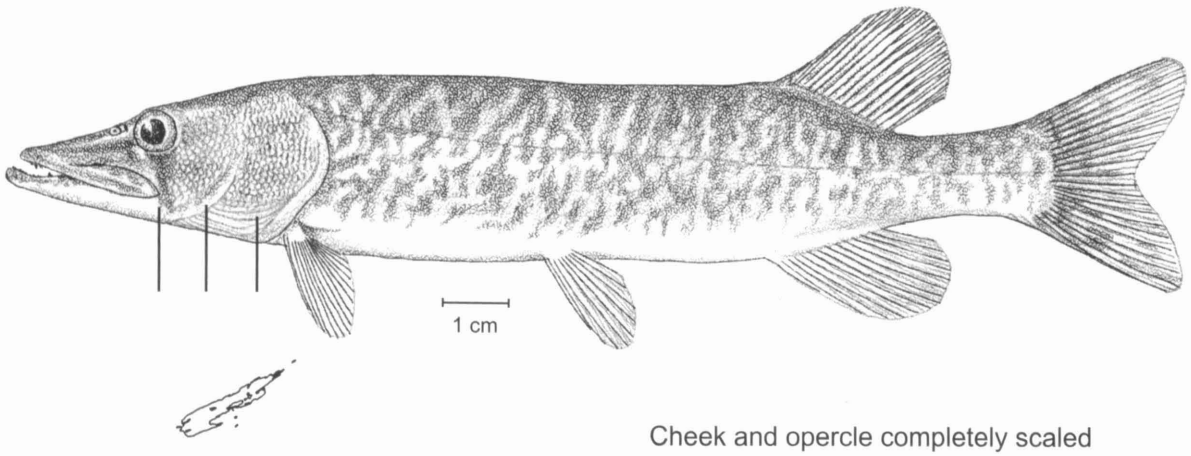
Adipose fin large, free

Head wide, flattened

Premaxillary tooth band with backward extensions

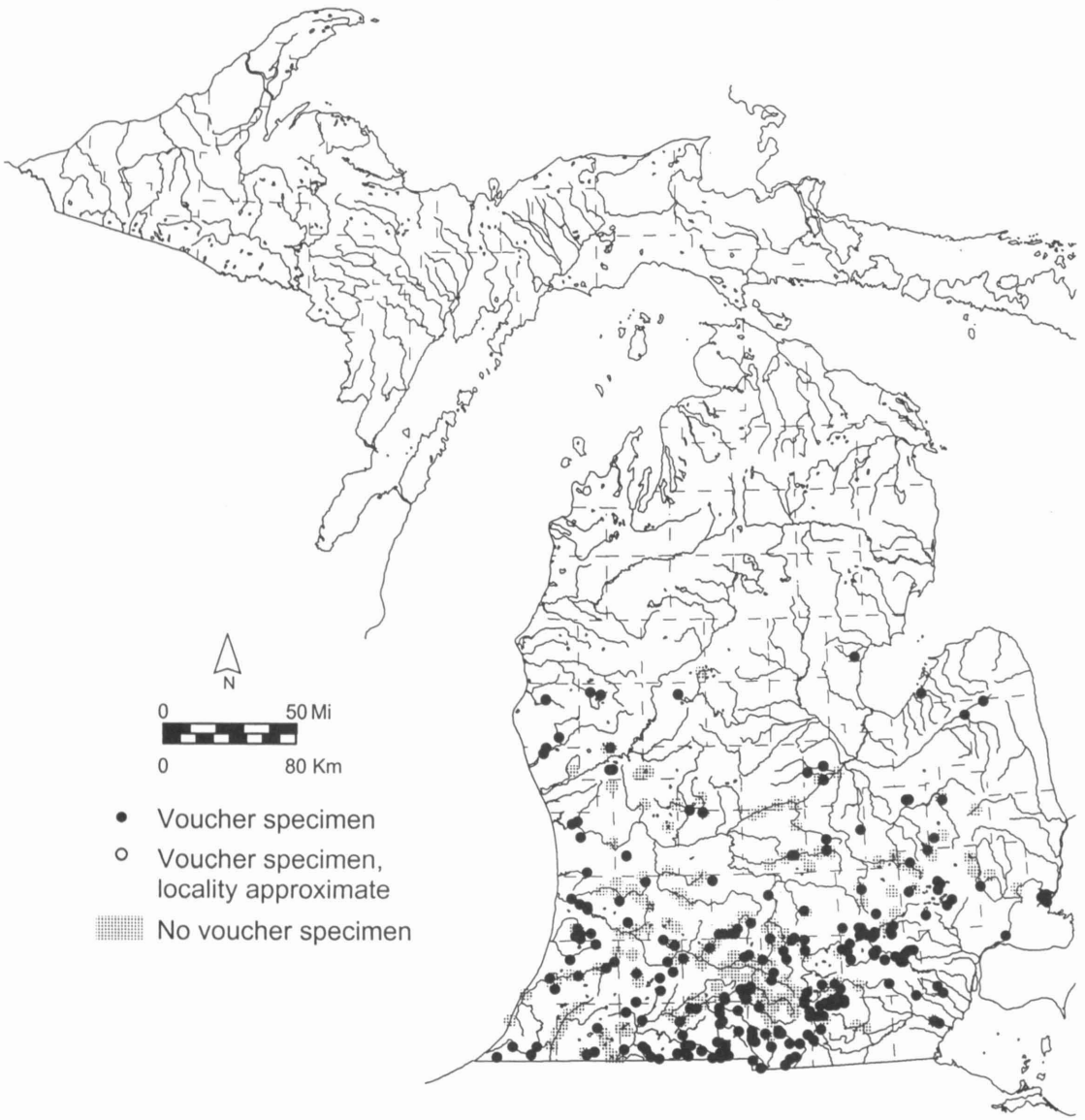
Grass Pickerel

Esox americanus vermiculatus



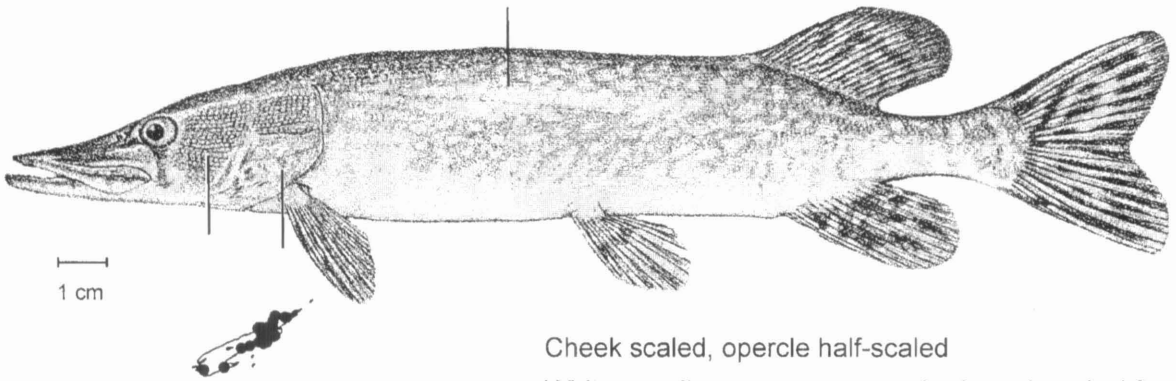
Cheek and opercle completely scaled

Dark teardrop tilts down and back



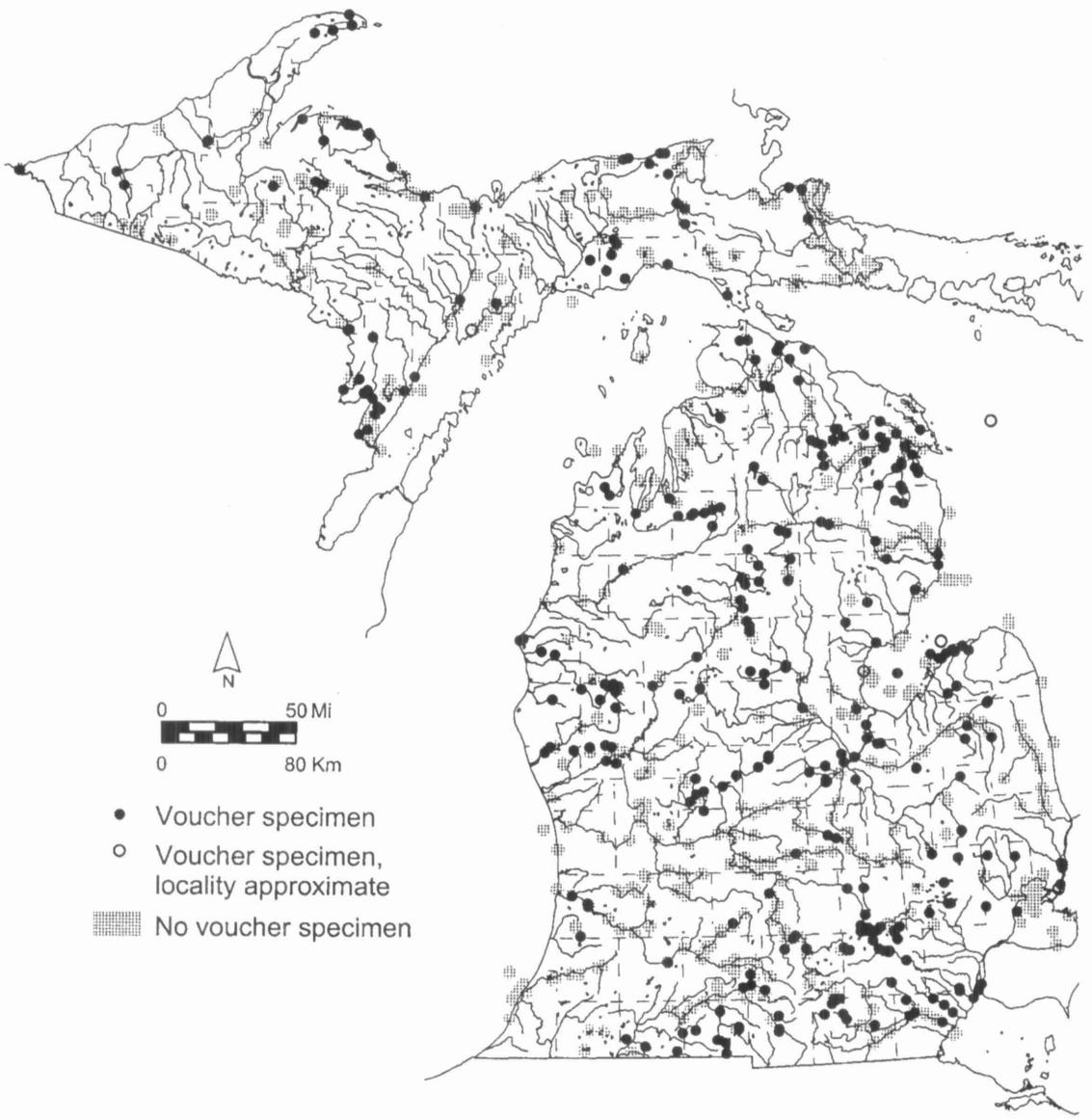
Northern Pike

Esox lucius

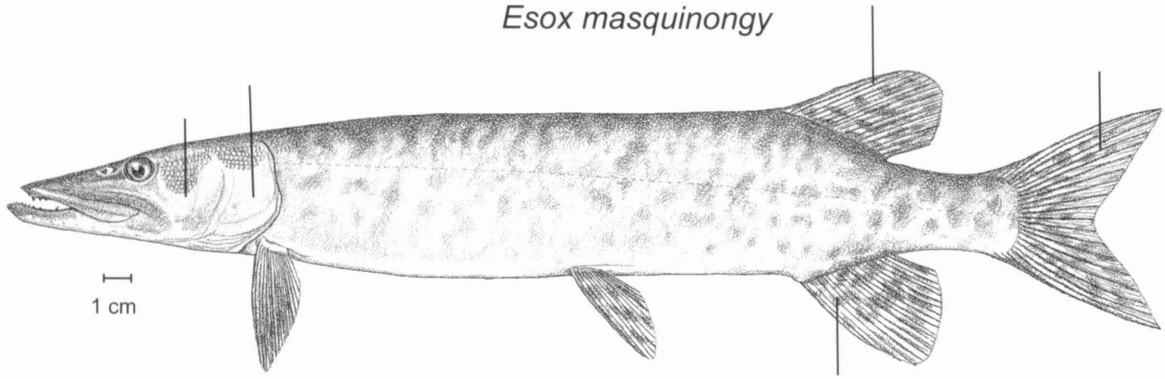


Cheek scaled, opercle half-scaled

White or yellow-green spots on body and vertical fins



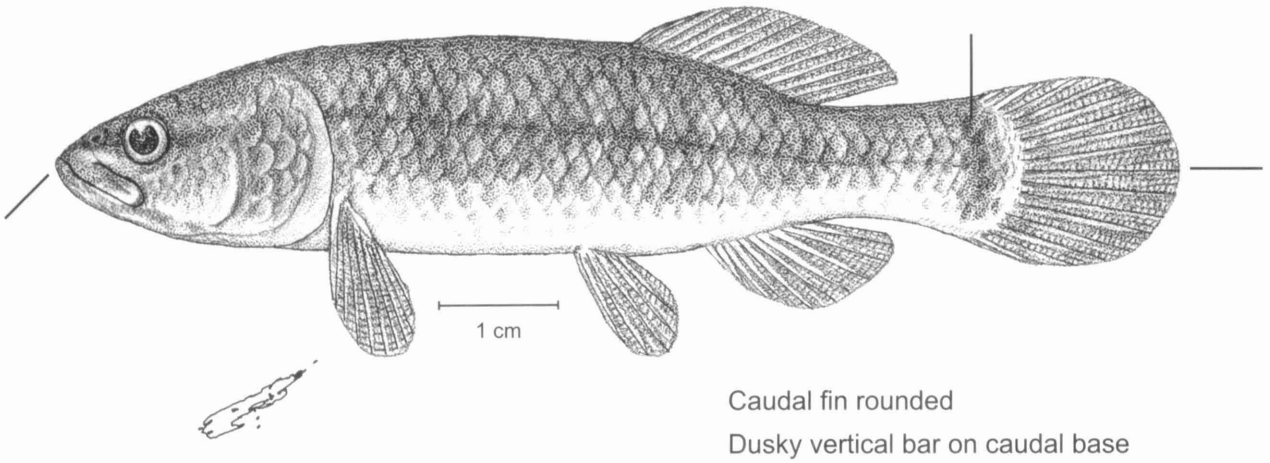
Muskellunge
Esox masquinongy



Scales only on upper half of cheek and opercle
Dorsal, caudal, and anal fins with dusky spots

Central Mudminnow

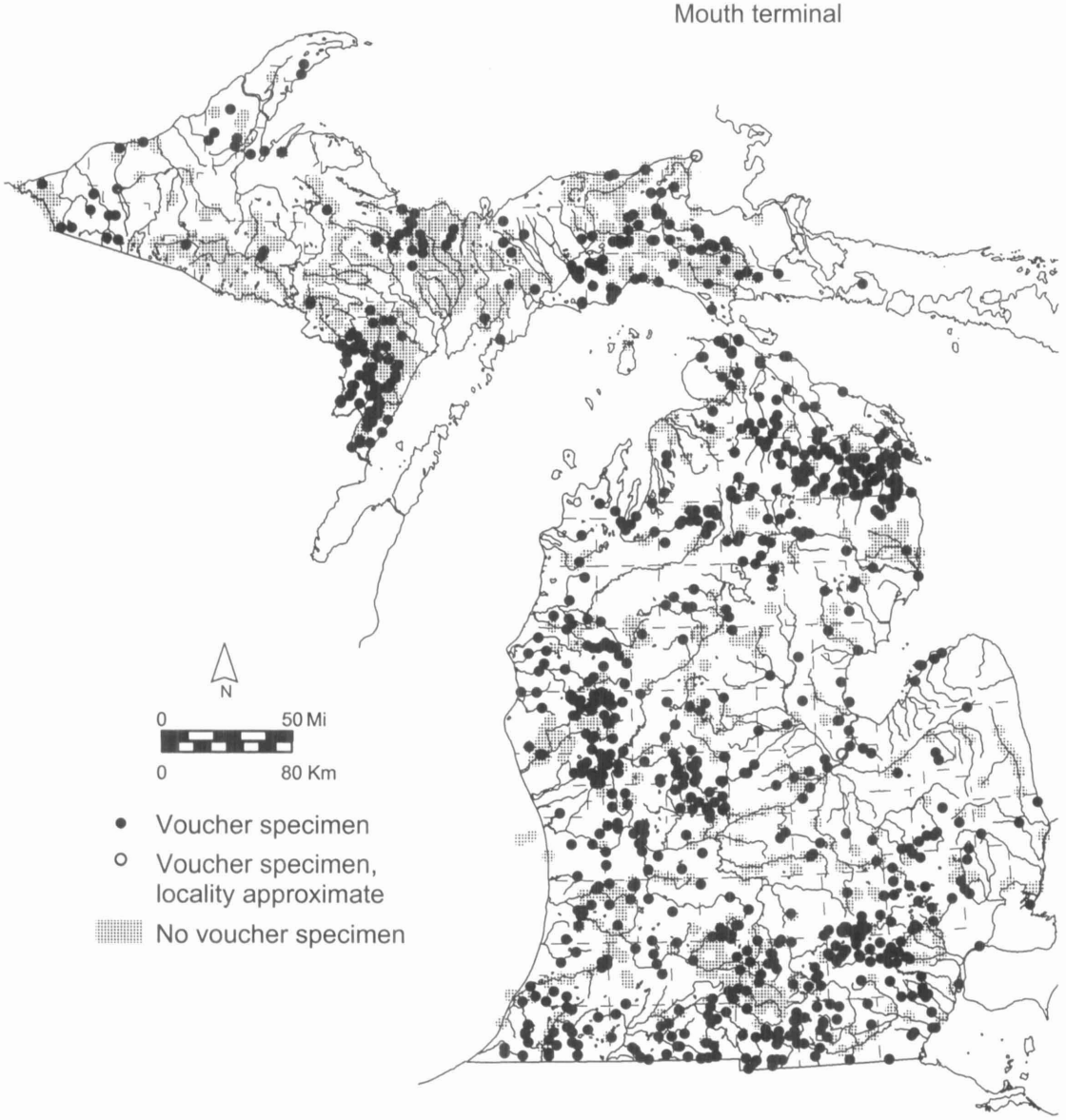
Umbra limi



Caudal fin rounded

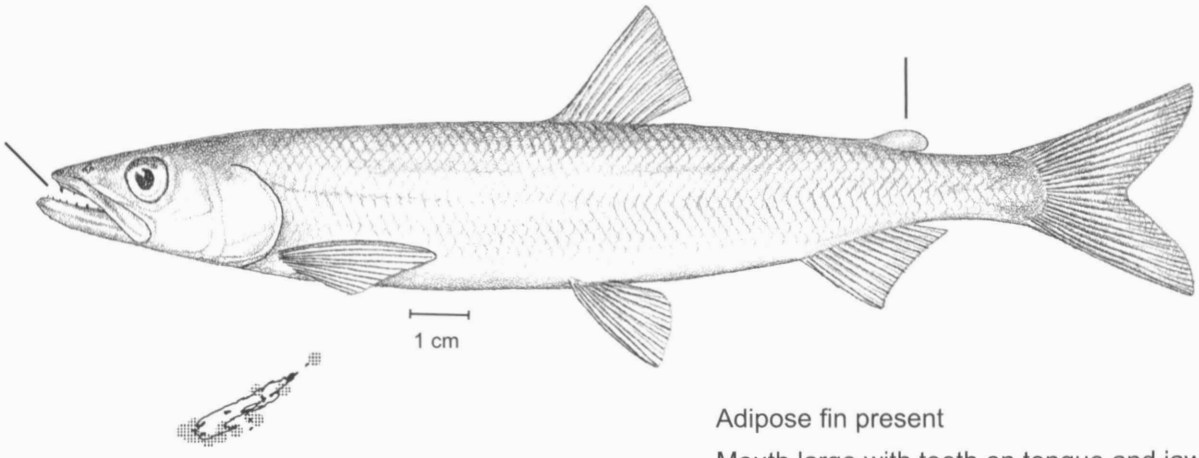
Dusky vertical bar on caudal base

Mouth terminal



Rainbow Smelt

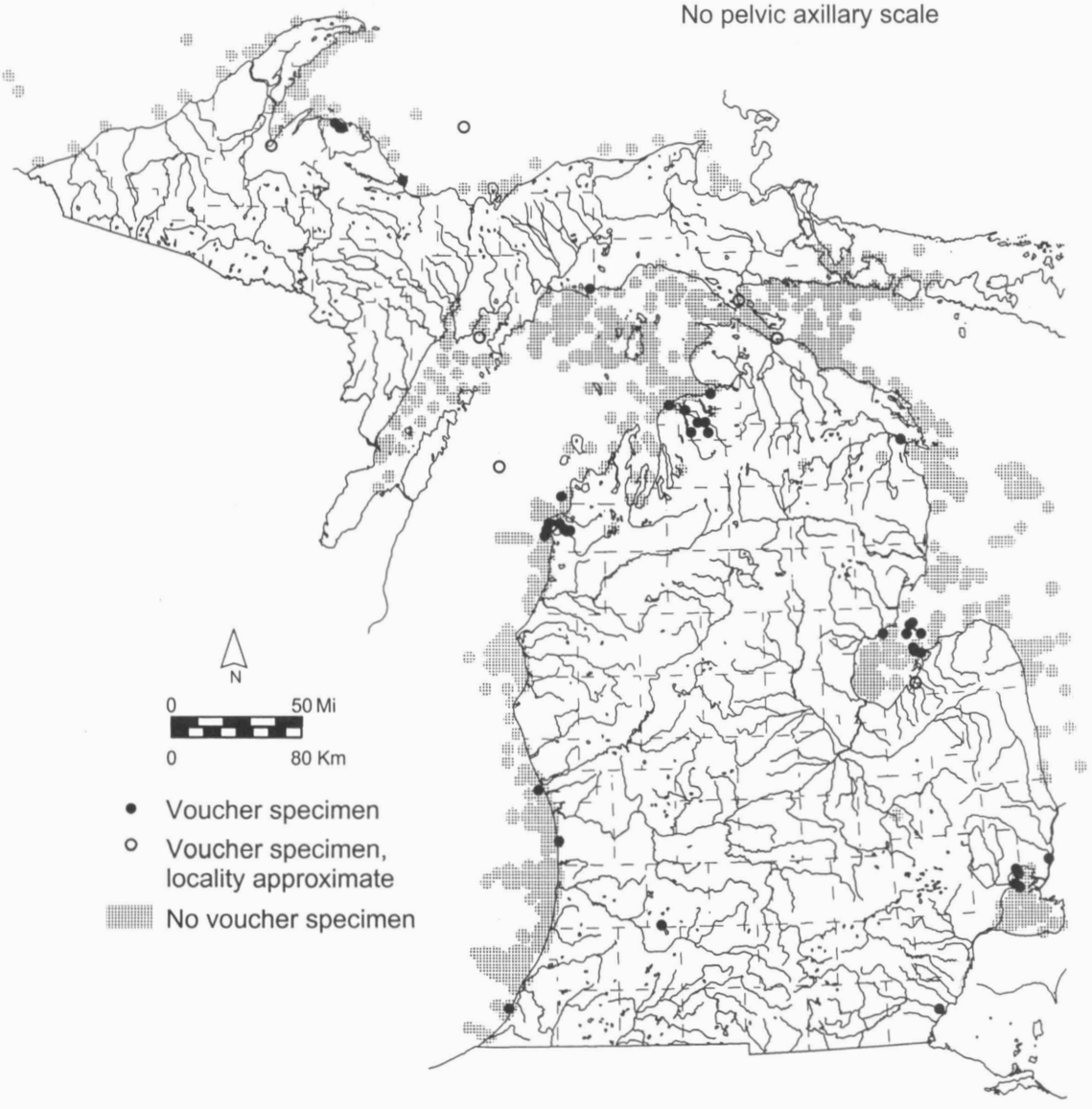
Osmerus mordax



Adipose fin present

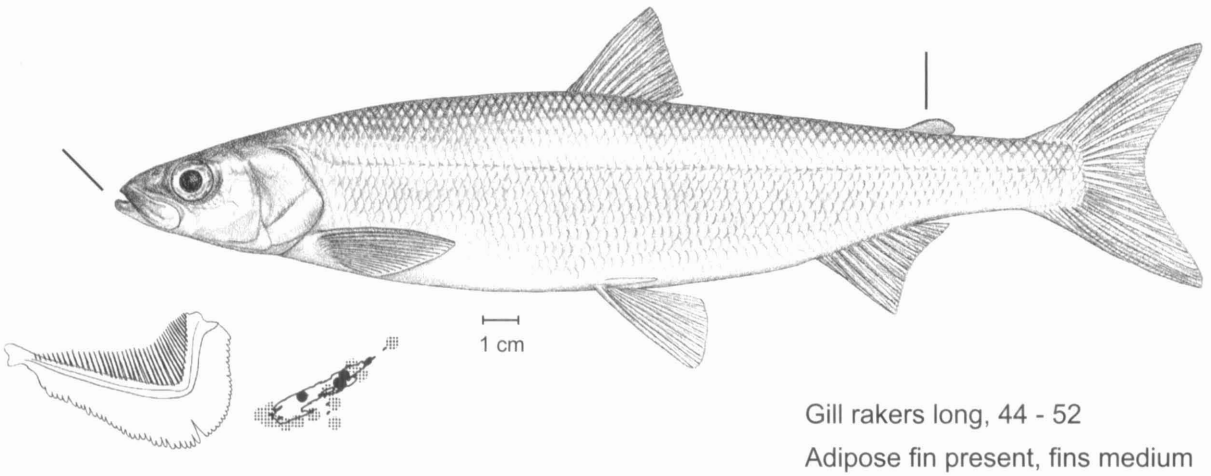
Mouth large with teeth on tongue and jaws

No pelvic axillary scale



Lake Herring

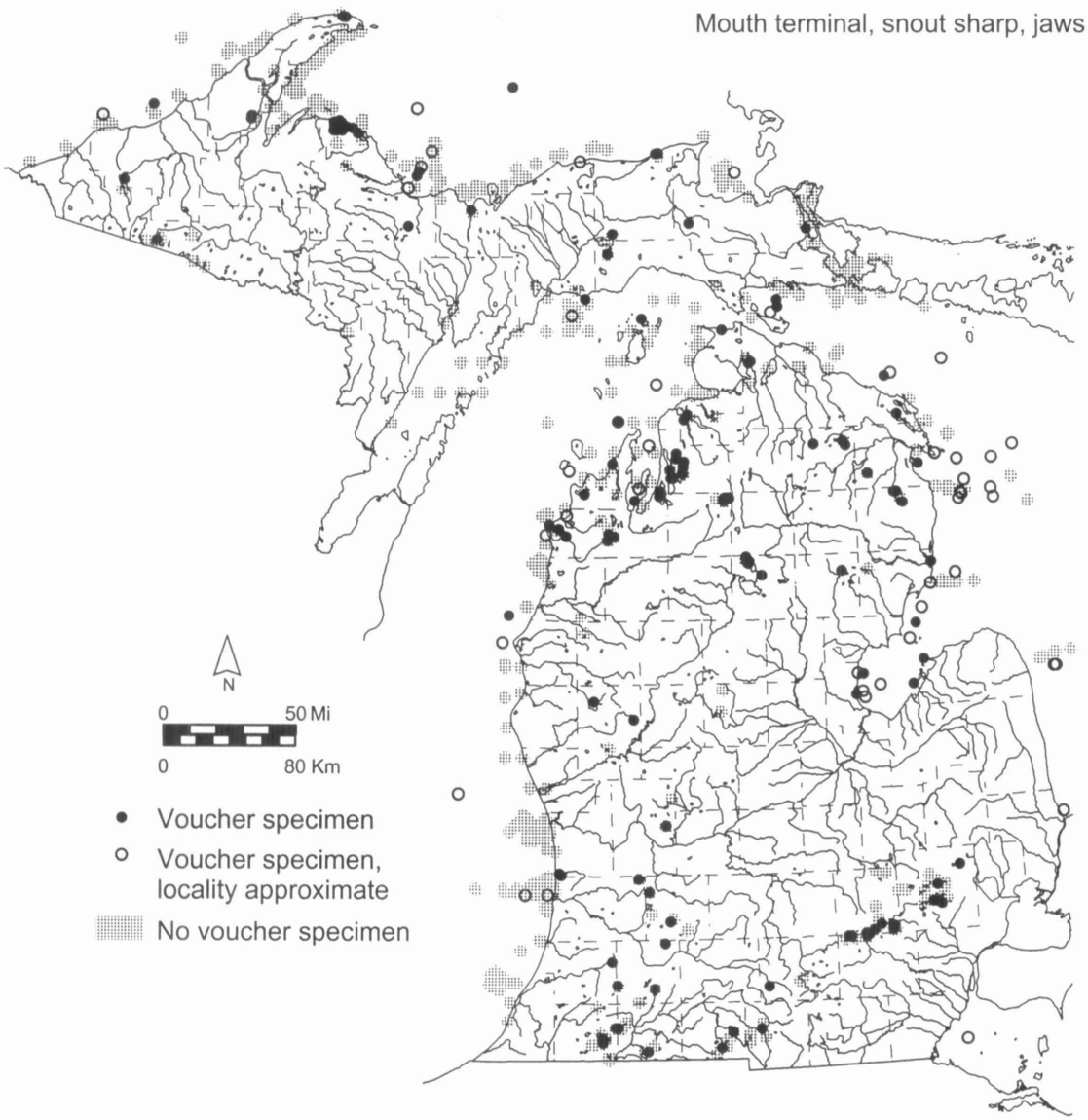
Coregonus artedi



Gill rakers long, 44 - 52

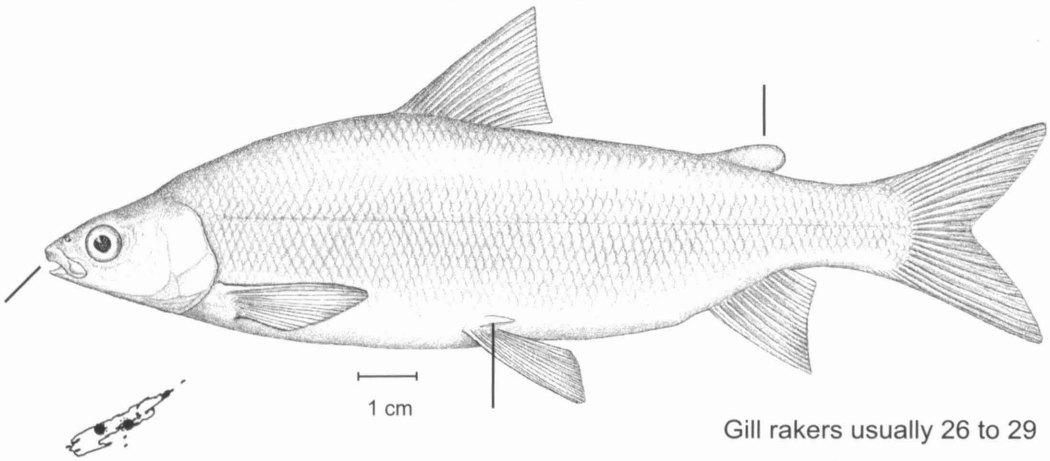
Adipose fin present, fins medium

Mouth terminal, snout sharp, jaws equal

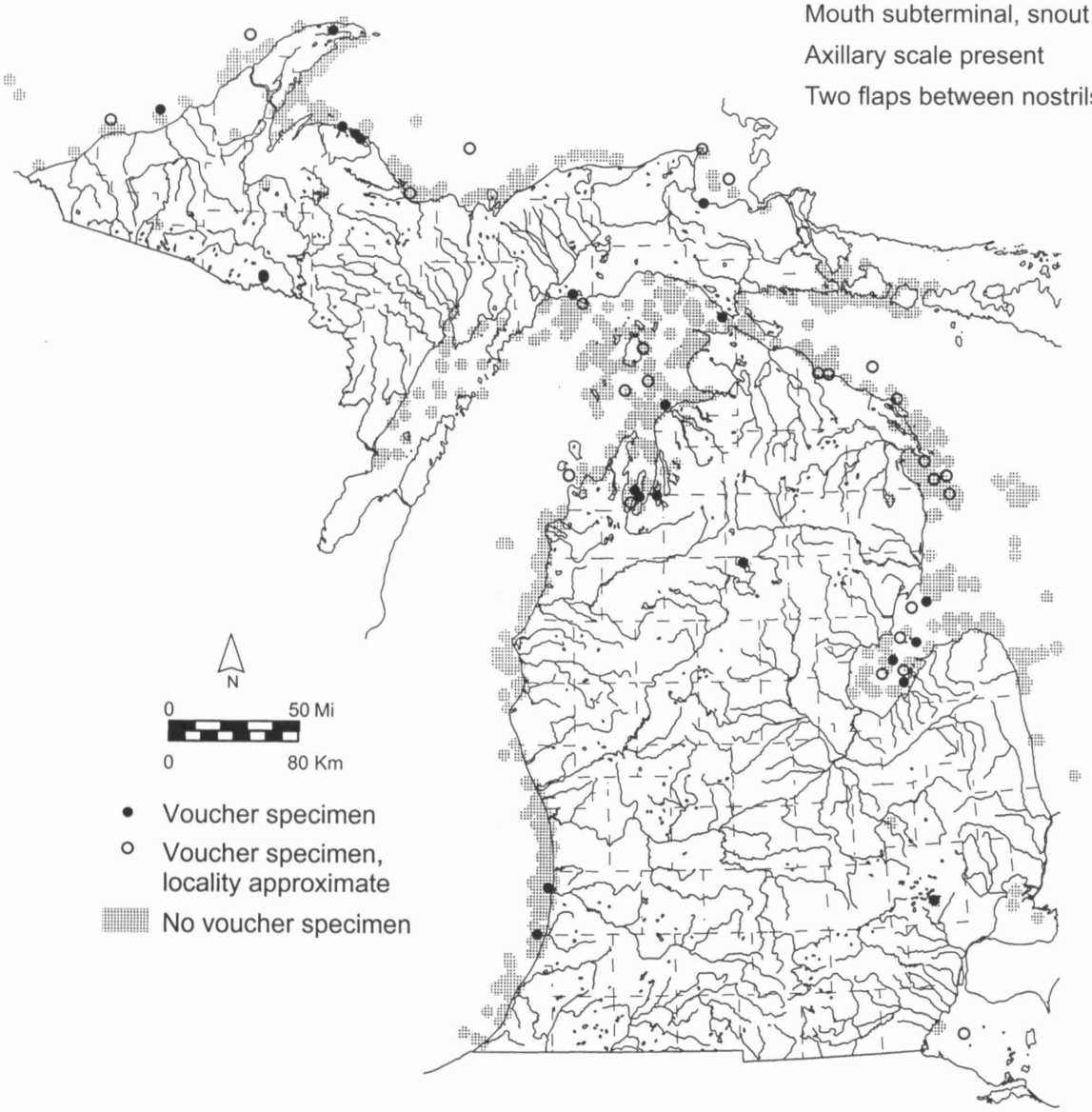


Lake Whitefish

Coregonus clupeaformis

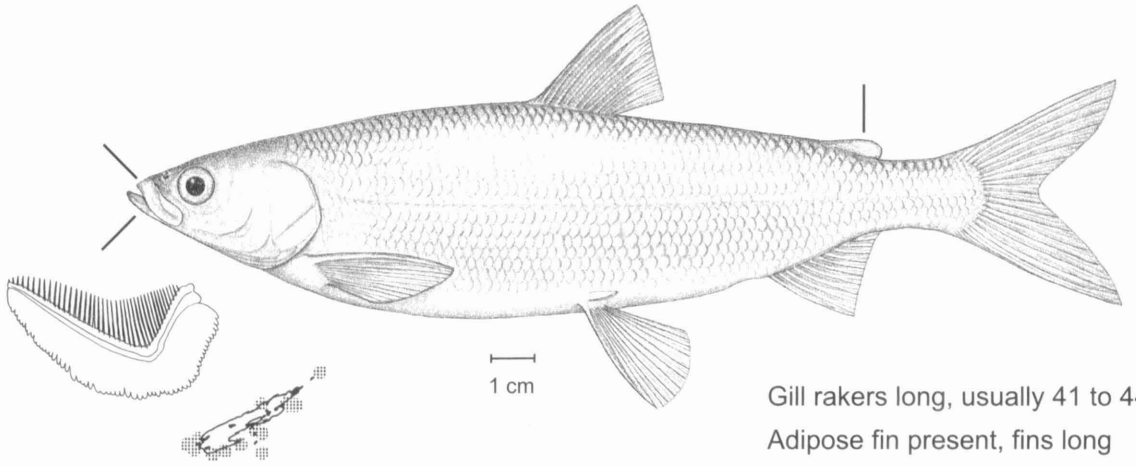


Gill rakers usually 26 to 29
Adipose fin present
Mouth subterminal, snout rounded
Axillary scale present
Two flaps between nostrils

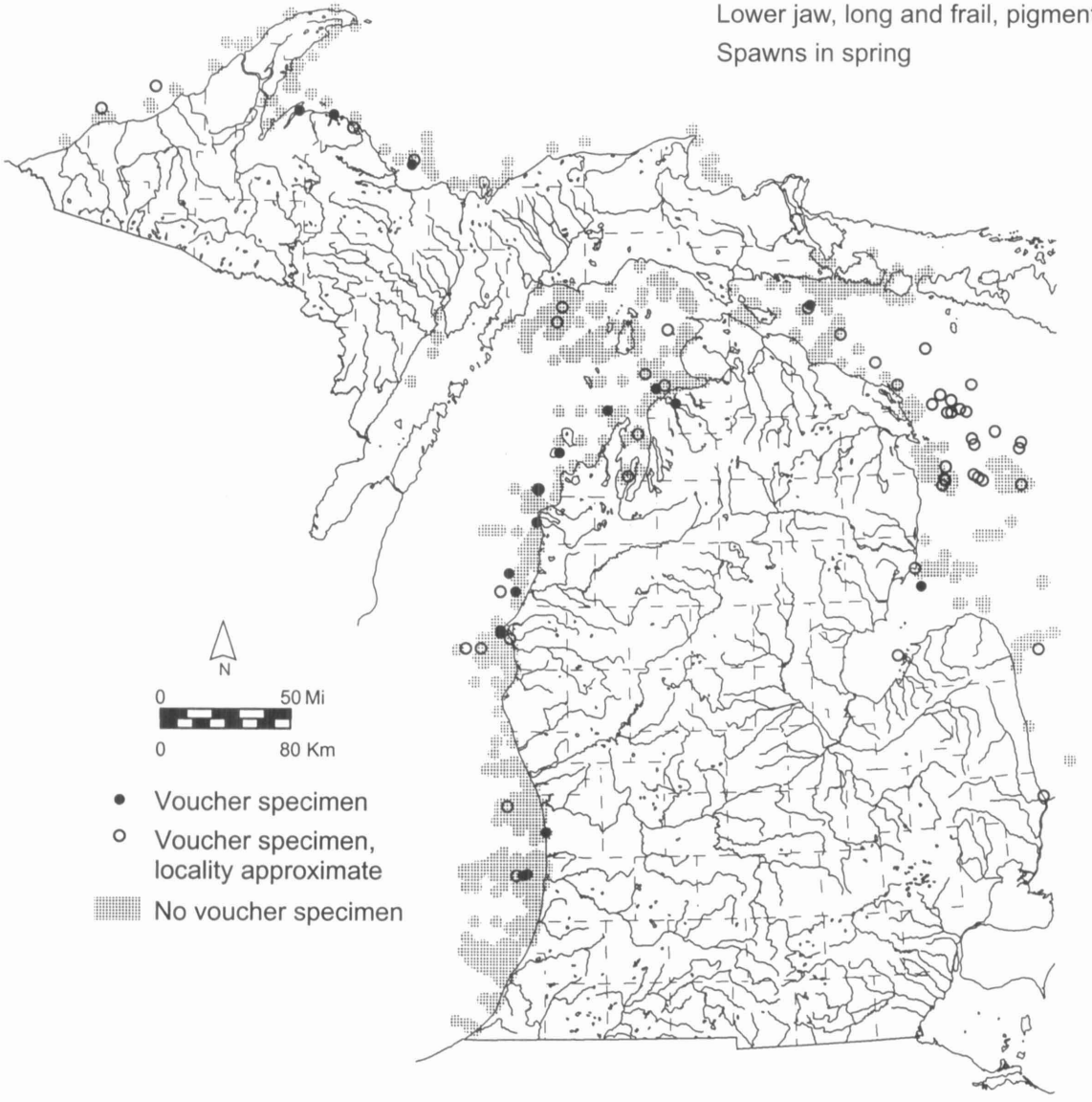


Bloater

Coregonus hoyi

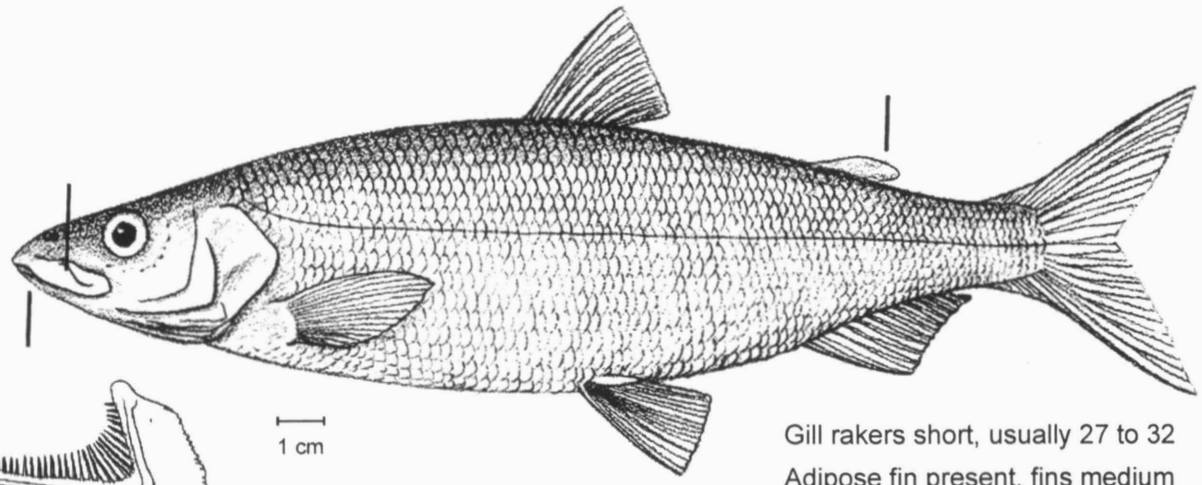


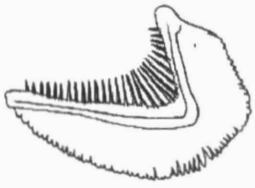
Gill rakers long, usually 41 to 44
Adipose fin present, fins long
Upper jaw, pigment light
Lower jaw, long and frail, pigment medium
Spawns in spring



Deepwater Cisco

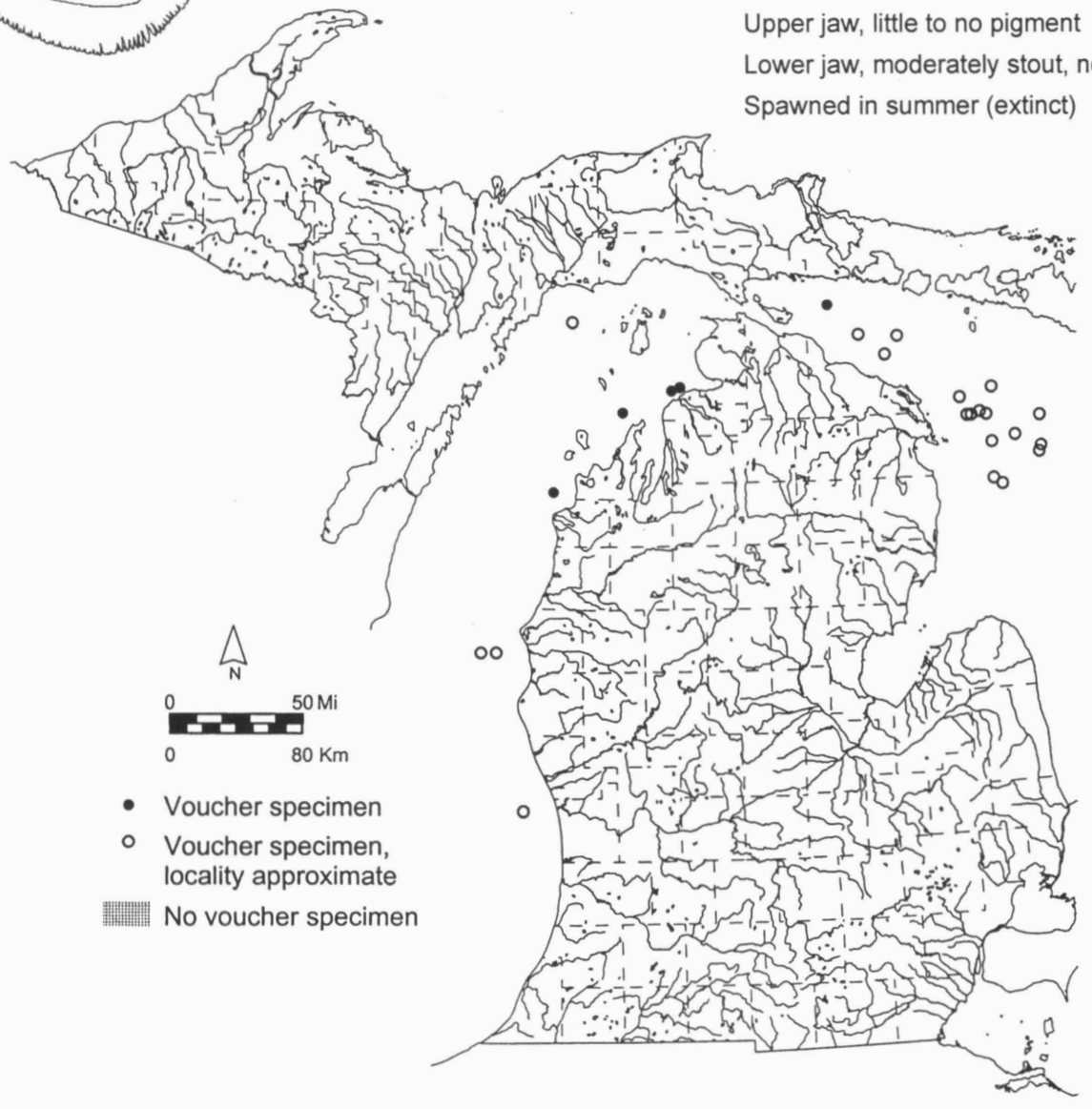
Coregonus johannae





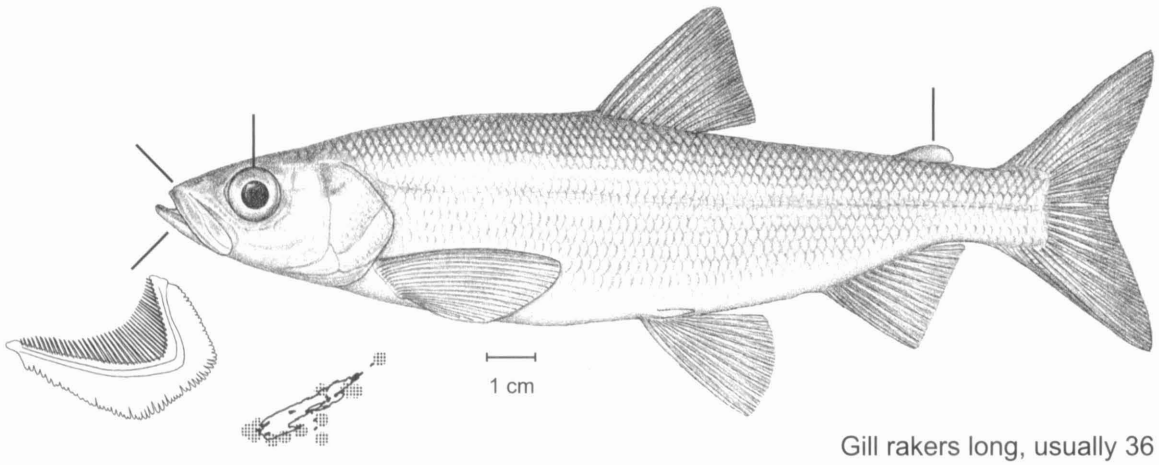
1 cm

Gill rakers short, usually 27 to 32
Adipose fin present, fins medium
Upper jaw, little to no pigment
Lower jaw, moderately stout, no pigment
Spawned in summer (extinct)

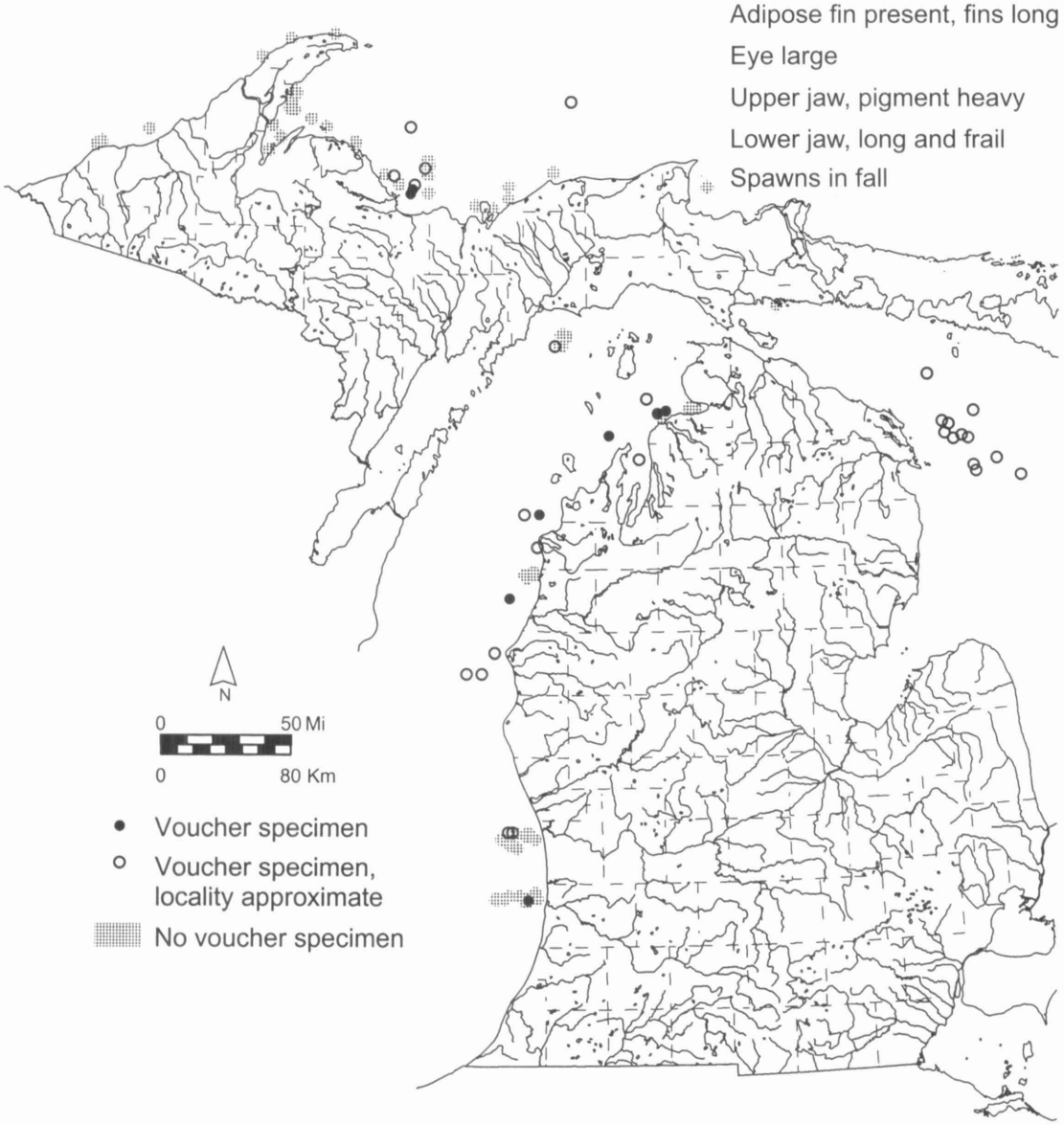


Kiyi

Coregonus kiyi

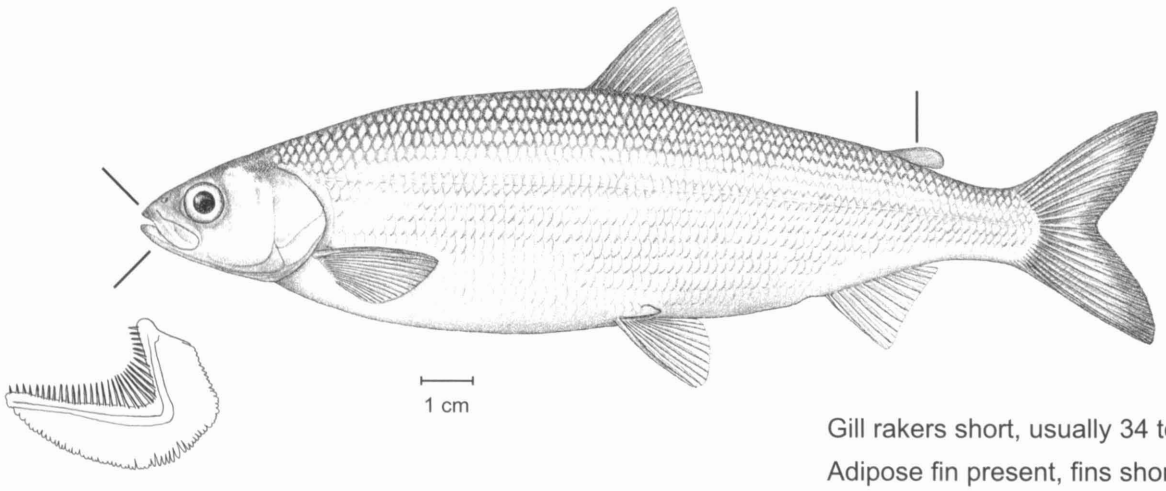


Gill rakers long, usually 36 to 41
Adipose fin present, fins long
Eye large
Upper jaw, pigment heavy
Lower jaw, long and frail
Spawns in fall

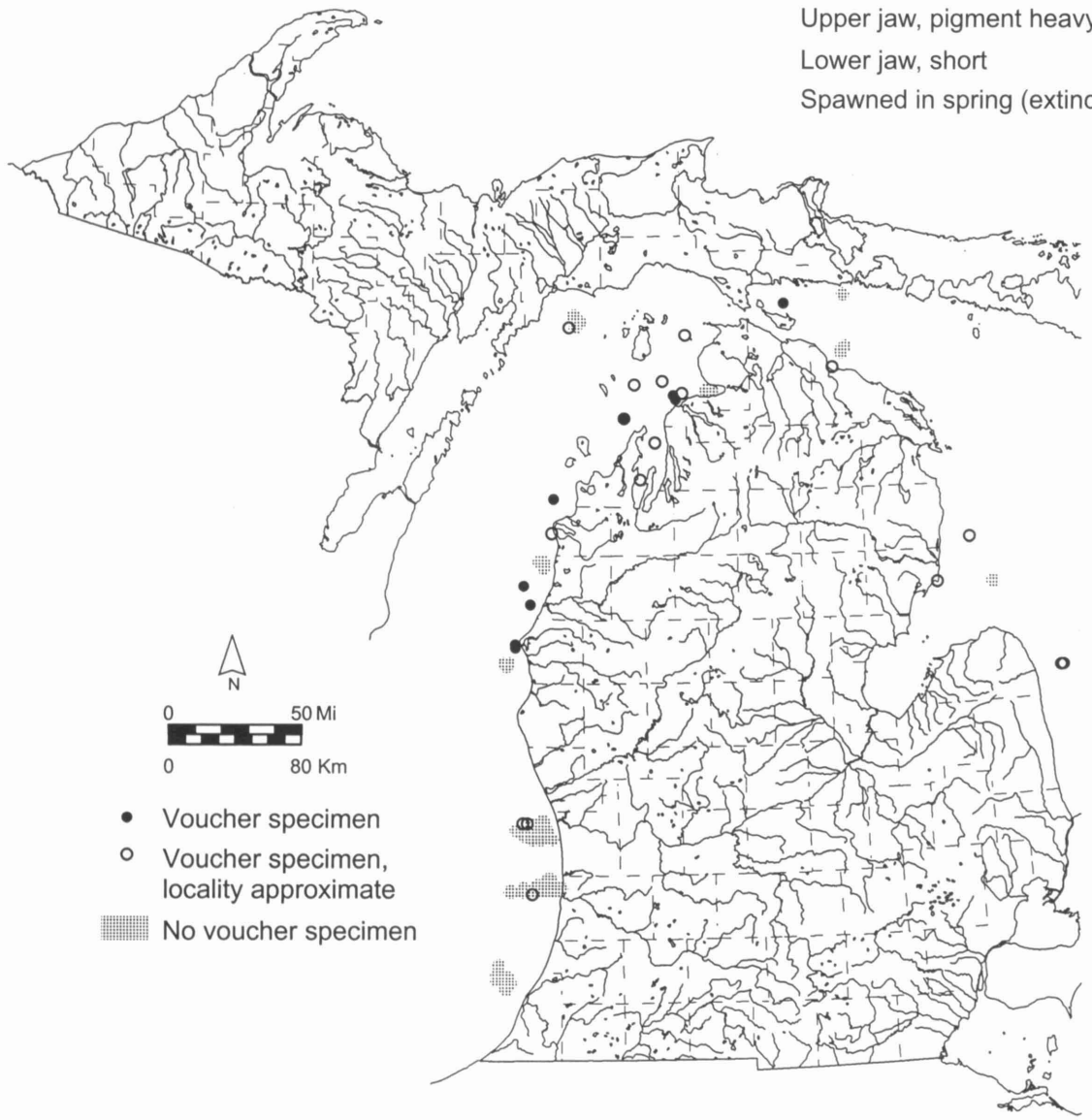


Shortnose Cisco

Coregonus reighardi

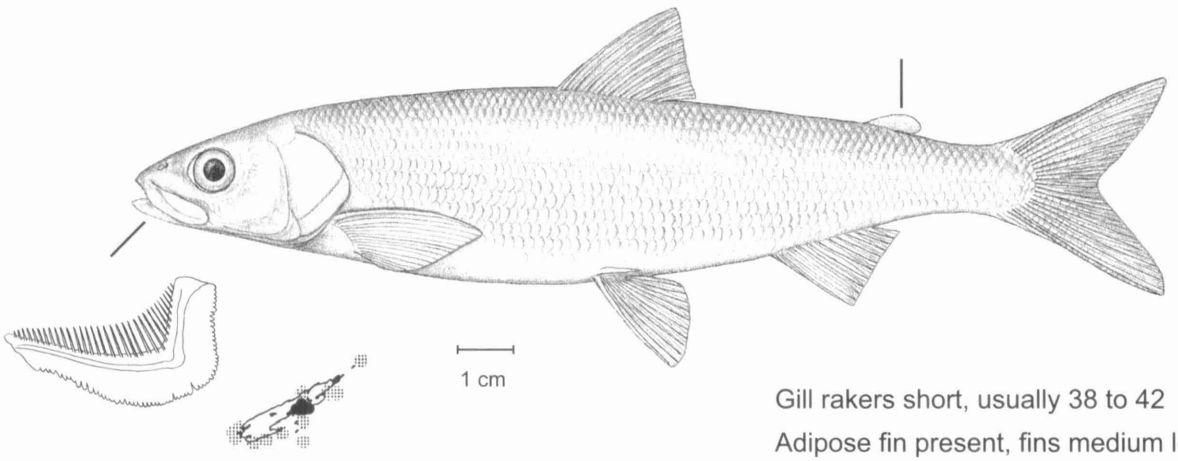


Gill rakers short, usually 34 to 39
Adipose fin present, fins short
Upper jaw, pigment heavy
Lower jaw, short
Spawned in spring (extinct)

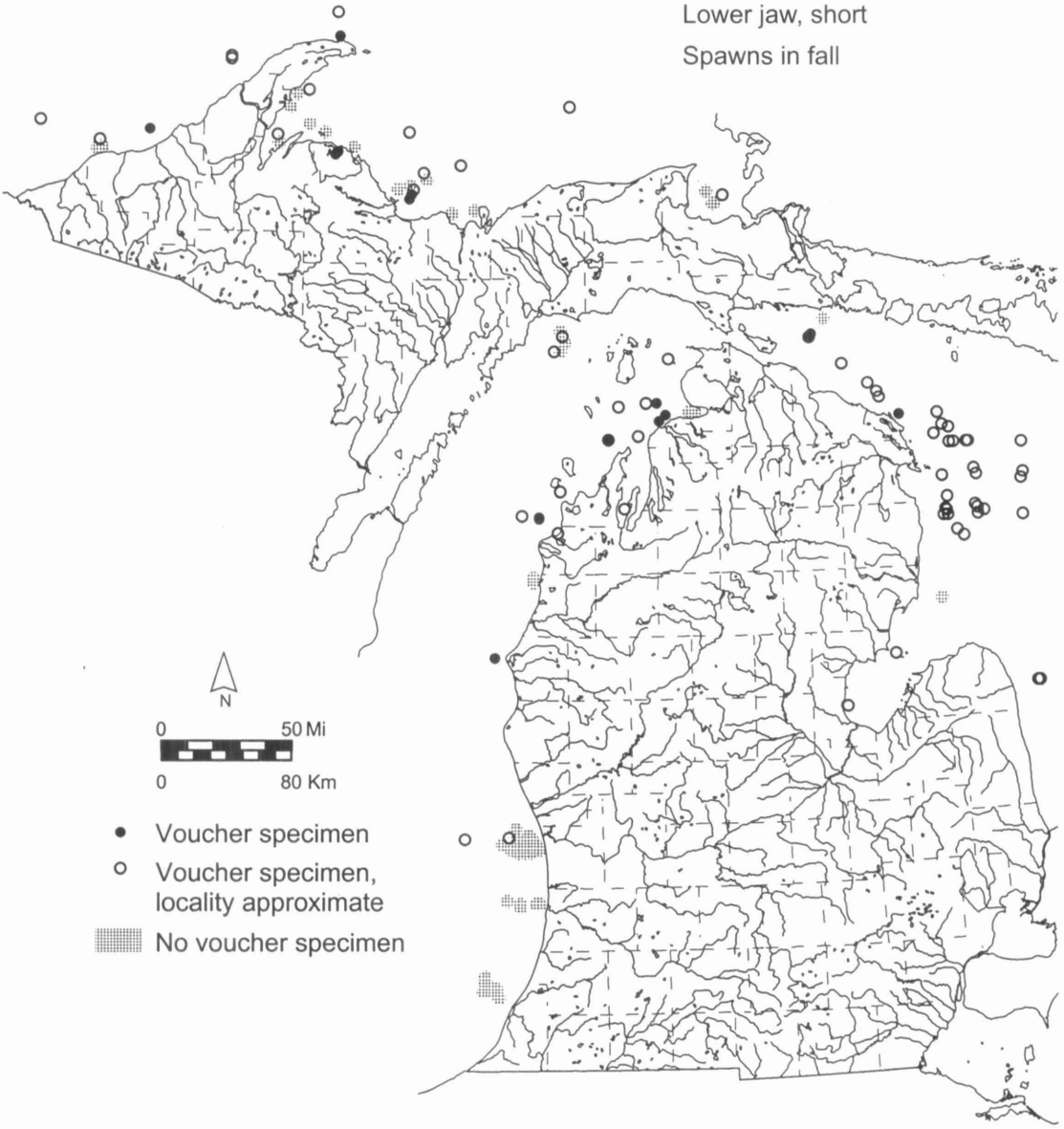


Shortjaw Cisco

Coregonus zenithicus

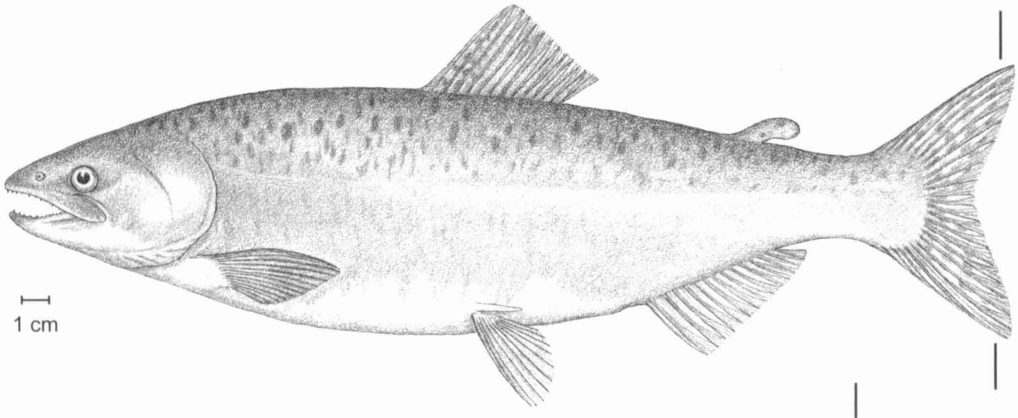


Gill rakers short, usually 38 to 42
Adipose fin present, fins medium length
Lower jaw, short
Spawns in fall



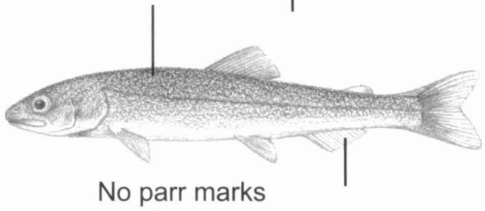
Pink Salmon

Oncorhynchus gorbuscha



Large black spots on back and both lobes of caudal fin

Breeding males with distinct dorsal hump

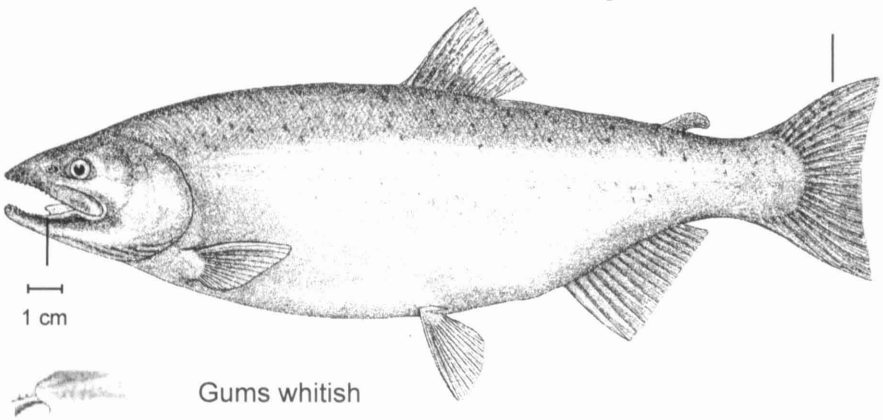


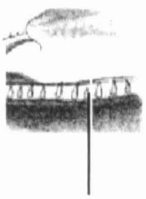
No parr marks

Anal fin with 13 or more rays

Coho Salmon

Oncorhynchus kisutch

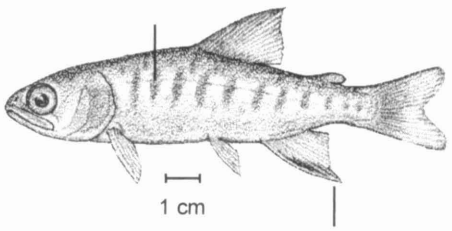




Gums whitish

Small black spots on upper lobe of caudal fin

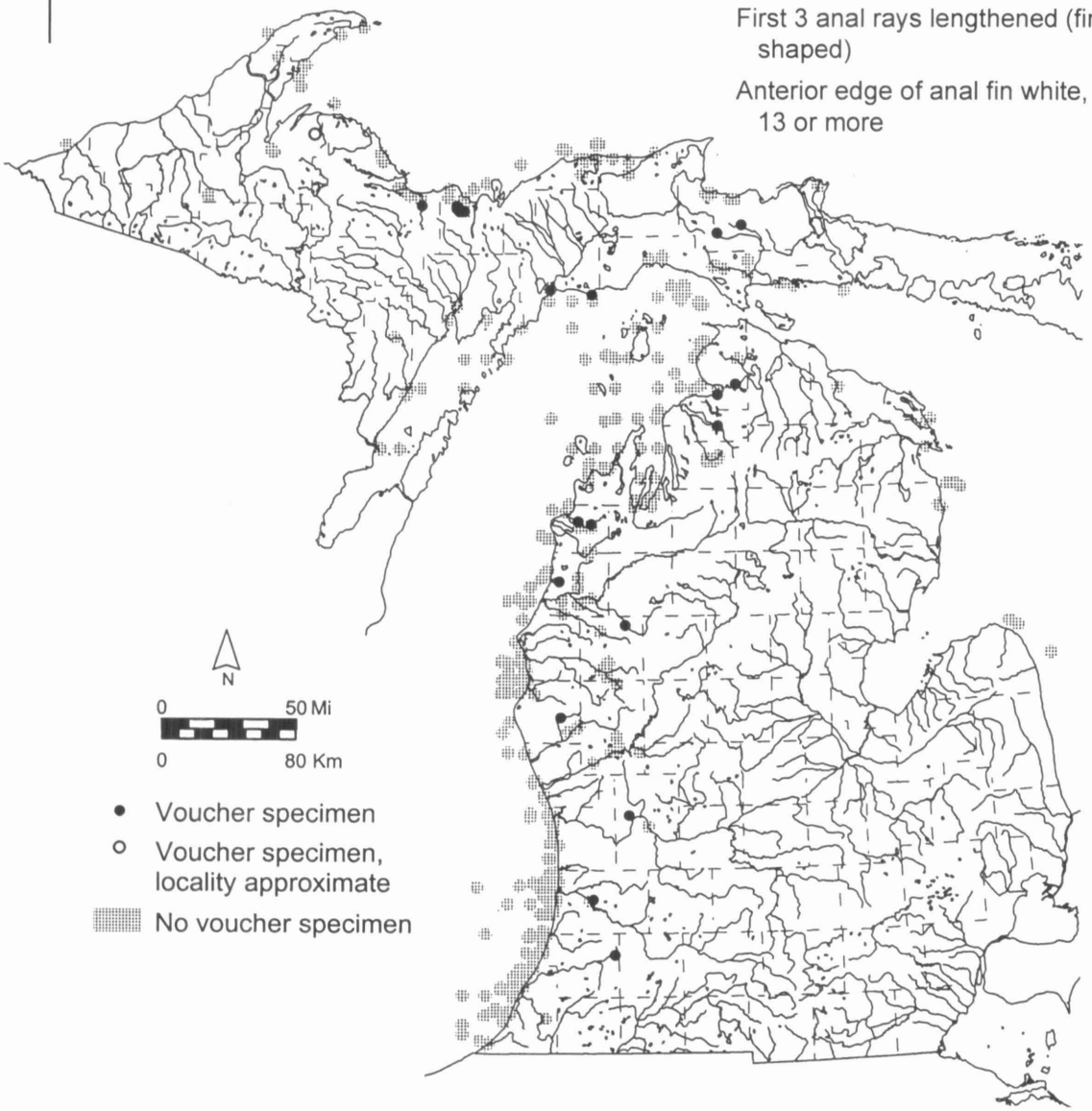
Spots may be lacking



Parr marks narrower than areas between

First 3 anal rays lengthened (fin sickle-shaped)

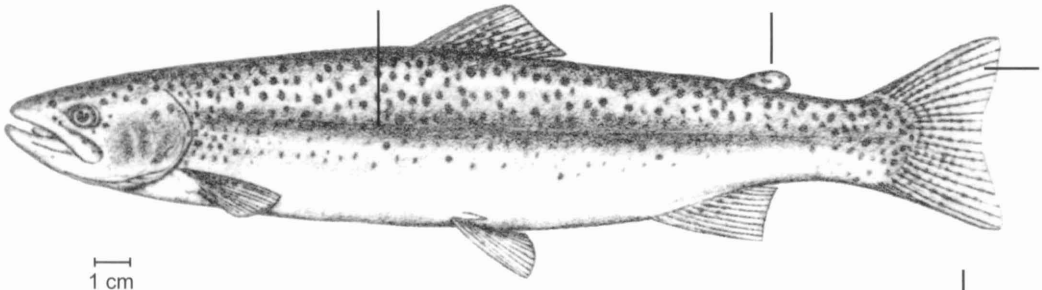
Anterior edge of anal fin white, rays 13 or more



- Voucher specimen
- Voucher specimen, locality approximate
- No voucher specimen

Rainbow Trout

Oncorhynchus mykiss

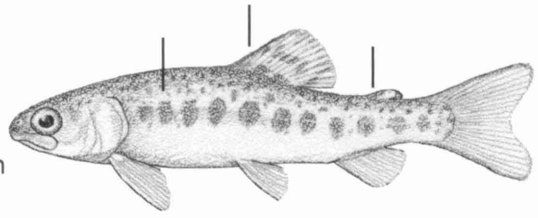


1 cm

Back, top of head, dorsal, and caudal fins with many small black spots

Usually pink stripe along side

Adipose usually spotted, with black margin

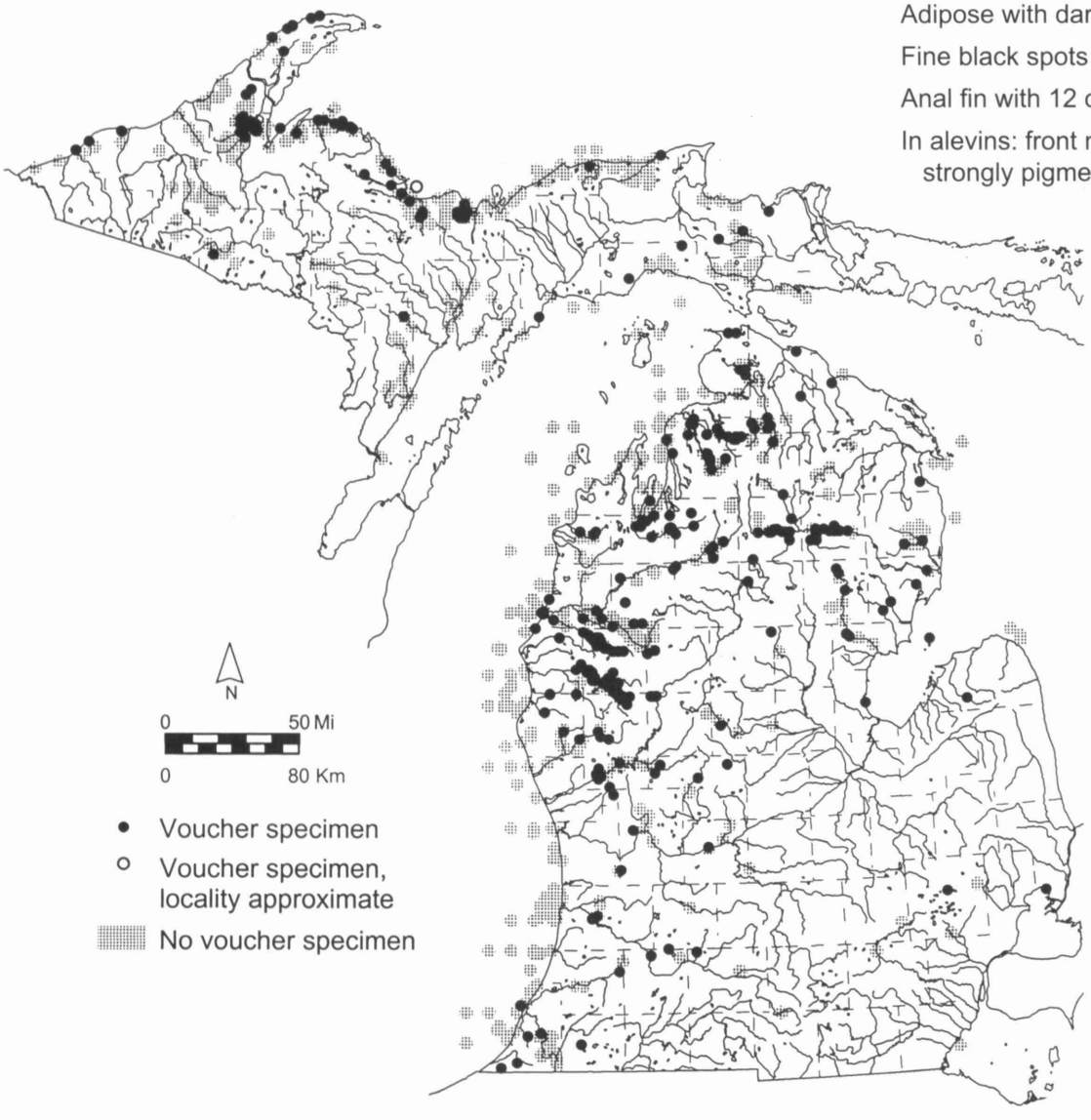


Adipose with dark border

Fine black spots on back and sides

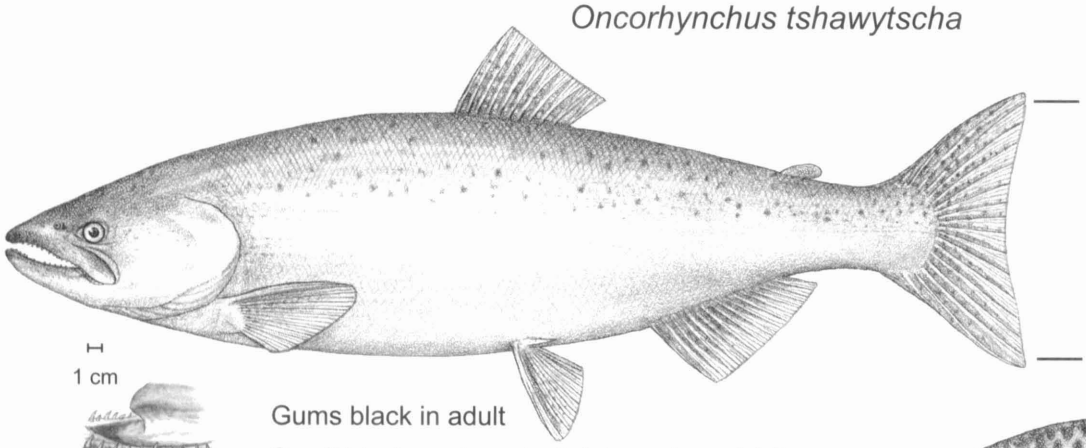
Anal fin with 12 or fewer rays

In alevins: front margin of dorsal fin strongly pigmented

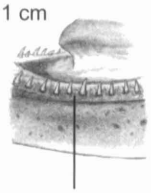


Chinook Salmon

Oncorhynchus tshawytscha



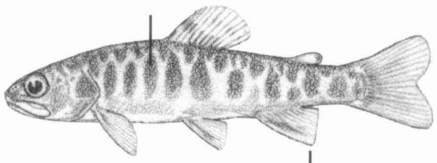
1 cm



Gums black in adult

Small black spots on both lobes of caudal fin

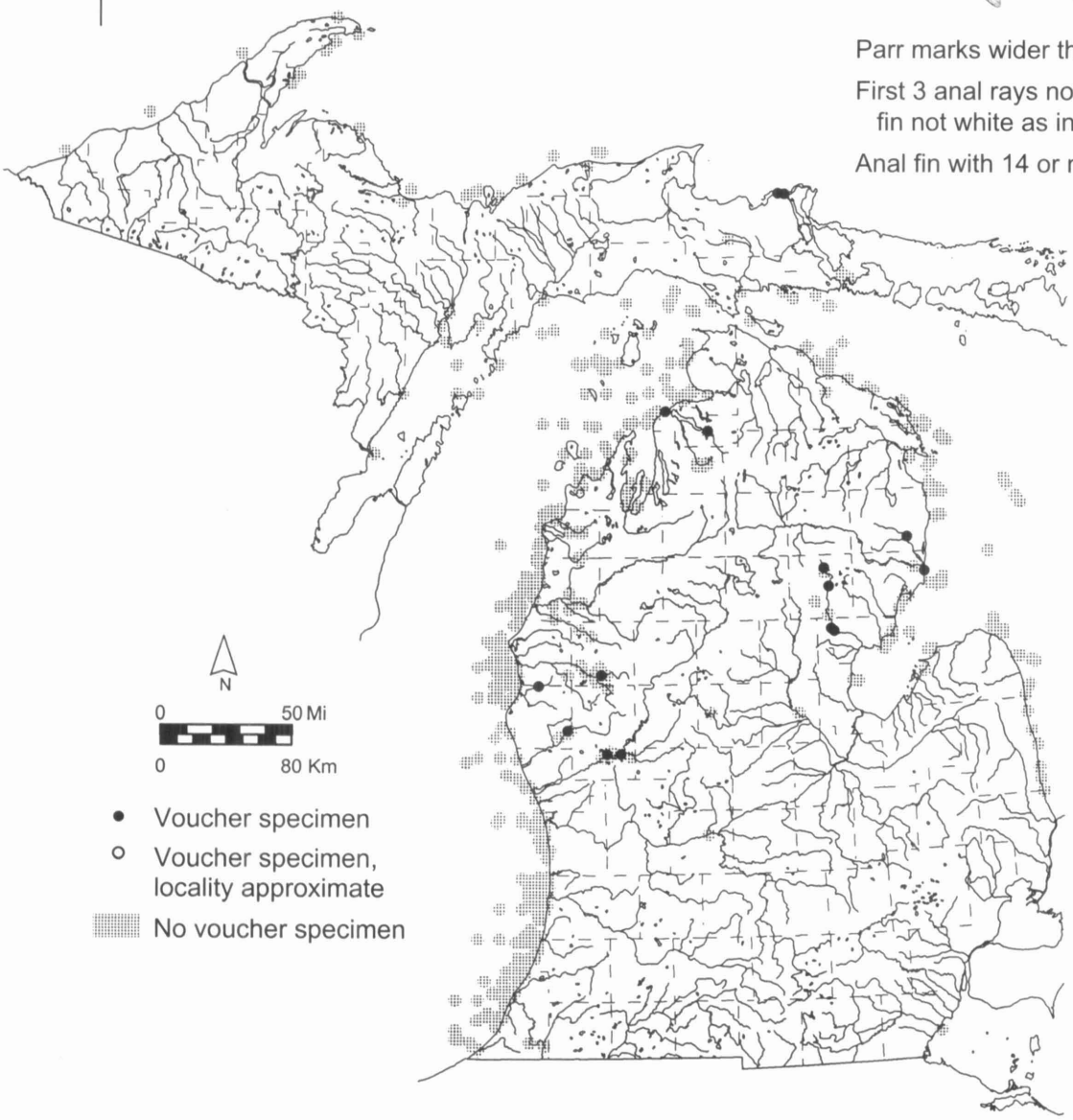
Spots may be lacking



Parr marks wider than areas between

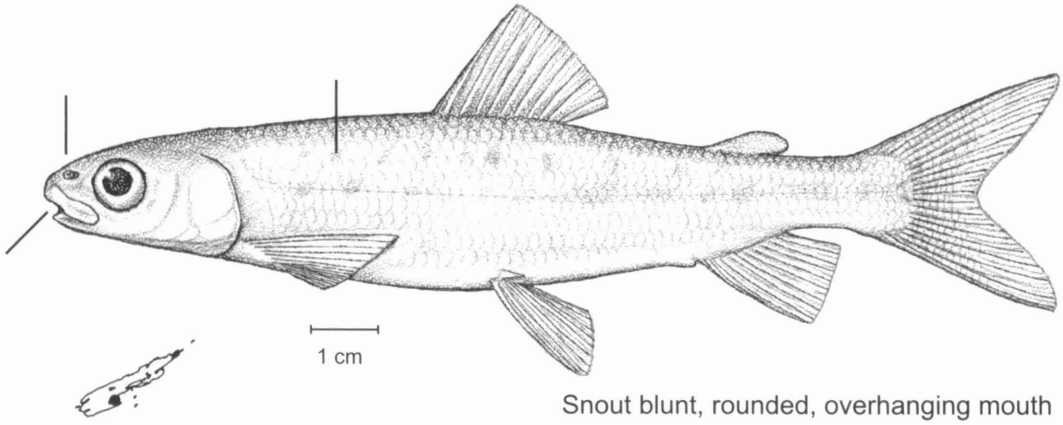
First 3 anal rays not long, edge of fin not white as in *O. kisutch*

Anal fin with 14 or more rays

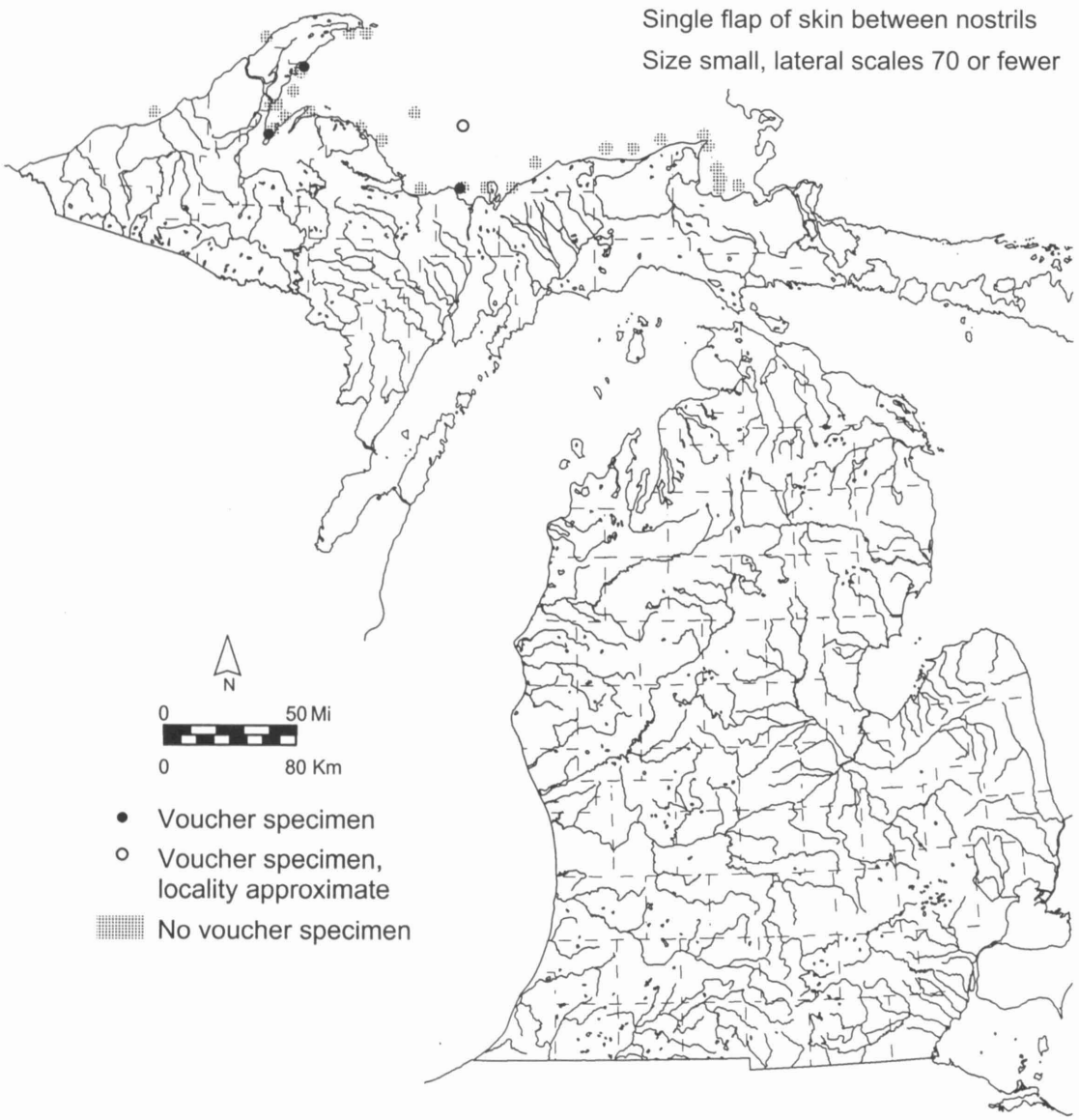


Pygmy Whitefish

Prosopium coulterii

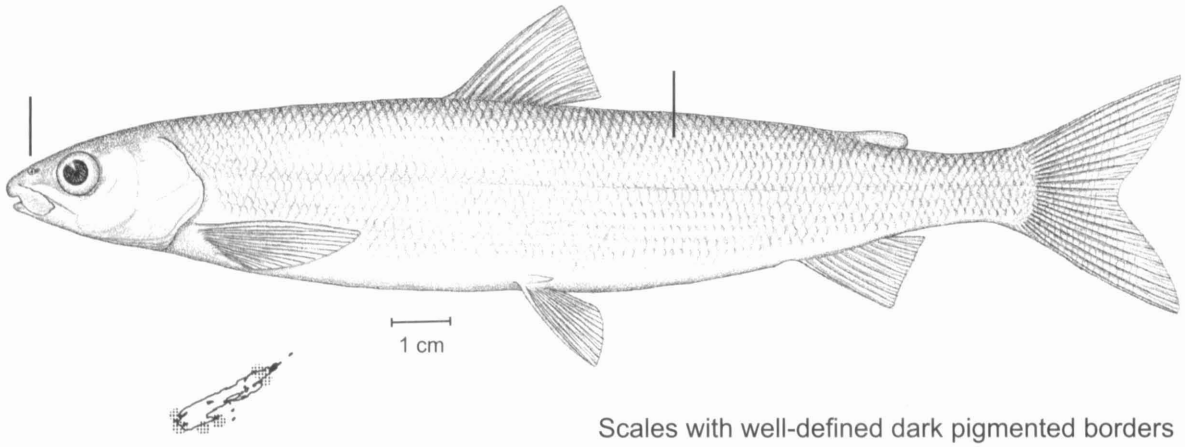


Snout blunt, rounded, overhanging mouth
12 to 14 spots along midline of back
Single flap of skin between nostrils
Size small, lateral scales 70 or fewer



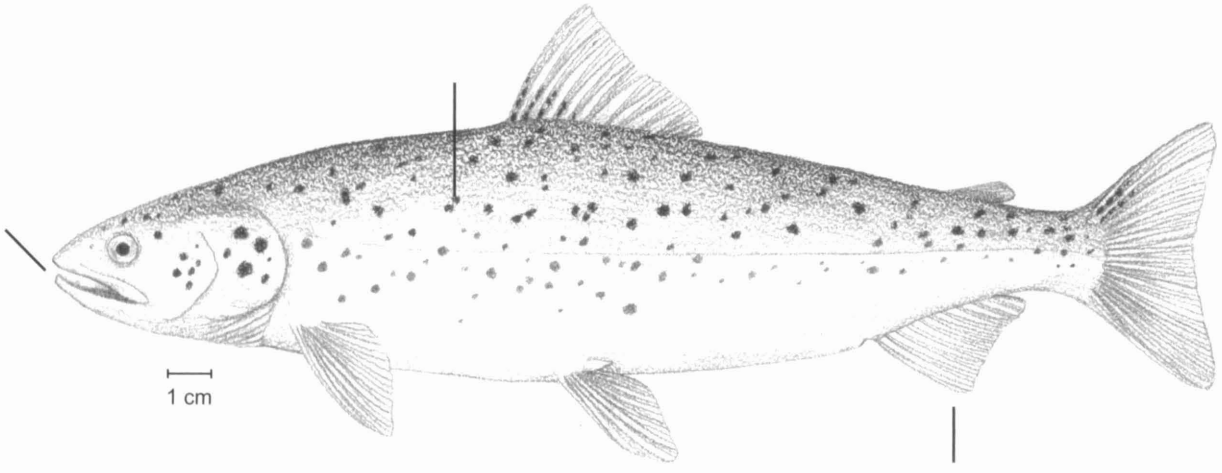
Round Whitefish

Prosopium cylindraceum

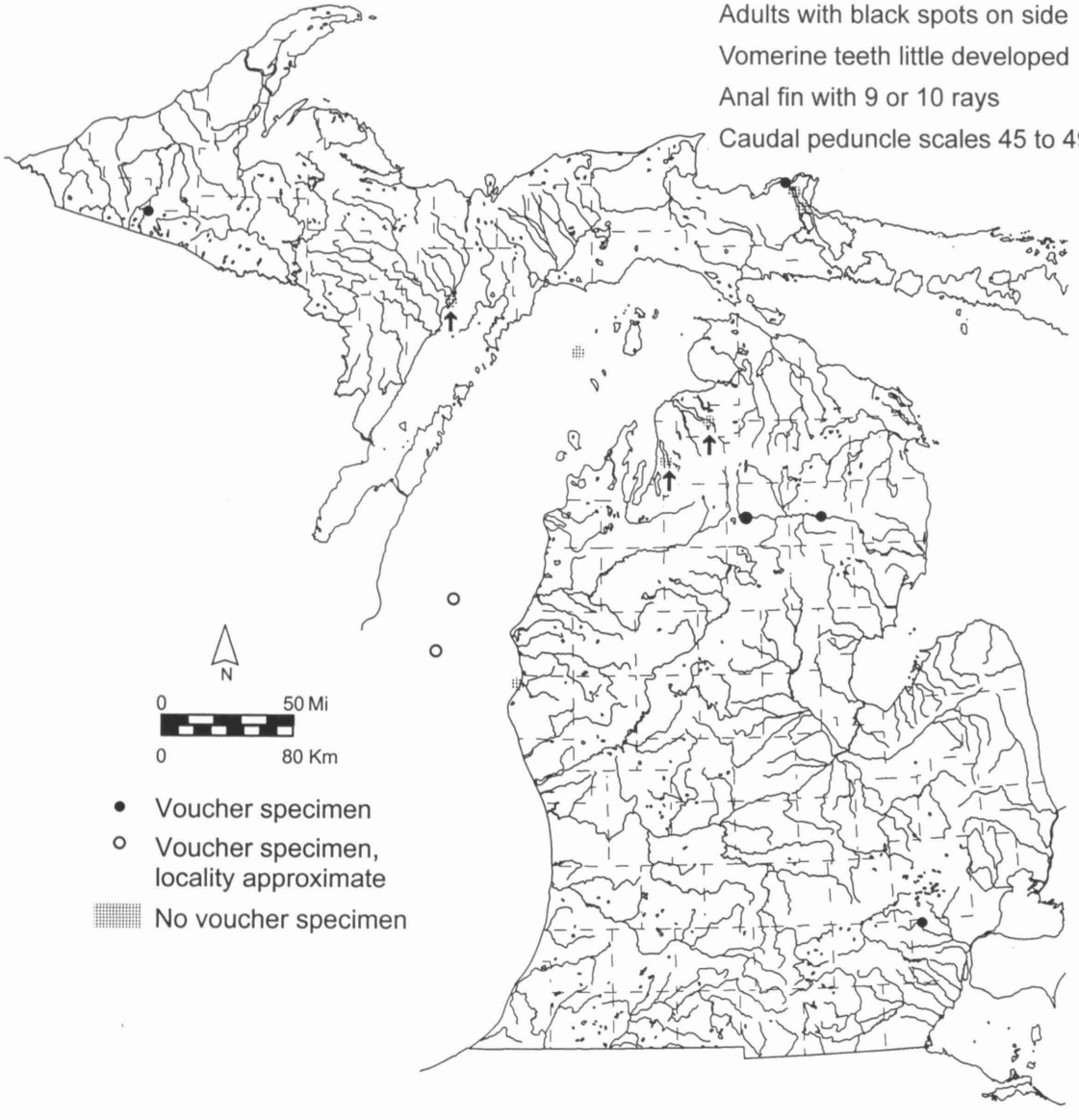


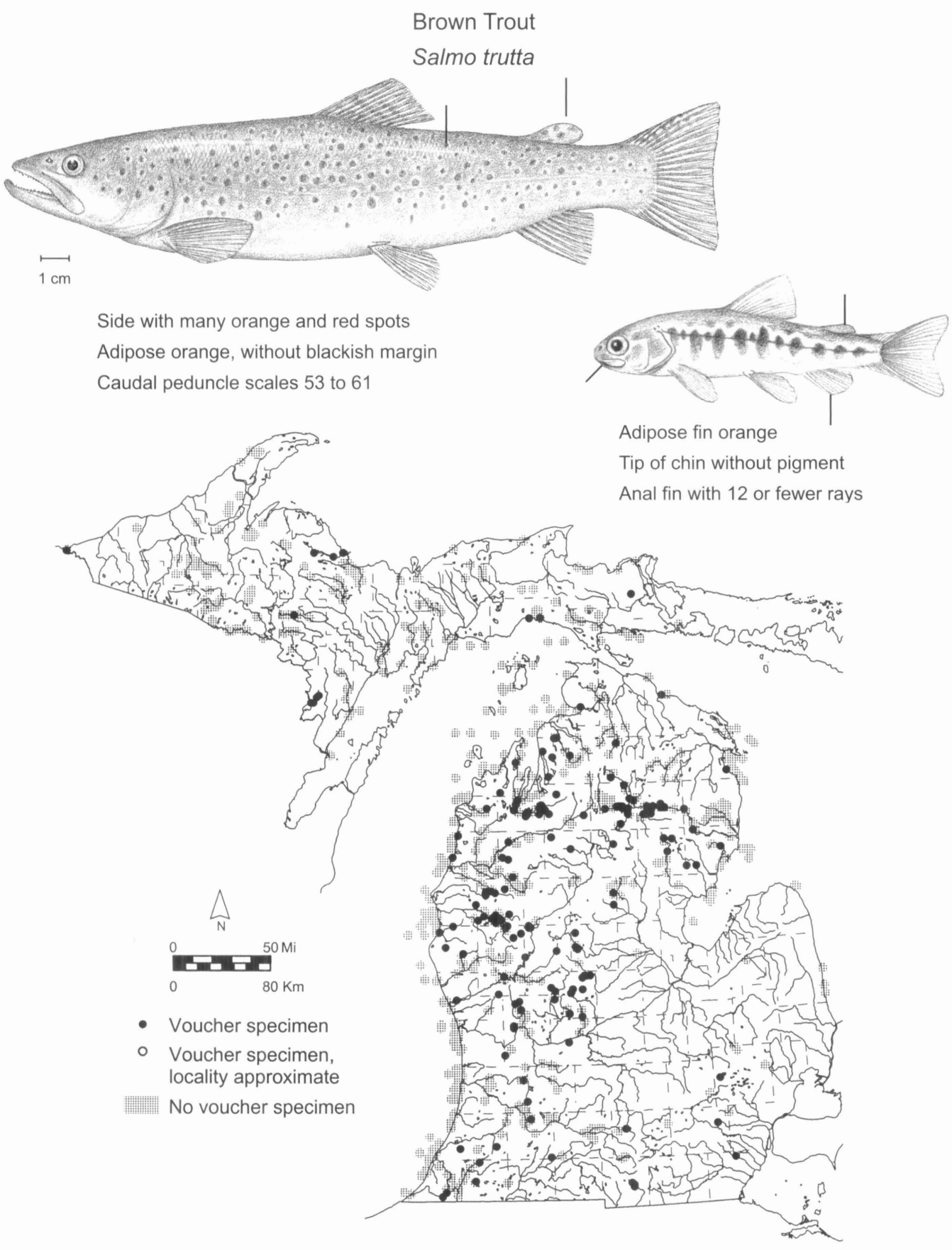
Scales with well-defined dark pigmented borders
Single flap of skin between nostrils
Size large, lateral scales 80 or more

Atlantic Salmon
Salmo salar

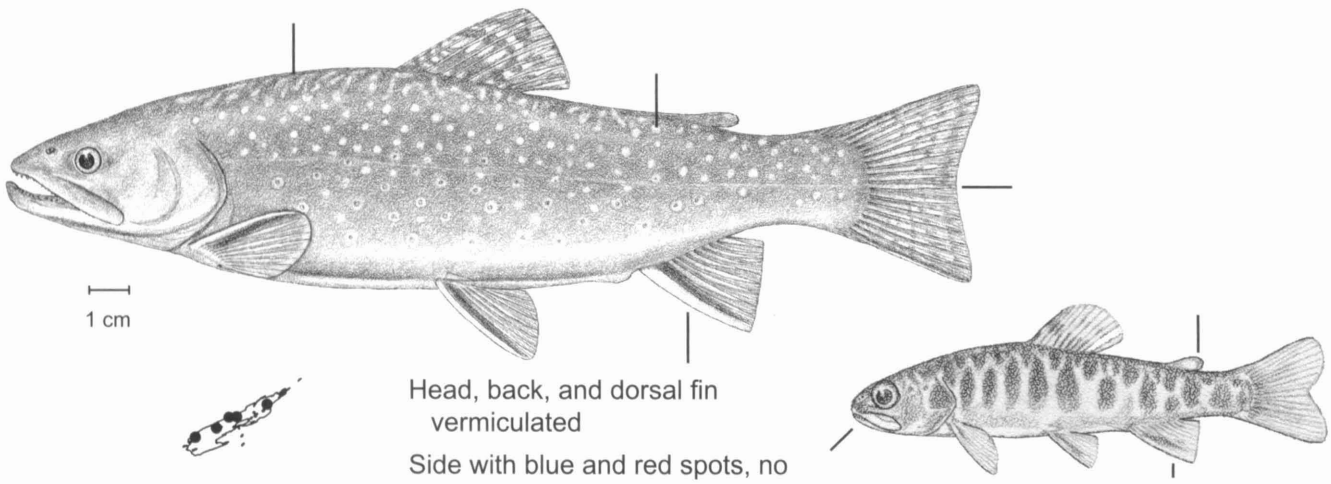


Adults with black spots on side
Vomerine teeth little developed
Anal fin with 9 or 10 rays
Caudal peduncle scales 45 to 49




Brown Trout
Salmo trutta
1 cm
Side with many orange and red spots
Adipose orange, without blackish margin
Caudal peduncle scales 53 to 61
Adipose fin orange
Tip of chin without pigment
Anal fin with 12 or fewer rays
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

Brook Trout
Salvelinus fontinalis



Head, back, and dorsal fin vermiculated

Side with blue and red spots, no dark spots

Anterior edge of lower fins white, dark behind

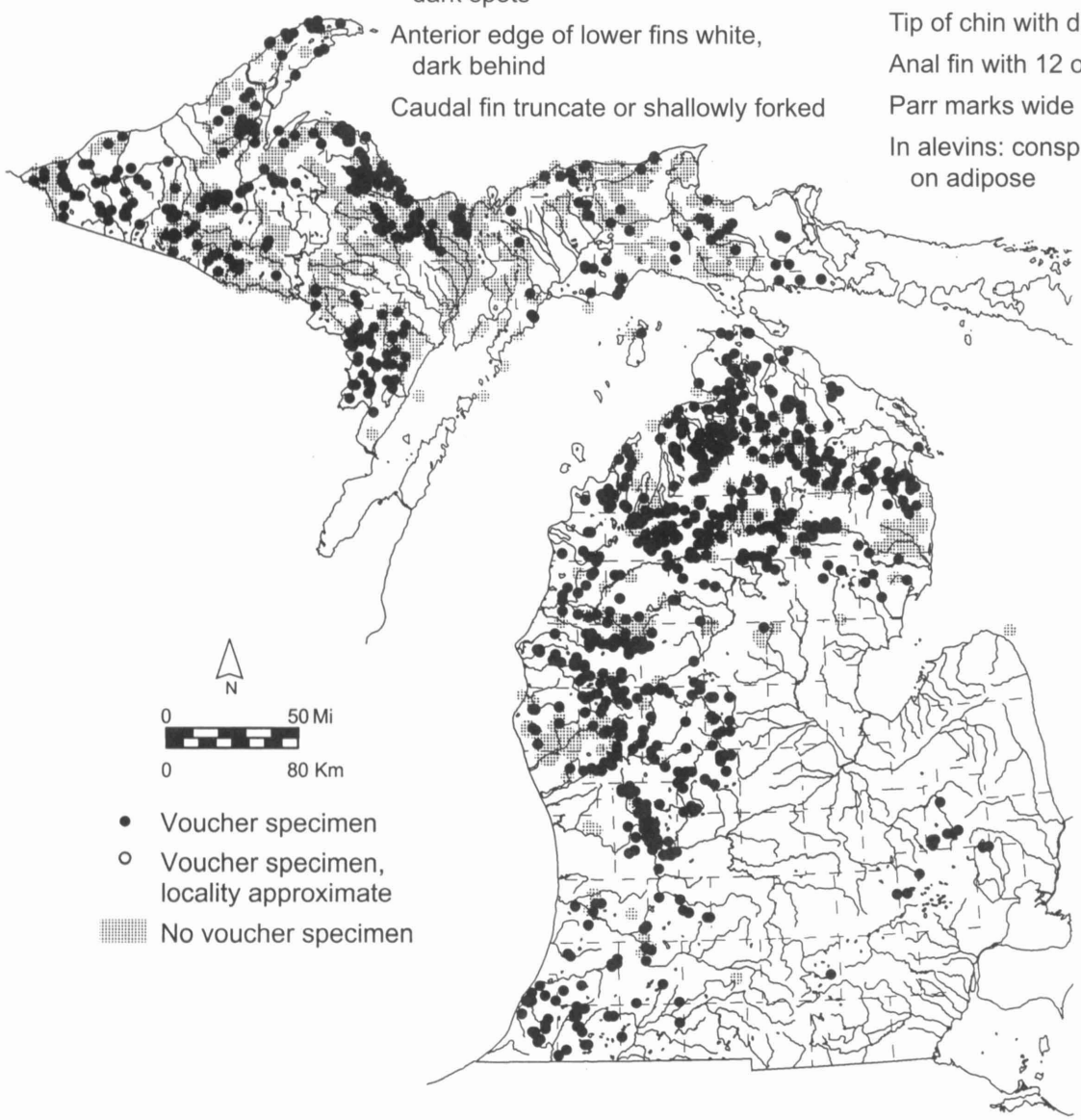
Caudal fin truncate or shallowly forked

Tip of chin with dark pigment border

Anal fin with 12 or fewer rays

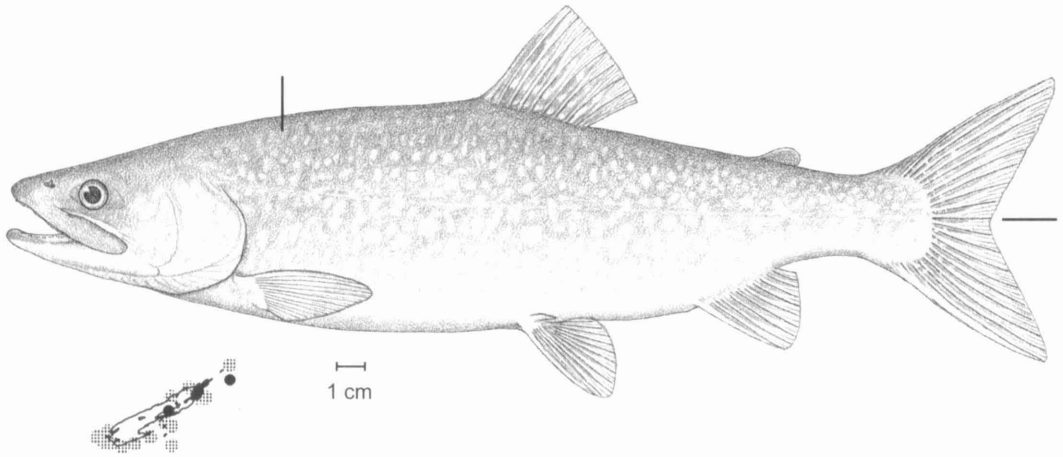
Parr marks wide

In alevins: conspicuous pigment on adipose



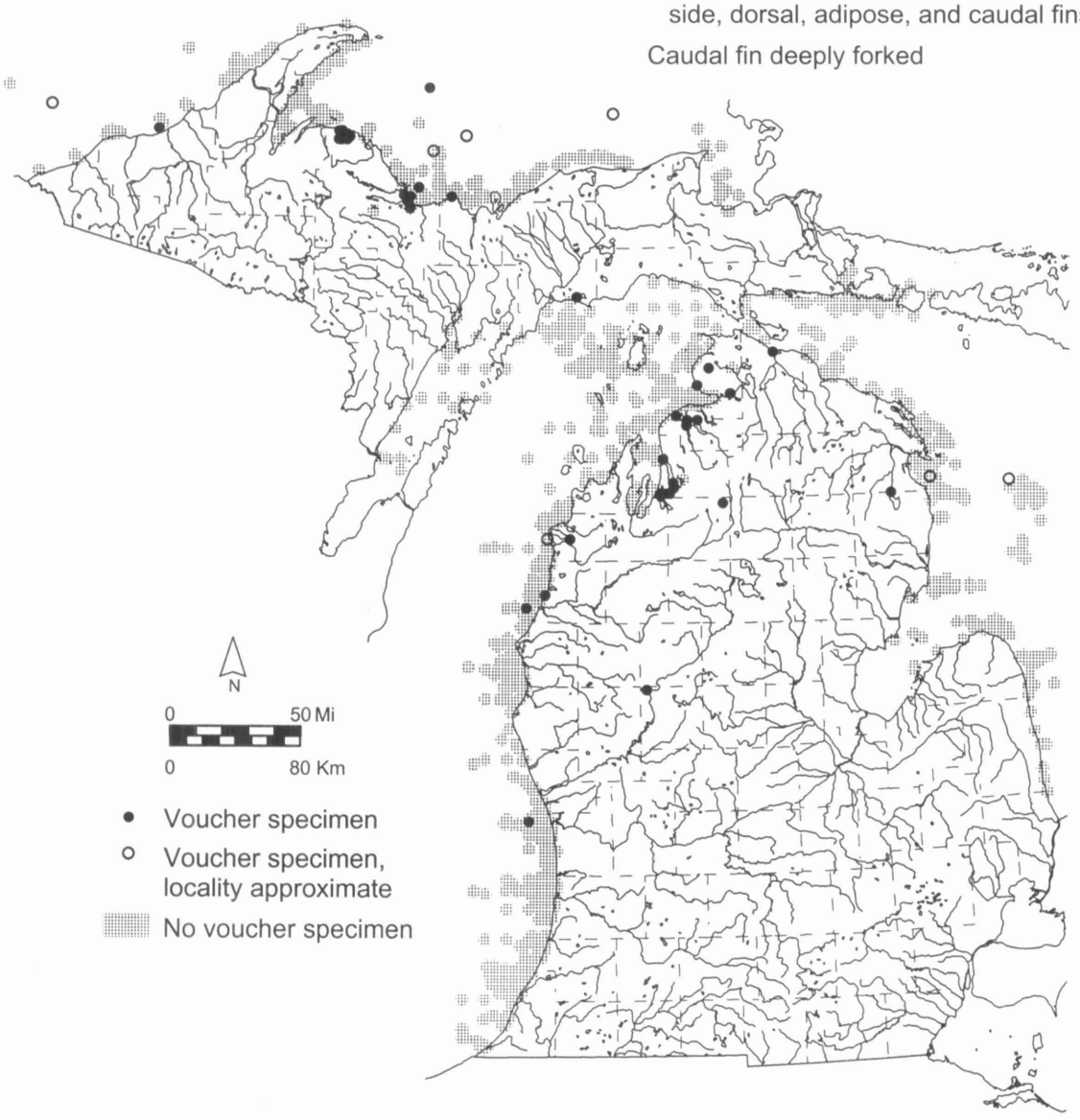
Lake Trout

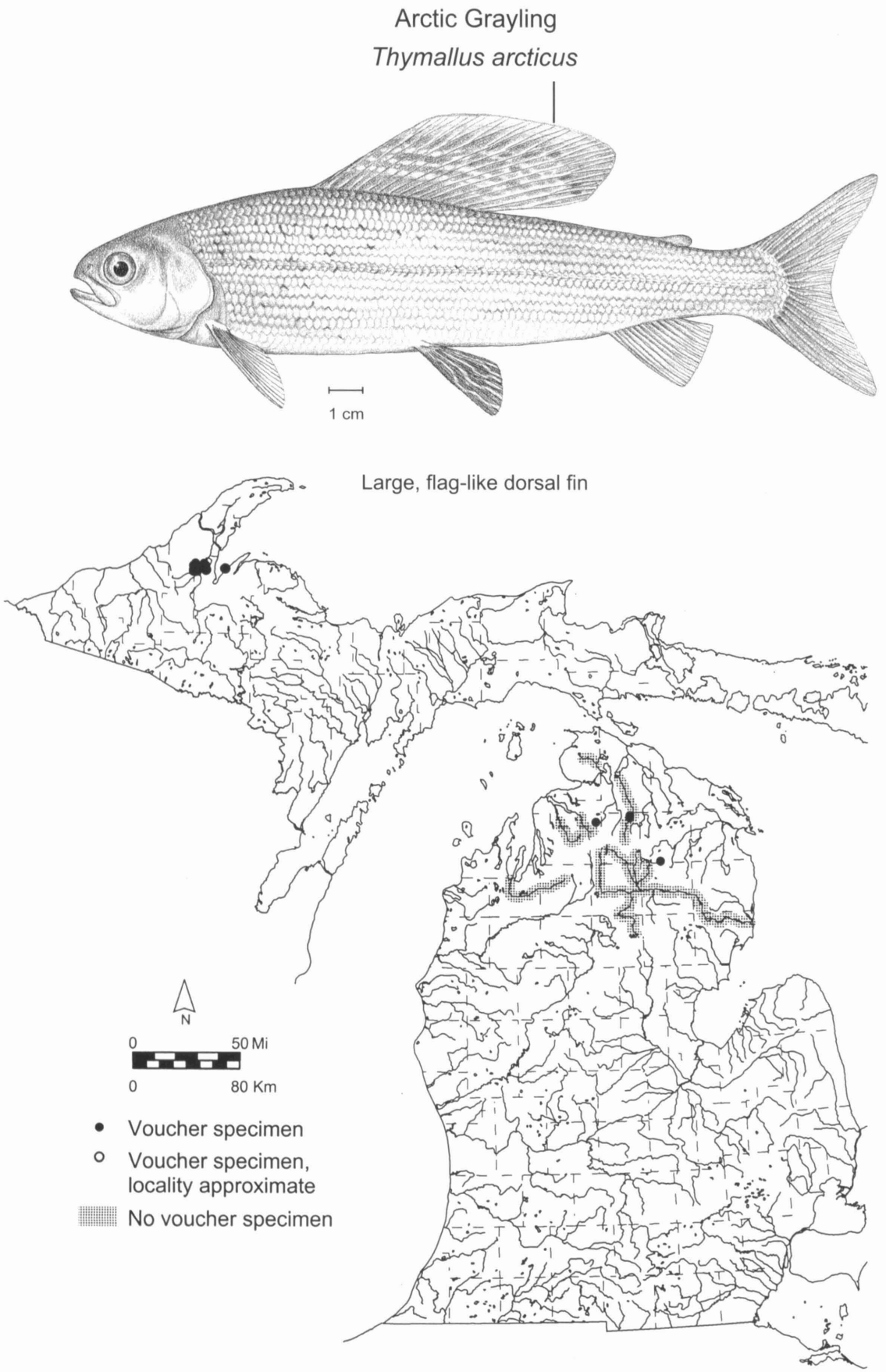
Salvelinus namaycush

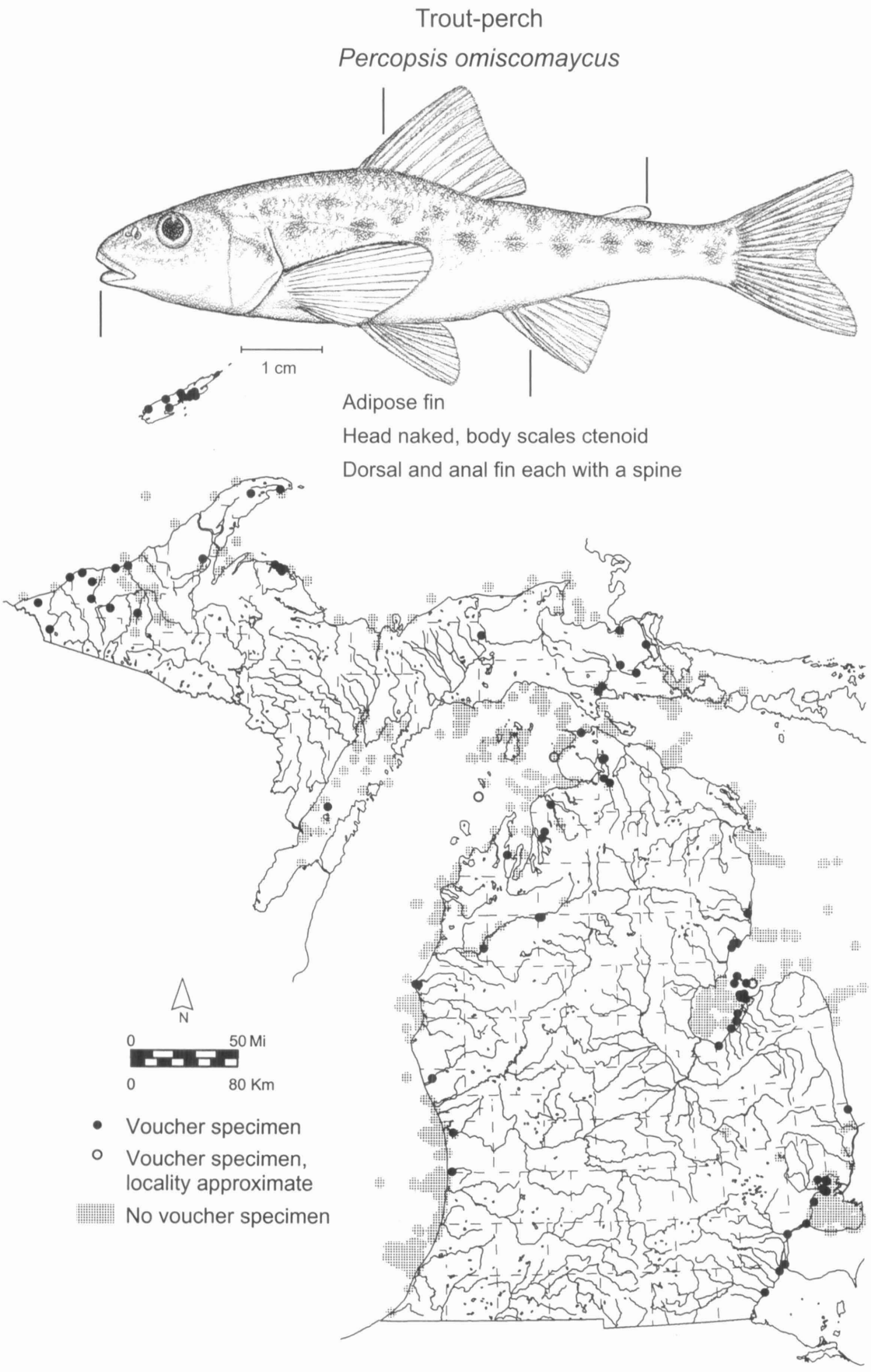


Olive-gray body with small light spots over back, side, dorsal, adipose, and caudal fins

Caudal fin deeply forked

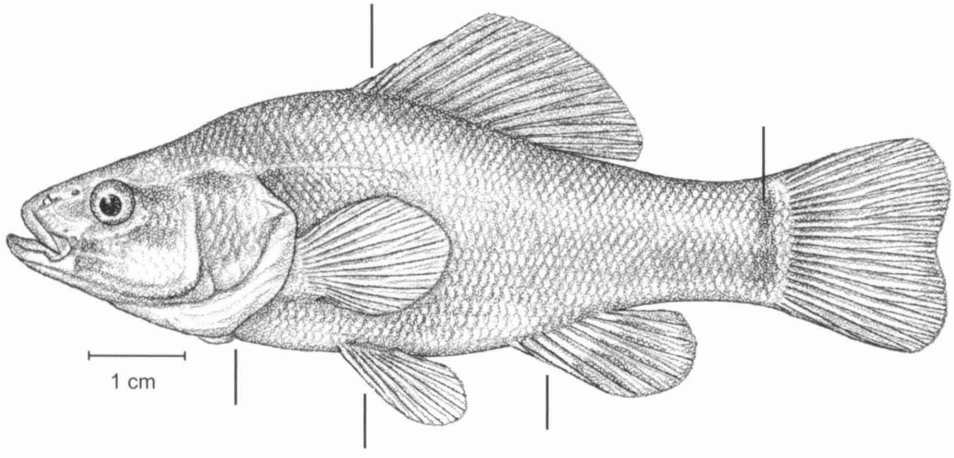



Arctic Grayling
Thymallus arcticus
1 cm
Large, flag-like dorsal fin
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

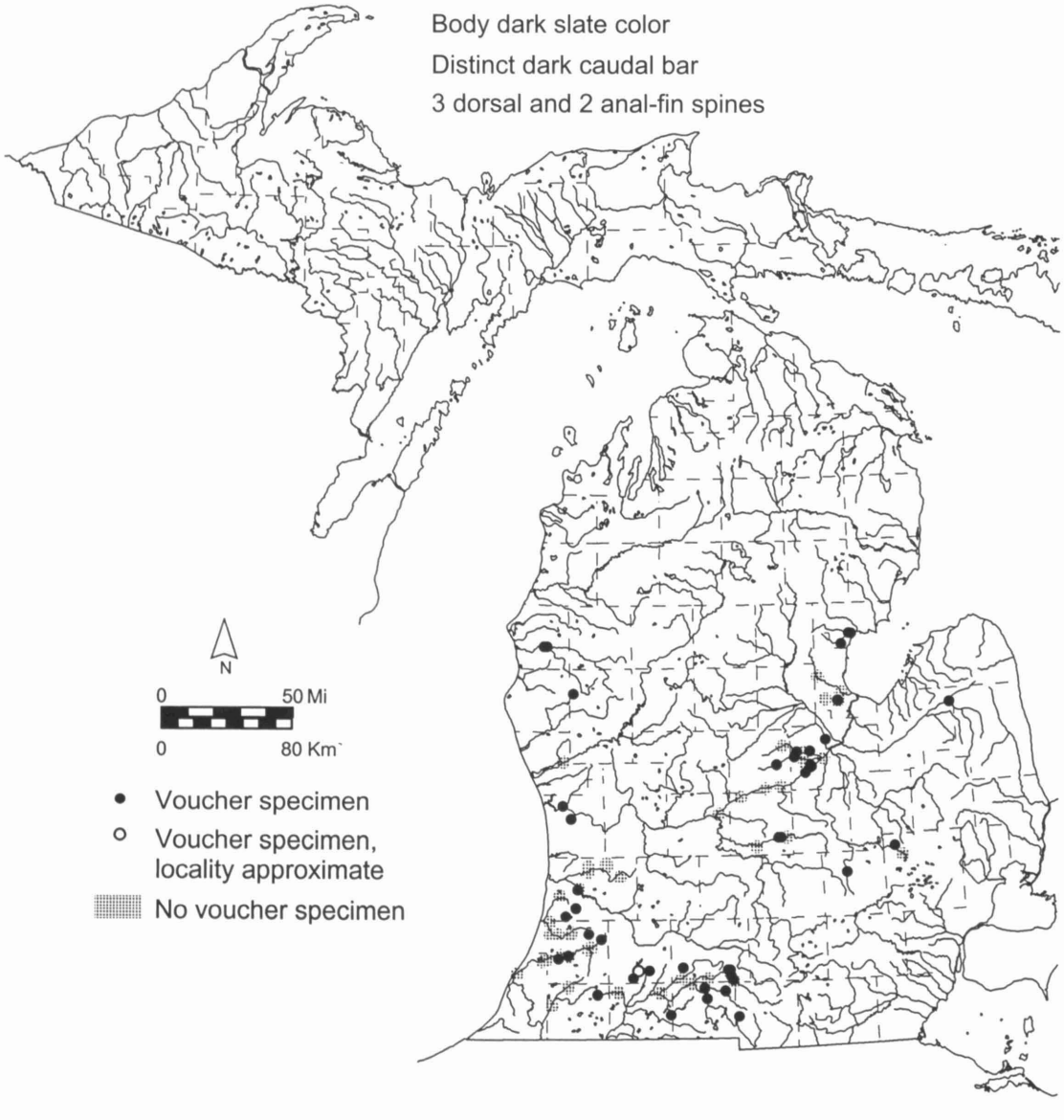

Trout-perch
Percopsis omiscomaycus
1 cm
Adipose fin
Head naked, body scales ctenoid
Dorsal and anal fin each with a spine
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

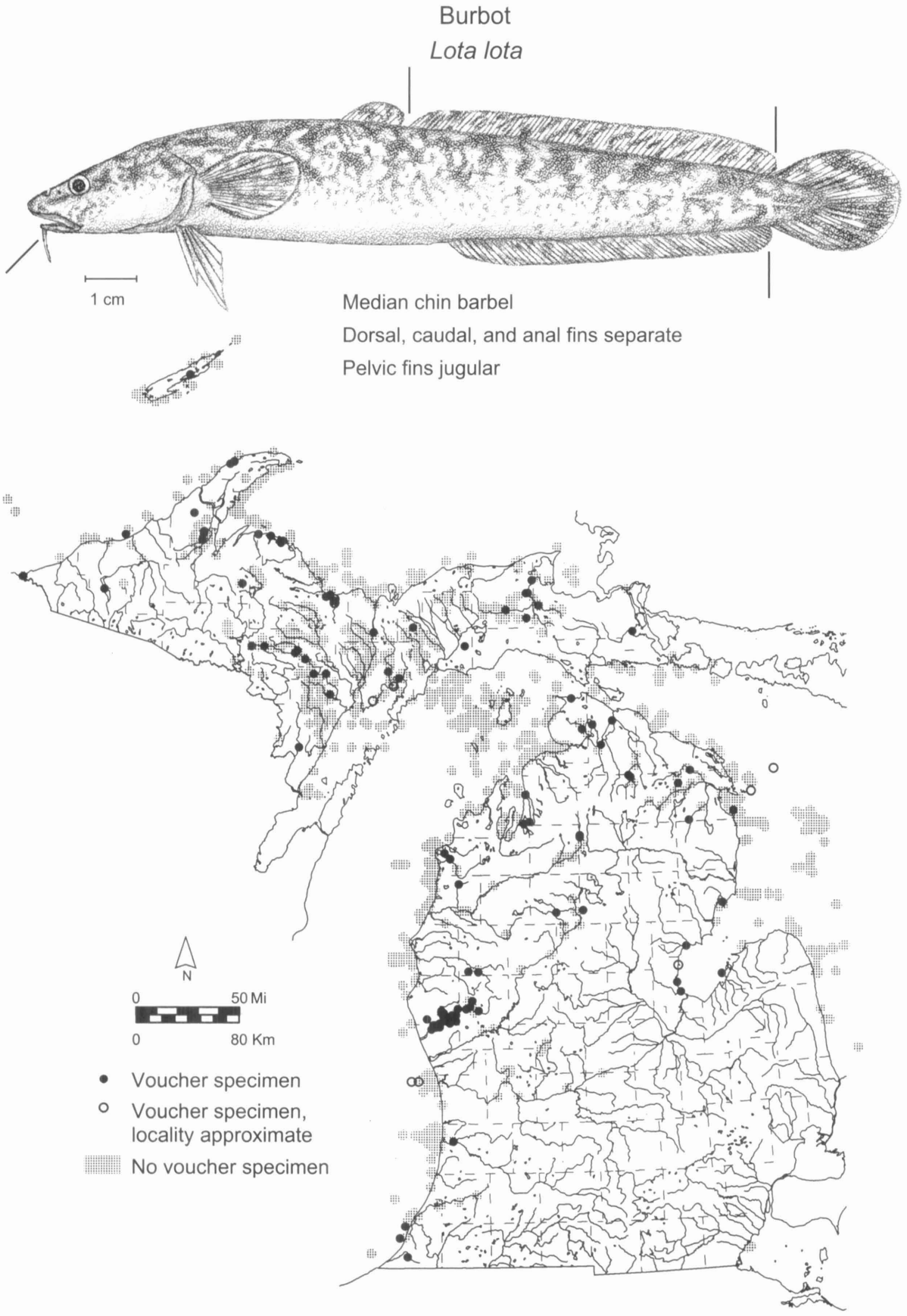
Pirate Perch

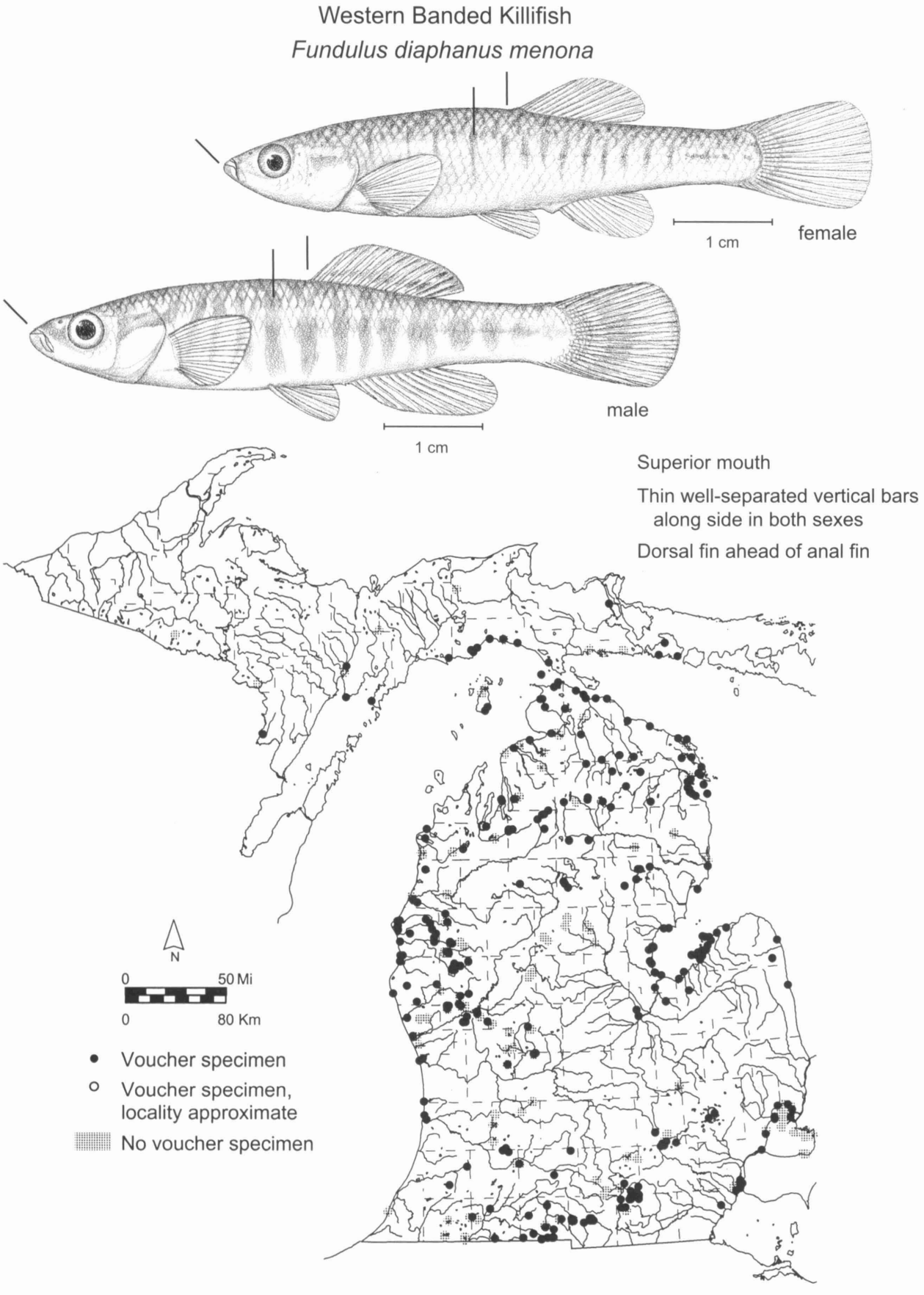
Aphredoderus sayanus



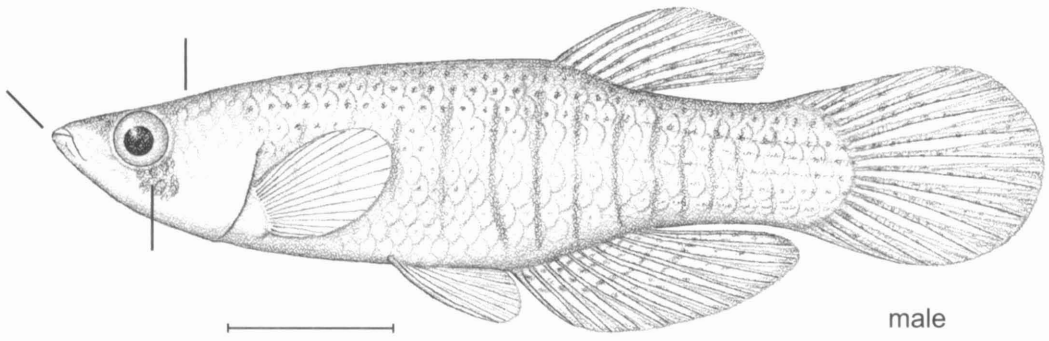
Anal opening anterior to pelvic fin (except in young)
Body dark slate color
Distinct dark caudal bar
3 dorsal and 2 anal-fin spines




Burbot
Lota lota
1 cm
Median chin barbel
Dorsal, caudal, and anal fins separate
Pelvic fins jugular
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen


Western Banded Killifish
Fundulus diaphanus menona
female
1 cm
male
1 cm
Superior mouth
Thin well-separated vertical bars along side in both sexes
Dorsal fin ahead of anal fin
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

Starhead Topminnow
Fundulus dispar



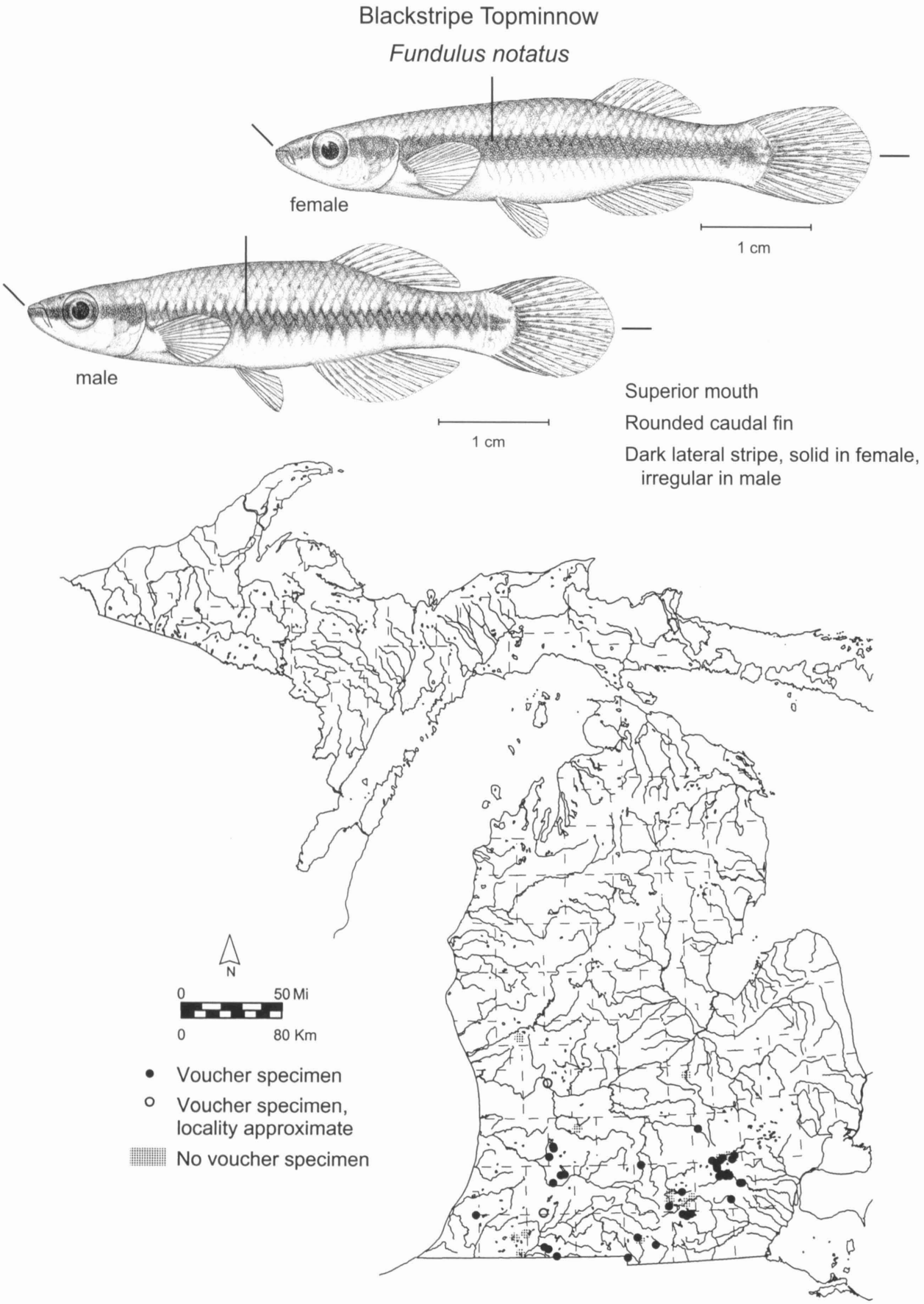
Superior mouth

Rounded caudal fin

Prominent blue-black blotch beneath eye

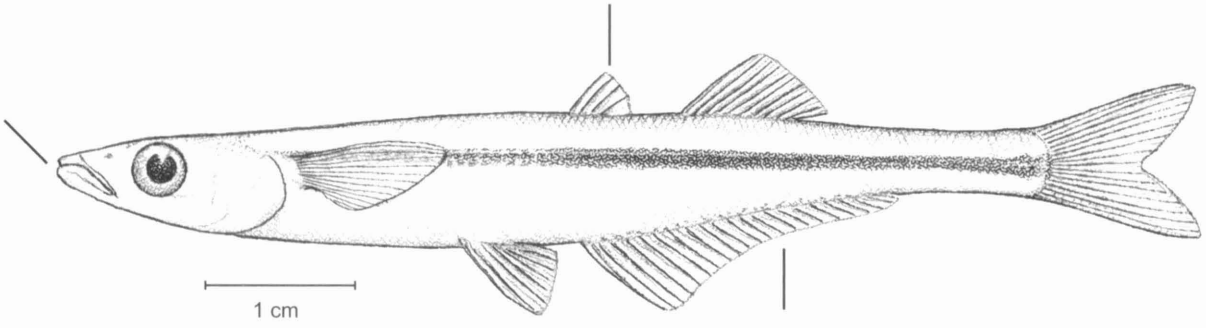
Vertical bars on side of male, longitudinal stripes on female

Gold spots on top of head in life


Blackstripe Topminnow
Fundulus notatus
female
1 cm
male
1 cm
Superior mouth
Rounded caudal fin
Dark lateral stripe, solid in female, irregular in male
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

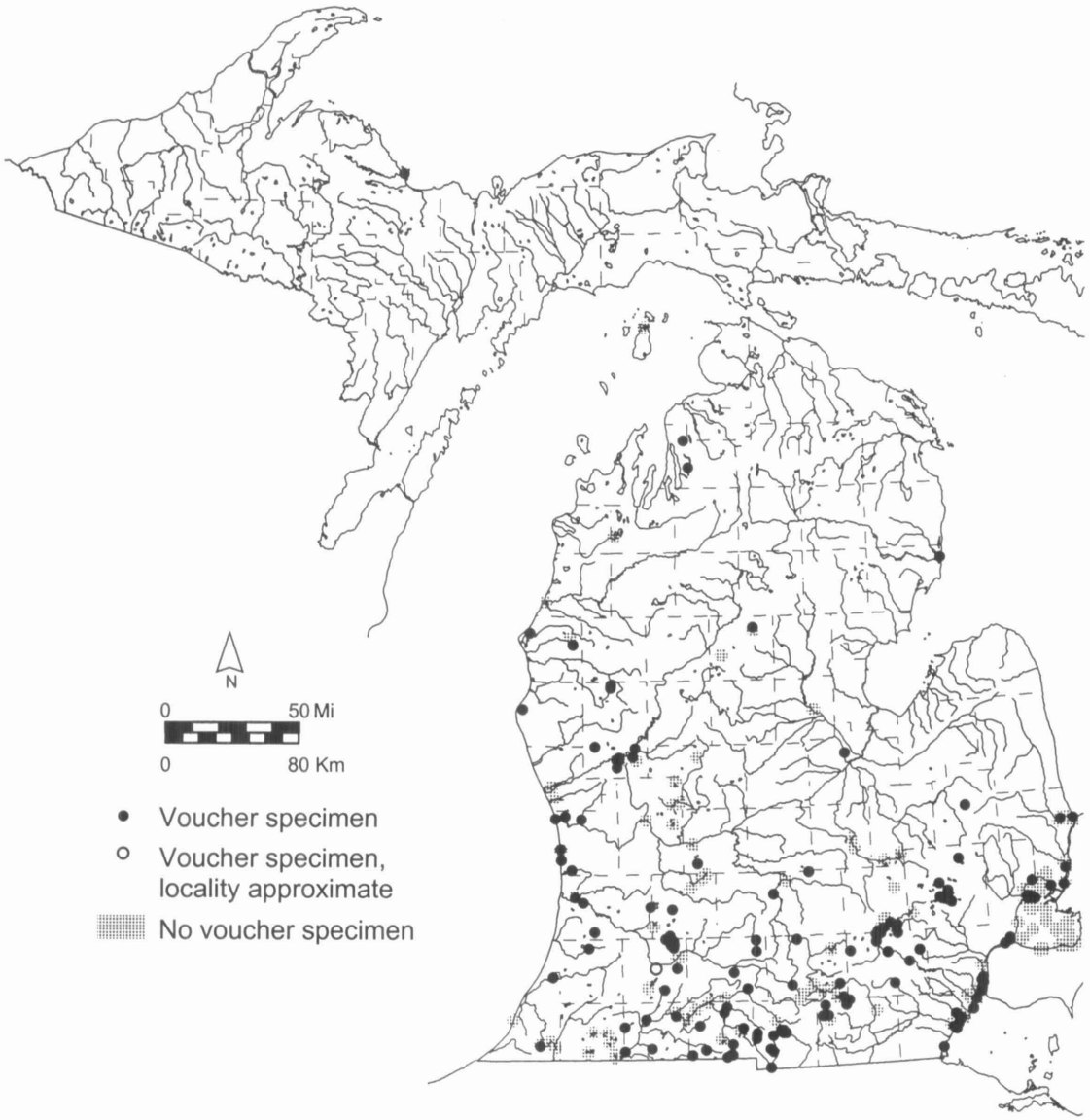
Brook Silverside

Labidesthes sicculus



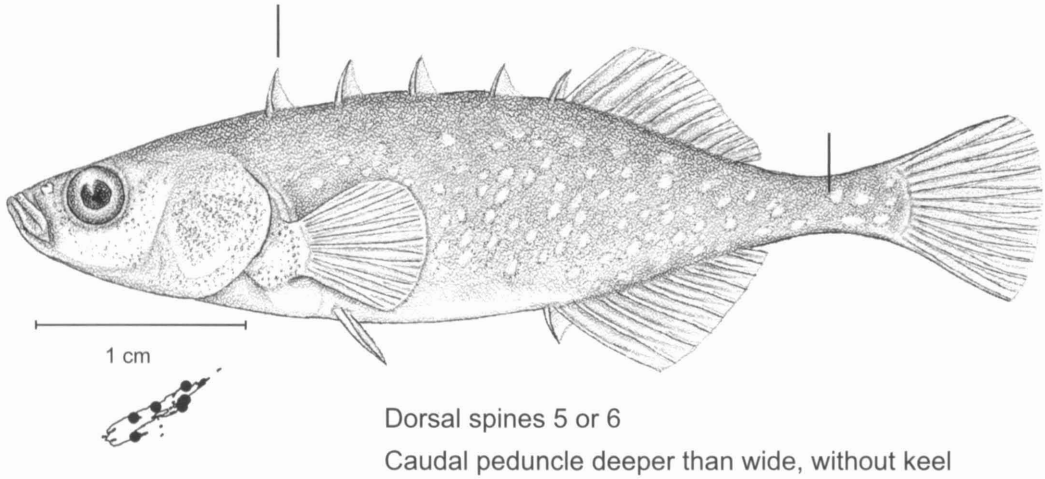
Mouth formed into a short beak

Small spinous dorsal fin, long anal fin



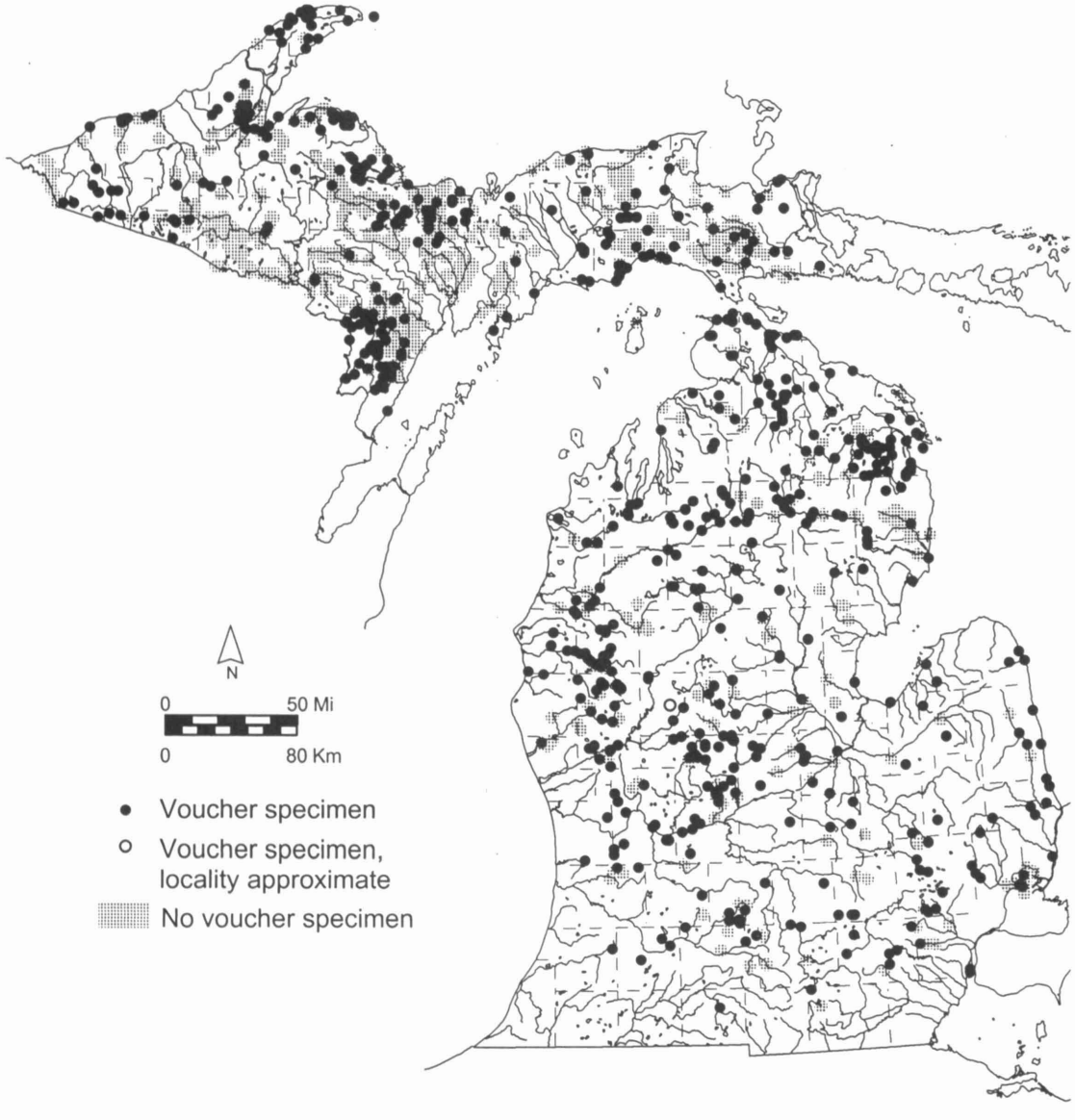
Brook Stickleback

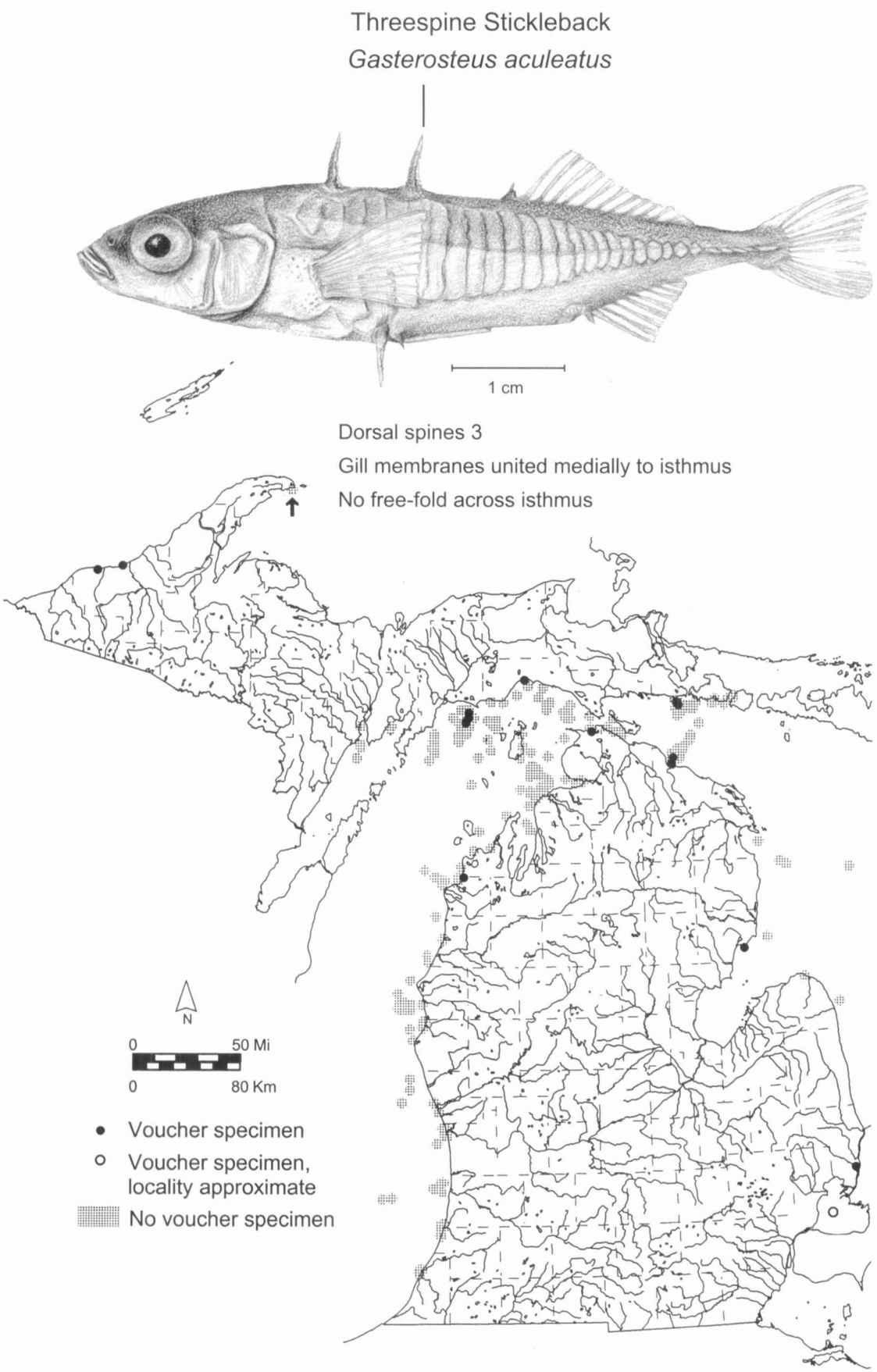
Culaea inconstans



Dorsal spines 5 or 6

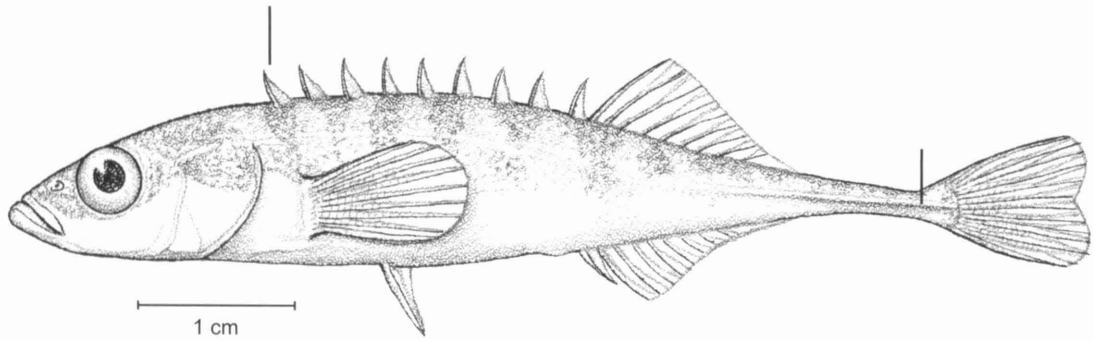
Caudal peduncle deeper than wide, without keel




Threespine Stickleback
Gasterosteus aculeatus
1 cm
Dorsal spines 3
Gill membranes united medially to isthmus
No free-fold across isthmus
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

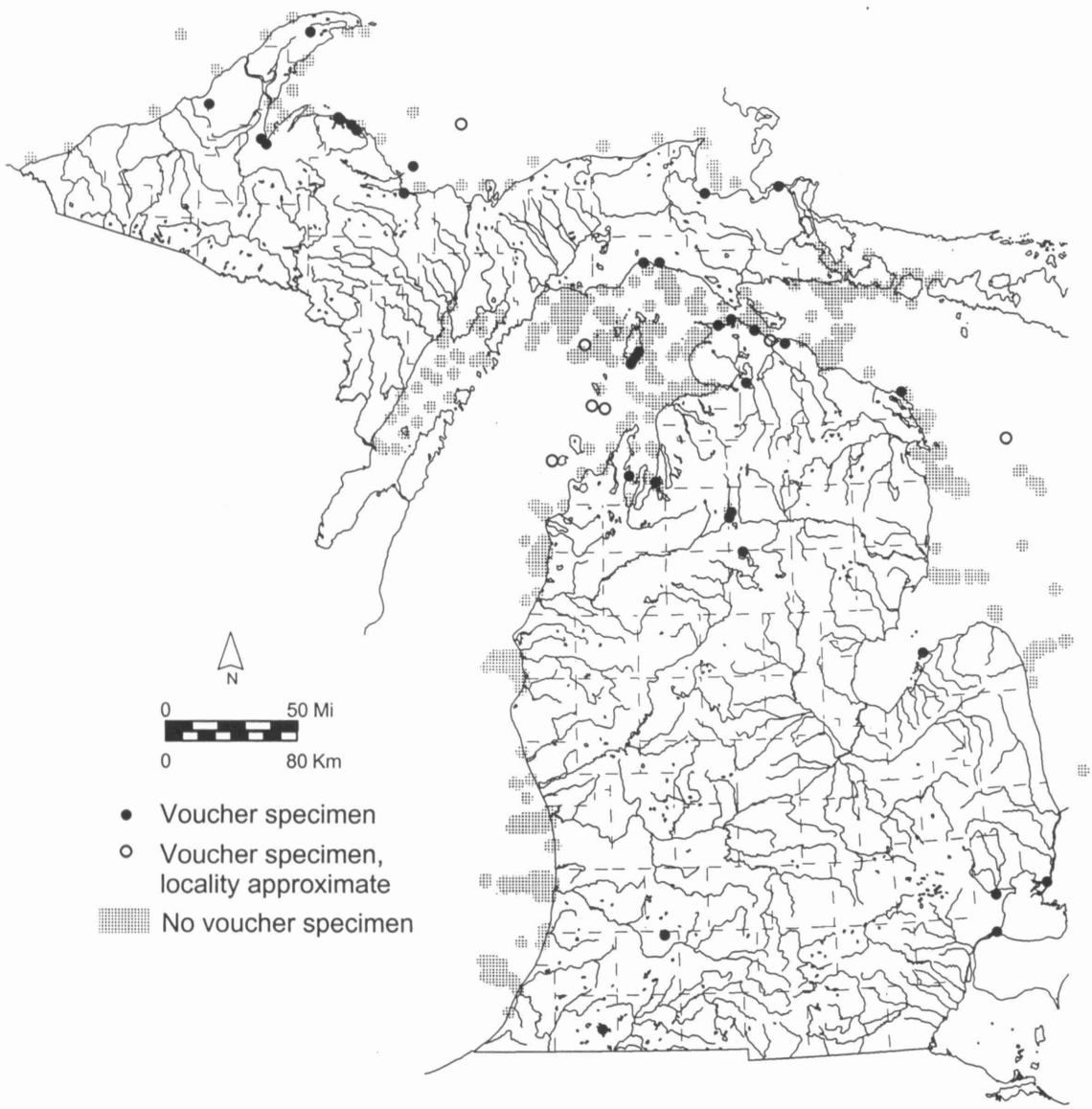
Ninespine Stickleback

Pungitius pungitius



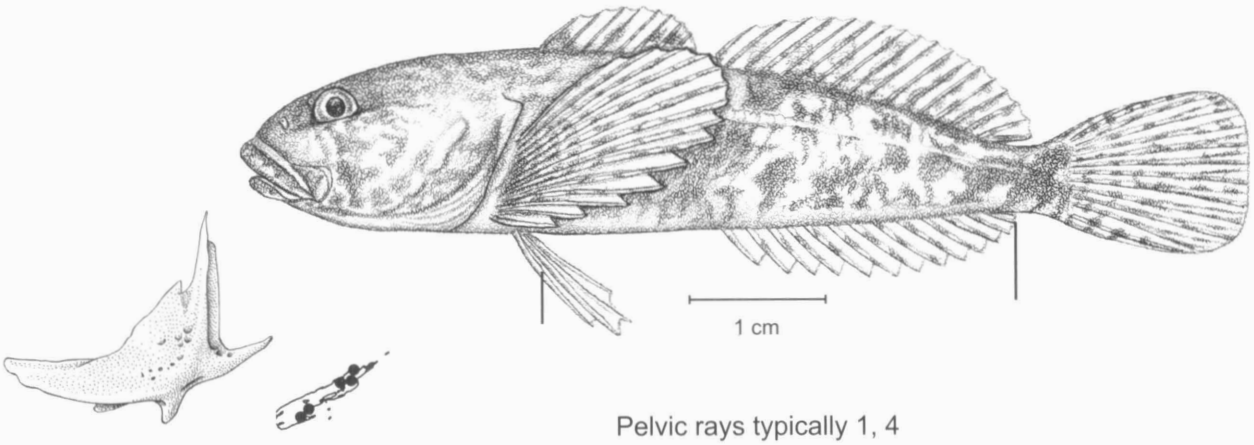
Dorsal spines 8 to 11

Caudal peduncle much wider than deep, with sharp lateral keel



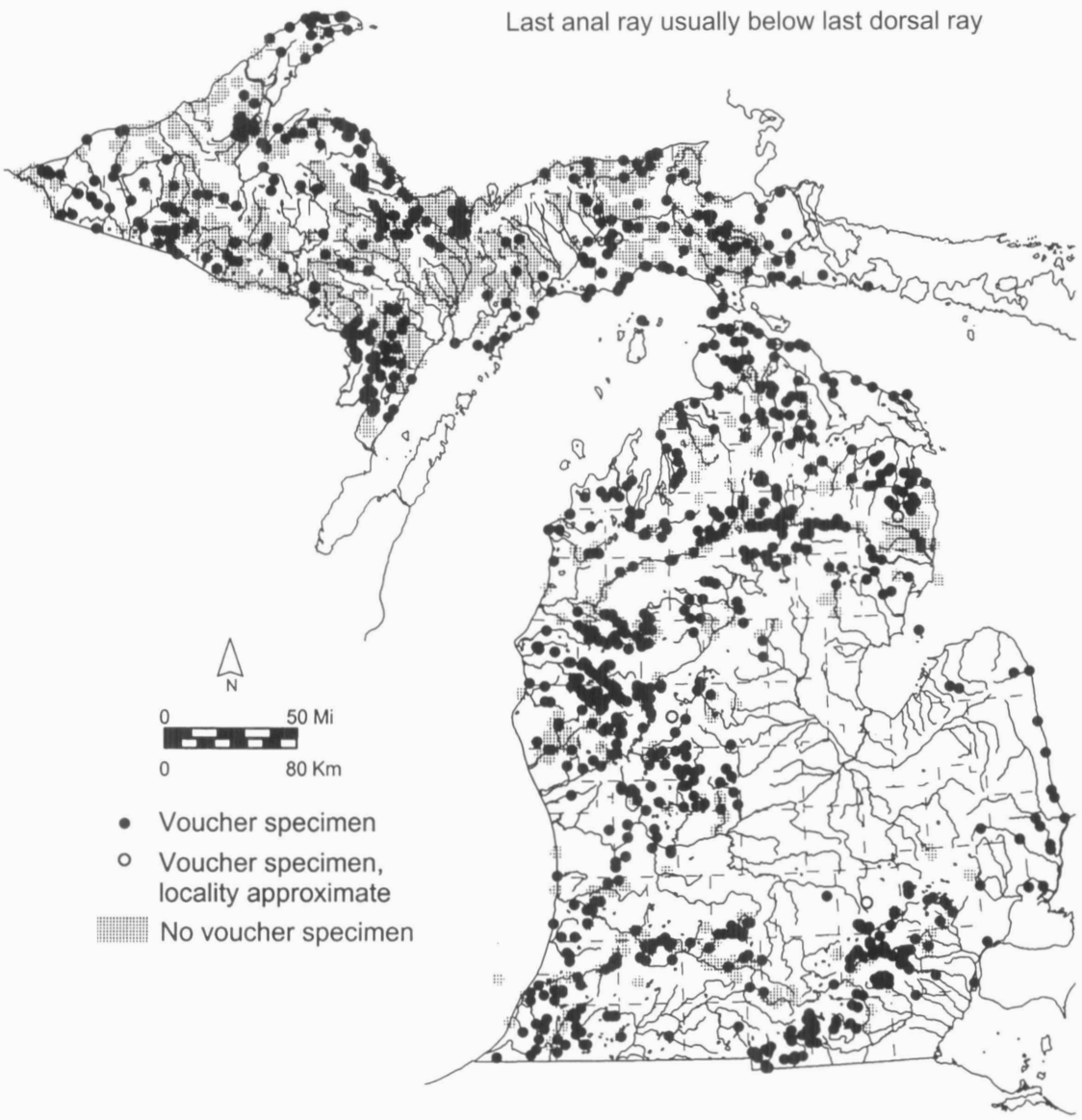
Mottled Sculpin

Cottus bairdii



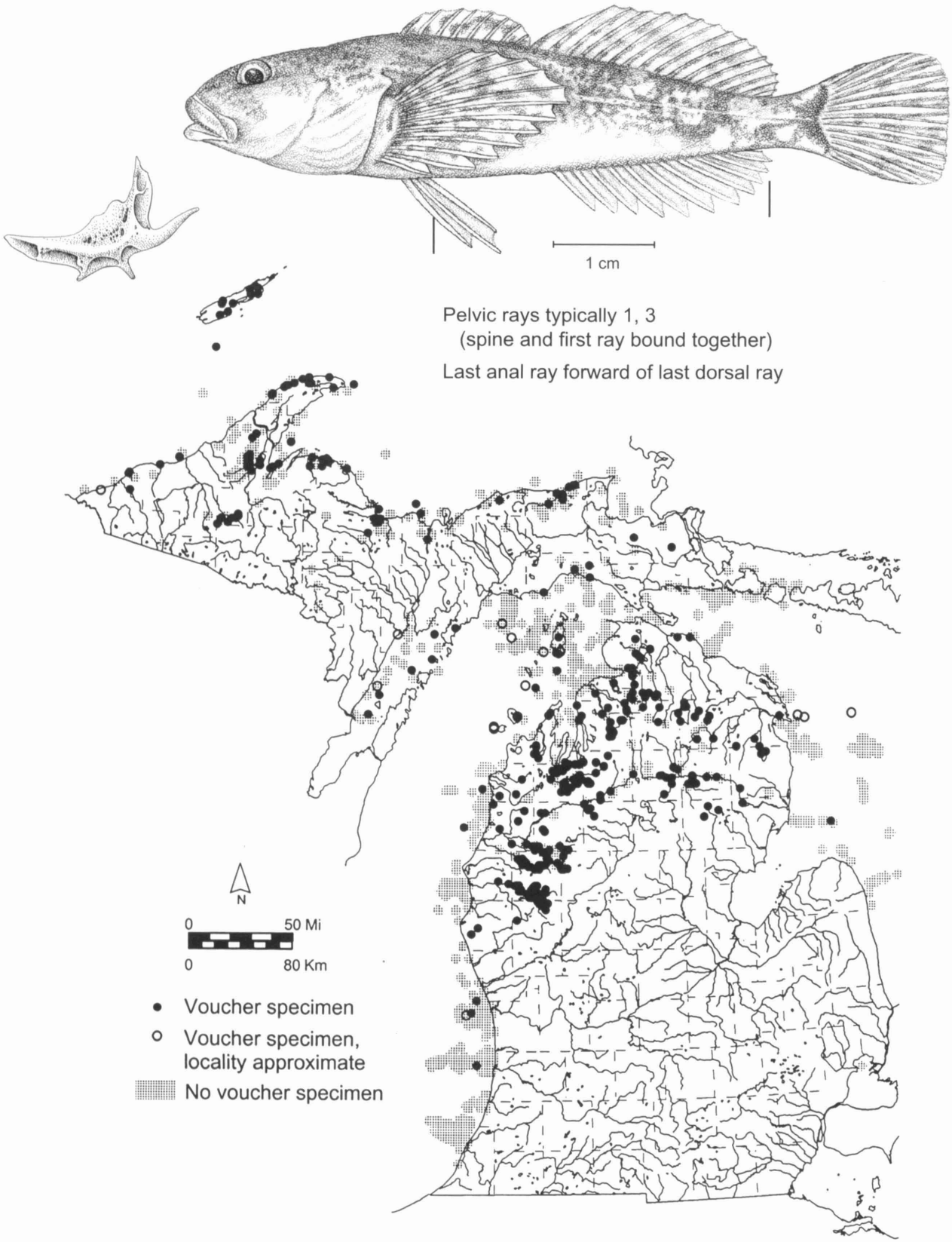
Pelvic rays typically 1, 4
(spine and first ray bound together)

Last anal ray usually below last dorsal ray



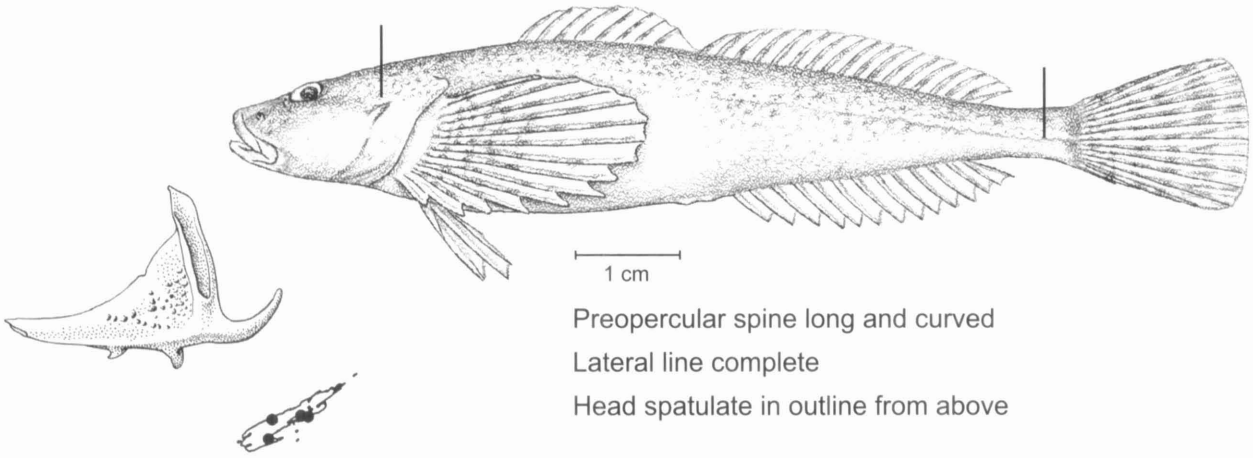
Slimy Sculpin

Cottus cognatus



Spoonhead Sculpin

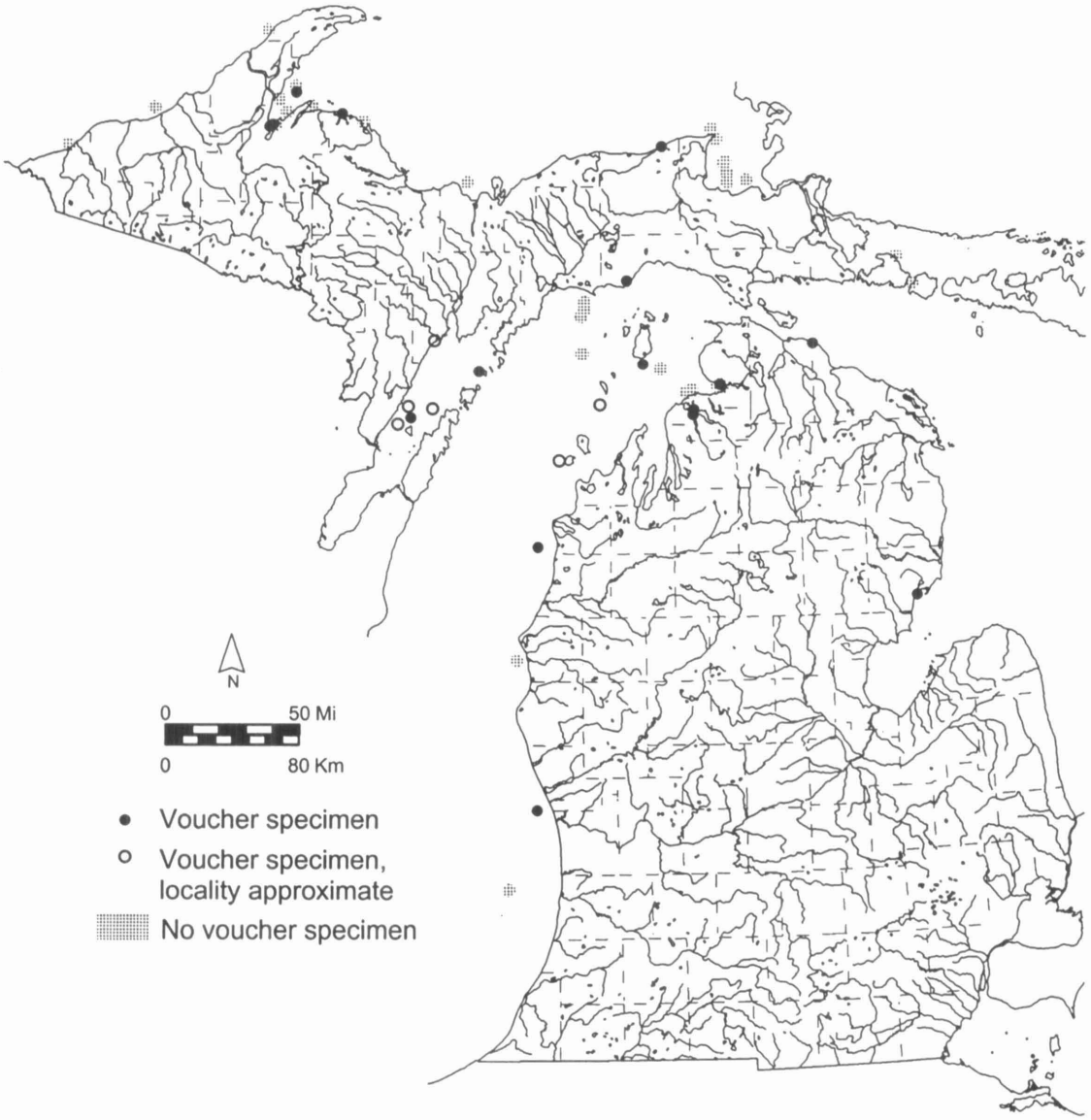
Cottus ricei



Preopercular spine long and curved

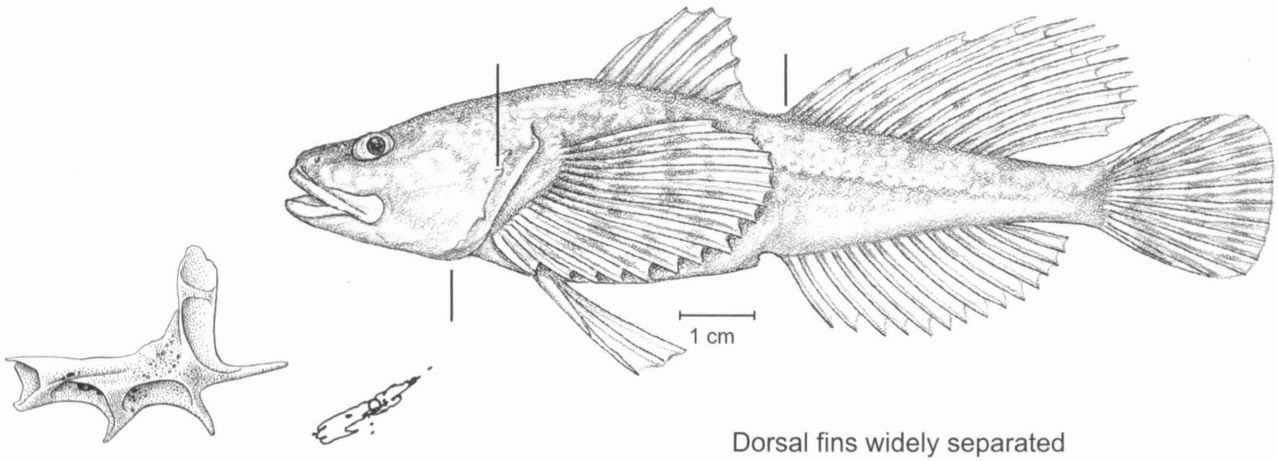
Lateral line complete

Head spatulate in outline from above

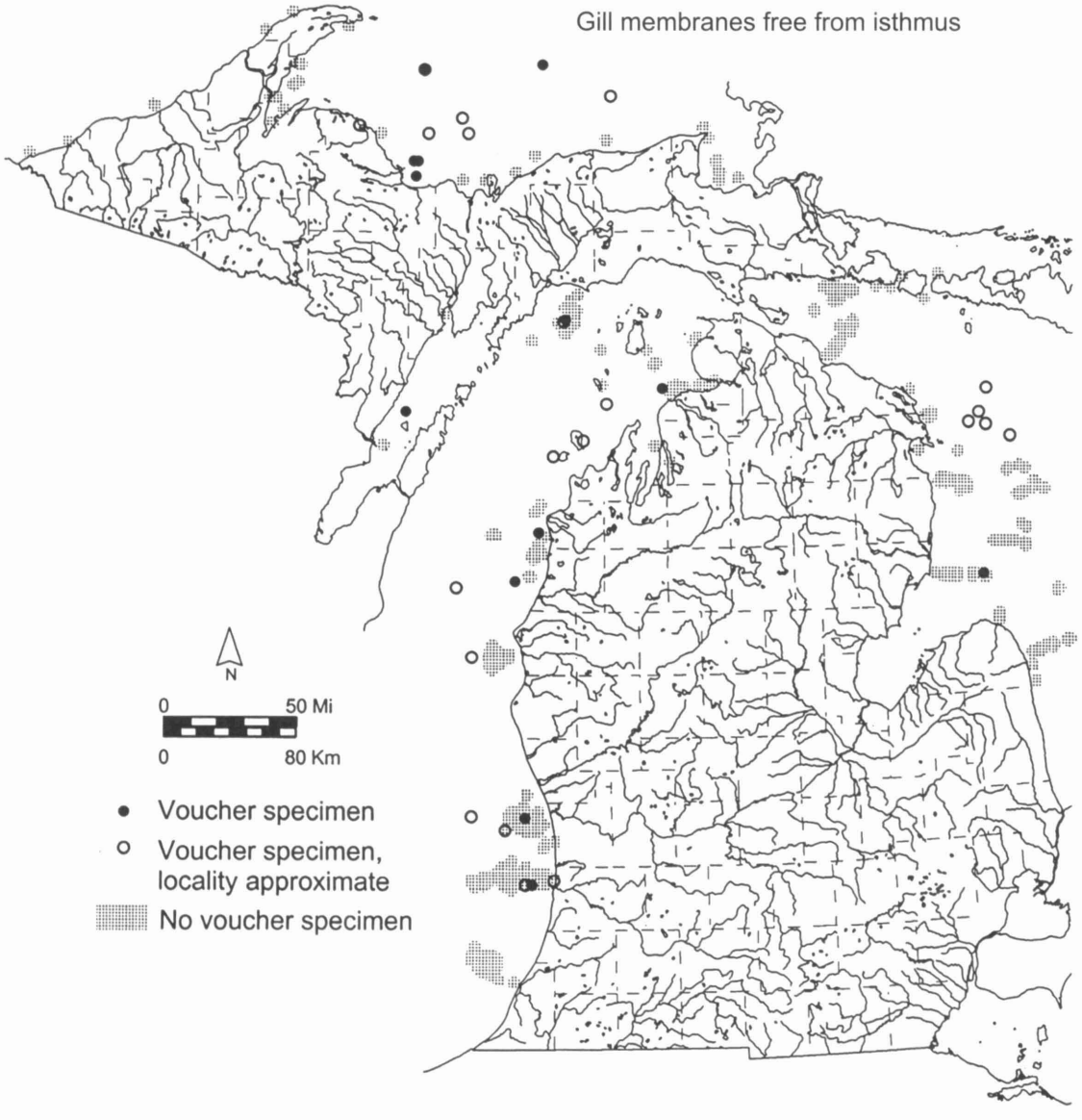


Deepwater Sculpin

Myoxocephalus thompsonii

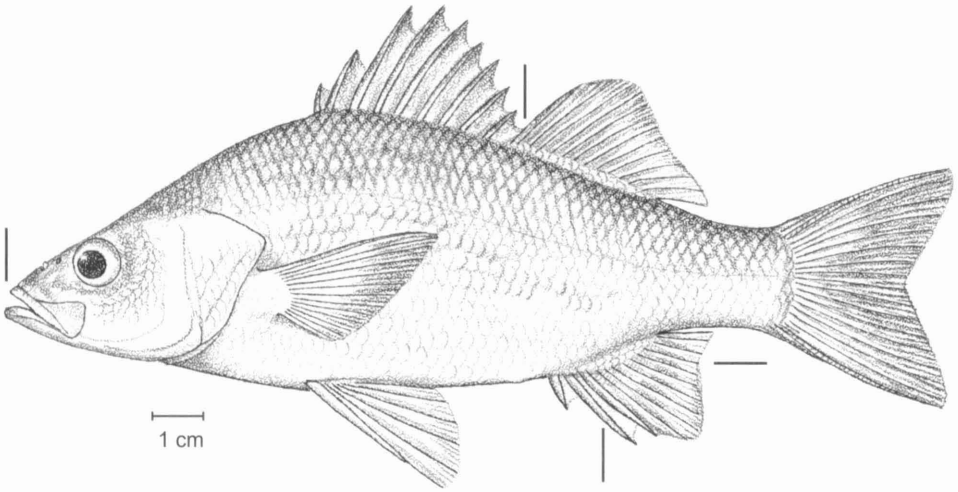


Dorsal fins widely separated
Second preopercular spine conspicuous
Gill membranes free from isthmus



White Perch

Morone americana



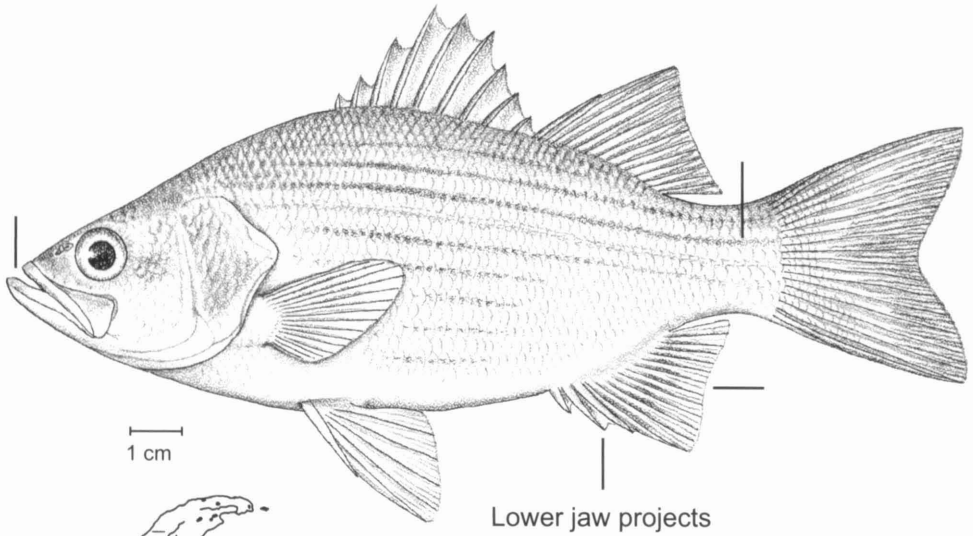
Jaws almost equal

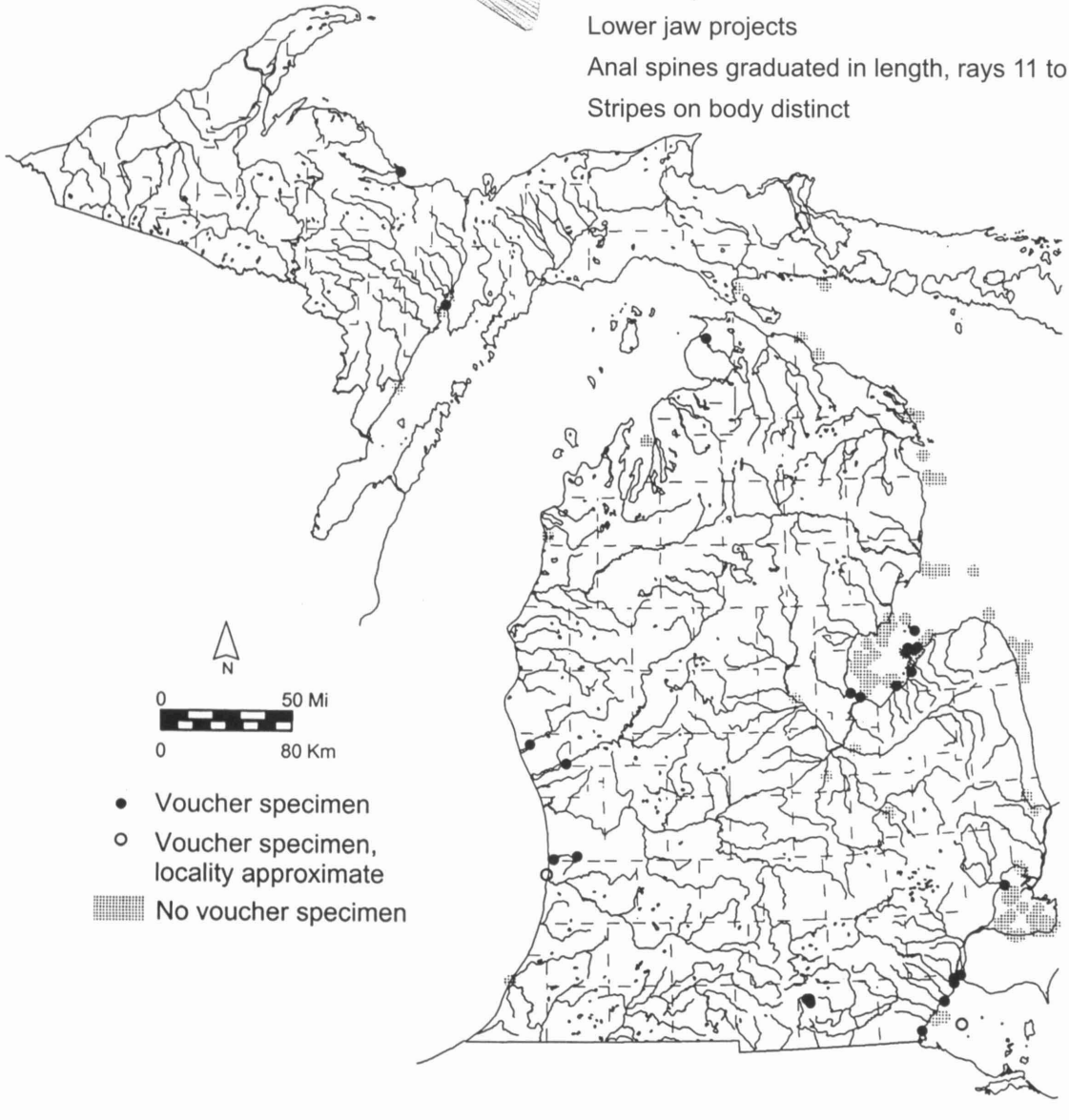
Second anal spine subequal in length, thicker than third, rays 8 to 10

Dorsal fins conjoined

White Bass

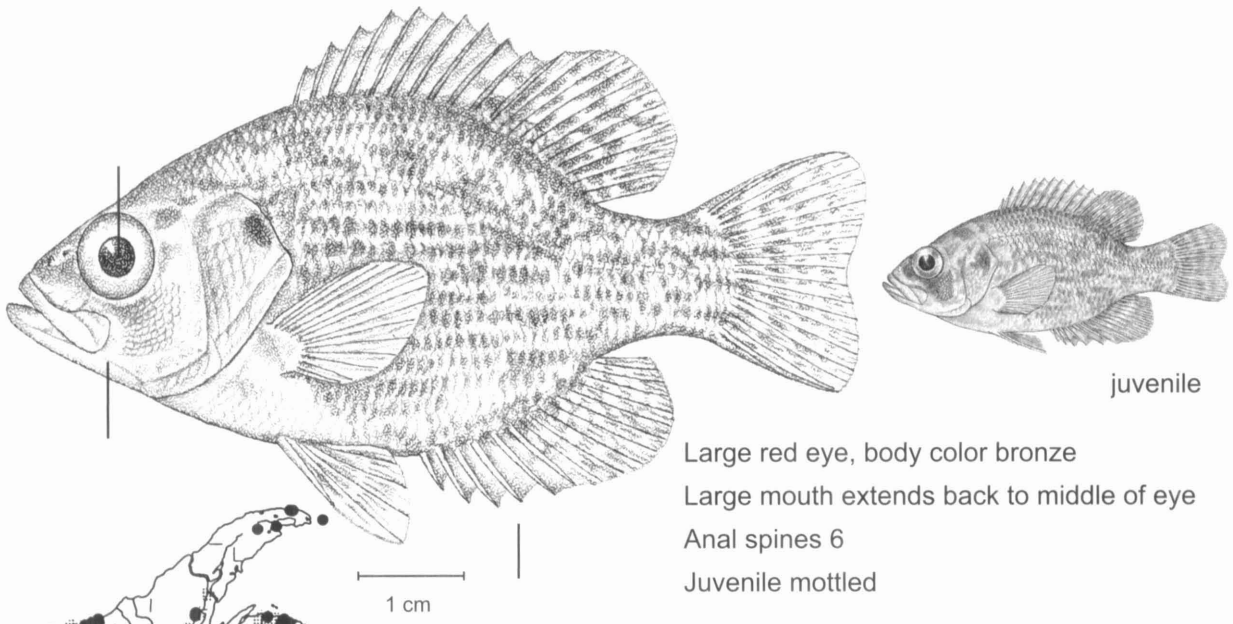
Morone chrysops

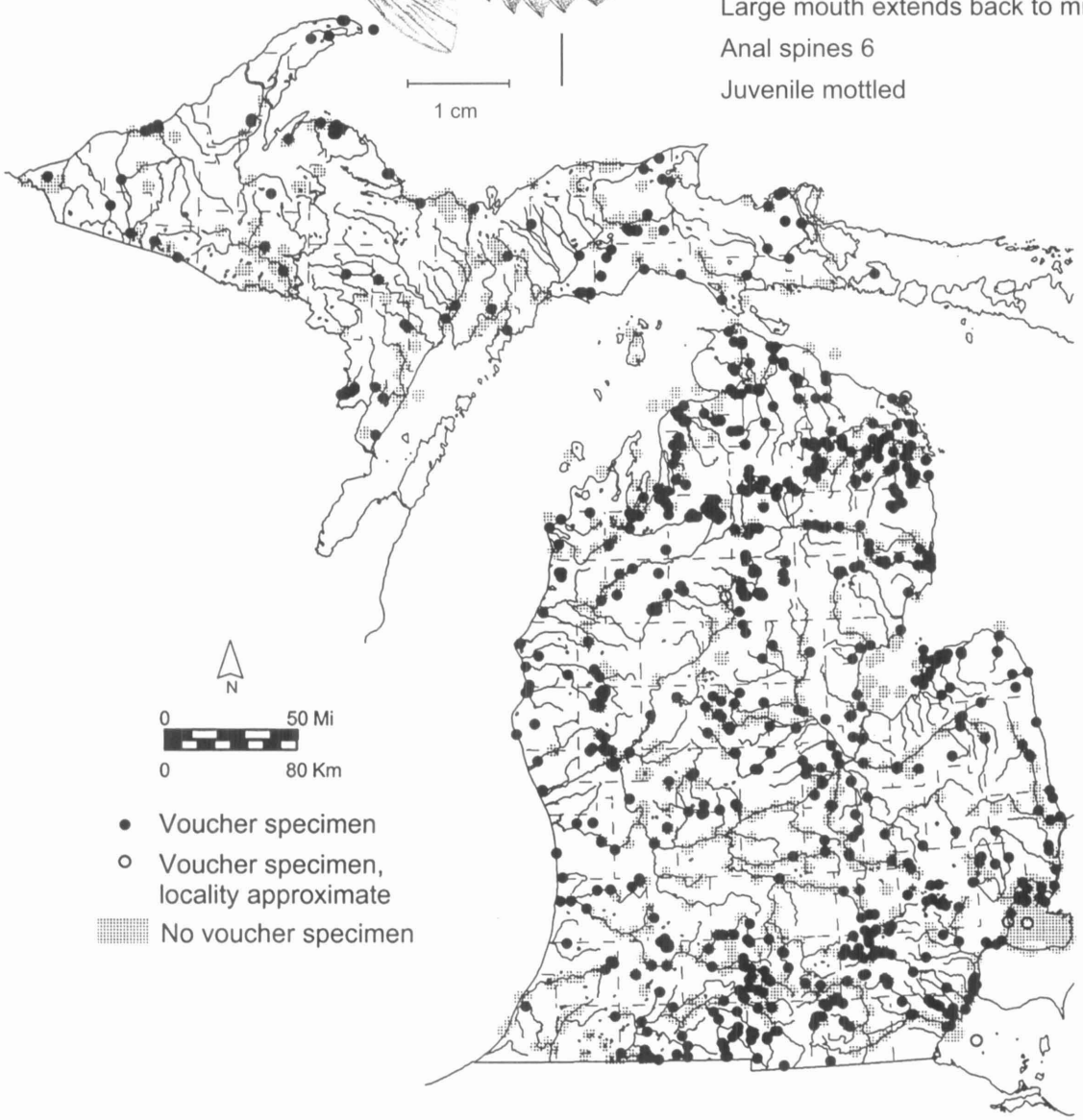




Rock Bass

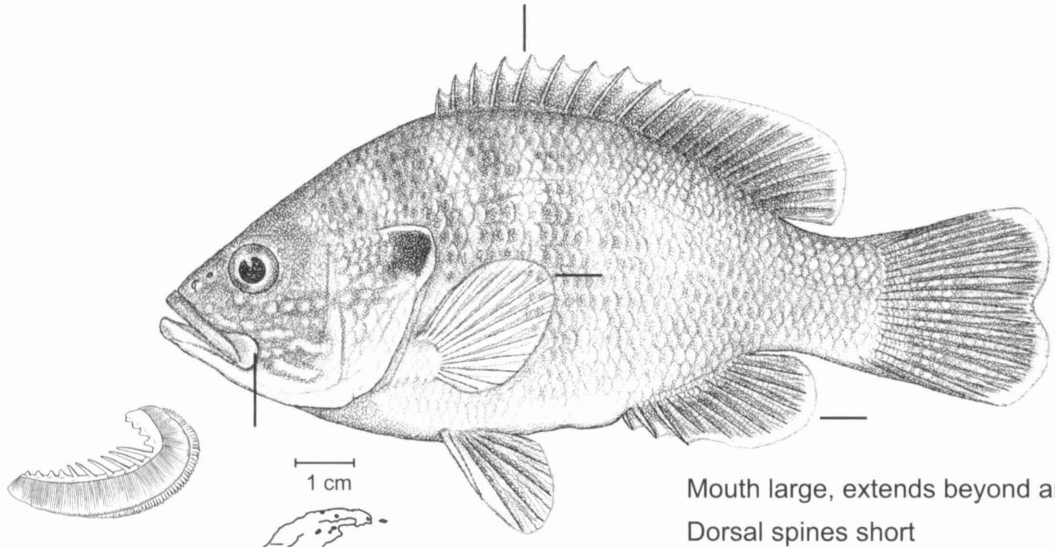
Ambloplites rupestris





Green Sunfish

Lepomis cyanellus

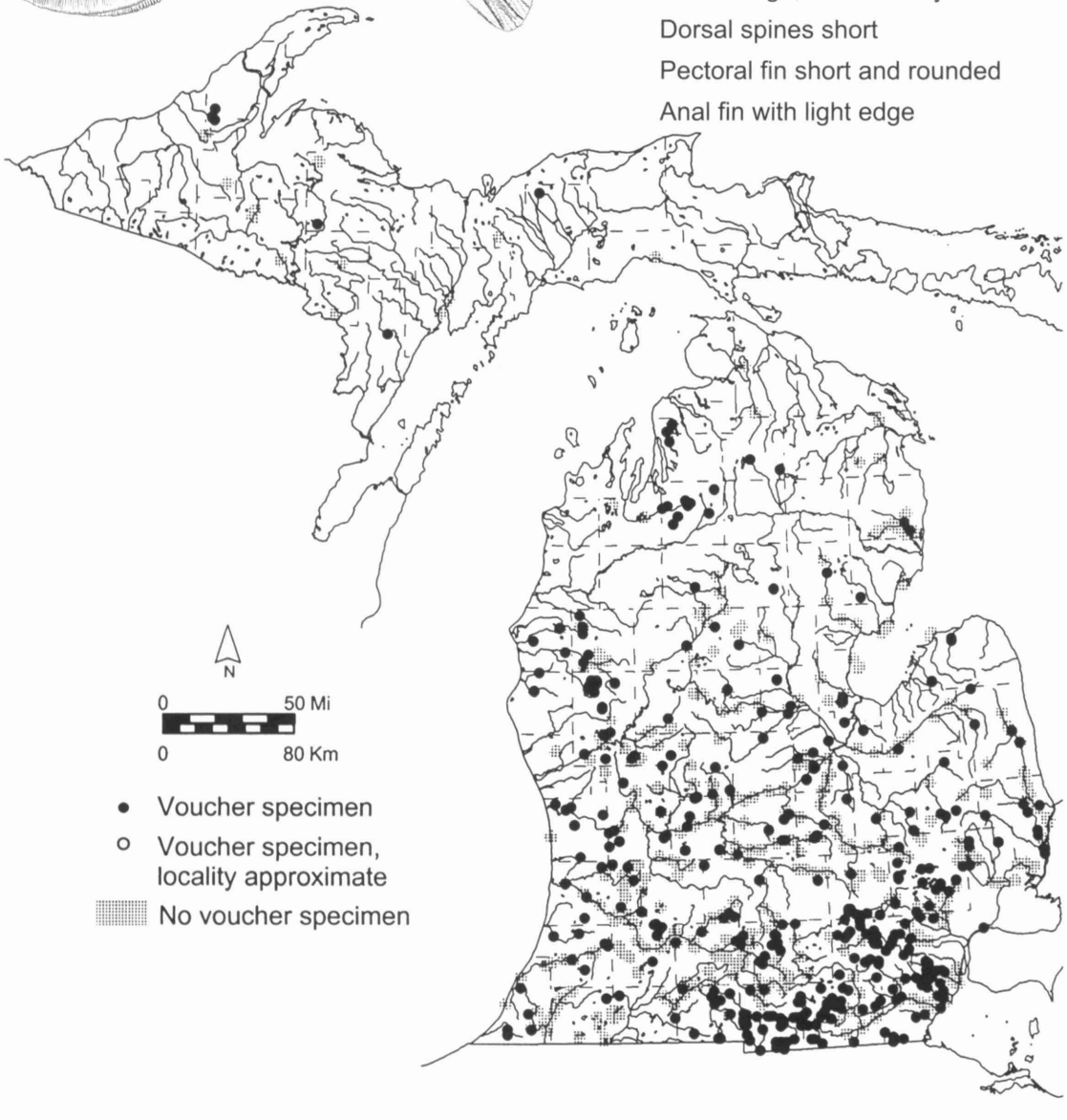


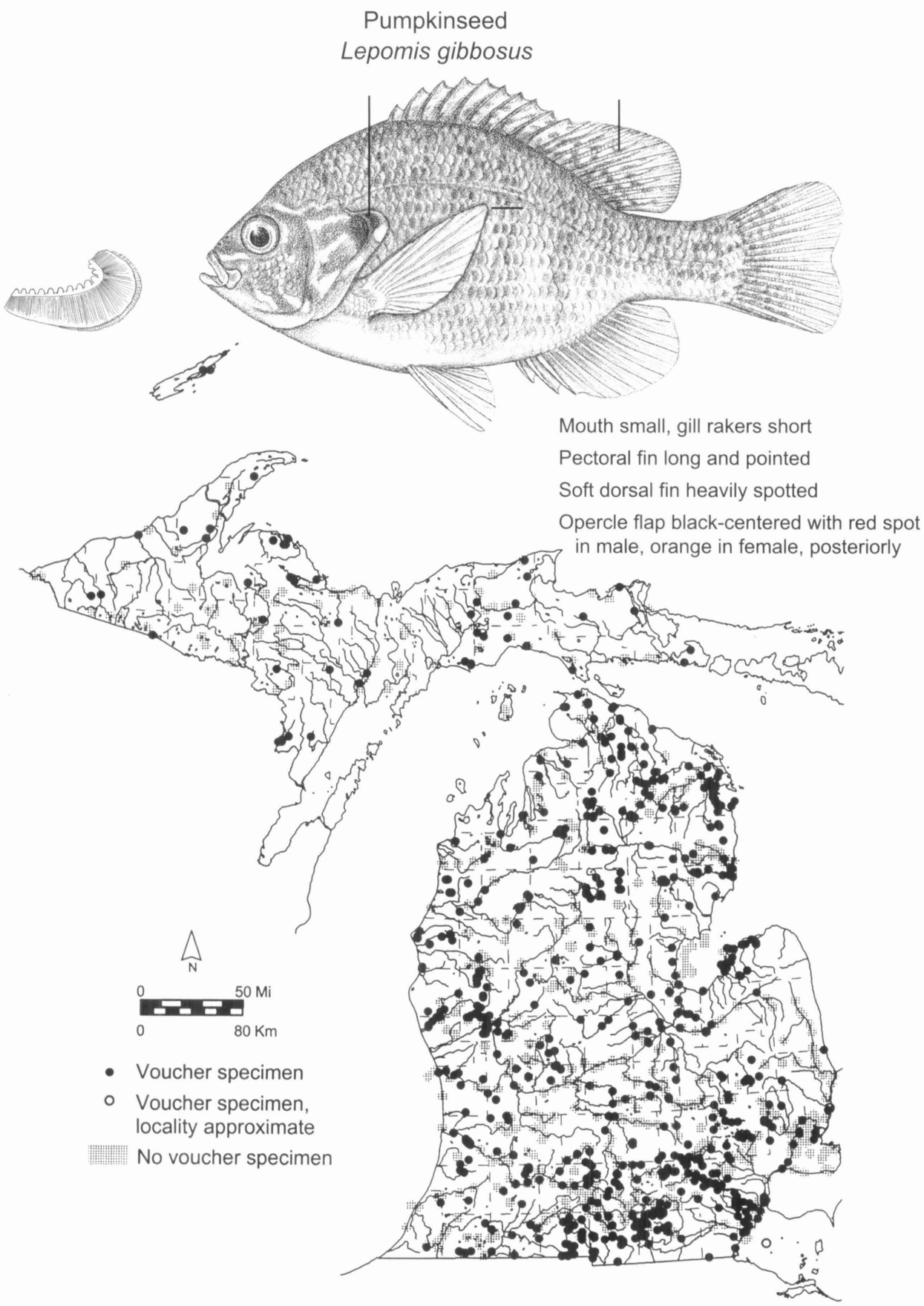
Mouth large, extends beyond anterior edge of eye

Dorsal spines short

Pectoral fin short and rounded

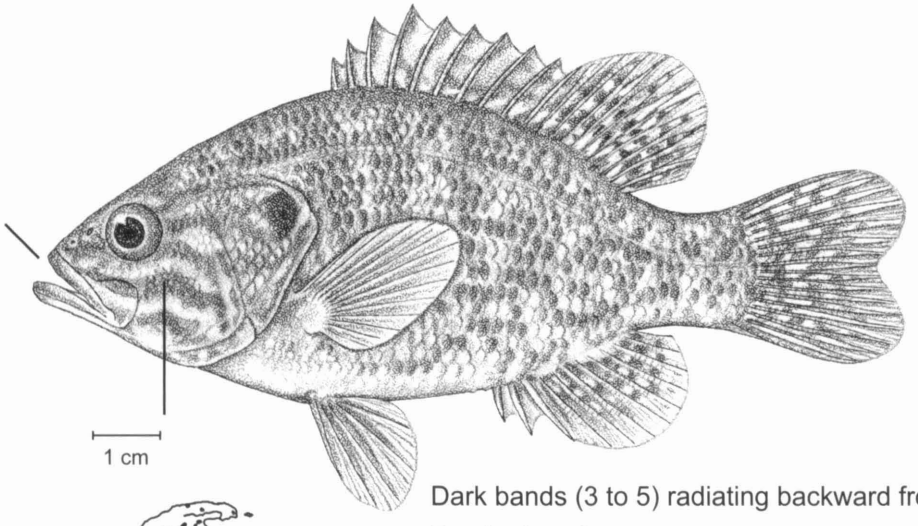
Anal fin with light edge




Pumpkinseed
Lepomis gibbosus
Mouth small, gill rakers short
Pectoral fin long and pointed
Soft dorsal fin heavily spotted
Opercle flap black-centered with red spot in male, orange in female, posteriorly
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

Warmouth

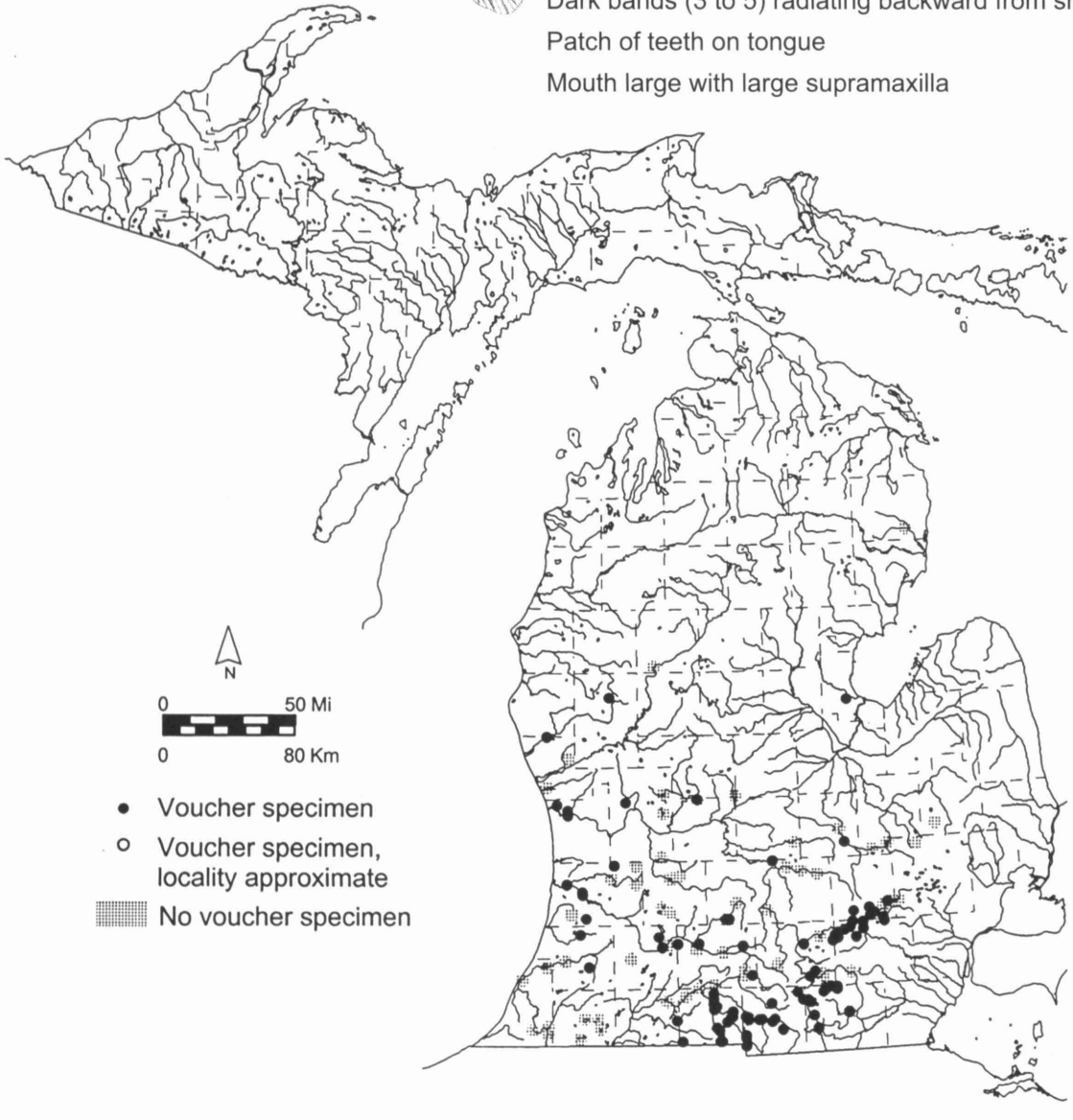
Lepomis gulosus

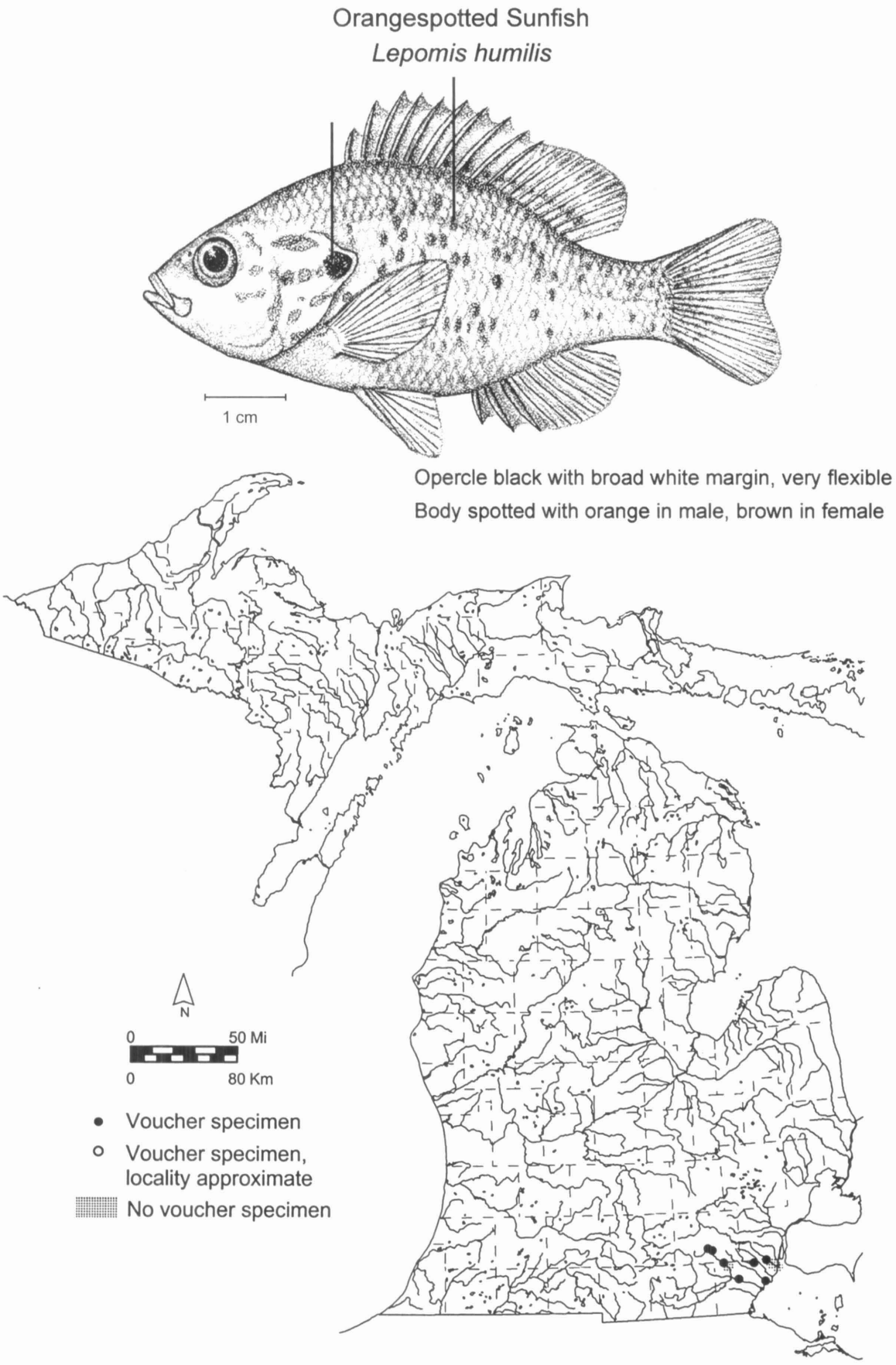


Dark bands (3 to 5) radiating backward from snout and eye

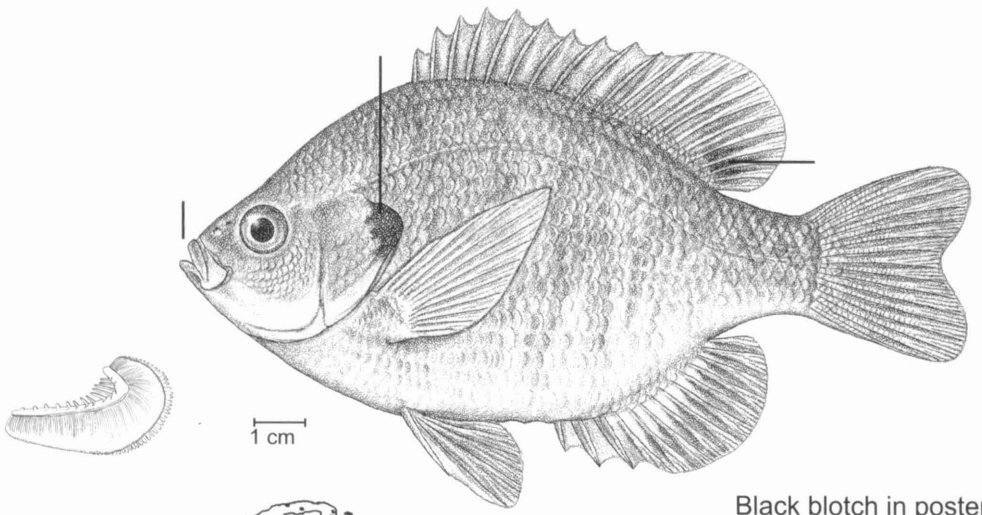
Patch of teeth on tongue

Mouth large with large supramaxilla

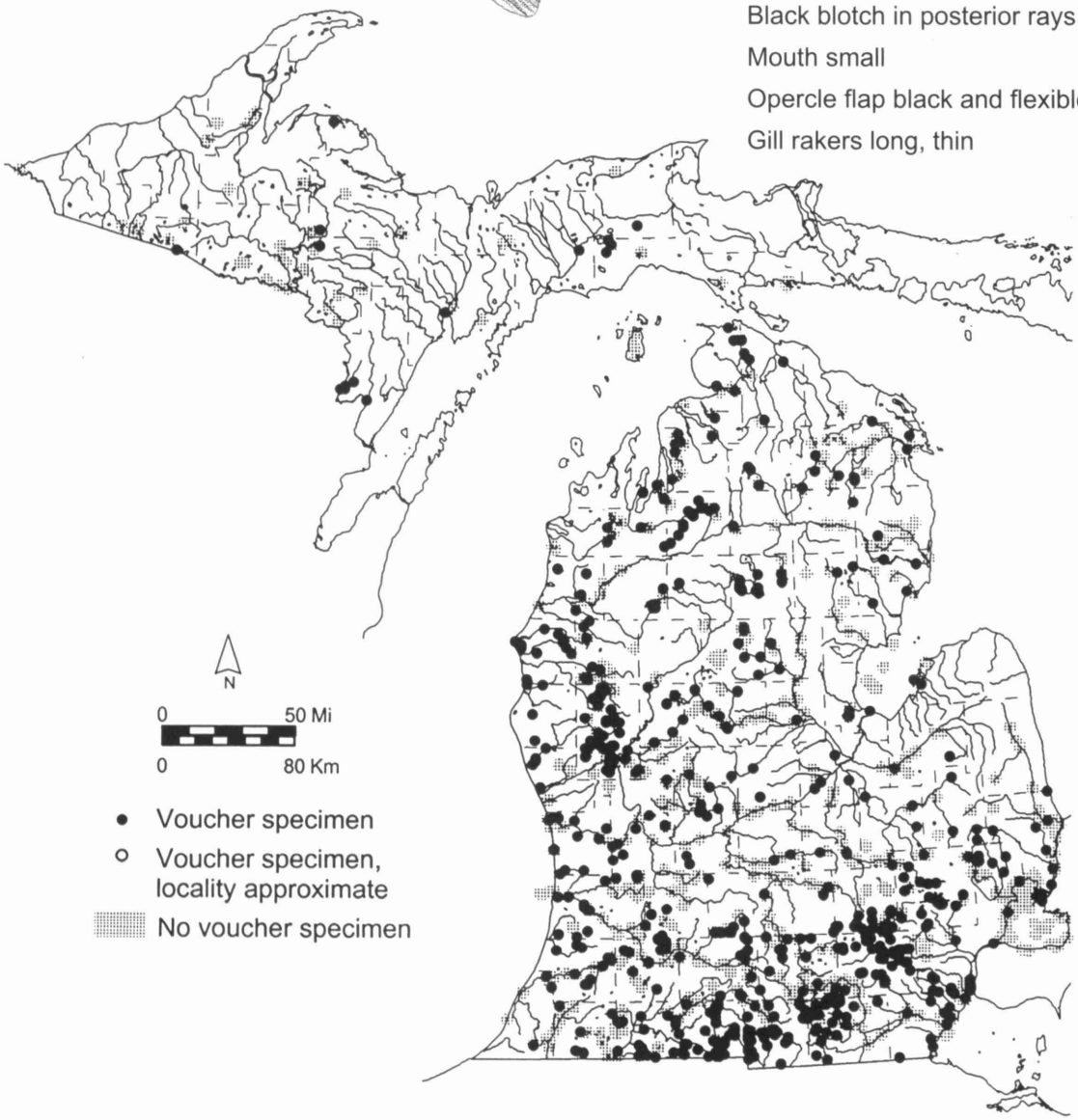


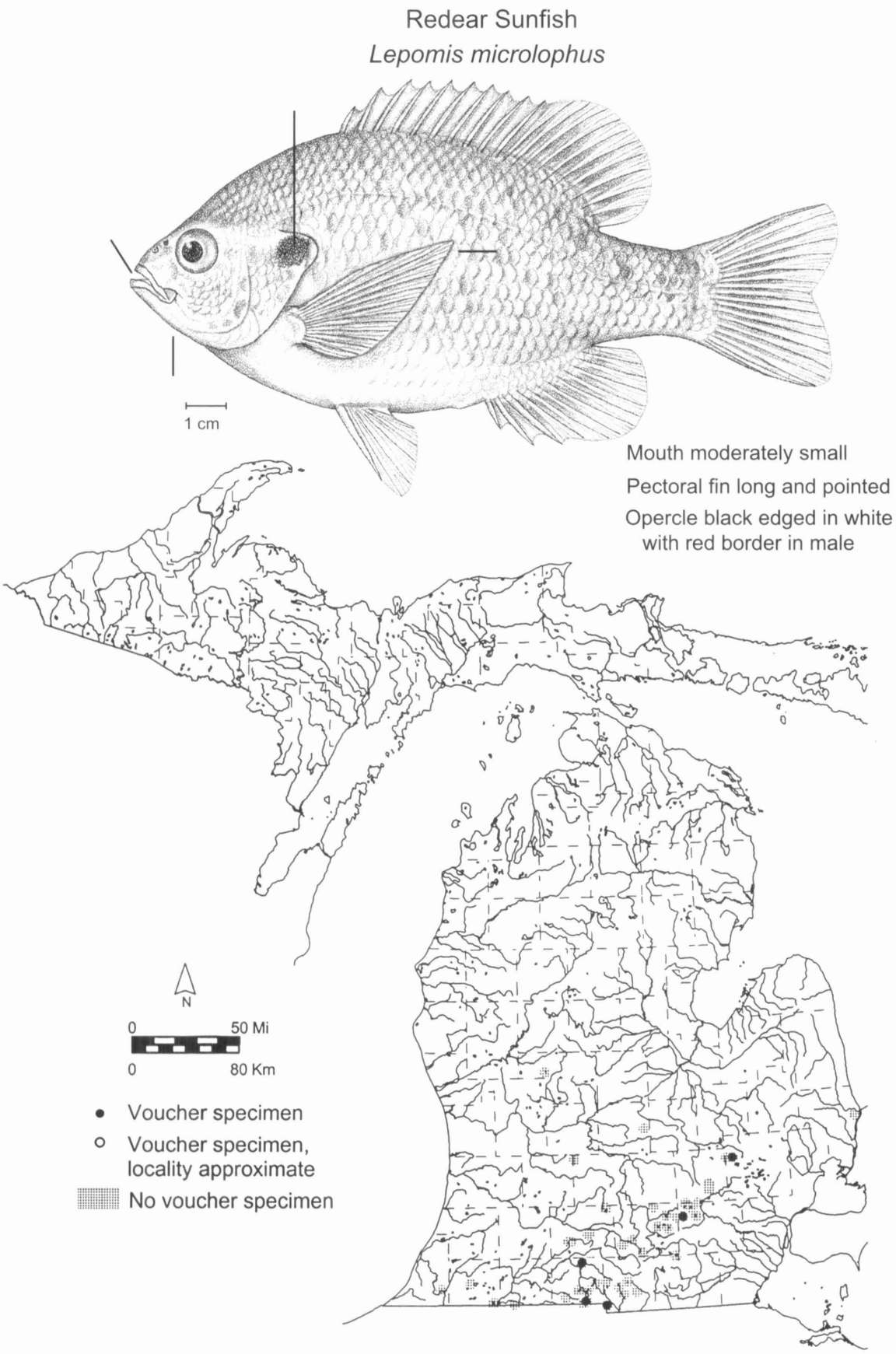

Orangespotted Sunfish
Lepomis humilis
1 cm
Opercle black with broad white margin, very flexible
Body spotted with orange in male, brown in female
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

Bluegill
Lepomis macrochirus



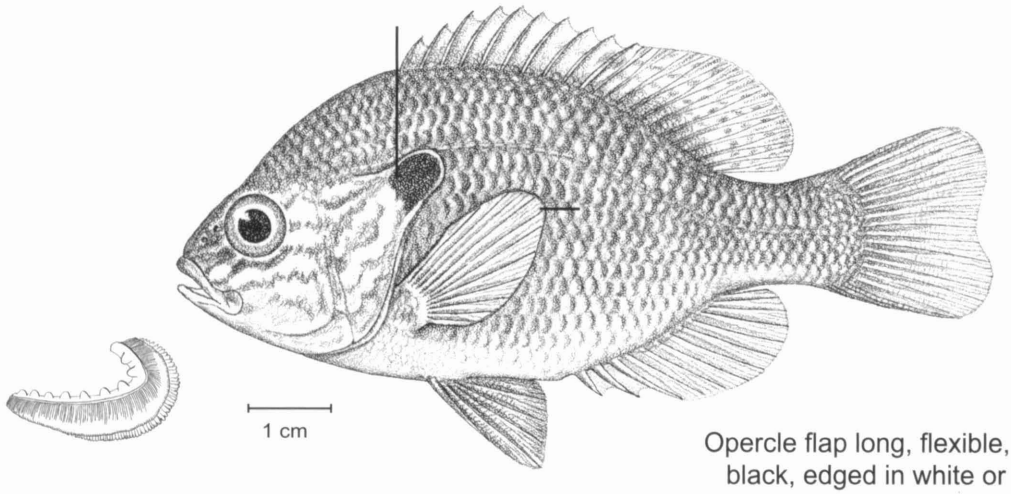
Black blotch in posterior rays of soft dorsal
Mouth small
Opercle flap black and flexible
Gill rakers long, thin




Redear Sunfish
Lepomis microlophus
1 cm
Mouth moderately small
Pectoral fin long and pointed
Opercle black edged in white with red border in male
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

Northern Longear Sunfish

Lepomis peltastes

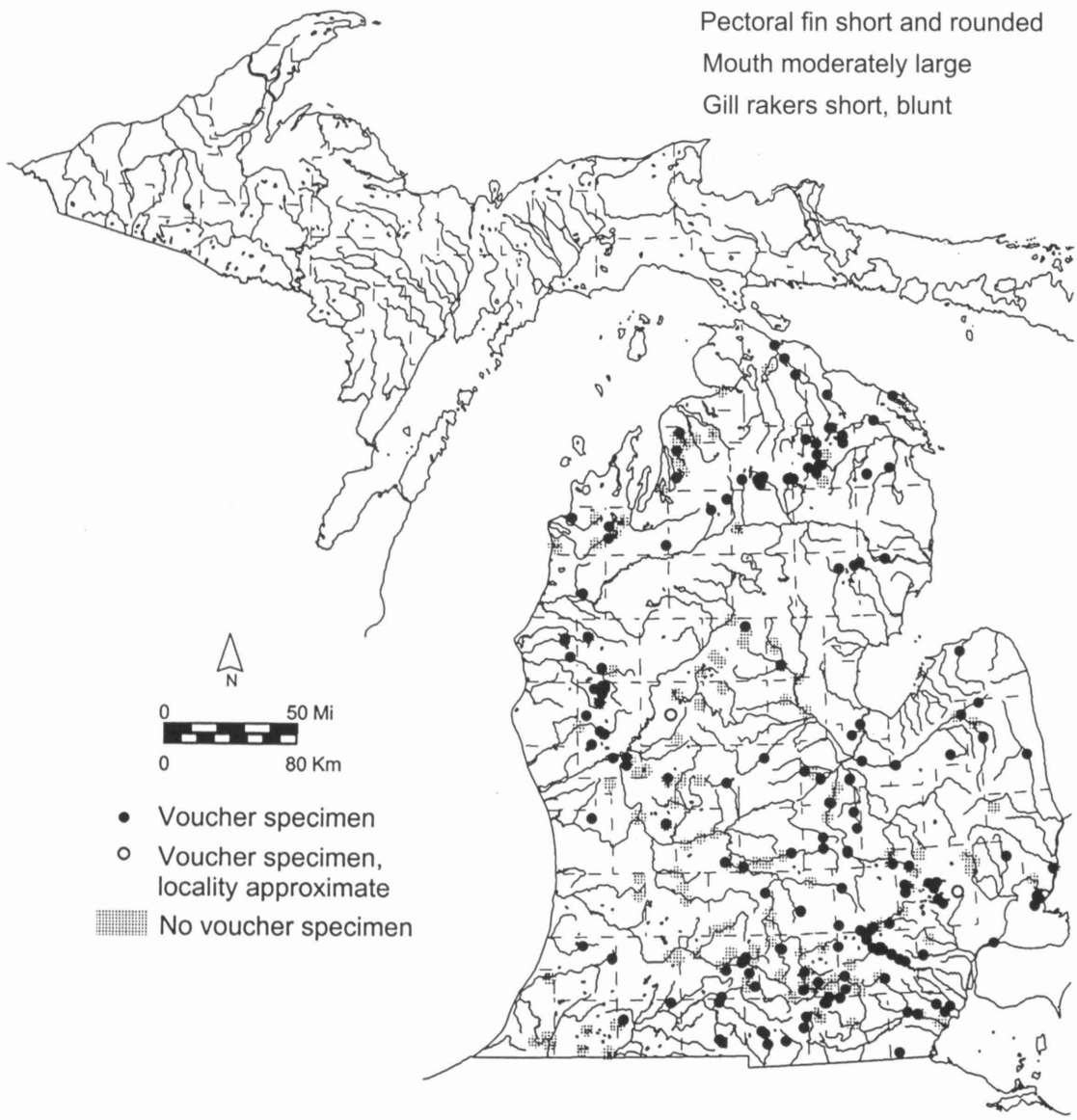


Opercle flap long, flexible, pointing upward, black, edged in white or red

Pectoral fin short and rounded

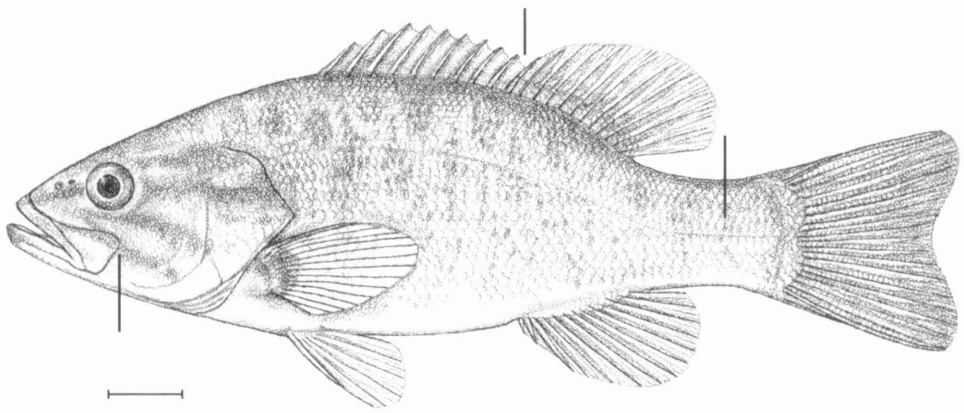
Mouth moderately large

Gill rakers short, blunt



Smallmouth Bass

Micropterus dolomieu



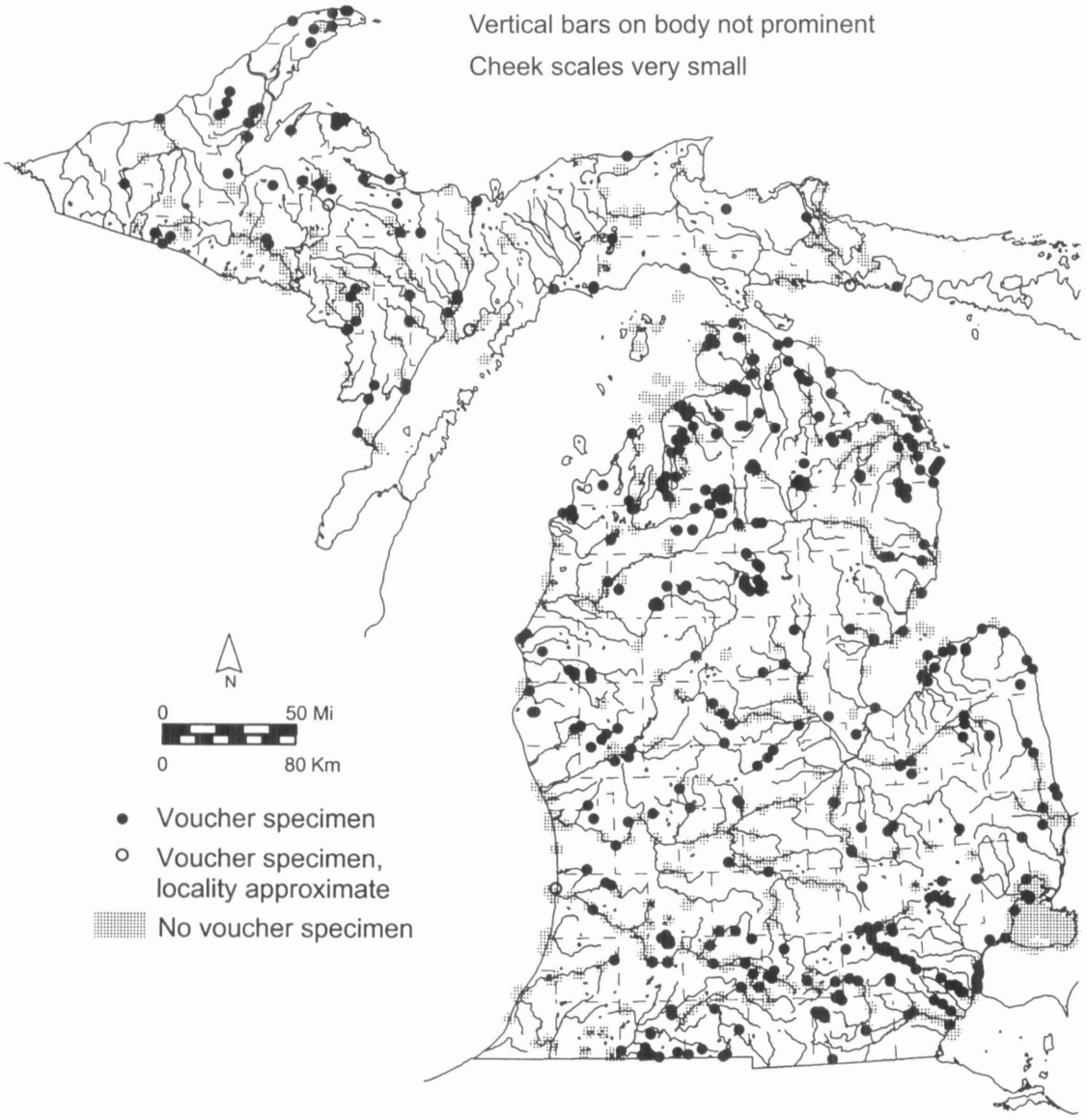
1 cm

Mouth extends to beneath eye or slightly beyond

Shallow notch between dorsals

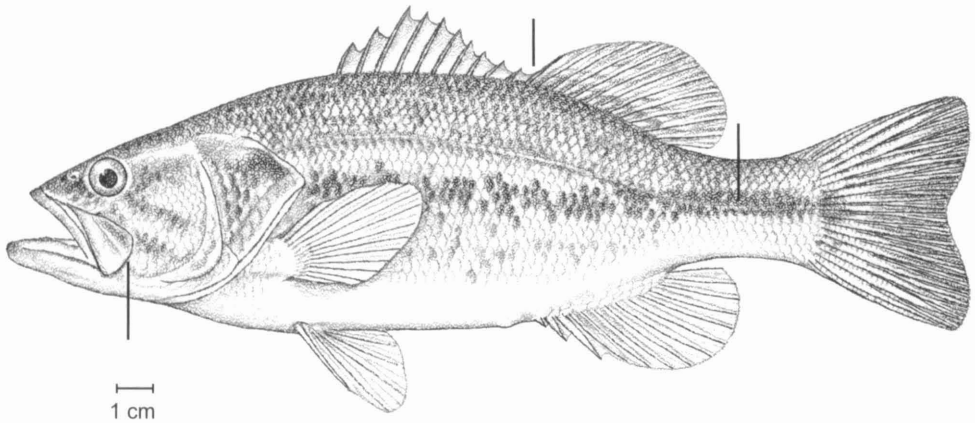
Vertical bars on body not prominent

Cheek scales very small



Largemouth Bass

Micropterus salmoides



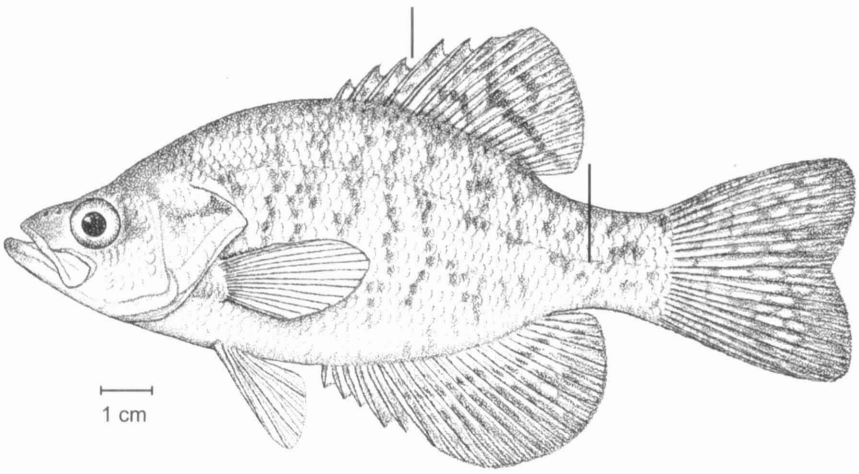
Mouth large, extends well beyond posterior edge of eye in adult

Notch between dorsal fins deep

Dark lateral stripe along body

White Crappie

Pomoxis annularis



Dorsal spines usually 6

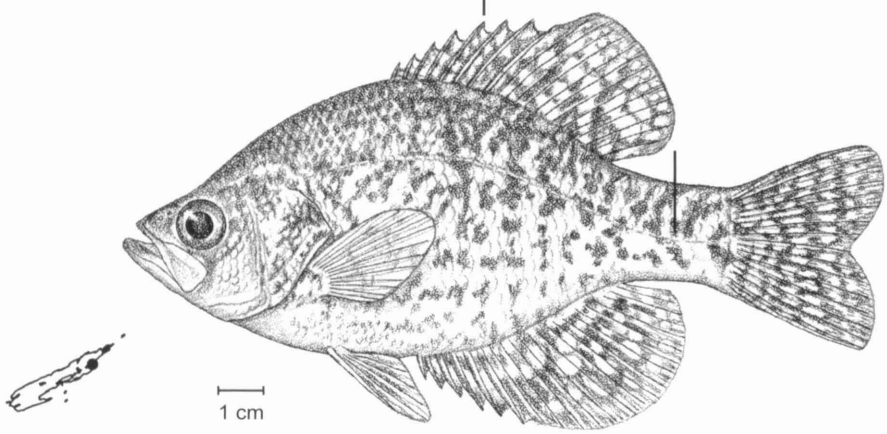
Dorsal base projects forward well short of eye

Mouth less oblique

Chain-like double bars on side

Black Crappie

Pomoxis nigromaculatus

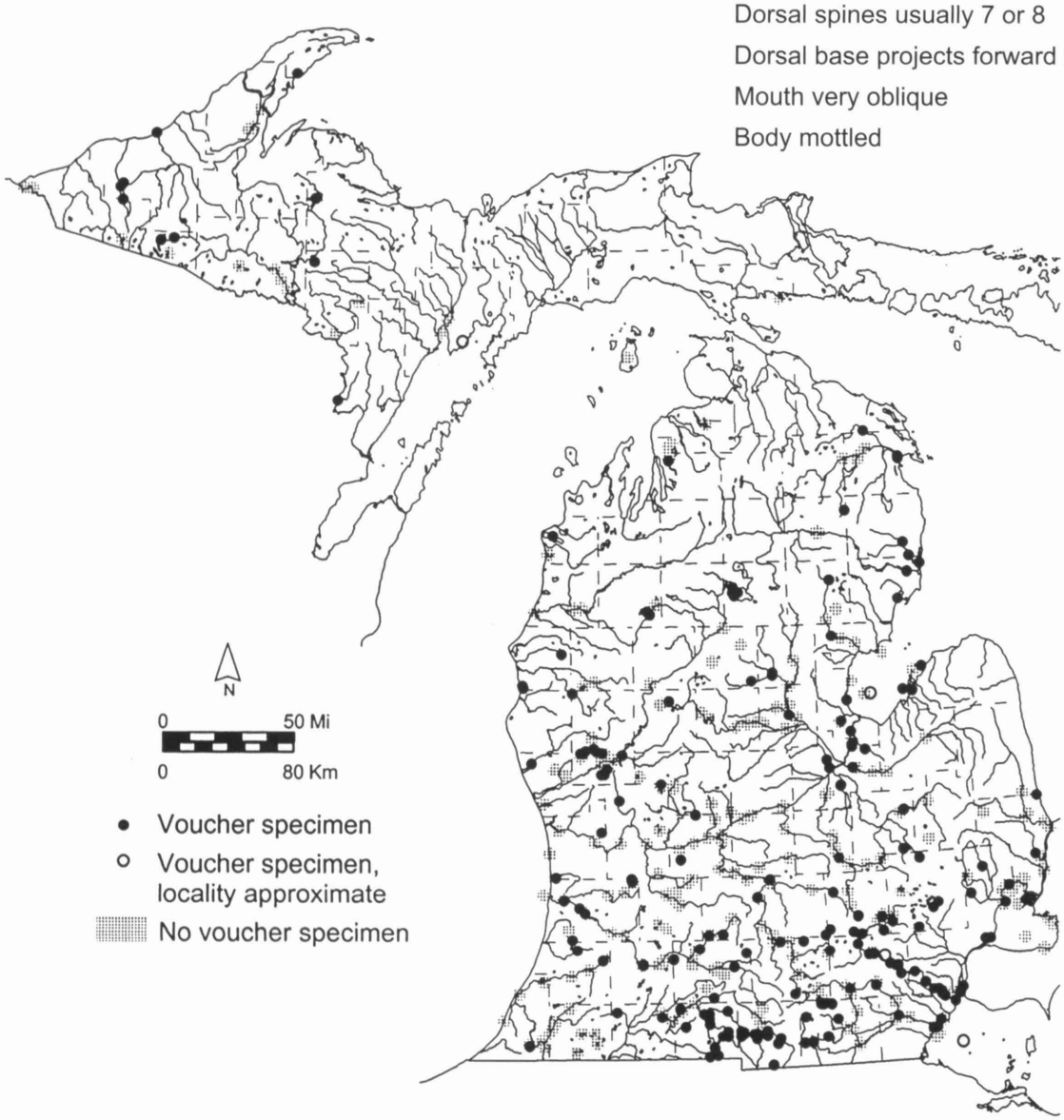


Dorsal spines usually 7 or 8

Dorsal base projects forward to about the eye

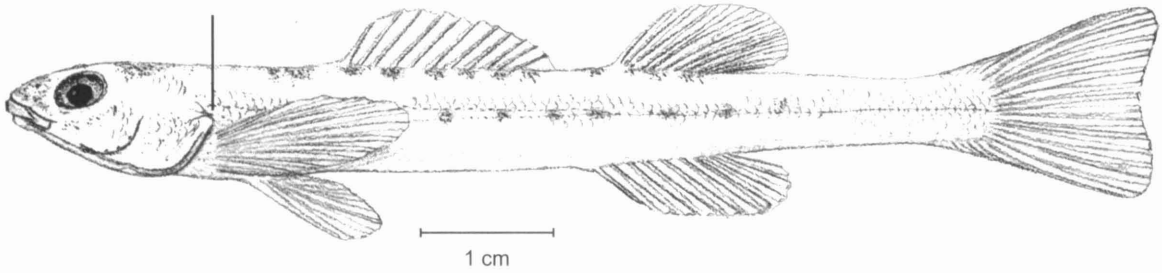
Mouth very oblique

Body mottled



Western Sand Darter

Ammocrypta clara



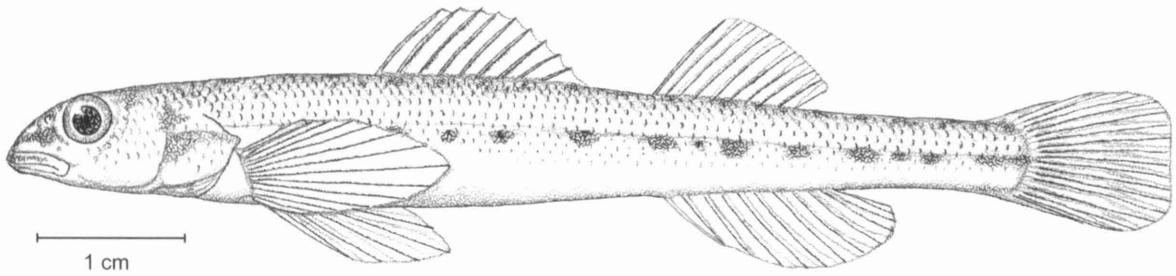
Body elongate, translucent in life

Spine on opercle

Anal origin ahead of soft dorsal

Eastern Sand Darter

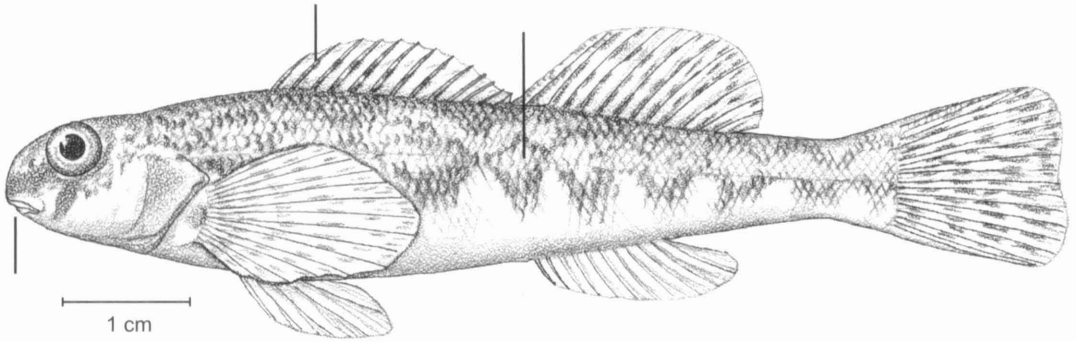
Ammocrypta pellucida



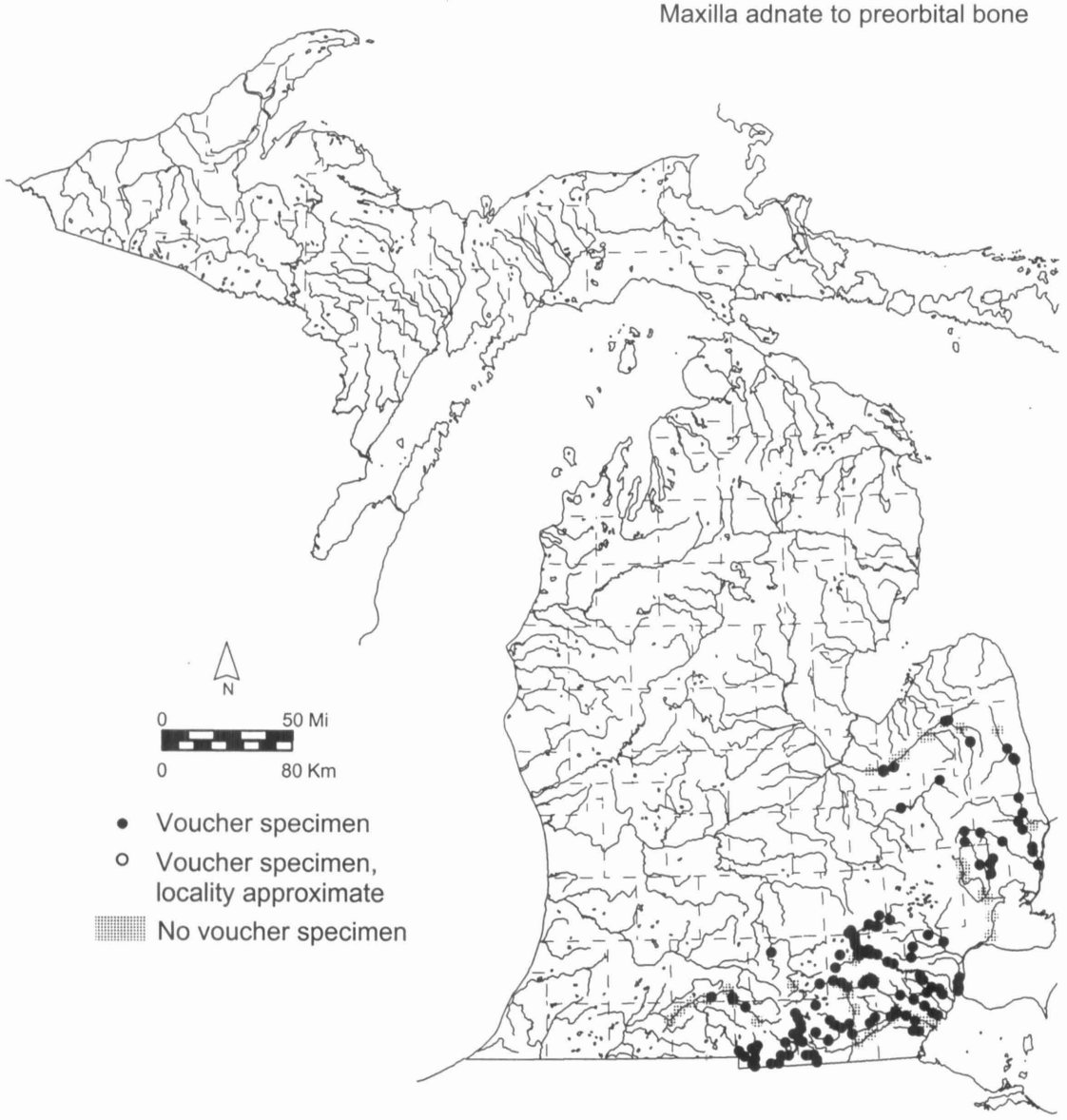
Body elongate, translucent in life
Dorsal fins separate
Opercle without spine
Anal origin behind soft dorsal

Greenside Darter

Etheostoma blennioides

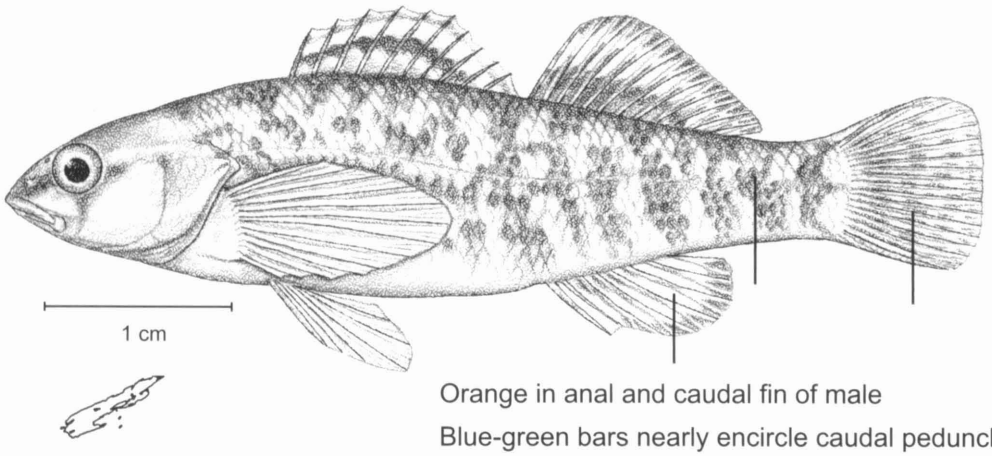


Side with series of V-shaped green marks
First dorsal has basal bar of rusty red
Maxilla adnate to preorbital bone



Rainbow Darter

Etheostoma caeruleum

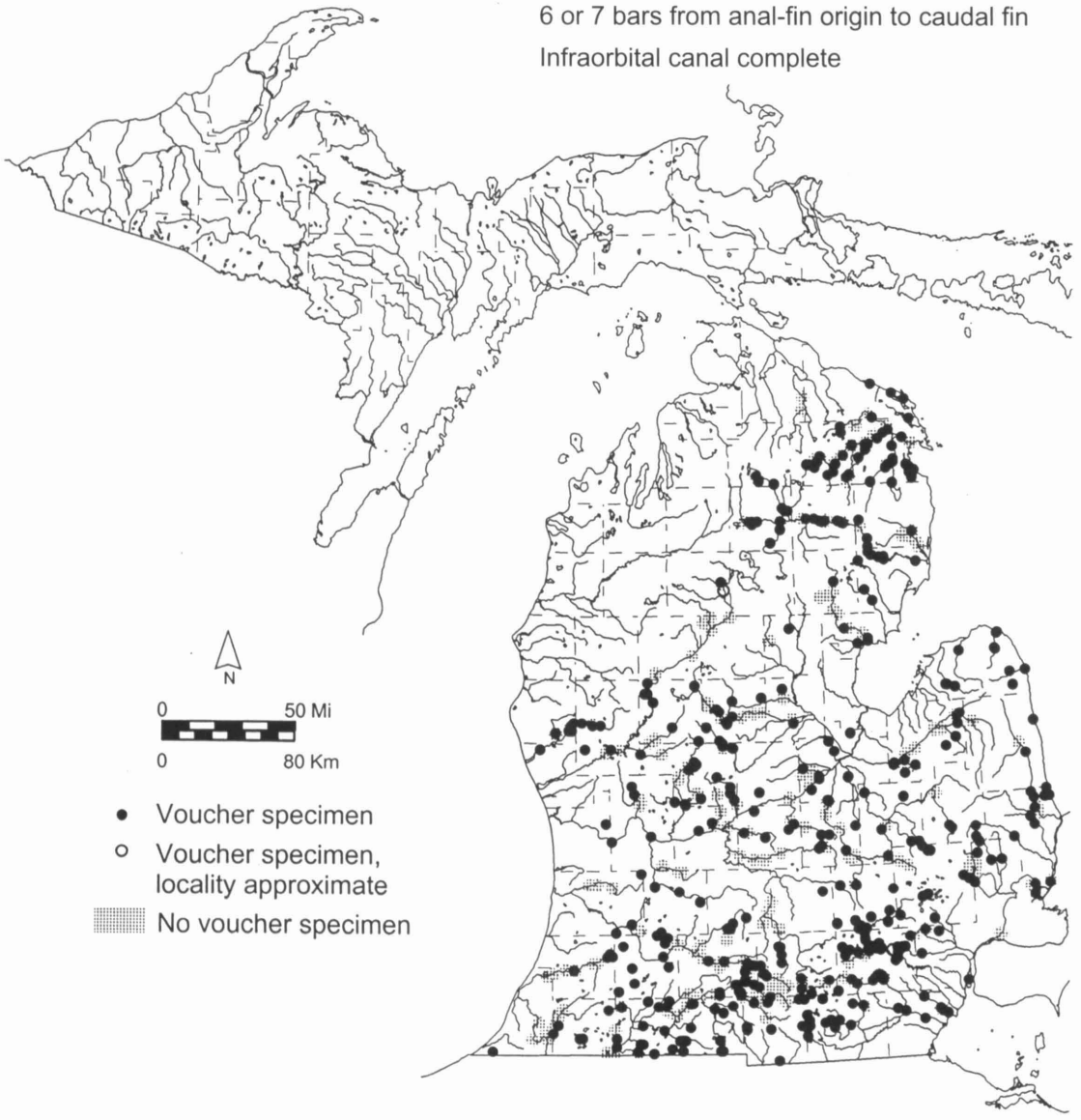


Orange in anal and caudal fin of male

Blue-green bars nearly encircle caudal peduncle, more pronounced than in orangethroat darter

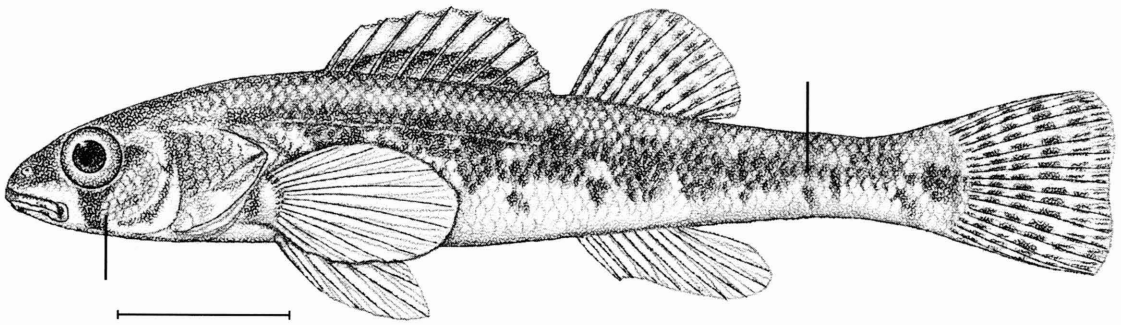
6 or 7 bars from anal-fin origin to caudal fin

Infraorbital canal complete

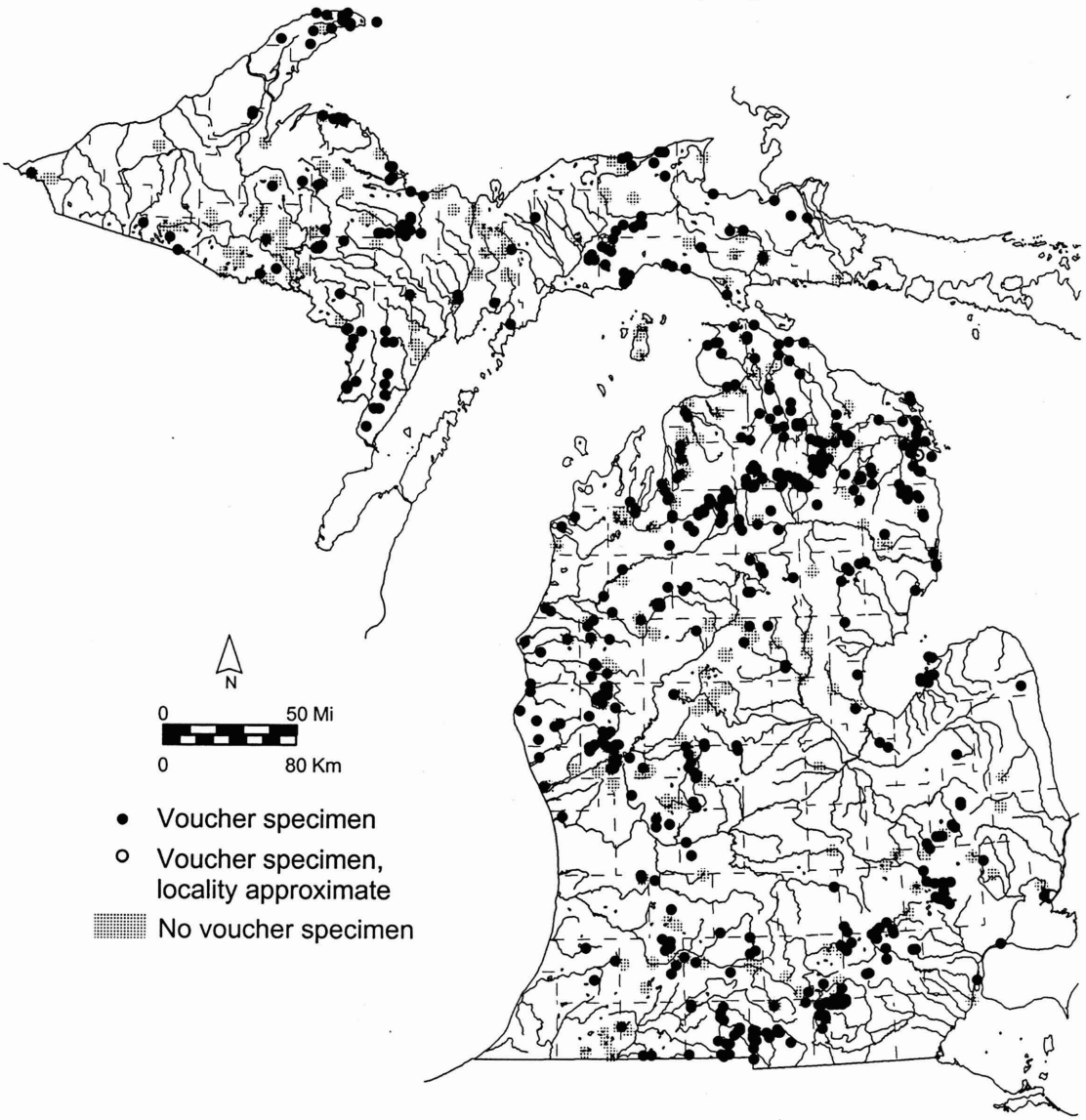


Iowa Darter

Etheostoma exile

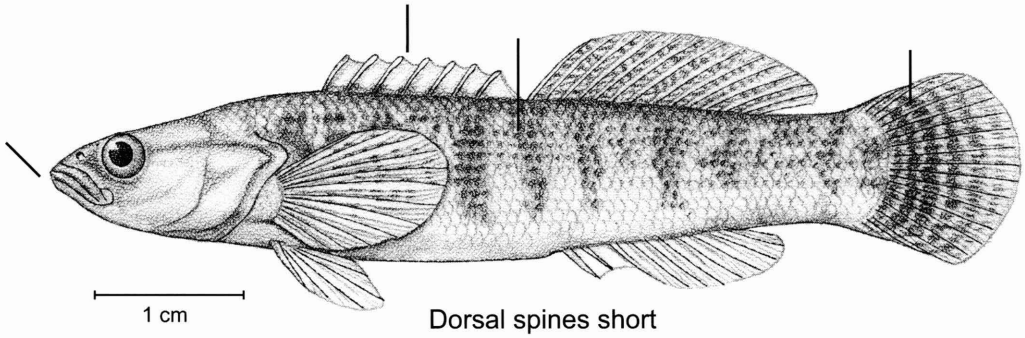


Red-orange and brown blotches on side
Cheek scaled, lateral scales 52 or more
Teardrop angled downward

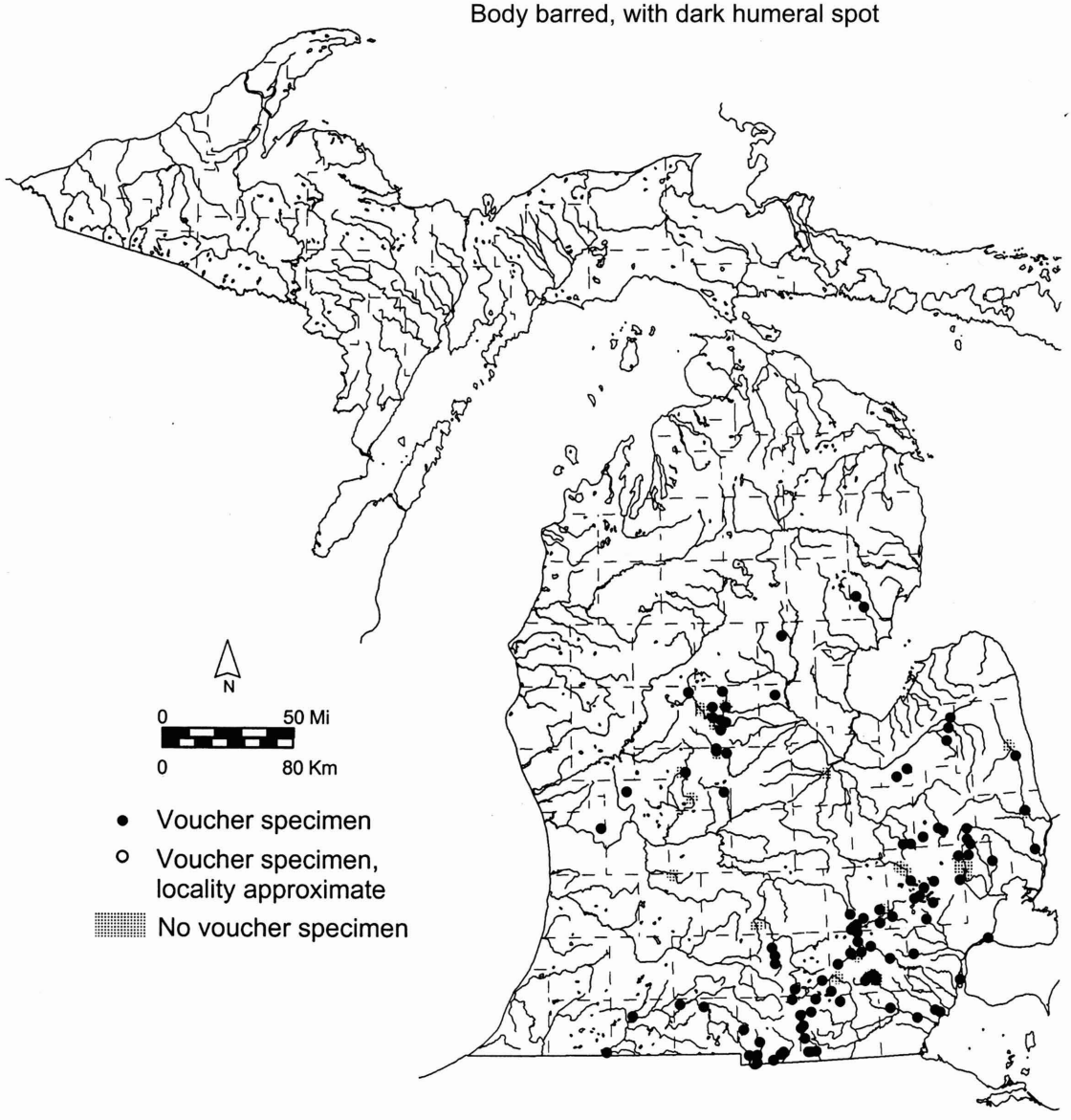


Barred Fantail Darter

Etheostoma flabellare flabellare

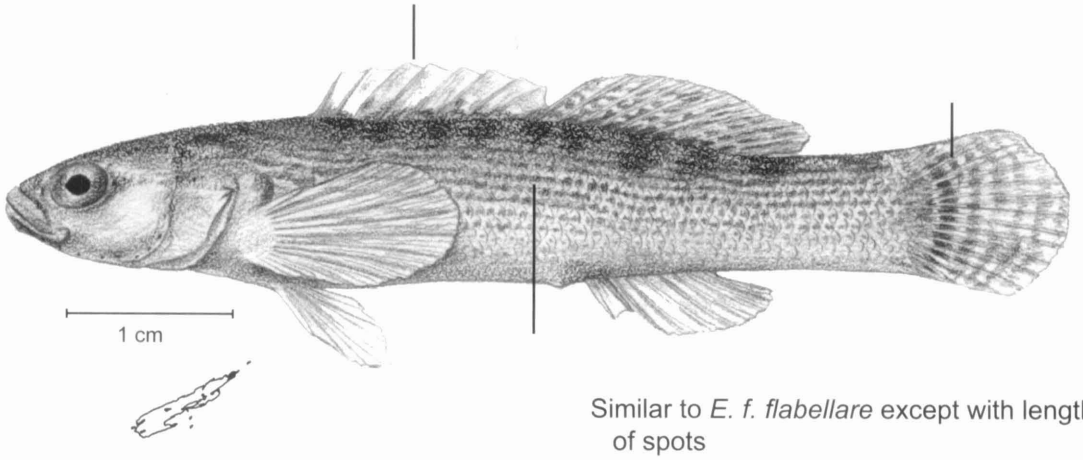


Dorsal spines short
Head naked
Mouth terminal
Caudal fin round, with cross bars
Body barred, with dark humeral spot



Striped Fantail Darter

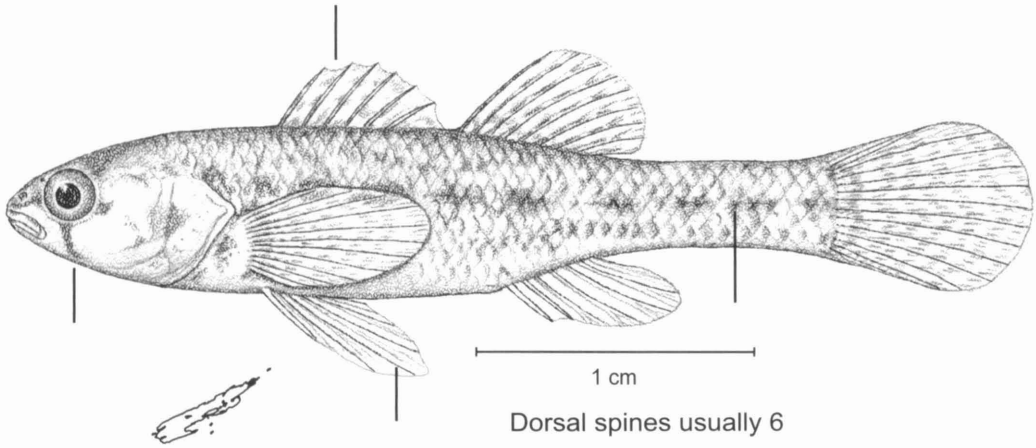
Etheostoma flabellare lineolatum



Similar to *E. f. flabellare* except with lengthwise rows of spots

Least Darter

Etheostoma microperca

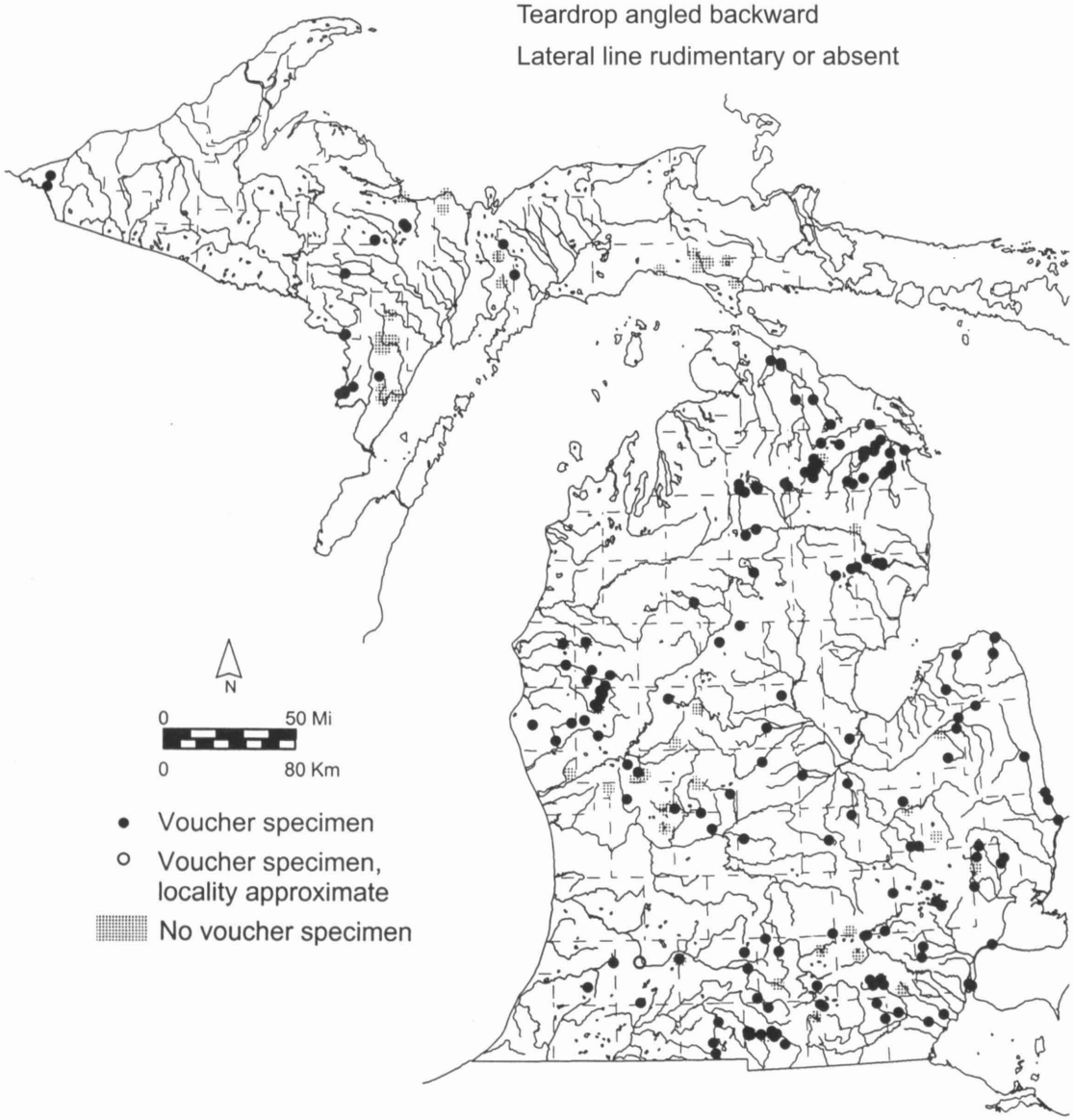


Dorsal spines usually 6

Males with enlarged tuberculate pelvic fin

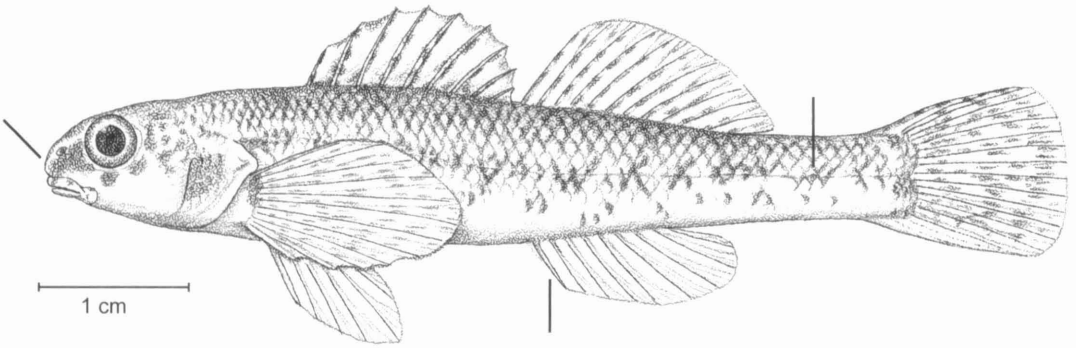
Teardrop angled backward

Lateral line rudimentary or absent



Johnny Darter

Etheostoma nigrum

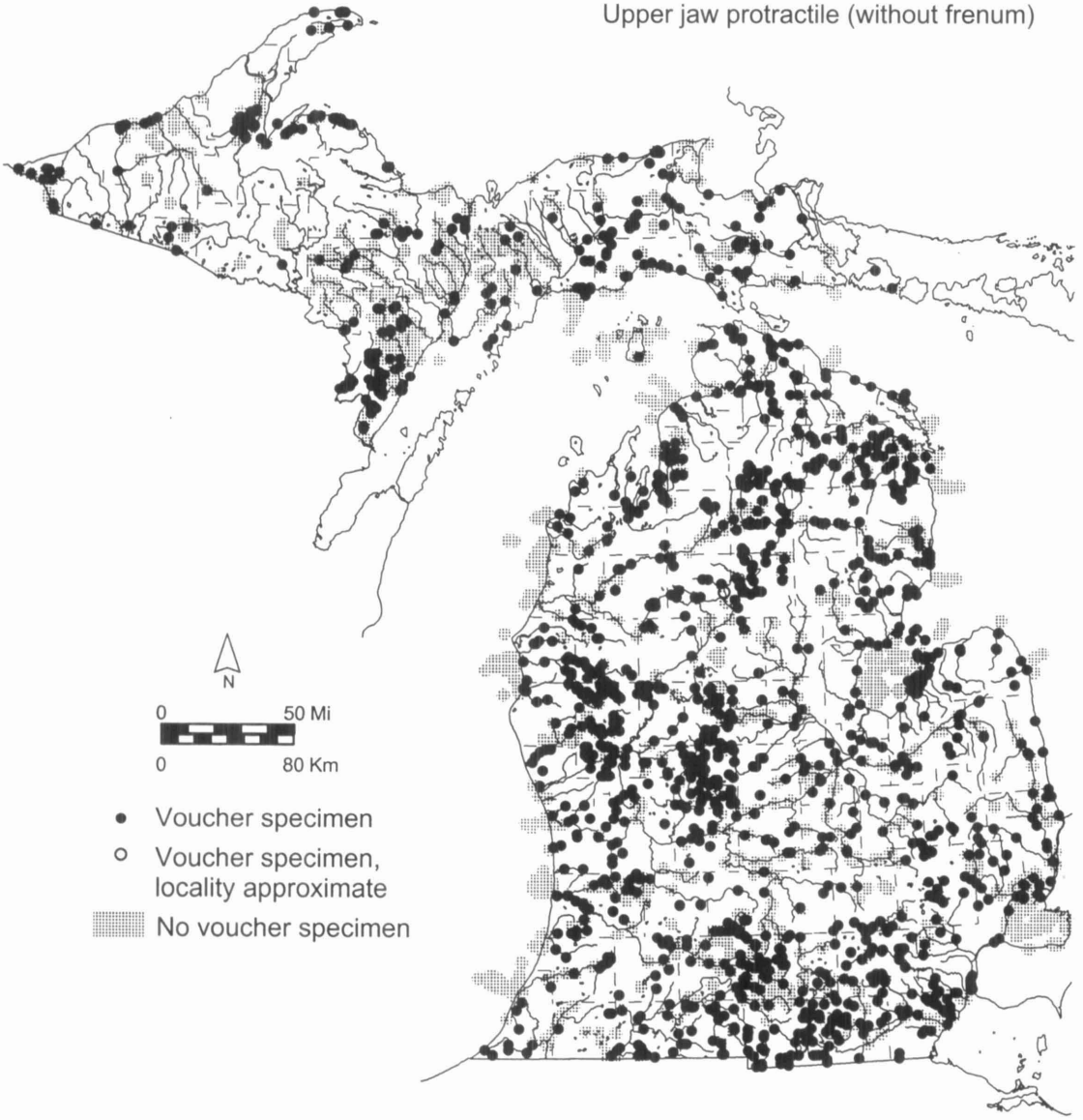


Body marked laterally with black X's and Y's

Males in breeding very dark, sometimes black

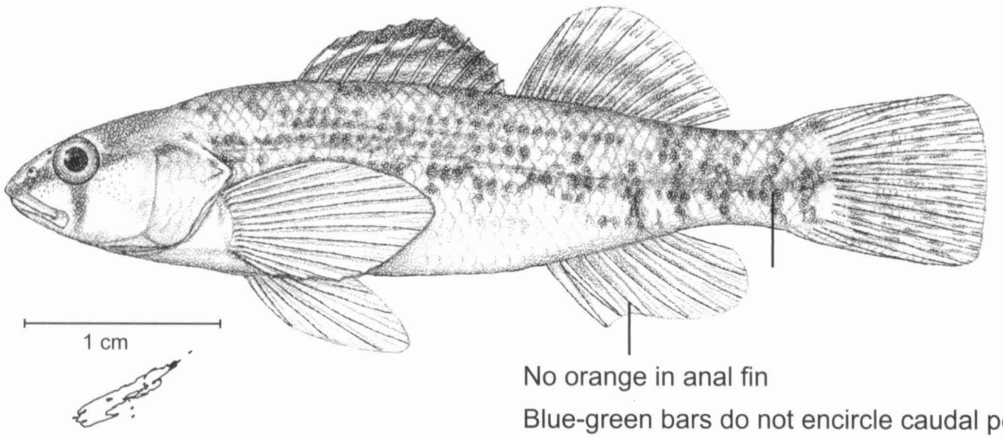
One anal spine

Upper jaw protractile (without frenum)



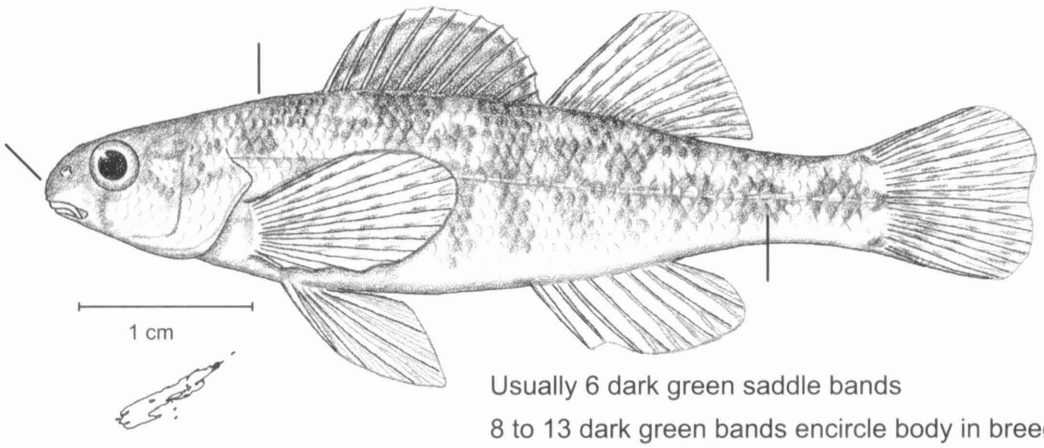
Orangethroat Darter

Etheostoma spectabile



Banded Darter

Etheostoma zonale

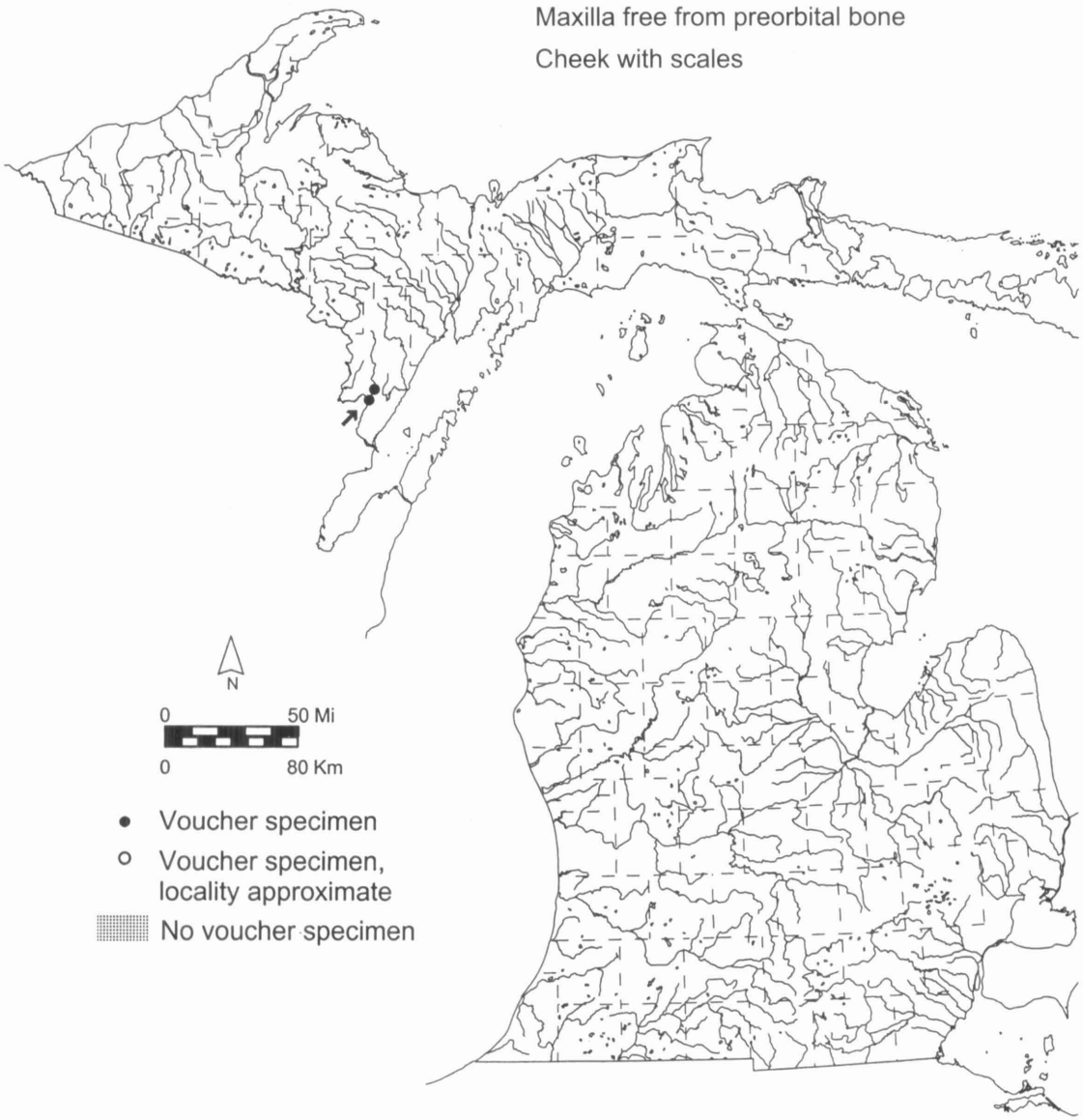


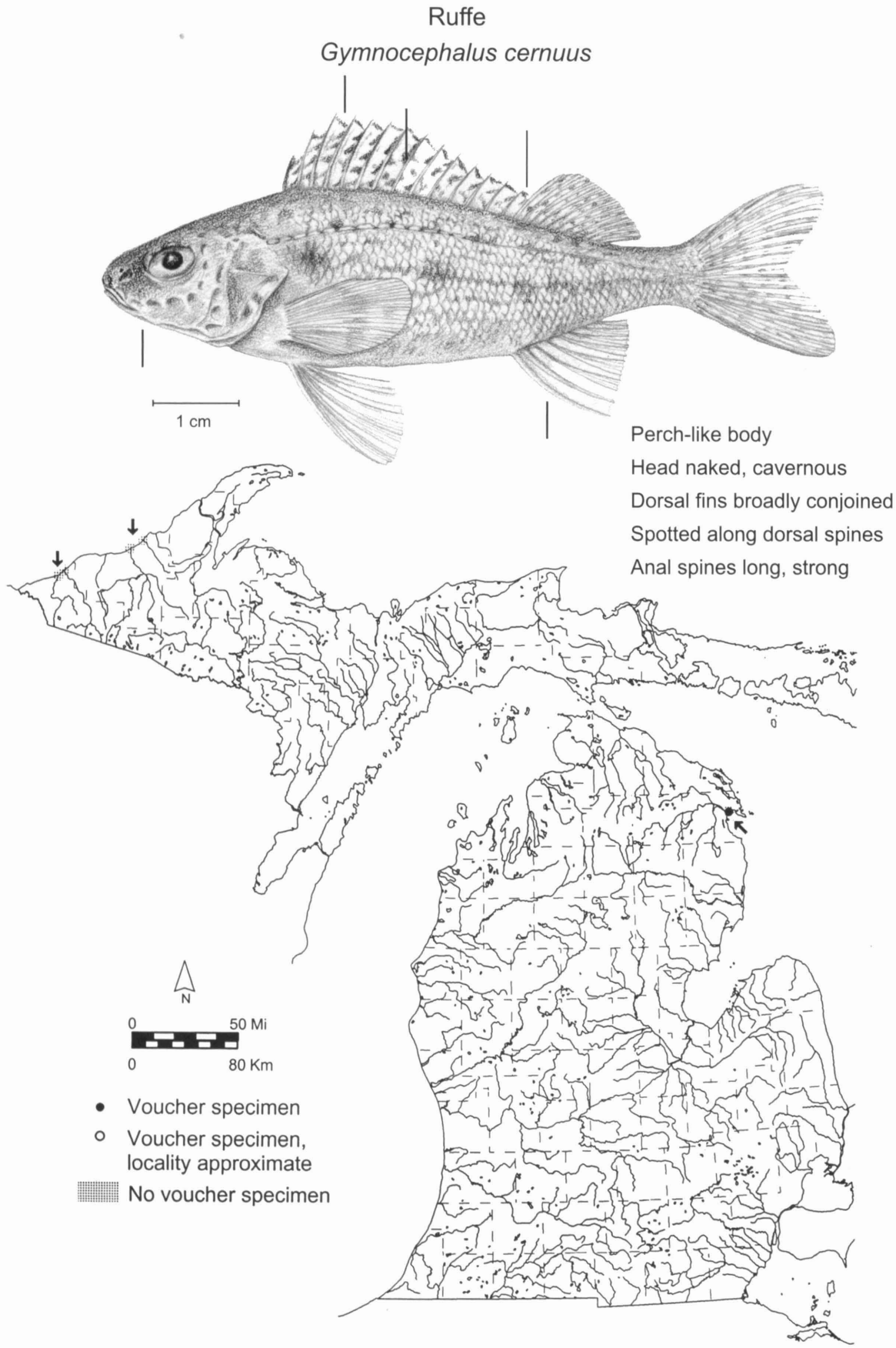
Usually 6 dark green saddle bands

8 to 13 dark green bands encircle body in breeding males, less apparent in females

Maxilla free from preorbital bone

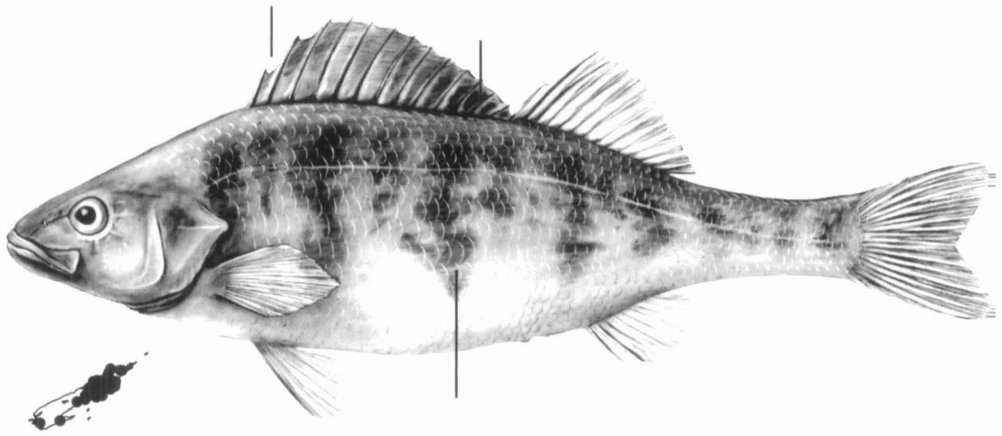
Cheek with scales




Ruffe
Gymnocephalus cernuus
1 cm
Perch-like body
Head naked, cavernous
Dorsal fins broadly conjoined
Spotted along dorsal spines
Anal spines long, strong
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

Yellow Perch

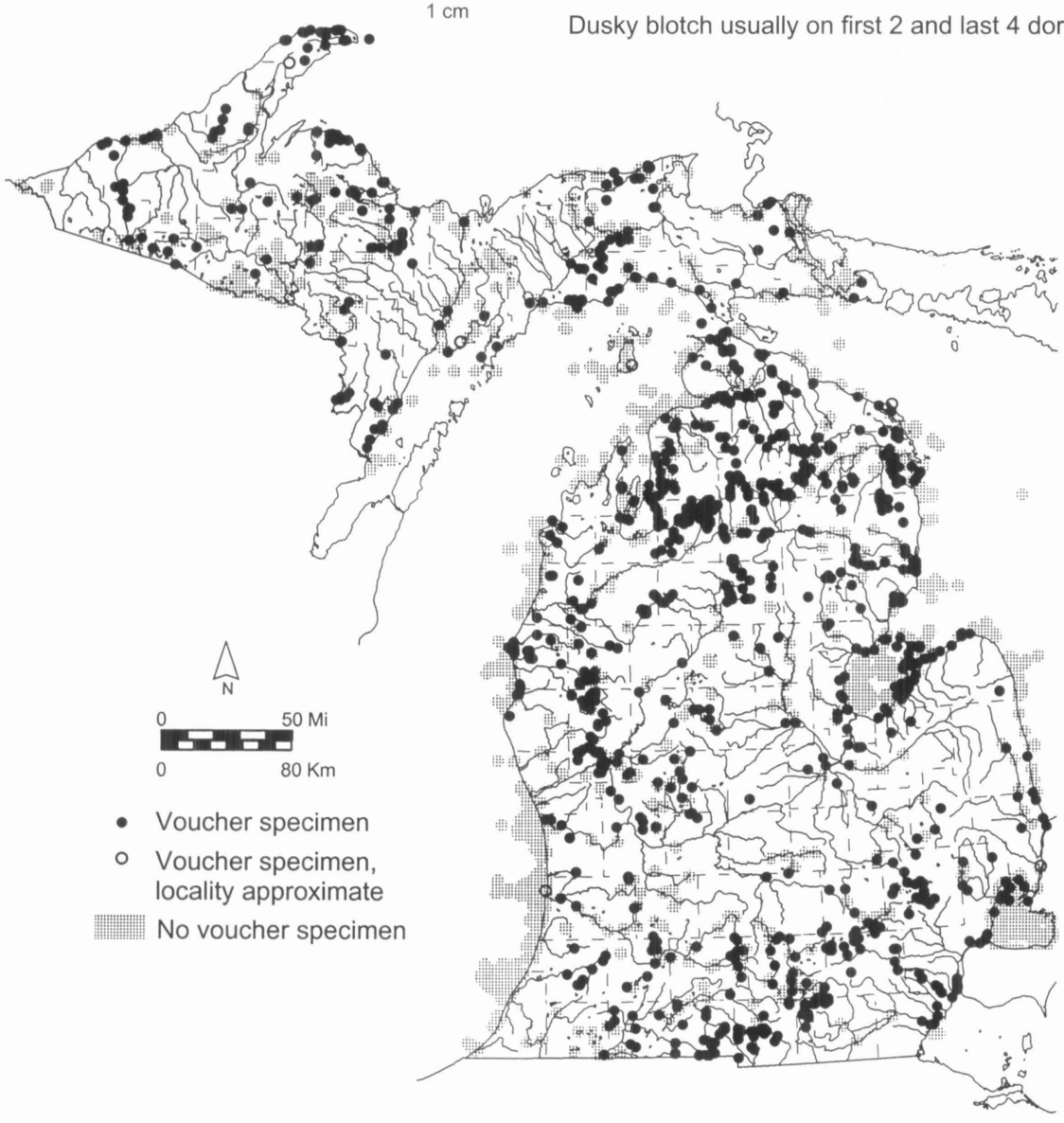
Perca flavescens



1 cm

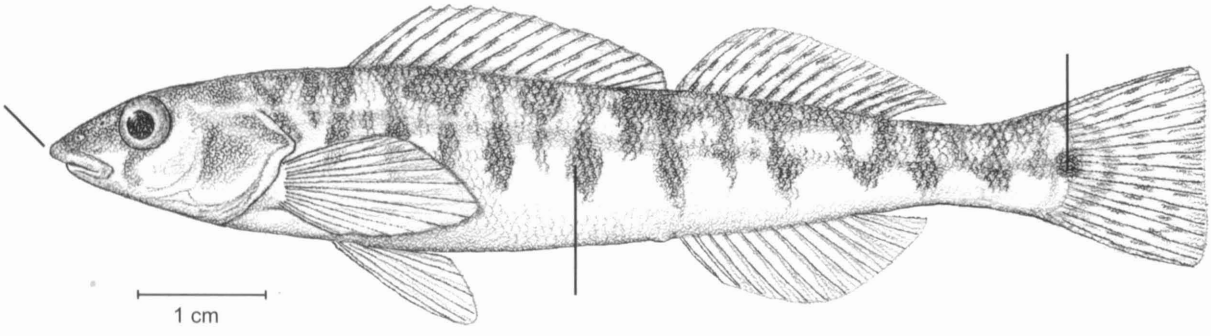
Blackish vertical bands crossing back and side

Dusky blotch usually on first 2 and last 4 dorsal spines



Northern Logperch

Percina caprodes semifasciata



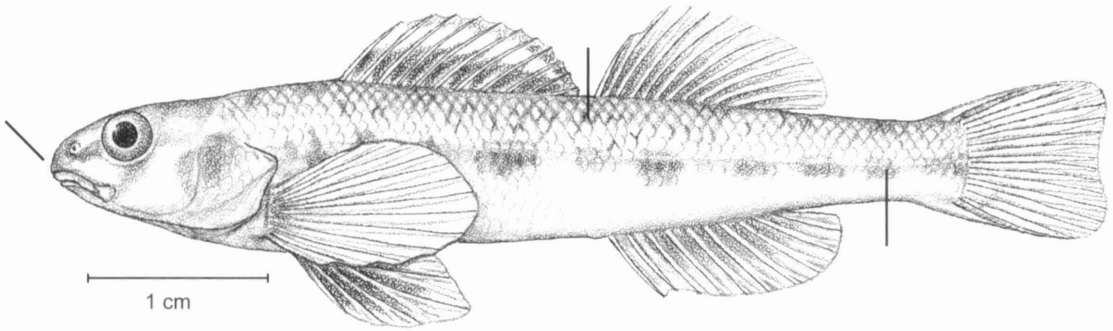
Conical snout

Many irregular lateral cross bands

Prominent caudal spot

Channel Darter

Percina copelandi

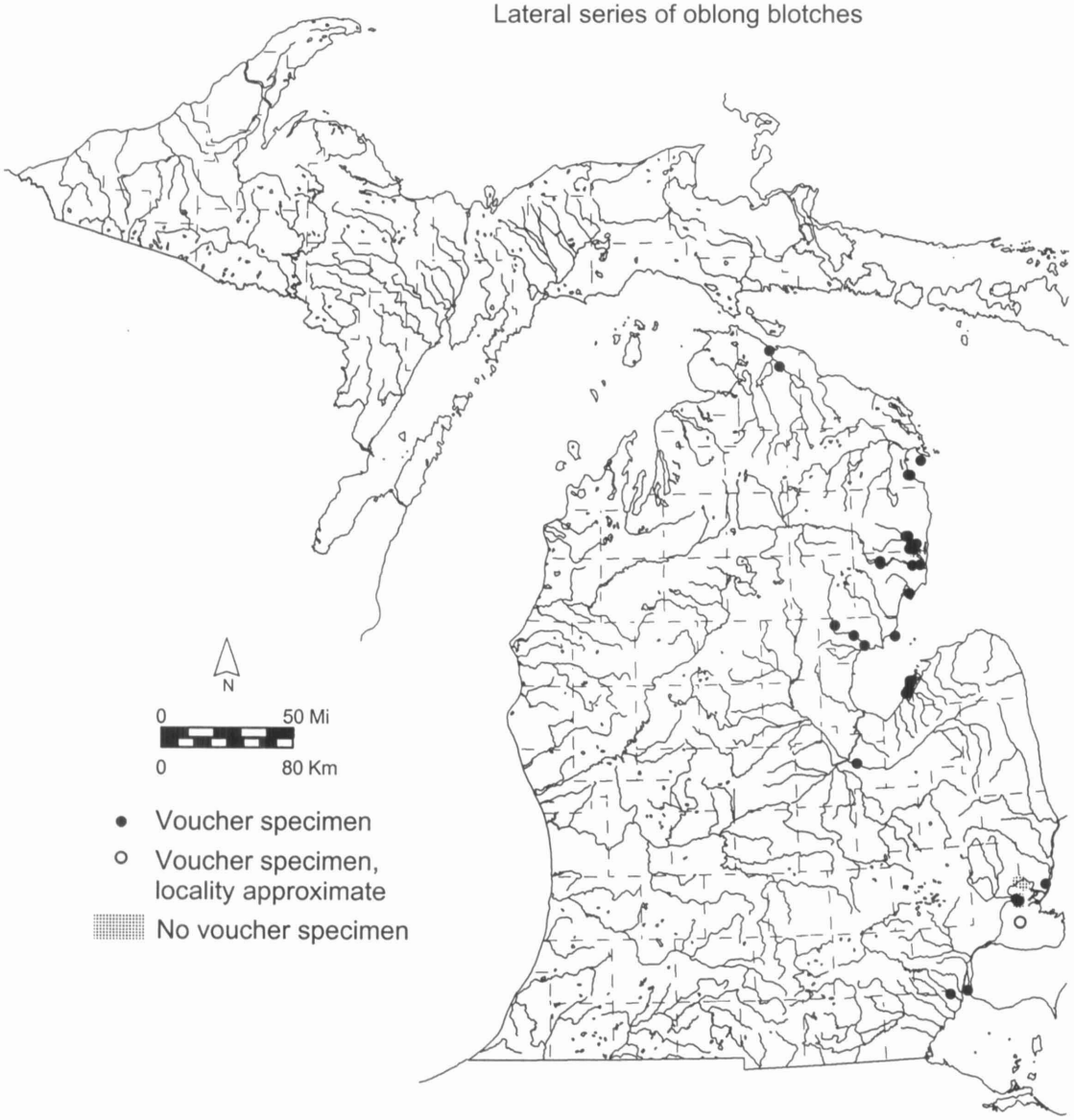


Usually V's and W's scattered over back

Snout blunt, no frenum

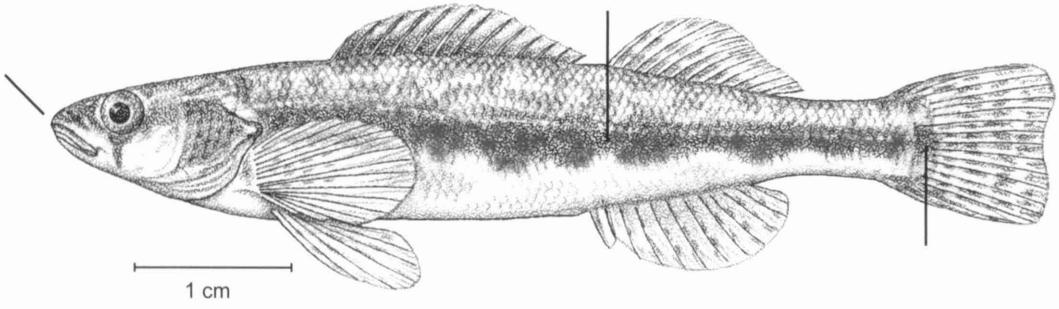
Spinous dorsal with basal and marginal dark bands

Lateral series of oblong blotches



Blackside Darter

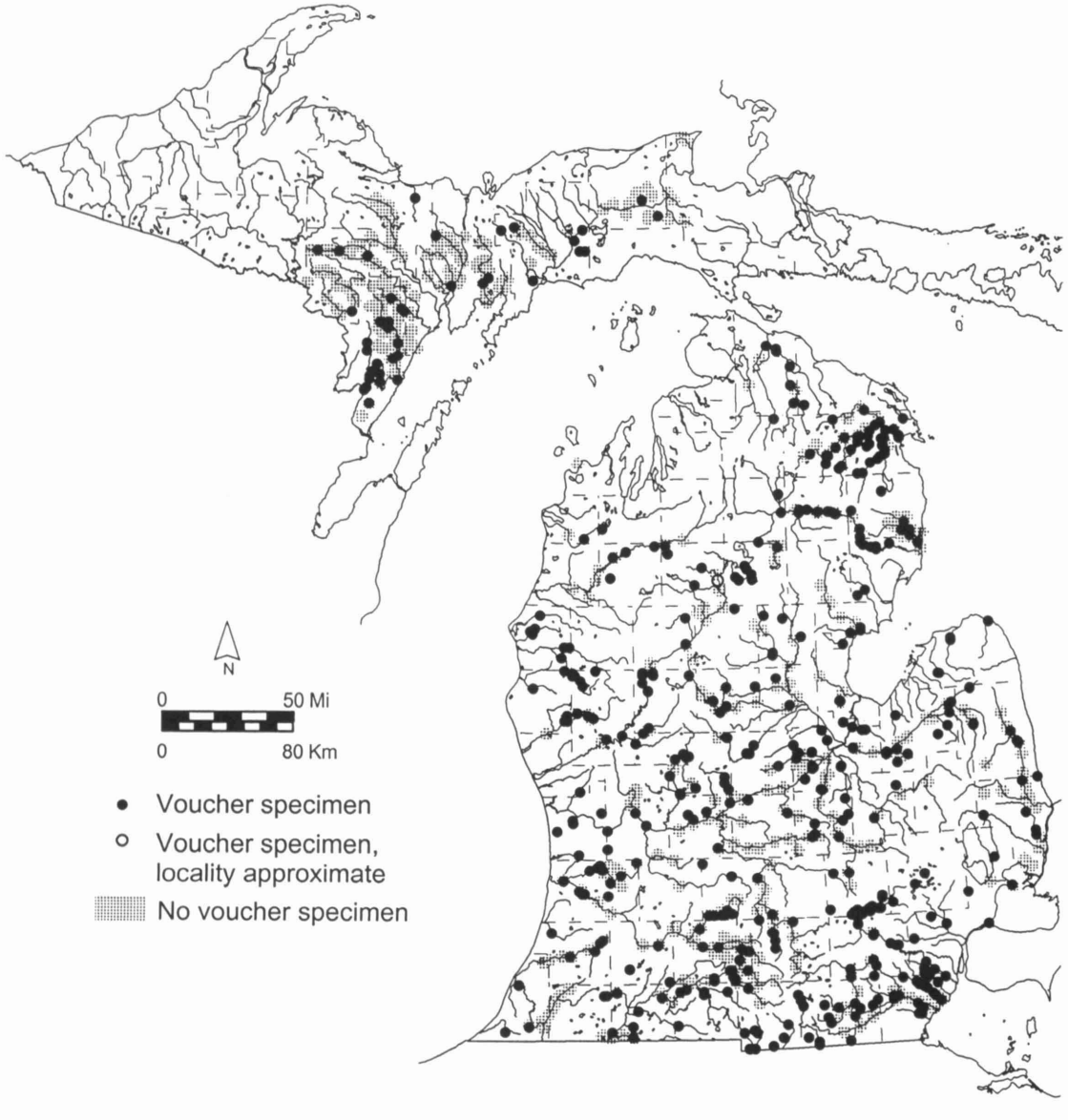
Percina maculata



Few confluent longitudinal blotches confined to side

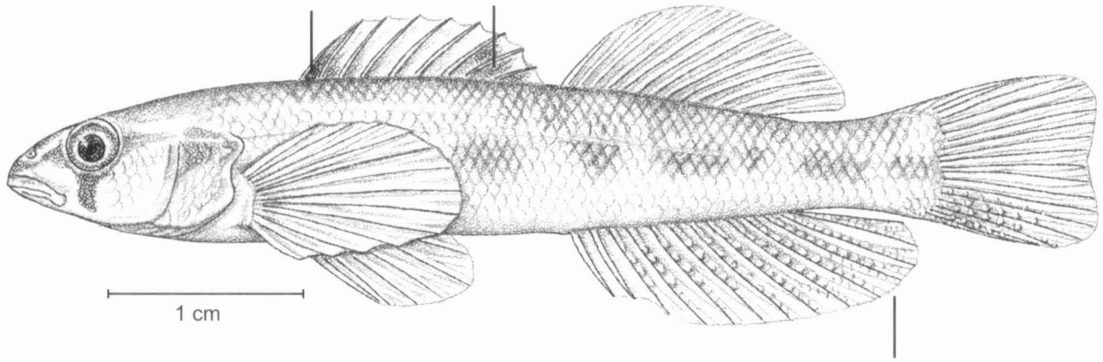
Prominent caudal spot

Broad frenum



River Darter

Percina shumardi

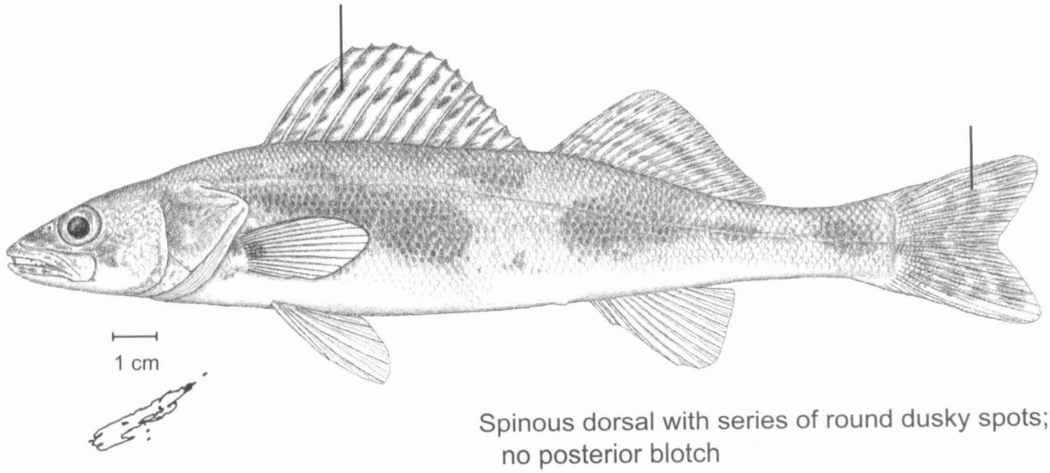


Dark blotches near front and back of spinous dorsal fin

Male with large anal fin, soft rays 10 - 13

Sauger

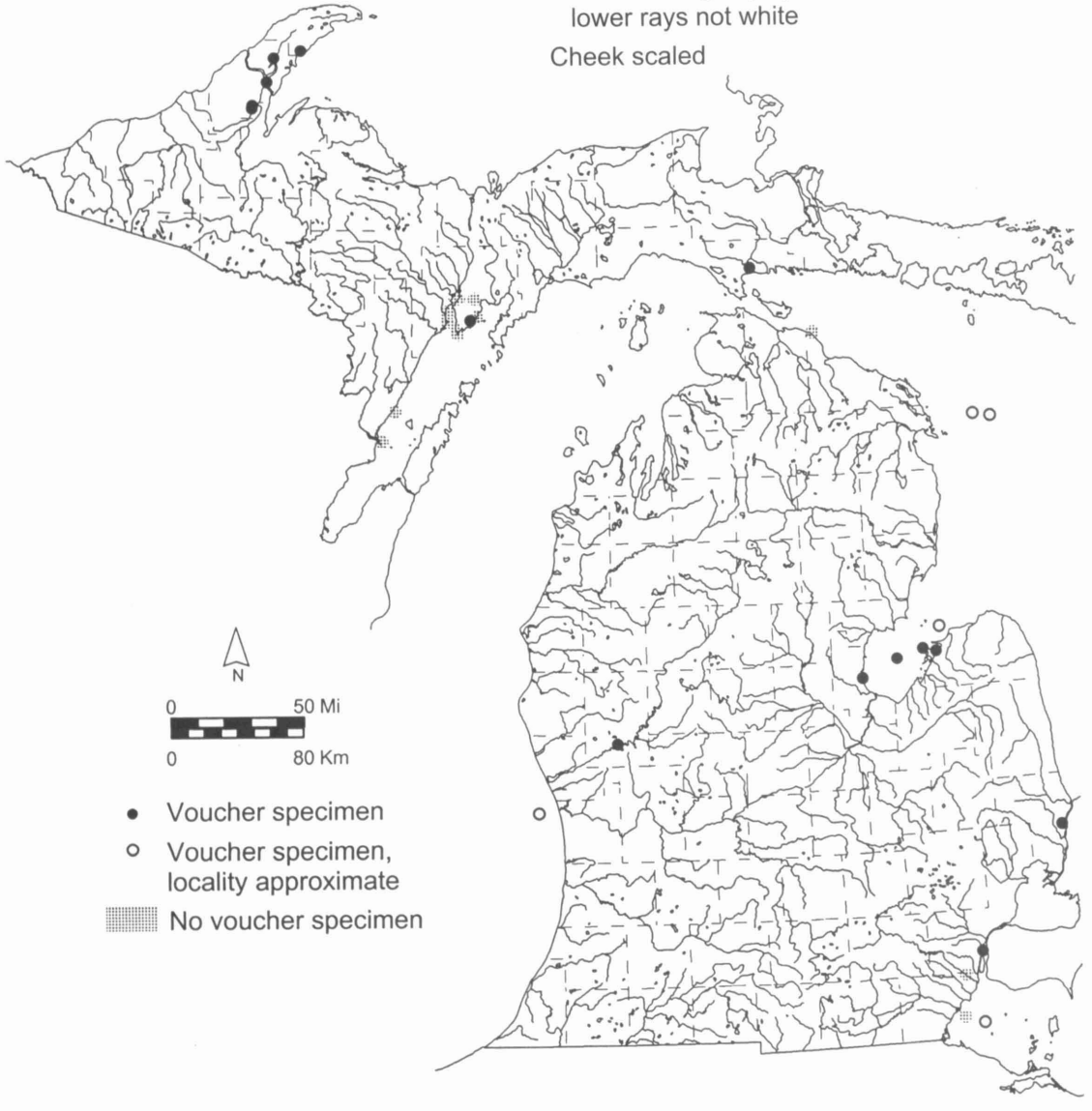
Sander canadensis

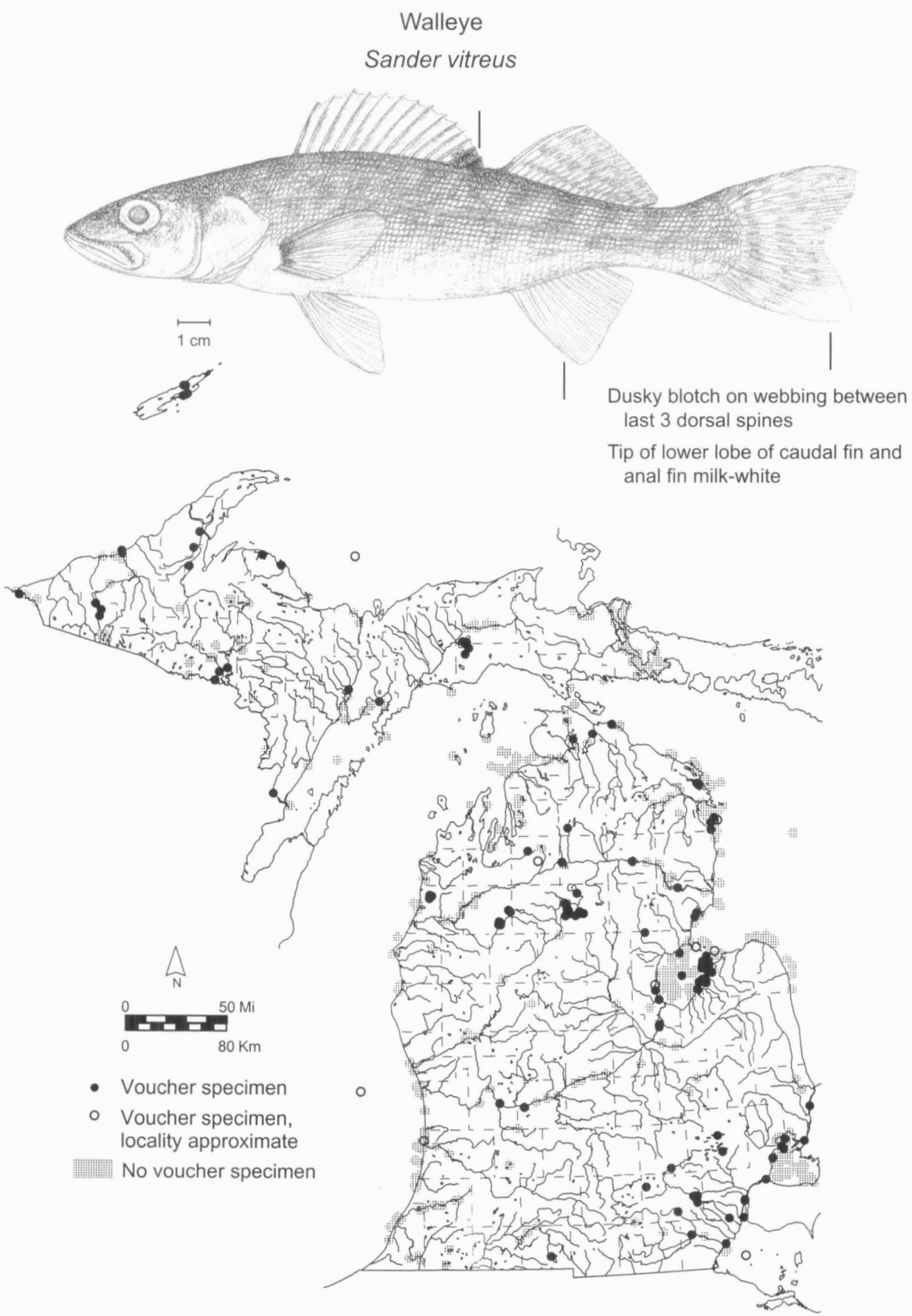


Spinous dorsal with series of round dusky spots; no posterior blotch

Caudal fin vaguely spotted or barred; lower rays not white

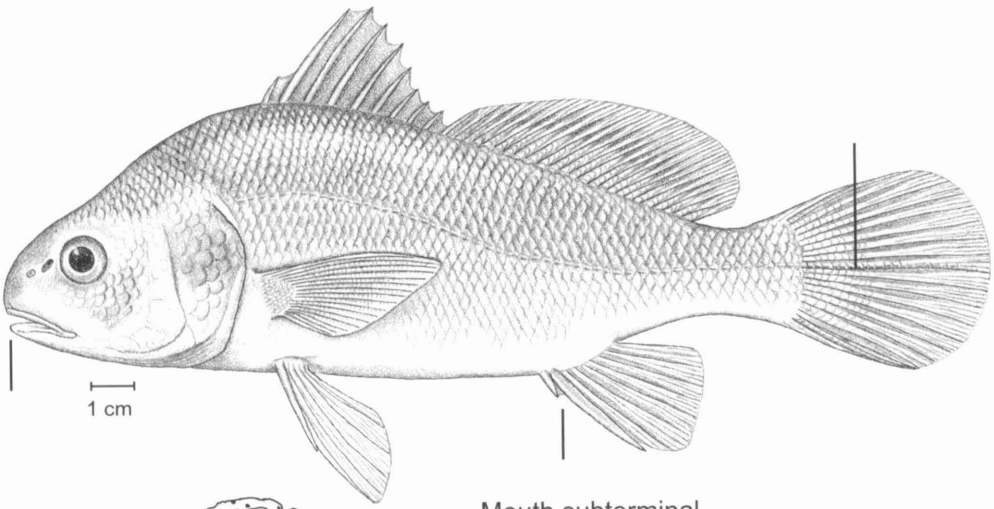
Cheek scaled




Walleye
Sander vitreus
1 cm
Dusky blotch on webbing between last 3 dorsal spines
Tip of lower lobe of caudal fin and anal fin milk-white
N
0 50 Mi
0 80 Km
Voucher specimen
Voucher specimen, locality approximate
No voucher specimen

Freshwater Drum

Aplodinotus grunniens



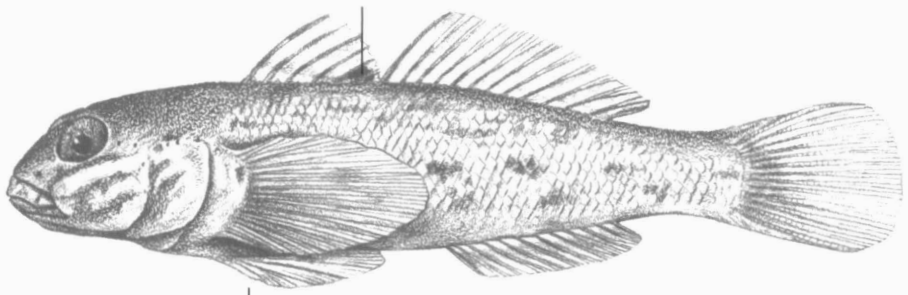
Mouth subterminal

Lateral line pores extend across tail

Two anal spines, first short, second long and stout

Round Goby

Neogobius melanostomus

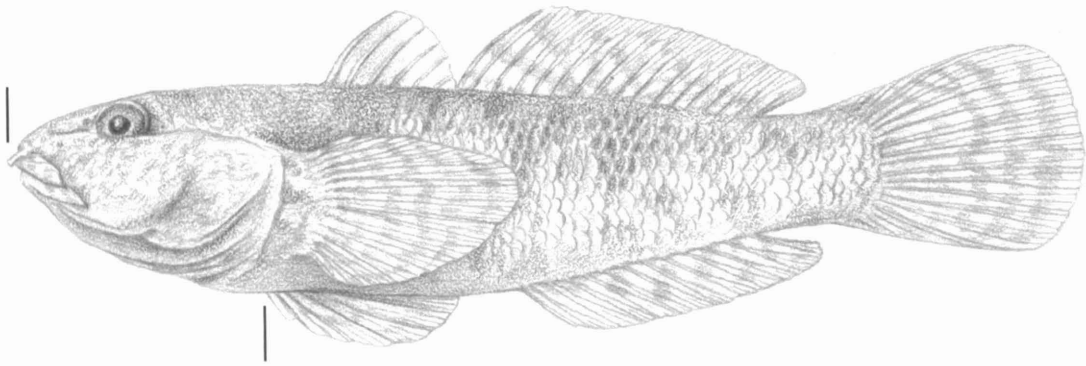


Pelvic fins fused into disc

Black spot at posterior of first dorsal fin

Tubenose Goby

Proterorhinus marmoratus



1 cm

Pelvic fins fused into disc

Tube-like projection from nostril

GLOSSARY

abbreviate – (adj.) comparatively shortened, as in dorsal lobe of gar caudal fin
abdominal – positioned on the abdomen, as the pelvic fin of many fishes
adipose eyelid – transparent covering over parts of eye
adipose fin – a median dorsal fin, usually small and without rays, ahead of caudal fin
allopatric – living in a separate area from a related form
anal fin – median ventral fin ahead of caudal fin
anal opening – opening of the digestive tract, usually ahead of anal fin
anguilliform – eel-shaped body
anterior gill arch – first of five gill arches behind the throat of bony fishes
axial – longitudinal, near the body axis (e.g., skeleton or muscles)
ballast – water taken into the hold of cargo ships for stability, often with organisms
band – vertical color mark, as opposed to horizontal stripe
barbels – finger-like, sensory projections of skin, usually near the mouth or nostrils
basibranchial plate – elongate bone behind tongue and between ventral ends of gill arches
beak – elongated jaws (e.g., as in gars or silverside)
bicuspid – two-pointed teeth
bony plates – usually flat bones in the skin (not scales)
bony stay (sculpins) – bone extending over cheek from the third suborbital to preopercle
branchiostegals – paired, fan-like series of 3-19 bones under the jaws and opercular series
buccal funnel – mouth of lamprey
caeca (pyloric) – finger-like sacs emerging from the digestive tract near the stomach
canine – long sharp teeth
caudal keel – raised, lateral, horizontal ridge on caudal peduncle (e.g., in some sticklebacks)
caudal peduncle – slender part of body ahead of caudal fin
caudal vertebrae – posterior vertebrae, counted as those with hemal arches and including the half-centrum of the hypural
cephalic canals – sensory canals, with pores, on head
chambers (of swimbladder) – one, two, or three sacs forming the swimbladder
circumoral (teeth in lampreys) – row of teeth surrounding center of mouth
circumpeduncular – number of scales counted diagonally around the caudal peduncle
compressed – flattened side-to-side
conjoined – connected, as in two dorsal fins
contiguous – touching each other, as in two dorsal fins
ctenoid scale – scale with an exposed field of tiny spines
cycloid scale – made of thin, circular or oval, overlapping plates that grow outward from a focus
dentary – the anterior paired bones of the lower jaw
dentition – pattern or presence of teeth
depressed – flattened top-to-bottom
dimorphic – with two shapes, as in male and female structures or coloration
dorsal – on or along the back of the body
ectopterygoid – paired bones post-ventral to the palatines on the roof of the mouth
eel-like – long, slender, and sinuous shape
emarginate – caudal fin weakly concave along its trailing edge
endangered – formally identified as a species at risk of extinction or extirpation
entire (bone or spine) – (adj.) smooth, without serrations or saw-edge
entopterygoid – paired flat bones in roof of mouth mesial to ectopterygoids
exotic – introduced from another region; alien
extinct – a species with no living members, anywhere
extirpated – a species that has been eliminated from a region, such as Michigan
extrascapular canal – sensory canal above shoulder (in northern pike and muskellunge)
falcate – fin with a strongly concave trailing edge
falciform – fin with a strongly concave trailing edge
filament – an extended, thread-like fin ray (e.g., in dorsal fin of gizzard shad)
fimbriate – bone edge drawn out into thin, irregular projections, like a tattered flag
fin base – the line of attachment of a fin to the body, used as a basis of measurement
flexible spines (sculpins) – unossified fin spines
fontanelle – an opening in the midline between paired bones of top of head
forked caudal fin – caudal fin with a strong notch in the trailing edge
free dorsal spines – spines not connected to each other by membranes (e.g., in sticklebacks)
free (gill) membrane – left and right gill membranes connected to each other, not to the isthmus
frenum – a surface bridge of skin from the snout to the upper lip (e.g., in some minnows and darters)
genital papilla – finger-like tube through which reproductive products are released
gibbous – rounded, convex, protuberant
gill aperture – opening of the pharynx from which water exits in respiration
gill arch – bony structures supporting gill filaments (and gill rakers in bony fishes)
gill cover – the opercular series covering the gills

gill filament – bright red (in life) threads of tissues with blood vessels for gas exchange
gill membranes – skin forming the borders of the opercular series and branchiostegals
gill rakers – rows of stiff anterior projections forming a food straining system on the gill arches in bony fishes; counts of rakers are usually restricted to the first arch
gills – in fishes, pairs of pharyngeal arches with filaments for respiration and sometimes rakers for food capture
gizzard – muscular stomach in some herrings
gular – (adj.) positioned on the throat
hemal arch – of caudal vertebrae, formed by joining of the ventral processes
heterocercal – caudal fin shape in which the upper lobe is stronger and longer
homocercal – caudal fin shape in which the upper and lower lobes are externally symmetrical
horny teeth in lampreys – teeth composed of cornified tissue, not bone and enamel
humeral spot – shoulder spot, above the pectoral fin base
hybrid – an individual whose parents belong to different species
hyoid (basibranchial) teeth – teeth on the floor of the mouth behind the tongue
hypural plate – the plates to which muscles attach, at the base of the caudal fin
imbedded – scales that are buried in skin
immaculate – spotless; referring to pigmentation pattern
inferior – low or below
infraorbitals – partial ring of bony plates in front of, below, and behind eye
insertion – the posterior or ventral end of the fin base opposite the origin
interorbital space – space measured between the dorsal edges of the two orbits
interradial membranes – flexible skin of the fins extending between spines or rays
interspaces (between parr marks or bands) – unpigmented spaces
introduced – an alien species planted out of its native range by humans
invader – an alien species that has gained access to a new area through waterways
isthmus – the area on the throat between the gills, below the pharynx
keel – ridge of skin or bone on (or of) scales; on plates, belly, or caudal peduncle
lachrymal or lacrimal – the first suborbital bone, anterior to the eye
lanceolate – narrow and tapering at each end
lateral line – sensory canal with nerves and pores along lateral body scales
lateral line incomplete – some number of the posterior lateral line scales lack canals
lateral line scales – approximately midlateral line of scales usually bearing sensory canal and pores
linear (scales) – elongate or elliptical scales
lingual lamina – bilateral fleshy structure near center of oral funnel (in lampreys)
lower jaw included – lower jaw shorter than upper and closes inside edges of upper jaw
lumen – the open tube through the digestive tract (e.g., in lamprey digestive tract)
lunate – (adj.) strongly concave trailing edge of caudal fin
mandible – lower jaw or the pairs of lower jaw bones
mandibular pores – sensory canal pores on ventral side of lower jaw
maxillae – the primary paired bones of the upper jaw, posterior to the premaxillae
median barbel – single barbel, located in the midline of the chin
median fins – dorsal, anal, and caudal fins, and adipose fin when present
median nostril – single nostril in the top of the head in lampreys
melanophore – cell containing black or dark brown pigment
mesial – at or near the center or axis
molariform tooth – with flat or rounded oclusal surface for crushing or grinding
myomeres – units of lateral muscle, usually appearing as a series of W-shaped bands along sides
nape – surface along the back, behind the head
nasal barbel – paired barbels originating near the nasal openings of catfish
nasal flap – partition between the incurrent and excurrent openings of each nostril
native – (adj.) distribution in the original, pre-human disturbance range of a species
nostril – anterior/posterior openings (sometimes single) over a rosette of olfactory organs
notched – concave or V-shaped trailing edge of a caudal fin
nuptial tubercles – cornified cones of tissue on fins or skin of breeding fish
oblique – (adj.) diagonal
occiput – (n.) the point or line where the body joins the back of the head
opercle – largest and most dorsal of the gill-covering bones
opercular spine – posterior point or spine on the opercle (e.g., in striped basses)
oral disc – mouth without jaws; round, often with radiating rows of cornified teeth (in lampreys)
origin (of fin) – the leading point of the fin base, often used as a point of measurement
ossified – bony
otoliths – three pairs of calcium carbonate hearing "stones" in the inner ears of fishes
ovate shape – body profile (lateral view) deepest ahead of middle (in some ciscoes)
paired fins – pectoral and pelvic fins
palatine – paired bones in front edges of the roof of the mouth lateral to the vomer
papillose – lips bearing rows of small bumps covered with taste buds
parasitic (lampreys) – those species in which adults attach to fish and feed on their fluids

parietals – paired bones in the skull roof behind the frontals and in front of the supraoccipital
parr marks – bands and patches of dark pigment on the sides of some juvenile salmonids
pectoral fin – anterior paired fins originating on the shoulder bones
pelvic axillary process – posterior pointed process of skin at axil of pelvic fin
pelvic fin (ventral fin) – usually posterior paired fins located on the abdomen or below the pectoral fins
peritoneum – connective tissue surrounding the coelom; often pigmented
pharyngeal arch – fifth gill arch, modified to bear teeth on the upper and sometimes lower bones
pharyngeal teeth – teeth located on the lower and sometimes upper bones of the fifth gill arches
plicate – ridges of skin bearing taste buds, on lips of some suckers (see *Moxostoma*)
precaudal vertebrae – anterior vertebrae defined by lack of a closed hemal arch
predorsal length – measured distance between tip of snout and origin of dorsal fin
predorsal scales – number of rows of scales (slightly off center, to avoid double counting) between occiput and origin of dorsal fin
premaxillae – the pair of anterior-most upper jaw bones, often with teeth
preopercle – the roughly half-moon shaped bone behind the cheek muscles, from which the cheek muscles originate
preopercular spines – posterior- and ventrally-directed spines on the outer margin of the preopercle
preoperculomandibular – the canal and its pores on the preopercle and mandible
preorbital – in front of eye, referring to (n.) the lachrymal bone or (adj.) distance to end of snout
prickles – small bony points ornamenting certain areas of skin of sculpins
principal fin rays – fin rays reaching the edge of the fin, comprising the ray count
protractile – (adj.) mouth and jaw bones capable of extending forward on internal hinges
protrusible mouth – protractile mouth, for example on most suckers
pseudobranchium – rudimentary gill filaments on inside of opercle
pyloric caeca – finger-like secretory structures attached to digestive tract near stomach
ramus (of mandible) – the biting arm of the dentary anterior to the muscle attachment process
rays – fin support structures formed of paired rows of tiny bones, the lepidotrichs
refugia – regions inhabited by subsequently-widespread populations during glacial times
retrorse – angled diagonally down and backwards as in premaxillae of lake whitefish
rhomboid or rhombic – scales with parallel diagonal and horizontal sides
rudimentary – reduced in size and function (e.g., rudimentary anterior rays of the anal fin in catfish)
rugose – wrinkled appearance
scale radii – lines extending posteriorly or outward from focus toward edges of scale
scales – thin bony plates made of bony laminae, in overlapping rows in the skin of fish
scutes – bony plates or scales with points or ridges (in sturgeons, on mid-belly of herring)
sensory cavities or chambers – enlarged sensory canal chambers, especially of the dentary and preopercle (e.g., in drum, orangespotted sunfish, and silverjaw minnow)
serrate – with tooth-like or saw-like edges
sexually dimorphic – characterized by size, shape, or color differences in males and females
smolt – young, silvery, salmon in downstream migratory phase
snout – the structure in front of the eye, measured from its anterior tip to the anterior rim of the orbit
soft rays – double, often branched fin supports constructed of pairs of tiny bones
spine – a consolidated (unjointed) fin ray, usually but not always hard and sharp
spinous (dorsal fin) – the first dorsal fin of percoid fishes, with spines
standard length (SL) – the length measured from the tip of the snout to the line of bend at the base of the caudal fin
stripe – a longitudinal, horizontal color pattern, as opposed to a vertical bar
subconical head – shape blunter or less conical than a head shaped more like a cone
subocular shelf – a bony shelf from a suborbital extending inward beneath the eye
subopercle – the half-moon shaped or triangular bone under the opercle
subterete – somewhat less than cigar-shaped
subterminal mouth – position slightly lower than the terminal position
sucking disc – the round mouth of the adult lamprey
superior mouth – directed diagonally upward (e.g., in killifishes)
superolateral eyes – directed diagonally upward (e.g., in sculpins)
supramaxilla – teardrop-shaped bone above the maxilla (e.g., in salmonids and percoids)
supraoccipital bone – the median bone at the back of the skull; in some catfish bearing a median extension back to (or toward) the bone at the base of the dorsal spine
supraorbital bone – cup-shaped bone above the eye in minnows and some suckers
supratemporal canal – sensory canal in the paired bones at the postero-lateral corners of the skull
swimbladder – the gas-filled (usually) sac in the upper body cavity, providing hydrostatic lift in fishes; also called the air-bladder or gas-bladder
sympatric – (adj.) living in the same geographic range as another species
symphyseal (knob) – the raised bump at the symphysis of the dentaries (e.g., in some ciscoes)
symphysis – the line of connection between the left and right dentaries
teardrop – the dark pigment mark beneath the eye (e.g., in some darters and esocids)
terete – cylindrical in cross-section and stream-lined; somewhat missile shaped
terminal – (adj.) position at the end of a structure such as a fin or maxilla
third infraorbital – (n.) the bone below the eye, behind the lachrymal (first suborbital) and jugal (second suborbital)
thoracic (pelvic fin) – position of the pelvic fin when it is on the chest, approximately beneath the pectoral fin
threatened – a formal category of species at risk, less severe than endangered

total length (TL) – the maximum length of a fish from its anteriormost tip to the end of the caudal fin lobes (with the caudal fin lobes squeezed together)
transverse scale rows – the number of horizontal rows of scales on the side of the body
truncate – (adj.) the squared-off shape of a caudal fin (e.g., in some bullhead catfishes)
tuberculate – (adj.) bearing nuptial tubercles
unbranched fin rays – fleshy, simple fin rays (e.g., in the second dorsal and anal fins of sculpins)
unicuspid – single-pointed teeth (e.g., in some lampreys)
unpored lateral-line scales – posterior scales in the lateral-line series, but without pores
urogenital – pore or papilla through which urine, eggs, or sperm are released
ventral fins – pelvic fins, usually in the abdominal or thoracic position
ventral mouth – mouth opening oriented downward toward the substrate
villiform – the shape of teeth characterized as slender, of variable length, and more or less pointed
vomer – the anterior median bone of the roof of the mouth usually with a head and a shaft, these parts separately bearing teeth or not
Weberian complex – the diagnostic chain of four or five modified anterior vertebrae and their associated parts, which transmit sound energy from the swimbladder to the inner ear, enhancing sound reception. Found in minnows, suckers, catfishes, and their relatives.

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ERRATA

Page 22, line 12, change date to 1758
Page 28, line 18, change "limb or first arch" to "limb of first arch"
Page 37, line 3 of *Luxilus* key, add hyphen at end of line
Page 40, line 4 from bottom, delete parentheses around "(Jordan, 1885)"
Page 41, line 29, after *Ameiurus* enter (Ictaluridae)
Page 47, last line, change date to 1840
Page 50, line 18, "G nther" should read "Günther"
Page 54, line 6 from bottom, change authors from "(Smith, 1834)" to "(Griffith & Smith, 1834)"
Page 114, map, Isle Royale is partly masked, so many localities are not shown
Page 114, below the fish figure, insert an 8 mm scale bar (to indicate 1 cm)
Page 116, below the fish figure, change "lateral scales 39 or more" to "lateral scales 38 or fewer"
Page 116, below the fish figure, insert a 6 mm scale bar (to indicate 1 cm)