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# AN UPDATED ANNOTATED LIST OF WISCONSIN'S FISHES

John Lyons and Konrad Schmidt

# The North American Native Fishes Association

**Est. 1972 — John Bondhus, founder**

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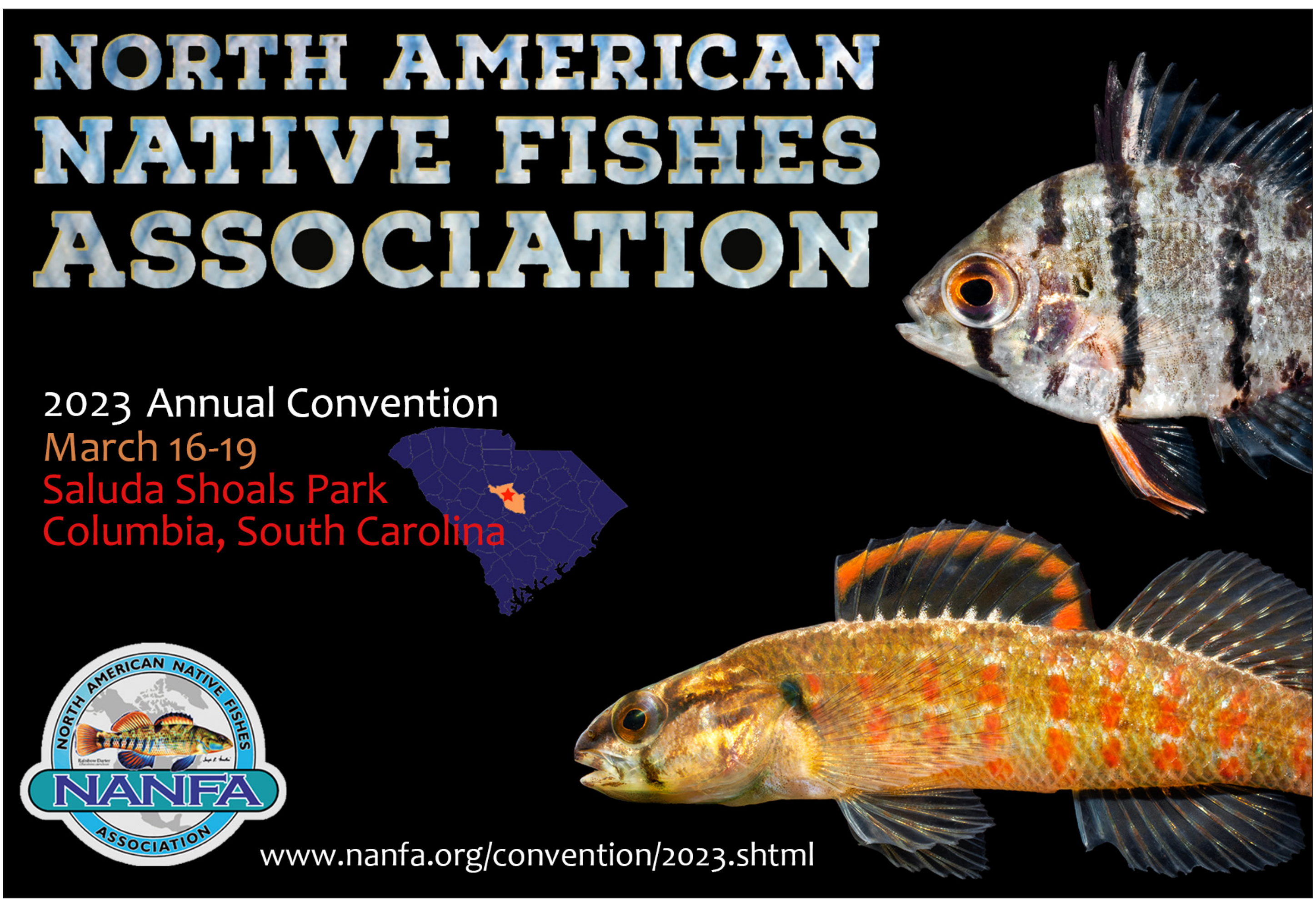

# AN UPDATED ANNOTATED LIST OF WISCONSIN'S FISHES

## John Lyons and Konrad Schmidt

University of Wisconsin Zoological Museum and North American Native Fishes Association

**Summary:** We provide an updated annotated list of the fishes known from the state of Wisconsin, building on the works of Becker (1983) and Lyons et al. (2000). As of 2022, we recognize 164 species that are currently or were once established in the state, 144 native and 20 non-native. Five of the native species have been extirpated, leaving 159 extant species. Since Lyons et al. (2000), we recognize seven additional species, one native and six non-native, and we treat six former native species as conspecific with other species and no longer consider them valid. For each species we provide a brief summary of statewide distribution and relative abundance and, where relevant, we explain why we added or removed species from the list, review recent proposed modifications to scientific names, summarize important studies since the late 1990s in Wisconsin and surrounding states, and discuss major changes in distribution and abundance since the late 1990s.

### INTRODUCTION

The fishes of the state of Wisconsin are diverse and well-studied. The most important and detailed summary of the fauna is George C. Becker's 1983 classic, *Fishes of Wisconsin*. Becker (1983) covered 158 species and subspecies, 147 native and 11 non-native, with nine of the native species considered extirpated. Lyons et al. (2000) updated the state's species list and recognized 161 species, 147 of which were native, 14 non-native, and six extirpated. Changes to the list from Becker (1983) were the addition of two newly discovered or recognized natives, the Southern Brook Lamprey *Ichthyomyzon gagei* and Channel Shiner *Notropis wickliffi;* the consideration of two native forms as no longer worthy of species status, the Longjaw Cisco *Coregonus alpenae* as part of the Shortjaw Cisco *C. zenithicus* and the Siscowet *Salvelinus namaycush siscowet* as part of the Lake Trout *S. namaycush;* the removal of two non-native species thought to be no longer established, the Red Shiner *Cyprinella* (*Notropis*) *lutrensis* and the Pink Salmon *Oncorhynchus gorbuscha;* and the addition of five recently established non-native species, Kokanee Salmon *O. nerka,* Threespine Stickleback *Gasterosteus aculeatus,* White Perch *Morone americana,* Ruffe *Gymnocephalus cernua,* and Round Goby *Neogobius melanostomus*.

Since Lyons et al. (2000), many additional changes have occurred in the Wisconsin fish fauna, and the scientific names of some species have been, or are likely to be, changed to reflect a better understanding of evolutionary relationships. Here we provide an updated fish list for the state using the latest scientific literature and taxonomy and based on 22 years of new collections and studies by us and dozens of other biologists, anglers, and native fish enthusiasts.

### METHODS

We based our updated list on the hundreds of fish collections we have made in Wisconsin since 2000, the thousands more made by state, federal, tribal, and private consultant biologists, myriad reports we have examined and verified from anglers and native fish enthusiasts, and a detailed review of the relevant scientific literature. We have accepted unusual or questionable records only if we could confirm them by examining a live or preserved specimen or a photograph. Whenever possible, we have deposited voucher specimens in the University of Wisconsin Zoological Museum (UWZM) or other regional fish collections. We have tracked the scientific and popular literature at least monthly and include relevant citations since the late 1990s.

We do not include on our list non-native fish species that have occurred but have not become established in Wisconsin. This includes failed gamefish stockings (e.g., Atlantic Salmon *Salmo salar;* Arctic Grayling *Thymallus arcticus*) and illegal releases of pet fish that did not survive to reproduce successfully (e.g., Guppy *Poecilia reticulata;* Oscar *Astronotus ocellatus*). Historically, government agencies and private entities have introduced at least eight species for fisheries that did not take (Becker 1983; Lyons et al. 2000; Lyons 2022). No legal introductions of new non-native gamefish species have been made since the 1970s. However, illegal releases of pets occur every year, and we have accumulated recent records from Wisconsin waters of more than a dozen non-native tropical and temperate pet fishes that did not persist.

For each species we recognize, we provide a brief summary of statewide distribution and relative abundance and describe any substantial changes since Lyons et al. (2000) in the Species Comments section (page 12). See Figure 1 for locations mentioned in the text and Figure 2 for photographs of some representative aquatic habitats. We also justify additions and subtractions to the Wisconsin list there. We base our common and scientific names on the latest

Photos by John Lyons unless otherwise indicated.

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Konrad Schmidt has kept native fishes since he was 15. He is a NANFA Fellow, co-editor of *American Currents,* and an Adjunct Curator of Fishes at the University of Wisconsin Zoological Museum. He was the Minnesota Department of Natural Resources Ichthyologist for 20 years. He continues to travel the upper Midwest, sampling for native fishes. He earned a BA in Biology from Bemidji State University in Minnesota.


**Figure 1a. Map of the major lakes and rivers of Wisconsin. Numbers along the Mississippi River identify each dam as well as the navigation pool upstream of it. The dashed line demarcates the approximate boundary of the unglaciated and hilly Driftless Area. (Map by Olaf Nelson)**

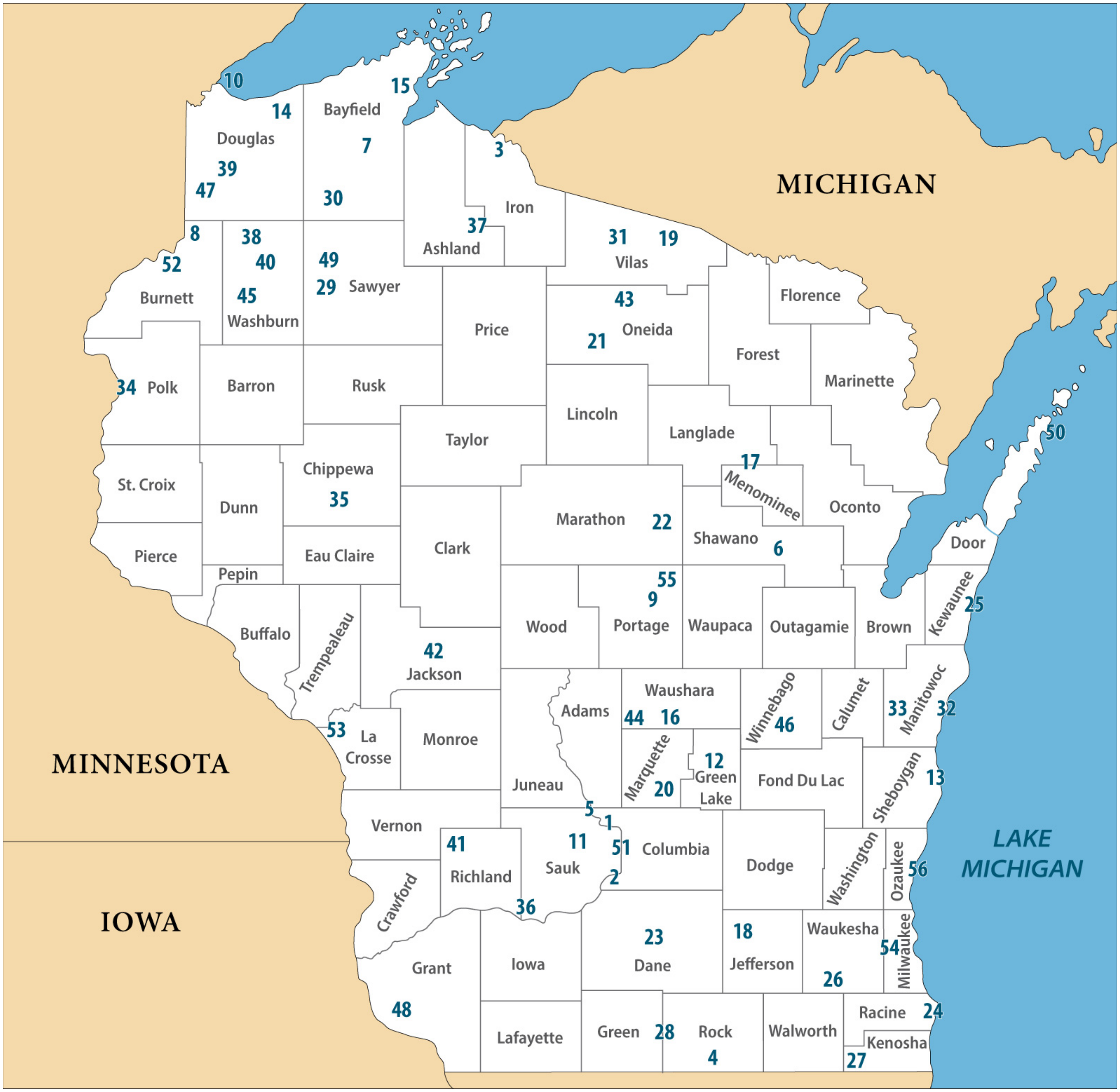


**Figure 1b. Map of the counties of Wisconsin. Numbers indicate specific locations identified by county in the text, listed alphabetically below and opposite. (Map by Olaf Nelson)**

| | | | | | |
|---|---|---|---|---|---|
| Bakkens Pond, Sauk County | 36 | Camp Lake, Kenosha County | 27 | City of Kewaunee, Kewaunee County | 25 |
| City of Baraboo, Sauk County | 11 | City of Chippewa Falls, Chippewa County | 35 | Lac Court Oreilles and Whitefish lakes, Sawyer County | 29 |
| City of Beloit, Rock County | 4 | Clear Lake, Oneida County | 43 | Long Lake, Manitowoc County | 33 |
| Big Green Lake, Green Lake County | 12 | Delta Lake, Bayfield County | 7 | City of Madison and Lake Monona, Dane County | 23 |
| Black Oak Lake, Vilas County | 19 | Drew Creek and Florence and Upper Bass lakes, Langlade and Menominee counties | 17 | City of Manitowoc and Manitowoc River, Manitowoc County | 32 |
| City of Black River Falls, Jackson County | 42 | Duluth-Superior Harbor, Douglas County (WI)/St. Louis County (MN) | 10 | Mecan River, Waushara County | 44 |
| Bois Brule River, Douglas County | 14 | Ennis Lake, Marquette County | 20 | Milwaukee County Zoo | 54 |
| Boomer Creek, Iron County | 3 | Gallus Slough, Wisconsin River, Sauk County | 51 | Moose River, Douglas County | 39 |
| Village of Boulder Junction, Vilas County | 31 | Village of Hayward, Sawyer County | 49 | Mukwonago River, Waukesha County | 26 |
| Village of Brodhead, Green County | 28 | | | | |
| Lake Butte des Morts, Winnebago County | 46 | | | | |
| Camp Creek, Richland County | 41 | | | | |

**Figure 2a. A small subset of the many different streams and rivers of Wisconsin. Top Left: Camp Creek, Richland County, 5 July 2006, a small coldwater stream in the Driftless Area, home to Brown Trout and Slimy Sculpin. Top Right: Mukwonago River, Waukesha County, 22 May 2009, a medium-sized warmwater river, home to the highest diversity of fishes at any one spot in the state in a single sample (45 species) and the best population of the state-threatened Northern Sunfish. Bottom Left: Black River, Jackson County, a few miles downstream of Black River Falls, 5 October 2006, a large warmwater river with stained ("black") water, home to the highest darter diversity in the state with nine species (Western Sand Darter, Rainbow Darter, Fantail Darter, Johnny Darter, Banded Darter, Logperch, Gilt Darter, Blackside Darter, and Slenderhead Darter) as well as many other non-darter fish species. Bottom Right: Mississippi River, Grant County, Pool 11, Jack Oak Slough, 10 July 2018, home to a diverse group of backwater fishes including Longnose Gar, Pallid Shiner, Pugnose Minnow, Weed Shiner, Orangespotted Sunfish, Mud Darter, and Bluntnose Darter.**

| | | | | | |
|---|---|---|---|---|---|
| Namekagon River, Burnett County | 8 | Rattlesnake Creek, Grant County | 48 | Tomahawk River, Oneida County | 21 |
| Norrie Brook and Norrie Lake, Marathon County | 22 | Rock Lake, Jefferson County | 18 | Totagatic River, Washburn County | 38 |
| North Bay, Door County | 50 | Sauk Creek, Ozaukee County | 55 | Trego Dam, Namekagon River, Washburn County | 40 |
| City of Onalaska, Lacrosse County | 53 | City of Shawano, Shawano County | 6 | Trout Lake, Vilas County | 18 |
| Pike, Onion, and Sioux rivers, Bayfield County | 15 | City of Sheboygan and Sheboygan River, Sheboygan County | 13 | Upper Eau Claire Lake, Bayfield County | 30 |
| Plover River, Portage County | 55 | Spillerberg Creek, Ashland County | 37 | Village of Webster, Burnett County | 52 |
| City of Portage and Portage Canal, Columbia County | 1 | St. Croix (Taylors) Falls, Polk County (WI) and Chisago County (MN) | 34 | West Branch of the White River, Waushara County | 16 |
| Prairie du Sac Dam, Wisconsin River, Sauk and Columbia counties | 2 | City of Stevens Point, Portage County | 9 | City of Wisconsin Dells, Columbia County | 5 |
| City of Racine, Racine County | 24 | Lower Sugar River, Green and Rock Counties | 28 | Yellow River, Washburn County | 45 |
| | | Toad Creek, Douglas County | 47 | | |

**Figure 2b. Photos of a small subset of the diverse ponds and lakes of Wisconsin: Top Left: Unnamed constructed stormwater detention pond in Madison, Dane County, 29 July 2006, home to Goldfish and Central Mudminnow. Top Right: Clear Lake, Oneida County, 27 September 2007, a medium-sized, deep, clearwater lake, home to Cisco, Rock Bass, Smallmouth Bass, Yellow Perch, and several other fishes. Bottom Left: Lake Winnebago, Winnebago County, 27 July 2007, a large, shallow, productive lake, home to a wide variety of fishes including Lake Sturgeon, Trout-Perch, White Bass, Walleye, and Freshwater Drum. Bottom Right: Lake Superior, Douglas County, near the mouth of the Bois Brule River, 7 June 2007, the largest freshwater lake in the world by surface area and home to at least four forms of Cisco, Lake Whitefish, Round Whitefish, Pygmy Whitefish, at least two forms of Lake Trout, Burbot, Ninespine Stickleback, Spoonhead Sculpin and Deepwater Sculpin, among many others.**

American Fisheries Society-American Society of Ichthyologists and Herpetologists (AFS-ASIH) list of common and scientific names for North American fishes (Page et al. 2013). This list is revised approximately every 10 years, and a new one is due soon. Where we believe the status or name of a species, genus, or family will change in the next edition, we use the new status or name here and provide supporting documentation. Where the nomenclature is in flux, we use the name from the most recent AFS-ASIH list but also provide and discuss proposed alternatives.

## RESULTS

We recognize 164 species that are or were once established in Wisconsin (Table 1). One hundred and forty-four of these species are native, that is, they were found in the state immediately prior to Euro-American exploration and settlement. Twenty species are non-native; that is, they have entered and become established in the state since Euro-American settlement through either intentional or accidental introductions or invasions via canals or other human modifications of waterways that gave them access. Of the native species, five have been extirpated; that is, they have disappeared from the state but still occur elsewhere, leaving 159 extant species currently present.

Seven species have been added to the state list since Lyons et al. (2000) (Table 1). One native species that had previously gone unrecognized is here considered valid, the Carmine Shiner *Notropis percobromus,* formerly part of the Rosyface Shiner *N. rubellus* species complex. In addition, six additional non-native species have become established (or reestablished) in the state: Grass Carp *Ctenopharyngodon idella,* Silver Carp *Hypophthalmichthys molitrix,* Bighead Carp *H. nobilis,* Pink Salmon *O. gorbuscha* (reestablished), Western Mosquitofish *Gambusia affinis,* and Freshwater Tubenose Goby *Proterorhinus semilunaris*. A new non-native subspecies, the Eastern Banded Killifish *Fundulus diaphanus diaphanus,* has also appeared.

Many native Wisconsin species have had their range and distribution within the state expanded because of human activities such as stocking or canal building. Thus, they are, by definition, non-native in certain parts of Wisconsin. Most of the stocking has been poorly documented, has involved gamefish and bait species that were already widespread, and has largely filled in natural "gaps" in distribution in specific lakes or streams or localized regions of the state where these species were absent historically. Consequently, in some waters it is unclear whether particular species are native or not.

**Table 1. Fishes formerly or currently established in Wisconsin waters as of 2022. Taxonomic order and nomenclature follow Page et al. (2013) except where superseded by more recent taxa-specific publications and explained in the text. Former names used in Lyons et al. (2000) or proposed since then but not used here are given in parentheses and explained in the text. For status, E = State of Wisconsin Endangered, T = State Threatened, S = State Special Concern, X = extirpated from Wisconsin.**

| Common Name | Scientific Name | Status | Comments |
|---|---|---|---|
| LAMPREYS | PETROMYZONTIDA | | |
| Chestnut Lamprey | *Ichthyomyzon castaneus* | Native | Could include *Ichthyomyzon gagei.* |
| Northern Brook Lamprey | *Ichthyomyzon fossor* | Native | Could be part of *Ichthyomyzon unicuspis.* |
| Southern Brook Lamprey | *Ichthyomyzon gagei* | Native | Could be part of *Ichthyomyzon castaneus.* |
| Silver Lamprey | *Ichthyomyzon unicuspis* | Native | Could include *Ichthyomyzon fossor.* |
| American Brook Lamprey | *Lethenteron* (*Lampetra*) *appendix* | Native | Recent genus change. |
| Sea Lamprey | *Petromyzon marinus* | Non-Native | |
| STURGEONS | ACIPENSERIDAE | | |
| Lake Sturgeon | *Acipenser fulvescens* | Native-S | Recently reestablished in several areas. |
| Shovelnose Sturgeon | *Scaphirhynchus platorynchus* | Native | |
| PADDLEFISHES | POLYODONTIDAE | | |
| Paddlefish | *Polyodon spathula* | Native-T | |
| GARS | LEPISOSTEIDAE | | |
| Longnose Gar | *Lepisosteus osseus* | Native | Hybridization with *L. platostomus* common. |
| Shortnose Gar | *Lepisosteus platostomus* | Native | Hybridization with *L. osseus* common. |
| BOWFINS | AMIIDAE | | |
| Bowfin | *Amia calva* (*ocellicauda*) | Native | Possibly part of species complex. |
| MOONEYES | HIODONTIDAE | | |
| Goldeye | *Hiodon alosoides* | Native-E | |
| Mooneye | *Hiodon tergisus* | Native | |
| FRESHWATER EELS | ANGUILLIDAE | | |
| American Eel | *Anguilla rostrata* | Native-S | |
| HERRINGS | CLUPEIDAE (ALOSIDAE, DOROSOMATIDAE) | | New family names proposed. |
| Skipjack Herring | *Alosa chrysochloris* | Native-E/X | Rare stray. Functionally extirpated. |
| Alewife | *Alosa pseudoharengus* | Non-Native | In decline in Lake Michigan. |
| Gizzard Shad | *Dorosoma cepedianum* | Native | |
| BARBS & CARPS (MINNOWS) | CYPRINIDAE | | Minnow families have been redefined. |
| Goldfish | *Carassius auratus* | Non-Native | |
| Common Carp | *Cyprinus carpio* | Non-Native | |
| EAST ASIAN MINNOWS | XENOCYPRIDIDAE | | Minnow families have been redefined. |
| Grass Carp | *Ctenopharyngodon idella* | Non-Native | Resident but no reproduction. |
| Silver Carp | *Hypophthalmichthys molitrix* | Non-Native | Resident but no reproduction. |
| Bighead Carp | *Hypophthalmichthys* (*Aristichthys*) *nobilis* | Non-Native | Resident but no reproduction. |
| MINNOWS | LEUCISCIDAE | | Minnow families have been redefined. |
| Central Stoneroller | *Campostoma anomalum* (*pullum*) | Native | Scientific name change likely. |
| Largescale Stoneroller | *Campostoma oligolepis* | Native | |

| Common Name | Scientific Name | Status | Comments |
|---|---|---|---|
| Northern Redbelly Dace | *Chrosomus* (*Phoxinus*) *eos* | Native | Recent genus change. |
| Southern Redbelly Dace | *Chrosomus* (*Phoxinus*) *erythrogaster* | Native | Recent genus change. |
| Finescale Dace | *Chrosomus* (*Phoxinus*) *neogaeus* | Native | Recent genus change. |
| Redside Dace | *Clinostomus elongatus* | Native | |
| Lake Chub | *Couesius plumbeus* | Native | |
| Spotfin Shiner | *Cyprinella spiloptera* | Native | |
| Gravel Chub | *Erimystax x-punctatus* | Native-E | |
| Brassy Minnow | *Hybognathus hankinsoni* | Native | |
| Mississippi Silvery Minnow | *Hybognathus nuchalis* | Native | |
| Pallid Shiner | *Hybopsis amnis* | Native-E | Recent increase in abundance. |
| Striped Shiner | *Luxilus chrysocephalus* | Native-E/X | Recently extirpated. |
| Common Shiner | *Luxilus cornutus* | Native | |
| Redfin Shiner | *Lythrurus umbratilis* | Native-T | |
| Shoal Chub | *Macrhybopsis hyostoma* | Native-T | |
| Silver Chub | *Macrhybopsis storeriana* | Native | |
| Northern Pearl Dace | *Margariscus nachtriebi* (*margarita*) | Native | Subspecies elevated to species. |
| Hornyhead Chub | *Nocomis biguttatus* | Native | |
| Golden Shiner | *Notemigonus crysoleucas* | Native | |
| Pugnose Shiner | *Notropis* (*Miniellus*) *anogenus* | Native-T | |
| Emerald Shiner | *Notropis atherinoides* | Native | |
| River Shiner | *Notropis* (*Alburnops*) *blennius* | Native | Proposed genus change. |
| Ghost Shiner | *Notropis* (*Paranotropis*) *buchanani* | Native-X | |
| Ironcolor Shiner | *Notropis* (*Alburnops*) *chalybaeus* | Native-X | Proposed genus change. |
| Bigmouth Shiner | *Notropis* (*Ericymba*) *dorsalis* | Native | Possibly part of a species complex. |
| Blackchin Shiner | *Notropis* (*Miniellus*) *heterodon* | Native | Proposed genus change. |
| Blacknose Shiner | *Notropis heterolepis* | Native | |
| Spottail Shiner | *Notropis* (*Hudsonius*) *hudsonius* | Native | Proposed genus change. |
| Ozark Minnow | *Notropis* (*Miniellus*) *nubilus* | Native-T | Possibly part of a species complex. |
| Carmine (Rosyface) Shiner | *Notropis percobromus* (*rubellus*) | Native | Formerly part of *Notropis rubellus*. |
| Rosyface Shiner | *Notropis rubellus* | Native | Split into *Notropis percobromus*. |
| Sand Shiner | *Notropis* (*Miniellus*) *stramineus* | Native | Possibly part of a species complex. |
| Weed Shiner | *Notropis* (*Alburnops*) *texanus* | Native | Proposed genus change. |
| Mimic Shiner | *Notropis* (*Paranotropis*) *volucellus* | Native | Relation to *Notropis wickliffi* uncertain. |
| Channel Shiner | *Notropis* (*Paranotropis*) *wickliffi* | Native | Relation to *Notropis volucellus* uncertain. |
| Pugnose Minnow | *Opsopoeodus emiliae* | Native | |
| Suckermouth Minnow | *Phenacobius mirabilis* | Native | |
| Bluntnose Minnow | *Pimephales notatus* | Native | |
| Fathead Minnow | *Pimephales promelas* | Native | |
| Bullhead Minnow | *Pimephales vigilax* | Native | |
| Longnose Dace | *Rhinichthys cataractae* | Native | |

| Common Name | Scientific Name | Status | Comments |
|---|---|---|---|
| Western Blacknose Dace | *Rhinichthys obtusus* (*atratulus*) | Native | Subspecies elevated to species. |
| Creek Chub | *Semotilus atromaculatus* | Native | |
| **SUCKERS** | **CATOSTOMIDAE** | | |
| River Carpsucker | *Carpiodes carpio* | Native | |
| Quillback | *Carpiodes cyprinus* | Native | Non-native Lake Superior population. |
| Highfin Carpsucker | *Carpiodes velifer* | Native | |
| Longnose Sucker | *Catostomus catostomus* | Native | |
| White Sucker | *Catostomus commersonii* | Native | |
| Blue Sucker | *Cycleptus elongatus* | Native-T | |
| Western Creek Chubsucker | *Erimyzon claviformis* (*oblongus*) | Native-X | Subspecies elevated to species. |
| Lake Chubsucker | *Erimyzon sucetta* | Native-S | Likely to have scientific name change. |
| Northern Hog Sucker | *Hypentelium nigricans* | Native | |
| Smallmouth Buffalo | *Ictiobus bubalus* | Native | Hybridization w/ *Ictiobus niger* common. |
| Bigmouth Buffalo | *Ictiobus cyprinellus* | Native | |
| Black Buffalo | *Ictiobus niger* | Native-T | Hybridization w/ *Ictiobus bubalus* common. |
| Spotted Sucker | *Minytrema melanops* | Native | |
| Silver Redhorse | *Moxostoma anisurum* | Native | |
| River Redhorse | *Moxostoma carinatum* | Native-T | |
| Black Redhorse | *Moxostoma duquesnei* | Native-E | |
| Golden Redhorse | *Moxostoma erythrurum* | Native | |
| Shorthead Redhorse | *Moxostoma macrolepidotum* | Native | |
| Greater Redhorse | *Moxostoma valenciennesi* | Native | No longer considered threatened in WI. |
| **BULLHEAD CATFISHES** | **ICTALURIDAE** | | |
| Black Bullhead | *Ameiurus melas* | Native | |
| Yellow Bullhead | *Ameiurus natalis* | Native | |
| Brown Bullhead | *Ameiurus nebulosus* | Native | |
| Channel Catfish | *Ictalurus punctatus* | Native | |
| Slender Madtom | *Noturus exilis* | Native-E | Lake population discovered. |
| Stonecat | *Noturus flavus* | Native | |
| Tadpole Madtom | *Noturus gyrinus* | Native | |
| Flathead Catfish | *Pylodictis olivaris* | Native | |
| **SMELTS** | **OSMERIDAE** | | |
| Rainbow Smelt | *Osmerus mordax* | Non-Native | Great lakes decline, inland lake expansion. |
| **TROUTS** | **SALMONIDAE** | | |
| Cisco | *Coregonus artedi* | Native | Includes 7 former Great Lakes species. |
| Lake Whitefish | *Coregonus clupeaformis* | Native | River-spawning has increased. |
| Pink Salmon | *Oncorhynchus gorbuscha* | Non-Native | Recently reestablished. |
| Coho Salmon | *Oncorhynchus kisutch* | Non-Native | |
| Rainbow Trout | *Oncorhynchus mykiss* | Non-Native | |
| Sockeye Salmon | *Oncorhynchus nerka* | Non-Native | |

| Common Name | Scientific Name | Status | Comments |
|---|---|---|---|
| Chinook Salmon | *Oncorhynchus tshawytscha* | Non-Native | |
| Pygmy Whitefish | *Prosopium coulterii* | Native | |
| Round Whitefish | *Prosopium cylindraceum* | Native | |
| Brown Trout | *Salmo trutta* | Non-Native | |
| Brook Trout | *Salvelinus fontinalis* | Native | |
| Lake Trout | *Salvelinus namaycush* | Native | |
| **PIKES** | **ESOCIDAE** | | |
| Grass Pickerel | *Esox americanus vermiculatus* | Native | New Great Lakes basin population. |
| Northern Pike | *Esox lucius* | Native | |
| Muskellunge | *Esox masquinongy* | Native | Wisconsin's official State Fish |
| **MUDMINNOWS** | **UMBRIDAE (ESOCIDAE)** | | **Classified as Esocidae by some.** |
| Central Mudminnow | *Umbra limi* | Native | |
| **TROUT-PERCHES** | **PERCOPSIDAE** | | |
| Trout-perch | *Percopsis omiscomaycus* | Native | In decline in Lake Michigan. |
| **PIRATE PERCHES** | **APHREDODERIDAE** | | |
| Pirate Perch | *Aphredoderus sayanus* | Native | |
| **CODFISHES (CUSKFISHES)** | **GADIDAE (LOTIDAE)** | | **Classified as Lotidae by some.** |
| Burbot | *Lota lota* (*maculosa*) | Native | Proposed scientific name change. |
| **NEW WORLD SILVERSIDES** | **ATHERINOPSIDAE (ATHERINIDAE)** | | **Family name changed.** |
| Brook Silverside | *Labidesthes sicculus* | Native | Non-native Lake Superior population. |
| **TOPMINNOWS** | **FUNDULIDAE** | | |
| Eastern Banded Killifish | *Fundulus diaphanus diaphanus* | Non-Native | Discovered in Lake Michigan. |
| Western Banded Killifish | *Fundulus diaphanus menona* | Native | Has declined in Lake Michigan. |
| Starhead Topminnow | *Fundulus dispar* | Native-E | Re-introduced into former range. |
| Blackstripe Topminnow | *Fundulus notatus* | Native | |
| **LIVEBEARERS** | **POECILIIDAE** | | |
| Western mosquitofish | *Gambusia affinis* | Non-Native | Recently established. |
| **STICKLEBACKS** | **GASTEROSTEIDAE** | | |
| Brook Stickleback | *Culaea inconstans* | Native | |
| Threespine Stickleback | *Gasterosteus aculeatus* | Non-Native | |
| Ninespine Stickleback | *Pungitius pungitius* | Native | Major decline in Lake Michigan. |
| **SCULPINS** | **COTTIDAE** | | |
| Mottled Sculpin | *Cottus* (*Uranidea*) *bairdii* | Native | Genus change? Decline in Great Lakes. |
| Slimy Sculpin | *Cottus* (*Uranidea*) *cognatus* | Native | Genus change? Decline in Great Lakes. |
| Spoonhead Sculpin | *Cottus ricei* | Native | |
| Deepwater Sculpin | *Myoxocephalus thompsonii* | Native | New family? Depth shift in Lake Michigan. |
| **WHITE BASSES** | **MORONIDAE** | | |
| White Perch | *Morone americana* | Non-Native | |
| White Bass | *Morone chrysops* | Native | Non-native Lake Superior population. |

| **Common Name** | **Scientific Name** | **Status** | **Comments** |
|---|---|---|---|
| Yellow Bass | *Morone mississippiensis* | Native | |
| SUNFISHES | CENTRARCHIDAE | | |
| Rock Bass | *Ambloplites rupestris* | Native | |
| Green Sunfish | *Lepomis cyanellus* | Native | |
| Pumpkinseed | *Lepomis gibbosus* | Native | |
| Warmouth | *Lepomis gulosus* | Native | |
| Orangespotted Sunfish | *Lepomis humilis* | Native | |
| Bluegill | *Lepomis macrochirus* | Native | |
| Northern (Longear) Sunfish | *Lepomis peltastes* (*megalotis*) | Native-T | Subspecies elevated to species. |
| Smallmouth Bass | *Micropterus dolomieu* | Native | |
| Largemouth Bass | *Micropterus nigricans* (*salmoides*) | Native | Major increase in northern lakes |
| White Crappie | *Pomoxis annularis* | Native | |
| Black Crappie | *Pomoxis nigromaculatus* | Native | |
| PERCHES | PERCIDAE | | |
| Western Sand Darter | *Ammocrypta clara* | Native | |
| Crystal Darter | *Crystallaria asprella* | Native-E | |
| Mud Darter | *Etheostoma asprigene* | Native-S | |
| Rainbow Darter | *Etheostoma caeruleum* | Native | Possibly part of a species complex. |
| Bluntnose Darter | *Etheostoma chlorosoma* | Native-E | |
| Iowa Darter | *Etheostoma exile* | Native | |
| Fantail Darter | *Etheostoma flabellare* | Native | |
| Least Darter | *Etheostoma microperca* | Native-S | |
| Johnny Darter | *Etheostoma nigrum* | Native | Species complex? In decline in Lake Michigan. |
| Banded Darter | *Etheostoma zonale* | Native | Possibly part of a species complex. |
| Ruffe | *Gymnocephalus cernua* | Non-Native | Change in spelling of species name. |
| Yellow Perch | *Perca flavescens* | Native | |
| Logperch | *Percina caprodes* | Native | In decline in Lake Michigan. |
| Gilt Darter | *Percina evides* | Native-T | Possibly part of species complex. |
| Blackside Darter | *Percina maculata* | Native | |
| Slenderhead Darter | *Percina phoxocephala* | Native | |
| River Darter | *Percina shumardi* | Native | |
| Sauger | *Sander* (*Stizostedion*) *canadensis* | Native | Disagreement over genus name. |
| Walleye | *Sander* (*Stizostedion*) *vitreus* | Native | Major decline in northern lakes. |
| DRUMS | SCIAENIDAE | | |
| Freshwater Drum | *Aplodinotus grunniens* | Native | Non-native Lake Superior population. |
| GOBIES | GOBIIDAE | | |
| Round Goby | *Neogobius* (*Apollonia*) *melanostomus* | Non-Native | Major increase in Lake Michigan. |
| Freshwater Tubenose Goby | *Proterorhinus semilunaris* (*marmoratus*) | Non-Native | Recently established in Lake Superior. |

**Table 2. Native Wisconsin fish species that are widespread in the Mississippi River basin but have their only (or nearly their only) Wisconsin Lake Michigan basin occurrences in drainages to Green Bay. These species likely colonized Green Bay drainages via**

| Common Name | Scientific Name | Green Bay Drainages | Other Lake Michigan Basin Occurrences in Wisconsin |
|---|---|---|---|
| Chestnut Lamprey | *Ichthyomyzon castaneus* | Fox-Wolf | |
| Northern Brook Lamprey | *Ichthyomyzon fossor* | Fox-Wolf, Peshtigo, Menominee | |
| Silver Lamprey | *Ichthyomyzon unicuspis* | Fox-Wolf, Oconto, Peshtigo, Menominee, Green Bay | |
| Longnose Gar | *Lepisosteus osseus* | Fox-Wolf, Green Bay | |
| Shortnose Gar | *Lepisosteus platostomus* | Fox-Wolf, Green Bay | |
| Bowfin | *Amia calva* | Fox-Wolf, Green Bay | |
| Mooneye | *Hiodon tergisus* | Fox-Wolf | |
| Shoal Chub | *Macrhybopsis hyostoma* | Fox-Wolf | |
| River Shiner | *Notropis blennius* | Fox-Wolf | |
| Bigmouth Shiner | *Notropis dorsalis* | Fox-Wolf | Also in Pike River drainage (colonization?) |
| Carmine Shiner | *Notropis percobromus* | Fox-Wolf, Suamico, Pensaukee, Oconto, Peshtigo, Menominee | |
| Weed Shiner | *Notropis texanus* | Fox-Wolf | |
| Channel Shiner | *Notropis wickliffi* | Fox-Wolf | |
| Pugnose Minnow | *Opsopoeodus emiliae* | Fox-Wolf | |
| Bullhead Minnow | *Pimephales vigilax* | Fox-Wolf | |
| Quillback | *Carpiodes cyprinus* | Fox-Wolf, Green Bay | Recently has expanded into Milwaukee River drainage |
| Lake Chubsucker | *Erimyzon sucetta* | Fox-Wolf | A few records from the Sheboygan (introduced?), Milwaukee, and Root River drainages (colonization?) |
| Spotted Sucker | *Minytrema melanops* | Fox-Wolf | |
| River Redhorse | *Moxostoma carinatum* | Fox-Wolf | |

A major question about native versus non-native fish distribution in the state concerns tributaries to Green Bay, particularly the Fox-Wolf River drainage (Figure 1a). Thirty-seven native Wisconsin species that are found primarily in the Mississippi River basin have their only (or nearly only) Lake Michigan basin occurrences in the Fox-Wolf and adjacent Green Bay drainages (Table 2). Whether these species are native in these Green Bay drainages is unclear. The Wisconsin River (Mississippi River basin) and upper Fox River come within a mile of each other at a low divide at the city of Portage in Columbia County (Figure 1b). Human travelers have crossed this divide to move between Lake Michigan and the Mississippi River for centuries, and a canal was built to facilitate boat traffic in the 1840s. This canal could be traversed by fish until it was sealed in the 1970s. Becker (1983) took the view that many Mississippi River basin species first used this canal to enter the Fox River and spread from there, making them non-native in the Green Bay drainage. Lyons et al (2000), while recognizing that fish used the canal to move between basins, argued that flooding that had routinely overtopped the divide for thousands of years and allowed the Wisconsin River to flow temporarily into the Fox River had given many species an opportunity to colonize Green Bay drainages naturally many years before the canal, making them native. It is probably impossible to resolve the native vs. non-native question for most species. That said, the time since a particular species first entered the Fox-Wolf drainage, less than 200 versus several thousand years, has important implications for understanding the post-glacial development of the Wisconsin fish fauna (Lyons 2022).

Six native species have been removed from the state list since Lyons et al. (2000). We treat the nominal species of Great Lakes ciscoes—Bloater *Coregonus hoyi,* Deepwater Cisco *C. johannae,* Kiyi *C. kiyi,* Blackfin Cisco *C. nigripinnis,* Shortnose Cisco *C. reighardi,* and Shortjaw Cisco *C. zenithicus*—as the same as the Cisco *Coregonus artedi* (Eshenroder et al. 2016).

Since Lyons et al. (2000), many Wisconsin species have had, or are soon likely to have, a change in their scientific names. Six species have had or will have a genus name change, six a species name change, and 14 more could have genus or species name changes in the future (Table 1). Family assignments have shifted for the minnows and silversides, may shift for the herrings, and are uncertain for the Central Mudminnow *Umbra limi,* Burbot *Lota lota,* and Deepwater Sculpin *Myoxocephalus thompsonii.*

**a crossover (either naturally during floods or via an artificial canal) at the low divide between the Wisconsin River and the Fox River near Portage.**

| Common Name | Scientific Name | Green Bay Drainages | Other Lake Michigan Basin Occurrences in Wisconsin |
|---|---|---|---|
| Channel Catfish | *Ictalurus punctatus* | Fox-Wolf, Green Bay | Introduced into a few direct tributaries to Lake Michigan |
| Flathead Catfish | *Pylodictis olivaris* | Fox-Wolf, Green Bay | |
| Grass Pickerel | *Esox americanus vermiculatus* | Fox-Wolf | Historically also in Milwaukee River drainage (colonization?) |
| Trout-Perch | *Percopsis omiscomaycus* | Fox-Wolf, Green Bay | |
| Burbot | *Lota lota* | Fox-Wolf, Suamico, Pensaukee, Oconto, Peshtigo, Menominee, Green Bay | Enters direct tributaries to Lake Michigan during winter spawning |
| Brook Silverside | *Labidesthes sicculus* | Fox-Wolf | |
| Blackstripe Topminnow | *Fundulus notatus* | Fox-Wolf | Also in Milwaukee River drainage (colonization?) |
| White Bass | *Morone chrysops* | Fox-Wolf, Green Bay | |
| Yellow Bass | *Morone mississippiensis* | Fox-Wolf, Green Bay | |
| Warmouth | *Lepomis gulosus* | Fox-Wolf, Oconto (introduced?) | |
| White Crappie | *Pomoxis annularis* | Fox-Wolf | Also in Pike River drainage (introduced?) |
| Western Sand Darter | *Ammocrypta clara* | Fox-Wolf, Menominee | |
| Rainbow Darter | *Etheostoma caeruleum* | Fox-Wolf | |
| Banded Darter | *Etheostoma zonale* | Fox-Wolf, Suamico, Pensaukee, Oconto, Peshtigo, Menominee | |
| Slenderhead Darter | *Percina phoxocephala* | Fox-Wolf | |
| River Darter | *Percina shumardi* | Fox-Wolf | |
| Sauger | *Sander canadensis* | Fox-Wolf | |
| Freshwater Drum | *Aplodinotus grunniens* | Fox-Wolf, Green Bay | Recently expanded into Milwaukee River drainage (colonization?) |

## SPECIES COMMENTS

### LAMPREYS (PETROMYZONTIDAE)

**Lampreys *Ichthyomyzon:*** The genus *Ichthyomyzon* consists of three pairs of closely related parasitic and nonparasitic lampreys for a total of six species (Potter et al. 2014). Wisconsin has two of the pairs, Chestnut Lamprey *I. castaneus* (parasitic) and Southern Brook Lamprey *I. gagei* (nonparasitic) and Silver Lamprey *I. unicuspis* (parasitic) and Northern Brook Lamprey *I. fossor* (nonparasitic) (Figure 3). Within each pair, the larval ammocoetes of the parasitic and nonparasitic species cannot be consistently distinguished, but the metamorphosed adult stages differ with the parasitic species being larger and having better developed teeth and a functional digestive tract. After transformation from the ammocoete stage during the fall and winter, the parasitic form feeds on the blood and bodily fluids of other fishes for about a year before maturing, spawning in the spring, and dying. The nonparasitic form does not feed after transformation and matures, spawns in the spring, and then dies.

Recent studies and observations indicate that the paired parasitic and nonparasitic species could be considered different life-history forms of the same species. There are three lines of evidence for this. First, genetic analyses indicate that parasitic and nonparasitic species populations from the same area are more closely related to (and almost indistinguishable from) each other than they are to their respective parasitic and nonparasitic populations from areas further away (from which they may be somewhat genetically distinct) (Docker 2009; April et al. 2011; Docker et al. 2012; Docker and Potter 2019). In other words, the parasitic and nonparasitic populations from one area are recently derived from the same common ancestor, and that ancestor differs from the most recent common ancestor of the parasitic and nonparasitic populations from elsewhere. If the parasitic and nonparasitic forms were truly separate species, the parasitic populations would be more closely related to each other than they would be to any of the nonparasitic populations and vice versa, and the parasitic and nonparasitic forms would be genetically distinct from each other even when they co-occurred.

Second, Chestnut Lampreys and Southern Brook Lampreys have been observed spawning together in the St. Croix River drainage

**Figure 3. A pair of closely related parasitic and nonparasitic *Ichthyomyzon* lampreys. Top: parasitic Silver Lamprey from the Wisconsin River below the Prairie Du Sac Dam, Sauk County, 25 October 2000. Bottom: nonparasitic Northern Brook Lamprey from the Mecan River, Waushara County, 3 May 2001. Although treated as separate species, these could be considered different life history forms of the same species.**

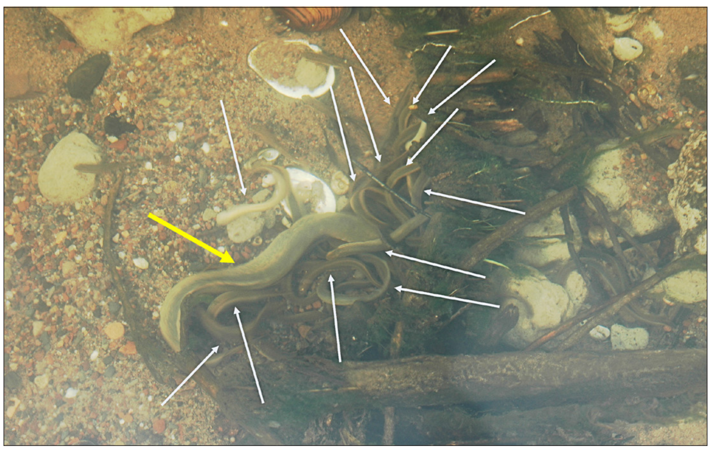

**Figure 4. Chestnut Lamprey (thicker yellow arrow) and Southern Brook Lampreys (thinner light blue arrows) spawning in the same pit in the Yellow River, Washburn County, 26 May 2006.**

(Figure 1a) in Wisconsin (Cochran et al. 2008; Figure 4) and in Missouri (personal communication, John Brant, Fort Leonard Wood, Missouri, 27 May 2021). These lampreys broadcast their eggs and sperm indiscriminately within their spawning pit, and it is hard to imagine that there would not be contact between parasitic and nonparasitic gametes. Yet intermediate "hybrid" forms have never been observed, suggesting that interbreeding between the two forms, if successful, only produces "pure" parasitic or nonparasitic offspring, which would be expected if both forms were the same species.

Finally, single parasitic lampreys have been collected from areas where they were thought to be absent but where their nonparasitic counterparts were widespread and common. This is circumstantial evidence that the nonparasitic form might sometimes give rise to a parasitic individual. We have single records of Chestnut Lamprey from the upper Wisconsin River drainage (Figure 1a; UWZM 12161, 13488), which is isolated by dams and where only the Southern Brook Lamprey is believed to occur (Lyons et al. 1997). In the Maquoketa River in northeastern Iowa, a single Silver Lamprey was recently collected from a well-studied area, isolated by impassable dams, where only Northern Brook Lamprey had been previously observed (personal communication, Greg Gelwicks, Iowa DNR, Manchester, 4 August 2021). The American Brook Lamprey, another Wisconsin nonparasitic species, is known to produce "giant" possibly parasitic forms on rare occasions in the Great Lakes basin (Cochran 2008).

Combining the paired parasitic and nonparasitic *Ichthyomyzon* lampreys into single species would be a major change in taxonomy and has not yet been proposed (Page et al. 2013; Potter et al. 2014). However, we feel the evidence to do this is compelling and we would not be surprised if it eventually occurs.

**Chestnut Lamprey *Ichthyomyzon castaneus:*** Common in medium to large rivers in the St. Croix River drainage and uncommon in the Mississippi River and the lower reaches of its other larger tributaries; rare in the Fox-Wolf River drainage to Green Bay in the Lake Michigan basin. Absent from the Lake Superior basin, direct drainages to Lake Michigan, and the Rock River and Fox-Illinois River drainages (Figure 1a) of the Mississippi River basin. Two recent studies have researched the feeding ecology of the Chestnut Lamprey in Wisconsin (Cochran et al. 2003; Cochran 2014a).

**Northern Brook Lamprey *Ichthyomyzon fossor:*** Locally common in small, coolwater streams in the upper or middle portions of drainages to Green Bay and to the Mississippi River excluding the St. Croix, upper Black (Figure 1a), and upper Wisconsin drainages and most of southern Wisconsin (Lyons et al. 1997). Historically common in the streams of the Lake Superior basin but almost completely eliminated from there (perhaps one small population remains) by lampricide treatments to control the non-native Sea Lamprey.

**Southern Brook Lamprey *Ichthyomyzon gagei:*** Locally common in streams and small rivers in the St. Croix, upper Black, and upper Wisconsin river drainages of the Mississippi River basin (Lyons et al. 1997). These populations are isolated and distant from the nearest other Southern Brook Lamprey occurrences in central Missouri. Absent from the Lake Superior and Lake Michigan basins.

**Silver Lamprey *Ichthyomyzon unicuspis:*** Uncommon in the Mississippi River and the lower reaches of its largest tributaries, the Fox-Wolf River drainage, Green Bay and larger tributaries, and historically present in Lake Superior and its tributaries. Not known from Lake Michigan proper or its direct tributaries or in the Rock River and Fox-Illinois drainages in the Mississippi River basin. The largest concentration is in the lower Wisconsin River below the Prairie du Sac Dam on the Sauk-Columbia County border (Figure 1b). The Silver Lamprey has probably been eliminated from the Lake Superior basin and is greatly reduced in Green Bay and its tributaries by lampricide treatments to control the non-native Sea Lamprey. Three recent studies have examined Silver Lamprey feeding in Wisconsin (Cochran et al. 2003; Cochran and Lyons 2004, 2016).

**American Brook Lamprey *Lethenteron appendix:*** Locally common in relatively cool and cold streams in the Mississippi River and Green Bay drainages (Lyons et al. 1997). Uncommon in direct drainages to Lake Michigan and not known from the Lake Superior basin in Wisconsin

For many years, including in Becker (1983) and Lyons et al. (2000), this species was known as *Lampetra appendix*. *Lethenteron* was considered a subgenus within *Lampetra*. A quantitative morphological analysis demonstrated that the various subgenera of *Lampetra* were distinct enough to be considered full genera (Gill et al. 2003), and this elevation of *Lethenteron* to the genus name for American Brook Lamprey was accepted by Page et al. (2013).

**Sea Lamprey *Petromyzon marinus* NON-NATIVE:** Common in the Great Lakes and in its colder tributaries. Numbers are kept in check by barriers that block spawning migrations and regular applications of lampricides in tributaries to kill the ammocoetes. Sea Lampreys are a blood parasite on larger fishes and have caused substantial mortality of salmon, trout, whitefish, Cisco, suckers, and Burbot. Control of Sea Lamprey abundance is a critical part of fisheries management in the Great Lakes.

## STURGEONS (ACIPENSERIDAE)

**Lake Sturgeon *Acipenser fulvescens* SPECIAL CONCERN** (Figure 5): Historically common in large rivers and lakes throughout Wisconsin in both the Mississippi and Great Lakes basins. However, pollution, habitat loss, overfishing, and dams blocking spawning migrations greatly reduced or eliminated populations in many areas of the state, particularly the Great Lakes and tributaries and the Mississippi River and some of its tributaries (Becker 1983). The Fox-Wolf River/Lake Winnebago (Figure 1a) population is the largest remaining in the state and is currently thriving (Bruch 1999). Carefully regulated recreational fisheries exist in Lake Winnebago and associated lakes (February spearing through the ice) and in several larger rivers (September open-water hook-and-line) (Rypel et al.

**Figure 5. Young-of-year Lake Sturgeon from the Chippewa River, Rusk County, 16 August 1996.**

2016; Embke et al. 2020). Recent studies have analyzed (1) mortality, habitat use, and movements of age-0 (Benson et al. 2005; Caroffino et al. 2010; Tucker et al. 2021 ) and adult Lake Sturgeon (Forsythe et al. 2012; Donofrio et al. 2018) in Green Bay tributaries, subadults in the Wolf River (Snobol et al. 2017), and adults in the Mississippi River and tributaries (Knights et al. 2002); (2) spawning behavior (Bruch and Binkowski 2002), (3) feeding (Stetzer et al. 2008), (4) age and growth (Bruch et al. 2009) in the Fox-Wolf River drainage; and (5) projected future changes in distribution in Wisconsin from climate warming (Lyons and Stewart 2014).

Since the early 1980s, a major statewide Lake Sturgeon restoration program has been underway in Wisconsin involving widespread stocking, strict fishing regulations, and fish passage through select dams (Wisconsin Department of Natural Resources (WDNR) Lake Sturgeon Management Plan 2000. https://dnr.wisconsin.gov/sites/default/files/topic/Fishing/Sturgeon_lsturmplan_eversion.pdf). Because female Lake Sturgeon take 15–25 years to mature, it is only recently that the success of these efforts can be judged. The earliest restoration effort, begun in 1983 in the St. Louis River in western Lake Superior along the border between Wisconsin and Minnesota (Figure 1a), has been a success. Natural reproduction of Lake Sturgeon now occurs regularly and abundance has continued to increase following the cessation of stocking in 1994, although the population remains relatively small (Schram et al. 1999; Welsh et al. 2019).

Elsewhere, it is too early to determine the degree of success of Lake Sturgeon restoration, although results to date are encouraging. In the Milwaukee River (Figure 1a), barrier mitigation (dam removal and provision of fish passage) began in 1993 and stocking began in 2003. The first adult-sized Lake Sturgeon were observed in potential spawning areas in 2020 and 2021. A detailed population model using abundance and size data over the last 18 years projects that if current trends continue, a self-sustaining population will be established by the early 2030s and stocking will no longer be required (Bruch et al. 2021). Farther north, in the Menominee River (Figure 1a), a fish lift has allowed Lake Sturgeon to be moved upstream for spawning past the first two dams on the river that block migrations from Green Bay (Schulze 2017). Reproduction and recruitment in the Menominee and other Green Bay tributaries have improved over the last 25 years (Scribner et al. 2022). In the middle Wisconsin River and its tributaries, where stocking began in the 1990s, stocked fish have survived well and are approaching maturity (Rennicke 2013; WDNR unpublished data). Transfer of adult lake sturgeon from the Wolf River below the Shawano Dam in the city of Shawano, Shawano County, to above the dam, from which the historical native population had disappeared, has led to the establishment of a small resident population and successful reproduction (Koenigs et al. 2019).

**Shovelnose Sturgeon *Scaphirhynchus platorynchus:*** Common in the Mississippi River and the lower reaches of the largest tributaries, particularly the lower Chippewa and Red Cedar (Figure 1a) and the lower Wisconsin rivers. There is a sport fishery in the Mississippi and Lower Wisconsin rivers, and a small commercial fishery in the Mississippi River along the border with Iowa (Klein et al. 2018). Recent studies describe the population demographics and habitat of spawning fish (Lyons et al. 2016a) and migratory behavior throughout the life cycle (Pracheil et al 2019) in the lower Wisconsin River.

### PADDLEFISHES (POLYODONTIDAE)

**Paddlefish *Polyodon spathula* THREATENED:** Uncommon in the Mississippi River and its larger tributaries but locally common in the lower Chippewa River and especially the lower Wisconsin River below the Prairie du Sac Dam. Formerly found in Green Bay and Lake Michigan but eliminated during the 1800s (Cochran and Wuepper 2005). Also lost from about 50 miles of the Wisconsin River and 15 miles of a tributary, the Baraboo River (Figure 1a), following the closure of the Prairie du Sac dam in 1914. Recent studies have looked at abundance and size structure (Runstrom et al. 2001), interactions with parasitic Silver Lamprey below the Prairie du Sac Dam (Cochran and Lyons 2016), and adult movements in the Mississippi, lower Chippewa, and lower Wisconsin rivers (Zigler et al. 2003, 2004).

### GARS (LEPISOSTEIDAE)

**Longnose Gar *Lepisosteus osseus:*** Locally common in rivers and lakes in southern and western Wisconsin in the Mississippi River basin and in the Fox-Wolf River drainage of Green Bay in eastern Wisconsin. Small sport fisheries occur in some waters (Embke et al. 2020) involving a mix of hook-and-line angling and shooting with bow and arrow ("bowfishing"; Scarnecchia and Schooley 2020).

**Shortnose Gar *Lepisosteus platostomus:*** Locally common in the Mississippi River and the lower reaches of its largest tributaries and uncommon in the Fox-Wolf River drainage of Green Bay. Small sport fisheries, both hook-and-line and bowfishing, exist in some waters. A genetic study indicates that of the seven living species of gars, the closest relative to the Longnose Gar is the Shortnose Gar (Wright et al. 2012). Katula (2017) described Shortnose Gar feeding and movements in the Mississippi River floodplain in Wisconsin.

The Longnose Gar and Shortnose Gar were recently found to hybridize, and hybrids are rare in the Mississippi River basin but common in the Fox-Wolf drainage of Green Bay, representing nearly 50% of all gar there (Lyons and Sipiorski 2020). Many hybrids appear similar to Spotted Gar *L. oculatus* (Figure 6), which likely accounts for many years of unconfirmed reports of possible Spotted Gar from anglers and WDNR biologists from the Fox-Wolf River drainage (e.g., Becker 1964). The Spotted Gar does not occur in Wisconsin. Many of the Longnose Gar X Shortnose Gar hybrids in the Fox-Wolf were previously identified as Shortnose Gar, and it has become apparent that "pure" Shortnose Gar are much less numerous there than once thought.

### BOWFINS (AMIIDAE)

**Bowfin *Amia calva:*** Locally common in rivers and lakes in the southern two-thirds of the state including Green Bay and tributaries, but not present in Lake Michigan proper or its tributaries. Absent from the Lake Superior basin. Small sport fisheries, both hook-and-line and bowfishing, occur in some waters (Embke et al. 2020). Katula (2017) described Bowfin feeding on bullheads (*Ameiurus* species) in the Mississippi River floodplain in Wisconsin.

The Bowfin is found throughout much of the eastern United States and southeastern Canada and has long been thought to be a single morphologically variable species. However, recent quantitative morphological analyses suggest that it may actually be a complex of multiple species (Sinopoli 2019). At least two distinctive forms may occur in Wisconsin, and if shown to be separate species, neither would be known as *A. calva* (personal communication, Don Stewart, State University of New York at Syracuse, May 14, 2019). A recent genetic study, not yet peer reviewed but circulating as a manuscript online (Brownstein et al. 2022), has found differences between Bowfin populations along the Atlantic Coast and those in the Great Lakes, Mississippi River, and other basins west of the Appalachian Mountains and proposed that Atlantic Coast populations retain the name *A. calva* and other populations, including those in Wisconsin, be rechristened *A. ocellicauda*. Whether the manuscript and its proposed name changes will be accepted is unknown.

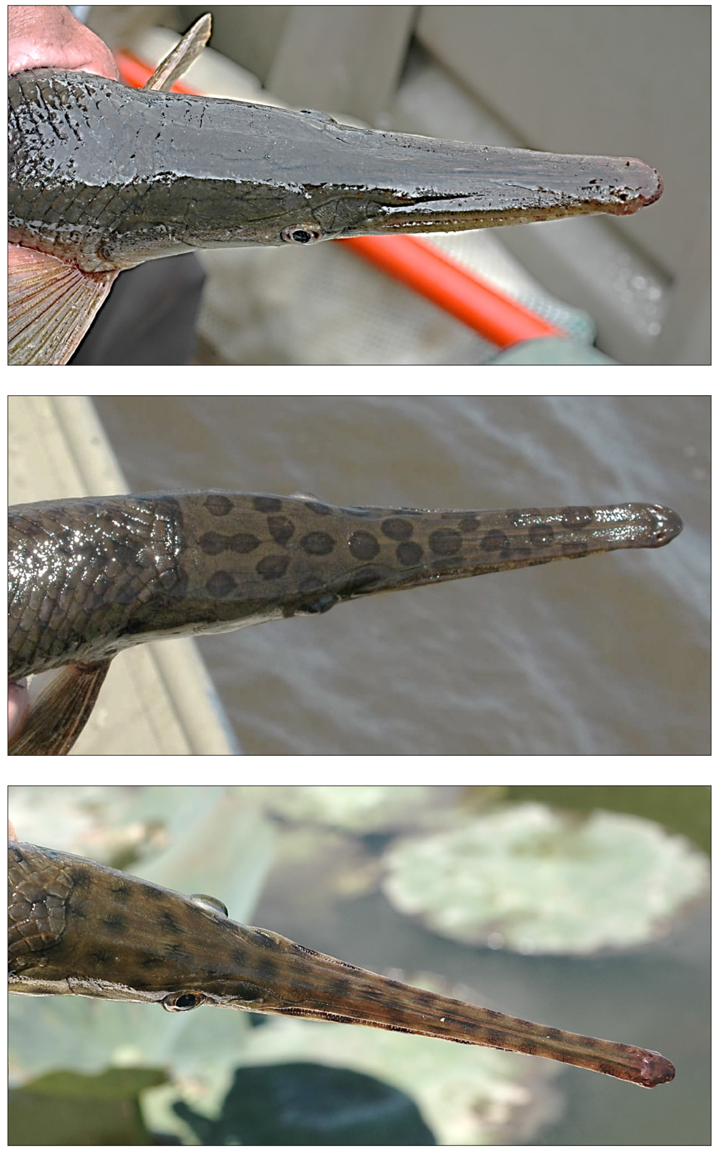

**Figure 6. Top views of the snouts of Wisconsin gars. Top: Shortnose Gar from the Wisconsin River mouth at the Mississippi River, Grant County, 15 September 2005. Middle: Hybrid Longnose Gar X Shortnose Gar from Lake Butte des Morts, Winnebago County, 5 August 2004. Bottom: Longnose Gar from the Fox River at Lake Butte des Morts, Winnebago County, 27 July 2005. Modified from Figure 3 of Lyons and Sipiorski (2020).**

### MOONEYES (HIODONTIDAE)

**Goldeye *Hiodon alosoides* ENDANGERED:** Rare in the Mississippi River and the lower reaches of its largest tributaries. Most frequently encountered in deep, turbid areas of the Mississippi River.

**Mooneye *Hiodon tergisus:*** Locally common in the Mississippi River and its larger tributaries and rare in the Fox-Wolf River drainage of Green Bay. Generally found in areas of current.

### FRESHWATER EELS (ANGUILLIDAE)

**American Eel *Anguilla rostrata* SPECIAL CONCERN:** Rare in the Mississippi River and its tributaries where it is native. Rare also in Lake Superior and Lake Michigan and their tributaries, which it accesses through the Welland Canal in Ontario, bypassing Niagara Falls, making it a non-native species there. The American Eel spawns in the eastern North Atlantic Ocean and migrates into fresh water, where it may reside for many years before returning to the ocean to spawn and die. Only females normally move as far inland as Wisconsin. The species has never been common in the state, but it seems to have dropped in abundance over the last 20–30 years, possibly reflecting a range-wide decline (Haro et al. 2000).

### HERRINGS (CLUPEIDAE)

As currently recognized, the herrings are a large, highly diverse and globally distributed family. A recent genetic analysis (Wang et al. 2022) proposes that this family be split into 10 separate families but whether this proposal will be accepted remains to be seen. Under this new classification, Skipjack Herring *Alosa chrysochloris* and Alewife *A. pseudoharengus* would be part of Alosidae and Gizzard Shad *Dorosoma cepedianum* would be part of Dorosomatidae.

**Skipjack Herring *Alosa chrysochloris* ENDANGERED/EXTIRPATED:** The native Skipjack Herring, once found in the Mississippi River, was considered extirpated by Becker (1983) but was classified as reestablished by Lyons et al. (2000). We now revisit that decision and consider the species once again extirpated.

Historically, Skipjack Herring were common in the Mississippi River in Wisconsin, but the population collapsed after the closure of the Keokuk Dam in southern Iowa in 1913 blocked seasonal migrations up and down the river. Before the dam, Skipjack Herring migrated north to the upper Mississippi in the spring for spawning. The adults remained in the upper Mississippi along with their newly hatched young during the summer to feed, and then all migrated back south in the fall, perhaps as far as downstream of the mouth of the Ohio River, to overwinter (Becker 1983; Lyons 2019). Becker (1983) considered the species extirpated because there had been no records from Wisconsin waters since the early 1950s. However, in the 1980s and 1990s, the occasional Skipjack Herring was observed in the Wisconsin and Minnesota portions of the Mississippi, apparently having used the navigation locks at Keokuk and at other dams to move upstream (Lyons et al. 2000). In 1986, newly produced young were observed in the upper Mississippi. More surprisingly, adult individuals began to be caught in Lake Michigan, presumably having traversed the Chicago Waterway System to enter the lake from the upper Illinois River (Fago 1993). Individuals were most likely to be encountered during high-water years when many of the dams on the Mississippi and Illinois rivers had open gates that did not impede movement. Based on these occurrences, Lyons et al. (2000) removed the species from the state's extirpated list and considered it present in Wisconsin.

We here reverse that decision and put Skipjack Herring back on the extirpated list for Wisconsin. Since 2000, records of Skipjack Herring from Wisconsin waters have decreased to very low levels. The installation of electric barriers to block carp movements in the Chicago Waterway system now prevents Skipjack Herring from moving from the Illinois River and the Mississippi (Parker et al. 2016), and no specimens have been observed in the Great Lakes since the early 2000s. On rare occasions, Skipjack Herring are still seen in the Mississippi, but reports have decreased since the 1990s despite many recent years of high flows. Although there was evidence of very limited reproduction in the upper Mississippi in 2011, the species cannot be considered either a permanent resident or regular visitor to the state. Rather, it occurs only as a very infrequent stray from further downstream and is functionally extirpated.

**Alewife *Alosa pseudoharengus* NON-NATIVE:** Common in Lake Michigan and Green Bay, occasionally entering the lowest portions of tributaries, and rare in Lake Superior. During the 1960s, the Alewife reached nuisance levels in Lake Michigan, fouling shorelines with regular large die-offs (Stewart et al. 1981; Flath and Diana 1985) and reducing the abundance of many native species through larval predation and competition for food (Smith 1970; Bunnell et al. 2006; Madenjian et al. 2005a, 2008). However, the Alewife has decreased dramatically since then and is now less than 5% of its former peak abundance (Egan 2017). Declines have been caused by consumption by introduced non-native trout and salmon (Hansen et al. 1990; Tsehaye et al. 2014) and by fundamental changes in the lake food web caused by the invasion of non-native dreissenid mussels (Turschak et al. 2014; Madenjian et al. 2015). The Alewife population is now dominated by young fish and numbers fluctuate greatly owing to annual variation in reproductive success (Madenjian et al. 2005a; Collingsworth et al. 2014). There are legitimate fears that the population could collapse, with likely major negative consequences for the trout and salmon fisheries it helps support.

**Gizzard Shad *Dorosoma cepedianum:*** Common but highly variable in abundance in the largest rivers and associated lakes and reservoirs in the southern half of Wisconsin including the Mississippi River and tributaries and the Fox-Wolf River drainage and Green Bay. Found in river mouths and the lower reaches of direct tributaries to Lake Michigan (UWZM 22025), which may represent recent colonists from further south in Lake Michigan, but absent from the Lake Superior basin. Gizzard Shad are at the northern edge of their range in Wisconsin and susceptible to large population swings owing to winter die-offs. Gizzard Shad may be abundant one year and quite scarce the next. However, they seem to be generally increasing over the long term, presumably in response to Wisconsin's warming climate.

### MINNOWS (CYPRINIDAE, XENOCYPRIDIDAE, LEUCISCIDAE)

For many years, all minnows were considered part of a very large, highly variable family, Cyprinidae, with many different subfamilies or other taxonomic groupings of related genera. A recent review and summary of previous systematics studies has redefined the minnows, placing them all in a new suborder Cyprinoidei and recognizing and defining many new families within this suborder (Tan and Armbruster 2018). All native Wisconsin (and North American) species are now considered to be part of the family Leuciscidae (Schonhuth et al. 2018a) and non-native species from Asia are considered part of the newly defined Cyprinidae or the Xenocyprididae.

### BARBS AND CARPS (CYPRINIDAE)

**Goldfish *Carassius auratus* NON-NATIVE:** Uncommon statewide. A widespread pet species that is illegally but routinely released from home fish tanks or flooded out of artificial ponds into natural waterways. Consequently, small numbers of Goldfish are possible almost anywhere in the state, although they are most likely near cities and towns. However, successfully reproducing populations are only found in stagnant or polluted areas such as stormwater detention ponds where other fishes are scarce. Goldfish are highly tolerant of environmental extremes but fare poorly where other fish species are present.

**Common Carp *Cyprinus carpio* NON-NATIVE:** Common to locally abundant in rivers and lakes in the southern two-thirds of Wisconsin in both the Mississippi River and Lake Michigan basins. Uncommon in river mouths and bays in Lake Superior. Generally absent from inland areas of the northern quarter of Wisconsin. Many years of effort and millions of dollars have been spent to try and control Common Carp numbers in Wisconsin over the last 120 years with only limited and localized success (Becker 1983; Lyons 2022). The species supports commercial and sport fisheries, including both hook-and-line and bowfishing, in some areas (Klein et al. 2018; Embke et al. 2020).

### EAST ASIAN MINNOWS OR SHARPBELLIES (XENOCYPRIDIDAE)

**Grass Carp *Ctenopharyngodon idella,* Silver Carp *Hypophthalmichthys molitrix,* and Bighead Carp *Hypophthalmichthys nobilis* NON-NATIVE:** These three species (Figure 7), along with the Black Carp *Mylopharyngodon piceus,* are native to China and adjacent countries and are often referred to in the popular press and scientific literature as "Asian carp." However, this term is confusing to scientists outside North America and has the potential to be offensive in some contexts (Kocovsky et al. 2018), and we will not use it further. The state of Illinois has proposed the term "copi" for these species (https://choosecopi.com/). All four carp species were introduced into Arkansas in the 1960s and 1970s and have spread and become widely established and common throughout much of the Mississippi River basin. They have the potential to cause great ecological harm, and there are major efforts underway to study and control them where they already occur and to prevent their spread to the Great Lakes basin via the Chicago waterway system (Chapman and Hoff 2011; Egan 2017; Pendleton et al. 2017).

**Figure 7. Non-native carps newly resident in Wisconsin. Top: Grass Carp from Arroyo Chiflón near the Usumacinta River, Tabasco, Mexico, 19 January 2002. Middle: Bighead Carp from the Illinois River upstream of Havana, Mason County, Illinois, 6 June 2002. Bottom: Silver Carp from Horseshoe Lake, Alexander County, Illinois, 9 May 2002.**

Grass Carp were first found in Wisconsin in the 1970s and 1980s, when they were sometimes stocked illegally to control aquatic vegetation (Becker 1983). In most instances, they were removed by poisoning when practical or eventually died out from natural attrition and old age, but by the late 1990s and early 2000s they began to appear in increasing numbers in the commercial fishery of the Mississippi River. They continue to be caught there today. In the Mississippi River and tributaries in Wisconsin, Grass Carp are thought to be migrants from established populations further downstream in the system. Some are sterile, artificially produced, triploid fish (three copies of the DNA), but others are fertile diploids (two copies of the DNA, the normal condition) capable of reproduction. At present, Grass Carp are uncommon but widespread and regularly encountered year round in the Mississippi River and occasionally seen in larger tributaries such as the lower Wisconsin River (Figure 8). Only large adults have been captured thus far, and there is as of yet no evidence of successful natural reproduction. However, eggs have been collected from the lower Wisconsin River and from the Mississippi River not far downstream from the Wisconsin border (Larson et al. 2017), indicating that

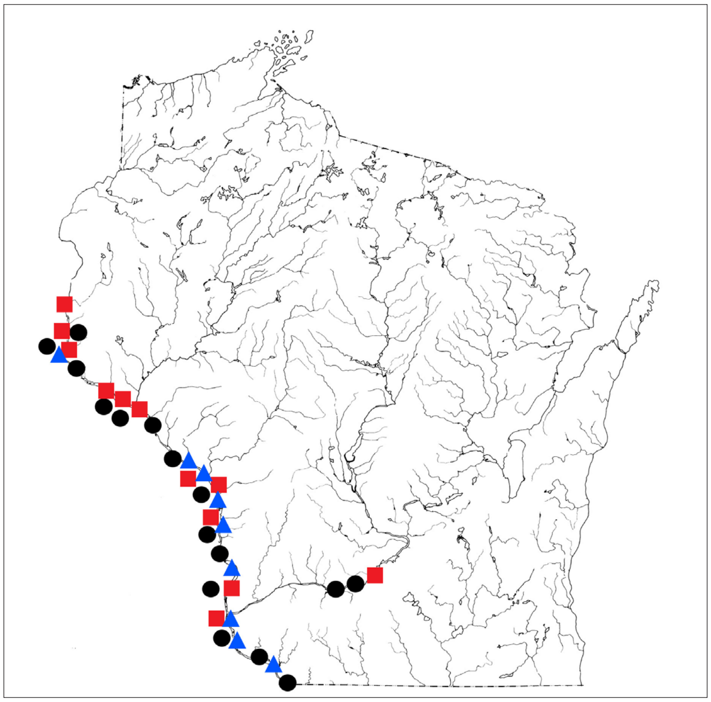

**Figure 8. Map of the recent occurrences of Grass Carp (circles), Bighead Carp (squares), and Silver Carp (triangles) in the Mississippi River basin in Wisconsin where we consider the species as a permanent resident. Records of stocked individuals from other areas are not included.**

spawning does occur. Grass Carp appear to persist in Wisconsin waters because of migration from further downstream in the Mississippi River system where they are established.

The first Bighead Carp from Wisconsin was collected in 1996 from the lower St. Croix River, and since then the species has been taken regularly from the Mississippi and lower St. Croix rivers from multiple locations. Specimens first appeared in the lower Wisconsin River below the Prairie du Sac Dam in 2011 and have been captured there several times since, most recently in July 2022. To date, only large adults have been encountered anywhere in Wisconsin, and there is as yet no evidence of spawning activity or successful reproduction (Larson et al. 2017). Bighead Carp are uncommon, but they are found year round at multiple spots in the Mississippi River (Figure 8). Like Grass Carp, they apparently persist in Wisconsin because of migration from further downstream in the Mississippi River system where they are established. Some scientists have used *Aristichthys nobilis* as the scientific name for Bighead Carp.

The Silver Carp was first captured in Wisconsin in 2008, and to date nearly all have been found only in the Mississippi River with one 2022 record from the Wisconsin River below the Prairie du Sac Dam (Figure 8). As is the case for Grass Carp and Bighead Carp, they are encountered in small numbers year round at multiple locations, only large individuals have been observed, there is no evidence of spawning or successful natural reproduction (Larson et al. 2017), and they likely persist in Wisconsin waters because of migration from further downstream.

Black Carp have as yet not been found in Wisconsin, and their nearest records are from the Mississippi and lower Illinois rivers in central and southern Illinois over 300 river miles to the south of the Wisconsin border.

We consider Grass Carp, Bighead Carp, and Silver Carp to be new additions to the Wisconsin fish fauna. Although they are not yet successfully reproducing, they are consistent, long-term, year-round residents of the Mississippi River and perhaps the lower St. Croix or Wisconsin rivers. They persist in the state because of regular movements up the Mississippi River, much like the American Eel. They are too widespread and regularly encountered to be considered a rare stray like the Skipjack Herring.

## MINNOWS (LEUCISCIDAE)

**Central Stoneroller *Campostoma anomalum:*** Common and widespread in moderate to high-gradient reaches of streams in southern and western Wisconsin and uncommon and localized in central Wisconsin in both the Mississippi and Lake Michigan basins. Absent from the Lake Superior basin.

As traditionally defined, the Central Stoneroller is a highly variable species occupying much of the eastern and central United States. Recent studies indicate that it is in fact a complex of several species. Wisconsin populations have tentatively been assigned to a different species, *C. pullum* (Blum et al. 2008; Etnier and Starnes 2008). Page et al. (2013) did not accept this proposed change because they felt that the definition and range boundary of this species were as yet too uncertain and imprecise. But it is likely that the form in Wisconsin is a different species from the nominal *C. anomalum* and that its scientific name will eventually change.

**Largescale Stoneroller *Campostoma oligolepis:*** Common and widespread in moderate to high-gradient reaches of streams in central and northwestern Wisconsin and uncommon and localized in southern and western Wisconsin in both the Mississippi and Lake Michigan basins. Absent from the Lake Superior basin. Largescale and Central stonerollers have a largely complimentary distribution in Wisconsin. They do not often occur together, and when they do, one species is usually much more common than the other.

**Genus *Chrosomus:*** The colorful Northern Redbelly Dace, Southern Redbelly Dace, and Finescale Dace were long considered members of *Phoxinus,* the only genus of minnows thought to be native to both North America and Eurasia. However, recent genetic analyses indicate that *Phoxinus* should be restricted to the Eurasian minnows, which, although they are superficially similar in appearance, are only distantly related to North American species (Strange and Mayden 2009; Schonhuth et al. 2018a). Based on these analyses, the North American species have been reassigned to the genus *Chrosomus,* where they had been classified up until the 1970s, a change accepted by Page et al. (2013).

**Northern Redbelly Dace *Chrosomus eos:*** Statewide in lower-gradient streams, beaver ponds, and small marshy lakes. Common and widespread in the northern half of the state and more localized in the south. Rare in the hilly Driftless Area of southwestern Wisconsin. Wild-caught Northern Redbelly Dace are sometimes sold as fishing bait in northern Wisconsin.

**Southern Redbelly Dace *Chrosomus erythrogaster:*** Widespread and common in higher-gradient reaches of streams in the southern half of the state in the Mississippi River and Lake Michigan basins. Absent from the Lake Superior basin. Particularly com-

**Figure 9. Northern Wisconsin *Chrosomus* dace from Toad Creek, Douglas County, 19 September 2001. Top: Finescale Dace. Middle: Hybrid Northern Redbelly Dace X Finescale Dace. Bottom: Northern Redbelly Dace.**

mon in cool and warmwater streams in the hilly Driftless Area of southwestern Wisconsin. Because of differences in habitat preferences, Northern and Southern Redbelly Dace usually do not occur together in the same streams.

**Finescale Dace *Chrosomus neogaeus:*** Locally common in lower-gradient streams, beaver ponds, and small marshy lakes in the northern half of the state. Many populations at the southern edge of the species range in central Wisconsin have declined or disappeared. Commonly co-occurs with the Northern Redbelly Dace but never with the Southern Redbelly Dace. Wild-caught Finescale Dace are sometimes termed "rainbow chubs" and sold as fishing bait in northern Wisconsin.

Hybrids of Northern Redbelly Dace and Finescale Dace are locally common in northern Wisconsin (Figure 9). These hybrids are unique among Wisconsin hybrid fishes in that they are an all-female clonal form. By some definitions, they could be considered a species separate from the Northern Redbelly Dace and Finescale Dace, particularly if one follows the arguments of Echelle (1990). However, we have decided to follow Vrijenhoek (1994) and not designate this hybrid as its own species.

Other fish hybrids in Wisconsin are newly formed on a regular basis via standard sexual reproduction, may be either male or female, and often have reduced fertility or are sterile. Northern Redbelly-Finescale Dace hybrids, however, have a much more unusual and complicated reproductive process. Northern Redbelly-Finescale Dace hybrids originated prior to the most recent ice age, perhaps as many as 50,000 years ago, and have persisted for thousands of generations via clonal reproduction that yields only female offspring (Angers and Schlosser 2007). Northern Redbelly-Finescale Dace hybrids have diploid eggs that have two copies of their DNA, which is unusual; female fish typically have haploid eggs with a single copy of their DNA. But the Northern Redbelly-Finescale Dace hybrid must spawn with either a male Northern Redbelly Dace or a male Finescale Dace for their eggs to produce viable young (Goddard and Dawley 1990). Haploid sperm from the male triggers egg development, but the DNA from the sperm is not usually incorporated into the offspring, as would happen in normal sexual reproduction in which the male and female DNA would combine to produce diploid offspring with half their DNA from the mother and half from the father. Consequently, the hybrid's offspring are all female, diploid with only the mother's DNA, and genetically identical to the mother (i.e., clonal).

However, on rare occasions the male DNA is incorporated into the hybrid eggs, producing triploid offspring with two copies of the mother's DNA and one of the father's. These triploids, which are still all female and look like the hybrid mother, produce two types of eggs, diploid with just the grandmother's DNA, and haploid, with just the grandfather's DNA. When the triploid female hybrid mates with a male Northern Redbelly or male Finescale Dace, the male's sperm triggers development, but its DNA does not get incorporated into the diploid eggs, producing all-female clonal hybrids. But the male's DNA does get incorporated into the haploid eggs, producing male and female non-clonal diploid offspring of the same species as the male. Thus, a triploid hybrid female produces two types of offspring, a clonal all-female hybrid form identical to the mother and a form that looks identical to the father (i.e., a Northern Redbelly Dace or a Finescale Dace), can be either male or female, and is distinguishable from the offspring of non-hybrid parents only via genetic analysis. This non-clonal form has half of its nuclear DNA from the father, half from the grandfather, and its mitochondrial DNA from the hybrid mother (mitochondrial DNA always comes only from the mother) and is termed a cybrid (Goddard and Schultz 1993). Cybrids are able to then spawn with either other cybrids or non-cybrids of their own species or with Northern Redbelly-Finescale Dace hybrids, resulting in even more complicated genetic combinations. Confused? You're not alone. We are too.

**Redside Dace *Clinostomus elongatus:*** Coolwater streams in central and southern Wisconsin in the Mississippi and Lake Michigan basins. One unconfirmed but plausible report from the Lake Superior basin, Boomer Creek, Iron County (WDNR unpublished data; Fig. 1b). Common in central Wisconsin but uncommon and in decline in southern Wisconsin. Genetic analyses indicate substantial variation across the range of the species, with Wisconsin populations similar to populations in Minnesota and the Upper Peninsula of Michigan and differing from populations further east (Serrao et al. 2018). Midwestern populations including Wisconsin were more tolerant of warm water, surviving at water temperatures over 90°F (Turko et al. 2021). Dieterman (2018) studied the life history of Redside Dace in the Little Cannon River, Minnesota, not far west of the Wisconsin border.

Ironically, improved land use in some southern Wisconsin watersheds has led to fewer Redside Dace. Removal of marginal land from agricultural production along some streams has resulted in colder and better-quality water, which in turn has increased numbers of predatory Brown Trout *Salmo trutta,* causing the reduction or elimination of several Redside Dace populations (Lyons et al. 2000; Marshall et al. 2008).

**Lake Chub *Couesius plumbeus:*** Nearshore areas of Lake Superior and Lake Michigan and in the lower reaches of their tributaries during spring spawning. We are unaware of any year-round tributary populations in Wisconsin, although these occur further north in Minnesota and Canada. Lake Chub are difficult to find in the Great Lakes except during spawning, and distribution, relative abundance, and population trends of Wisconsin Lake Chub are uncertain.

**Spotfin Shiner *Cyprinella spiloptera:*** Widespread and common in small to large rivers and some lakes in the Mississippi and Lake Michigan basins, although not known from Lake Michigan or Green Bay proper. Absent from the Lake Superior basin. A recent study examined spawning habitat in submerged fallen trees in the Mississippi River (Cochran and Cochran 2005) in Wisconsin and Minnesota. Schonhuth and Mayden (2010) provide a genetic analysis of the relationships among the many species of the widely distributed genus *Cyprinella*.

**Gravel Chub *Erimystax x-punctata* ENDANGERED:** Uncommon to rare in small rivers in the Rock River drainage of far southern Wisconsin, specifically the lower Pecatonica River, Sugar River, Turtle Creek, and the Rock River below the dam in Beloit (Figure 1b). A transplant effort to establish Gravel Chub in the Rock River above the dam in Beloit in the early 1990s was unsuccessful (WDNR, unpublished data).

**Brassy Minnow *Hybognathus hankinsoni:*** Statewide in lower gradient streams and small marshy lakes. Common and widespread in the north and more localized in the south. Wild-caught Brassy Minnow are sometimes sold as fishing bait in northern Wisconsin.

**Mississippi Silvery Minnow *Hybognathus nuchalis:*** Common in the Mississippi River and lower Wisconsin, Black, and Chippewa-Red Cedar rivers and the lower reaches of their larger tributaries. Historically present in the Rock River and Fox-Illinois river drainages but now largely gone. A single individual was captured in the lower Sugar River in Rock County in 2009 in the Rock River basin (Figure 1b; UWZM 22060) Absent from the Lake Michigan and Lake Superior basins. Abundance of the Mississippi Silvery Minnow in the Mississippi River and its larger tributaries fluctuates dramatically. In some years it is one of the most common minnows, occurring in vast schools, and in others it is scarce and difficult to find. Reasons for this variation are unknown. A recent genetics study investigated relationships among the species of *Hybognathus* and determined that the Brassy Minnow and Mississippi Silvery Minnow are not particularly closely related (Moyer et al. 2009).

**Pallid Shiner *Hybopsis amnis* ENDANGERED (Figure 10):** The Pallid Shiner, now found primarily in the Mississippi River, has changed dramatically in distribution and abundance in Wisconsin waters and for a time was one of the rarest fishes in the state. Although still uncommon, it has increased substantially over the last 20 years.

In Wisconsin, the Pallid Shiner is known only from the largest rivers of the state, mainly the Mississippi River. In the 1920s it was common throughout the Wisconsin portion of the Mississippi River and was reported from five large tributaries (Greene 1935). From the 1940s through the 1960s it disappeared from all the tributaries except the lowermost 10 miles of the Wisconsin River, but it remained relatively common in much of the Mississippi (Becker 1983; Torreano 1998). Surveys in the 1970s revealed that Pallid Shiner were gone from the lower Wisconsin River and were limited to Pools 9–11 of the Mississippi River (Figure 1a) where the species was uncommon to rare (Fago 1992). As a result, the Pallid Shiner was designated as a Wisconsin State Endangered Species. During the 1990s, all of the sites where Pallid Shiners occurred in the 1970s plus other sites in their vicinity were sampled, but only a single individual was captured, from Pool 11 in 1999 (Lyons et al. 2000). It appeared then that this species was on the brink of disappearing from the state.

**Figure 10. Pallid Shiner from the Sabine River, Newton Co., Texas, 12 April 2001.**

Unexpectedly, the Pallid Shiner began to rebound after 2000. It was caught in low numbers in surveys of Pool 11 during the early 2000s, and by the 2010s it was observed regularly and in higher numbers in Pools 10 and 11 (WDNR, unpublished data; UWZM 11753,11754, 13761, 14634, 16287, 17069, 17757). It also was caught consistently in Pool 13 in northern Iowa and sporadically and in low numbers in Pool 4 and 8 in Wisconsin and Minnesota (UWZM 16642; US Geological Survey [USGS], Long-Term Resource Monitoring Program (https://www.umesc.usgs.gov/data_library/fisheries/graphical/fish_front.html). In 2015, a Pallid Shiner was collected from the Wisconsin River about five miles upstream of the Mississippi River (UWZM 16280). The reappearance of the species was associated with increases in water clarity and aquatic vegetation in the Mississippi River that began during the mid-2000s (Burdis et al. 2020). Surveys up to the present indicate that the Pallid Shiner is found in modest numbers in the Mississippi River, and it is far more secure in the state than it was 20 years earlier (WDNR unpublished data; Bowler and Schmidt 2016).

**Striped Shiner *Luxilus chrysocephalus* ENDANGERED/EXTIRPATED:** Historically, this species was known from streams and rivers in southeastern Wisconsin in the Mississippi and Lake Michigan basins (Greene 1935; Becker 1983). By the late 1980s, it had greatly declined and was limited to the Milwaukee River, where it was rare (Lyons et al. 2000). The last individual was collected from the Milwaukee River in 1999, and none have been seen since despite regular surveys. Reasons for the species' decline and disappearance are uncertain but may include hybridization and introgression with the closely related and much more numerous Common Shiner *L. cornutus*. We now consider the Striped Shiner extirpated from the state.

**Common Shiner *Luxilus cornutus:*** Widespread and common statewide in streams, rivers, and lakes. Uncommon or absent from the largest rivers and the Great Lakes. Wild-caught Common Shiner are sometimes sold as fishing bait in northern Wisconsin.

**Redfin Shiner *Lythrurus umbratilis* THREATENED:** Uncommon and highly localized in lower-gradient streams and small rivers in the southern two-thirds of the state in the Mississippi River and Lake Michigan basins. Absent from the Lake Superior basin. Pramuk et al. (2007) published a genetic study of the relationships among the 11 species of *Lythrurus* species across their range in the central and eastern United States.

**Shoal Chub *Macrhybopsis hyostoma* THREATENED:** Uncommon in fast water on sand shoals in the Mississippi River and the Wisconsin River as far upstream as Wisconsin Dells, Columbia County, and in a small area of the Wolf River downstream of Shawano, Shawano County, in the Lake Michigan basin (Figure 1b; Lyons et al. 2000; Lyons 2005). Echelle et al. (2018) analyzed the genetics of the genus *Macrhybopsis*.

**Silver Chub *Macrhybopsis storeriana:*** Uncommon in deep, fast-flowing areas of the Mississippi River and the lower reaches of its largest tributaries, particularly the Wisconsin and Chippewa rivers, and the lower Pecatonica and Sugar rivers (Figure 1a) in the Rock River drainage. Absent from the Lake Michigan and Lake Superior basins. Echelle et al. (2018) found few genetic differences among most populations of this species across its range in the central United States, although the population in the Pearl River in Mississippi was distinctive.

**Northern Pearl Dace *Margariscus nachtriebi:*** Low gradient streams and small marshy lakes statewide, although most widespread and common in the north. Wild-caught Northern Pearl Dace are sometimes sold as fishing bait in northern Wisconsin.

Formerly this species was known simply as the Pearl Dace *M. margarita,* including in Becker (1983; as *Semotilus margarita*) and Lyons et al. (2000), but now it has a new scientific and common name. Historically, two subspecies were recognized, the Allegheny Pearl Dace *M. margarita margarita,* found on the Atlantic slope and in the upper Ohio River basin of the northeastern United States, and the Northern Pearl Dace *M. margarita nachtriebi,* found in the Great Lakes, Upper Mississippi, Missouri, and Hudson Bay basins in the northern United States, including Wisconsin, and much of Canada east of the Rockies. Bailey et al. (2004) examined the available data and elevated the two subspecies to full species, Allegheny Pearl Dace *M. margarita* and Northern Pearl Dace *M. nachtriebi,* a change accepted by Page et al. (2013).

**Hornyhead Chub *Nocomis biguttatus:*** Common and widespread statewide in moderate-gradient reaches of streams and small rivers. Wild-caught Hornyhead Chub are sometimes sold as fishing bait under the name "redtail chub" and are especially valued for Walleye fishing in northern Wisconsin. Bait and angling harvest appears to have reduced populations in parts of Minnesota (Schmidt 2012a) and perhaps locally in Wisconsin as well, such as in the lower Mukwonago River (WDNR unpublished data). Genetic studies have recently reviewed the relationships among the members of the genus *Nocomis* (Nagle and Simons 2012; Echelle et al. 2014).

**Golden Shiner *Notemigonus crysoleucas:*** Common and widespread statewide. Wild-caught and farm-raised Golden Shiners are widely sold and used as fishing bait, and consequently individuals might be encountered almost anywhere, but established populations are most likely in lower-gradient streams and small, shallow, weedy lakes. Golden Shiner is the only native minnow species in Wisconsin more closely related to European minnows rather than to other North American minnows (Schonhuth et al. 2018a).

**SHINERS (*Notropis*):** Historically, *Notropis* has been the largest, most complex, and difficult-to-identify genus of North American minnows. It has long been recognized as an unnatural grouping of what should be classified as a variety of different genera (Mayden 1989), but progress in distinguishing, diagnosing, and naming these genera has been slow. Genetic studies by Mayden et al. (2007) and Stout et al. (2022) have been major efforts to better understand the evolutionary relationships among minnows traditionally classified as *Notropis* and to revise their taxonomy, and they have resulted in the proposed placement of 11 Wisconsin species in new genera (Table 3). These changes have not yet been fully reviewed or accepted by the ichthyological community, so for now we have retained these species in *Notropis*. However, it seems likely that most or all of them will eventually be placed in different genera.

**Table 3. Changes in genus names for *Notropis* shiners proposed by Mayden et al. (2007) or Stout et al. (2022). We follow Page et al. (2013) and have retained these species in *Notropis* for our list, but we recognize that at least some will likely see name changes in the future.**

| Common name | Our scientific name | Alternative genus name |
|---|---|---|
| Pugnose Shiner | *Notropis anogenus* | *Miniellus anogenus* |
| River Shiner | *Notropis blennius* | *Alburnops blennius* |
| Ghost Shiner | *Notropis buchanani* | *Paranotropis buchanani* |
| Ironcolor Shiner | *Notropis chalybaeus* | *Alburnops chalybaeus* |
| Bigmouth Shiner | *Notropis dorsalis* | *Ericymba dorsalis* |
| Blackchin Shiner | *Notropis heterodon* | *Miniellus heterodon* |
| Spottail Shiner | *Notropis hudsonius* | *Hudsonius hudsonius* |
| Ozark Minnow | *Notropis nubilus* | *Miniellus nubilus* |
| Sand Shiner | *Notropis stramineus* | *Miniellus stramineus* |
| Weed Shiner | *Notropis texanus* | *Alburnops texanus* |
| Mimic Shiner | *Notropis volucellus* | *Paranotropis volucellus* |
| Channel Shiner | *Notropis wickliffi* | *Paranotropis wickliffi* |

**Pugnose Shiner *Notropis anogenus* THREATENED:** Statewide and widely distributed but uncommon and highly localized in clear, well-vegetated lakes and lower-gradient streams and small rivers. Only one record, Delta Lake, Bayfield County (UWZM 11958), from the Lake Superior basin. Typically co-occurs with Blackchin *N. heterodon* and Blacknose *N. heterolepis* shiners. McCusker et al. (2014a) characterized the genetics of the species across its range including Wisconsin.

The ecology of the Pugnose Shiner has not been studied in Wisconsin since the 1970s (Becker 1983) but has been the subject of substantial recent research in eastern Ontario and New York including temperature, turbidity, and dissolved oxygen tolerances (Gray et al. 2016; McDonnell et al. 2021) and habitat preferences (McCusker et al. 2014b; Potts et al. 2021). The species has relatively narrow habitat requirements and environmental tolerances, undoubtedly contributing to its rarity throughout its range. The species has been successfully introduced into small ponds and lakes in northeastern Illinois (Schaeffer et al. 2012; Bland 2013) and southeastern Minnesota (Schmidt 2014) near the Wisconsin border for conservation purposes.

**Emerald Shiner *Notropis atherinoides:*** Statewide, widely distributed, and common in the largest rivers and lakes. Wild-caught preserved (salted or frozen) Emerald Shiner is often used as fishing bait. Historically, Emerald Shiner were caught and sold live as bait in the winter, but restrictions on capture from their main habitats in the Mississippi River and Great Lakes have eliminated this. Common and widespread in Lake Michigan up to the 1950s but now much less abundant and largely restricted to river mouths and protected bays because of competition with and egg and larval predation by Alewife (Bunnell et al. 2006; Madenjian et al. 2008). If the Alewife population in Lake Michigan were to collapse, as has happened in Lake Huron, Emerald Shiner numbers and distribution would probably increase (Schaeffer et al. 2008).

**River Shiner *Notropis blennius:*** Common and widespread in the Mississippi River and its larger tributaries, rare in the Rock River drainage in the Mississippi River basin, and uncommon in the Fox-Wolf drainage, including Lake Winnebago, in the Lake Michigan basin (Becker 1983; Lyons et al. 2000; Lyons 2005). Absent from the Lake Superior basin. Hatch and Elias (2002) described reproductive characteristics of female River Shiner in Pool 4 of the Mississippi River.

**Ghost Shiner *Notropis buchanani* EXTIRPATED:** Formerly rare in the Mississippi River, but no specimens have been seen in Wisconsin waters since the 1940s (Becker 1983). Closely related to the Mimic Shiner and Channel Shiner (Dowell 2010).

**Ironcolor Shiner *Notropis chalybaeus* EXTIRPATED:** Formerly known from two location in the Fox-Wolf drainage of the Lake Michigan basin, but no records since the early 1900s (Becker 1983).

**Bigmouth Shiner *Notropis dorsalis:*** Widespread and common in streams and rivers of the Mississippi River basin. In the Lake Michigan basin, locally common in streams and rivers in the Fox-Wolf River drainage to Green Bay and in the Pike River drainage to Lake Michigan in southeastern Wisconsin. Absent from the Lake Superior basin. An ongoing study is examining the genetics and morphology of this species across its wide range in the north-central United States, and early results suggest that it may actually be a complex of more than one species (personal communication, Bob Hrabik, Missouri Department of Conservation, Jackson, 3 November 2021).

**Blackchin Shiner *Notropis heterodon:*** Locally common in well-vegetated, clear lakes and slow-moving streams statewide. Largely absent from the hilly Driftless Area of southwestern Wisconsin. The species has been successfully introduced into small ponds and lakes in northeastern Illinois (Schaeffer et al. 2012; Bland 2013) and southeastern Minnesota (Schmidt 2014) near the Wisconsin border for conservation purposes, and this conservation work has led to publications on life history (Davis 2006), habitat and movement (Valley et al. 2010), and genetics (Ozer and Ashley 2013).

**Blacknose Shiner *Notropis heterolepis:*** Common and widespread statewide in well-vegetated, clear lakes and slow-moving streams and rivers. Largely absent from the hilly Driftless Area of southwestern Wisconsin. Often co-occurs with the Blackchin Shiner but is more broadly distributed. The species has been successfully introduced into small ponds and lakes in northeastern Illinois (Schaeffer et al. 2012; Bland 2013) and southeastern Minnesota (Schmidt 2014) near the Wisconsin border for conservation purposes, and this conservation work has led to publications on reproduction and diet (Roberts et al. 2006), habitat use and movement (Valley et al. 2010), and genetics (Ozer and Ashley 2013). Laboratory experiments have shown the Blacknose Shiner to be more tolerant of turbidity than the Pugnose Shiner (Gray et al. 2016), but it still requires relatively clear water.

**Spottail Shiner *Notropis hudsonius:*** Common in the largest rivers and lakes statewide, particularly the Mississippi River and near-shore areas of Lake Michigan and Lake Superior. A popular bait species in Minnesota, but rarely available in Wisconsin. Although still common, Spottail Shiner appears to have declined in Lake Michigan over the last 20 years (personal communications, David Bunnell, 2 November 2021, and Charles Madenjian, 9 November 2021, USGS, Ann Arbor, Michigan), perhaps because of the fundamental changes in the lake food web caused by the invasion of non-native dreissenid mussels (Turschak et al. 2014; Madenjian et al. 2015). A recent study documents seasonal and geographic characteristics of Spottail Shiner diets in Lake Michigan (Happel et al. 2015).

**Ozark Minnow *Notropis nubilus* THREATENED:** Uncommon in rocky runs and riffles of small streams to small rivers in southern and northwestern Wisconsin in the Mississippi River basin. Absent from the Lake Michigan and Lake Superior basins. Possible declines in southwestern Wisconsin over the last 25 years.

Genetic analyses indicate substantial variation across the range of Ozark Minnow and suggest that it may be a complex of up to three species, only one of which occurs in Wisconsin (Berendzen et al. 2010). These three forms are distinctive genetically but differ only subtly in morphology (Berendzen et al. 2021).

**Figure 11. The Rosyface Shiner species complex. Top: Carmine Shiner from Rattlesnake Creek, Grant County, 30 September 2000. Bottom: Rosyface Shiner from the Mukwonago River, Waukesha County, 25 May 2001.**

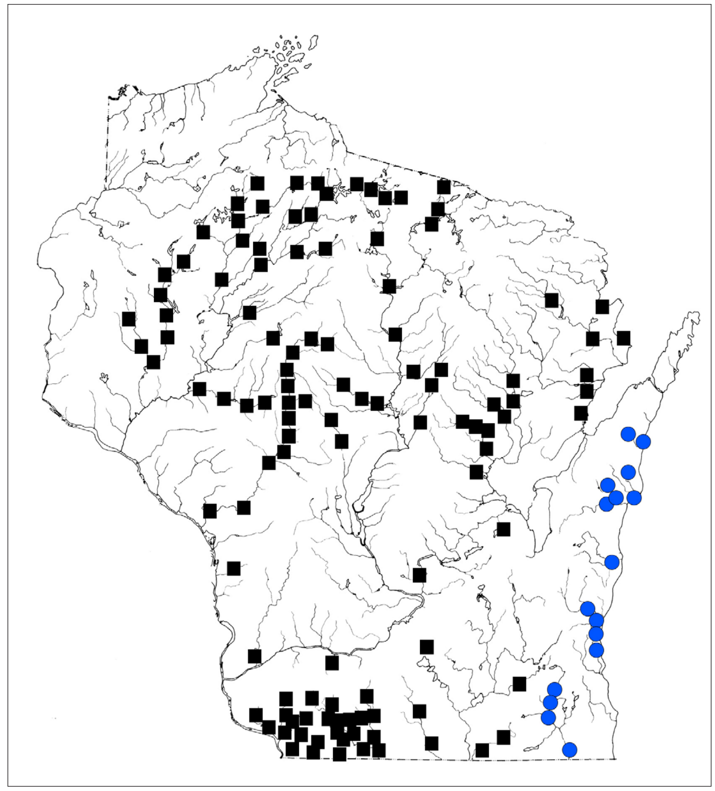

**Figure 12. Map of Carmine Shiner (squares) and Rosyface Shiner (circles) occurrences in Wisconsin.**

**Carmine Shiner *Notropis percobromus* and Rosyface Shiner *Notropis rubellus:*** As previously defined, the Rosyface Shiner was widely distributed throughout the central United States including much of Wisconsin. However, genetic analyses over the last 20 years (Wood et al. 2002; Berendzen et al. 2008, 2009) have found that the Rosyface Shiner is actually a species complex with up to seven different forms. Two of these are found in Wisconsin, the Carmine Shiner and the redefined Rosyface Shiner (Figure 11). The Carmine Shiner is a newly recognized addition to the Wisconsin fish fauna. Both species are common in rocky riffles and runs in small to medium-sized rivers and have similar habitats and ecology but do not overlap in distribution. Although they differ slightly in morphology, they can only reliably be distinguished by genetic analyses (Berendzen et al. 2009). Based on molecular data courtesy of Kyle Piller (Southern Louisiana University, Hammond, from 2010), Carmine Shiner occurs throughout the Mississippi River basin except for the Fox-Illinois drainage and in the Lake Michigan basin in drainages to Green Bay, whereas Rosyface Shiner occurs in the Illinois-Fox drainage and in direct drainages to Lake Michigan (Figure 12). Neither species occurs in the Lake Superior basin.

**Sand Shiner *Notropis stramineus:*** Widespread and common in the larger rivers of the Mississippi and Lake Michigan basins. Less common and more localized in rivers of the Lake Superior basin. The population dynamics of Sand Shiner in Iowa rivers, including the Turkey River just upstream of the Mississippi River on the Iowa-Wisconsin border, has recently been quantified (Smith et al. 2010). Cochran (2014b) described captive spawning of Sand Shiner collected from the Root River, Minnesota, not far from the Wisconsin border.

A recent genetic analysis indicates this species, which is widely distributed throughout much of the central United States, may be a complex of up to five species (Pittman 2011). However, even if these species were distinguished and described, Mississippi basin populations in Wisconsin would likely retain the name *N. stramineus*. Great Lakes basin populations were not included in this analysis, and their relationship with Mississippi River basin populations is unknown.

**Weed Shiner *Notropis texanus:*** Uncommon to locally common in the Mississippi River and the lower reaches of its larger tributaries and uncommon in the larger rivers of the Fox-Wolf drainage of the Lake Michigan basin. Absent from the Lake Superior basin. The species has disappeared from some of the smaller rivers it once occupied in the early 1900s (Becker 1983; Lyons et al. 2000). Weed Shiners prefer off-channel, slow-moving, well-vegetated, riverine areas. There are a few unconfirmed reports from shallow weedy lakes in northwestern Wisconsin (Fago 1992), but these could be misidentified Blackchin Shiner.

**Mimic Shiner *Notropis volucellus:*** Common statewide in small to large rivers and sand-bottomed glacial lakes including nearshore areas of Lake Michigan and Lake Superior. Often in large schools. As the common name implies, a species that is easily confused with other *Notropis,* including Bigmouth, Sand, and especially Channel Shiner *N. wickliffi* (Lyons et al. 2000).

**Channel Shiner *Notropis wickliffi:*** Common in the Mississippi River and the lower part of its largest tributaries, the Wisconsin, Chippewa, and St. Croix rivers. Also found in the lower part of the

Wolf River in the Fox-Wolf drainage of the Lake Michigan basin (Lyons 2005). Absent from the Lake Superior basin.

The Channel Shiner and Mimic Shiner are difficult to distinguish, and their relationship to each other is unclear (Dowell 2010). They overlap in parts of the St. Croix, Wisconsin, and Wolf rivers and possibly elsewhere and appear to hybridize (Lyons et al. 2000). Both species are likely part of a species complex that may also include the Ghost Shiner and one or more undescribed species. The Channel Shiner was originally described from the Ohio River basin, and the "Channel Shiner" that occurs in Wisconsin and the Upper Mississippi River basin may prove to be a different species (personal communication, Bob Hrabik, Missouri Department of Conservation, Jackson, 23 August 2015 and subsequently). An ongoing genetic study of the Mimic Shiner species complex at the University of Illinois should help clarify the status of the Wisconsin Channel Shiner.

**Pugnose Minnow *Opsopoeodus emiliae:*** Uncommon to locally common in the Mississippi River and its largest tributaries including the Chippewa, Black, Wisconsin, Rock, and Illinois-Fox rivers, and in the Fox-Wolf River drainage in the Lake Michigan basin. Absent from the Lake Superior basin. Prefers slow-moving, well-vegetated, off-channel areas of rivers. Occasionally found in shallow, weedy, glacial lakes in the Illinois-Fox drainage.

The correct genus for the Pugnose Minnow has long been debated. At times the species has been considered part of *Notropis* or *Cyprinella*. The most recent analysis, encompassing several genetic markers, concluded that the genus *Opsopoeodus* was most appropriate (Blanton et al. 2011), a recommendation accepted by Page et al. (2013).

**Suckermouth Minnow *Phenacobius mirabilis:*** Uncommon to common in higher gradient rocky reaches of streams and small rivers in southern Wisconsin in the Mississippi River basin, particularly extreme southwestern Wisconsin. Absent from the Lake Michigan and Lake Superior basins. The evolutionary relationships among the five species of *Phenacobius* were reviewed by Dimmick and Burr (1999).

**Bluntnose Minnow *Pimephales notatus:*** Common and widespread statewide in streams, rivers, and lakes with sand or gravel bottoms. Uncommon in the largest rivers, where it is replaced by the Bullhead Minnow *P. vigilax,* and in the Great Lakes proper, where it is rare and limited to creek mouths. A recent morphological study found differences in Bluntnose Minnow shape associated with the size and current velocity of streams habitats they occupied in Indiana (Jacquemnin et al. 2013), and a genetic analysis found few differences among populations across most of the species' range in eastern North American except for a distinctive lineage in the Ozark Highlands in Missouri and Arkansas (Schonhuth et al. 2016).

**Fathead Minnow *Pimephales promelas:*** Widespread statewide. A common fishing bait minnow tolerant of crowding and poor water quality, mainly raised in fish farms but sometimes wild-caught. Smaller individuals are sold as "crappie minnows." Bait-bucket-released individuals might be expected almost anywhere. However, established self-sustaining populations occur only in small marshy streams or small well-vegetated lakes with few fish predators. Also widely used as a bioassay organism for monitoring pollution and occasionally stocked for mosquito control in urban areas.

There has not been a comprehensive study of morphological or genetic variation in the Fathead Minnow across its large range in eastern North America. Recent genetic analysis of wild populations at the southern edge of their distribution in the southwestern United States and northern Mexico reveal several distinctive lineages (Ballesteros-Nova et al. 2019; Klymus et al. 2022), suggesting that a range-wide analysis would be valuable.

**Bullhead Minnow *Pimephales vigilax:*** Common in the Mississippi River and its largest tributaries and in the Wolf and Fox rivers in the Lake Michigan basin. Most frequently found in sloughs and off-channel areas with limited current. Traditionally, two subspecies have been recognized, *P. vigilax vigilax* and *P. vigilax perspicuous,* with the latter found in Wisconsin. A genus-wide genetic analysis found relatively large differences between the two subspecies and suggested that they might warrant elevation to separate species (Schmidt et al. 1994), but apparently no follow-up work has been done.

**Longnose Dace *Rhinichthys cataractae:*** Common statewide except for inland areas of southeastern Wisconsin. Usually found in fast-flowing rocky areas of streams and small rivers but also known from rocky, wave-swept shores of the Great Lakes. However, populations along the shoreline of Lake Michigan appear to have declined sharply as non-native Round Goby have become abundant.

The Longnose Dace has one of the broadest ranges of any North American freshwater fish species, extending from the Atlantic Coast to the Pacific Coast and from far northern Canada to the Mexican border in the Rio Grande River, and there is substantial genetic variation and several distinctive lineages across the continent (Kim and Conway 2014). A Mississippi River tributary population in Minnesota near the Wisconsin border was genetically most similar to populations in the Hudson Bay and Missouri River basins, but other upper Mississippi River and upper Great Lakes populations have not been examined.

**Western Blacknose Dace *Rhinichthys obtusus:*** Common statewide in rocky streams with current. Tolerant of poor water quality and found in degraded urban or agricultural waters (as well as in high-quality waters) as long as firm bottom material is present and water temperatures are relatively cool in the summer.

The taxonomy and evolutionary history of the Blacknose Dace species group have been complicated and a bit confused. Populations in Wisconsin have long been known as Blacknose Dace *R. atratulus* (Becker 1983; Lyons et al. 2000; Page et al. 2013). However, more recent genetic analyses indicate that this scientific name should be reserved for populations east of the Appalachian Mountains, now termed the Eastern Blacknose Dace or just the Blacknose Dace, and that populations in the Mississippi River and upper Great Lakes basins, including all of Wisconsin, should be called the Western Blacknose Dace *R. obtusus* (Kraczkowski and Chernoff 2014), a recommendation we follow.

**Creek Chub** ***Semotilus atromaculatus:*** Common to abundant statewide in streams. Tolerant of poor water quality and degraded habitat. Wild-caught and pond-raised fish are sold as fishing bait under the name "black-tailed chub." A recent genetic analysis found relatively little genetic differentiation among populations of this species across most of its wide range in eastern North America including Wisconsin (Schonhuth et al. 2018b).

## SUCKERS (CATOSTOMIDAE)

**Carpsuckers (*Carpiodes*) and Buffalofishes (*Ictiobus*):** The three carpsucker and three buffalofish species found in Wisconsin are highly variable in shape (e.g., Suttkus and Bart 2002), sometimes hybridize (Bart et al. 2010; personal communication, Henry Bart, Tulane University, New Orleans, Louisiana, 25 September 2008 and subsequently; WDNR unpublished data), and can be difficult to distinguish (Chen et al. 2008; Bart et al. 2010). Reports of particular species not backed by voucher specimens or photos or confirmed by a trained biologist may be suspect. Carpsuckers and buffalofishes are closest relatives and form the subfamily Ictiobinae (Harris and Mayden 2001; Doosey et al. 2010; Chen and Mayden 2012; Bagley et al. 2018).

**River Carpsucker** ***Carpiodes carpio:*** Occasional to common in the Mississippi River and the lower reaches of its largest rivers, particularly the lower Wisconsin River. Absent from the Rock and Illinois-Fox river drainages and the Lake Michigan and Lake Superior basins. Found mainly in areas of current. Recent ecological studies examined gill raker morphology and diet and age, growth, and environmental correlates of annual reproductive success of the River Carpsucker in the larger interior rivers of Iowa (Spiegel et al. 2011; Quist and Spiegel 2012).

**Quillback** ***Carpiodes cyprinus:*** Common in medium to large rivers in the Mississippi River and the lower reaches of its largest tributaries as far north as the St. Croix River near the junction of the Namekagon River, Burnett County, and the Wisconsin River at Stevens Point, Portage County (Figure 1b; WDNR unpublished data; identifications confirmed by us). Also common in the Rock River and Fox-Illinois River drainages in southern Wisconsin and uncommon in the Fox-Wolf River drainage including Lake Winnebago and Green Bay. Recently observed in small numbers in the lower Milwaukee River, likely colonists from populations further south in Lake Michigan, and in Duluth-Superior Harbor in the Lake Superior basin, likely brought there in ballast water from inter-lake shipping (Rup et al. 2010) (WDNR unpublished data; identifications confirmed by us).

There have been several recent ecological studies of the Quillback in the Upper Midwest. Timing of the spawning run has been documented in the Baraboo River in Sauk County, a Wisconsin River tributary (Figure 1b; Catalano and Bozek 2015), and in the lower Wisconsin River (Lyons et al. 2016). A genetic analysis found no differentiation among populations in the Wisconsin River fragmented and isolated by dams (Ruzich et al. 2019). Studies have also examined gill raker morphology and diet and also age, growth, and environmental correlates of annual reproductive success in the larger interior rivers of Iowa (Spiegel et al. 2011; Quist and Spiegel 2012).

**Highfin Carpsucker** ***Carpiodes velifer:*** Occasional to common in the Mississippi River and the lower reaches of its largest rivers, especially the lower Wisconsin River. Absent from the Rock and Illinois-Fox river drainages and the Lake Michigan and Lake Superior basins. Found mainly in areas of current. Recent investigations into the Highfin Carpsucker have documented gill raker morphology and diet and also age, growth, and environmental correlates of annual reproductive success in the larger interior rivers of Iowa (Spiegel et al. 2011; Quist and Spiegel 2012).

**Longnose Sucker** ***Catostomus catostomus:*** Occasional to common in nearshore areas of Lake Michigan and Lake Superior (Gamble et al. 2011a), entering tributaries in large numbers, often together with White Sucker, to spawn in the spring. However, tributary residence is brief, and both adults and newly hatched fry move to the lake within a few days (Childress et al. 2016). One small inland population occurs in the Brule River, Florence County, a tributary to the Menominee River, which flows into Green Bay (UWZM 11082, 11873, 12132, 12135). This resident population has long been isolated from Lake Michigan, historically by at least four waterfalls and currently by seven dams. Longnose Sucker is absent from the Mississippi River basin. The Longnose Sucker has a vast range across much of northern and western North America and northeastern Asia, but there have been only a few studies of morphological or genetic variation among different populations (e.g., Langille et al. 2016) and none in the Great Lakes. The evolutionary relationship between Longnose Sucker and White Sucker is not certain, with some studies finding them only distantly related (Doosey et al 2010; Bangs et al. 2018) and others concluding that they are close relatives (e.g., Bagley et al. 2018).

The large spawning migrations of Longnose Sucker and White Sucker into Great Lakes tributaries are spectacular (Figure 13). Historically, these runs were important for subsistence and commercial fisheries (Cooke and Murchie 2015), although these uses have faded in Wisconsin. Currently, some sport fishing and fish viewing occurs. The migrations have been the subject of several recent scientific studies (e.g., Swanson et al. 2021). Of particular interest has been the transport of nutrients into the tributaries from the Great Lakes via spawning and the resulting increases in algal and invertebrate productivity in the streams (Childress et al. 2014; Childress and McIntyre 2015, 2016; Jones and Mackereth 2016).

**White Sucker** ***Catostomus commersonii:*** Common to abundant and widespread statewide in streams, rivers and lakes, including the nearshore areas of the Great Lakes. The most broadly distributed fish species in the state and one of the most common. The only places where the White Sucker is not found in good numbers are the Mississippi River and the lower reaches of its largest tributaries, where the species is limited to the mouths of cooler tributaries. Farm-raised and wild-caught White Sucker are widely used as fishing bait, and some sport fishing occurs, particularly during the spring spawning run (WDNR unpublished data). Catalano and Bozek (2015) studied the temporal progression of White Sucker spawning and the associated environmental conditions in the Baraboo River, Sauk County, a Wisconsin River tributary.

**Blue Sucker** ***Cycleptus elongatus*** **THREATENED:** Rare to locally common in fast flowing areas of the Mississippi River and the

**Figure 13. Spawning migration of Longnose Suckers in an unnamed tributary to Lake Michigan, Door County, 10 April 2021. (Photos from Dr. Karen Murchie, Shedd Aquarium, Chicago, Illinois)**

lower reaches of its largest tributaries. The best populations are in the lower Wisconsin and Chippewa rivers. Absent from the Lake Michigan and Lake Superior basins. The species disappeared from about 50 miles of the Wisconsin River and 15 miles of a tributary, the Baraboo River, following the closure of the Prairie du Sac Dam in 1914. Lyons et al. (2016) described the habitat, timing, and population demographics of Blue Sucker spawning in the lower Wisconsin River.

**Western Creek Chubsucker *Erimyzon claviformis* EXTIRPATED:** Known historically from two slow-moving, well-vegetated streams in the Des Plaines River drainage (Figure 1a) of the Mississippi River basin in far southeastern Wisconsin, but no records since 1928 despite many surveys (Becker 1983). The Creek Chubsucker was long thought to be a single species that occupied most of the eastern United States. It consisted of two subspecies, the Eastern Creek Chubsucker *E. oblongus oblongus* in Atlantic Coast drainages and the Western Creek Chubsucker *E. oblongus claviformis* in the central United States including Wisconsin. Bailey et al. (2004) presented evidence that these two subspecies should be elevated to full species, a change accepted by Page et al. (2013), and the scientific name for the fish formerly found in Wisconsin has changed from *E. oblongus* to *E. claviformis*.

**Lake Chubsucker *Erimyzon sucetta* SPECIAL CONCERN:** Occasional in slow-moving, well-vegetated streams and lakes in the Rock and Fox-Illinois river drainages in southern Wisconsin and in floodplain backwaters, lakes, and tributary mouths in the floodplain of the lower Wisconsin River in southwestern Wisconsin in the Mississippi River basin. Also known from streams, shallow lakes, and impoundments in the Fox-Wolf, Sheboygan, Milwaukee, and Root River drainages (Figure 1a,b) in the Lake Michigan basin (Becker 1983; Fago 1992). Populations are widespread in the Fox-Wolf but limited in the Sheboygan, Milwaukee and Root. None have been found in the Sheboygan drainage since the 1960s and we judge that these were introduced and are now gone. The Milwaukee and Root populations are close to the low divides between the upper Rock and Fox-Illinois drainages; we believe these populations originated from colonization from the Mississippi River basin.

The Lake Chubsucker is widely distributed across the eastern United States and southeastern Ontario, but a recent genetic analysis indicates that two species are actually present (Hunt et al. 2021). One is in Atlantic Coast drainages and the other in Great Lakes and Gulf of Mexico drainages including Wisconsin. Because the Atlantic Coast populations include the type locality from which the first specimens were scientifically described and named, they will retain the scientific name *E. sucetta,* and populations from the central United States and southern Ontario will require a new scientific name. The specific name *kennerlii* has been applied in the past to a Texas Lake Chubsucker population and may become the new scientific name for all Wisconsin populations.

**Northern Hog Sucker *Hypentelium nigricans:*** Common and widespread in rocky fast areas of streams and rivers in the Mississippi River and Lake Michigan basins. Broadly distributed in drainages to Green Bay but largely absent and limited to a few localized areas in direct drainages to Lake Michigan. Absent from the Lake Superior basin. A genetic analysis found substantial variation across the range of the Northern Hog Sucker in the eastern United States and southeastern Ontario with Wisconsin populations most similar to other upper Midwest and northern Ozarks populations (Berendzen et al. 2003). Recent studies have examined gill raker morphology and diet and also age, growth, and environmental correlates of annual reproductive success in the larger interior rivers of Iowa (Spiegel et al. 2011; Quist and Spiegel 2012).

**Smallmouth Buffalo *Ictiobus bubalus:*** Common in areas of current in the Mississippi River and the lower reaches of its largest tributaries, especially the lower Wisconsin River. Not found in the Rock River drainage in Wisconsin and absent from the Lake Michigan and Lake Superior basins. Supports a commercial fishery in the Mississippi River (Klein et al. 2018). Recent studies have found that Smallmouth Buffalo live to much older ages than once thought with specimens up to at least 39 years old in the Mississippi River in Missouri (Love et al. 2019) and up to 62 years old in Oklahoma (Snow et al. 2020).

**Bigmouth Buffalo *Ictiobus cyprinellus:*** Common in the Mississippi River and the lower reaches of its larger tributaries and in the rivers and larger lakes of the Rock River drainage in southern Wiscon-

**Figure 14. Confusing buffalofishes. Top: Black Buffalo from the Mississippi River, Alexander County, Illinois, opposite Cape Girardeau, Missouri, 20 July 2001. Middle: Hybrid Smallmouth Buffalo X Black Buffalo from the Wisconsin River, Richland County, 3 September 2003. Bottom: Smallmouth Buffalo from the Wisconsin River, Iowa County, 20 June 2001.**

sin. Absent from the Lake Michigan and Lake Superior basins. Most common in standing water, tending to avoid areas of strong current except during spawning movements. Supports a small sport fishery throughout its Wisconsin distribution, mainly via bowfishing, and a commercial fishery in the Mississippi River (Klein et al. 2018) and a few inland lakes (WDNR unpublished data). Recent studies of populations in Minnesota and North Dakota indicate that the Bigmouth Buffalo is one of the longest-lived freshwater fishes with some populations having many individuals over 40 years of age and some over 100 (Lackmann et al. 2019, 2021).

**Black Buffalo *Ictiobus niger* THREATENED:** Uncommon in the Mississippi River, the Wisconsin River up to Wisconsin Dells and its tributary the Baraboo River, and the lower reaches of the Pecatonica River in the Rock River drainage. Absent from the Lake Michigan and Lake Superior basins. Longer lived than previously believed with a 56-year-old specimen reported from Michigan (Lackmann et al. 2019). Genetic and morphological analyses indicate that Smallmouth and Black buffalos commonly hybridize in the Mississippi and lower Wisconsin rivers (Figure 14; Bart et al. 2010; personal communication, Henry Bart, Tulane University, New Orleans, Louisiana, 25 September 2008 and subsequently; WDNR unpublished data). Many Black Buffalo there appear to be hybrids or introgressed with Smallmouth Buffalo, and "pure" Black Buffalo are probably even less common than previous studies would suggest.

**Spotted Sucker *Minytrema melanops:*** Occasional to common in the Mississippi River and the lower reaches of its larger tributaries, the Des Plaines River in southeastern Wisconsin, and the larger rivers and associated lakes of the Fox-Wolf drainage. Absent from the Rock River drainage, direct tributaries of Lake Michigan, and the Lake Superior basin. Primarily found in slow moving, well-vegetated, off-channel areas of rivers and reservoirs except during spawning, which takes place in the spring in fast-flowing rocky areas of the main channel (Becker 1983; Lyons 2005). Catalano and Bozek (2015) studied the temporal progression of Spotted Sucker spawning and the associated environmental conditions in the Baraboo River, Sauk County, a Wisconsin River tributary. The closest relatives of the Spotted Sucker are the chubsuckers (*Erimyzon*) (Harris and Mayden 2001; Doosey et al. 2010; Chen and Mayden 2012; Bagley et al. 2018).

**Redhorses (*Moxostoma*):** The six redhorse species found in Wisconsin are similar in appearance and often misidentified. Reports of particular species not backed by voucher specimens or photos or confirmed by a trained biologist may be suspect. The Black and Golden redhorses and the River, Greater, and Shorthead redhorses are the species most likely to be confused. Despite looking alike, none of the Wisconsin redhorses are nearest relatives to each other, and no hybridization has been observed (Harris et al. 2002; Clements et al. 2012)

**Silver Redhorse *Moxostoma anisurum:*** Common and widespread in medium to large rivers statewide. There are small, localized, sport fisheries, particularly during the spawning run. Catalano and Bozek (2015) studied the temporal progression of Silver Redhorse spawning and the associated environmental conditions in the Baraboo River, Sauk County, a Wisconsin River tributary. Other recent studies have examined gill raker morphology and also diet and age, growth, and environmental correlates of annual reproductive success in the larger interior rivers of Iowa (Spiegel et al. 2011; Quist and Spiegel 2012).

**River Redhorse *Moxostoma carinatum* THREATENED:** Uncommon to locally common in areas of current in the Mississippi River and its larger tributaries, particularly the St. Croix River, in small areas of the Sugar and Rock rivers in the Rock River drainage, and at a few locations in the Fox-Wolf drainage. Absent from direct tributaries to Lake Michigan and the Lake Superior basin.

**Black Redhorse *Moxostoma duquesnei* ENDANGERED:** Currently found only in areas of current in the Wisconsin River and the lower part of a tributary, the Eau Claire River, near the city of Wausau in Marathon County, where it is uncommon (Figure 1b). Historically, however, the species was more widely distributed, including other parts of the Wisconsin River drainage and possibly the Mississippi River and some of its other tributaries (Becker 1983; Lyons 2022). The Black Redhorse still occurs in Mississippi River tributaries in Minnesota and Iowa near Wisconsin.

**Golden Redhorse *Moxostoma erythrurum:*** Common and widespread in areas of current in small to large rivers in the Mississippi River and Lake Michigan basins. No confirmed reports and likely absent from the Lake Superior basin. There are small, localized, sport fisheries, particularly during the spawning run. Catalano and Bozek (2015) studied the temporal progression of Golden Redhorse spawning and the associated environmental conditions in the Baraboo River, Sauk County, a Wisconsin River tributary. Other recent studies have examined gill raker morphology and diet and also age, growth, and environmental correlates of annual reproductive success in the larger interior rivers of Iowa (Spiegel et al. 2011; Quist and Spiegel 2012).

**Shorthead Redhorse *Moxostoma macrolepidotum:*** Common and widespread in medium to large rivers statewide. There are small, localized, sport fisheries, particularly during the spawning run. We have noted that many state or line class angling records for this species in the Midwest are almost certainly based on misidentified Greater Redhorse *M. valenciennesi*. The two species are difficult to distinguish, but the Greater Redhorse reaches a much large size (10–12 pounds vs. 3–4 pounds).

There have been several recent ecological studies of the Shorthead Redhorse in the Upper Mississippi River basin. Catalano and Bozek (2015) documented the temporal progression of shorthead redhorse spawning and the associated environmental conditions in the Baraboo River, Sauk County, a Wisconsin River tributary, and Lyons et al. (2016) provided observations on habitat use and timing during spawning in the lower Wisconsin River. Ruzich et al. (2019) found no genetic differences among populations in a stretch of the Wisconsin River fragmented by dams. In large interior rivers of Iowa, Spiegel et al. (2011) examined gill raker morphology and diet, and Quist and Spiegel (2012) analyzed age, growth, and environmental correlates of annual reproductive success.

**Greater Redhorse *Moxostoma valenciennesi:*** Occasional at widely scattered locations throughout the Mississippi River and Lake Michigan basins. Most widespread and common in the St. Croix River drainage in northwestern Wisconsin and the Milwaukee River drainage in southeastern Wisconsin. Absent from the Lake Superior basin. Although mainly found in small to large rivers, the Greater Redhorse is also regularly seen in lakes including harbors and tributary mouths in Lake Michigan. For many years the Greater Redhorse was formally listed as a threatened species in Wisconsin, but ongoing sampling demonstrated that it was more common and widespread than once believed, and it was delisted in 2012.

## BULLHEAD CATFISHES (ICTALURIDAE)

**Bullheads (*Ameiurus*):** The three bullhead species found in Wisconsin are similar in appearance and often misidentified. Black Bullhead and Brown Bullhead are closely related (Hardman and Page 2003; Arce-H. et al. 2017) and especially difficult to distinguish and may hybridize (Walter et al. 2014). Reports of particular species not backed by voucher specimens or photos or confirmed by a trained biologist may be suspect. Collectively, bullheads often reach high densities in small shallow lakes and may have strong effects on the ecosystem (e.g., Sikora et al. 2021). They support popular sport fisheries in some areas (Rypel et al. 2016; Embke et al. 2020).

**Black Bullhead *Ameiurus melas:*** Common and widespread near the bottom in slow-moving areas of streams, rivers, and lakes statewide.

**Yellow Bullhead *Ameiurus natalis:*** Common and widespread near the bottom in slow moving areas of streams, rivers, and lakes in the Mississippi River and Lake Michigan basins. Uncommon and localized in the Lake Superior basin.

**Brown Bullhead *Ameiurus nebulosus:*** Locally common near the bottom in vegetated lakes statewide, including harbors and sheltered shallow bays of the Great Lakes. Curiously, Brown Bullhead is rarely found in flowing waters in Wisconsin even though they occur in streams and rivers elsewhere in their range.

**Channel Catfish *Ictalurus punctatus:*** Common and widespread in medium to large rivers and larger lakes in the Mississippi River basin in the southern half of the state, with populations extending north to the mouth of the Namekagon River in Burnett County in the St. Croix River drainage (Figure 1a), and in the Fox-Wolf River drainage and Green Bay. A few reports from impoundments and rivers in direct drainages to Lake Michigan and in Duluth-Superior Harbor of Lake Superior, but these populations are likely introduced and are probably not self-sustaining. An important commercial fish in the Mississippi River (Krogman et al. 2011; Klein et al. 2018) and a popular sport fish (Rypel et al. 2016; Embke et al. 2020).

**Slender Madtom *Noturus exilis* ENDANGERED:** Rare in fast-flowing rocky areas of streams in the Rock River drainage in southern Wisconsin. Formerly more widespread and common but has disappeared from many locations over the last 40 years. Unexpectedly, a small Slender Madtom population was recently discovered along the rocky shore of Rock Lake, Jefferson County, in the Rock River drainage but far from other existing stream populations (Figure 15; Lyons et al. 2020). This species has never before been reported from a natural lake. Surveys of other lakes with rocky shorelines in southern Wisconsin have not detected other Slender Madtom populations. Genetic analyses of Slender Madtom populations across the species range indicate substantial variation, with Wisconsin populations most similar to populations from the northern Ozarks and the Missouri River basin (Hardy et al. 2002) The evolutionary relationship of the Slender Madtom with the Stonecat *N. flavus,* species that sometimes co-occur in Wisconsin, is unclear; one analysis indicates that they are only distantly related (Hardman 2004), but another finds them to be closest relatives (Arce-H. et al. 2017).

**Stonecat *Noturus flavus:*** Common in fast-flowing rocky streams in the Mississippi River and Lake Michigan basins in the southern

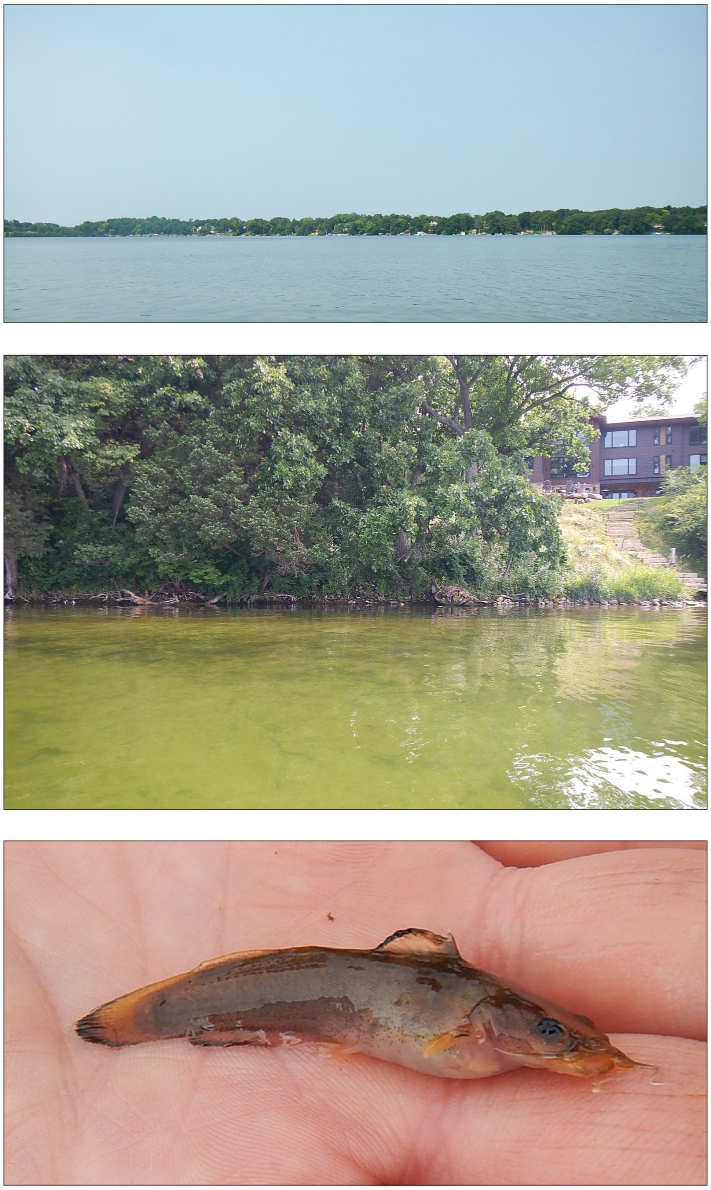

**Figure 15. Top and middle: Rock Lake shoreline, Jefferson County, 8 July 2019. Bottom: a Slender Madtom captured from the lake (and released) on 25 June 2019. Madtoms were caught from the rocks at the edge of the shoreline.**

two-thirds of Wisconsin. Uncommon and localized in the northern third of the state including the Lake Superior basin. Wild-caught Stonecat are occasionally sold and used as fishing bait (Cochran and Zoller 2009). A genetic analysis of Stonecat across its range found substantial variation, and populations in most of the Mississippi River and Great Lakes basins were relatively similar to each other but differed from populations in the Cumberland River and Tennessee River drainages of the Mississippi River basin in Kentucky, Tennessee, and northern Alabama (Faber et al. 2009).

**Tadpole Madtom** ***Noturus gyrinus:*** Occasional to locally common statewide in slow-moving, heavily vegetated areas of medium to large rivers and in a few lakes, including sheltered shallow bays of Lake Superior. Most frequently encountered in sloughs and backwaters of the Mississippi River. There, wild-caught Tadpole Madtom are termed "willow cats" and have traditionally been a popular fishing bait, especially for large Walleye (Cochran and Zoller 2009; Cochran 2011).

**Flathead Catfish** ***Pylodictus olivaris:*** Occasional to locally common in the Mississippi River and the lower reaches of its largest tributaries, especially the Wisconsin and Chippewa rivers, and in the Fox-Wolf River drainage. Small, localized populations also exist at a few spots in the Rock River drainage. Recently, Flathead Catfish have been captured in the lower part of the Milwaukee River, where they are thought to have migrated from populations farther south in Lake Michigan (Fuller and Whelan 2018). An important commercial fish in the Mississippi River (Krogman et al. 2011; Klein et al. 2018) and a popular sport fish (Rypel et al. 2016; Embke et al. 2020). A recent study looked at seasonal movements of adult male Flathead Catfish in the Fox-Wolf River drainage (Piette and Niebur 2011).

## SMELTS (OSMERIDAE)

**Rainbow Smelt** ***Osmerus mordax*** **NON-NATIVE:** Established in Lake Michigan and Lake Superior and about 20 deep inland lakes in northern Wisconsin in the Lake Superior, Mississippi River, and Lake Superior basins (Mercado-Silva 2006; WDNR unpublished data). Usually found in mid-water in areas from 20 to 200 feet deep, moving to the shore and sometimes into the lower reaches of tributaries during spring spawning (Gamble et al. 2011a; Gaeta et al. 2015). In Lake Michigan, the Rainbow Smelt was abundant from the 1930s through 1980s, but it has declined dramatically since then and is now only moderately common (Stewart et al. 1981; Tingley et al. 2021). It formerly supported a large commercial fishery and a popular sport fishery using dip nets and seines during spring spawning, but those fisheries have collapsed (WDNR unpublished data). In Lake Superior, Rainbow Smelt have also declined substantially since the 1980s but still remain common and continue to support commercial and sport fisheries (Gorman 2007; Myers et al. 2009; Vinson et al. 2018). Increased predation from rising numbers of Lake Trout, Coho Salmon *Oncorhynchus kisutch,* and Chinook Salmon *O. tshawytscha* are thought to have contributed to the Rainbow Smelt declines. The drop in Rainbow Smelt abundance has led to a rebound in the populations of Cisco in Lake Superior (Gorman 2007; Meyers et al. 2009).

In inland lakes, the establishment of Rainbow Smelt has caused substantial drops, and in some cases the elimination, of native Cisco, Lake Whitefish, Yellow Perch, and Walleye populations (Mercado-Silva et al. 2007; Roth et al. 2010). A variety of management practices have been applied in some of these lakes to control Rainbow Smelt numbers and restore native fishes, including stocking Walleye and protecting them from harvest to increase predation on Rainbow Smelt (Krueger and Hrabik 2005; Lawson and Carpenter 2014), manually removing spawning Rainbow Smelt (Gaeta et al. 2015), and disrupting lake stratification to eliminate suitably cold Rainbow Smelt summer habitats (Lawson et al. 2015), but these efforts have seen only limited success.

## TROUTS (SALMONIDAE)

**Cisco** ***Coregonus artedi:*** Known from Lake Michigan and Lake Superior, where it is often called the "Lake Herring," and about 140 deep inland lakes statewide in both the Great Lakes and the Mississippi River basins where it is sometimes known as the "Inland

Cisco" (Renik et al. 2020). Deep-bodied inland populations in Minnesota are often called "Tullibee." Cisco populations in Lake Michigan are now greatly reduced from overfishing and competition and predation from non-native species (Eshenroder et al. 2016), and Cisco have disappeared from about 30% of the inland lakes and become rare in several others because of water quality declines or predation on young by non-native Rainbow Smelt (Hrabik et al. 1998; Lyons et al. 2016b; Renik et al. 2020). Cisco remain common in Lake Superior. Climate warning threatens the existence of up to 70% of the remaining inland lake populations by 2100 (Sharma et al. 2011). Commercial fisheries for Cisco are longstanding and important in the Great Lakes (WDNR unpublished data), and small subsistence seine or dip net fisheries in the shallows during fall spawning and hook-and-line sport fisheries through the winter ice exist on some of the inland lakes (Embke et al. 2020).

Historically, Lake Michigan and Lake Superior supported at least six additional types of ciscoes beyond the "Lake Herring," traditionally considered different species, the "Bloater" *Coregonus hoyi,* "Deepwater Cisco" *C. johannae,* "Kiyi" *C. kiyi,* "Blackfin Cisco" *C. nigripinnis,* "Shortnose Cisco" *C. reighardi,* and "Shortjaw Cisco" *C. zenithicus* (Figure 16; Becker 1983; Lyons et al. 2000). These Cisco types were similar in appearance and very difficult to distinguish, but they generally occupied different habitats, to a certain extent fed on different prey in different places, differed in growth rate and maximum size, spawned at different times and places, and were often targeted and managed for fisheries separately (Eshenroder et al. 2016). Overfishing and non-native species took a heavy toll on all the ciscoes in Lake Michigan and at present only the Bloater remains in Wisconsin waters. Its population is much reduced from historical levels (Tingley et al. 2021). An effort to reintroduce "Lake Herring" in Green Bay in the early 2000s by stocking fertilized eggs was unsuccessful (personal communication, Ted Treska, US Fish and Wildlife Service, New Franken, Wisconsin, 3 August 2016). The "Lake Herring," "Bloater," and "Kiyi" remain relatively common and the "Shortjaw Cisco" rare in the Wisconsin waters of Lake Superior (Vinson et al. 2018).

The ciscoes of the Great Lakes have been the subject of much study, and the current view is that, despite their differences, they are all merely distinctive life-history forms of a single highly variable species, the Cisco *C. artedi* (Eshenroder et al. 2016; Eshenroder and Jacobson 2020). Accordingly, we consider all Cisco forms in Wisconsin waters a single species and have removed "Bloater," "Deepwater Cisco," "Kiyi," "Blackfin Cisco," "Shortnose Cisco," and "Shortjaw Cisco" from the state list of fishes. Support for this change in taxonomy comes from genetics. Although the different types of ciscoes within a lake can be distinguished consistently from each other by gene sequencing (Ackiss et al. 2020), all the different "species" within a lake tend to be more similar to each other genetically than they are to their same "species" in other lakes (Turgeon and Bernatchez 2003; Eshenroder et al. 2016; Turgeon et al. 2016). This finding indicates that the ciscoes within a lake are likely all derived from the same common ancestor, which differs from the common ancestor for the ciscoes in other lakes. If the different types of ciscoes were true species, then each type would be more similar to its own type in other lakes than it would be to different types within its own lake, and it would share the same common ancestor with its same type in other lakes.

**Figure 16. Types of Cisco (from top): "Inland Cisco" from Big Green Lake, Green Lake County, 8 November 2001. "Lake Herring" from Lake Superior, Ashland County, 16 May 2002. "Bloater" from Lake Superior, Ontonagon County, Michigan, 29 August 2001."Kiyi" from Lake Superior, Bayfield County, 13 July 2005.**

**Lake Whitefish** ***Coregonus clupeaformis:*** Common and widespread in Lake Michigan and Lake Superior and known historically from nine deep inland lakes in the Lake Michigan and Mississippi River basins in northern Wisconsin. Of the nine inland populations, three have disappeared because of habitat losses, and the remaining six are small and vulnerable (Renik et al. 2020). Both Lake Michigan and Lake Superior support important commercial fisheries, and a major sport fishery through the winter ice has developed along the eastern side of Green Bay in Lake Michigan (WDNR unpublished data).

Lake Whitefish in the Wisconsin waters of Lake Michigan have undergone a substantial shift in distribution and spawning habitat over the last 30 years. Prior to European settlement in the 1800s, there were many different Lake Whitefish spawning areas, but by the 1900s most Wisconsin Lake Michigan Lake Whitefish were produced from spawning areas in North and Moonlight Bay on the Lake Michigan side of the Door County Peninsula (Figure 1b) and


**Figure 17. Pink Salmon from the Sioux River, Bayfield County. Top: Spawning female from 1 October 2009. Bottom: Spawning male from 26 September 2013.**

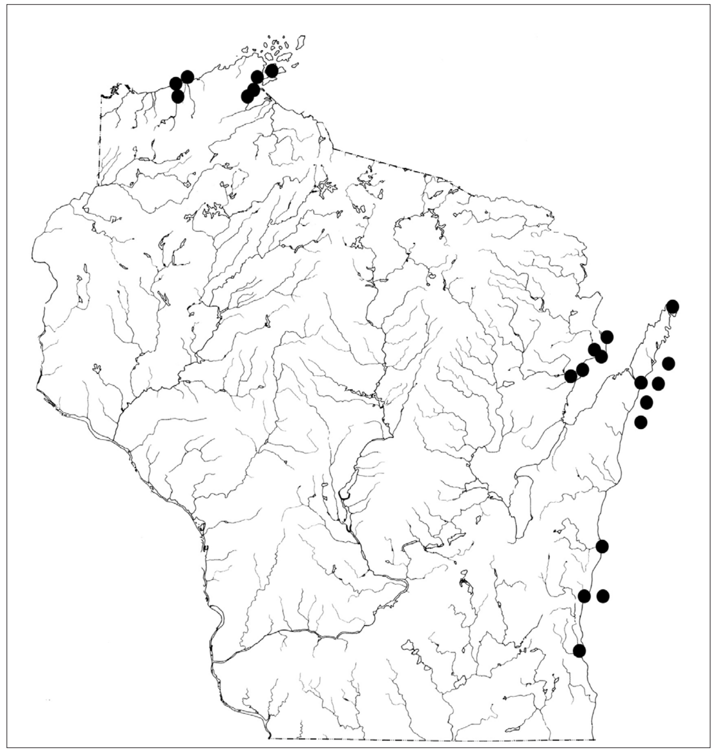

**Figure 18. Map of recent (since 1995) Pink Salmon records from Wisconsin.**

in Big Bay de Noc in northern Green Bay along the Upper Peninsula of Michigan (Nathan et al. 2016). Lake Whitefish were common in Lake Michigan proper and northern Green Bay but uncommon in southern and central Green Bay. In the 1990s, after pollution controls had improved water quality, Lake Whitefish began using the lower reaches of the larger Wisconsin tributaries of Green Bay for spawning, particularly the Menominee, Peshtigo, Oconto, and Fox rivers (Ransom et al. 2021). Since 2000, the amount of spawning along the Door County Peninsula has declined, as has the overall abundance of Lake Whitefish on the Wisconsin side of Lake Michigan, but spawning in Green Bay tributaries and Lake Whitefish populations in southern and central Green Bay have grown dramatically (WDNR unpublished data).

**Pink Salmon *Oncorhynchus gorbuscha* NON-NATIVE (**Figure 17**):** The Pink Salmon, a species introduced into the Great Lakes from the west coast of North America in the 1950s, was considered established in the Wisconsin waters of the Great Lakes by Becker (1983) but was removed from the Wisconsin list by Lyons et al. (2000) based on an absence of occurrences or evidence of reproduction during the 1980s and 1990s. We here restore this species to the list of established non-native species.

Beginning in the late 1990s, very small but apparently self-sustaining runs of Pink Salmon reappeared in tributaries to northern Green Bay and Lake Superior. These runs increased in the 2000s and have continued up to the present. The species is now clearly reestablished in the state. Specifically, Pink Salmon spawning runs have been observed annually in the lower Menominee, Peshtigo, and Oconto rivers, tributaries to Green Bay (Figure 1a), and in the lower Bois Brule, Douglas County, direct tributary to Lake Superior, and in the Pike, Onion, and Sioux rivers, Bayfield County, tributaries to Chequamegon Bay, Lake Superior (Figure 1b, 18). One or two mature individuals have also been captured sporadically from direct tributaries to Lake Michigan over the last 20 years (WDNR, unpublished data), and in 2021 over a dozen were observed in the Milwaukee River (personal communication, Aaron Schultz, WDNR, Milwaukee, 8 October 2021). We observed the first specimen in Sauk Creek, Ozaukee County (Fig. 1b), just north of the Milwaukee River, in 2022. However, it is unclear if any of these direct Lake Michigan tributaries have established populations. On occasion, anglers also catch non-spawning Pink Salmon from Lake Michigan and Lake Superior.

Two hybrids with Chinook Salmon, known colloquially as "pinook" salmon, have also been captured from Lake Michigan off of Door County (WDNR unpublished data; we have seen photos). Pinooks are seen regularly in the St. Marys River, which connects Lake Superior and Lake Huron (Rosenfield 1998; Kirkpatrick et al. 2007), and this area may be the source of the Wisconsin records.

Wisconsin Pink Salmon spawning runs have never been quantified but are likely small, perhaps averaging less than 100 fish per year in most tributaries. However, numbers fluctuate annually, and occasionally larger runs occur. For example, over 190 Pink Salmon were observed passing a weir on the Bois Brule River in 2017 (WDNR, unpublished data) and over 900 were seen in the Lake Sturgeon passage facility on the Menominee River in 2021 (personal communication, Tammie Paoli, WDNR, Peshtigo, 5 October 2021). Catches of spawning Pink Salmon tend to be greatest in odd-numbered years.

Spawning Pink Salmon in Wisconsin tributaries of Lake Michigan are consistently larger than those from Lake Superior tributaries. For instance, in October 2013, 14 Pink Salmon from the Menominee River averaged 20 inches in total length (range 16.5–23.0 inches) and 2.3 pounds in weight (range 1.5–3.3 pounds), whereas 19 Pink Salmon from the Sioux River averaged 15 inches (range 13.5–16.5 inches) and 1.0 pounds (range 0.7–1.5 pounds). Males were larger than females. All measured fish were two years old, which is the typical age of spawning Pink Salmon throughout their native and introduced range, indicating that Lake Michigan fish grew faster than Lake Superior fish and that males grew faster than females.

**Coho Salmon *Oncorhynchus kisutch* NON-NATIVE:** Common in Lake Superior and Lake Michigan and their tributaries. A popular sport fish species. Although some limited natural reproduction occurs in a few small Lake Michigan tributaries, the vast majority of fish in the lake are the result of regular stocking. Populations in Lake Superior are naturalized and self-sustaining. Reproduction occurs in many tributaries in the fall with the Bois Brule River, Douglas County (Figure 1b), having the largest spawning run. Juveniles usually spend one year in these streams (Lonzarich et al. 2009; Hintz and Lonzarich 2012) before migrating to the lake. They then typically spend two years in the lake before returning to the tributaries, usually the same one where they were born, to spawn and die.

**Rainbow Trout *Oncorhynchus mykiss* NON-NATIVE:** Widespread and common statewide in coldwater streams and in Lake Michigan and Lake Superior. A popular sport fish species. Most inland populations persist only because of stocking, and only two naturalized, self-sustaining populations are known, one in the West Branch of the White River in Waushara County and the other in the Drew Creek system, including Florence and Upper Bass lakes, in Langlade and Menominee counties (Figure 1b; WDNR unpublished data). Lake Michigan is also heavily stocked. A few Lake Michigan tributaries have limited natural reproduction, but their contribution to the lake population is limited, and the lake fishery is dependent on annual additions of large numbers of juveniles. Lake Superior is not stocked and has a naturalized population, and successful natural reproduction occurs in many tributaries with the Bois Brule River, Douglas County, having the largest spawning run and producing the most offspring.

**Sockeye (Kokanee) Salmon *Oncorhynchus nerka* NON-NATIVE:** The Kokanee Salmon is the non-ocean-going, inland form of the Sockeye Salmon and is native to lakes in the Pacific Northwest, Alaska, northeastern Asia, and the northern Pacific Ocean. It was accidentally introduced into Wisconsin in the 1960s from a fish farm and is now established in two small, adjacent, connected lakes, Florence in Langlade County, and Upper Bass in Menominee County (Figure 1b), in the upper part of the Fox-Wolf drainage in northeastern Wisconsin. These lakes are relatively small, shallow, low-elevation, and southerly compared to other lakes with Kokanee Salmon (Lyons et al. 2019). Fish in Florence Lake are relatively fast-growing and reproduce at a relatively young age. Spawning adults average 15–16 inches in length and range from 11–21 inches and 3–5 years in age. They complete their life cycle within the lake and only rarely enter the inlet and outlet streams. Although thriving now, climate warming threatens the long-term persistence of Kokanee Salmon in Wisconsin.

**Chinook Salmon *Oncorhynchus tshawytscha* NON-NATIVE:** Uncommon in Lake Superior and its tributaries and common in Lake Michigan and its tributaries. A popular sport fish species. Heavily stocked in Lake Michigan. Occasional successful natural reproduction in a few Wisconsin Lake Michigan tributaries but their contribution to the lake population is negligible. However, successful reproduction is common in Michigan's Lake Michigan tributaries, and many of these fish spend much of their lives in Wisconsin waters, returning to Michigan tributaries to spawn and die (Kerns et al. 2016). No Chinook Salmon stocking has occurred in the Wisconsin waters of Lake Superior since 2007, and a small, naturalized population exists, spawning mainly in the Bois Brule River, Douglas County (Figure 1b; WDNR unpublished data).

**Pygmy Whitefish *Prosopium coulterii:*** Known only from Lake Superior, where it is common near the bottom in 25 to 250 feet of water. Pygmy Whitefish spawn on rocky shoals in the fall. Populations have fluctuated over the last 30 years and are relatively low today (Van der Lee, et al. 2022). Age, growth, and size of Lake Superior populations have been recently quantified (Stewart et al. 2016).

**Round Whitefish *Prosopium cylindraceum:*** Occasional to common in Lake Michigan and Lake Superior near the bottom in 10 to 200 feet of water, spawning on rocky shoals in the fall. On rare occasions, Round Whitefish enter tributary streams in the spring, perhaps following White Sucker and Longnose Sucker spawning migrations to feed on their eggs. A small commercial fishery exists in both Great Lakes, in which the species is known as the "Menominee Whitefish."

**Brown Trout *Salmo trutta* NON-NATIVE:** Common and widespread in coldwater streams statewide, particularly in the Driftless Area of southwestern Wisconsin; also in Lake Michigan and Lake Superior. A popular sport fish species. The Lake Superior Brown Trout population is largely self-sustaining, but the Lake Michigan population is completely maintained by stocking. Some inland populations are also maintained or supplemented by stocking, particularly in southeastern Wisconsin, but most are largely or completely self-sustaining. Many decades of stream protection and restoration have increased Brown Trout distribution and abundance statewide. However, climate change threatens inland populations, and without further interventions Brown Trout distribution is projected to decline by 33% by mid-century (Mitro et al. 2019).

**Brook Trout *Salvelinus fontinalis:*** Common statewide in coldwater streams and small heavily spring-fed ponds. A popular sport fish species. Widely stocked inland, and some populations only persist because of regular introductions, particularly in southern Wisconsin. Currently largely absent from Wisconsin waters of Lake Michigan and Lake Superior despite occasional stocking, but nearshore populations of relatively large "coasters," a life-history form that spent part of its life feeding in the Great Lakes and reached a relatively large size, were present historically. Prior to 1840, Brook Trout were ubiquitous in the state, but land use changes and environmental degradation from Euro-American settlement essentially eliminated them from southern Wisconsin and the Great Lakes and greatly reduced their abundance in the north. Decades of improved land use, water quality improvements, and reintroductions have restored Brook Trout to most of their historical range, but many populations now have non-native genetic material (mainly from the northeastern United States), particularly in southern Wisconsin (Erdman et al. 2022). Climate change threatens inland Brook Trout populations, and without

**Figure 19. The two varieties of Lake Trout found in Wisconsin. Top: "Lean" form from Trout Lake, Vilas County, 2 November 2000. Bottom: "Siscowet" or "Fat" form from Lake Superior, Ontonagon County, Michigan, 29 August 2001.**

intensive protection efforts their distribution is projected to decrease by 67% by mid-century (Mitro et al. 2019).

**Lake Trout *Salvelinus namaycush:*** Common in Lake Michigan and Lake Superior and occasional to common in 11 deep inland lakes. A popular sport fish with a commercial fishery on Lake Superior. Historically, the Lake Trout was abundant in Lake Michigan and Lake Superior and was also found in two inland lakes, Trout and Black Oak in Vilas County (Figure 1b). These two inland lakes still have natural reproduction and have retained their genetically distinctive populations, although they are supplemented by regular introductions of juvenile fish reared from eggs taken from each lake (Piller et al. 2005). Populations in the other nine inland lakes are maintained by stocking (WDNR unpublished data). Overfishing and predation by the non-native Sea Lamprey eliminated the Lake Trout from Lake Michigan by the 1950s and reduced it to low levels in Lake Superior. A massive effort to control Sea Lamprey, regulate fishing, and reintroduce Lake Trout had largely restored the species in Lake Superior by the 1990s (Lyons et al. 2000), but it was not until the 2010s that significant natural reproduction by Lake Trout was observed in Lake Michigan (Hanson et al. 2013). At present, nearly all Lake Trout in Lake Superior are naturally reproduced, and only limited and localized stocking occurs in Wisconsin waters. In Lake Michigan, heavy stocking still occurs, but the proportion of naturally reproduced Lake Trout has steadily increased over the last decade and now exceeds 50% in some areas (personal communication, Charles Madenjian, USGS, Ann Arbor, Michigan, 9 November 2021).

The Lake Trout is an extremely variable species morphologically and ecologically, and historically both Great Lakes contained many distinctive forms that, although all part of the same species, looked different, occupied different areas of the lakes, fed on different foods, spawned in different areas and times, and supported different fisheries (Figure 19; Muir et al. 2016). The form found nearshore in the Great Lakes and in the inland lakes was termed the "Lean" because of its relatively low fat content and elongated shape (Figure 19). Currently this is the only form remaining in Lake Michigan, and it is also the form that occurs in Wisconsin's inland lakes. However, across all of Lake Superior at least four distinctive forms still persist: "Lean," "Siscowet," "Humper," and "Redfin." The "Humper" and "Redfin" are not known from Wisconsin waters, but the "Siscowet" or "Fat" Lake Trout form, so named because of its high body fat content and rotund shape, is common in areas deeper than about 250 feet. The "Lean" occurs in Wisconsin waters shallower than about 250 feet, and there is some limited overlap and interbreeding between the two forms. Although the "Lean" is more familiar to anglers and is the mainstay of the commercial fishery, the "Siscowet" is actually more abundant (Gamble et al. 2011b).

**Figure 20. Ennis Lake, Marquette County, and one of its Grass Pickerel, 19 August 2021.**

### PIKES (ESOCIDAE)

**Grass Pickerel *Esox americanus vermiculatus:*** Moderately common in low-gradient, vegetated reaches of rivers and floodplain lakes in the southern third of the state. An accidentally introduced population has become established and seems to be slowly spreading in the upper Flambeau and Wisconsin river drainages in northern Wisconsin (Becker et al. 1983; Lyons et al. 2000; WDNR unpublished data). This species is found almost exclusively in the Mississippi River basin in Wisconsin. No records are known from the Lake Superior basin, but historically there were a few records from the Milwaukee River drainage in the Lake Michigan basin (Greene 1935). These may have originated from fish that crossed the low divide with the upper Rock River drainage during floods. Urbanization had eliminated the Milwaukee River drainage populations by the 1950s (Becker 1983). At that point the species was believed to occur only in the

Mississippi River basin. However, we recently discovered a new Lake Michigan basin population in Ennis Lake in the upper Fox River drainage (Figures 1b; 20; UWZM 22004) close to a low divide with the Wisconsin River drainage. Ennis Lake was the boyhood home of famous conservationist John Muir, champion of Yosemite National Park and a founder of the Sierra Club. The small lake is undeveloped, beautiful, and protected as a county park with gasoline-powered motors banned. Whether this population resulted from an undocumented stocking or colonization in the recent or distant past is unknown.

The Grass Pickerel is one of only two Wisconsin species for which a subspecies designation is relevant, the other being the Banded Killifish. The Grass Pickerel is found in the Mississippi and Great Lakes basins, whereas the closely related Redfin Pickerel *E. americanus americanus* occurs on the Atlantic slope (Page and Burr 2011). The two subspecies differ in snout profile, fin coloration, and some scale characteristics, but are considered subspecies rather than separate species because intergrades with intermediate characteristics occur in tributaries to the eastern Gulf of Mexico and in Florida where the ranges of the two subspecies overlap (Boschung and Mayden 2004). The tendency lately in ichthyology has been to do quantitative morphological and genetic analyses comparing distinctive subspecies such as these, but to date no such work has been done for *E. americanus*. We would not be surprised if, once such a study was completed, the Grass Pickerel would be recognized as a full species separate from the Redfin Pickerel.

**Northern Pike *Esox lucius:*** Common statewide in slow-moving reaches of streams and rivers and all types of lakes, including bays and sheltered areas of Lake Michigan and Lake Superior. A popular sport fish and widely and regularly stocked, particularly in southern Wisconsin lakes (Margenau et al. 2003, 2008; Rypel et al. 2016; Embke et al. 2020). Recent years have seen publication of several studies on Northern Pike spawning movements and on the early life history of their newly hatched offspring in Green Bay and its tributaries (Oele et al. 2015, 2019; Cottrell et al. 2021). Hybrids between Northern Pike and Grass Pickerel are known in a few areas.

**Muskellunge *Esox masquinongy:*** The official state fish of Wisconsin (Figure 21). Native to larger lakes and rivers in the northern third of Wisconsin in the Chippewa-Flambeau, Black, and Wisconsin river drainages in the Mississippi River basin. Not known historically from inland areas of the Lake Michigan or Lake Superior basins but present in bays of the Great Lakes themselves and the lower reaches of some of their larger tributaries (Becker 1983). A popular sport fish (Rypel et al. 2016; Embke et al. 2020), the Muskellunge, known colloquially as the "musky" or "muskie," has been widely introduced and now is common in all three major basins throughout the state. Natural reproduction is limited outside of its native range and many populations are maintained by regular stocking. A recent genetic analysis across the Great Lakes region has found evidence of genetic mixing of stocked and native populations in some lakes but has also found that natural patterns of genetic diversity largely remain intact, with Green Bay populations distinctive from other Wisconsin populations (Turnquist et al. 2017). The Muskellunge has been heavily studied in Wisconsin, and the latest work is summarized in Kapuscinski et al. (2017).



**Figure 21. Popular images of Muskellunge, Wisconsin's official State Fish. Top: Muskellunge painted on a large propane storage tank in Boulder Junction, Vilas County, which claims to be the "Musky Capital of the World," 22 July 2009. Bottom: a postcard of a large, mounted Muskellunge, for a brief period the angling world record, from a display in the Moccasin Bar in Hayward, Sawyer County, which also claims to be the "Musky Capital of the World."**

## MUDMINNOWS (UMBRIDAE)

The mudminnow family is most closely related to the pike family (Lopez et al. 2004), and Page et al. (2013) concluded that Umbridae did not warrant full family status and subsumed it as a subfamily, Umbrinae, within Esocidae. However, a recent comprehensive review of the mudminnows provides compelling evidence that the mudminnows do indeed warrant their own family separate from the pikes (McCormick et al. 2020), and we have chosen to retain Umbridae pending publication of the next AFS-ASIH fish list.

**Central Mudminnow *Umbra limi:*** Common statewide in slow-moving reaches of streams, wetlands, and ponds and small lakes. Highly tolerant of environmental extremes and able to live and even thrive in habitats where other fishes cannot (e.g., Currie et al. 2010) but does not do well where other potential competitor or predator fish species are common. Wild-caught Central Mudminnow is sometimes sold for fishing bait in northern Wisconsin.

## TROUT-PERCHES (PERCOPSIDAE)

**Trout-perch *Percopsis omiscomaycus:*** Occasional to locally common in larger rivers and lakes in the Mississippi River basin in the northern half of Wisconsin, the Lake Superior basin, and the Fox-Wolf drainage and Green Bay, and historically common in Lake Superior and Lake Michigan. Lake Michigan and Lake Superior fish routinely enter tributaries during spring spawning. Uncommon and localized in the Mississippi River. Typically found near the bottom over sand or rock. Still relatively common in Lake Superior (Gamble et al. 2011a), but Trout-perch abundance in Lake Michigan has declined substantially since 2000, perhaps owing to the expansion of Round Goby (personal communication, Charles Madenjian, 9 November 2021, USGS, Ann Arbor, Michigan).

### PIRATE PERCHES (APHREDODERIDAE)

**Pirate Perch *Aphredoderus sayanus:*** Occasional in the Mississippi River and the lower reaches of its tributaries, the Wisconsin River and the lower reaches of its tributaries as far north as Juneau and Adams counties with a disjunct population further upstream in the Tomahawk River system in Oneida County. Other disjunct populations in Wisconsin are the Des Plaines River drainage in far southeastern Wisconsin, and Norrie Lake and Norrie Creek in Marathon County (Figure 1b, UWZM 11878) in the Fox-Wolf River drainage close to the low divide with the Wisconsin River drainage. Occurrences in Oneida and Marathon counties may be due to introductions (Becker 1983). Recent research on Pirate Perch has described their unique spawning behavior (Poly and Wetzel 2003; Fletcher et al. 2004) and documented their unusual ability to mask their chemical scent from their prey (Resetarits and Binckley 2013).

### CODFISHES (GADIDAE)

The codfishes are a large, primarily marine family. Some authors have placed the Burbot and closely related forms in their own family, the Cuskfishes, Lotidae (e.g., Blumstein et al. 2018), but others have considered the Burbots as a subfamily, Lotinae, within Gadidae (Berendzen 2020). This latter classification was followed by Page et al. (2013) and we use it here.

**Burbot *Lota lota:*** Locally common in streams, rivers, and some deeper lakes in the Mississippi River basin, the Lake Superior basin, and drainages to Green Bay in the Lake Michigan basin, and in Lake Michigan and Lake Superior. Found near the bottom in rocky or sandy areas. Absent from direct drainages to Lake Michigan except during winter when some fish from the lake enter the lower reaches of tributaries to spawn (Blumstein et al. 2018). Others remain in the lake to reproduce on rocky shoals. Burbot are also absent from the Mississippi River basin in the southern third of Wisconsin except for cold tributaries to the lower Wisconsin River. Burbot abundance has declined in Wisconsin waters of Green Bay and Lake Michigan for reasons that are unclear (personal communication, Charles Madenjian, 9 November 2021, USGS, Ann Arbor, Michigan). A small commercial fishery occurs in the Great Lakes (WDNR unpublished data), and there are also small winter sport fisheries in Great Lakes tributaries and through the ice in a few inland lakes (Embke et al. 2020).

The Burbot is circumpolar in distribution and is widespread in northern North America, Europe, and Asia. Two subspecies are often recognized, *L. lota lota* from Europe, Asia, Alaska, and the Yukon, and *L. lota maculosa* from the rest of North America (Elmer et al. 2008). Kottelat and Freyhof (2007) elevated these two subspecies to full species, calling North American populations *L. maculosa*. However, Page et al. (2013) rejected this proposed change because no supporting evidence was presented and thus retained *L. lota* for all North American Burbot, a classification we and others follow.

### NEW WORLD SILVERSIDES (ATHERINOPSIDAE)

Earlier works (e.g., Becker 1983; Lyons et al. 2000) considered all North American and South American silversides as part of a large globally distributed family, the silversides, Atherinidae, which also included species from Europe, Asia, Africa, and Australia. Several more recent analyses (e.g., Campanella et al. 2015) indicate that many (but not all) of the North American and Southern American species, including the Brook Silverside, are distinctive enough to warrant recognition as their own family, christened the New World Silversides, Atherinopsidae. Atherinidae has been renamed the Old-World Silversides. This change was accepted by Page et al. (2013).

**Brook Silverside *Labidesthes sicculus:*** Common to abundant in lakes and slow-moving reaches of rivers in the Mississippi River basin in western and southern Wisconsin and in the Fox-Wolf River drainage. Absent from north-central Wisconsin in the Mississippi River basin and from direct drainages to Lake Michigan. Historically absent from the Lake Superior basin, but a small population appears to be established now in Duluth-Superior harbor (Figure 1b; UWZM 11717, 20481, 20703), presumably arriving from ballast water transfers during inter-lake shipping (Rup et al. 2010). Werneke and Armbruster (2015) quantified morphological variation in Brook Silverside across their range. Brook Silverside are unusual in that in Canada, and probably in Wisconsin, they are an "annual" species, born during the summer and then maturing the following year and spawning and then dying, with few or no individuals living beyond their second summer (Powles and Sandeman 2008).

### TOPMINNOWS (FUNDULIDAE)

**Banded Killifish *Fundulus diaphanus:*** Sporadic statewide in well-vegetated, glacial, sandy-bottomed lakes and their larger tributaries and in river mouths and sheltered, sandy-bottomed, well-vegetated bays along Lake Michigan and Green Bay. Unknown from the Lake Superior basin, but it is plausible populations could occur in one or more small glacial lakes near the divide with the Mississippi River basin. Some populations in southern Wisconsin have declined or disappeared over the last 50 years (Marshall and Lyons 2008), although a new population was recently discovered in Lake Wisconsin, the first record from the Wisconsin River drainage (UWZM uncataloged). The species has been successfully introduced into small ponds and lakes in northeastern Illinois (Schaeffer et al. 2012; Bland 2013) and southeastern Minnesota (Schmidt 2014) near the Wisconsin border for conservation purposes. A recent publication described Banded Killifish habitat use and movement in Square Lake, Minnesota (Valley et al. 2010), in the St. Croix drainage of the Mississippi River basin close to Wisconsin.

The Banded Killifish has two distinctive subspecies, the Eastern Banded Killifish, *F. diaphanus diaphanus,* which is native to the Atlantic slope of the eastern United States and Canada, and the Western Banded Killifish *F. diaphanus menona,* the subspe-

**Figure 22. Preserved specimens of Banded Killifish. Top: Four Western Banded Killifish from North Bay, Lake Michigan, Door County, 28 September 2021, UWZM 22029. Middle: One Eastern Banded Killifish from an unnamed tributary to Lake Michigan near Racine, Racine County, 11 April 2002, UWZM 11715. Bottom: Four Eastern Banded Killifish from the Pike River at Lake Michigan in Kenosha, Kenosha County, 1 October 2021, UWZM 22032.**

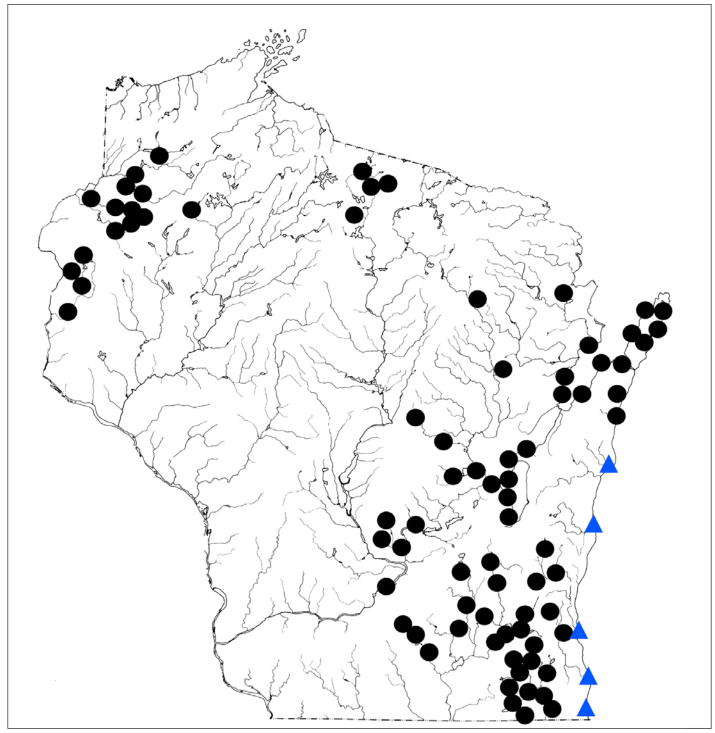

**Figure 23. Map of the occurrences of Western (circles) and Eastern (triangles) Banded Killifish in Wisconsin.**

cies native to Wisconsin and originally described from and named for Lake Monona in Madison (Figure 1b; Becker 1983), which is found in the Great Lakes, Hudson Bay, and Mississippi River basins (Page and Burr 2011). The subspecies overlap and have hybridized historically in the Lake Ontario basin and more recently in the Lake Erie basin. Although similar in appearance (Figure 22), the eastern subspecies having more scales in the lateral line series, genetic analyses indicate substantial differences and long separation between the two subspecies (April and Turgeon 2006), and we would not be surprised if they were one day elevated to separate species.

The Eastern Banded Killifish was recently discovered in southern Lake Michigan, where it is non-native (Willink et al. 2018, 2019). In Wisconsin, the eastern subspecies has been reported in good numbers at multiple locations along the Lake Michigan shoreline from the Illinois border north to Kewaunee, Kewaunee County (personal communication, Jeremy Tiemann, Illinois Natural History Survey, Champaign, 14 September 2021; UWZM 22032; uncataloged; Figures 1b, 23). The earliest confirmed records from Wisconsin are from near Racine, Racine County, in 2001 (Figure 1b; UWZM 11715), but shoreline seining catch data suggest they may have been in the state as early as 1997 (WDNR unpublished data).

The entire Wisconsin Lake Michigan shoreline was likely occupied by Western Banded Killifish in the early 1900s (Greene 1935; Becker 1983), but the populations south of the Door Peninsula appear to have been eliminated by environmental degradation by the 1970s. Western Banded Killifish still persist along the Door County Peninsula and in Green Bay (e.g., UWZM 22032, uncataloged). Thus, the Eastern Banded Killifish, a more environmentally tolerant form (Ohio EPA 1988), may have occupied Lake Michigan habitats already lacking Western Banded Killifish. How the eastern subspecies arrived in Lake Michigan is unknown, but transfer via ballast water from commercial shipping within the Great Lakes seems a plausible route (Rup et al. 2010). Whether the eastern subspecies will continue to spread in Lake Michigan and Wisconsin and possibly displace existing populations of the western subspecies remains to be seen.

**Starhead Topminnow *Fundulus dispar* ENDANGERED:** Rare to uncommon in the lower Black River, the lower Wisconsin River, the Sugar and Bark rivers in the Rock River drainage, and the Fox and Mukwonago rivers and associated lakes (Walworth and Waukesha counties) and Camp Lake (Kenosha County) in the Fox-Illinois drainage, all in the Mississippi River basin in southern Wisconsin. Likely more widespread and common in this region historically (Lyons et al. 2021). Absent from the Lake Michigan and Lake Superior basins. In rivers, found in slow-moving, well-vegetated, off-channel areas with groundwater inputs.

The stronghold for the Starhead Topminnow in Wisconsin has long been the sloughs, backwaters, and floodplain lakes of the lower Wisconsin River below the Prairie du Sac Dam, but these populations have come under threat in recent years from intensive corn and soybean agriculture in adjacent floodplain terraces (Lyons et al. 2021). Surface runoff and groundwater contamination from crop fields have degraded water quality in some areas, and Starhead Topminnow populations have declined as a result. Another potential danger is the recent establishment of the non-native Western Mosquitofish in nearby areas of the Mississippi River from which there is no complete barrier to prevent expansion into the lower Wisconsin River. Laboratory experiments have

Figure 24. Top: Reintroducing Starhead Topminnow into Gallus Slough, Wisconsin River, Sauk County, 30 August 2019. Bottom: Starhead Topminnow offspring from the previous year's stocking caught from Gallus Slough on that same date. Two generations of Starhead Topminnow have been produced from the reintroduction, indicating that the species has become established.

shown that Western Mosquitofish outcompete Starhead Topminnow and reduce their growth (Sutton et al. 2009). In response to these threats, Starhead Topminnow has been collected from the Lower Wisconsin, cultured in an isolated pond (Marshall et al. 2021), and then reintroduced successfully in suitable habitats without floodplain agriculture or risk from Western Mosquitofish in the Wisconsin River above the Prairie du Sac Dam (Figure 24; Lyons et al. 2022).

**Blackstripe Topminnow *Fundulus notatus:*** Common and widespread in streams and small to large rivers in southeastern Wisconsin in the Sugar, Rock, Fox-Illinois, and Des Plaines River drainages, and localized in sloughs and backwaters of the lower Wisconsin River in southwestern Wisconsin. Also common in the upper Fox River system in the Fox-Wolf drainage to Green Bay and the Milwaukee River drainage in the Lake Michigan basin. The populations in the Lake Michigan basin likely originated from colonization across low divides with the Wisconsin River (upper Fox) and Rock River (Milwaukee) drainages in the Mississippi River basin. The Blackstripe Topminnow has seen little research in Wisconsin, but it has been the subject of several recent studies on morphology, genetics, and ecology in central and southern Illinois and states further south (Alldredge et al. 2011; Schaefer et al. 2011; Duvernell et al. 2013; Welsh et al. 2013; Welsh and Fuller 2015).

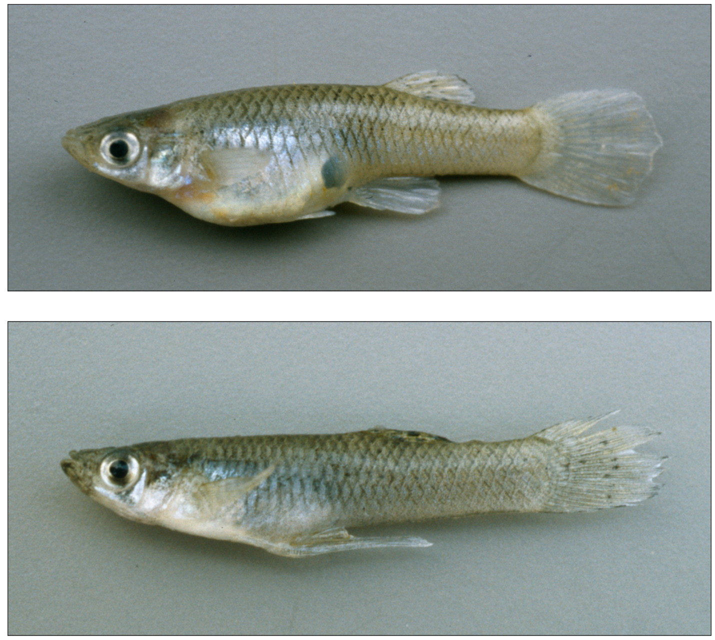

Figure 25. Female (top) and male Western Mosquitofish from Honey Cypress Ditch, Dunkin County, Missouri, 18 May 2001.

### LIVEBEARERS (POECLIIDAE)

**Western Mosquitofish *Gambusia affinis* NON-NATIVE:** The Western Mosquitofish (Figure 25) is a recent addition to the fish fauna of Wisconsin. It was first encountered in the Iowa waters of Pool 11 of the Mississippi River on the opposite shore from Wisconsin in 2008 and then found in Wisconsin waters in the downstream half of Pool 11 and the lower reaches of several tributaries in 2009 (Figure 26; UWZM 13519, 13520, 13532, 13578, 13579, 13604, 13754, 14639). Also in 2009, a population was discovered in a slough of the Sugar River near the town of Brodhead in Green County (Figure 1b; UWZM 13533; 13573). Based on annual surveys, both the Mississippi River and Sugar River populations have persisted ever since but as of yet they do not appear to have spread. Western Mosquitofish are found in shallow, marginal areas with slow or no current and extensive vegetation. They are most frequently found where there is groundwater input in the form of springs or seeps.

The origin of Western Mosquitofish in Wisconsin is uncertain, but we believe it to be from specimens mixed in with Fathead Minnow raised in fish farms outside the state and then transported to Wisconsin for use as fishing bait rather than via natural colonization from populations to the south. This then makes the Western Mosquitofish non-native rather than native in Wisconsin. The evidence for this is twofold. First, many shipments of Fathead Minnow are made annually to Wisconsin from other states where Western Mosquitofish are present and often found in fish farm ponds. Western Mosquitofish were observed in some shipments from out of state and in bait dealer tanks in southern Wisconsin between 2007–2010 (WDNR unpublished data; UWZM 12092). Second, if natural spread had occurred, it would be reasonable to expect established Western Mosquitofish populations to exist just to the south of the Wisconsin border that could serve

**Figure 26. Map of Western Mosquitofish occurrences in Wisconsin.**

as a source for movements into the state. However, the established Western Mosquitofish population nearest to Pool 11 is in Pool 14 of the Mississippi River over 60 river miles and three dams downstream. Two individuals were collected from Pool 13 in 2017, but there is no conclusive evidence of a self-sustaining population there (USGS, Long-Term Resource Monitoring Program). The population nearest to the Sugar River is in the Rock River below Rockford, Illinois, over 65 river miles and two dams downstream. Western Mosquitofish are relatively weak swimmers and do not undertake long-distance migrations (Prenosil et al. 2016) and so would be unlikely to travel dozens of miles upstream and over dams to colonize new habitats in Wisconsin.

Western Mosquitofish have been widely cultured for mosquito control for over a century, and they were stocked for this purpose in Wisconsin and in the Chicago area just south of the state border prior to 1950 (Krumholz 1948). These introductions led to self-sustaining populations around Chicago, but they were unsuccessful in Wisconsin. Then why did Western Mosquitofish become established in Wisconsin in the 2000s? The answer is likely climate change. Western Mosquitofish are at the northern edge of their range in northern Illinois and southern Wisconsin, and their existence and distribution there is probably limited by winter conditions. Since 1950, Wisconsin winters have gotten notably shorter and less severe (Wisconsin Initiative on Climate Change Impacts https://wicci.wisc.edu/wisconsin-climate-trends-and-projections/), presumably making conditions more hospitable for Western Mosquitofish. Supporting this idea is the observation that Western Mosquitofish favor areas with springs or groundwater seeps that keep water temperatures slightly warmer than in surrounding areas during the winter. If Wisconsin winters continue to become milder, as is projected, the potential for Western Mosquitofish to expand in the state should increase.

## STICKLEBACKS (GASTEROSTEIDAE)

**Brook Stickleback *Culaea inconstans:*** Common statewide in wetlands, slow-moving, well-vegetated areas of small streams, and small lakes. Often the dominant fish in very small streams (Lyons 2006) but does not do well in water bodies with fish predators. Brook Stickleback display substantial genetic and morphological variation across their range in North America, and fish from the upper Great Lakes and Upper Mississippi River basins, including Wisconsin, tend to have narrower, more elongated bodies than those from the lower Great Lakes basin and Atlantic Coast drainages (Ward and McLennan 2009). The Brook Stickleback and the Ninespine Stickleback are nearest relatives (Kawahara et al. 2009).

**Threespine Stickleback *Gasterosteus aculeatus* NON-NATIVE:** Presumably uncommon near the bottom in nearshore areas of Lake Michigan and Lake Superior, entering the lower reaches of tributaries and wetlands during spring spawning. Absent from inland waters in Wisconsin. The Threespine Stickleback, sometimes termed the Three-Spined Stickleback (e.g., Ostlund-Nilsson et al. 2007), is not seen often other than during spawning, and its abundance is poorly known. Catches in Lake Michigan bottom trawling survey in Wisconsin waters, although never high, have dropped to very low levels (Tingley et al. 2021; personal communication, Charles Madenjian, 9 November 2021, USGS, Ann Arbor, Michigan), but the species is still caught occasionally in trawling surveys in Lake Superior. A study of trout and salmon diets along the Upper Peninsula of Michigan indicated that Threespine Sticklebacks were an important prey item, suggesting that they may be more common in Lake Superior than the trawling data indicate (Vasquez et al. 2021).

The Threespine Stickleback has become a model species for studies of evolution and the mechanisms by which genetics affect morphology and behavior (e.g., Ostlund-Nilsson, et al. 2007; Fang et al. 2018). However, to date, no studies of Threespine Stickleback biology have occurred in Wisconsin waters, although one is underway at the University of Wisconsin–Madison.

**Ninespine Stickleback *Pungitius pungitius:*** Occasional to common near bottom in more than 30 feet of water in Lake Michigan and Lake Superior and in four inland lakes: Trout (Vilas County; UWZM 7896), Whitefish (Sawyer County; UWZM 11718), and Lac Court Oreilles (Sawyer County; UWZM 12040) in the Chippewa-Flambeau River drainage of the Mississippi River basin, and Upper Eau Claire (Bayfield County; UWZM 13523) in the Lake Superior basin (Figure 1b). Other deep northern Wisconsin lakes may also have populations; the species is difficult to detect other than by trawling, which is rarely done in inland Wisconsin lakes. Ninespine Sticklebacks from Lake Michigan and Lake Superior will occasionally enter the lower reaches of tributaries and shoreline wetlands during spring spawning. The Ninespine Stickleback population in Lake Michigan increased dramatically in the early 2000s in response to the dreissenid mussel invasion, perhaps because of increased spawning habitat created by mussels carpeting the bottom (Madenjian et al. 2010). However, the population subsequently collapsed for reasons that are unclear, and the species is now uncommon (Tingley et al. 2021; personal communication, Charles Madenjian, 9 November 2021, USGS, Ann Arbor, Michigan). Ninespine Stickleback numbers have also declined in Lake Superior but not to the same extent, and the species is still moderately common there (Gamble et al. 2011; Vinson et al. 2017).

Across its large range, which encompasses most of northern North America and northern Europe and parts of northeastern Asia, the Ninespine Stickleback displays substantial genetic and morphological variation. Populations in the upper Great Lakes region, including Wisconsin, are most similar to populations in central Canada and differ from those in Alaska, the Arctic, the lower Great Lakes, and northeastern North America (Aldenhoven et al. 2010).

### SCULPINS (COTTIDAE)

**Sculpins (*Cottus*):** In a genetic analysis of *Cottus,* Kinzinger et al. (2005) found substantial variation and proposed splitting the genus into five genera. For the three Wisconsin *Cottus,* the Mottled Sculpin and Slimy Sculpin were moved to *Uranidea* and the Spoonhead Sculpin remained in *Cottus*. However, these proposed changes were not accepted (or even noted) by Page et al. (2013), and it is unclear to us whether *Uranidea* should be used. Some ichthyologists have adopted it (Smith and Busby 2014), but others have not (e.g., Robinson et al. 2021). For now, we continue to use *Cottus,* but we would not be surprised if *Uranidea* becomes the preferred genus name for the Mottled Sculpin and the Slimy Sculpin in the next AFS-ASIH fish list.

**Mottled Sculpin *Cottus bairdii:*** Common on the bottom statewide in coldwater streams, deep lakes, and nearshore areas of Lake Michigan and Lake Superior. Populations in Lake Michigan have declined substantially, probably because of Round Goby expansion (Janssen and Jude 2001; Lauer et al. 2004). For inland streams, Mottled Sculpin distribution is projected to decline 21–95% by the late 2000s depending on the severity of climate change (Lyons et al. 2010).

**Slimy Sculpin *Cottus cognatus:*** Common on the bottom out to about 350 feet in Lake Michigan and Lake Superior. Known inland from widely scattered coldwater streams and deep lakes in the Mississippi River, Lake Superior, and Lake Michigan basins. The inland stronghold for the species is in the coldest streams of the Driftless Area of southwestern Wisconsin. Great Lakes populations have declined over the last 20–40 years (Robinson et al. 2021), probably because of increased predation from recovering Lake Trout populations (Madenjian et al. 2005) and possibly the expansion of Round Goby (Bergstrom and Mensinger 2009), but the species remains broadly distributed and common (Gamble et al. 2011a; Vinson et al. 2017; Tingley et al. 2021). Inland populations are stable but are threatened by climate change (Lyons et al. 2010; Mitro et al. 2019). In the Driftless Area of southeastern Minnesota, not far from the Wisconsin border, Slimy Sculpin have been successfully introduced into several environmentally restored streams (Huff et al. 2010, 2011; Mundahl et al. 2012a,b). Studies of Slimy Sculpin reproduction have also been carried out in streams in southeastern Minnesota near the Wisconsin border (Majeski and Cochran 2009; Katula 2012a).

**Spoonhead Sculpin *Cottus ricei:*** Historically common on the bottom out to about 300 feet in Lake Michigan and Lake Superior. Spoonhead Sculpin long ago disappeared from Lake Michigan for reasons that are not clear, and it has not been seen in Wisconsin waters since the 1950s. The species remains moderately common in Lake Superior, although it has declined since the 1970s, perhaps in response to increased predation from the recovered Lake Trout population (Robinson et al. 2021). In the laboratory, Spoonhead Sculpin are outcompeted by Round Goby (Bergstrom and Mensinger 2009).

**Deepwater Sculpin *Myoxocephalus thompsonii:*** Common on the bottom in water deeper than about 250 feet in Lake Michigan and Lake Superior. In Lake Michigan, Deepwater Sculpin were reduced to relatively low levels in the 1950s through 1970s by Alewife predation on their larvae, but they bounced back to higher abundance as Alewife numbers declined in the 1980s (Bunnell et al. 2006; Madenjian et al. 2008). Since then, Deepwater Sculpin have remained common but have moved to deeper water, perhaps in response to dreissenid mussels and Round Goby (Madenjian et al. 2005b; Madenjian and Bunnell 2008; personal communication, Charles Madenjian, 9 November 2021, USGS, Ann Arbor, Michigan). In Lake Superior, Deepwater Sculpin have declined somewhat in abundance since the 1970s, probably because of increased Lake Trout predation, but they still remain common (Robinson et al. 2021).

A comprehensive genetic and morphological analysis of the Cottidae found that the family was highly variable and diverse and concluded that it needed to be reconfigured (Smith and Busby 2014). The Mottled, Slimy, and Spoonhead sculpins are proposed to stay in Cottidae, but the Deepwater Sculpin has been recommended to be moved to a different family, Psychrolutidae. This potential change has not been widely recognized (e.g., Robinson et al. 2021), and we have retained the Deepwater Sculpin in Cottidae pending publication of the next AFS-ASIH fish list.

### TEMPERATE BASES (MORONIDAE)

**White Perch *Morone americana* NON-NATIVE:** Common in Duluth/Superior Harbor in Lake Superior and the lower reaches of its tributaries and Green Bay in Lake Michigan and the lower reaches of its tributaries. Elsewhere, a few individuals have been seen in Chequamegon Bay, Bayfield and Ashland counties, in Lake Superior (Figure 1b), and in Milwaukee and Sheboygan harbors in Lake Michigan, but they appear to be strays rather than part of established populations. Absent from the Mississippi River basin. Recent genetic analyses indicate that White Perch and Yellow Bass are closest evolutionary relatives and that these two species together are in turn the closet relatives to the White Bass (Williams et al. 2012; Bian et al. 2016).

**White Bass *Morone chrysops:*** Common in rivers and larger lakes in the Mississippi River and the lower reaches of its larger tributaries in western Wisconsin, including the Wisconsin River at least as far upstream as Mosinee Dam in Marathon County; in the Rock River and Fox-Illinois drainages in southern Wisconsin; and in the Fox-Wolf River drainage in eastern Wisconsin including Lake Winnebago and Green Bay. Not known historically from the Lake Superior basin, but a small non-native population has become established in Duluth/Superior Harbor (UWZM 21043), presumably arriving there in ballast water via inter-lake shipping (Rup et al. 2010). A few White Bass have also been captured from Milwaukee Harbor in Lake Michigan, but these appear to be strays from populations further south rather than an established population (WDNR unpublished data). A popular sport fish species (Rypel et al. 2016; Embke et al. 2020).

**Yellow Bass *Morone mississippiensis:*** Occasional in rivers and larger lakes in the Mississippi River and the lower reaches of its larger tributaries in western Wisconsin, including the Wisconsin River at least as far upstream as Wisconsin Dells; in the Rock River and Fox-Illinois drainages in southern Wisconsin; and in the Fox-Wolf River drainage in eastern Wisconsin including Lake Winnebago and Green Bay. Habitat and distribution are similar to that of White Bass, but Yellow Bass are not as widespread and common. Yellow Bass populations outside of the Mississippi River and its direct tributaries could be the result of introductions and be non-native (Becker 1983). Unequivocal introductions of Yellow Bass took place in the 1950s into a few lakes in the Milwaukee, Sheboygan, and Manitowoc River drainages to Lake Michigan. Most of these populations appear to have disappeared, but the species persists in Long Lake, Manitowoc County, in the Manitowoc River drainage, Manitowoc County (Figure 1b; WDNR unpublished data). Yellow Bass support a sport fishery (Embke et al. 2020), but they are not as popular as White Bass because of their smaller size and lower abundance. Many anglers confuse the two species.

### SUNFISHES (CENTRARCHIDAE)

**Rock Bass *Ambloplites rupestris:*** Common statewide in rivers and lakes. Relatively uncommon and limited to marginal habitats in the very largest rivers and in the Great Lakes proper. A popular sport fish species (Rypel et al. 2016; Embke et al. 2020). Genetic analyses reveal relatively little variation among Rock Bass populations in the upper Mississippi River and Great Lakes basins (Roe et al. 2008).

**Green Sunfish *Lepomis cyanellus:*** Common in streams and small lakes in the Mississippi River and Lake Michigan basins in the southern half of Wisconsin. Occasional widely scattered small populations in northern Wisconsin including a few small lakes in the Lake Superior basin near the divide with the St. Croix drainage. Supports small sport fisheries where common, but the Green Sunfish is not heavily targeted because of its small size (Rypel et al. 2016; Embke et al. 2020). It is one of the Wisconsin species most tolerant of environmental degradation and persists in polluted habitats where few other species can survive (Lyons 2006).

**Pumpkinseed *Lepomis gibbosus:*** Common in slow-moving, vegetated areas of streams, rivers, and lakes statewide. Absent from the Great Lakes proper except in shoreline marshes and tributary mouths. A popular sport fish species (Rypel et al. 2016; Embke et al. 2020). Genetic analyses indicate two distinct lineages across the species' native range in eastern North America, one in the Mississippi and Great Lake basins, including Wisconsin, and the other in coastal Atlantic Ocean drainages (Yavno et al. 2020).

**Warmouth *Lepomis gulosus:*** Uncommon to occasional in well-vegetated lakes and slow-moving reaches of streams and rivers at widely separated locations in the Mississippi River basin and the Fox-Wolf River drainage. The species is most frequently encountered in the Rock River and Fox-Illinois River drainages in southeastern Wisconsin where it is more continuously distributed. The Warmouth is generally absent from the hilly Driftless Area of southwestern Wisconsin except in the floodplains of the lower Wisconsin and Mississippi rivers. There are a few scattered records from small lakes and rivers from the Oconto River drainage to Green Bay, from direct drainages to Lake Michigan, and from the Lake Superior basin, but whether these populations are native or the result of undocumented introductions is unclear. Sport fishing for Warmouth in Wisconsin is limited (Embke et al. 2020), primarily because of their scarcity. Anglers who do catch Warmouth often confuse it with Rock Bass.

**Orangespotted Sunfish *Lepomis humilis:*** Common in the Mississippi River and the lower reaches of its larger tributaries as far north as the Chippewa River and in rivers in the Rock River and Fox-Illinois River drainages in southern Wisconsin. There are two records from the Milwaukee River drainage from the 1970s (Fago 1992; Lyons et al. 2000), but there have been no subsequent captures (WDNR unpublished data). We presume that these two records were from undocumented introductions and that Orangespotted Sunfish no longer occur at these locations. There are no other occurrences from the Wisconsin waters of the Lake Michigan basin, and the species is absent from the Lake Superior basin. A study of morphological variation within Wisconsin populations of the colorful Orangespotted Sunfish is ongoing (personal communication, Mike Pauers, University of Wisconsin–Milwaukee at Waukesha, 27 July 2021).

**Bluegill *Lepomis macrochirus:*** Common to abundant statewide in slow moving areas of streams and rivers and vegetated areas of lakes, although generally absent from the Great Lakes proper except in harbors and shoreline wetlands. Arguably the most popular sport fish species in the state (Figure 27) and heavily fished everywhere in Wisconsin (Rypel et al. 2016; Tingley et al. 2019; Embke et al. 2020). Widely introduced historically, and still stocked in some constructed ponds and small lakes. A recent genetic analysis across much of the native range of the Bluegill in the Mississippi River and Great Lakes basins found two groups of populations, one in the north, including Wisconsin, that was limited to areas that had been glaciated during past ice ages and that had relatively low genetic diversity, and the other further to the south in unglaciated areas and that had much higher genetic diversity (Kawamura et al. 2009).

**Northern (Longear) Sunfish *Lepomis peltastes* THREATENED:** Uncommon and localized in a few slow-moving streams, small rivers, and small lakes in the Mississippi River and Lake Michigan basins. Not found in the hilly Driftless Area in southwestern Wisconsin. Absent from the Lake Superior basin. The largest remaining population in the state is in the lower Mukwonago River, Waukesha County, in the Fox-Illinois drainage (Figure 1b; WDNR unpublished data). This site has good habitat and water quality but is at risk from a possible accidental toxic spill from a busy highway and a heavily used railroad line that pass over this part of the river. To protect against a catastrophic loss, Northern Sunfish adults from the lower Mukwonago were moved to the landlocked semi-natural Aviary Pond at the Milwaukee County



**Figure 27. Public images of the Bluegill, Wisconsin's most widely distributed and popular sport fish species. Top: Bluegill image on the municipal water tower in Webster, Burnett County, 20 June 2013. Bottom: fiberglass model of Bluegill in Onalaska, Lacrosse County, 3 July 2018.**

Zoo in 2014 (Figure 28). There they have successfully reproduced for at least two generations and have established a large self-sustaining population (personal communication, Mike Pauers, University of Wisconsin–Milwaukee at Waukesha, 10 August 2021).

Until recently, Wisconsin populations were considered a subspecies, *L. megalotis peltastes,* of the widespread Longear Sunfish. However, morphological and genetic studies have shown that this subspecies, limited to the upper Midwest and southern Canada, actually warrants recognition as a full species (Bailey et al. 2004; Kim et al. 2021; Near and Kim 2021), a taxonomic change accepted by Page et al. (2013).

**Smallmouth Bass** ***Micropterus dolomieu:*** Common statewide in streams, rivers, and lakes, including the Great Lakes, with sandy or rocky bottoms. A popular sport fish that has been heavily studied (Rypel et al. 2016; Embke et al. 2020). Historically, widely introduced but currently infrequently stocked. Recent Wisconsin investigations have addressed genetic variation (Borden and Krebs 2009), spawning habitat and behavior in lakes (Bozek et al. 2002; Saunders et al. 2002; Welsh et al. 2017) and seasonal movements (Lyons and Kanehl 2002) and reproductive success in streams (Haglund et al. 2019).

**Figure 28. Top: Aviary Pond at the Milwaukee County Zoo, where a refuge population of Mukwonago River Northern Sunfish has been established, 17 June 2018. Bottom: Northern Sunfish from Aviary Pond on the same date. At least two generations of Northern Sunfish have been produced there.**

**Largemouth Bass** ***Micropterus salmoides:*** Common statewide in lakes and larger rivers. Generally absent from the Great Lakes proper. An important sport fish species (Rypel et al. 2016; Tingley et al. 2019; Embke et al. 2020) and historically widely stocked and still regularly introduced into constructed ponds. Abundance has increased substantially in Wisconsin, particularly in lakes in the north, over the last 30 years in response to reduced sport fishing harvest and shorter and less severe winters (Hansen, J.F., et al. 2015). Largemouth Bass are projected to become even more widespread and common in both rivers and lakes as the climate continues to warm (Lyons et al. 2010; Hansen et al. 2017).

In a recent genetic analysis of the genus *Micropterus,* Kim et al. (2022) proposed that, based on an improved understanding of species definitions and distributions and on the locations and dates of initial scientific species descriptions, the name *M. salmoides* should be reserved for the Florida bass and that the largemouth bass should be renamed *M. nigricans.*

**White Crappie** ***Pomoxis annularis:*** Uncommon to occasional in lakes and larger rivers in the Mississippi River basin, particularly in the southern half of the state. Few confirmed records from northern Wisconsin where the species reaches the northern edge of its range. Uncommon in the Fox-Wolf drainage. A handful of reports from direct drainages to Lake Michigan, but these could be introduced populations. There are no official records of White Crappie stocking in Wisconsin, but they were undoubtedly mixed in with some early stockings of Black Crappie and in "fish rescue" transfers from drying Mississippi River floodplain ponds into inland waters (Becker 1983). Absent from the Lake Superior basin. A popular sport fish (Rypel et al. 2020; Embke et al. 2020) but often conflated with and not distinguished by anglers from the much more common Black Crappie.

**Black Crappie** ***Pomoxis nigromaculatus:*** Common statewide in lakes and larger rivers. Generally absent from the Great Lakes proper. An important sport fish species (Rypel et al. 2016; Embke et al. 2020). Historically introduced into many waters, but little to no stocking occurs in Wisconsin now.

### PERCHES (PERCIDAE)

**Western Sand Darter** ***Ammocrypta clara:*** Locally common on sand bottoms with strong currents in the Mississippi River and its largest tributaries and in the Fox, Wolf, and Menominee Rivers draining to Green Bay (Lyons et al 2000; Lyons 2005). Absent from direct Lake Michigan tributaries and the Lake Superior basin. When given a choice in captivity between bottom substrates ranging from fine sand to fine gravel, Western Sand Darters preferred medium and coarse sands (Thompson et al. 2017).

**Crystal Darter** ***Crystallaria asprella*** **ENDANGERED:** Rare and localized on the bottom in fast flowing areas of the Mississippi River and the lower reaches of its largest tributaries. The largest remaining populations are in the St. Croix, Chippewa, and Wisconsin rivers. Absent from the Lake Michigan and Lake Superior basins. Genetic variation across the wide but highly fragmented range of this species was summarized by Morrison et al. (2006). Prior to 2003, the Crystal Darter was usually known as *Ammocrypta asprella* (e.g., Becker 1983; Lyons et al. 2000).

**Mud Darter** ***Etheostoma asprigene*** **SPECIAL CONCERN:** Occasional on the bottom in slower moving areas of the Mississippi River and its largest tributaries as far north as the Chippewa River. Usually only a few individuals can be found at a particular spot. Absent from the Lake Michigan and Lake Superior basins. Katula (2012b) summarized biology in the Upper Mississippi region including Wisconsin.

**Rainbow Darter** ***Etheostoma caeruleum:*** Locally common and widely scattered in rocky fast flowing bottom areas of streams and rivers in the Mississippi River basin, although absent from the upper St. Croix drainage above St. Croix Falls, Polk County (WI)/ Chisago County (MN), and the upper Chippewa River drainage above Chippewa Falls, Chippewa County (Figure 1b). Also found in the Fox-Wolf drainage of Green Bay. Absent from direct Lake Michigan drainages and from the Lake Superior basin. Lake populations of Rainbow Darters are rare range-wide (Katula 2013; Oliveira et al. 2021), but a few are known in Wisconsin from the upper part of the Rock River drainage in Waukesha County (Fago 1992; UWZM 21046, 21047).

**Figure 29. Two genetically distinct forms of Rainbow Darter from Wisconsin. Top: male from the Mukwonago River, Waukesha County, Fox-Illinois River drainage, 25 May 2001. Bottom: male from the Plover River, Portage County, Wisconsin River drainage, 13 June 2002.**

Genetic analyses have found substantial variation across the range of the Rainbow Darter in the central United States and southern Ontario and indicate that the currently recognized species might be a complex of several different species (Ray et al. 2006). In Wisconsin, two moderately distinct genetic forms are present, one in the upper Illinois-Fox drainage and the other in the rest of the state (Figure 29). A recent study from southern Michigan, involving the same form as in the Illinois-Fox has found that the amount of genetic variation within a population was positively correlated with their ability to tolerate warmer temperatures, which could differentially affect each population's response to climate change (Oliveira et al. 2021). The Rainbow Darter is projected to expand its range in Wisconsin streams in response to global warming (Lyons et al. 2010).

**Bluntnose Darter** ***Etheostoma chlorosoma*** **ENDANGERED:** Rare on the bottom at a few widely scattered slow-moving backwater and tributary mouth locations in the Mississippi River. This is likely the rarest fish species still resident in Wisconsin. Since their first discovery in the state in 1944, a total of only 15 Bluntnose Darters have ever been collected from a total of eight Mississippi River sites including adjacent border areas of Minnesota and Iowa (Lyons et al. 2000; Schmidt 2012b).

**Iowa Darter** ***Etheostoma exile:*** Widespread and locally common statewide on the bottom in well-vegetated lakes and streams and small rivers. Absent from the Great Lakes proper except perhaps in a few coastal marshes. The Iowa Darter has been successfully introduced into small ponds and lakes in northeastern Illinois (Schaeffer et al. 2012; Bland 2013) near the Wisconsin border for conservation purposes.

**Fantail Darter** ***Etheostoma flabellare:*** Common and widespread on the bottom in fast-flowing rocky areas of streams in the Mississippi River basin, although not found in the St. Croix River drainage above St. Croix Falls. Also common in Green Bay drainages. Known from the Milwaukee River drainage but not from any other direct Lake Michigan drainages, suggesting that Fantail Darter may have colonized the Milwaukee drainage naturally across the low divide with the Rock River drainage (Greene 1935). Absent from the Lake Superior basin.

**Least Darter** ***Etheostoma microperca*** **SPECIAL CONCERN:** Sporadic and uncommon to locally common on the bottom in well-vegetated lakes and slow-moving streams in the Mississippi River and Lake Michigan basins, excluding most of the hilly Driftless Area in southwestern Wisconsin, where it is only known only from Bakkens Pond, Sauk County, a marshy floodplain lake associated with the lower Wisconsin River (Figure 1b). Found at only one location in the Lake Superior basin, Spillerberg Creek, Ashland County (Figure 1b), which is close to the low divide with the upper Chippewa River drainage. The species has been successfully reintroduced into small lakes in southeastern Minnesota (Schmidt 2014) near the Wisconsin border for conservation purposes.

A recent genetic analysis found that Least Darter populations in the Ozarks differed substantially from those in the Hudson Bay, Upper Mississippi River, Great Lakes, and Ohio River basins, including Wisconsin, which were relatively similar to each other (Echelle et al. 2015). The Ozark populations may warrant recognition as separate species, but if that happened, the populations in Wisconsin would likely retain the same scientific name.

**Johnny Darter** ***Etheostoma nigrum:*** Widespread and common statewide on the bottom in nearly all types of habitats from small streams to the largest rivers and small ponds to the Great Lakes. One of the most successful native species in the state. However, numbers in nearshore areas of Lake Michigan have dropped sharply, presumably from competition with non-native Round Goby (Lauer et al. 2004). Genetic analyses of the Johnny Darter across its broad range in eastern North America indicate that it may be a complex of species and that Wisconsin populations may eventually have a name change (Heckman et al. 2009).

**Banded Darter** ***Etheostoma zonale:*** Locally common in rocky bottom areas of small to large rivers in the Mississippi River basin and drainage to Green Bay in the Lake Michigan basin in the southern two-thirds of Wisconsin. Absent from northern Wisconsin and the Lake Superior basin. Katula (2014) described spawning behavior of captive Banded Darter collected from Wisconsin and Minnesota. The Banded Darter has substantial genetic variation across its large range in the central United States and may actually be a complex of two or more species (Halas and Simons 2014).

**Ruffe** ***Gymnocephalus cernua*** **NON-NATIVE:** Common to occasional near the bottom in bays, harbors, and the lower reaches of tributaries along the Wisconsin shoreline of Lake Superior. Populations in Duluth/Superior Harbor may have declined as Round Goby have become more common. There are no confirmed records from the Wisconsin waters of Lake Michigan, but environmental DNA analyses suggest Ruffe may be found in nearby areas in Michigan and Illinois in low abundance (Tucker et al. 2016). Absent from the Mississippi River basin. Ruffe may compete with Yellow Perch and other native fishes (Newman et al. 2020). Gutsch and Hoffman (2016) summarized Ruffe life history in Lake Superior. Most publications prior to 2013 used *G. cernuus* as the scientific name, but Page et al. (2013) changed it to *G. cernua* based on Kottelat and Freyhof (2007).

**Yellow Perch** ***Perca flavescens:*** Widespread and locally common statewide in inland lakes and larger rivers, especially in northern Wisconsin, and in Lake Michigan and Lake Superior. Supports important sport fisheries statewide (Rypel et al. 2016; Embke et al. 2020) and a commercial fishery in Green Bay (WDNR unpublished data). Lake Michigan populations declined precipitously in the 1990s and have remained low because of regular reproductive failures, perhaps related to food web changes in the lake brought about by non-native dreissenid mussels and Round Goby (Bremigan et al. 2003; Marsden and Robillard 2004; Wilberg et al. 2005; Houghton and Janssen 2015).

**Logperch** ***Percina caprodes:*** Common and widespread statewide on the bottom in medium to large rivers and lakes including nearshore areas of Lake Michigan and Lake Superior. Logperch have declined in rocky areas of the Great Lakes as Round Goby have become common, presumably owing to competition, but Logperch have persisted in sandy areas (Blashine et al. 2005; Bergstrom and Mensinger 2009; Leino and Mensinger 2017). Logperch are highly variable across their broad range in the east-central United States. Several new species have been described from the southern United States (e.g., Near and Benard 2004), but northern populations, including those in Wisconsin, have seen relatively little morphological or genetic study.

**Gilt Darter** ***Percina evides*** **THREATENED:** Uncommon and localized on the bottom in fast-flowing rocky areas of the St. Croix River and the lower reaches of three major tributaries: the Namekagon and Totogatic rivers in Washburn County and the Moose River in Douglas County (Figure 1b); also found in the upper Chippewa River and the lower reaches of two of its tributaries, the Flambeau and Jump rivers (Figure 1a); present in the Black River in Jackson County (Jennings et al. 2014). Not known from the Lake Michigan or Lake Superior basins. An effort in 1997 to transplant Gilt Darter above the Trego Dam on the Namekagon River, Washburn County, proved unsuccessful.

As currently recognized, the Gilt Darter is widely distributed in the greater Mississippi River basin including the Ohio, Tennessee, Upper Mississippi, Lower Missouri, and White River basins. However, genetic analyses indicate that the Gilt Darter is in fact of complex of two or more species, and Upper Mississippi basin populations, including those in Wisconsin, will likely eventually be given a new species name (Near et al. 2001).

**Blackside Darter** ***Percina maculata:*** Common and widespread on the bottom in small to larger rivers throughout the Mississippi and Lake Michigan basins. Absent from the Lake Superior basin.

**Slenderhead Darter** ***Percina phoxocephala:*** Locally common on rocky bottom areas in fast current areas of medium to large rivers throughout the Mississippi River basin and in the Fox-Wolf drainage of the Lake Michigan basin. Absent from the Lake Superior basin.

**River Darter** ***Percina shumardi:*** Locally common on the bottom in main channel areas with strong current in the Mississippi River and the lower reaches of its largest tributaries and in the Fox-Wolf drainage including Lake Winnebago. No studies on the species in Wisconsin since Becker (1983), but Pratt et al. (2016) provided data on the life history of the species in Canada.

**Genus** ***Sander versus Stizostedion:*** There is disagreement about which genus name is most appropriate for Sauger and Walleye. For most of the 1900s up until the early 2000s, *Stizostedion* was used, but in 2003, *Sander* was substituted (Nelson et al. 2003). Most scientists adopted the new name, and it was accepted by Page et al. (2013). However, Bruner (2021) has made arguments that the genus name should revert to *Stizostedion*. But his position was countered by Scharpf and Fricke (2021), who urged retention of *Sander*. We are unsure which name is most appropriate, and we have retained *Sander* for Sauger and Walleye pending the publication of the next AFS-ASIH fish names list.

**Sauger** ***Sander canadensis:*** Common in main channel areas of the Mississippi River and the lower reaches of its largest tributaries, where it is a popular gamefish. Uncommon in the Fox-Wolf drainage and southern Green Bay. Absent from the Lake Superior basin. Lyons and Oele (2018) analyzed 30 years of data on Sauger and Walleye reproductive success and population dynamics in the lower Wisconsin River below the Prairie du Sac Dam.

**Walleye** ***Sander vitreus:*** Common statewide in main channel areas of larger rivers and many lakes, including Lake Michigan and Lake Superior. An important gamefish that has been extensively studied in Wisconsin (Rypel et al. 2016; Tingley et al. 2019; Embke et al. 2020) and that is widely and heavily stocked to support sport fisheries. These introductions have muddled genetic stocks in some lakes, but original patterns of native genetic diversity still remain evident in most areas (Bootsma et al. 2021). Many currently stocked lakes did not have Walleye historically, and many populations and fisheries exist only because of stocking. Successful Walleye reproduction and self-sustaining populations are widespread and common in rivers (e.g., Lyons and Oele 2018) and in the Great Lakes (e.g., Dembkowski et al. 2018) but rare in southern Wisconsin lakes and in decline in many northern Wisconsin lakes (Hansen, G.J.A., et al. 2015). Reduced reproduction has resulted in decreasing populations and the need for more stocking to maintain fisheries (Rypel et al. 2018). Causes of reproduction failures and population declines are complex and not completely understood but likely are the result of a warming climate that has led to food web changes, most notably a major increase in Largemouth Bass (Hansen et al. 2018). Walleye losses in northern Wisconsin lakes are projected to get worse as the climate continues to warm (Hansen et al. 2017), and populations may also begin to decline in rivers (Lyons et al. 2010). The most recent work on the extent and possible causes of declines in Walleye populations in Wisconsin and other Midwestern lakes are described in a series of recent articles in the *North American Journal of Fisheries Management*, Volume 42, Issue 3, 2022.

## DRUMS (SCIAENIDAE)

**Freshwater Drum** ***Aplodinotus grunniens:*** Common in the Mississippi River and its larger tributaries and associated lakes in southern Wisconsin, including the Madison chain of lakes, and in the Fox-Wolf drainage and southern Green Bay. Occasional specimens are now seen in the Milwaukee River drainage (UWZM 11895), and these may be recent migrants from further south in Lake Michigan. A small population has become established in Lake Superior in Duluth/Superior Harbor (UWZM 21044, 21045), presumably from ballast water releases during inter-lake Great Lakes shipping (Rup et al. 2010). A recent study validated that Freshwater Drum, known throughout Wisconsin as "sheepshead," exceed 50 and perhaps even 70 years of age in the Lake Winnebago system, making them one of the longest-lived fishes in the state (Davis-Foust et al. 2009).

## GOBIES (GOBIIDAE)

**Round Goby** ***Neogobius melanostomus*** **NON-NATIVE:** Common to abundant on rocky bottoms in Lake Michigan out to at least 60 feet deep (Tingley et al. 2021; WDNR unpublished data) and in all tributaries up to the first impassable waterfall or dam, in some cases over 40 miles upstream (Kornis and Vander Zanden 2010; WDNR unpublished data). Common in Lake Superior in Duluth/Superior Harbor and associated bays and the lower reaches of tributaries (Bergstrom et al. 2008), but as yet unknown elsewhere in the Wisconsin waters of the Lake Superior basin. Movement rates within Duluth/Superior Harbor tend to be relatively low (Lynch and Mensinger 2012). No records from the Mississippi River basin in Wisconsin.

The Round Goby, native to the Black Sea basin of western Asia and eastern Europe, first arrived in North America in 1990 via the ballast water of ocean-going ships and then rapidly spread throughout the Great Lakes (Jude et al. 1992). The first records from Wisconsin were in the mid to late 1990s from several widely separated Great Lakes port areas (Lyons et al. 2000), suggesting that they arrived in the state via the ballast water of inter-lake shipping (Rup et al. 2010). Since then, they have expanded explosively in Lake Michigan (Clapp et al. 2001) and are now one of the most abundant fish in shallow rocky areas of the lake (WDNR unpublished data) and they have also become common in many tributaries (Kornis and Vander Zanden 2010; WDNR unpublished data)

In Lake Michigan and other Great Lakes, Round Goby are associated with, and are probably at least partially responsible for, declines in abundances of native, small, bottom-dwelling fishes and aquatic invertebrates in shallow rocky areas (Lauer et al. 2004; Balshine et al. 2005; Lederer et al. 2008; Bergstrom and Mensinger 2009; Burkett and Jude 2015; Houghton and Janssen 2015; Leino and Mensinger 2017). They have become an important prey for many fish-eating fishes and birds, and, as a result, Smallmouth Bass growth and condition has improved in some areas (e.g., Crane et al. 2015). However, the exact extent and mechanism of Round Goby impacts are difficult to untangle from concurrent habitat and climate warming effects

**Figure 30. Freshwater Tubenose Goby from Lake St. Clair, Macomb County, Michigan, 26 July 2002.**

**Figure 31. Map of occurrences of Freshwater Tubenose Goby in Wisconsin.**

and food web changes caused by the invasion and exponential increase of non-native dreissenid mussels (Turschak et al. 2014; Madenjian et al. 2015; Foley et al. 2017; Volkel et al. 2021). In tributaries, direct impacts of Round Goby on native fishes and invertebrates are as yet uncertain, although there are fears they will displace benthic minnows, sculpins, and darters (Poos et al. 2010; Abbett et al. 2013; Kornis et al. 2013). Some of the scientific literature refers to the Round Goby as *Apollina* or *Apollonia melanostomus*.

**Freshwater Tubenose Goby** ***Proterorhinus semilunaris*** **NON-NATIVE:** Newly established and added to the list of Wisconsin fishes in the early 2000s (Figure 30). Currently common in Lake Superior in Duluth/Superior Harbor and its associated bays and primary tributary, the St. Louis River (UWZM 11716, 11920, 13524, 20490; Figure 31). Found on the bottom in shallow, heavily vegetated areas with little current or wave action. In 2018, a small population was discovered at the mouth of Dutchman Creek, a small direct tributary of Lake Superior, about two miles east and independent of Duluth/Superior Harbor, which suggests that the species may be spreading eastward along the Lake Superior shore. None were captured there during an earlier sampling in 2012

The Freshwater Tubenose Goby is native to the Black Sea basin in western Asia and eastern Europe and first appeared in North America in 1990 in the St. Clair River, the outlet of Lake Huron (Jude et al. 1992). It reached the Great Lakes in the ballast water of ocean-going ships. Its spread to Wisconsin and other disjunct locations in the Great Lakes has presumably involved ballast water transport via inter-lake shipping (Rup et al. 2010). Initially, specimens in the St. Clair River were identified as the similar-looking *P. marmoratus,* a brackish water species, but genetic analyses indicate that Great Lakes populations are actually *P. semilunaris,* a freshwater species (Neilson and Stepien 2009). The possible effects of the Freshwater Tubenose Goby on native Great Lakes fishes and ecosystems have as yet been little studied.

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### ON THE COVERS

**Front Cover:** Muskellunge *Esox masquinongy* (Wisconsin's official State Fish), Spread Eagle Chain of Lakes, Florence County. (Photo © Eric Engbretson, underwaterfishphotos.com).

**Back Cover:** Blue Sucker *Cycleptus elongatus* by Wisconsin artist and sculptor Joshua Knuth, a life-long lover of Wisconsin's fishes, angler, and advocate for native fish conservation. As a 10-year-old he met and spent hours talking about fish with George C. Becker, after which Becker presented him with a signed copy of *Fishes of Wisconsin*. The book accompanied him as he explored his local waters and is "in rough shape." Whether sculpting detailed, realistic, life-size fish replicas for educational institutions or creating equally true-to-life fish illustrations for scientific publications and art prints, he combines skill and artistry with expertise about each species and a dedication to accuracy in every detail. Since Becker and his book played a formative role in the development of that expertise, it is fitting that his depiction of an extraordinary but little-known Wisconsin native fish is featured on this continuation of Becker's work. Josh is @fishart.knuth on Instagram and Fish Art by Joshua Knuth on Facebook..

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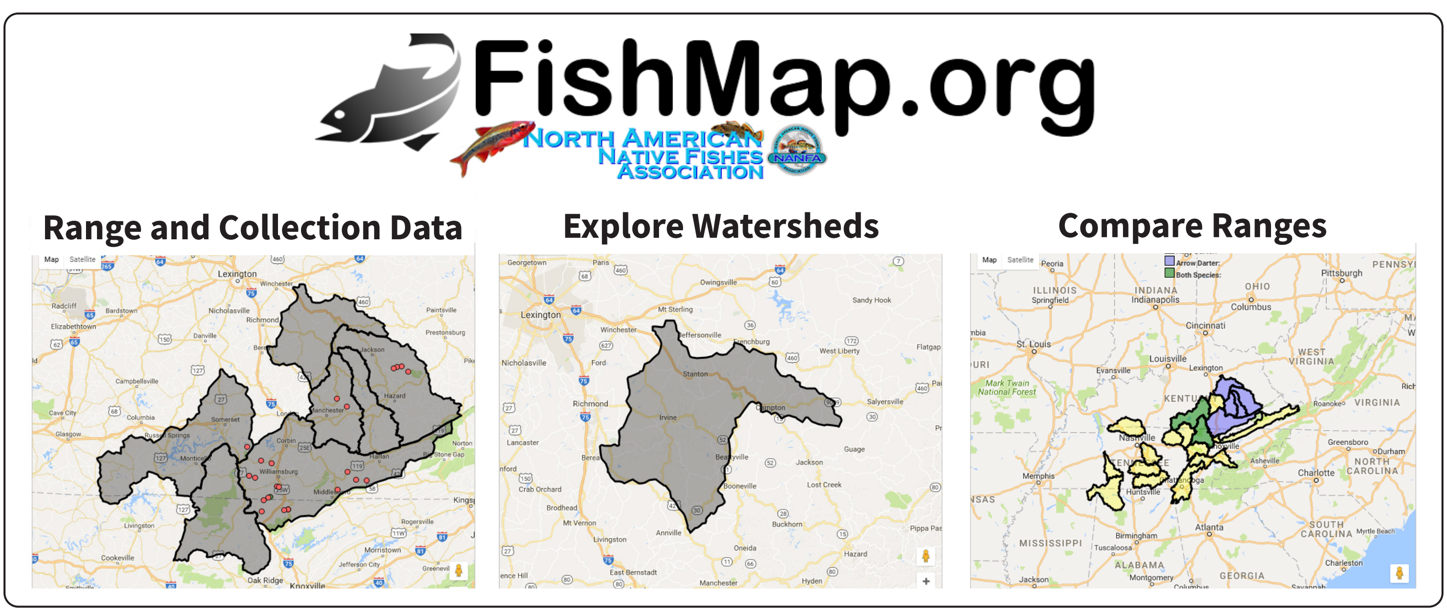


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**FISHES OF WISCONSIN POSTERS**


The University of Wisconsin Zoological Museum has some amazing fish posters for sale. The 13-foot canvas poster shows all 183 species found in the state, at life size, and costs $150. Nine smaller posters, each depicting a subset (eight show families: the sunfishes, the pikes, the perches, the gars, the suckers, the salmonids, the catfishes, and the minnows; "The Little Fishes of Wisconsin" includes 16 families) are also available. The excellent art is by Kandis Elliot, UW-Senior Artist Emerita, and reference photos were provided by NANFA member John Lyons. See https://charge.wisc.edu/zoology/items.aspx for more info.

# THE NORTH AMERICAN NATIVE FISHES ASSOCIATION

DEDICATED TO THE APPRECIATION, STUDY AND CONSERVATION OF THE CONTINENT'S NATIVE FISHES

## AN INVITATION TO JOIN OR RENEW

The North American Native Fishes Association is a 501(c)(3) not-for-profit, tax-exempt corporation that serves to bring together professional and amateur aquarists, anglers, fisheries biologists, ichthyologists, fish and wildlife officials, educators, and naturalists who share an interest in the conservation, study, and captive husbandry of North America's native fishes. A portion of each member's dues helps support three important initiatives: NANFA's Conservation Research Grant Program, which funds research on the biology and conservation of North America's most neglected and imperiled fishes; the Gerald C. Corcoran Education Grant, which funds educational outreach programs aimed at children and the general public; and the John Bondhus Conservation Grant, which supports organizations and groups working to conserve native fish populations.

### MEMBER BENEFITS

- ***AMERICAN CURRENTS,*** a quarterly publication featuring articles and news items on collecting, keeping, observing, conserving, and breeding North American fishes.
- **REGIONAL NANFA CHAPTERS.** State and regional aquarium groups where members may get together to collect and discuss native fishes, remove exotics, and perform conservation and stream restoration work.
- **NEW MEMBER PACKET.** An 8-page newsletter that's sent to new NANFA members introducing them to NANFA, and to the fascinating world of collecting, keeping and conserving North America's native fishes.
- **ANNUAL CONVENTION.** Where NANFA members from around the country meet for lectures, collecting trips, auctions, fun and finship. The 2023 convention will be held in mid-March in South Carolina.
- **GRANT FUNDING.** Only NANFA members can apply for NANFA's Conservation Research Grant and Gerald C. Corcoran Education Grant programs. For details, see NANFA's website (www.nanfa.org), or contact Dr. Bruce Lilyea, Conservation Grant Chair, 863-513-7611, bruce.lilyea@gmail.com, or Scott Schlueter, Education Grant Chair, scott_schlueter@hotmail.com.

DUES: USA, $30/year ◆ CANADA and MÉXICO, $35/year ◆ ALL OTHER COUNTRIES, $44/year (All amounts in US$)

Please renew or begin my NANFA membership, or send a gift membership to the person named below.

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or **join online at http://www.nanfa.org/join.shtml**

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**Feel free to photocopy this page and share it with other native fish enthusiasts.**

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(See page 56.)