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Abstract.–From 1993 through 2001, 636 collections were made to determine the status of those Michigan fishes declining in occurrence. Eight species are currently recognized as endangered, seven as threatened, nine as extirpated from Michigan (or extinct), and eleven as special-concern. I collected five of the endangered, two of the threatened, and five of the special-concern species. I consider the bigeye chub, the ironcolor shiner, and the weed shiner to be extirpated in Michigan because none were taken with extensive sampling effort (last seen in 1941, 1942, and 1952, respectively). For the 37 species occurring less frequently, I discuss distribution, collection history, and status, and make recommendations for classification and actions for recovery. In total, 119 species of the 147 currently existing in the state were collected. Collections were made in all 83 Michigan counties, but primarily in the Lower Peninsula. Frequency-of-occurrence percentage and distribution maps are provided for all species collected. The five most frequently collected species (found at one-third or more of the sites) were: johnny darter, white sucker, creek chub, bluntnose minnow, and common shiner. Thirty-four species were found at less than 1.0% of the sites.

Introduction

Michigan's Endangered Species Act of 1974 (Act 203) requires the listing of endangered and threatened fishes every 2 years. The current list, recognized in 1999, contains eight endangered, seven threatened, and nine extirpated or extinct species (Table 1). In addition, there is a list of 11 species labeled "special-concern" which have no legal status but are considered likely candidates for the threatened list. A committee of six experts from the state of Michigan recommends species for these lists. The lists of fishes are dynamic because of environmental perturbations and variability, and the difficulties in measuring the distribution and abundance of fishes in a large geographical area such as the State of Michigan. As more information accumulates, the classification of fishes changes.

Protection of fishes that are declining in number is beneficial to man. Endangered fishes in Michigan, usually populations on the fringe of their ranges, are likely to be genetically unique (White 1988; Scudder 1989; Lesica and Allendorf 1995; Novinger 1995; Smith et al. 1995). Scudder (1989) declared, "Marginal populations have a high adaptive significance to the species as a whole and marginal habitat conservation, preservation and management is one of the 'best' ways to conserve the genetic diversity and resources of the species." Likewise, Lesica and Allendorf (1995) wrote, "Available empirical evidence suggests that peripheral populations are often genetically and morphologically divergent from central populations." White (1988) showed a genetic difference in peripheral populations of the rosyside dace (*Clinostomus funduloides*) in

Ohio, and Novinger (1995) found morphological and metabolic differences in the redside dace (*Clinostomus elongatus*), a species that occurs in Michigan. The loss of a unique part of an ecosystem, no matter how small, decreases the efficiency of the system; the potential biomass is reduced and the system produces less for humankind (Carlander 1955; Smith 1972; Schneider 1995; Tilman 1996). Carlander (1955), Smith (1972), and Schneider (1995) showed a biomass decrease as species numbers decreased in reservoirs, the Great Lakes, and a small inland lake in Michigan, respectively. Also, changes in species abundance and distribution may indicate a change in ecosystem health which, in all likelihood, is caused by a harmful perturbation.

Michigan's 1974 legislation broadly defined endangered and threatened species. However, the specific implementation of those definitions was addressed in a 1986 document, which was evolved in technical advisory committees, entitled "Guidelines for listing endangered, threatened, probably extirpated and special-concern species in Michigan." These guidelines quantify the definitions with arbitrary numbers and time (Table 2). Although there are in the literature several more sophisticated systems for classifying endangered or threatened species (e.g., Millsap et al. 1990; Mace and Lande 1991; Taylor 1995), Masters (1991) points out they generally require much life history information that is not available for all species. He advocates the practicality and usefulness of guidelines like those used by The Nature Conservancy or the State of Michigan.

In 1993–2001, I collected fishes statewide in an investigation of the status of Michigan's endangered, threatened, special-concern, and other fishes. Collections were made at historical sites where a species were last known to be present and at exploratory sites where the species might occur. Through 2001, 636 collections were made and 119 species of fishes were collected of the 153 currently existing in the state (Bailey and Smith 2002). Collections were made in all 83 Michigan counties. Complete records of species collected, locations and analysis of fish assemblages are given in earlier reports (Latta 1993, 1994, 1995a, 1996, 1998a, 1998b, 1999, 2000, 2001), and the field notes are on file in the Fish Division, University of Michigan, Museum of Zoology (UMMZ).

The objectives of this report are to provide: (1) a review of the status and classification of those fishes recognized as endangered, threatened, extirpated from Michigan (or extinct), or of special-concern, and (2) distribution maps and frequency of occurrence, an indicator of abundance, for all species of fishes collected.

Methods

Most fishes were captured with a backpack shocker (pulsated direct-current) and seines (6-, 10-, 15- and 25-feet long with mesh sizes 1/8-, 3/16- or 1/4-inch). A few samples were taken with a 200-foot bag seine or boat boom shocker operated by personnel of the Michigan Department of Natural Resources (MDNR), Fisheries Division. Also, several collections were made with a trawl operated by the crew of the research vessel Channel Cat from the MDNR, Lake St. Clair Fisheries Research Station, Harrison Township. In field notes, each of the 636 sites was described in terms of size, water characteristics, vegetation, bottom types, cover, shore conditions, and current. The locations of the historical sites to be sampled were obtained mostly from the collection records of UMMZ, with a few from the MDNR, Fisheries Division. A sample of all fishes collected was preserved for later identification and deposition in the UMMZ fish collection. Dr. Reeve M. Bailey, Curator of Fishes Emeritus, UMMZ, participated in most of the collecting and identified, or verified the identification of, most of the fishes.

Using Geographic Information Systems software, fish collection sites were mapped using their location according to either the Public Land Survey System (PLSS) or latitude-longitude. In the former case, each point was placed at the calculated center of the section in which the collection occurred. (The location is accurate to within approximately 0.7 mile.) The points were mapped using PLSS ArcView point coverage created by Jennifer Kotanchik and maintained by the University of Michigan (UM), School of Natural Resources and Environment (SNRE). Latitude and longitude were used only for sites in Saginaw Bay and Lake St. Clair. For

these sites, a point coverage was created in ArcInfo and re-projected from decimal degrees into the Universal Transverse Mercator (UTM) projection.

All maps are in UTM projection zone 16, North American Datum of 1927. They were made using ArcView Version 3.1. ArcInfo Version 7.2.1 was used in some cases to modify and re-project coverages. County boundaries were obtained from the Spatial Information Resource Center, MDNR. Major and minor watershed boundaries (edition 10/19/98) were provided by the Michigan Department of Environmental Quality; however, some modifications were made and the boundaries were simplified to make the species collection maps more readable. The fish distribution maps were created in Geographic Information Systems Laboratories at UM, SNRE and the Institute for Fisheries Research (IFR).

Results

The cumulative frequency of occurrence for the fishes collected in 1993–2001 at 636 sites is listed in Table 3. This provides a combined measure of a species' geographic spread, relative abundance, and adaptability. The distributions of 10 species were widespread, with some found throughout the state and the rest found over most of the state. Each of these species was found at 221 or more of the 636 sites sampled, about one-third of the sites. The johnny darter occurred most frequently. It was found at 64.8% of the sites. It was followed by the white sucker, at 59.7% of the sites. The remaining species, occurring less frequently, were creek chub (56.6%), bluntnose minnow (53.3%), common shiner (44.3%), bluegill (40.7%), largemouth bass (40.3%), mudminnow (36.0%), green sunfish (35.5%), and rock bass (34.7%). Thirty-four species were found at less than 1.0% of the sites (six or less sites). The 75 species remaining of the 119 total were found individually at an intermediate number of sites (11 to 84). This species distribution pattern is illustrated in Figure 1.

The counties and major watersheds of Michigan are identified in figures 2 and 3. The location of collection sites by county and watershed are illustrated in figures 4 and 5. Detailed information on collection sites and species taken at each may be found in my earlier reports (cited above), notes on file in UMMZ, and these two websites: State of Michigan Center for Geographic Information: www.mcgi.state.mi.us/mgdl/?rel=thext&action=thmname&cid=8&cat=Fish+Atlas and University of Michigan Museum of Zoology: www.ummmz.lsa.umich.edu/dbases.html.

Appendix A contains the distribution maps for the 119 species of Michigan fishes I collected in 1993–2001. The maps are arranged in taxonomic and alphabetical order according to scientific name. Collecting was neither random nor systematic but biased toward the distributions of Michigan fishes perceived to be endangered, threatened, special-concern, or rare. Collections were made in all 83 Michigan counties, but the Upper Peninsula was lightly sampled and few maps provide a complete distribution record for a species. However, they significantly update and complement the historical distribution records (Bailey et al. 2003).

Michigan fishes recognized as endangered, threatened, extirpated (or extinct), and special-concern are listed in Table 1. NatureServe (Association for Biodiversity Information), an off-shoot of The Nature Conservancy, compiles the conservation status of the fishes of the United States and Canada in ranks comparable to the Michigan classification of endangered and threatened fishes. The system ranks fishes globally, and at the national and sub-national level (state, province, or other) and provides a more detailed classification than does Michigan. Essential definitions for the NatureServe classification are presented in Table 4. Their ranks for Michigan's endangered, threatened, extirpated (or extinct), and special-concern fishes in Michigan, Wisconsin, Illinois, Indiana, Ohio, Ontario, and globally are presented in Table 5. The global and state distribution of each species and its presumed status is discussed in the following pages. Historical and recent collections are compared.

Endangered Species

Redside dace *Clinostomus elongatus*

This species occurs in the upper Susquehanna River drainage of New York and

Pennsylvania, the Lake Ontario drainage of southern Ontario and New York, the Ohio River basin of Pennsylvania and New York, and west through the lower Great Lakes and upper Mississippi River basin to Iowa (where it is now extirpated) and Minnesota. The range is discontinuous and contains several widely disjunct populations (Gilbert, *in* Lee et al. 1980). In Michigan, it occurs in the Rouge River drainage in Seeley Drain, upper River Rouge, and Johnson Drain; the Bean Creek-Maumee River drainage in St. Joseph Creek; the Huron River drainage in Fleming Creek; and in the Presque Isle River drainage in the western Upper Peninsula. The Fleming Creek population was established as the result of a 1990 stocking of fish from Seeley Drain. The Presque Isle population was first reported in 1981; the St. Joseph Creek population in 1993. Historically, a specimen was collected in 1927 in the headwaters of Bean Creek and in 1945 from Loch Alpine inlet (Boyden Creek) in the Huron River drainage.

This species typically inhabits small- to medium-sized, cool, clear streams with rubble and gravel bottoms. It prefers to live in pools. In 1993, I found a population of redside dace in St. Joseph Creek, and in 1996 exploratory sampling established its presence in the north tributary and in the mainstream about a mile above the tributary confluence. The species, reported in 1981 in the Presque Isle River drainage by Jerry Edde, a U.S. Forest Service biologist, was not noted as rare. Earlier surveys in 1963 and 1964 did not find (or recognize) the species. In 1998, a specimen was collected by Philip D. Doepke, U. S. Forest Service, in Pomeroy Creek of that drainage and brought to my attention. Subsequent collections in 1998, 1999, and 2000 by U. S. Forest Service crews and me indicated that the species was well established in the Presque Isle drainage, but apparently not in contiguous watersheds. During the 1999 survey, conversations with Pat Lillie, a commercial minnow dealer who lives in the Presque Isle drainage area (Marenisco), revealed that he routinely harvests redside dace to sell for bait and that he had stocked the species in various tributaries in the drainage. He also reported that a minnow dealer from Eagle River, Wisconsin and one from Iron River, Michigan annually harvest minnows from the Presque Isle River. He said he had not stocked redside dace outside the drainage and did not believe that it was present in neighboring drainages. He believes the species has become abundant only in the last 10 years. The suggestions that the species was apparently absent in early surveys and has been increasing in numbers recently, implies the species has been introduced, perhaps accidentally or purposely, as a bait minnow, probably from the northern Wisconsin population (Lyons et al. 2000) which is about 50 miles south of the Presque Isle drainage. This species is established in four areas in Michigan. It would appear that the St. Joseph Creek and Presque Isle River populations are secure, but the other two areas (Rouge River drainage and Fleming Creek) definitely are being threatened by the vagaries of land development.

The redside dace is classified as apparently secure (G4) globally (Table 5). At the state level, it is considered vulnerable (S3) in Wisconsin, critically imperiled (S1) in Indiana, and vulnerable (S3) in Ontario. It should be considered endangered in Michigan.

Silver shiner *Notropis photogenis*

This species occurs north from eastern Tennessee and western North Carolina to eastern Indiana, southeastern Michigan, Ohio, western Pennsylvania, and southwestern New York to the Grand River, southern Ontario (Gilbert, *in* Lee et al. 1980). In Michigan, historically, it was found in the Huron, Raisin, and St. Joseph of the Maumee rivers. It inhabits moderate to large-sized streams that have moderate to high gradient and clean gravel and boulders (Trautman 1981). The species probably no longer occurs in Michigan's Huron River (Yant and Humphries 1978), but is still found in the St. Joseph of the Maumee (Latta 1993), and was taken at two historical sites in the Raisin River in 1995 (Latta 1995a). At the first site, one adult and five young were preserved and 20 adults were returned to the water; at the second site, one adult and eight young were preserved and about 12 adults and 44 young were released. Apparently, natural reproduction is substantial.

Globally, the silver shiner is considered demonstrably secure (G5), but may be rare in parts of its range at the periphery (Table 5). At the state level, it is considered critically imperiled

(S1) in Michigan and imperiled/vulnerable (S2, S3) in Wisconsin and Ontario. Apparently, it is secure (S4) in Indiana. This species should be considered endangered in Michigan.

Pugnose minnow *Opsopoeodus emiliae*

The species occurs from southern Texas east to South Carolina, north in the Mississippi valley to southeastern Minnesota, Wisconsin, east to extreme southern Michigan and western Ontario in the Lake Erie drainage, and Ohio and western West Virginia (Gilbert *in* Lee et al. 1980). In Michigan, it was found historically only in the southeast corner at three sites in the lower Huron River and one site at the mouth of the Raisin River. The species inhabits clear, quiet waters of lakes and rivers where there is aquatic vegetation and a bottom of sand or organic debris (Smith 1979; Trautman 1981; Becker 1983). Scott and Crossman (1973) reported the pugnose minnow has been found in the Detroit River, Lake St. Clair, and the Thames River in southwestern Ontario, but considered the species rare in Canada. In 1994, I collected at two sites on the Huron River where the species once occurred and two adjacent sites where it was thought the species might be found. One site not sampled (Huron River, 2 miles east of Willow) was not easily accessible, and the site on the lower Raisin River was poorly identified and not sought. Smith *et al.* (1981), who sampled the Raisin River intensively in 1978, did not find the pugnose minnow. Because the species had been reported in Lake St. Clair (Gilbert and Bailey 1972; Scott and Crossman 1973; Herdendorf et al. 1986; and correspondence from E. Holm to R. C. Haas, 1994) three collections were made in the Harsens Island area in northern Lake St. Clair. Trautman (1981) reported a drastic decrease in the numbers and localities of the pugnose minnow in Ohio since 1930. In the years 1955–80, only two Ohio populations were known to still exist—one in the mouth of the Chagrin River in eastern Ohio and the other in Nettle Lake in extreme northwest Ohio. Nettle Lake is less than a mile from the southern boundary of Branch County, Michigan. I sampled for the pugnose minnow in a Michigan tributary of Nettle Lake and in a lake in the same drainage shared with Indiana. The species was not found at either site.

In 1995, three additional sites were sampled in the Harsens Island area of Lake St. Clair. None were found in that area, but sampling in the lagoon outlet at Sterling State Park, Monroe County, produced two specimens. This site is probably very close to the historic site at the mouth of the Raisin River described as "slip to old carp pond." This species had been last collected in Michigan in 1941, 54 years prior. In 1997, I sampled two small tributaries of Lake Erie (Muddy and Plum creeks, Monroe County) in an effort to find more pugnose minnows. None were found.

Globally the pugnose minnow is considered secure (G5) although perhaps rare at the periphery of its range. At the state level, it is considered rare or uncommon in Wisconsin (S3), imperiled/vulnerable (S2, S3) in Illinois, imperiled (S2) in Indiana, and critically imperiled (S1) in Ohio. The classification of endangered seems appropriate for this species in Michigan.

Southern redbelly dace *Phoxinus erythrogaster*

This species occurs in small upland streams from Minnesota and western Pennsylvania to Arkansas and Alabama with isolated populations south and east of the central distribution (Starnes and Starnes, *in* Lee et al. 1980). In Michigan, it was historically found at eight locations in Washtenaw County and one in Livingston County (Huron River drainage); three locations in Lenawee County, and one in Monroe County (Raisin River drainage). The most recent collections (1977 and 1978) were the one in Livingston County and the two in Lenawee County (Yant and Humphries 1978; Smith et al. 1981). Trautman (1981) described the preferred habitat of southern redbelly dace as "permanent brooks of clear waters which were not subjected to frequent flooding which flowed between wooded banks and contained long pools of moving water, and which had 'cut banks' overhung by vegetation." Of the 13 historical locations, 7 were sampled in 1995 and another 15 locations were sampled in the drainages thought likely to contain the species (Latta 1995a). The six historic sites not visited had been subjected to substantial habitat perturbations in recent years. In 1996, one of the more promising historical sites was revisited and eight other likely sites were explored. In

1997, three more sites were visited—two historical and one exploratory. In 2000, the southern redbelly dace was sought in Malletts Creek, a tributary of the Huron River, on the east side of Ann Arbor. It was reported there in 1912 and 1922. Malletts Creek is a typically degraded urban stream that has been selected by the Huron River Watershed Council for restoration. Three collections seeking the species were made in this stream and two other sites in the Huron River drainage. In 2001, the southern redbelly dace was sought at three exploratory sites in the Macon Creek, Raisin River drainage, Washtenaw and Lenawee counties. Through 2001, no specimens had been found at any site. However, in 2002, two collections[1] were made in Wallace-Fleming Creek in Lenawee County, a drainage previously sampled three times, and where the southern redbelly dace was last collected in 1978 (Smith et al. 1981). One specimen was found at the upstream site.

Globally, the southern redbelly dace is secure (G5). At the state level, it is considered apparently secure in Wisconsin (S4), apparently secure/secure in Illinois (S4, S5), vulnerable in Indiana (S3), and unranked in Ohio (S?). In Michigan, the species is classified as endangered.

Western creek chubsucker *Erimyzon claviformis*

This species occurs in the Atlantic slope streams from Maine south to Georgia, in the Gulf slope streams from western Florida to Texas, and then north in the Mississippi valley to Ohio, Michigan, and Wisconsin (Wall and Gilbert, *in* Lee et al. 1980). In Michigan, it occurs only in the southern counties in the St. Joseph, Raisin, and Ottawa river drainages. It is found in small rivers and creeks with a wide variety of gradients, bottom types, and vegetation (Smith 1979; Trautman 1981; Becker 1983). Becker (1983) reported western creek chubsuckers move upstream to spawn in spring and then move back downstream in early summer to larger creeks. In Michigan, it has been taken at seven locations historically; the last collection was in Swamp Raisin Creek of the Raisin River drainage in 1978. The prior six collections dated from 1925 to 1940. In 1994, three of the seven sites were sampled and samples were taken in vicinity of three others in 1993 or 1994. The historic site identified only as the Branch of the Portage River in Kalamazoo County was not sought. The Swamp Raisin Creek historic site and a second site 4.5 miles downstream from the historic site were sampled in 1994. In the Ottawa drainage, the historic site on North Tenmile Creek at the Ohio line was sampled in 1993 and 1994. The Fisheries Division, MDNR, reported taking creek chubsuckers with rotenone in the North Branch Kalamazoo River in 1982, in the Battle Creek River in 1986 at two locations, and in the St. Joseph River in 1987. However, the specimen from the North Branch Kalamazoo River was subsequently identified as a lake chubsucker (*Erimyzon sucetta*) by the UMMZ. It is doubtful that the creek chubsucker ever occurred in the Battle Creek - Kalamazoo river drainages. I sampled at the St. Joseph River site in 1993, at the North Branch Kalamazoo River site in 1994, and just upstream from Bellevue Cemetery on the Battle Creek River site in 1994. No creek chubsuckers were taken.

In 1993–94, 23 samples were taken also from the St. Joseph drainage (Latta 1994). In 1995, two poorly described historical sites (Branch of Portage River, Kalamazoo County, and Prairie River, 8 miles southwest of Bronson, Branch County) were sampled at sites judged to be close to the originals. In addition, another five sites were sampled in waters thought likely to contain creek chubsuckers. However, in 1995, Sandra Kosek, Surface Water Quality Division, MDNR, caught a creek chubsucker (subsequently deposited in UMMZ) in Branch Creek at North Adams Road, Hillsdale County. In 1996, I sampled at the Branch Creek site and 14 other sites thought likely to contain creek chubsuckers. To date, 48 samples (Kosek sample included) have been taken in the years 1993 through 1996 in search of the creek chubsucker. Only the one specimen has been found.

Globally the creek chubsucker is considered secure although rare at its periphery (G5). At

[1] These two extraneous collections are not included in the summary data presented here. The addition would increase the total collections to 638 and the total species to 120. The specimen was collected at the junction of a tributary and Wallace-Fleming Creek just south of Rome Center on US 223 (Lenawee County, T6S, R2E, S22 NE1/4).

the state level, it is considered extirpated (SX) in Wisconsin, secure (S5) in Illinois, apparently secure (S4) in Indiana, and vulnerable (S3) in Ohio. Trautman (1981) noted that for the years 1955–80, in some locations in Ohio, the species was numerically holding its own or increasing in abundance at sites where there was an observable decrease in amounts of silt deposited on the substrate. Although obviously very rare in Michigan, it is not extirpated. It should be classified as endangered.

Northern madtom *Noturus stigmosus*

This species occurs from Mississippi and western Tennessee north to Indiana, southern Michigan, Ohio, and western Pennsylvania (Rhode *in* Lee et al. 1980). In Michigan, it occurs only in the Huron River in the southeast part of the state and the Detroit and St. Clair rivers. It is found in small to large rivers with moderate to strong currents and a substrate of sand, gravel, and boulders. It avoids extremely silty conditions and the shallows during the day when the water is clear. According to the UMMZ records, it was last collected in the Huron River in 1977 in the Hudson Mills Metropark area of Washtenaw County (Yant and Humphries 1978). It was also reported from the junction of Lake St. Clair and Detroit River at the foot of Alter Road, Windmill Point in 1937, and from the Detroit River on the impingement screen of the downtown Detroit coal-fired plant in 1978. In 1993–94, D. J. Jude, Fisheries Research Scientist at UM, captured many specimens in the St. Clair River off Algonac (personal communication). In 1993, I sampled at three sites on the Huron River where the species is known to have occurred. In 1994, I sampled two sites on the Huron River below the Hudson Mills area, but within the known historic range of the species on the river, and a UM ichthyology class collected intensively at Hudson Mills in the fall. No northern madtoms were taken.

In 1995, I again tried to collect the species in the Huron River, in June, during the day at four sites where it occurred historically, and then revisited two of the sites in July after dark when the species is more readily captured. In addition, the St. Clair River was sampled where the species was reported taken regularly in recent years. No specimens were found at any site.

Globally, the northern madtom is considered vulnerable (G3). At the state level, it is considered to be possibly extirpated (SH) in Illinois, critically imperiled (S1) in Indiana, and critically imperiled/imperiled (S1, S2) in Ohio. With perhaps only one population remaining in Michigan (St. Clair River), the species should be classified as endangered.

Channel darter *Percina copelandi*

This species has a widely disjunct distribution. One population occurs in Oklahoma, Arkansas, northern Louisiana, southeastern Kansas, and southwestern Missouri; another occurs in Kentucky, Tennessee, Virginia northeast to Ohio and the Great Lakes basins of Huron, Erie and Ontario; and a third is located in eastern Ontario, southwestern Quebec, New York, and Vermont (Gilbert and Burgess, *in* Lee et al. 1980; Suttkus, et al. 1994). In Michigan, the species occurs in several large tributaries of lakes Huron and Erie, in their connecting waters, and in Lake Huron proper. It inhabits sand and gravel beaches in lakes and large rivers where the current is slow or sluggish (Scott and Crossman 1973; Trautman 1981; Kuehne and Barbour 1983; Smith 1985).

In 1986, D. L. Schultz sampled 18 of 20 historic Michigan sites that once had populations of channel darters. He found the species at five of the sites (Schultz 1986). I identified 27 historic sites and sampled 19 of the sites (or close to the sites, as did Schultz). I found the channel darter at only three of the five sites reported by Schultz. Schultz found channel darters in the Au Sable River below Five Channels Dam, the Au Sable River below Foote Dam, the Pine River at Kings Corner Road, Van Etten Creek at Barlow Road, and the Pine River at Mikado Road. I did not find channel darters below Foote Dam or at Van Etten Creek, but did find them below Five Channels Dam, at Kings Corner Road, and at Mikado Road (Latta 1994). In general, about seven times as many individuals were collected with three-quarters of the effort in 1986 compared with 1994 (138 individuals in 5.25 hours in 1986, 21 individuals in 6.83 hours in 1994).

Another historic location of the channel darter was in Saginaw Bay. It is obvious from the historic descriptions that the collections at Lone Tree Island and vicinity were made offshore. Neither Schultz nor I were able to duplicate these samples. Saginaw Bay samples were taken offshore in 1994 with the MDNR research vessel Channel Cat, but at sites considerably north of this area. My sample closest to Lone Tree Island was on shore at Rose Island Road, similar to the Schultz effort. No channel darters were taken at either site. Another historic site (sampled in 1952 but not subsequently) was in the lower Detroit River near Sugar Island. In 1994, I collected onshore opposite the island and took none. In 1994 sampling, the channel darter was not found in the Cheboygan River, where Winn (1953) studied the reproductive habits of the species, nor in the Rifle River where Locke (1951) found it common at several stations.

On August 12, 1993, a channel darter was collected in a trawl by the crew of the Channel Cat in Lake St. Clair. In 1994, 21 channel darters were collected in Lake St. Clair in trawl hauls at sites in Anchor Bay southeast of Mt. Clemens (Latta 1994). D. J. Jude (UM fisheries scientist) also reported taking many channel darters in the St. Clair River off Algonac in 1993–94 (personal communication).

In 1995, a closer reading of Winn's 1953 paper revealed that the site I sampled in 1994 was considerably upstream of the actual site where Winn had made his observations and collections. In 1951, spawning took place between July 9 and 27, and by August 8, all channel darters were gone. In 1995, the site was visited on July 29 (Latta 1995a); no channel darters were seen or captured in the area. Again, Lone Tree Island in Saginaw Bay, an historic site for this species, was not visited; however, several trawl hauls were made in the open water around the Charity Islands in Saginaw Bay but no channel darters were taken. Although channel darters were taken in trawl hauls in northwestern Lake St. Clair in 1994, collections made in 1995 in the same area failed to find any. A collection was made also in the St. Clair River at Algonac State Park where D. J. Jude had collected channel darters. None were found. In 1996, I used a small boat to reach Lone Tree Island and adjacent Defoe Island. No channel darters were taken by shoreline seining. At Lake St. Clair, in 1996, the MDNR (Mike Thomas, personal correspondence) took one specimen in a trawl.

Globally, the channel darter is considered apparently secure (G4), although it may be quite rare at the periphery of its range. At the state level, it is considered imperiled (S2) in Indiana and Ohio, likewise in Ontario. In Michigan, it should be considered endangered (even though new populations have been found in Lake St. Clair and the St. Clair River), assuming the reduction in size of the population in the Au Sable drainage is real.

River darter *Percina shumardi*

This species occurs in Manitoba and western Ontario south to the Gulf coast, and from Kansas, Oklahoma, Texas, and Alabama northeast to Tennessee, Ohio, and Michigan (Gilbert *in* Lee et al. 1980). In Michigan, historically it was found only in the Au Sable River below Foote Dam, lower Huron River, Cass River, and one site in Saginaw Bay. It typically inhabits rivers of moderate to large size with substantial current and a substrate of gravel or rubble (Scott and Crossman 1973; Smith 1979; Trautman 1981; Kuehne and Barbour 1983). On August 12, 1993, a river darter was taken in a trawl in Anchor Bay, Lake St. Clair by the crew of MDNR research vessel Channel Cat. This is the first record of the species in Michigan since 1941. However, it has been reported taken in recent years (1973, 1985, 1989, and 1991) in the Ontario waters and tributaries of Lake St. Clair (correspondence from E. Holm to R. C. Haas 1994). The 1993 specimen was identified by R. M. Bailey and deposited in the UMMZ collection. In 1994, I sampled at or near three of the five historic sites of the river darter, and the Channel Cat trawled in Lake St. Clair in the area where the river darter was captured in 1993 (Latta 1994). In 1995, two samples were taken in the Saginaw River drainage and additional trawling was done in Saginaw Bay and Lake St. Clair (Latta 1995a). No river darters were taken. In 1986, Schultz (1986) visited all of the historic sites, but he was only able to sample onshore at Fish Point and Lone Tree Island in Saginaw Bay; whereas the historic samples were taken in open water. In 1996, the water around Lone Tree

Island was seined (Latta 1996). The island was completely inundated, with only a clump of willow trees marking its location. At Defoe Island, about 1/4-mile north and slightly larger than Lone Tree Island, the shallow water was also sampled. No river darters were found at either island.

Kuehne and Barbour (1983) believed this species has survived better than most other darters in big rivers because of its tolerance of turbidity. Globally, this species is ranked as secure (G5), although perhaps rare in some parts of its range, especially at the periphery. At the state level, it is considered critically imperiled (S1) in Ohio, although Trautman (1981) thought its rarity might be associated with the difficulty of collecting them. In Wisconsin and Indiana, it is ranked as apparently secure (S4). In Michigan, the river darter is considered an endangered species.

Threatened Species

Lake sturgeon *Acipenser fulvescens*

This species occurs from the St. Lawrence River in the east, to Hudson Bay in the north, west to the North Saskatchewan River in Alberta, and south to the Tennessee River in Alabama (Hay-Chmielewski and Whelan 1997). In Michigan, it is found in all of the Great Lakes, many of the larger rivers, and a few inland lakes. Hay-Chmielewski and Whelan (1997) provide a list of many Michigan waters where they exist at present. However, in my sampling, one specimen was caught in 1994 in a trawl in Lake St. Clair (Latta 1994).

Globally, the lake sturgeon is considered vulnerable or apparently secure (G3, G4). At the state level, it is considered imperiled (S2) in Michigan, vulnerable (S3) in Wisconsin, imperiled (S2) in Illinois and critically imperiled (S1) in Indiana. In Michigan, the classification of threatened is judged to be appropriate. The Fisheries Division, MDNR, has prepared a lake sturgeon rehabilitation strategy (Hay-Chmielewski and Whelan 1997) that provides in-depth plans for the protection and recovery of this fish in the state.

Mooneye *Hiodon tergisus*

This species occurs in the Mobile Bay drainage west to the Mississippi River and then north into the Hudson Bay basin of south-central Canada, but excluding the Great Plains region (Gilbert *in* Lee et al. 1980). It is found in the Great Lakes basin (including upper St. Lawrence) except Lake Superior; also, it has a semi-disjunct population in the James Bay region. In Michigan, it was most abundant in lakes St. Clair and Erie. Habitat is larger lakes and rivers with clear water (Trautman 19981). In 1994, D. J. Jude caught a mooneye in the St. Clair River. In 1997, MDNR fisheries biologists reported in a questionnaire on the distribution and abundance of some of the uncommon fishes of the state that mooneye were caught by anglers in 1990 and 1996 in Lake St. Clair-Detroit River (Latta 1998a).

Globally, the mooneye is reported secure (G5). In Wisconsin, it is considered apparently secure (S4), in Illinois imperiled/vulnerable (S2, S3), in Indiana apparently secure (S4), and in Ohio vulnerable but not yet assessed (S3?). Until more information is available, the threatened classification for Michigan is appropriate.

River redhorse *Moxostoma carinatum*

This species occurs widely in the central Mississippi basin from Oklahoma to North Carolina north to Minnesota, southern Ontario, and Pennsylvania, with scattered populations along the Gulf coast and in the St. Lawrence drainage (Jenkins *in* Lee et al. 1980). In Michigan, it has been found in the Muskegon, Grand, and St. Joseph rivers. The river redhorse prefers large rivers with substantial flow and is intolerant of turbidity and siltation (Trautman 1981; Becker 1983). The species has been considered rare in Michigan partly because it is difficult to sample the flowing deeper water of large rivers; however, in recent years the Fisheries Division, MDNR, has successfully sampled the larger rivers with rotenone, a fish toxicant (Nelson and Smith 1981). This technique, plus electrofishing below power plants, has revealed a modest population of the river redhorse in the St. Joseph, as well as the Muskegon and Grand rivers. In 1995, an unsuccessful attempt was made to collect river

redhorse from the St. Joseph River at the site where they had been most abundant in the rotenone survey (65 specimens recovered). The river at this location is large and the current strong; the seines used were ineffectual in capturing river redhorse.

Globally, the river redhorse is considered apparently secure (G4) although possibly rare at the periphery of its range. At the state level, in Wisconsin it is considered imperiled/vulnerable (S2, S3), in Indiana and Ohio it is vulnerable (S3). In Michigan, it should be considered threatened, because there are few viable populations and its apparent habitats are vulnerable.

Lake herring *Coregonus artedi*

This species is widely distributed in northern North America from upper Mississippi River and Great Lakes basins north to Labrador and northwest to the Mackenzie River drainage. In a 1995 report on its distribution and abundance in Michigan, I identified its occurrence in at least 153 lakes in the state (Latta 1995b). (Since 1995, four more lakes have been identified, bringing the total to 157.) The status of the lake herring in the 153 lakes was unknown in 51 of them, judged stable in 80, declining in 8, and extirpated in 14. In the Great Lakes, it is considered threatened in lakes Erie and Michigan, rare in Huron and abundant in Superior (Todd and Smith 1992).

The lake herring is considered secure (G5) globally. At the state level, it is considered vulnerable (S3) in Wisconsin, critically imperiled but not assessed (S1?) in Illinois, imperiled (S2) in Indiana and critically imperiled (S1) in Ohio. Based on the information available, a classification of threatened should be continued for the Great Lakes populations, but the inland populations could be reduced to special-concern.

Shortjaw cisco *Coregonus zenithicus*

This species occurred in Great Lakes waters (except possibly Lake Ontario) and northwest in deeper lakes to Great Slave Lake (Clarke and Todd *in* Lee et al. 1980). It is apparently extirpated in lakes Erie, Huron, and Michigan, but still extant in Lake Superior (Todd and Smith 1992). The shortjaw cisco is most commonly found in the intermediate depths of the Great Lakes (Smith 1964).

Globally, the shortjaw cisco is considered vulnerable (G3). At the state level, it is considered imperiled/vulnerable (S2, S3) in Wisconsin, extirpated (SX) in Illinois, and critically imperiled (S1) in Indiana. The threatened classification should be continued for Michigan.

Eastern sand darter *Ammocrypta pellucida*

This species occurs in the Ohio River basin in Illinois and Kentucky, northeast to the Great Lakes basins of lakes Huron, St. Clair, and Erie, and to southern Ontario and western New York. A disjunct population occurs in the St. Lawrence-Lake Champlain drainage in New York, Vermont, Ontario, and Quebec (Hocutt, *in* Lee et al. 1980). In Michigan, it was reported in the historic records from the upper Huron River drainage, the Rouge River, the Raisin River, the St. Joseph of the Maumee River, the Pine River, and Lake St. Clair. The species has been collected in the upper Huron River in 1977 (Yant and Humphries 1978) and 1992 (Davis Creek, Mark Oemke, personal communication), in the Pine River, St. Clair County in 1985 (MDNR, Wildlife Division), and in Lake St. Clair in 1993 (Mt. Clemens Fisheries Research Station, MDNR). It inhabits the clean, sandy areas of streams ranging in size from small creeks to large rivers, and is usually found in shifting sand substrate free of silt (Smith 1979; Trautman 1981; Smith 1985). In 1994 (Latta 1994), the species was taken in a trawl haul in Lake St. Clair (four specimens) and in the Black River at Church Road in Sanilac County (10 specimens). In addition, there was a reliable report of the species being collected in 1993 in the Belle River, St. Clair County. The Black River collection extended the known distribution in Michigan north about 40 miles into the next county. In 1995, the report of this species in the Belle River in St. Clair County was checked. No eastern sand darters were taken at that site nor were any taken at two exploratory sites in the same drainage (Latta 1995a). Likewise, the sampling in Lake St. Clair in 1995 failed to capture any eastern sand darters. In 1996, two historic sites in the Huron River drainage were sampled. Two specimens of the eastern sand darter were taken at the Davis Creek site; none

at the main Huron River site. Likewise, none were taken at an upstream Davis Creek site or at three miscellaneous sites in the Huron drainage.

In 1997, two additional historic sites and one exploratory site were sampled, but no specimens were found. In 2000, while seeking a different species, the sand darter was collected in the Belle River (12 specimens) and in the Pine River (2 specimens). Although the species had been reported in both rivers, I had not captured it in earlier collections.

Kuehne and Barbour (1982) categorized the eastern sand darter as a steadily declining species over much of its range and believed that siltation was the probable cause. The species is ranked globally as vulnerable (G3). At the state level, it is considered critically imperiled (S1) in Illinois, imperiled (S2) in Indiana, and vulnerable (S3) in Ohio. In Michigan, the rank of threatened is judged to be appropriate.

Sauger *Sander canadensis*

This species is widely distributed throughout central North America. It occurs from Quebec south through the Great Lakes and Mississippi valley, northwest to Montana, and north as far as James Bay (Barila *in* Lee et al. 1980). In Michigan, where it has been depleted in recent years, it occurred in lakes Michigan, Huron, Superior, and Erie; it was most abundant in Lake Erie and Saginaw Bay, Lake Huron. Typically, it is found in large, often turbid, free-flowing streams, lakes, rivers, and impoundments. Results from a questionnaire in 1997 to MDNR fishery biologists revealed that sauger were caught commonly in Little Bay de Noc and occasionally in Lake Erie and the Huron River, a tributary, in 1990–97.

Globally the sauger is considered secure (G5). In Wisconsin, Illinois, and Indiana it is reported apparently secure (S4). In Ohio, the status has not been assessed (S?). It is classified as threatened in Michigan and should retain that rating until some indication of recovery is noted in areas other than Little Bay de Noc.

Extirpated (or Extinct) Species

Paddlefish *Polyodon spathula*

This species was formerly common in large bodies of water throughout much of the Mississippi Valley and adjacent Gulf slope drainages (Burr *in* Lee et al. 1980). In the Great Lakes, it was known to have occurred in Lake Erie prior to 1903 (Trautman 1981), and recently there was confirmation of its occurrence in the Lake Michigan drainage with a report of a specimen caught in 1869 in the St. Joseph River at Niles, Berrien County, Michigan (Wuepper 2001). Hubbs and Lagler (1974) believed the species was recorded in the Great Lakes on its way to natural extirpation.

Globally, the paddlefish is considered apparently secure (G4). At the state level, it is imperiled although not assessed (S2?) in Wisconsin, imperiled/vulnerable (S2, S3) in Illinois, vulnerable (S3) in Indiana, imperiled (S2) in Ohio, and extirpated (SX) in Michigan.

Bigeye chub *Notropis amblops*

This species occurs in Alabama, Tennessee, Oklahoma north in Missouri, Illinois, Indiana, Ohio, and Michigan to New York (Clemmer *in* Lee et al. 1980). In Michigan, it was historically collected in the drainages of the Maumee, Raisin, Rouge rivers, and Stoney Creek. It was last collected in 1941 in Stoney Creek, Monroe County. Both Smith (1979) and Trautman (1981) described the preferred habitat as moderate-sized streams with a bottom of sand and fine gravel free of silt. Between 1940 and 1960, the number of populations of bigeye chub in Ohio declined dramatically. Trautman (1981) reported, "since 1960 . . . not a single large concentration of individuals being noted despite determined efforts to locate one." Smith (1979) believed it had been extirpated in Illinois since last collected in 1961, but that it still occurred in clear streams of adjacent Indiana. Smith (1979) and Trautman (1981) agreed that the cause of the decline of bigeye chub is increased siltation over the needed substrates of sand and gravel. The species is still present in New York streams (Smith 1985).

In recent years, all Michigan drainages in which the bigeye chub occurred have been extensively surveyed, and the species has not been found. In 1978, Smith et al. (1981) sampled 160 localities in the Raisin River drainage. In 1984, Gary L. Towns of the MDNR used rotenone to sample at 15 sites in this drainage (Towns 1985). In 1990–91, Paul W. Seelbach of the MDNR sampled four sites

intensively (personal communication). In 1992, graduate students of Professor J. David Allan, UM, School of Natural Resources and Environment collected at 23 sites in the Raisin River drainage. In the Rouge River drainage, Nuhfer (1989) sampled 22 sites in an assessment of water quality, but did not find any bigeye chubs. I collected at eight sites in the drainage in 1993 looking for the redside dace but found neither the dace nor the chub. Gerald R. Smith (UM Emeritus Curator of Fishes) has collected in the Stoney Creek drainage in recent years, but has not found the bigeye chub (personal communication). In the Maumee and Ottawa river drainages, Schultz et al. (1982) collected at 27 sites. In 1993, I collected at 29 sites, which included the 2 historical sites, plus 11 of the 1982 sites. The bigeye chub was not found. In 1994, I sampled Stoney, Swan, and Otter creeks in southeastern Michigan, in the center of the known historic distribution of the bigeye chub, looking for the species. Collections were made at seven sites in both Stoney and Swan creeks and at three sites in Otter Creek. The bigeye chub was not taken.

Globally, the bigeye chub is considered secure (G5), but quite rare in parts of its range, especially at the periphery. At the state level, it is listed as critically imperiled (S1) in Illinois, imperiled (S2) in Indiana, and vulnerable (S3) in Ohio. It appears to be extirpated in Michigan.

Ironcolor shiner *Notropis chalybaeus*

The species occurs from southeastern New York south in the coastal lowlands to Florida and west to Texas, then north in the Mississippi valley with disjunct populations in Iowa, Wisconsin, Illinois, Indiana, and Michigan (Swift *in* Lee et al. 1980). In Michigan, it was found only in the St. Joseph River drainage in the southwest corner of the state. The species prefers sand-bottomed pools in streams with slow current and an abundance of aquatic vegetation, although it is found in a variety of habitats (Smith 1979; Becker 1983; Smith 1985). This species was taken only in 1925 and 1926 in Wisconsin and is now considered extirpated there. Smith (1979) reported it surviving in two sand areas in the Illinois River drainage, Kankakee and Iroquois counties, and Mason and Tazewell counties, Illinois. He also indicated it was abundant in the Kankakee sand area of northwestern Indiana. Seegert (1987) reported the ironcolor shiner in 11 of 89 stations that he sampled in 1986 in the Kankakee River basin of Indiana. Seegert (1988, unpublished report) also found the species in Crooked Creek (which becomes the Fawn River in Michigan) about 2 miles south of the Michigan border in northeast Indiana. Kwak (1993) reported the species is classified as threatened in Illinois. Neil Ledet (Indiana Division of Fish and Wildlife, 1993 personal communication) believes it occurs in the St. Joseph River where it flows through Indiana, although the identification has not been verified.

In August 1981, R. M. Bailey and a crew of UM co-workers sampled nine sites in the St. Joseph River drainage. They collected at three of the five historical sites where the ironcolor shiner had been collected in Michigan -- St. Joseph River at Mottville, Rocky River at Marcellus, and Rocky River at Howardsville. They did not find the ironcolor shiner.

In 1987, the Fisheries Division, MDNR, used rotenone to collect fish at 11 sites on the Upper St. Joseph River above the village of Mendon (Towns 1988). They did not find the ironcolor shiner.

I sampled 15 sites in the St. Joseph River drainage in 1993. All of the historical sites were revisited, including those sampled in 1981. Collections were made at three sites on the Fawn River downstream of where Seegert (1988, unpublished report) found many ironcolor shiners. None were taken.

In 1994, the district fisheries crew of the MDNR sampled three sites on the Fawn River, including one identical with one of my 1993 sites, one about 1/2 mile downstream, and one about 2 miles upstream. The five-man crew used a boat shocker. The larger shocker and crew would sample more effectively than I did, but they did not find any ironcolor shiners. Also in 1994, I took five samples from the St. Joseph River drainage, of which four were from the Coldwater River portion, without catching ironcolor shiners. However, in 1927, five specimens of the ironcolor shiner were taken from the Coldwater Lake outlet (Latta 1993).

In 2001, the ironcolor shiner was sought at six sites, four in the Fawn River drainage, and two in other tributaries of the St. Joseph River just north of the Fawn River, Branch and

St. Joseph counties. Sites with an abundance of aquatic vegetation, slow current, sand bottoms, and clear water (habitat preferred by ironcolor shiners) were targeted. No ironcolor shiners were found.

Globally, the ironcolor shiner is considered secure (G5), although perhaps rare at the periphery. At the state level, it is considered extirpated (SX) in Wisconsin, imperiled (S2) in Illinois, but apparently secure (S4) in Indiana. I judge that the ironcolor shiner is extirpated in Michigan since it has not been found since 1940 in 49 documented collections made in the St. Joseph drainage (9 in 1981, 11 in 1987, 15 in 1993, 8 in 1994, and 6 in 2001).

Weed shiner *Notropis texanus*

This species occurs in the lowlands in Florida west to Texas and north in the Mississippi valley to Minnesota; it also occurs in the Red River (Hudson Bay) drainage in Minnesota and in the Great Lakes drainage in Wisconsin and Michigan (Swift *in* Lee et al. 1980). The northern populations are disjunct. In Michigan, it was found in the Kalamazoo, Grand, and Saginaw river drainages. The species prefers sand substrate with quiet or slow water in medium-sized streams or large rivers. Aquatic vegetation is not essential. It sometimes occurs with the ironcolor shiner (Smith 1979; Becker 1983). In Wisconsin, the species is still present but not common; it has been given watch status (Fago 1992). Likewise, Smith (1979) reported it rare in Illinois except in the Kankakee River. Seegert (1987), in a survey of the Kankakee River in Indiana, found the weed shiner at 9 of 89 stations and considered it a "species of special concern." Kwak (1993) classified the species as endangered in Illinois. The Fisheries Division, MDNR, sampled multiple sites with rotenone on the Grand (1978), Kalamazoo (1982), Cass (1985), Battle Creek (1986), and Shiawassee (1987) rivers without finding the weed shiner (Nelson and Smith 1981; Towns 1984, 1987).

In 1993, I sampled 21 sites in the Kalamazoo, seven in the Grand, one in the Black, and two in the Saginaw river drainages (Latta 1993). Of the 16 historical sites where the weed shiner was found in the past, collections were made at 12 of them. Of the remaining four, collections were made close to the original site in three places. The weed shiner was not found.

Judging from the number of specimens preserved in the UMMZ fish collection, the weed shiner was formerly very abundant at several sites in Michigan. In the bayou at the dike of the Swan Creek Experimental Station (Allegan County) 323 specimens were collected in 1939. Likewise, in 1941, 203 specimens were collected in Sandstone Creek below the dam at Minards Mill (Jackson County) and 208 specimens were taken from the Grand River above Waverly Road Bridge (Eaton County). In 1993, a sample was taken below the dike and in 1994 above the dike in the bayou. Sandstone Creek at Minards Mill was sampled in 1993 and 1994. No samples were taken on the Grand River at Waverly Road because urban developments have made it very difficult to reach the site but, in 1993, a collection was made about 2-1/2 miles downstream. In 1994, four sites in the Grand River drainage and eight sites in the Kalamazoo River drainage, including the above, were sampled.

In 1995, a 1934 historical site described as "Grand River bay behind government piers, Grand Haven" was visited. It is now an extensive marina impractical to sample. Other samples were taken in the Grand, Kalamazoo, and Saginaw river drainages. No weed shiners were found.

The disjunct distribution of the weed shiner in Michigan showed a large population in the Kalamazoo and Grand rivers of Lake Michigan, and a smaller population in the Saginaw River watershed of Lake Huron. Few collections have been made in the counties of central Michigan where the headwaters of these river systems occur and remnant populations of this species might be found. In 1997, 18 collections were made in this area, but no specimens were taken (Latta 1998a). In 1993, 31 collections were made looking for the weed shiner: in 1994 - 12, in 1995 - 11, and in 1997 - 18.

Globally, the weed shiner is considered secure (G5). At the state level, it is considered imperiled/vulnerable (S2, S3) in Wisconsin, critically imperiled/imperiled (S1, S2) in Illinois, and imperiled (S2) in Indiana. The absence of the weed shiner in 72 recent collections suggests that the species, last seen in 1952, is extirpated in Michigan.

Deepwater cisco *Coregonus johannae*

This species was endemic to lakes Michigan and Huron (Todd *in* Lee et al. 1980). It was found at depths of 50–160 m and spawned in August–September. The last specimen collected was in 1951. Globally this species is considered extinct (GX) (Bailey and Smith 1981).

Blackfin cisco *Coregonus nigripinnis*

The species occurred in the deep waters (90–160 m) of lakes Michigan and Huron and in much shallower water (2–100 m) in Lake Nipigon (Clarke and Todd *in* Lee et al. 1980). It apparently spawned from October to January in the Great Lakes. The last known record was from Lake Michigan in 1969. It is probably a synonym (taxonomically the same) of the lake herring (Bailey and Smith 2002). Globally, this form is considered extinct (GX).

Shortnose cisco *Coregonus reighardi*

The species formerly occurred in the deep waters (10–160 m) of lakes Michigan, Huron, and Ontario (Todd *in* Lee et al. 1980). The shortnose cisco was last seen in Lake Ontario in 1964 and in Lake Michigan in 1972. In Michigan waters of Lake Huron, it was last seen in 1982 off Detour when one specimen was taken by U. S. Fish and Wildlife Service biologists. It was reported caught in 1985 in assessment nets in the Ontario waters of northern Georgian Bay, Lake Huron. The shortnose cisco is one of seven endemic species of *Coregonus* that evolved in the Great Lakes. Two of these species, as indicated above (deepwater cisco - *Coregonus johannae* and blackfin cisco - *Coregonus nigripinnis*), have already become extinct. In 1992 and 1993, Shane A. Webb, UM doctoral student, extensively sampled the commercial and assessment survey catches in Georgian Bay. No shortnose ciscoes were observed. Webb and Todd (1995) concluded that the shortnose cisco is now extinct. Globally, it is classified as critically imperiled (G1).

Arctic grayling *Thymallus arcticus*

This species has a holarctic distribution in northern freshwater drainages from Hudson Bay west to northern Eurasia (Scott and Crossman 1973). In Michigan, it occurred in the Otter and Little Carp rivers, in the Lake Superior drainage, and in the Lower Peninsula from the Jordan to the Muskegon rivers in the Lake Michigan drainage and the Cheboygan to the Rifle rivers in the Lake Huron drainage. It persisted in the Otter River until 1936 (Taylor 1954; Hubbs and Lagler 1974). Globally, the species is secure (G5). In Michigan, it is extirpated (SX).

Blue pike *Sander glaucus*

A genetically identifiable stock of *Sander* (formerly *Stizostedion),* named blue pike, occurred in lakes Erie and Ontario (particularly western Lake Erie and eastern Lake Ontario) before its extinction in the 1960s. In the past, authorities disagreed as to whether it was a distinct species (*glaucus*) or a subspecies of the walleye (Bailey and Smith 2002). However, at the 2002 meeting of the Society of Ichthyologists and Herpetologists, Stepien et al. (2002) reported that *glaucus* was a distinct species. There are no specimens from Michigan waters. Globally, the species is extinct (GX).

Special-concern Species

Spotted gar *Lepisosteus oculatus*

This species occurs from Texas and western Florida north into Illinois, Indiana, Michigan, Ohio, and Ontario (Lee and Wiley, *in* Lee et al. 1980). In Michigan, it is found in most southwest counties north to Muskegon and Ionia counties. It is most abundant in quiet, clear waters with an abundance of aquatic vegetation (Smith 1979; Trautman 1981). In Michigan, it was taken at 10 locations historically. In 1993, I took one specimen in Allegan County (Latta 1993). In 1995, an attempt was made to collect the spotted gar in Duck Lake, Calhoun County, which is the type locality for the species (1864). No specimens were found. In a 1997 mail survey, MDNR fishery biologists reported catching spotted gar in recent years in 16 lakes and in the Grand River at 2 sites. Only the two river sites and Long Lake, Kalamazoo County, had been reported before. Globally, this species is secure (G5), although it may be quite rare in parts of its range, especially the periphery. At the state level, it is apparently secure (S4) in

Indiana, but critically imperiled (S1) in Ohio. The special-concern classification is not needed for the spotted gar in Michigan.

Silver chub *Macrhybopsis storeriana*

This species occurs from Texas and Alabama north into Minnesota and Manitoba on the west and to Ohio, New York, and Ontario on the east (Gilbert, *in* Lee et al. 1980). In the Great Lakes basin, it is confined to Lake Erie-Lake St. Clair. It is found in large sandy or silty rivers and lakes (Scott and Crossman 1973; Trautman 1981). Trautman (1981), from collecting observations, assumed this species needs a clean river or lake bottom of gravel or sand. In Michigan, it has been taken historically in only two locations—in Lake Erie 4 miles north of the Ohio state border and in Anchor Bay, Lake St. Clair. In 1995, I sampled the Lake Erie and the Lake St. Clair sites (Latta 1995a). No silver chub were taken. However, R. C. Haas, MDNR fisheries biologist, reported silver chub were common in experimental trawl hauls made in 1995 in Ohio waters of western Lake Erie. In 1996, this species was sought at two shoreline sites at the Sterling State Park on Lake Erie. No specimens were taken.

Globally, the silver chub is secure (G5). At the state level, it is considered unrankable (SU) in Wisconsin, secure (S5) in Illinois, apparently secure (S4) in Indiana, and vulnerable (S3) in Ohio. Although it is rare or uncommon in Michigan, it does not appear to be a declining population. It is doubtful the special-concern classification is needed, but it should be continued until information accumulates which would suggest a change.

Pugnose shiner *Notropis anogenus*

This species occurs from western New York and eastern Ontario west to southeastern North Dakota (Bailey 1959; Gilbert *in* Lee et al. 1980). In Michigan, it is found only in the Lower Peninsula where it is distributed widely, but appears to be absent from the Saginaw River drainage. The species prefers clear glacial lakes and streams of low gradient with an abundance of vegetation (Bailey 1959; Trautman 1981; Becker 1983).

In Michigan, this species has been collected at 36 sites where a vouchered specimen is available in the UMMZ collection to ensure the identification of the species is correct. It has been reported in collections from other sites but identification was not verified. In the years 1995–98, I collected at 31 of the sites. In 1995, two pugnose shiners were taken at a site on the Black River, Cheboygan County, where the species had been collected in 1965 and 1968. In 1994, while looking for other species, the pugnose shiner was captured in Long Lake, Hillsdale County, near the Ohio-Michigan border. Likewise, four specimens were captured in 1997 from Long Lake, Ionia County. It was not found at eight other sites where it had been reported (but not verified) or suspected to be present.

Globally, the pugnose shiner is categorized as vulnerable (G3). At the state level, it is considered rare or uncommon (S3) or perhaps imperiled (S2) in Wisconsin, critically imperiled (S1) in Illinois and Indiana, and extirpated (SX) in Ohio. With such a poor return from recent sampling in Michigan, it seems appropriate to change the classification of the pugnose shiner from special-concern to threatened.

Brindled madtom *Noturus miurus*

This species occurs south from New York, Ontario, and Michigan, west of the Appalachian Mountains, to Mississippi and Louisiana and west to Oklahoma, Kansas, and Illinois (Rohde, *in* Lee et al. 1980). In Michigan, the species occurs in Bean Creek; the Huron, Raisin, and St. Joseph of the Maumee rivers; and in Lake St. Clair. It seems to prefer clear water in pools below riffles, in lowland streams with some current, and a bottom of sand, fine gravel, silt, and detritus (Scott and Crossman 1973; Smith 1979; Trautman 1981). It was found historically at 42 sites. I sampled one of those in 1993 and three in 1995 (Latta 1993, 1995a). The historical site on the Huron River was sampled a second time after dark. A site visited on the Raisin River at Allen Road was immediately downstream from a historical site. In 1995, two brindled madtom were taken at an exploratory site on the Huron River a mile upstream from the historical site, and three specimens were taken by trawling on Lake St. Clair at two sites. In 1996, eight specimens of brindled madtom again were taken in trawls by MDNR biologists

on Lake St. Clair. Lake St. Clair is a new location for this species.

Globally, the brindled madtom is considered secure (G5). At the state level, Illinois and Indiana consider the species vulnerable (S3). It is unranked in Ohio (S?). In Michigan, it is rare and uncommon and the special-concern ranking appears appropriate until more information is available.

Black buffalo *Ictiobus niger*

This species occurs in the Mississippi, Missouri, and Ohio river basins south to the Gulf Coast with a disjunct population in southern Michigan (Shute *in* Lee et al. 1980). It prefers large rivers and is often in strong currents. In Michigan, it has been taken in the St. Joseph, Kalamazoo, and Grand rivers, Saginaw Bay in Lake Huron, and Lake St. Clair. In the 1997 mail survey of MDNR biologists, the black buffalo was reported to have been seen three times. One specimen was found in a 1978 fish collection from the Grand River, a second specimen was caught in 1994 from the St. Joseph River by an angler, and two specimens were taken in 1997 from the Grand River by an angler. The latter fish were taken with bow and arrow. The largest, which weighed 29.52 pounds and was 26 inches long, set a new state record for size of this species.

Globally, the black buffalo is demonstrably secure (G5). In Wisconsin and Indiana, it is considered imperiled because of rarity (S2). In Michigan, there is no defined population and no evidence of a decline in numbers. It should remain on the special-concern list until information indicating otherwise is forthcoming.

Siskiwit Lake cisco *Coregonus bartletti*

This species, endemic to the Great Lakes basin, is found only in Siskiwit Lake on Isle Royale, Lake Superior. Hubbs and Lagler (1974) recognized it as a species, but Bailey and Smith (1981) considered it to be the same as the shortjaw cisco (*Coregonus zenithicus).* It was last collected in 1997 (Kallemeyn 2000). The NatureServe classification of GHQ is in error (Table 5). The population is still extant and not threatened. This species should be removed from the special-concern list.

Ives Lake cisco *Coregonus hubbsi*

This species, endemic to the Great Lakes basin, is found only in Ives Lake, Marquette County, in the Upper Peninsula of Michigan. Hubbs and Lagler (1974) recognized it as a species, but Bailey and Smith (1981) considered it to be the same as the lake herring (*Coregonus artedi*). It also should be removed from the special-concern list.

Kiyi *Coregonus kiyi*

This species, endemic to the Great Lakes, occurred in lakes Superior, Michigan, Huron, and Ontario (Todd *in* Lee et al. 1980). It is now considered extirpated in all of the lakes except Lake Superior (Todd and Smith 1992). In Superior, it is relatively common at depths of 100 to 180 meters.

Globally, the kiyi is considered rare and local throughout its range making it vulnerable to extinction (G3). In Wisconsin it is classified as imperiled/vulnerable (S2, S3), in Indiana it is reported as critically imperiled (S1) although it is probably no longer present, and in Illinois it is falsely reported to have occurred (SRF). In Michigan, the kiyi should still be listed as special-concern. Evidence of a decline in abundance in Lake Superior would be cause to rate this species as threatened.

Starhead topminnow *Fundulus dispar*

This species occurs in Louisiana and Alabama north to Illinois, Indiana, and Michigan (Wiley, *in* Lee et al. 1980). In Michigan, it occurs in the southern counties, Hillsdale west to Berrien, plus one location in Barry County. It commonly inhabits clear, well-vegetated lakes, swamps, and marshes (Smith 1979). In Michigan, it has been taken at nine locations historically and at three new locations in 1994, 1995, and 1996 (Latta 1994, 1995a, 1996).

The starhead topminnow is apparently secure (G4), but may be rare in parts of its range. At the state level, it is considered imperiled (S2) in Wisconsin and Illinois, and apparently secure (S4) in Indiana. In Michigan, it is ranked as a species of special-concern, which is appropriate until there is evidence otherwise.

Spoonhead sculpin *Cottus ricei*

This species occurs in lakes and rivers from the Great Lakes and St. Lawrence drainages through Hudson Bay and Arctic drainages to the mouth of the McKenzie River (McAllister and Parker *in* Lee et al. 1980). In Michigan, historically, it was taken most often in Lake Michigan. It was less abundant in Lake Superior and uncommon in Lake Huron. It was found at intermediate depths. In the 1970s and 1980s, the spoonhead sculpin was considered rare or absent in Lake Michigan, but in 1990, it was taken at four sites (Potter and Fleischer 1992). The species is still common in Lake Superior.

Globally, the spoonhead sculpin is considered secure (G5). In Wisconsin, it is rated as apparently secure (S4), but in Ohio it is considered extirpated (SX). In Michigan, the special-concern rank for this species should be retained until further recovery is noted.

Banded darter *Etheostoma zonale*

This species occurs in the Mississippi River basin from Kansas and Tennessee north to Minnesota and New York. It was reportedly introduced into the Savannah River, North Carolina and South Carolina, and the Susquehanna River, Pennsylvania (Denoncourt, *in* Lee et al. 1980). In Michigan, it has been reported only from the Little Cedar River, a tributary to the Menominee River, Menominee County, in the Upper Peninsula. It is usually found among gravel, rubble, and boulders in riffles with moderate to swift current, primarily in small- to medium-sized rivers and shore-zone riffles of large rivers. The banded darter was first collected in Michigan in 1979 (Erickson and Mahan 1982). John N. Lowe made extensive collections in Menominee County in 1927, but did not find this species (Taylor 1954). I found the species abundant at the historic site, common where the Little Cedar River meets the Menominee River, and present in the Little Cedar River 5 miles upstream from the original site.

At present, the banded darter is listed as of special-concern in Michigan. It is secure globally (G5) and apparently secure (S4) in most contiguous states. As a recent immigrant to Michigan that is apparently not declining in numbers, it probably should not be listed as a special-concern species.

Other Species of Concern

In addition to those species of special-concern discussed above (Table 1), the status of the bigmouth shiner (*Notropis dorsalis*) and the orangethroat darter (*Etheostoma spectabile*) should be reviewed. The abundance of the bigmouth shiner appears to be considerably reduced in parts of its range, particularly the Upper Peninsula, and the orangethroat darter has a very limited range in an area of the state undergoing rapid suburban development. The following segments review the status of these two species in Michigan and contiguous states.

Bigmouth shiner *Notropis dorsalis*

This species occurs from southern Manitoba, eastern Wyoming, and northeastern Colorado east to western New York, north-central Pennsylvania, and northern West Virginia. The distribution is continuous eastward to Illinois and Wisconsin, but discontinuous from there with isolated populations in upper and lower Michigan, northern Ohio, and western New York and Pennsylvania (Gilbert and Burgess, *in* Lee et al. 1980). In Michigan, it had been reported from the western side of the Lower Peninsula and a northwest segment of the Upper Peninsula. It inhabits shallow, open, prairie-like streams with predominantly sand bottoms overlain with silt and is much less abundant in the eastern than western half of its range. In Michigan, prior to my sampling, the species has been collected 74 times in the past, but only twice since 1975. In 1993, I sampled two historic sites in Allegan County, where this species occurred, while looking for the weed shiner (Latta 1993). No bigmouth shiners were collected. In 1996, I visited six of the historic sites--four in the Lower Peninsula and two in the Upper Peninsula. The bigmouth shiner was found at two sites in the Lower and one in the Upper Peninsula. In the Lower Peninsula, both sites were in the Muskegon drainage and the species was abundant to common; in the Upper Peninsula, the single site was on the Otter River, Baraga County and only two specimens were taken. No specimens were found at five

exploratory sites. In 1997, I visited 19 historic sties, of which three were in the Upper Peninsula. The species was taken at four of the sites in the Lower Peninsula. In 1999, I collected again in the Otter River, an exploratory site close to the historical ones. Thirty-eight specimens were captured in 75 minutes of seining. In the 4 years, 27 of the 74 sites were visited, of which 22 were in the Lower and 5 were in the Upper Peninsula. The species has been found at five historical sites in the Lower and one in the Upper Peninsula. Eleven exploratory sites were sampled; two contained the bigmouth shiner. One site was on the South Branch White River, Oceana County, a watershed not reported before, and the second was a new site on the Otter River, where, historically, the species was abundant.

Globally, the bigmouth shiner is secure (G5), and in the contiguous states, it is apparently secure (S4) in Wisconsin, secure (S5) in Illinois, but imperiled (S2) in Indiana and Ohio. In Michigan, it appears to be much less abundant now than in the past in the Upper Peninsula. In the Lower Peninsula, the populations in the Muskegon watershed are robust, but those in the Kalamazoo and Grand rivers watershed appear to be less abundant than in the past. I suggest this species be classified as special-concern and further evaluated.

Orangethroat darter *Etheostoma spectabile*

This species occurs in Lake Erie and Mississippi River basins from southeast Michigan and Ohio to eastern Wyoming, and south to Tennessee and northern Texas; also in the Gulf drainages of Texas (Page and Burr 1991). In Michigan, it is found only in the southeast corner of the state in the Lake Erie drainage. It inhabits shallow gravel riffles in the headwaters of creeks and small rivers. The UMMZ collections show the species has been collected in the state 22 times between 1920–1982, with 11 of the collections made in 1978. In 1978, Smith et al. (1981) captured the species in at least 25 locations in the Raisin River system. Most of the 25 locations were in the Macon River basin, with the others in the upper tributaries of the Saline River. I sampled 5 of the 22 sites listed in the UMMZ records. The species was caught at only three of the sites. Although much sampling was done in my other surveys in this southeast corner of the state, the orangethroat darter was not taken. More site-specific sampling is needed, but until that has been done, the species should be listed as of special-concern.

Globally, the orangethroat darter is rated as secure (G5). In Wisconsin, it was erroneously reported to occur (SRF), in Illinois, it is considered secure (S5), in Indiana apparently secure (S4), and in Ohio not yet assessed (S?). The rapid increase in residential development in the area where this species occurs in Michigan will make it difficult for it to survive.

Recovery Recommendations

Implementing the recovery of an endangered or threatened species is a complex and difficult task. Miller et al. (1989) list the causes for extinction of North American fishes as: (1) Habitat alteration or loss; (2) Introduced species; (3) Chemical alteration or pollution; (4) Hybridization; and (5) Over harvest. Richter et al. (1997) give the three leading threats to fishes nationwide as: 1) Sediment and nutrients from non-point pollution; 2) Interference from exotic species; and 3) Altered hydrologic regimes associated with impoundments. These listings have provided the background for my proposed recovery actions for Michigan endangered, threatened, and special-concern fishes (Table 6). Below I categorize and define recovery actions as protection, habitat improvement, and stocking. Some important questions are raised:

1. Protection. This category includes protecting the species from adverse land use, pollution, and competition or predation. Adverse land use includes suburban development or agricultural practices that increase turbidity. Pollution means the addition of toxic chemicals or nutrients to the water. Competition or predation considers the effect of introduced exotic species that might compete with, or prey on, the endangered species. Predation also includes the harvest of the species by man.
2. Habitat improvement. This includes the correction or cessation of adverse land

use and pollution as well as advocating physical changes such as development of buffer zones along stream banks to reduce non-point pollution runoff, reduction of bank erosion, regulation of water flow below impoundments, and dam removal to permit fish passage.

3. Stocking. This means either adding fish to existing populations, introducing the species to new suitable water where it would be expected to survive, or re-establishing extirpated populations. Fish for stocking may be cultured or they may be transplanted from existing populations. Both actions raise serious questions, however. Although the culture of fish has a long history, it has been practiced with relatively few species. Whether or not most endangered or threatened fishes can be cultured is unknown. In many cases, the endangered or threatened population of a species is peripheral to the total range. It is likely that these peripheral (or perhaps disjunct) populations are genetically unique (Latta 1998c). If these peripheral populations are not abundant enough for transplanting or suitable for culture, is it possible or desirable to supplement or establish populations from a different gene pool thriving in another part of their range? Is it possible or desirable to replace an extirpated population with a different gene pool? Will the removal of fish from a remnant population for stocking be detrimental to that population? If fish are stocked in habitat where they have never before occurred, but are likely to survive, will that introduction be detrimental to the existing fish community? These questions are relevant and are reflected in the recovery actions proposed for Michigan's endangered and threatened species.

The classification and recovery action proposed for Michigan's endangered, threatened, extirpated, and special-concern fishes are presented in Table 6. I used the historic and present (1993–2001) collection data as well as any other relevant observations to apply the Michigan Guidelines (Table 2). The proposed recovery actions are based on the defined protection, habitat improvement and stocking criteria. Unfortunately, aquatic habitats in Michigan continue to deteriorate and animal populations fluctuate for biotic and abiotic reasons. The fishes of Michigan need to be frequently monitored for distribution and abundance in order to make the management decisions that will ensure their survival.

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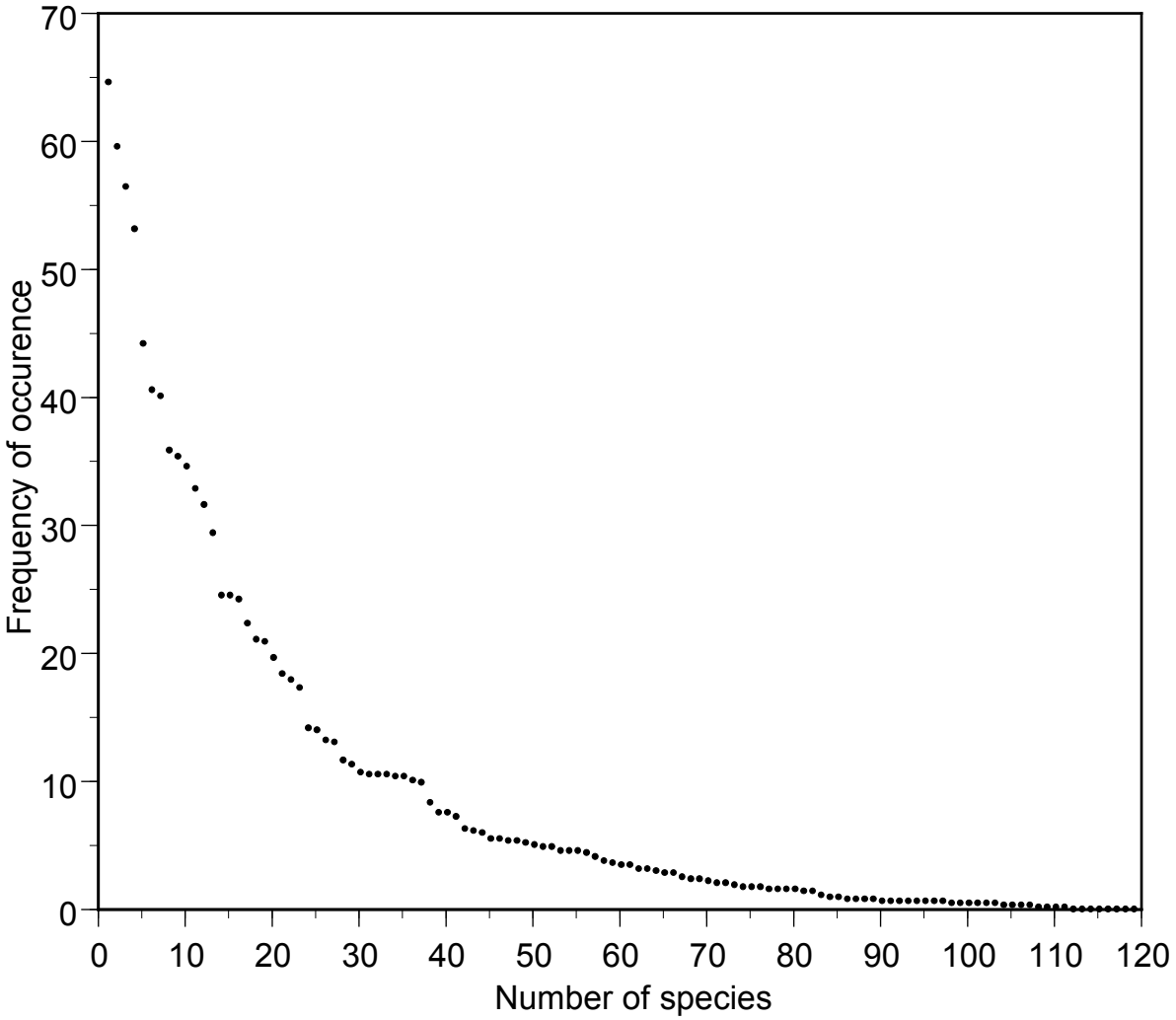

Figure 1.−Frequency of occurrence of Michigan fishes in collections, 1993-2001.

Figure 2.−Michigan counties.

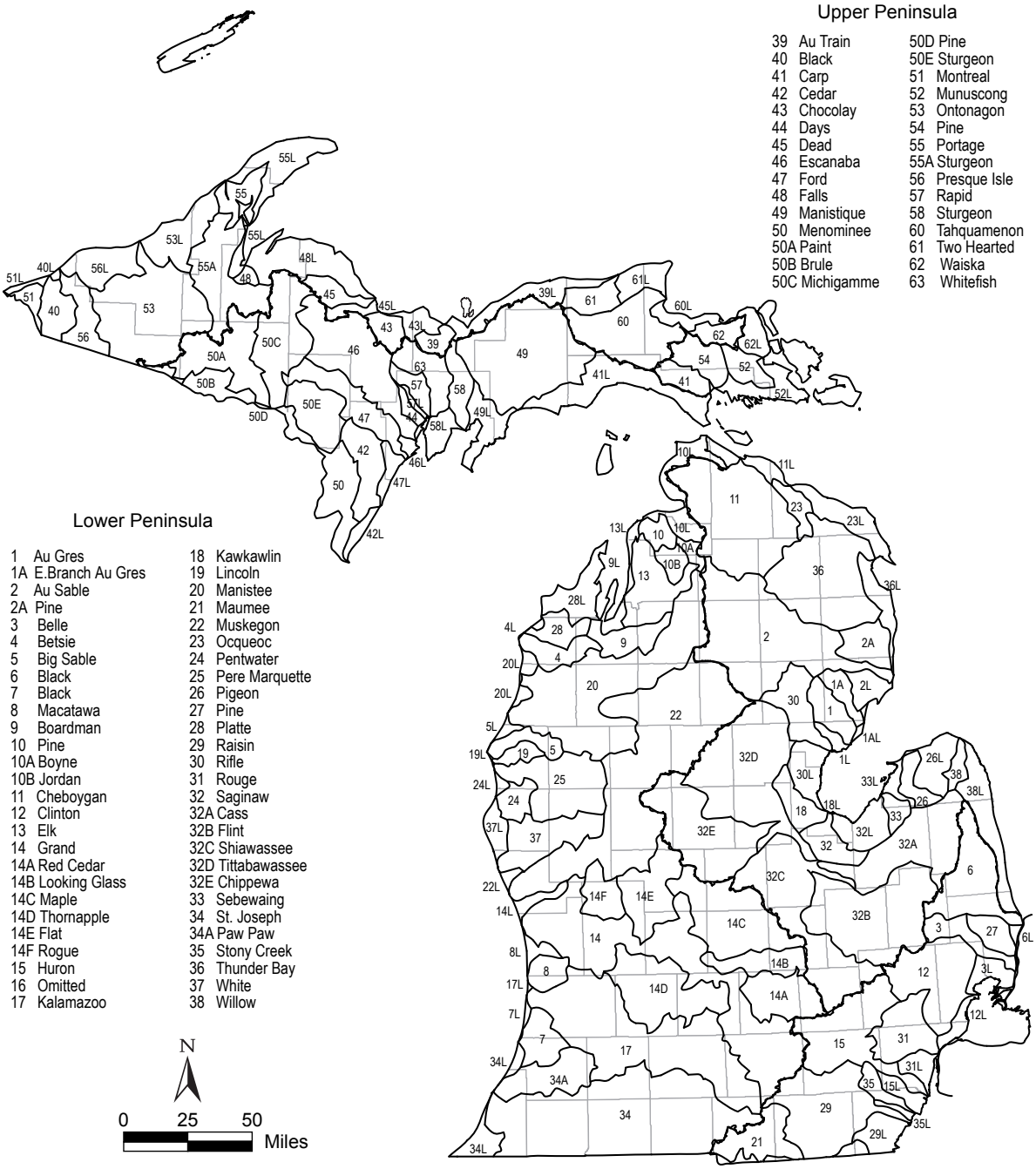

Figure 3.−Michigan's major watersheds.

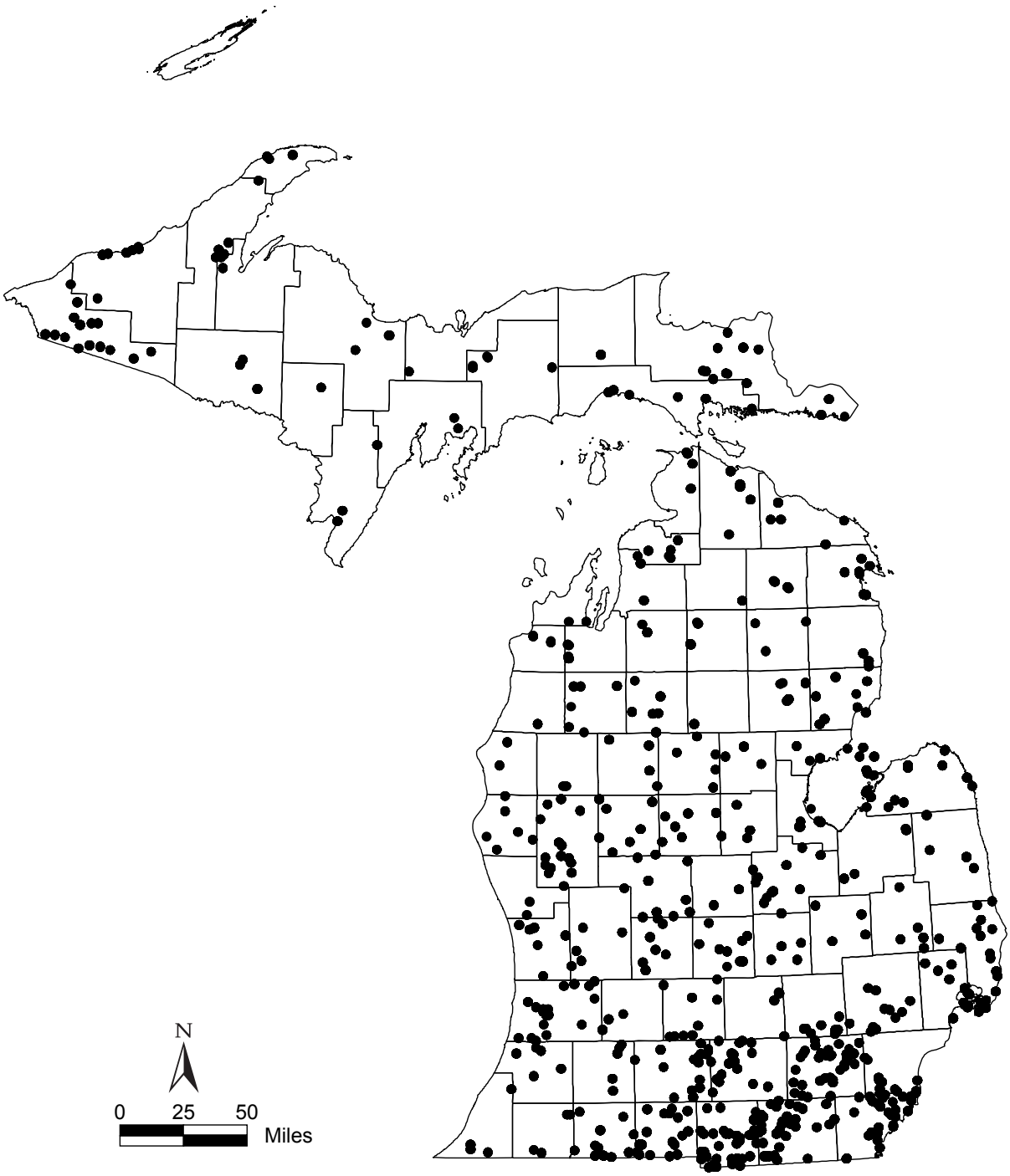

Figure 4.−Total number of fish collection sites visited, by county, 1993-2001.

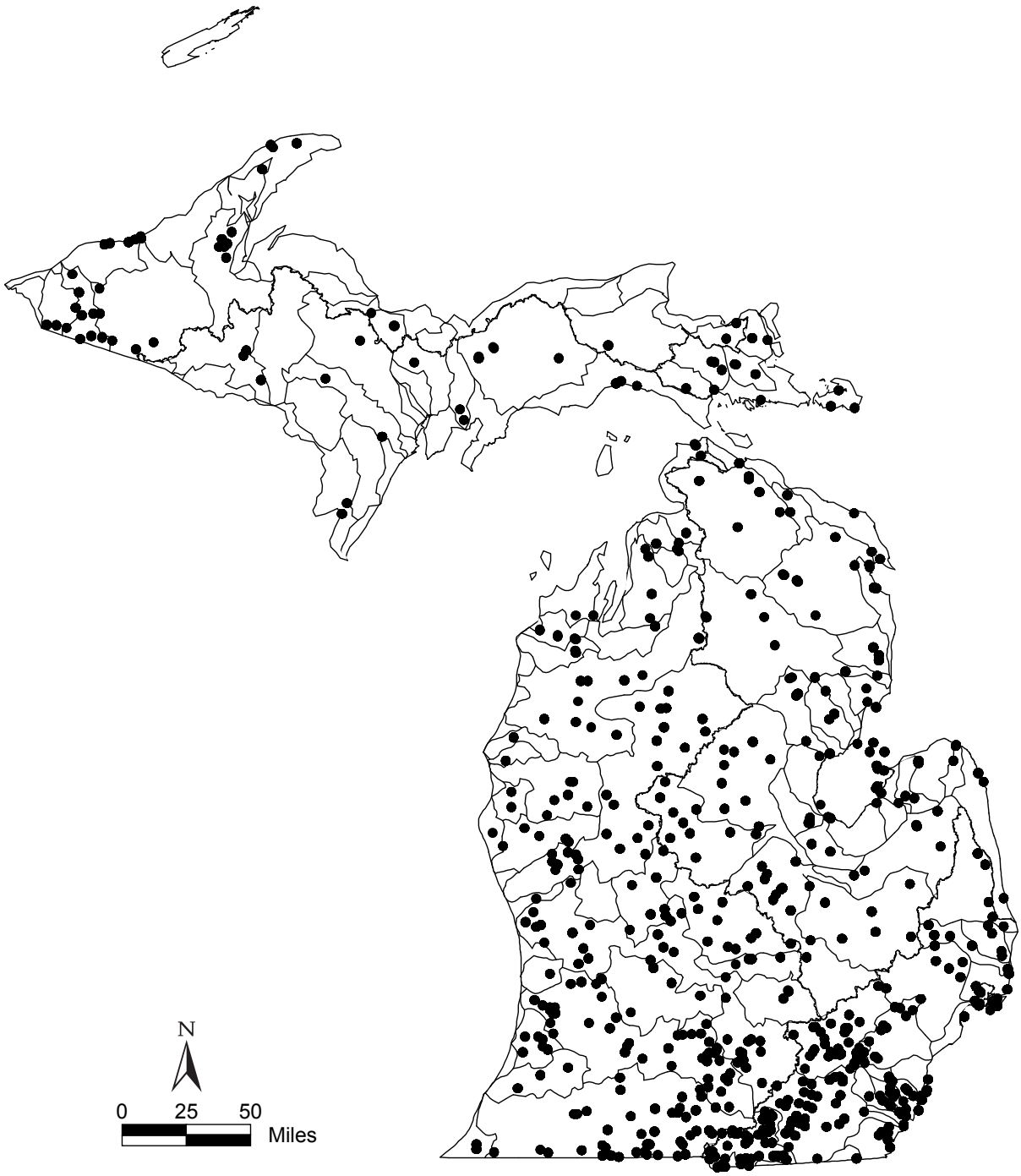

Figure 5.−Total number of fish collection sites visited, by watershed, 1993-2001.

Table 1.–Endangered, threatened, extirpated (or extinct), and special-concern fishes of Michigan as of 1999.

Common name	Scientific name
Endangered	
Redside dace	*Clinostomus elongatus*
Silver shiner	*Notropis photogenis*
Pugnose minnow	*Opsopoeodus emiliae*
Southern redbelly dace	*Phoxinus erythrogaster*
Creek chubsucker	*Erimyzon oblongus*
Northern madtom	*Noturus stigmosus*
Channel darter	*Percina copelandi*
River darter	*Percina shumardi*
Threatened	
Lake sturgeon	*Acipenser fulvescens*
Mooneye	*Hiodon tergisus*
River redhorse	*Moxostoma carinatum*
Lake herring	*Coregonus artedi*
Shortjaw cisco	*Coregonus zenithicus*
Eastern sand darter	*Ammocrypta pellucida*
Sauger	*Sander canadensis*
Extirpated (or extinct)	
Paddlefish	*Polyodon spathula*
Bigeye chub	*Notropis amblops*
Ironcolor shiner	*Notropis chalybaeus*
Weed shiner	*Notropis texanus*
Deepwater cisco	*Coregonus johannae* (extinct)
Blackfin cisco	*Coregonus nigripinnis* (extinct)
Shortnose cisco	*Coregonus reighardi* (extinct)
Arctic grayling	*Thymallus arcticus*
Bluepike	*Sander glaucus* (extinct)
Special-concern	
Spotted gar	*Lepisosteus oculatus*
Silver chub	*Macrhybopsis storeriana*
Pugnose shiner	*Notropis anogenus*
Brindled madtom	*Noturus miurus*
Black buffalo	*Ictiobus niger*
Siskiwit Lake cisco	*Coregonus bartletti*
Ives Lake cisco	*Coregonus hubbsi*
Kiyi	*Coregonus kiyi*
Starhead topminnow	*Fundulus dispar*
Spoonhead sculpin	*Cottus ricei*
Banded darter	*Etheostoma zonale*

Table 2.–Michigan's guidelines for defining endangered, threatened, extirpated, and special-concern species**.**

TECHNICAL ADVISORY COMMITTEE

GUIDELINES FOR LISTING ENDANGERED, THREATENED, PROBABLY EXTIRPATED AND SPECIAL-CONCERN SPECIES IN MICHIGAN

February, 1986

DEFINITIONS IN THE MICHIGAN ENDANGERED SPECIES LAW

ENDANGERED: A species "which is in danger of extinction throughout all or a significant portion of its range".

THREATENED: A species "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range".

GUIDELINES FOR ENDANGERED STATUS

A. Considered by the Secretary of the Interior to be endangered in the United States.

or

B. Extreme rarity in Michigan meeting one of the following three population criteria:

1. There are estimated to be 3[1] or fewer viable (stable or expanding) reproducing populations separated by unfavorable habitat in Michigan;

or

2. There are estimated to be fewer than 100 reproducing individuals in the state;

or

3. Extreme rarity throughout its range: known recently (last 20 years) from 20 or fewer sites through its entire range;

and one of the following secondary conditions:

1. The species has declined seriously and noncyclically throughout a significant portion of its range;

or

2. Endemism or near-endemism to Michigan;

or

3. Special factors cause this species to be unusually vulnerable to extirpation, e.g. danger of exploitation, highly specialized requirements, or sensitive habitat.

GUIDELINES FOR THREATENED STATUS

A. Considered by the Secretary of the Interior to be threatened in the United States.

or

B. Rarity throughout its range: known recently (last 20 years) from 60 or fewer sites in its entire range with known decline or demonstrable threat to Michigan populations.

Table 2.–Continued.

or

C. Extreme rarity in Michigan, but not meeting one of the three secondary conditions for endangered status; not recently adventive to the state; and with a demonstrable threat to Michigan populations.

or

D. Rarity in Michigan meeting one of the following four population criteria and not recently adventive in the state:

1. There are estimated to be 10 or fewer viable (stable or expanding) reproducing populations separated by unfavorable habitat in Michigan;

or

2. There are estimated to be fewer than 300 reproducing individuals in the state;

or

3. Endemism or near-endemism in Michigan;

or

4. The species is somewhat less scarce than 1 or 2 above, but special factors cause it to be especially vulnerable to population declines and extirpation;

and one of the following secondary conditions:

1. The species has declined seriously and noncyclically in the state or Great Lakes region;

or

2. There is a demonstrable threat to all or most state populations;

or

3. The species is especially vulnerable to exploitation;

or

4. Its habitat is unusually vulnerable to loss, modification, or variations in quality (e.g. wetland, dune, lakeshore, prairie, Great Lakes island);

or

5. Low reproductive potential or success causes the species to be especially vulnerable to population declines and extirpation;

or

6. The species has an extremely localized distribution (e.g. 1 or 2 counties) and exists in vulnerable habitat.

or

E. There are no known extant or recently reported populations, but the guidelines for Extirpated status are not met.

Table 2.–Continued.

GUIDELINES FOR PROBABLY EXTIRPATED[2] STATUS

A. Repeated surveys of all specific historical localities or potential habitats have been unsuccessful.

and

B. All non-specific historical localities are at least 50 years old.

GUIDELINES FOR SPECIAL-CONCERN STATUS

A. The species appears to have undergone a serious, noncyclical decline in Michigan, such that it could become Threatened in the foreseeable future if the decline continues unchecked.

or

B. The species is sufficiently uncommon that any reduction in its population or habitat conditions would cause it to become Threatened in the foreseeable future.

or

C. The species is apparently rare in Michigan, but is on uncertain taxonomic status or identification, and further evaluation is required.

[1] Numbers are intended as guidelines only and are interpreted in light of species biology.
[2] Extirpated = Extinct in Michigan.

Table 3.–The cumulative frequency of occurrence of Michigan fishes collected in 1993–2001.

Common name (family)	Scientific name	Number of sites	Percent
Lampreys (Petromyzontidae)			
Chestnut lamprey	*Ichthyomyzon castaneus*	2	0.3
Northern brook lamprey	*Ichthyomyzon fossor*	3	0.5
Silver lamprey	*Ichthyomyzon unicuspis*	1	0.2
American brook lamprey	*Lampetra appendix*	19	3.0
Sturgeons (Acipenseridae)			
Lake sturgeon	*Acipenser fulvescens*	1	0.2
Gars (Lepisosteidae)			
Spotted gar	*Lepisosteus oculatus*	1	0.2
Longnose gar	*Lepisosteus osseus*	16	2.5
Bowfins (Amiidae)			
Bowfin	*Amia calva*	11	1.7
Herrings (Clupeidae)			
Alewife	*Alosa pseudoharengus*	17	2.7
Gizzard shad	*Dorosoma cepedianum*	19	3.0
Carps & Minnows (Cyprinidae)			
Central stoneroller	*Campostoma anomalum pullum*	158	24.8
Goldfish	*Carassius auratus*	7	1.1
Redside dace	*Clinostomus elongatus*	10	1.6
Lake chub	*Couesius plumbeus*	5	0.8
Spotfin shiner	*Cyprinella spiloptera*	126	19.8
Common carp	*Cyprinus carpio*	65	10.2
Brassy minnow	*Hybognathus hankinsoni*	24	3.8
Striped shiner	*Luxilus chrysocephalus*	64	10.1
Common shiner	*Luxilus cornutus*	282	44.3
Redfin shiner	*Lythrurus umbratilis*	32	5.0
Northern pearl dace	*Margariscus nachtriebi*	23	3.6
Hornyhead chub	*Nocomis biguttatus*	143	22.5
River chub	*Nocomis micropogon*	36	5.7
Golden shiner	*Notemigonus crysoleucas*	91	14.3
Pugnose shiner	*Notropis anogenus*	3	0.5
Emerald shiner	*Notropis atherinoides*	30	4.7
Silverjaw shiner	*Notropis buccatus*	10	1.6
Ghost shiner	*Notropis buchanani*	3	0.5
Bigmouth shiner	*Notropis dorsalis*	12	1.9
Blackchin shiner	*Notropis heterodon*	40	6.3
Blacknose shiner	*Notropis heterolepis*	73	11.5
Spottail shiner	*Notropis hudsonius*	46	7.2
Silver shiner	*Notropis photogenis*	5	0.8
Rosyface shiner	*Notropis rubellus*	54	8.5
Sand shiner	*Notropis stramineus*	85	13.4
Mimic shiner	*Notropis volucellus*	68	10.7
Pugnose minnow	*Opsopoeodus emiliae*	1	0.2

Table 3.–Continued.

Common name (family)	Scientific name	Number of sites	Percent
Suckermouth minnow	*Phenacobius mirabilis*	2	0.3
Northern redbelly dace	*Phoxinus eos*	68	10.7
Finescale dace	*Phoxinus neogaeus*	16	2.5
Bluntnose minnow	*Pimephales notatus*	339	53.3
Fathead minnow	*Pimephales promelas*	135	21.2
Longnose dace	*Rhinichthys cataractae*	49	7.7
Blacknose dace	*Rhinichthys obtusus*	210	33.0
Creek chub	*Semotilus atromaculatus*	360	56.6
Suckers (Catostomidae)			
Quillback	*Carpiodes cyprinus*	11	1.7
Longnose sucker	*Catostomus catostomus*	4	0.6
White sucker	*Catostomus commersonii*	380	59.7
Lake chubsucker	*Erimyzon sucetta*	36	5.7
Northern hog sucker	*Hypentelium nigricans*	116	18.2
Spotted sucker	*Minytrema melanops*	5	0.8
Silver redhorse	*Moxostoma anisurum*	12	1.9
Black redhorse	*Moxostoma duquesnei*	8	1.3
Golden redhorse	*Moxostoma erythrurum*	41	6.4
Shorthead redhorse	*Moxostoma macrolepidotum*	6	0.9
Greater redhorse	*Moxostoma valenciennesi*	4	0.6
Bullhead catfishes (Ictaluridae)			
Black bullhead	*Ameiurus melas*	25	3.9
Yellow bullhead	*Ameiurus natalis*	69	10.8
Brown bullhead	*Ameiurus nebulosus*	23	3.6
Channel catfish	*Ictalurus punctatus*	12	1.9
Stonecat	*Noturus flavus*	27	4.2
Tadpole madtom	*Noturus gyrinus*	39	6.1
Brindled madtom	*Noturus miurus*	5	0.8
Pikes (Esocidae)			
Grass pickerel	*Esox americanus vermiculatus*	90	14.2
Northern pike	*Esox lucius*	68	10.7
Muskellunge	*Esox masquinongy*	2	0.3
Mudminnows (Umbridae)			
Central mudminnow	*Umbra limi*	229	36.0
Smelts (Osmeridae)			
Rainbow smelt	*Osmerus mordax*	11	1.7
Trouts (Salmonidae)			
Lake whitefish	*Coregonus clupeaformis*	1	0.2
Coho salmon	*Oncorhynchus kisutch*	5	0.8
Rainbow trout	*Oncorhynchus mykiss*	30	4.7
Chinook salmon	*Oncorhynchus tshawytscha*	7	1.1
Brown trout	*Salmo trutta*	35	5.5
Brook trout	*Salvelinus fontinalis*	33	5.2

Table 3.–Continued.

Common name (family)	Scientific name	Number of sites	Percent
Trout perches (Percopsidae)			
Trout-perch	*Percopsis omiscomaycus*	20	3.1
Pirate perches (Aphredoderidae)			
Pirate perch	*Aphredoderus sayanus*	21	3.3
Cods (Gadidae)			
Burbot	*Lota lota*	4	0.6
Killifishes (Fundulidae)			
Banded killifish	*Fundulus diaphanous menona*	32	5.0
Starhead topminnow	*Fundulus dispar*	4	0.6
Blackstripe topminnow	*Fundulus notatus*	13	2.0
Silversides (Atherinidae)			
Brook silverside	*Labidesthes sicculus*	35	5.5
Sticklebacks (Gasterosteidae)			
Brook stickleback	*Culaea inconstans*	115	18.1
Threespine stickleback	*Gasterosteus aculeatus*	4	0.6
Ninespine stickleback	*Pungitius pungitius*	1	0.2
Sculpins (Cottidae)			
Mottled sculpin	*Cottus bairdii*	188	29.6
Slimy sculpin	*Cottus cognatus*	14	2.2
Striped basses (Moronidae)			
White perch	*Morone americana*	21	3.3
White bass	*Morone chrysops*	6	0.9
Sunfishes (Centrarchidae)			
Rock bass	*Ambloplites rupestris*	221	34.7
Green sunfish	*Lepomis cyanellus*	226	35.5
Pumpkinseed	*Lepomis gibbosus*	202	31.8
Warmouth	*Lepomis gulosus*	34	5.3
Orangespotted sunfish	*Lepomis humilis*	1	0.2
Bluegill	*Lepomis macrochirus*	259	40.7
Northern longear sunfish	*Lepomis peltastes*	49	7.7
Redear sunfish	*Lepomis microlophus*	2	0.3
Smallmouth bass	*Micropterus dolomieu*	118	18.6
Largemouth bass	*Micropterus salmoides*	256	40.3
White crappie	*Pomoxis annularis*	6	0.9
Black crappie	*Pomoxis nigromaculatus*	67	10.5

Table 3.–Continued.

Common name (family)	Scientific name	Number of sites	Percent
Perches (Percidae)			
Western sand darter	*Ammocrypta clara*	1	0.2
Eastern sand darter	*Ammocrypta pellucida*	5	0.8
Greenside darter	*Etheostoma blennioides*	84	13.2
Rainbow darter	*Etheostoma caeruleum*	134	21.1
Iowa darter	*Etheostoma exile*	67	10.5
Barred fantail darter	*Etheostoma flabellare flabellare*	30	4.7
Striped fantail darter	*Etheostoma flabellare lineolatum*	4	0.6
Least darter	*Etheostoma microperca*	29	4.6
Johnny darter	*Etheostoma nigrum*	412	64.8
Orangethroat darter	*Etheostoma spectabile*	5	0.8
Banded darter	*Etheostoma zonale*	3	0.5
Yellow perch	*Perca flavescens*	157	24.7
Northern logperch	*Percina caprodes semifasciata*	75	11.8
Channel darter	*Percina copelandi*	6	0.9
Blackside darter	*Percina maculata*	155	24.4
Walleye	*Sander vitreus*	14	2.2
Drums (Sciaenidae)			
Freshwater drum	*Aplodinotus grunniens*	11	1.7
Gobies (Gobiidae)			
Round goby	*Neogobius melanostomus*	15	2.4
Tubenose goby	*Proterorhinus marmoratus*	5	0.8

Table 4.–Global and state conservation status ranks defined by NatureServe (Association for Biodiversity Information).

Rank	Definition
	Global Conservation Status
GX	Presumed Extinct (species) – Believed to be extinct throughout its range. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
GH	Possibly Extinct (species) – Known from only historical occurrences, but may nevertheless still be extant; further searching needed.
G1	Critically Imperiled – Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. Typically 5 or fewer occurrences or very few remaining individuals (<1,000) or acres (<2,000) or linear miles (<10).
G2	Imperiled – Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction or elimination. Typically 6 to 20 occurrences or few remaining individuals (1,000 to 3,000) or acres (2,000 to 10,000) or linear miles (10 to 50).
G3	Vulnerable – Vulnerable globally either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extinction or elimination. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.
G4	Apparently Secure – Uncommon but not rare (although it may be rare in parts of its range, particularly on the periphery), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long–term concern. Typically more than 100 occurrences and more than 10,000 individuals.
G5	Secure – Common, widespread, and abundant (although it may be rare in parts of its range, particularly on the periphery). Not vulnerable in most of its range. Typically with considerably more than 100 occurrences and more than 10,000 individuals.
GU	Unrankable – Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. NOTE: Whenever possible, the most likely rank is assigned and the question mark qualifier is added (e.g., G2?) to express uncertainty, or a range rank (e.g., G2G3) is used to delineate the limits (range) of uncertainty.
G?	Unranked – Global rank not yet assessed.
Q	Questionable taxonomy that may reduce conservation priority – Distinctiveness of this entity as a taxon at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon in another taxon, with the resulting taxon having a lower–priority (numerically higher) conservation status rank.

Table 4.–Continued.

Rank	Definition
	State Conservation Status
SX	Presumed Extirpated – Element is believed to be extirpated from the state (province). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
SH	Possibly Extirpated (Historical) – Element occurred historically in the state (province), and there is some expectation that it may be rediscovered. Its presence may not have been verified in the past 20 years. An element would become SH without such a 20–year delay if the only known occurrences in a state (province) were destroyed or if it had been extensively and unsuccessfully looked for. Upon verification of an extant occurrence, SH–ranked elements would typically receive an S1 rank. The SH rank should be reserved for elements for which some effort has been made to relocate occurrences, rather than simply using this rank for all elements not known from verified extant occurrences.
S1	Critically Imperiled – Critically imperiled in the state (province) because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state (province). Typically 5 or fewer occurrences or very few remaining individuals (<1,000).
S2	Imperiled – Imperiled in the state (province) because of rarity or because of some factor(s) making it very vulnerable to extirpation from the nation or subnation. Typically 6 to 20 occurrences or few remaining individuals (1,000 to 3,000).
S3	Vulnerable – Vulnerable in the state (province) either because rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.
S4	Apparently Secure – Uncommon but not rare, and usually widespread in the state (province). Possible cause of long–term concern. Usually more than 100 occurrences and more than 10,000 individuals.
S5	Secure – Common, widespread, and abundant in the state (province). Essentially ineradicable under present conditions. Typically with considerably more than 100 occurrences and more than 10,000 individuals.
S?	Unranked – State (province) rank not yet assessed.
SU	Unrankable – Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
S#S#	Range Rank – A numeric range rank (e.g., S2S3) is used to indicate the range of uncertainty about the exact status of the element. Ranges cannot skip more than one rank (e.g., SU should be used rather than S1S4).
SRF	Reported Falsely – Element erroneously reported in the state (province) (e.g., misidentified specimen) and the error has persisted in the literature.

Table 5.–Global and state (province) ranks for Michigan's endangered, threatened, extirpated (or extinct), and special-concern fishes. Dash (–) indicates non-occurrence.

Species	States and province[1]						
	Global	WI	IL	IN	OH	ONT	MI
Endangered							
Redside dace	G4	S3	–	S1	S?	S3	S1, S2
Silver shiner	G5	S2, S3	–	S4	S?	S2, S3	S1
Pugnose minnow	G5	S3	S2, S3	S2	S1	S2	S1
Southern redbelly dace	G5	S4	S4, S5	S3	S?	–	S1
Creek chubsucker	G5	SX	S5	S4, S5	S3, S4	–	S1, S2
Northern madtom	G3	–	SH	S1	S1, S2	S1, S2	S1
Channel darter	G4	–	–	S2	S2	S2	S1, S2
River darter	G5	S4	S2, S3	S4	S1	S3	S1
Threatened							
Lake sturgeon	G3, G4	S3	S2	S1	S2, S3	S3	S2
Mooneye	G5	S4	S2, S3	S4	S3?	S4	S2
River redhorse	G4	S2, S3	S2	S3	S3	S2	S1
Lake herring	G5	S3	S1?	S2	S1	S5	S3
Shortjaw cisco	G3	S2, S3	SX	S1	–	S2	S2
Eastern sand darter	G3	–	S1	S2	S3	S2	S1, S2
Sauger	G5	S4	S4	S4	S?	S4	S1
Extirpated (or extinct)							
Paddlefish	G4	S2?	S2, S3	S3	S2	SX	SX
Bigeye chub	G5	–	S1	S2	S3	–	SH
Ironcolor shiner	G4	SX	S2	S4	–	–	S1
Weed shiner	G5	S2, S3	S1, S2	S2	–	–	S1
Deepwater cisco	GX	SX	SX	SX	–	SX	SX
Blackfin cisco	GXQ	SRF	SX	SX	–	SX	SX
Shortnose cisco	G1	SH	SX	SX	–	SX	SH
Arctic grayling	G5	–	–	–	–	–	SX
Blue pike	GXQ	–	–	–	SX	SX	SX
Special–concern							
Spotted gar	G5	–	S2, S3	S4	S1	S2	S2, S3
Silver chub	G5	SU	S5	S4	S3	S2	S2, S3
Pugnose shiner	G3	S2, S3	S1	S1	SX	S2	S3
Brindled madtom	G5	–	S3	S3	S?	S2	S2, S3
Black buffalo	G5	S2?	S2, S3	S2	S?	SU	S3
Siskiwit Lake cisco	GHQ	–	–	–	–	–	S1
Ives Lake cisco	G1Q	–	–	–	–	–	S1
Kiyi	G3	S2, S3	SRF	S1	–	S3?	S3
Starhead topminnow	G4	S2	S2	S4	–	–	S2
Spoonhead sculpin	G5	S4	SH	–	SX	SX	S3
Banded darter	G5	S4	S3	S4	S?	–	S1

[1] WI - Wisconsin, IL - Illinois, IN - Indiana, OH - Ohio, ONT - Ontario, and MI - Michigan

Table 6.–Classification (current and recommended reclassification) and recovery action proposed for Michigan fishes considered endangered, threatened, extirpated, or special-concern.

Species	Classification	Recovery action proposed
Endangered		
Redside dace *Clinostomus elongatus*	Endangered; see Category B1, and 1 and 3 under Guidelines for Endangered Status	Protect; consider planting in new suitable sites if existing populations will not be harmed by some removal and fauna of new sites will not be jeopardized by an additional species
Silver shiner *Notropis photogenis*	Endangered; see Category B1, and 1 and 3 under Guidelines for Endangered Status	Protect; consider planting in historical site where species no longer exists if existing populations will not be harmed by some removal
Pugnose minnow *Opsopoeodus emiliae*	Endangered; see Category B2, and 1 and 3 under Guidelines for Endangered Status	Protect; existing population too small to consider any manipulation
Southern redbelly dace *Phoxinus erythrogaster*	Endangered; see Category B2, and 1 and 3 under Guidelines for Endangered Status	Protect; existing population too small to consider any manipulation
Creek chubsucker *Erimyzon oblongus*	Endangered; see Category B2, and 1 and 3 under Guidelines for Endangered Status	Protect; existing population too small to consider any manipulation
Northern madtom *Noturus stigmosus*	Endangered; see Category B1, and 1 and 3 under Guidelines for Endangered Status	Protect; if existing population is substantial, plant fish from there in historical site
Channel darter *Percina copelandi*	Endangered; see Category B1, and 1 and 3 under Guidelines for Endangered Status	Protect from adverse land use, pollution, competition/predation
River darter *Percina shumardi*	Endangered; see Category B2, and 1 and 3 under Guidelines for Endangered Status	Protect; existing population too small to consider any manipulation
Threatened		
Lake sturgeon *Acipenser fulvescens*	Threatened; see Category D1 and 1 under Guidelines for Threatened Status	Protect, remove dams, improve habitat, culture, plant in new suitable and historical sites; see lake sturgeon rehabilitation strategy (Hay-Chmielewski and Whelan 1997)
Mooneye *Hiodon tergisus*	Threatened; see Category D1 and 1 under Guidelines for Threatened Status	Protect from adverse land use, pollution, competition/predation
River redhorse *Moxostoma carinatum*	Threatened; see Category D1 and 4 under Guidelines for Threatened Status	Protect from adverse land use, pollution, competition/predation

Table 6.–Continued.

Species	Classification	Recovery action proposed
Lake herring *Coregonus artedi*	Threatened in Great Lakes, see Category D4 and 1 under Guidelines for Threatened Status. Special-concern in inland lakes; see Category B under Guidelines for Special-concern Status	Protect from adverse land use, pollution, competition/predation (Latta 1995b)
Shortjaw cisco *Coregonus zenithicus*	Threatened; see Category B under Guidelines for Threatened Status	Protect from adverse land use, pollution, competition/predation
Eastern sand darter *Ammocrypta pellucida*	Threatened; see Category D1 and 4 under Guidelines for Threatened Status	Protect from adverse land use, pollution, competition/predation
Sauger *Sander canadensis*	Threatened; see Category D1, 1 under Guidelines for Threatened Status	Protect from adverse land use, pollution, competition/predation. Remove dams, consider stocking from native fish.
Extirpated (or extinct)		
Paddlefish *Polyodon spathula*	Extirpated; see Guidelines for Probably Extirpated Status	None; probably was a naturally declining population in Great Lakes
Bigeye chub *Notropis amblops*	Extirpated; see Guidelines for Probably Extirpated Status	None; unable to replace gene pool for Michigan population
Ironcolor shiner *Notropis chalybaeus*	Extirpated; as above	Consider planting historical sites with fish from Indiana
Weed shiner *Notropis texanus*	Extirpated; as above	None; unable to replace gene pool for Michigan population
Deepwater cisco *Coregonus johannae*	Extinct	None; species was endemic to Great Lakes
Blackfin cisco *Coregonus nigripinnis*	Extinct	None; species was endemic to Great Lakes. Probably synonymous with *C. artedi*
Shortnose cisco *Coregonus reighardi*	Extirpated; see Category A under Guidelines for Probably Extirpated Status	None; species endemic to Great Lakes, probably extinct
Arctic grayling *Thymallus arcticus*	Extirpated; see Guidelines for Probably Extirpated Status	None; repeated attempts to reintroduce species into Michigan have failed (Nuhfer 1992)

Table 6.–Continued.

Species	Classification	Recovery action proposed
Bluepike *Sander glaucus*	Extinct	None; species or stock was endemic to Great Lakes
Special-concern		
Spotted gar *Lepisosteus oculatus*	Remove from list; populations identified in 16 lakes and a river	None needed
Silver chub *Macrhybopsis storeriana*	Special-concern; see Category B under Guidelines for Special-concern Status	Protect from adverse land use, pollution, competition/predation
Pugnose shiner *Notropis anogenus*	Change to Threatened; see Category D1and 1 under Threatened Status; only three populations found in sampling 1993–2001.	Protect from adverse land use, pollution, competition/predation
Brindled madtom *Noturus miurus*	Special-concern; see Category B under Guidelines for Special-concern status	Protect from adverse land use, pollution, competition/predation
Black buffalo *Ictiobus niger*	Special-concern; see Category B under Guidelines for Special-concern status	Protect from adverse land use, pollution, competition/predation
Siskiwit Lake cisco *Coregonus bartletti*	Remove from list; synonymous with shortjaw cisco *(Coregonus zenithicus)*	None
Ives Lake cisco *Coregonus hubbsi*	Remove from list; synonymous with lake herring *(Coregonus artedi)*	None
Kiyi *Coregonus kiyi*	Special-concern; see Category A under Guidelines for Special-concern Status	Protect from adverse land use, pollution, competition/predation
Starhead topminnow *Fundulus dispar*	Special-concern; see Category B under Guidelines for Special-concern Status	Protect from adverse land use, pollution, competition/predation
Spoonhead sculpin *Cottus ricei*	Special-concern; see Category A under Guidelines for Special-concern Status	Protect from adverse land use, pollution, competition/predation
Banded darter *Etheostoma zonale*	Special-concern; see Category B under Guidelines for Special-concern Status	Protect from adverse land use, pollution, competition/predation

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