Diversity, Distribution, and Conservation Status of the Native Freshwater Fishes of the Southern United States

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ABSTRACT

The Southeastern Fishes Council Technical Advisory Committee reviewed the diversity, distribution, and status of all native freshwater and diadromous fishes across 51 major drainage units of the southern United States. The southern United States supports more native fishes than any area of comparable size on the North American continent north of Mexico, but also has a high proportion of its fishes in need of conservation action. The review included 662 native freshwater and diadromous fishes and 24 marine fishes that are significant components of freshwater ecosystems. Of this total, 560 described, freshwater fish species are documented, and 49 undescribed species are included provisionally pending formal description. Described subspecies (86) are recognized within 43 species, 6 fishes have undescribed subspecies, and 9 others are recognized as complexes of undescribed taxa. Extinct, endangered, threatened, or vulnerable status is recognized for 28% (187 taxa) of southern freshwater and diadromous fishes. To date, 3 southern fishes are known to be extinct throughout their ranges, 2 are extirpated from the study region, and 2 others may be extinct. Of the extant southern fishes, 41 (6%) are regarded as endangered, 46 (7%) are regarded as threatened, and 101 (15%) are regarded as vulnerable. Five marine fishes that frequent fresh water are regarded as vulnerable. Our assessment represents a 75% increase in jeopardized southern fishes since 1989 and a 125% increase in 20 years. The trend for fishes in the southern United States is clear; jeopardized fishes are successively being moved from the vulnerable category to that of imminent threat of extinction.

The southern United States has the richest fish diversity and highest number of endemic fishes in North America north of Mexico (Burr and Mayden 1992; Warren et al. 1997). Unfortunately, this region also has a high proportion of its fish fauna threatened with extinction, a situation paralleled only in the arid western United States (Minckley and Deacon 1991; Warren and Burr 1994). Despite more than 150 years of research on southern fishes, scientific accounting of the ecology and taxonomy of this rich, complex fauna still continues. Over three dozen new southern fishes have been discovered, and many of these scientifically described, since publication of the last American Fisheries Society (AFS) conservation assessment (Williams et al. 1989) and AFS list of common and scientific names of fishes (Robins et al. 1991). Often, newly discovered fish taxa are on the brink of extinction (e.g., Williams and Clemmer 1991; Boschung et al. 1992; Warren et al. 1994), and the lack of critical information on their habitats and life histories precludes informed recovery efforts.

The Southeastern Fishes Council (SFC), modeled after the Desert Fishes Council (Pister 1991), is an organization of fisheries professionals dedicated to the conservation of fishes in the southern United States. The Council recognized a need to provide up-to-date taxonomic, distributional, and conservation information on southern U.S. fishes due to two factors related to dissemination of science-based information. First, research on taxonomy, distribution, and status of fishes, whether involving descriptions of new taxa, the backlog of undescribed taxa, or distributional surveys, is not usually readily available nor consulted and understood by the public, natural resource managers, or policy makers. In the southern states, this communication lapse is exacerbated by the sheer number of native fishes, the rapidity of taxonomic discovery, the backlog of taxa awaiting formal description or additional analysis, and the growing numbers of jeopardized fishes. Second, the U.S. Fish and Wildlife Service (USFWS) discontinued the designation of Category 2 species as candidates for listing under the Endangered Species Act of 1973, as amended (USFWS 1996). The USFWS emphasized, however, that information derived from "States, and other private and public interests" would be sought on species in need of protection and these information sources would serve as "the pool from which future candidates for listing" are drawn (USFWS 1996). To bridge the information gap from

scientific discovery to management and policy, the SFC sought to provide in summary form the best available science-based information on the diversity, distribution, and status of southern fishes. In 1997, the SFC Technical Advisory Committee was charged with reviewing the southern fish fauna. Acting upon that charge, the Technical Advisory Committee compiled available data on southern U.S. fishes and is responsible for the resulting conclusions. The SFC views dissemination of this information as critical to the management, integrity, and ultimate survival of the southern U.S. fish fauna.

The AFS has provided a leadership forum for the development and communication of professionally derived conservation status designations for North American fishes (Deacon et al. 1979; Williams et al. 1989), freshwater mussels (Williams et al. 1993), and crayfishes (Taylor et al. 1996). Using the AFS efforts as a template, our purposes are to assess potential and realized diversity of southern fishes, to provide distributions of fishes within major southern hydrologic units, and to assign conservation status to all native fishes of the southern United States.

Imperilment: patterns, causes, and challenges

Decline of native fishes in the southern United States generally is attributable to pervasive, complex habitat degradation across the landscape that both reduces and fragments ranges and increases isolation of fish populations (Angermeier 1995; Warren et al. 1997). Human-induced impacts to southern aquatic systems are similar to those repeatedly cited for fish declines or losses across the United States and worldwide (Moyle and Leidy 1992; Stiassny 1996; Richter et al. 1997). Physical habitat alteration in the form of channelization, impoundment, sedimentation, and flow modification are frequently associated with species declines and continue to threaten southern fishes (Walsh et al. 1995; Etnier 1997; Burkhead et al. 1997). Because so many southern fishes are geographically restricted and isolated endemics (Burr and Mayden 1992; Warren and Burr 1994), many are vulnerable to extirpation from even very localized degradation of aquatic habitats (Burkhead et al. 1997). Other fishes occur in several major river drainages but have been reduced in distribution to the point that their ranges are fragmented and existing populations have no avenues for dispersal.

Recent analyses of extirpated and imperiled southern fishes have highlighted specific ecological attributes and habitat affinities that are associated disproportionately with imperilment. Specialization for benthic habitats, especially prominent among darters and madtom catfishes, spring habitats, small to medium-size river habitats, and anadromy are associated consistently with disproportionate imperilment and extirpation (Angermeier 1995; Etnier 1997; Warren et al. 1997). Benthic habitats are predictably affected first by long-term, cumulative impacts on aquatic systems. Springs in the southern United States have undergone dramatic human-induced alterations for water withdrawals or have been inundated by artificial impoundment (Bowles and Arsuffi 1993; Etnier 1997). Small to medium-size rivers of the region have been dammed and channelized extensively (Soballe et al. 1992), are subjected to urban sprawl (Burkhead et al. 1997), and/or are recipients of point (e.g., Fenholloway River, FL; Gilbert 1992) and nonpoint source pollutants (e.g., Etowah River, GA; Burkhead et al. 1997). Nearly all large rivers in the southern United States are dammed (Dynesius and Nilsson 1994) and existing large river dams and associated flow alterations have reduced or precluded spawning runs of many anadromous species (Angermeier 1995; Burkhead et al. 1997). Importantly, we emphasize that imperilment is not constrained to a particular taxonomic group of southern fishes nor a particular river basin. Research clearly has shown that population decline and range shrinkage are widespread across taxonomic groups of fishes and among river basins in the region (Angermeier 1995; Warren et al. 1997).

Rapid population growth and concomitant increases in consumption of natural resources in the southern United States are the greatest challenges to aquatic resource management and dictate what we can do now and what we will be able to do in the future to conserve southern fishes (Noss and Peters 1995; Folkerts 1997; Cordell et al. 1998). Southern aquatic biota face multiple threats as development of land and water resources continues to accelerate to accommodate population growth of 84% from 1950 to 1990. Most of this growth occurred in the last 20 years (Cordell et al. 1998; Wear et al. 1998). Population growth is the underlying cause for efforts to build more dams (e.g., Locust Fork of Black Warrior River, AL), for continuous proposals for channel maintenance dredging (e.g., White River, AR), for major interbasin transfers of water for metropolitan areas (e.g., Mobile basin to Apalachicola-Chattahoochee River, AL, FL, GA), for over-pumping of major aquifers that feed vital and diverse aquatic habitats (e.g., Edwards Aquifer, TX; Bowles and Arsuffi 1993), and for diminishment of once-rich, biologically productive river deltas (e.g., Mobile Delta, AL; Finch 1998). A national assessment of risk to ecosystems classified eight southern states in the "extreme risk" category (Alabama, Florida, Georgia, North and South Carolina, Tennessee, Texas, and Virginia) and two others in the "high risk" category (Mississippi and Louisiana) because of high developmental pressure, numbers of imperiled species (including fishes and freshwater mussels), and already endangered ecosystems (Noss and Peters 1995).

Land ownership patterns further confound fish conservation management in the southern United States. For example, predominantly forested watersheds support most of the biologically significant streams and rivers in the region but only 11% of the 212 million acres of forested land in the region is in public ownership (e.g., national parks and national forests) (Southern Research Station 1997). Most forested watersheds in public ownership are at high elevations with relatively limited fish diversity. As a result, and unlike the western United States, most jeopardized fishes in the southern United States are not afforded protection through federal ownership of the waters they

Table 1. List of drainage units (1–51) for the southern United States used to document distributional status of fishes. Drainage unit numbers reference Figure 1.

(1) Potomac-Rappahannock-York River unit
(2) James River unit
(3) Roanoke River unit (including Chowan River and drainages of Albemarle Sound)
(4) Tar-Neuse River unit
(5) Cape Fear River unit (including drainages of Cape Lookout south to and including Cape Fear River)
(6) Peedee River unit (including drainages from south of Cape Fear River to and including Peedee River)
(7) Santee-Cooper River unit (including drainages from south of Peedee River to and including Cooper River)
(8) Edisto-Combahee River unit (including drainages from south of Cooper River to north of Savannah River)
(9) Savannah River unit
(10) Ogeechee-Altamaha River unit (including drainages from south of the Savannah River to and including the Altamaha River)
(11) Satilla-St. Marys-St. Johns River unit (including drainages from south of the Altamaha River to and including St. Johns River)
(12) Everglades-Tampa Bay-Waccasassa River unit (including southern and western Florida drainages northwest to and including Waccasassa River)
(13) Suwannee-Aucilla-Ochlockonee River unit (including drainages northwest of Waccasassa River to east of Apalachicola Bay)
(14) Apalachicola Basin unit (including the Chipola, Chattahoochee, Flint, and Apalachicola Rivers)
(15) St. Andrew-Choctawhatchee-Pensacola bays unit (including drainages from west of Apalachicola Bay to and including Perdido River)
(16) Coosa-Tallapoosa River unit
(17) Alabama-Cahaba River unit (from Mobile Bay upstream on the Mobile, Tensaw and Alabama rivers to the confluence of the Coosa and Tallapoosa rivers)
(18) Tombigbee-Black Warrior River unit
(19) Pascagoula-Biloxi-Bay St. Louis unit (including drainages from west of Mobile Bay to east of the Pearl River)
(20) Pearl River unit
(21) Lake Pontchartrain unit (including drainages from west of Pearl River to east of Mississippi River)
(22) Minor Mississippi tributaries south unit (eastern Mississippi River tributaries from mouth of Mississippi River to south of Black River, Mississippi)
(23) Black-Yazoo River unit
(24) Minor Mississippi tributaries north unit (eastern Mississippi River tributaries from north of the Yazoo River to and including Mayfield Creek, Kentucky)
(25) Mississippi River mainstem unit
(26) Lower Tennessee River unit (from the mouth to west of Sequatchie River)
(27) Upper Tennessee River unit (including Sequatchie River and upstream)
(28) Cumberland River unit
(29) Green-Tradewater River unit (including southern Ohio River tributaries northeast of Mayfield Creek, Kentucky, to and including the Green River, Kentucky)
(30) Kentucky-Salt River unit (including southern Ohio River tributaries from east of Green River, Kentucky, to west of Licking River, Kentucky)
(31) Licking-Big Sandy River unit (including southern Ohio River tributaries from the Licking River, Kentucky, to west of the Guyandotte River, West Virginia)
(32) Kanawha-New-Guyandotte-Little Kanawha River unit (including southern Ohio River tributaries from the Guyandotte River, West Virginia, to Little Kanawha River, West Virginia)
(33) Ohio River mainstem unit (from the mouth upstream to the mouth of the Little Kanawha River, West Virginia)
(34) Delmarva Peninsula unit
(35) Missouri River mainstem unit (from the mouth upstream to the mouth of the Osage River)
(36) Osage River unit
(37) Gasconade River unit
(38) Meramec River unit
(39) St. Francis River unit (including minor western tributaries to the Mississippi River)
(40) White River unit
(41) Arkansas River unit (from the mouth upstream to Illinois-Neosho rivers unit)
(42) Illinois-Neosho River unit
(43) Ouachita River unit
(44) Red River unit (from the mouth upstream to and including the Kiamichi River)
(45) Atchafalaya Basin-Calcasieu River unit (including major and minor coastal drainages west to Sabine Lake)
(46) Sabine Lake unit (including minor coastal drainages west to Galveston Bay)
(47) Galveston Bay unit (including minor coastal drainages west to mouth of Brazos River)
(48) Brazos River unit
(49) Colorado River unit
(50) San Antonio Bay unit (including minor coastal drainages west of mouth of Colorado River to mouth of Nueces River)
(51) Nueces River unit

inhabit (Neves et al. 1997; Master et al. 1998). Nearly 70% of forested land in the region is held by nonindustrial private landowners in small parcels of one to several hundred acres (Southern Research Station 1997). These owners, many of whom are absentee owners, are diverse in their knowledge and attitudes towards the environment and their reasons for land ownership (Cordell et al. 1998). We believe these landowners and their urban counterparts must be involved and empowered to participate in the protection and restoration of southern aquatic resources, because it is in everyone's long-term interest. Recent syntheses on aquatic resources make it clear that the southern United States faces major challenges in conserving not only native fishes, but the entire, richly diverse system of streams, rivers, and wetlands of the region (Lydeard and Mayden 1995; Benz and Collins 1997; Master et al. 1998).

Methods and definitions

We included all native freshwater fishes (and selected diadromous and marine fishes) in major rivers of the southern United States. The area of coverage included all of Alabama, Arkansas, Georgia, Florida, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia, as well as the Delmarva Peninsula of Delaware and Maryland, southern West Virginia, southern Missouri, southeastern Kansas, eastern Oklahoma, and the Gulf Slope rivers of Texas, exclusive of the Rio Grande drainage (Table 1; Figure 1). We divided the region into 51 hydrologic units delimited by fish faunal similarity analyses (Burr and Warren 1986; Conner and Suttkus 1986; Cross et al. 1986; Hocutt et al. 1986; Swift et al. 1986; Matthews and Robison 1988; Warren et al. 1991; Warren et al. 1997), historical biogeography (Mayden 1988), drainage proximity and interconnectivity, and drainage into a common lake, sound, or bay (e.g., Chesapeake Bay, units 1 and 2; Albemarle and Pamlico Sounds, units 3 and 4; Lake Pontchartrain, unit 21).

We recognized all fish species and subspecies, and many known, but undescribed, fishes that occur or occurred in the region. We generally included species listed by Robins et al. (1991), Mayden et al. (1992), and Starnes (in press) and added fish taxa that have been described or resurrected from synonymy in subsequent publications. We also included many undescribed fish species (or subspecies) if they have been described or distinguished in an unpublished dissertation or published work, or for which an abstract was available that indicated there was substantial evidence of taxonomic distinctiveness. Our inclusion of undescribed taxa was provisional and in the spirit of tallying potential diversity. Our acceptance of

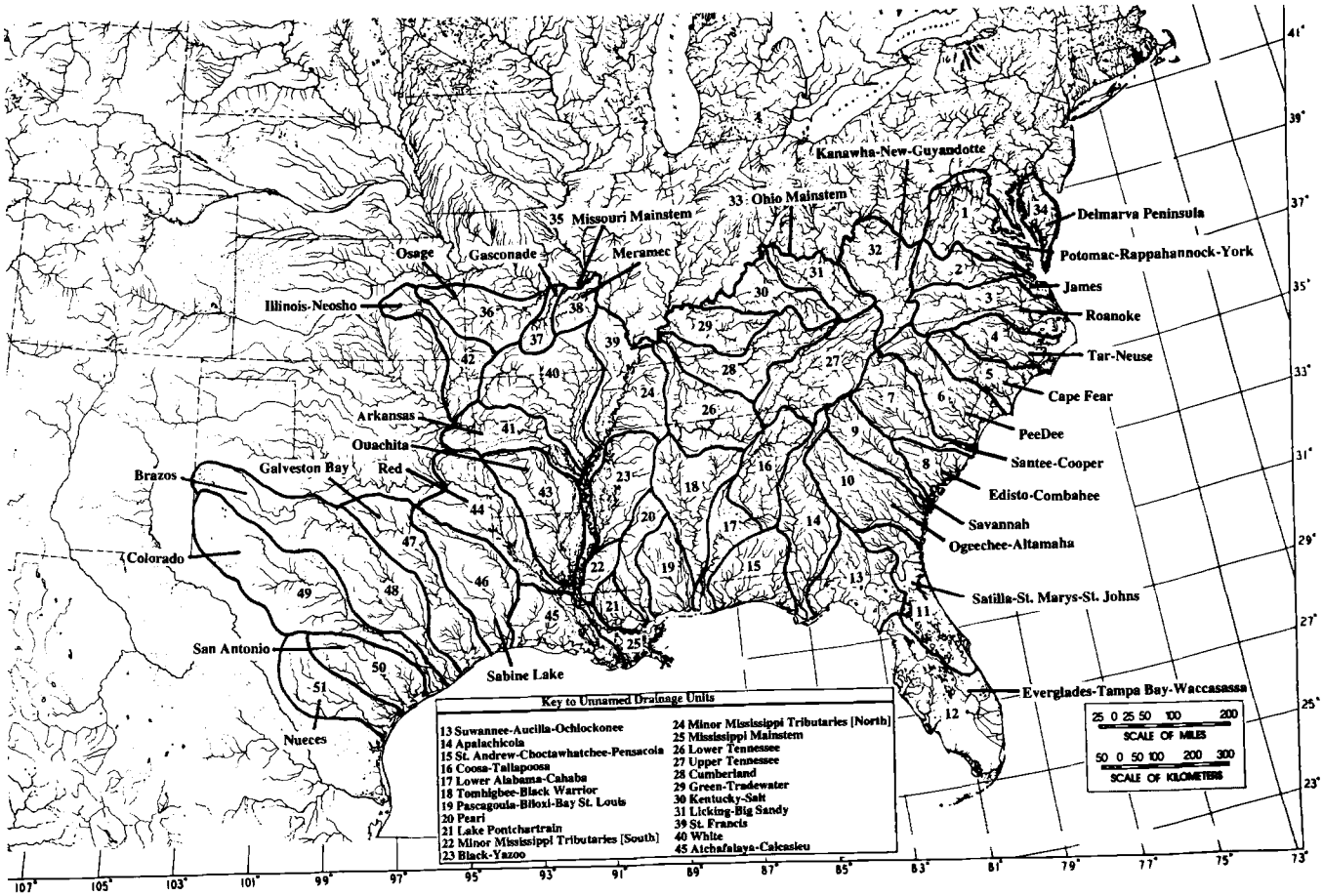

Figure 1. Drainage units (1-52) for the southern United States used to document distributional status of fishes. Drainage unit numbers reference Table 1. Drainage map courtesy of the University of Michigan Museum of Zoology.

these taxa as valid awaits peer review and publication of formal taxonomic descriptions. We differentiated among subspecies for many southern fishes in the list and considered the category of subspecies as indicative of a potential need for further taxonomic evaluation. We did not treat subspecies within the family Centrarchidae because transplants and introductions have obscured native distributions for some members of this family (e.g., bluegill, *Lepomis macrochirus*, Avise and Smith 1974; largemouth bass, *Micropterus salmoides*, Philipp et al. 1983) or because putative polytypic species are known but poorly defined geographically (e.g., longear sunfish, *Lepomis megalotis*, Bauer 1980). In a few cases, we designated a species as a complex if there was evidence that it actually is comprised of two or more forms, but taxonomic analysis was too incomplete to designate geographic ranges (e.g., *Carpiodes* spp. in Mettee et al. 1996:329–331 and Jenkins and Burkhead 1994:469). We delimited contact zones (i.e., areas of suspected intergradation or hybridization) (Wiley 1981) for many fishes. For these cases, we separated scientific names of the parental taxa with an "x" (e.g., taxon A x taxon B) and indicated drainage units of occurrence but did not assign conservation status.

We based the presence or absence and native versus nonindigenous status of fishes within a particular drainage primarily on published literature. The works of Lee et al. (1980) and Hocutt and Wiley (1986), which formed the framework for the distributional assignments, were updated from distributions presented in Page and Burr (1991), Warren et al. (1997), Fuller et al. (1999), and state fish books or checklists (Burr and Warren 1986, KY; Robison and Buchanan 1988, AR; Menhinick 1991, NC; Hubbs et al. 1991, TX; Etnier and Starnes 1993, TN; Jenkins and Burkhead 1994, VA; Stauffer et al. 1995, WV; Mettee et al. 1996, AL; Pflieger 1997, MO; Ross in press, MS). Distributions were further augmented with unpublished but verified recent records provided by committee members or other fishery professionals. These records are housed in research collections listed by Walsh and Meador (1998).

All diadromous fishes that regularly use freshwater habitats in southern U.S. waters also were included in the list of taxa. A moderate number of euryhaline, predominately nearshore marine species also commonly enter coastal rivers of the study region. We have included in our list a select number of primarily marine or brackish water species that are known or suspected to spawn in fresh water, those that commonly penetrate far inland, and/or those that are frequently common or abundant in freshwater habitats on a regular basis (e.g., Atlantic needlefish, *Strongylura marina*; Atlantic stingray, *Dasyatis sabina*; bay anchovy, *Anchoa mitchilli*; hogchoker, *Trinectes maculatus*; certain species of Gobiidae). However, we excluded a large number of species that are rare in freshwater habitats or that are generally limited to estuaries or the extreme downstream portions of rivers in their occurrence at the saltwater-freshwater boundary. The families and approximate number of species (in parentheses) represented by infrequent marine invaders of southern U.S. fresh waters that we excluded from the list are: Ariidae (2); Atherinopsidae (1); Bothidae (2); Carangidae (1); Carcharhinidae (1); Centropomidae (4); Clupeidae (4); Elopidae (2); Gerreidae (3–5); Gobiidae (4), Haemulidae (1); Lutjanidae (1); Mugilidae (1); Sciaenidae (5); and, Sparidae (2). We recognized conservation status for some of the euryhaline, diadromous, or primarily marine species included in the list of taxa, in part, on the basis of Huntsman (1994); conservation status applies only to populations in the continental waters of the southern United States. Additional scientific study is needed to better document distributions and ecology of euryhaline and marine species in freshwater habitats of the region and to assess conservation status of nonexploited nearshore species.

List of taxa

Fish species and subspecies of the southern United States are arranged alphabetically by family, by genus within a family, and by species and subspecies within a genus. For each fish, the list includes the scientific name, the author(s) who originally described the taxon, the common name, the status in bold letters, and the historic native distribution referenced by drainage unit number (Table 1; Figure 1). Marine fishes that spawn, have resident populations, or frequently occur in freshwater are indicated by "M." Diadromous fishes are indicated by "D." Four other categories are indicated for the distribution of each taxon within drainage units: native with reservation (drainage number followed by a question mark); native or introduced status uncertain (number in brackets); introduced (number in parentheses); and introduced but establishment uncertain (number in parentheses followed by a question mark). Common names generally follow Robins et al. (1991) except in the case of subspecies and undescribed taxa that are not treated in Robins et al. (1991), or those cases where changes are proposed or anticipated for the next edition of *List of Common and Scientific Names of Fishes from the United States and Canada*. We were aware that the genitive endings of some patronyms will be modified from one "i" to double "i" (e.g., *Micropterus treculi* to *M. treculii*) in the next list but presented here the endings used by Robins et al. (1991). We have provided a detailed explanation for all variances from Robins et al. (1991), in the *Fisheries* section of the AFS World Wide Web site, <www.fisheries.org>.

Conservation status of each taxon within the region was judged from the best information available to the SFC Technical Advisory Committee. Conservation status categories generally follow those in recent AFS evaluations (Williams et al. 1989; Williams et al. 1993; Taylor et al. 1996), except we used *vulnerable*, rather than *of special concern*, for reasons discussed by Musick (1999). Definitions are: *endangered* (E)—a species or subspecies in danger of extinction throughout all or a significant portion of its range; *threatened* (T)—a species or subspecies likely to become endangered throughout all or a significant portion of its range; *vulnerable* (V)—a species or subspecies that

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Figure 2. Once common in large rivers and northern lakes, the spectacular but threatened lake sturgeon (*Acipenser fulvescens*) is beginning to show an increase in range and abundance and was recently captured in the Ohio River mainstem.

J. E. JOHNSON

Figure 3. Early settlers in the Ozarks considered the presence of the now federally threatened Ozark cavefish (*Amblyopsis rosae*) in their well waters to be a good-luck charm because the species was thought to be a talisman of excellent water quality and safe drinking water.

R. K. WALLACE

Figure 4. Common in eastern North America, the bowfin (*Amia calva*), is well known for its unique appearance, blue-green spawning colors, nest-building and care-giving habits, and skeletal anatomy.

W. N. ROSTON

Figure 5. The tiny blackfin sucker (*Thoburnia atripinnis*), reaching only 6 1/2 inches, has a small range limited to the upper Barren River system of Kentucky and Tennessee, and is one of the most phenotypically distinctive suckers in North America.

may become endangered or threatened by relatively minor disturbances to its habitat or that deserves careful monitoring of its distribution and abundance in continental waters of the United States to determine its status; *currently stable* (CS)—a species or subspecies whose distribution is widespread and stable or a species or subspecies that may have declined in portions of its range but is not in need of immediate conservation management actions. Species with an "X" in the status category are regarded as extinct throughout their range; those with an "XS" are considered extinct within the study area.

Achiridae–American soles

Trinectes maculatus (Bloch & Schneider). hogchoker (M). **CS.** 1–15, 17–21, 34, 45–47, 49, 51.

Acipenseridae–sturgeons

Acipenser brevirostrum Lesueur. shortnose sturgeon (D). **E.** 1, 3–11, 34.

Acipenser fulvescens Rafinesque. lake sturgeon. **T.** 16, 25–28, 33, 35–37, 39, 43.

Acipenser oxyrinchus desotoi Vladykov. Gulf sturgeon (D). **T.** 12–21, 23, 25?.

Acipenser oxyrinchus oxyrinchus Mitchill. Atlantic sturgeon (D). **V.** 1–5, 6?, 7–11, 34.

Scaphirhynchus albus (Forbes & Richardson). pallid sturgeon. **E.** 23, 25, 35, 39.

Scaphirhynchus platorynchus (Rafinesque). shovelnose sturgeon. **CS.** 25–27, 31, 33, 35–37, 39–45.

Scaphirhynchus suttkusi Williams & Clemmer. Alabama sturgeon. **E.** 16–18.

Amblyopsidae–cavefishes

Amblyopsis rosae (Eigenmann). Ozark cavefish. **T.** 36, 40, 42.

Amblyopsis spelaea DeKay. northern cavefish. **T.** 29, 30.

Chologaster cornuta Agassiz. swampfish. **CS.** (2), 3–10.

Forbesichthys agassizi (Putnam). spring cavefish. **CS.** 26, 28, 29, 39.

Speoplatyrhinus poulsoni Cooper & Kuehne. Alabama cavefish. **E.** 26.

Typhlichthys subterraneus Girard. southern cavefish. **V.** 16, 26, 28, 29, 36, 40, 42.

Amiidae–bowfins

Amia calva Linnaeus. bowfin. **CS.** 1-29, (30–32), 33–35, 39–49.

Anguillidae–freshwater eels

Anguilla rostrata (Lesueur). American eel (D). **CS.** 1–51.

Aphredoderidae–pirate perches

Aphredoderus sayanus gibbosus Lesueur. western pirate perch. **CS.** 20–26, 28-30, 33, 39–41, 43–49.
Aphredoderus sayanus gibbosus x *A. s. sayanus*. 10–19.
Aphredoderus sayanus sayanus (Gilliams). eastern pirate perch. **CS.** 1–9, 34.

Aplocheilidae–rivulins

Rivulus marmoratus Poey. mangrove rivulus. **V.** 12.

Atherinopsidae–New World silversides

Labidesthes sicculus (Cope). brook silverside. **CS.** (1?), (6), 7–33, 35–47.
Menidia beryllina (Cope). inland silverside. **CS.** 1–15, 17, 19–26, 28, 34, (36?), 39–41, 43–51.
Menidia extensa Hubbs & Raney. Waccamaw silverside. **T.** 6.

Belonidae–needlefishes

Strongylura marina (Walbaum). Atlantic needlefish (M). **CS.** 1–22, 25, (26?), 34, 45–51.

Catostomidae–suckers

Carpiodes carpio (Rafinesque). river carpsucker. **CS.** 22–33, 35–51.
Carpiodes cyprinus complex. quillbacks. **CS.** 1–3, 6, 7, 9, 10, 14–41, 43, 44.
Carpiodes velifer complex. highfin carpsuckers. **CS.** 5–7, 9, 10, 15–23, 25–31, 33, 35–43.
Catostomus commersoni (Lacepède). white sucker. **CS.** 1–5, 7, (14), [16], 24–38, 40, 42.
Cycleptus elongatus (Lesueur). blue sucker. **V.** 23–33, 35, 36, 38–44, 46–51.
Cycleptus meridionalis Burr & Mayden. southeastern blue sucker. **V.** 16–20.
Erimyzon oblongus claviformis (Girard). western creek chubsucker. **CS.** 14, 16–24, 26, 28–30, 38–48.
Erimyzon oblongus claviformis x *E. o. oblongus*. 10.
Erimyzon oblongus oblongus (Mitchill). eastern creek chubsucker. **CS.** 1–9, 34.
Erimyzon sucetta (Lacepède). lake chubsucker. **CS.** 3–24, 26, 29, 33, 38–41, 43–48, 49?, 50.
Erimyzon tenuis (Agassiz). sharpfin chubsucker. **CS.** 15–21.
Hypentelium etowanum (Jordan). Alabama hog sucker. **CS.** 14, 16–18, (27).
Hypentelium nigricans (Lesueur). northern hog sucker. **CS.** 1–4, 6, 7, 9, 10, 14, [16], 19–43.
Hypentelium roanokense Raney & Lachner. Roanoke hog sucker. **CS.** 3.
Ictiobus bubalus (Rafinesque). smallmouth buffalo. **CS.** (4?), (6, 7), 16–33, 35–51.
Ictiobus cyprinellus (Valenciennes). bigmouth buffalo. **CS.** (6, 7), (17?), [19], 21, 23–31, 33, 35–45, 46?.
Ictiobus niger (Rafinesque). black buffalo. **CS.** 23–30, 32, 33, 35–46, 49.
Minytrema melanops (Rafinesque). spotted sucker. **CS.** 5–11, 13–24, 26–33, 36–48, 49?.
Moxostoma anisurum (Rafinesque). silver redhorse. **CS.** 25–33, 35–40.
Moxostoma carinatum (Cope). river redhorse. **CS.** 15–20, 25?, 26–33, 35–44.
Moxostoma collapsum (Cope). v-lip redhorse. **CS.** 3–7, 9, 10.
Moxostoma duquesnei (Lesueur). black redhorse. **CS.** [7], 16-18, 26–33, 35–44.
Moxostoma erythrurum (Rafinesque). golden redhorse. **CS.** (1), 2, 3, 16–18, 22–24, 26–33, 35–44.
Moxostoma sp. cf. *erythrurum*. Carolina redhorse. **E.** 5, 6.
Moxostoma lacerum (Jordan & Brayton). harelip sucker. **X.** 26–28, 30, 40.
Moxostoma macrolepidotum breviceps (Cope). shorthead redhorse. **CS.** 26–33.
Moxostoma macrolepidotum macrolepidotum (Lesueur). northern redhorse. **CS.** 1–7, 34.
Moxostoma macrolepidotum macrolepidotum x *M. m. pisolabrum*. 37, 38.
Moxostoma macrolepidotum pisolabrum Trautman & Martin. pealip redhorse. **CS.** 25, 35, 36, 38–42.
Moxostoma sp. cf. *macrolepidotum*. sicklefin redhorse. **T.** 27.
Moxostoma pappillosum (Cope). slender redhorse. **CS.** 3–7.
Moxostoma poecilurum Jordan. blacktail redhorse. **CS.** 15–24, 43, 44.
Moxostoma sp. cf. *poecilurum*. Apalachicola redhorse. **CS.** 14.
Moxostoma robustum (Cope). robust redhorse. **E.** 6, 7, 9, 10.
Moxostoma valenciennesi Jordan. greater redhorse. **XS.** 33.
Scartomyzon ariommus (Robins & Raney). bigeye jumprock. **CS.** 3.
Scartomyzon cervinus (Cope). black jumprock. **CS.** (2), 3, 4, (32).
Scartomyzon congestus (Baird & Girard). gray redhorse. **CS.** 48–51.
Scartomyzon lachneri (Robins & Raney). greater jumprock. **CS.** 14, (16?).
Scartomyzon sp. cf. *lachneri*. brassy jumprock. **CS.** 5–7, 9, 10.
Scartomyzon rupiscartes (Jordan & Jenkins). striped jumprock. **CS.** (6), 7–10, 14.
Thoburnia atripinnis (Bailey). blackfin sucker. **V.** 29.
Thoburnia hamiltoni Raney & Lachner. rustyside sucker. **V.** 3.
Thoburnia rhothoeca (Thoburn). torrent sucker. **CS.** 1–3, [32].

Centrarchidae–sunfishes

Acantharchus pomotis (Baird). mud sunfish. **CS.** 1–11, 13, 34.
Ambloplites ariommus Viosca. shadow bass. **CS.** 14–22, 39–44.
Ambloplites cavifrons Cope. Roanoke bass. **V.** 3, 4, (5?).
Ambloplites constellatus Cashner & Suttkus. Ozark bass. **CS.** (36?), 40, (42?).
Ambloplites rupestris (Rafinesque). rock bass. **CS.** (1–3), (6, 7), (9), 26–33, (34), (36, 37), 38, (42), 49, 50.
Centrarchus macropterus (Lacepède). flier. **CS.** 1–26, 28, 29,

33, 39–41, 43–48.
Enneacanthus chaetodon (Baird). blackbanded sunfish. **V.** 3–13, 34.
Enneacanthus gloriosus (Holbrook). bluespotted sunfish. **CS.** 1–15, 17–19, (23), 34.
Enneacanthus obesus (Girard). banded sunfish. **CS.** 1–15, 34.
Lepomis auritus (Linnaeus). redbreast sunfish. **CS.** 1–15, [16], (18), (24), (26–32), 34, (40, 41), (43–51).
Lepomis cyanellus Rafinesque. green sunfish. **CS.** (1–7), (9, 10), (14), 15–33, (34), 35–51.
Lepomis gibbosus (Linnaeus). pumpkinseed. **CS.** 1–9, (27), (31), 32, 33, [34], (38).
Lepomis gulosus (Cuvier). warmouth. **CS.** (1), [2], 3–33, (34), 35, 36, 38–51.
Lepomis humilis (Girard). orangespotted sunfish. **CS.** (14), 16–30, 33, 35–49.
Lepomis macrochirus Rafinesque. bluegill. **CS.** (1–4), 5–33, (34), 35–51.
Lepomis marginatus (Holbrook). dollar sunfish. **CS.** 4–15, 17–24, 26, 39–41, 43–48.
Lepomis megalotis complex. longear sunfishes. **CS.** (1), [10], 14–33, 35–51.
Lepomis microlophus complex. redear sunfishes. **CS.** (1–8), 9–24, 26–29, (30, 31), 33, (36?), (37?), 38–51.
Lepomis miniatus Jordan. redspotted sunfish. **CS.** 16–24, 26, 28, 29, 39–41, 43–51.
Lepomis miniatus x *L. punctatus*. 14–16, 27.
Lepomis punctatus (Valenciennes). spotted sunfish. **CS.** 5–13.
Lepomis symmetricus Forbes. bantam sunfish. **CS.** 19–24, 39–41, 43–49.
Micropterus cataractae Williams & Burgess. shoal bass. **V.** (10), 14.
Micropterus coosae Hubbs & Bailey. redeye bass. **CS.** [7], 9, 10, 14, 16–18, (27, 28), (40?).
Micropterus dolomieu Lacepède. smallmouth bass. **CS.** (1–4), (6, 7), [9], [10], (14?), (16), (18), 25–33, (34), 35–44, (48–50).
Micropterus notius Bailey & Hubbs. Suwannee bass. **V.** 13.
Micropterus punctulatus (Rafinesque). spotted bass. **CS.** (1–3), (5), (6?), (7?), (9, 10), (14), 15–33, (35–38), 39–49.
Micropterus salmoides (Lacepède). largemouth bass. **CS.** (1–3), 4–33, (34), 35–51.
Micropterus treculi (Vaillant & Bocourt). Guadalupe bass. **V.** 48–50, (51).
Pomoxis annularis Rafinesque. white crappie. **CS.** (1–7), (9, 10), (14, 15), 16–33, (34), 35–51.
Pomoxis nigromaculatus (Lesueur). black crappie. **CS.** (1, 2), 3–33, (34), 35–44, [45], 46–48, (49–51).

Characidae–characins

Astyanax mexicanus (Filippi). Mexican tetra. **CS.** (42), (44), (47–50), 51.

Clupeidae–herrings

Alosa aestivalis (Mitchill). blueback herring (D). **CS.** 1–11, (27), 34, (44?).
Alosa alabamae Jordan & Evermann. Alabama shad (D). **V.** 13–21, 25–28, 33, 36–38, 41–44.
Alosa chrysochloris (Rafinesque). skipjack herring. **CS.** 13–33, 35, 36, 38–49.
Alosa mediocris (Mitchill). hickory shad (D). **CS.** 1–11, 34.
Alosa pseudoharengus (Wilson). alewife (D). **CS.** 1–6, 10, (27, 28), (32, 33), 34.
Alosa sapidissima (Wilson). American shad (D). **CS.** 1–11, 34.
Dorosoma cepedianum (Lesueur). gizzard shad. **CS.** 1–51.
Dorosoma petenense (Günther). threadfin shad. **CS.** (1–11), 12–15, (16), 17–26, (27), 28, 29, (30–32), (34), (36), 39–41, (42), 43–51.

Cottidae–sculpins

Cottus baileyi Robins. black sculpin. **CS.** 27.
Cottus bairdi bairdi Girard. mottled sculpin. **CS.** 26–28, 30–32, 36–38, 40.
Cottus bairdi ssp. 1. smoky sculpin. **CS.** 7, 9, 14, 16, 27.
Cottus sp. cf. *bairdi* 1. Blueridge sculpin. **CS.** 1–3, 34.
Cottus sp. cf. *bairdi* 2. Tallapoosa sculpin. **CS.** 16.
Cottus carolinae carolinae (Gill). banded sculpin. **CS.** 26–30, 36–40, 42.
Cottus carolinae complex 1. fall-line sculpins. **CS.** [14], 16–18.
Cottus carolinae complex 2. grotto sculpins. **V.** 39
Cottus carolinae infernatis Williams & Robins. Alabama banded sculpin. **CS.** 16–18.
Cottus carolinae zopherus (Jordan). Coosa banded sculpin. **CS.** 16.
Cottus sp. cf. *carolinae*. Kanawha sculpin. **CS.** 32.
Cottus girardi Robins. Potomac sculpin. **CS.** 1, 2.
Cottus hypselurus Robins & Robison. Ozark sculpin. **CS.** 36–38, 40.
Cottus paulus Williams. pygmy sculpin. **E.** 16.
Cottus sp. cf. broadband sculpin 1. Bluestone sculpin. **V.** 32.
Cottus sp. cf. broadband sculpin 2. Clinch sculpin. **V.** 27.
Cottus sp. cf. broadband sculpin 3. Holston sculpin. **V.** 27.
Cottus sp. cf. *cognatus*. checkered sculpin. **CS.** 1.

Cyprinidae–carps and minnows

Campostoma anomalum anomalum (Rafinesque). central stoneroller. **CS.** 1–3, [6], 7, 9, 27, 28, 30–33.
Campostoma anomalum pullum (Agassiz). Mississippi stoneroller. **CS.** 22–25, 35–44, 47–51.
Campostoma oligolepis Hubbs & Greene. largescale stoneroller. **CS.** (15), 16–18, 26–29, 35–40, 42.
Campostoma oligolepis x *C. pauciradii*. 16.
Campostoma pauciradii Burr & Cashner. bluefin stoneroller. **CS.** 10, 14, 16, 27?.
Clinostomus elongatus (Kirtland). redside dace. **CS.** 30, 31.
Clinostomus funduloides estor (Jordan & Brayton). highland dace. **CS.** 26–28.
Clinostomus funduloides estor x *C. f.* ssp. 27.
Clinostomus funduloides ssp. smoky dace. **V.** 9, 27.
Clinostomus funduloides funduloides Girard. rosyside dace. **CS.** 1–7, 9, 31, 32, 34.
Cyprinella analostana Girard. satinfin shiner. **CS.** 1–6, 34.
Cyprinella caerulea (Jordan). blue shiner. **E.** 16, 17.
Cyprinella callisema (Jordan). Ocmulgee shiner. **CS.** 10.
Cyprinella callistia (Jordan). Alabama shiner. **CS.** 16–18.

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Figure 6. Suckers sometimes spawn at night as exemplified by this trio of golden redhorse (*Moxostoma erythrurum*) quivering in loose gravel while eggs and milt are released.

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Figure 7. Many fisheries professionals are unaware that there are seven species allocated to *Micropterus*, one of which is the Suwannee bass (*Micropterus notius*), endemic to clear streams of north Florida and extreme southern Georgia.

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Figure 8. Generally common on the central Atlantic Slope in dense growths of aquatic vegetation, the banded sunfish (*Enneacanthus obesus*) is a popular ornamental fish in the United States and Europe.

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Figure 9. A grotto sculpin, the hypogean member of the *Cottus carolinae* species complex, is found only in caves of Perry County, Missouri, where it shows reductions in pigmentation, eye size, and pelvic fin-ray number. These cave populations are extremely sensitive to groundwater pollution.

Cyprinella callitaenia (Bailey & Gibbs). bluestripe shiner. **V.** 14.
Cyprinella camura (Jordan & Meek). bluntface shiner. **CS.** 20, 22–26, 41, 42.
Cyprinella chloristia (Jordan & Brayton). greenfin shiner. **CS.** 7.
Cyprinella galactura (Cope). whitetail shiner. **CS.** 7, 9, 26–28, (31, 32), 39, 40.
Cyprinella gibbsi (Howell & Williams). Tallapoosa shiner. **CS.** [14], 16.
Cyprinella leedsi (Fowler). bannerfin shiner. **CS.** 8–10, 13.
Cyprinella lepida Girard. plateau shiner. **V.** 50?, 51.
Cyprinella sp. cf. *lepida*. Nueces shiner. **V.** 51.
Cyprinella labrosa (Cope). thicklip chub. **CS.** 6, 7.
Cyprinella lutrensis (Baird & Girard). red shiner. **CS.** (3), (6), (14), (16), (18?), 22–25, (26), 29, 33, 35–51.
Cyprinella nivea (Cope). whitefin shiner. **CS.** 4–9.
Cyprinella pyrrhomelas (Cope). fieryblack shiner. **CS.** 6, 7, [9].
Cyprinella spiloptera (Cope). spotfin shiner. **CS.** 1, (3), 25–35, 37, 38, 40, 42.
Cyprinella trichroistia (Jordan & Gilbert). tricolor shiner. **CS.** 16–18.
Cyprinella venusta cercostigma (Cope). southeastern blacktail shiner. **CS.** [10], 13–21.
Cyprinella venusta cercostigma x *C. v. stigmatura*. 16, 17.
Cyprinella venusta stigmatura (Jordan). Mobile blacktail shiner. **CS.** 16–18, (26).
Cyprinella venusta venusta Girard. Mississippi blacktail shiner. **CS.** 23–25, 33, (36), 39–41, 43–51.
Cyprinella whipplei Girard. steelcolor shiner. **CS.** 18, 22–33, 38–44.
Cyprinella xaenura (Jordan). Altamaha shiner. **V.** 10.
Cyprinella zanema (Jordan & Brayton). Santee chub. **CS.** 5–7.
Dionda nigrotaeniata (Cope). Guadalupe roundnose minnow. **CS.** 49, 50.
Dionda serena Girard. Nueces roundnose minnow. **CS.** 51.
Erimonax monacha (Cope). spotfin chub. **E.** 26, 27.
Ericymba buccata Cope. silverjaw minnow. **CS.** 1, [10], 14–20, 22, 28–33, 38, (39?), (40?).
Erimystax cahni (Hubbs & Crowe). slender chub. **E.** 27.

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Figure 10. Because of the habit of using its mouth to scrape algae from rocks, the stoneroller (*Campostoma anomalum*) is one of the most ecologically significant species in streams of the southeast. Here a school of pre-spawning males moves upstream during spring.

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Figure 11. Known to be locally abundant in tiny headwaters and small tributary streams, the redside dace (*Clinostomus elongatus*) is appropriately named because it maintains a red stripe on its side throughout the year.

Erimystax dissimilis (Kirtland). streamline chub. **CS.** 26–32.
Erimystax harryi (Hubbs & Crowe). Ozark chub. **V.** 39, 40.
Erimystax insignis eristigma (Hubbs & Crowe). mountain blotched chub. **CS.** 27.
Erimystax insignis eristigma x *E. i. insignis*. 27.
Erimystax insignis insignis (Hubbs & Crowe). blotched chub. **CS.** 26, 28.
Erimystax x-punctatus x-punctatus (Hubbs & Crowe). gravel chub. **CS.** 25, 29, 33, 35–38, 40–43.
Exoglossum laurae (Hubbs). tonguetied minnow. **CS.** 32.
Exoglossum maxillingua (Lesueur). cutlips minnow. **CS.** 1–3, (32), 34.
Hemitremia flammea (Jordan & Gilbert). flame chub. **V.** 16, 26–28.
Hybognathus argyritis Girard. western silvery minnow. **CS.** 25, 35–38.
Hybognathus hayi Jordan. cypress minnow. **CS.** 15–26, 29, 39–41, 43–46.
Hybognathus nuchalis Agassiz. Mississippi silvery minnow. **CS.** 16-31, 33, 38–41, 43–48.
Hybognathus placitus Girard. plains minnow. **CS.** 25, 35, 41, 42, 44, 48, 49.
Hybognathus regius Girard. eastern silvery minnow. **CS.** 1–7, 9, 10, 34.
Hybopsis amblops (Rafinesque). bigeye chub. **CS.** 26–33, 38–42.
Hybopsis amnis (Hubbs & Greene). pallid shiner. **V.** 21–26, 28, 29, 38–41, 43–46, 50.
Hybopsis hypsinotus (Cope). highback chub. **CS.** 6, 7.
Hybopsis lineapunctata Clemmer & Suttkus. lined chub. **V.** 16.
Hybopsis rubrifrons (Jordan). rosyface chub. **CS.** 7?, 9, 10.
Hybopsis winchelli Girard. clear chub. **CS.** [13], 16–22.
Hybopsis sp. cf. *winchelli*. coastal chub. **CS.** 14, 15, 16?.
Luxilus albeolus (Jordan). white shiner. **CS.** 3–5, 32.
Luxilus cardinalis (Mayden). cardinal shiner. **CS.** 41, 42.
Luxilus cerasinus (Cope). crescent shiner. **CS.** (2), 3, (4?), (5), [32].
Luxilus chrysocephalus chrysocephalus Rafinesque. northern striped shiner. **CS.** 16, 18, 25–33, 35–40, 42.
Luxilus chrysocephalus chrysocephalus x *L. c. isolepis*. 18, 26.
Luxilus chrysocephalus isolepis (Hubbs & Brown). southern striped shiner. **CS.** (15), 16–26, 41, 43, 44.
Luxilus coccogenis (Cope). warpaint shiner. **CS.** [7], 9, 26, 27, (32?).
Luxilus cornutus (Mitchill). common shiner. **CS.** 1, 2, [32], 34.
Luxilus pilsbryi (Fowler). duskystripe shiner. **CS.** 40.
Luxilus zonatus (Agassiz). bleeding shiner. **CS.** 35–40.
Luxilus zonistius Jordan. bandfin shiner. **CS.** 9, 10, 14, 16, (27?).
Lythrurus ardens (Cope). rosefin shiner. **CS.** (1), 2, 3, (5), 32.
Lythrurus atrapiculus (Snelson). blacktip shiner. **CS.** [10], 14, 15, (16).
Lythrurus bellus alegnotus (Snelson). Warrior shiner. **CS.** 18.
Lythrurus bellus alegnotus x *L. b. bellus*. 18.
Lythrurus bellus bellus (Hay). pretty shiner. **CS.** 16–18, 26.
Lythrurus fasciolaris (Gilbert). scarletfin shiner. **CS.** 18, 26–31.
Lythrurus fumeus (Evermann). ribbon shiner. **CS.** 21–26, 28, 29, 39–49.
Lythrurus lirus (Jordan). mountain shiner. **CS.** 16, 17, 26, 27.
Lythrurus matutinus (Cope). pinewoods shiner. **CS.** 4.
Lythrurus roseipinnis (Hay). cherryfin shiner. **CS.** 17–23.
Lythrurus snelsoni (Robison). Ouachita shiner. **V.** 44.
Lythrurus umbratilis cyanocephalus Copeland. eastern redfin shiner. **CS.** 22–26, 28–32, 38–41, 43–45.
Lythrurus umbratilis cyanocephalus x *L. u. umbratilis*. 41.
Lythrurus umbratilis umbratilis (Girard). western redfin shiner. **CS.** 35–37, 41, 42.
Macrhybopsis gelida (Girard). sturgeon chub. **V.** 25, 35.
Macrhybopsis hyostoma (Gilbert). speckled chub. **CS.** 22–33, 35, 36, 37?, 38?, 39–44, 46, 47, 49.
Macrhybopsis marconis (Jordan & Gilbert). burrhead chub. **CS.** 49, 50.
Macrhybopsis meeki (Jordan & Evermann). sicklefin chub. **V.** 25, 33, 35.
Macrhybopsis sp. cf. *aestivalis* 1. Florida chub. **V.** 15.

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Figure 12. Few minnows rival the color of that displayed by a school of rosyside dace (*Clinostomus funduloides*), a currently stable species that is often abundant in clear, cool streams in highland areas.

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Figure 13. Cyprinids associated with bayous, swamps, lowland lakes, and sloughs are relatively uncommon, one exception being the cypress minnow (*Hybognthaus hayi*), often captured in schools over a substrate of organic debris and mud.

Macrhybopsis sp. cf. *aestivalis* 2. Pine Hills chub. **CS.** 17–21.
Macrhybopsis sp. cf. *aestivalis* 3. fall line chub. **V.** 16, 17.
Macrhybopsis storeriana (Kirtland). silver chub. **CS.** 16–33, 35, 36, 38–44.
Margariscus margarita margarita (Cope). pearl dace. **V.** 1.
Nocomis asper Lachner & Jenkins. redspot chub. **CS.** 42–44.
Nocomis biguttatus (Kirtland). hornyhead chub. **CS.** 30, 36–40.
Nocomis effusus Lachner & Jenkins. redtail chub. **CS.** 26, 28, 29.
Nocomis leptocephalus bellicus Girard. Gulf chub. **CS.** (15), 16–23, 26.
Nocomis leptocephalus interocularis Lachner & Wiley. Georgian chub. **CS.** 9, 10, 14.
Nocomis leptocephalus interocularis x *N. l. leptocephalus*. 8.
Nocomis leptocephalus leptocephalus (Girard). bluehead chub. **CS.** 1–7, (27), 32.
Nocomis micropogon (Cope). river chub. **CS.** 1, 2, (7?), [9], [16], 26–28, 30–32, 34.
Nocomis platyrhynchus Lachner & Jenkins. bigmouth chub. **CS.** 32.
Nocomis raneyi Lachner & Jenkins. bull chub. **CS.** 2–4, (5).
Notemigonus crysoleucas (Mitchill). golden shiner. **CS.** 1–51.
Notropis albizonatus Warren & Burr. palezone shiner. **E.** 26–28.
Notropis alborus Hubbs & Raney. whitemouth shiner. **CS.** 3, 5–7.
Notropis altipinnis (Cope). highfin shiner. **CS.** 3–7, 9.
Notropis amabilis (Girard). Texas shiner. **CS.** 49–51.
Notropis ammophilus Suttkus & Boschung. orangefin shiner. **CS.** 16–18, 23, 24, 26.
Notropis amoenus (Abbott). comely shiner. **CS.** 1–5, (6), 34.
Notropis ariommus (Cope). popeye shiner. **V.** 26–32.
Notropis asperifrons Suttkus & Raney. burrhead shiner. **CS.** 16–18.
Notropis atherinoides Rafinesque. emerald shiner. **CS.** 16–33, 35–46.
Notropis atrocaudalis Evermann. blackspot shiner. **CS.** 44–48.
Notropis baileyi Suttkus & Raney. rough shiner. **CS.** (14, 15), 16–19, 26.
Notropis bairdi Hubbs & Ortenburger. Red River shiner. **CS.** 44.
Notropis bifrenatus Cope. bridle shiner. **V.** 1–4, 7, 34.
Notropis blennius (Girard). river shiner. **CS.** 22–26, 28–33, 35, 41, 42, 44.
Notropis boops Gilbert. bigeye shiner. **CS.** 25, 26, 28–31, [35], (37), 38–44.
Notropis buccula Cross. smalleye shiner. **E.** 48, (49?).
Notropis buchanani Meek. ghost shiner. **CS.** 22, 23, 25–33, 35, 36, 38–51.
Notropis cahabae Mayden & Kuhajda. Cahaba shiner. **E.** 17, 18.
Notropis candidus Suttkus. silverside shiner. **CS.** 16–18.
Notropis chalybaeus (Cope). ironcolor shiner. **V.** 1–15, 17–20, 34, 39–41, 43–46, 50.
Notropis chiliticus (Cope). redlip shiner. **CS.** 3, (5), 6, (7?), (32).
Notropis chlorocephalus (Cope). greenhead shiner. **CS.** 7.
Notropis sp. cf. *chlorocephalus*. Piedmont shiner. **CS.** 6, 7.
Notropis chrosomus (Jordan). rainbow shiner. **CS.** 16–18, 26, 27.
Notropis cummingsae Myers. dusky shiner. **CS.** 4–11, 13–15.
Notropis dorsalis (Agassiz). bigmouth shiner. **CS.** 24, 25, 35, 38.
Notropis edwardraneyi Suttkus & Clemmer. fluvial shiner. **CS.** 16–18.
Notropis girardi Hubbs & Ortenburger. Arkansas River shiner. **T.** 41, 42.
Notropis greenei Hubbs & Ortenburger. wedgespot shiner. **CS.** 36–42.
Notropis harperi Fowler. redeye chub. **CS.** 10–15.
Notropis heterolepis Eigenmann & Eigenmann. blacknose shiner. **V.** 36, 37, 38?.
Notropis hudsonius (Clinton). spottail shiner. **CS.** 1–7, 9, 10, 14, 25, (32), 34.
Notropis hypsilepis Suttkus & Raney. highscale shiner. **V.** [9], 14.
Notropis leuciodus (Cope). Tennessee shiner. **CS.** (7?), 9, (14), [16], 26–29, (32).

Notropis longirostris (Hay). longnose shiner. **CS.** [10], 14–17, 19–23, 43.
Notropis ludibundus (Girard). sand shiner. **CS.** 24, 25, 27, 28, 30–33, 35–38, 42, 44, 47–51.
Notropis lutipinnis (Jordan & Brayton). yellowfin shiner. **CS.** 8–10, 14, 16, (27).
Notropis maculatus (Hay). taillight shiner. **CS.** 5–15, 17–24, 39–41, 43–45, 46?.
Notropis mekistocholas Snelson. Cape Fear shiner. **E.** 5.
Notropis melanostomus Bortone. blackmouth shiner. **T.** 15, 19.
Notropis nubilus (Forbes). Ozark minnow. **CS.** 25, 35–42.
Notropis ortenburgeri Hubbs. Kiamichi shiner. **V.** 41–44.
Notropis oxyrhynchus Hubbs & Bonham. sharpnose shiner. **T.** 48, (49?).
Notropis ozarcanus Meek. Ozark shiner. **V.** 39, 40, (42).
Notropis perpallidus Hubbs & Black. peppered shiner. **V.** 43, 44.
Notropis petersoni Fowler. coastal shiner. **CS.** 5–15, 17, 19.
Notropis photogenis (Cope). silver shiner. **CS.** 26–33.
Notropis potteri Hubbs & Bonham. chub shiner. **CS.** 25, 44, [47], 48, [49].
Notropis procne (Cope). swallowtail shiner. **CS.** 1–5, [6], 7, (32), 34.
Notropis rafinesquei Suttkus. Yazoo shiner. **CS.** 23.
Notropis rubellus micropteryx (Cope). redface shiner. **CS.** 26–29.
Notropis rubellus rubellus (Agassiz). rosyface shiner. **CS.** 1, 2, 28, 30–32, 34–40, 42, 43.
Notropis rubricroceus (Cope). saffron shiner. **CS.** 7, 9, 27, (32).
Notropis rupestris Page. bedrock shiner. **V.** (26?), 28.
Notropis sabinae Jordan & Gilbert. Sabine shiner. **CS.** 23, 39, 40, 43–47
Notropis scabriceps (Cope). New River shiner. **CS.** 32.
Notropis scepticus (Jordan & Gilbert). sandbar shiner. **CS.** 5–7, 9.
Notropis semperasper Gilbert. roughhead shiner. **V.** 2.
Notropis shumardi (Girard). silverband shiner. **CS.** 20?, 22–25, 28, 29, 33, 35, 41, 44, 45, (46?), 47–49.
Notropis spectrunculus (Cope). mirror shiner. **CS.** 7, 9, 27.
Notropis sp. cf. *spectrunculus*. sawfin shiner. **CS.** 26–28.
Notropis stilbius (Jordan). silverstripe shiner. **CS.** 16–18, [26].
Notropis suttkusi Humphries & Cashner. rocky shiner. **V.** 44.
Notropis telescopus (Cope). telescope shiner. **CS.** (2), (6?), (7), 26–29, (31?), (32), 39, 40.
Notropis texanus (Girard). weed shiner. **CS.** [10], 13–25, (26), 39–41, 43–51.
Notropis topeka (Gilbert). Topeka shiner. **E.** 35.
Notropis uranoscopus Suttkus. skygazer shiner. **CS.** 16, 17.
Notropis volucellus (Cope). mimic shiner. **CS.** 2–4, 16–33, 36–50.
Notropis wickliffi Trautman. channel shiner. **CS.** 25–27, 33, 35, 36, 40, 41.
Notropis xaenocephalus (Jordan). Coosa shiner. **CS.** [14], 16.
Opsopoeodus emiliae emiliae Hay. pugnose minnow. **CS.** 8–10, 14–30, 33, 39–51.
Opsopoeodus emiliae emiliae x *O. e. peninsularis*. 11, 13.
Opsopoeodus emiliae peninsularis (Gilbert & Bailey). peninsula pugnose minnow. **CS.** 11, 12.
Phenacobius catostomus Jordan. riffle minnow. **CS.** 16–18.
Phenacobius crassilabrum Minckley & Craddock. fatlips minnow. **CS.** 27.
Phenacobius mirabilis (Girard). suckermouth minnow. **CS.** 24–26, 28–33, 35, 36, 38, 39, 41, 42, 44, 46, 47, 49.
Phenacobius teretulus Cope. Kanawha minnow. **CS.** 32.
Phenacobius uranops Cope. stargazing minnow. **CS.** 26–29.
Phoxinus cumberlandensis Starnes & Starnes. blackside dace. **T.** 28.
Phoxinus erythrogaster (Rafinesque). southern redbelly dace. **CS.** 22–32, 35–40, 42.
Phoxinus oreas (Cope). mountain redbelly dace. **CS.** 1–4, (6), (27), 32.
Phoxinus tennesseensis Starnes & Jenkins. Tennessee dace. **V.** 27.
Phoxinus sp. cf. *tennesseensis*. laurel dace. **E.** 27.
Pimephales notatus (Rafinesque). bluntnose minnow. **CS.** (1–3), 15–18, 20–33, 35–44.
Pimephales promelas Rafinesque. fathead minnow. **CS.** (1), (3), (6, 7), (10), (14), (16–20), (23, 24), 25, (26, 27), 28–33, (34), 35, 36, (37), 38, (39), 40, (41), 42, (43, 44), (46), 47–49, (50, 51).
Pimephales tenellus parviceps (Hubbs & Black). eastern slim minnow. **T.** 39–41, 43, 44.
Pimephales tenellus parviceps x *P. t. tenellus*. 41.
Pimephales tenellus tenellus (Girard). western slim minnow. **CS.** 41, 42.
Pimephales vigilax (Baird & Girard). bullhead minnow. **CS.** 16–33, 38–51.
Platygobio gracilis gracilis (Richardson). flathead chub. **V.** 25, 33, 35.
Pteronotropis euryzonus (Suttkus). broadstripe shiner. **V.** 14.
Pteronotropis hubbsi (Bailey & Robison). bluehead shiner. **V.** 43–45.
Pteronotropis hypselopterus (Günther). sailfin shiner. **CS.** 6–15, 17, 18.
Pteronotropis signipinnis (Bailey & Suttkus). flagfin shiner. **CS.** 14, 15, 17–20.
Pteronotropis welaka (Evermann & Kendall). bluenose shiner. **V.** 11, 14, 15, 17–20.
Rhinichthys atratulus atratulus (Hermann). eastern blacknose dace. **CS.** 1–3, 34.
Rhinichthys atratulus atratulus x *R. a. obtusus*. 2, 3.
Rhinichthys atratulus obtusus Agassiz. southern blacknose dace. **CS.** 3, 6, 7, 9, 14, 16, 18, 24, 26–32.
Rhinichthys cataractae (Valenciennes). longnose dace. **CS.** 1, 2, (3), 7, 9, 27, 28, [31], 32, 34.
Semotilus atromaculatus (Mitchill). creek chub. **CS.** 1–7, 9, 10, 14, 16–24, 26–47, (49?).
Semotilus corporalis (Mitchill). fallfish. **CS.** 1, 2, (3), 34.
Semotilus lumbee Snelson & Suttkus. sandhills chub. **V.** 5, 6.
Semotilus thoreauianus Jordan. Dixie chub. **CS.** 13–18, 26.

Cyprinodontidae–killifishes

Cyprinodon variegatus hubbsi Carr. Lake Eustis pupfish. **V.** 11.
Cyprinodon variegatus variegatus Lacepède. sheepshead

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Figure 14. A school of male cardinal shiners (*Luxilus cardinalis*) in spawning colors is a common site in clear streams of the Ozark Highlands of Missouri and Arkansas during the spring months.

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Figure 15. The Tennessee shiner (*Notropis leuciodus*) is considered currently stable over its range where it often schools in large numbers.

minnow. **CS.** 1, 2, 4–10, 12–15, 17, 19–21, 34, 45–51.
Cyrinodon rubrofluviatilis Fowler. Red River pupfish. **CS.** 48, (49).
Jordanella floridae Goode & Bean. flagfish. **CS.** 11–13.

Dasyatidae–stingrays

Dasyatis sabina (Lesueur). Atlantic stingray (M). **CS.** 1, 3?, 4–6, 7?, 8, 9?, 10?, 11–15, 17, 18?, 19–21, 22?, 25, 45, 46?, 47, 48, 49?, 50, 51.

Elassomatidae–pygmy sunfishes

Elassoma alabamae Mayden. spring pygmy sunfish. **E.** 26.
Elassoma boehlkei Rohde & Arndt. Carolina pygmy sunfish. **V.** 6, 7.
Elassoma evergladei Jordan. Everglades pygmy sunfish. **CS.** 5–15, 17.
Elassoma okatie Rohde & Arndt. bluebarred pygmy sunfish. **V.** 8, 9.
Elassoma okefenokee Böhlke. Okefenokee pygmy sunfish. **CS.** 10–13.
Elassoma sp. cf. *okefenokee*. Apalachicolan pygmy sunfish. **CS.** 12–15.
Elassoma zonatum Jordan. banded pygmy sunfish. **CS.** 3–26, 29, 39–41, 43–48.

Eleotridae–sleepers

Dormitator maculatus (Bloch). fat sleeper (M). **CS.** 4, 5, 8–15, 17, 19, 20, 22?, 25, 45–47, 48?, 49, 50?, 51.
Eleotris pisonis (Gmelin). spinycheek sleeper (M). **CS.** 5, 8, 10–12, 13?, 14, 15, 17, 19, 20?, 21?, 25, 45, 46?, 47, 48?, 49?, 50?, 51.
Gobiomorus dormitor Lacepède. bigmouth sleeper (M). **V.** 11, 12, 25, 51.

Engraulidae–anchovies

Anchoa mitchilli (Valenciennes). bay anchovy (M). **CS.** 1–15, 17–21, 25, 34, 45, 47, 50, 51.

Esocidae–pikes

Esox americanus americanus Gmelin. redfin pickerel. **CS.** 1–11, 13, 16, 34.
Esox americanus americanus x *E. a. vermiculatus*. 12–19.
Esox americanus vermiculatus Lesueur. grass pickerel. **CS.** 20–26, 28–31, 38–41, 43, 44.
Esox lucius Linnaeus. northern pike. **CS.** (1–3), 25, (27), [35], [36], (37–44).
Esox masquinongy Mitchill. muskellunge. **CS.** (1–3), (7), (16?), 27–33, (34), (36), (38), (40), (43).
Esox niger Lesueur. chain pickerel. **CS.** 1–24, 26, (27?), 28, (32), 34, (37?), 39–41, 43–46.

Fundulidae–topminnows

Fundulus albolineatus Gilbert. whiteline topminnow. **X.** 26.
Fundulus auroguttatus (Hay). banded topminnow. **CS.** 12–15, 17.
Fundulus bifax Cashner & Rogers. stippled studfish. **V.** 16.
Fundulus blairae Wiley & Hall. western starhead topminnow. **CS.** 15, 17–19, 22, 23, 44–48.
Fundulus catenatus (Storer). northern studfish. **CS.** 20–22, 26–30, (31), 36–41, [42], 43, 44.
Fundulus chrysotus (Günther). golden topminnow. **CS.** 6–15, 17–25, 39–41, 43–47, [50].
Fundulus confluentus Goode & Beane. marsh killifish (M). **CS.** 11–15.
Fundulus diaphanus diaphanus (Lesueur). banded killifish. **CS.** 1–6, 34.
Fundulus dispar (Agassiz). starhead topminnow. **CS.** 17, 18, 20, 23–26, 39–41, 43.
Fundulus escambiae (Bollman). russetfin topminnow. **CS.** 13–15.
Fundulus euryzonus Suttkus & Cashner. broadstripe topminnow. **V.** 21.
Fundulus grandis grandis Baird & Girard. gulf killifish (M). **CS.** 11–15, 17, 19, 25, 46–48, 50, 51.

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Figure 16. The federally endangered Cape Fear shiner (*Notropis mekistocholas*), a narrow range endemic in the Cape Fear River drainage, has experienced recent population declines.

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Figure 17. No other North American minnow rivals the bluenose shiner (*Pteronotropis welaka*) in spectacular fin development, a vulnerable species in several southern rivers.

Fundulus grandis saguanus Rivas. southern gulf killifish (M). **CS.** 12.
Fundulus heteroclitus (Linnaeus). mummichog (M). **CS.** 1–11, 34.
Fundulus julisia Williams & Etnier. Barrens topminnow. **E.** 26, 28.
Fundulus lineolatus (Agassiz). lined topminnow. **CS.** 3–14.
Fundulus notatus (Rafinesque). blackstripe topminnow. **CS.** 17–31, 33, 35, 36, 38–50.
Fundulus notti (Agassiz). bayou topminnow. **CS.** 17-23.
Fundulus olivaceus (Storer). blackspotted topminnow. **CS.** 14–29, 35–48.
Fundulus pulvereus (Evermann). bayou killifish. **CS.** 11, 19, 20, 45–50.
Fundulus rathbuni Jordan & Meek. speckled killifish. **CS.** 3–7.
Fundulus rubrifrons (Jordan). redface topminnow. **CS.** 11, 12.
Fundulus sciadicus Cope. plains topminnow. **CS.** 36, 37, 42.
Fundulus seminolis Girard. Seminole killifish. **CS.** 11, 12.
Fundulus stellifer (Jordan). southern studfish. **CS.** 14, 16, 17.
Fundulus waccamensis Hubbs & Raney. Waccamaw killifish. **T.** 3, 6.
Fundulus zebrinus Jordan & Gilbert. plains killifish. **CS.** 35, 42, 47–49.
Leptolucania ommata (Jordan). pygmy killifish. **CS.** 10–15, 19.
Lucania goodei Jordan. bluefin killifish. **CS.** [5], 8, 10–15.
Lucania parva (Baird & Girard). rainwater killifish. **CS.** 1–6, 8, 11–15, 17–21, 34, 45–51.

Gadidae–cods

Lota lota (Linnaeus). burbot. **CS.** 30, 31, 33.

Gasterosteidae–sticklebacks

Apeltes quadracus (Mitchill). fourspine stickleback (M). **CS.** 1, 2, 4, 34.
Gasterosteus aculeatus Linnaeus. threespine stickleback. **CS.** 1, 2, 34.

Gobiidae–gobies

Awaous banana (Valenciennes). river goby (M). **V.** 9, 11–13, 15.
Ctenogobius boleosoma (Jordan & Gilbert). darter goby (M). **CS.** 1?, (2), 3?, 4–6, 7?, 8, 9?, 10–15, 17, 18?, 19, 20, 21?, 25, 34, 45–48, 49?, 50, 51.
Ctenogobius pseudofasciatus (Gilbert & Randall). slashcheek goby (M). **V.** 11.
Ctenogobius shufeldti (Jordan & Eigenmann). freshwater goby (M). **CS.** 6, 7?, 8, 9?, 10–12, 13?, 14, 15?, 17, 19–21, 25, 45?, 46?, 47.
Gobioides broussoneti Lacepède. violet goby (M). **CS.** 8, 9?, 10–12, 17, 19, 20?, 21, 25, 45, 46, 47?, 48.
Gobiosoma bosc (Lacepède). naked goby (M). **CS.** 4, 5, 6?, 7?, 8, 9?, 10–15, 17, 19–21, 25, 45, 46?, 47, 48?, 49?, 50?, 51.
Microgobius gulosus (Girard). clown goby (M). **CS.** 1?, 2?, 3?, 6?, 7?, 8?, 9?, 10?, 11–15, 17, 18?, 19, 20?, 21?, 25?, 45?, 46?, 47?, 48?, 49?, 50, 51.

Hiodontidae–mooneyes

Hiodon alosoides (Rafinesque). goldeye. **CS.** 23–31, 33, 35–38, 40–44.
Hiodon tergisus Lesueur. mooneye. **CS.** 16–21, 23, 25–31, 33, 35–41, 43, 44.

Ictaluridae–bullhead catfishes

Ameiurus brunneus Jordan. snail bullhead. **V.** (3), 4–11, 14, 16, (27).
Ameiurus catus (Linnaeus). white catfish. **CS.** 1–14, (15?), (16?), (17?), (18?), (25?), (26?), (27), 34, (36?), (40?), (41?), (42?), (43?), (44?).
Ameiurus melas (Rafinesque). black bullhead. **CS.** (3), (6), (15), 16–31, (32), 33, 35–49.
Ameiurus natalis (Lesueur). yellow bullhead. **CS.** 1–31, [32], 33–51.
Ameiurus nebulosus (Lesueur). brown bullhead. **CS.** 1–20, 23–27, 29, (30, 31), 32–34, (36?), (38?), 39, (40–44).
Ameiurus platycephalus (Girard). flat bullhead. **V.** [2], 3–10,

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Figure 18. The banded pygmy sunfish (*Elassoma zonatum*) is the most wide-ranging species in the family Elassomatidae, and its common name may be misleading because recent anatomical evidence indicates that it is closely related to sticklebacks, not sunfishes.

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Figure 19. The checkered madtom (*Noturus flavater*), endemic to the Ozark Highlands, nests in pools of clear streams under large flat rocks during June and July.

[14], (27).
Ameiurus serracanthus (Yerger & Relyea). spotted bullhead. **V.** 13–15.
Ictalurus furcatus (Lesueur). blue catfish. **CS.** (1, 2), (4?), (5–7), (9, 10), (14, 15), 16–33, 35–37, 39–51.
Ictalurus lupus (Girard). headwater catfish. **XS.** 49, 50, 51.
Ictalurus punctatus (Rafinesque). channel catfish. **CS.** (1–8), [9], [10], 11–33, (34), 35–51.
Noturus albater Taylor. Ozark madtom. **CS.** 40.
Noturus sp. cf. *albater*. eastern Ozark madtom. **CS.** 39, 40.
Noturus baileyi Taylor. smoky madtom. **E.** 27.
Noturus elegans Taylor. elegant madtom. **CS.** 26, 28, 29.
Noturus sp. cf. *elegans* 1. Chucky madtom. **T.** 26, 27.
Noturus sp. cf. *elegans* 2. saddled madtom. **V.** 26.
Noturus eleutherus Jordan. mountain madtom. **CS.** 24–33, 39, 40, 43, 44.
Noturus exilis Nelson. slender madtom. **CS.** 26, 28, 29, 36–42, 44.
Noturus flavater Taylor. checkered madtom. **V.** 40.
Noturus flavipinnis Taylor. yellowfin madtom. **E.** 27.
Noturus flavus Rafinesque. stonecat. **CS.** 25, 30–33, 35–38, 42.
Noturus sp. cf. *flavus*. highlands stonecat. **CS.** 25–28, 30–33.
Noturus funebris Gilbert & Swain. black madtom. **CS.** 14–20, 26.
Noturus furiosus Jordan & Meek. Carolina madtom. **V.** 4.
Noturus gilberti Jordan & Evermann. orangefin madtom. **T.** (2), 3.
Noturus gyrinus (Mitchill). tadpole madtom. **CS.** 1–26, 28–30, 33, 34, 36, 39–51.
Noturus hildebrandi hildebrandi (Bailey & Taylor). least madtom. **CS.** 22, (26).
Noturus hildebrandi hildebrandi x *N. h. lautus*. 23.
Noturus hildebrandi lautus Taylor. ivory-bellied madtom. **CS.** 24.
Noturus insignis insignis (Richardson). margined madtom. **CS.** 1–10, (27), 32, 34.
Noturus insignis ssp. spotted madtom. **V.** 3.
Noturus lachneri Taylor. Ouachita madtom. **T.** 43.
Noturus leptacanthus Jordan. speckled madtom. **CS.** 7–11, 13–21.
Noturus sp. cf. *leptacanthus*. broadtail madtom. **V.** 5, 6, 8.
Noturus miurus Jordan. brindled madtom. **CS.** 19–24, 26, 28–32, 39–43.
Noturus munitus Suttkus & Taylor. frecklebelly madtom. **T.** 16–18, 20.
Noturus sp. cf. *munitus*. Coosa madtom. **T.** 16.
Noturus nocturnus Jordan & Gilbert. freckled madtom. **CS.** 16–26, 28–31, 33, 36–47.
Noturus phaeus Taylor. brown madtom. **CS.** 20, 22–24, 26, 43, 44.
Noturus placidus Taylor. Neosho madtom. **T.** 41, 42.
Noturus stanauli Etnier & Jenkins. pygmy madtom. **E.** 26, 27.
Noturus stigmosus Taylor. northern madtom. **V.** 23–25, 29–31, 33.
Noturus taylori Douglas. Caddo madtom. **T.** 43.
Pylodictis olivaris (Rafinesque). flathead catfish. **CS.** (1), (2?), (3–11), (14, 15), 16–33, 35–51.
Satan eurystomus Hubbs & Bailey. widemouth blindcat. **E.** 50.
Trogloglanis pattersoni Eigenmann. toothless blindcat. **E.** 50.

Lepisosteidae–gars

Atractosteus spatula (Lacepède). alligator gar. **V.** 15, 17, 19–21, 23–26, 28, 33, 36, 39–41, 43–51.
Lepisosteus oculatus (Winchell). spotted gar. **CS.** 14–29, 33, 38–51.
Lepisosteus osseus (Linnaeus). longnose gar. **CS.** 1–51.
Lepisosteus platostomus Rafinesque. shortnose gar. **CS.** 21–26, 28, 29, 33, 35–45.
Lepisosteus platyrhincus DeKay. Florida gar. **CS.** 9–13.

Moronidae–temperate basses

Morone americana (Gmelin). white perch. **CS.** 1-6, (7), (9), (25?), 34.
Morone chrysops (Rafinesque). white bass. **CS.** (1–3), (5?), (6, 7), (9, 10), (14), (15?), (16?), (17?), (18?), 22–33, 35–44,

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Figure 20. Found in spring-fed, vegetated headwaters and creeks, the Arkansas darter (*Etheostoma cragini*), is vulnerable to the array of environmental problems that plague springs and groundwater.

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Figure 21. A vulnerable narrow-range endemic, the smallscale darter (*Etheostoma microlepidum*) is localized and uncommon in the lower Cumberland River drainage.

(45–51).

Morone mississippiensis Jordan & Eigenmann. yellow bass. **CS.** (16), 17–19, 21–28, (30), 33, 39–41, 43–47.

Morone saxatilis (Walbaum). striped bass (D). **CS.** 1–11, 13–21, (22, 23), (25–33), 34, (35, 36), (40, 41), (43, 44).

Mugilidae–mullets

Agonostomus monticola (Bancroft). mountain mullet (M). **V.** 6, 9, 11–15, 25, 46, 51.

Mugil cephalus Linnaeus. striped mullet (M). **CS.** 3, 4, 8–15, 17–21, 25, 44–50.

Percidae–perches

Ammocrypta beani Jordan. naked sand darter. **CS.** 16–24.

Ammocrypta bifascia Williams. Florida sand darter. **CS.** [14], 15.

Ammocrypta clara Jordan & Meek. western sand darter. **V.** 23, 25, 27–29, 31, 38–40, 43, 44, 46.

Ammocrypta meridiana Williams. southern sand darter. **CS.** 16–18.

Ammocrypta pellucida (Agassiz). eastern sand darter. **V.** 28–33.

Ammocrypta vivax Hay. scaly sand darter. **CS.** 19, 20, 22–24, 26, 39–41, 43–47.

Crystallaria asprella complex. crystal darters. **V.** 15–20, 22, 28, 29, 33, 37–40, 43, 44.

Crystallaria asprella ssp. Elk River crystal darter. **T.** 32.

Etheostoma acuticeps Bailey. sharphead darter. **V.** 27.

Etheostoma aquali Williams & Etnier. coppercheek darter. **V.** 26.

Etheostoma asprigene (Forbes). mud darter. **CS.** 22–26, 28, 29, 38–41, 43–46.

Etheostoma baileyi Page & Burr. emerald darter. **CS.** 28, 30.

Etheostoma barbouri Kuehne & Small. teardrop darter. **CS.** 29.

Etheostoma barrenense Burr & Page. splendid darter. **CS.** 29.

Etheostoma bellator Suttkus & Bailey. Warrior darter. **CS.** 18.

Etheostoma sp. cf. *bellator* 1. Sipsey darter. **V.** 18.

Etheostoma sp. cf. *bellator* 2. Locust Fork darter. **T.** 18.

Etheostoma bellum Zorach. orangefin darter. **CS.** 29.

Etheostoma bison Ceas & Page. buffalo darter. **CS.** 26.

Etheostoma blennioides blennioides Rafinesque. greenside darter. **CS.** (1), 30–33.

Etheostoma blennioides blennioides x *E. b. newmanii*. 29.

Etheostoma blennioides newmanii (Agassiz). highlands greenside darter. **CS.** 26–28, 39–43.

Etheostoma blennioides newmanii x *E. b. pholidotum*. 37.

Etheostoma blennioides pholidotum Miller. central greenside darter. **CS.** 36, 38.

Etheostoma blennioides gutselli (Hildebrand). Tuckasegee darter. **V.** 27.

Etheostoma blennius blennius Gilbert & Swain. blenny darter. **CS.** 26.

Etheostoma blennius blennius x *E. b. sequatchiense*. 26.

Etheostoma blennius sequatchiense Burr. Sequatchie darter. **V.** 27.

Etheostoma boschungi Wall & Williams. slackwater darter. **T.** 26.

Etheostoma brevirostrum Suttkus & Etnier. holiday darter. **T.** 16.

Etheostoma burri Ceas & Page. brook darter. **CS.** 40.

Etheostoma caeruleum caeruleum Storer. rainbow darter. **CS.** (1), 22–24, 26–33, 35–39.

Etheostoma caeruleum ssp. 1. Ozark rainbow darter. **CS.** 40.

Etheostoma caeruleum ssp. 2. Homochitto rainbow darter. **CS.** 22.

Etheostoma sp. cf. *caeruleum* 1. relict rainbow darter. **T.** 39.

Etheostoma sp. cf. *caeruleum* 2. Arkansas rainbow darter. **CS.** 40.

Etheostoma camurum (Cope). bluebreast darter. **CS.** 26–28, 30–32.

Etheostoma chermocki Boshung, Mayden, & Tomelleri. vermilion darter. **E.** 18.

Etheostoma chienense Page & Ceas. relict darter. **E.** 24.

Etheostoma chlorobranchium Zorach. greenfin darter. **CS.** 27.

Etheostoma chlorosoma (Hay). bluntnose darter. **CS.** 16–26,

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Figure 22. The headwater darter, a taxonomically undescribed species in the orangethroat darter (*Etheostoma spectabile*) complex, is currently stable in streams of eastern Kentucky and north-central Tennessee.

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Figure 23. A pair of Missouri saddled darters (*Etheostoma tetrazonum*), part of a species complex in the Missouri Ozarks, provide a glimpse of the color males achieve during the spawning season.

28, 29, 33, 36, 39–50.
Etheostoma chuckwachatte Mayden & Wood. lipstick darter. **V.** 16.
Etheostoma cinereum Storer. ashy darter. **T.** 26–28.
Etheostoma collettei Birdsong & Knapp. creole darter. **CS.** 43, 44.
Etheostoma collis (Hubbs & Cannon). Carolina darter. **V.** 3–7.
Etheostoma colorosum Suttkus & Bailey. coastal darter. **CS.** 15.
Etheostoma coosae (Fowler). Coosa darter. **CS.** 16.
Etheostoma corona Page & Ceas. crown darter. **V.** 26.
Etheostoma cragini Gilbert. Arkansas darter. **V.** 42.
Etheostoma crossopterum Braasch & Mayden. fringed darter. **CS.** 24, 26, 28.
Etheostoma davisoni Hay. Choctawhatchee darter. **CS.** 15.
Etheostoma denoncourti Stauffer & van Snik. golden darter. **V.** 26, 27.
Etheostoma ditrema Ramsey & Suttkus. coldwater darter. **T.** 16.
Etheostoma douglasi Wood & Mayden. Tuskaloosa darter. **CS.** 18.
Etheostoma duryi Henshall. black darter. **CS.** 26, 27.
Etheostoma edwini (Hubbs & Cannon). brown darter. **CS.** 11, 13–15.
Etheostoma etnieri Bouchard. cherry darter. **CS.** 28.
Etheostoma etowahae Wood & Mayden. Etowah darter. **E.** 16.
Etheostoma euzonum erizonum (Hubbs & Black). Current saddled darter. **CS.** 40.
Etheostoma euzonum euzonum (Hubbs and Black). Arkansas saddled darter. **CS.** 40.
Etheostoma flabellare brevispina (Coker). Carolina fantail darter. **CS.** 6, 7.
Etheostoma flabellare humerale (Girard). Chesapeake fantail darter. **CS.** 1–5.
Etheostoma flabellare complex. fantail darters. **CS.** 26–33, 36–42.
Etheostoma flavum Etnier & Bailey. saffron darter. **CS.** 26, 28.
Etheostoma fonticola (Jordan & Gilbert). fountain darter. **E.** 50.
Etheostoma forbesi Page & Ceas. Barrens darter. **T.** 28.
Etheostoma fragi Distler. Strawberry darter. **CS.** 40.
Etheostoma fricksium Hildebrand. Savannah darter. **CS.** 8, 9, 10?.
Etheostoma fusiforme barratti (Holbrook). scalyhead darter. **CS.** 6–15, 17–21, 23, 24, (27?), 39–41, 43, 44.
Etheostoma fusiforme fusiforme (Girard). swamp darter. **CS.** 1–5, 34.
Etheostoma gracile (Girard). slough darter. **CS.** 18-20, 22–26, 28, 29, 36, 39–51.
Etheostoma histrio Jordan & Gilbert. harlequin darter. **CS.** 15–26, 29, 39–41, 43–46, 47?.
Etheostoma hopkinsi binotatum Bailey & Richards. Christmas-Eve darter. **CS.** 9.
Etheostoma hopkinsi hopkinsi (Fowler). Christmas darter. **CS.** 10.
Etheostoma inscriptum (Jordan & Brayton). turquoise darter. **CS.** 8–10.
Etheostoma jessiae (Jordan & Brayton). blueside darter. **CS.** 26, 27.
Etheostoma jordani Gilbert. greenbreast darter. **CS.** 16, 17.
Etheostoma juliae Meek. yoke darter. **CS.** 40.
Etheostoma kanawhae (Raney). Kanawha darter. **CS.** 32.
Etheostoma kantuckeense Ceas & Page. Highland Rim darter. **CS.** 29.
Etheostoma kennicotti (Putnam). stripetail darter. **CS.** 26–29.
Etheostoma lachneri Suttkus & Bailey. Tombigbee darter. **CS.** 17, 18.
Etheostoma lepidum (Baird & Girard). greenthroat darter. **CS.** 49–51.
Etheostoma longimanum Jordan. longfin darter. **CS.** 2.
Etheostoma luteovinctum Gilbert & Swain. redband darter. **CS.** 26, 28.
Etheostoma lynceum Hay. brighteye darter. **CS.** 19–24.
Etheostoma maculatum Kirtland. spotted darter. **V.** 29–32.
Etheostoma mariae (Fowler). pinewoods darter. **V.** 6.
Etheostoma meadiae (Jordan & Evermann). bluespar darter. **CS.** 27.

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Figure 24. Rare and sporadic in clear runs of streams in the Cumberland and Tennessee River drainages, the blotchside logperch (*Percina burtoni*) is vulnerable and declining in parts of its range.

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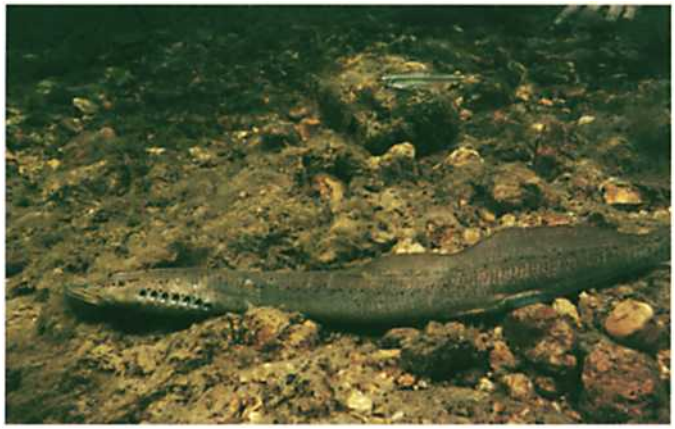

Figure 25. The chestnut lamprey (*Ichthyomyzon castaneus*), an obligate parasitoid on numerous fish species, maintains relatively stable populations throughout its range, and is known to spawn in the same riffles as its presumed sister species, the southern brook lamprey (*I. gagei*), a free-living species.

Etheostoma microlepidum Raney & Zorach. smallscale darter. **V.** 28.
Etheostoma microperca Jordan & Gilbert. least darter. **CS.** 28?, 30, 36, 37, 42.
Etheostoma moorei Raney & Suttkus. yellowcheek darter. **T.** 40.
Etheostoma neopterum Howell & Dingerkus. lollypop darter. **V.** 26.
Etheostoma nianguae Gilbert & Meek. Niangua darter. **T.** 36.
Etheostoma nigripinne Braasch & Mayden. blackfin darter. **CS.** 18, 26.
Etheostoma nigrum nigrum Rafinesque. johnny darter. **CS.** 2–4, 16–18, 22–24, 26, 28, 29–33, 35–44.
Etheostoma nuchale Howell & Caldwell. watercress darter. **E.** 18.
Etheostoma obeyense Kirsch. barcheek darter. **CS.** 28.
Etheostoma okaloosae (Fowler). Okaloosa darter. **E.** 15.
Etheostoma olivaceum Braasch & Page. sooty darter. **V.** 28.
Etheostoma olmstedi complex. tessellated darters. **CS.** 1–11, [32], 34.
Etheostoma oophylax Ceas & Page. guardian darter. **CS.** 26.
Etheostoma osburni (Hubbs & Trautman). candy darter. **V.** 32.
Etheostoma pallididorsum Distler & Metcalf. paleback darter. **T.** 43.
Etheostoma parvipinne Gilbert & Swain. goldstripe darter. **CS.** 9?, 10, 14–24, 26, 39, 40, 43, 44, 46–49.
Etheostoma percnurum Jenkins. duskytail darter. **E.** 27, 28.
Etheostoma perlongum (Hubbs & Raney). Waccamaw darter. **T.** 6.
Etheostoma phytophilum Bart & Taylor. rush darter. **E.** 18.
Etheostoma podostemone Jordan & Jenkins. riverweed darter. **CS.** 3.
Etheostoma proeliare (Hay). cypress darter. **CS.** 15, 17–24, 26, 28, 29, 39–41, 43–47, 49.
Etheostoma pseudovulatum Page & Ceas. egg-mimic darter. **T.** 26.
Etheostoma punctulatum (Agassiz). stippled darter. **CS.** 36–40.
Etheostoma sp. cf. *punctulatum*. sunburst darter. **CS.** 41, 42.
Etheostoma pyrrhogaster Bailey & Etnier. firebelly darter. **V.** 24.
Etheostoma radiosum paludosum (Moore & Rigney). Washita darter. **CS.** 44.
Etheostoma radiosum radiosum (Hubbs & Black). orangebelly darter. **CS.** 43, 44.
Etheostoma rafinesquei Burr & Page. Kentucky darter. **CS.** 29.
Etheostoma ramseyi Suttkus & Bailey. Alabama darter. **CS.** 17.
Etheostoma raneyi Suttkus & Bart. Yazoo darter. **V.** 23.
Etheostoma rubrum Raney & Suttkus. bayou darter. **E.** 22.
Etheostoma rufilineatum (Cope). redline darter. **CS.** 26–28.
Etheostoma rupestre Gilbert & Swain. rock darter. **CS.** 16–18.
Etheostoma sagitta sagitta (Jordan & Swain). Cumberland arrow darter. **CS.** 28.
Etheostoma sagitta spilotum Gilbert. Kentucky arrow darter. **V.** 30.
Etheostoma sanguifluum (Cope). bloodfin darter. **CS.** 28.
Etheostoma scotti Bauer, Etnier, & Burkhead. Cherokee darter. **T.** 16.
Etheostoma sellare (Radcliffe & Welsh). Maryland darter. **E.** 1.
Etheostoma serrifer (Hubbs & Cannon). sawcheek darter. **CS.** 2–10.
Etheostoma simoterum atripinne (Jordan). Cumberland snubnose darter. **CS.** 26, 28.
Etheostoma simoterum atripinne x *E. s. simoterum*. 26.
Etheostoma simoterum simoterum (Cope). Tennessee snubnose darter. **CS.** 26, 27, (31, 32).
Etheostoma smithi Page & Braasch. slabrock darter. **CS.** 26, 28.
Etheostoma spectabile pulchellum (Girard). plains darter. **CS.** 41, 44.
Etheostoma spectabile spectabile (Agassiz). orangethroat darter. **CS.** 24, 31, 35–38.
Etheostoma spectabile squamosum Distler. plateau darter. **CS.** 42.
Etheostoma sp. cf. *spectabile* 1. Caney Fork darter. **CS.** 28.
Etheostoma sp. cf. *spectabile* 2. Cumberland darter. **CS.** 28.
Etheostoma sp. cf. *spectabile* 3. headwater darter. **CS.** 28–30.
Etheostoma sp. cf. *spectabile* 4. Ozark darter. **CS.** 40.
Etheostoma sp. cf. *spectabile* 5. Sheltowhee darter. **CS.** 28.
Etheostoma squamiceps Jordan. spottail darter. **CS.** 28, 29.

Etheostoma stigmaeum (Jordan). speckled darter. **CS.** 15–24, 26, 39, 40, 43–46, 47?.
Etheostoma sp. cf. *stigmaeum* 1. highland darter. **CS.** 40–42.
Etheostoma sp. cf. *stigmaeum* 2. beaded darter. **V.** 43.
Etheostoma sp. cf. *stigmaeum* 3. bluegrass darter. **CS.** 29.
Etheostoma sp. cf. *stigmaeum* 4. bluemask darter. **E.** 28.
Etheostoma sp. cf. *stigmaeum* 5. clown darter. **CS.** 26.
Etheostoma sp. cf. *stigmaeum* 6. longhunt darter. **CS.** 28.
Etheostoma striatulum Page & Braasch. striated darter. **T.** 26.
Etheostoma susanae (Jordan & Swain). Cumberland johnny darter. **T.** 28.
Etheostoma swaini (Jordan). gulf darter. **CS.** 13–24, 26.
Etheostoma swannanoa Jordan & Evermann. Swannanoa darter. **CS.** 27.
Etheostoma tallapoosae Suttkus & Etnier. Tallapoosa darter. **CS.** 16.
Etheostoma tecumsehi Ceas & Page. Shawnee darter. **T.** 29.
Etheostoma tetrazonum (Hubbs & Black). Missouri saddled darter. **CS.** 35–37.
Etheostoma sp. cf. *tetrazonum*. Meramec saddled darter. **CS.** 38.
Etheostoma thalassinum (Jordan & Brayton). seagreen darter. **CS.** 7.
Etheostoma tippecanoe Jordan & Evermann. Tippecanoe darter. **V.** 28–32.
Etheostoma trisella Bailey & Richards. trispot darter. **E.** 16.
Etheostoma tuscumbia Gilbert & Swain. Tuscumbia darter. **V.** 26.
Etheostoma uniporum Distler. Current darter. **CS.** 40.
Etheostoma variatum Kirtland. variegate darter. **CS.** 30–33.
Etheostoma virgatum (Jordan). striped darter. **CS.** 28.
Etheostoma vitreum (Cope). glassy darter. **CS.** 1–4.
Etheostoma vulneratum (Cope). wounded darter. **V.** 27.
Etheostoma wapiti Etnier & Williams. boulder darter. **E.** 26.
Etheostoma whipplei artesiae (Hay). redspot darter. **CS.** 14, 16–20, 22, 23, 43–46.
Etheostoma whipplei whipplei (Girard). redfin darter. **CS.** 40–42.
Etheostoma zonale (Cope). banded darter. **CS.** (9), 26–33, 36–43.
Etheostoma zonifer (Hubbs & Cannon). backwater darter. **CS.** 14, 16–18.
Etheostoma zonistium Bailey & Etnier. bandfin darter. **CS.** 24, 26.
Etheostoma sp. cf. *zonistium*. blueface darter. **T.** 18, 26.
Perca flavescens (Mitchill). yellow perch. **CS.** 1–3, (4–10), (14–16), 17, (18), (26–28), (31–33), 34, (37).
Percina antesella Williams & Etnier. amber darter. **E.** 16.
Percina aurantiaca (Cope). tangerine darter. **CS.** 27.
Percina aurolineata Suttkus & Ramsey. goldline darter. **T.** 16, 17.
Percina aurora Suttkus & Thompson. Pearl darter. **E.** 19, 20.
Percina austroperca Thompson. southern logperch. **V.** 15.
Percina brevicauda Suttkus & Bart. coal darter. **T.** 16–18.
Percina burtoni Fowler. blotchside logperch. **V.** 26–28.
Percina caprodes caprodes (Rafinesque). logperch. **CS.** 1, 23, 26–33, 39, 40, 43–45.
Percina caprodes caprodes x *P. c. fulvitaenia*. 24?, 25, 39, 40.
Percina caprodes fulvitaenia Morris & Page. Ozark logperch. **CS.** 36–38, 41, 42.
Percina caprodes fulvitaenia x *P. c. semifasciata*. 39.
Percina carbonaria (Baird & Girard). Texas logperch. **CS.** 48–50.
Percina copelandi (Jordan). channel darter. **CS.** 26–33, 41–44.
Percina crassa (Jordan & Brayton). Piedmont darter. **CS.** 5–7.
Percina cymatotaenia (Gilbert & Meek). bluestripe darter. **T.** 36, 37.
Percina evides evides (Jordan & Copeland). gilt darter. **CS.** 26–32.
Percina evides ssp. 1. Appalachian gilt darter. **CS.** 27.
Percina evides ssp. 2. Ozark gilt darter. **CS.** 36–40.
Percina gymnocephala Beckham. Appalachia darter. **CS.** 32.
Percina jenkinsi Thompson. Conasauga logperch. **E.** 16.
Percina kathae Thompson. Mobile logperch. **CS.** 16–18.
Percina lenticula Richards & Knapp. freckled darter. **T.** 16–20.
Percina macrocephala (Cope). longhead darter. **T.** 26–32.
Percina sp. cf. *macrocephala* 1. Warrior bridled darter. **V.** 18.
Percina sp. cf. *macrocephala* 2. muscadine bridled darter. **V.** 16.
Percina sp. cf. *macrocephala* 3. upland bridled darter. **V.** 16.
Percina macrolepida Stevenson. bigscale logperch. **CS.** 44, 46–50.
Percina maculata (Girard). blackside darter. **CS.** 16–18, 20–24, 26–32, 38–41, 43–45.
Percina nasuta (Bailey). longnose darter. **T.** 39–41.
Percina sp. cf. *nasuta*. Ouachita darter. **T.** 43.
Percina nevisense Cope. chainback darter. **CS.** 3, 4.
Percina nigrofasciata (Agassiz). blackbanded darter. **CS.** 8–22.
Percina nigrofasciata x *P. n. raneyi*. 8, 9, 10.
Percina nigrofasciata raneyi Crawford. Savannah blackbanded darter. **CS.** 9.
Percina sp. cf. *nigrofasciata*. Halloween darter. **V.** 14.
Percina notogramma montuosa Hogarth & Woolcott. mountain stripeback darter. **CS.** 1, 2.
Percina notogramma notogramma (Raney & Hubbs). stripeback darter. **CS.** 2.
Percina oxyrhynchus (Hubbs & Raney). sharpnose darter. **CS.** 30–32.
Percina palmaris (Bailey). bronze darter. **CS.** 16.
Percina pantherina (Moore & Reeves). leopard darter. **T.** 44.
Percina peltata (Stauffer). shield darter. **CS.** 1, 2, 34.
Percina phoxocephala (Nelson). slenderhead darter. **CS.** 23–26, 28–31, 33, 36–38, 41, 42, 44.
Percina rex (Jordan & Evermann). Roanoke logperch. **E.** 3.
Percina roanoka (Jordan & Jenkins). Roanoke darter. **CS.** (2), 3, 4, (32).
Percina sciera apristis (Hubbs & Hubbs). Guadalupe dusky darter. **CS.** 50.
Percina sciera sciera (Swain). dusky darter. **CS.** 17–33, 39–41, 43–49.
Percina shumardi (Girard). river darter. **CS.** 16–20, 22–31, 33, 38–44, 46, 50.
Percina squamata (Gilbert & Swain). olive darter. **V.** 27, 28.
Percina stictogaster Burr & Page. frecklebelly darter. **CS.** 29, 30.
Percina suttkusi Thompson. Gulf logperch. **CS.** 17–21.

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Figure 26. As its common name suggests, the central mudminnow (*Umbra limi*) is often associated with organic and muddy substrates of lowlands and swamps, but has a limited range in the southeastern United States.

Percina tanasi Etnier. snail darter. **T.** 26, 27.
Percina uranidea (Jordan & Gilbert). stargazing darter. **V.** 39, 40, 43.
Percina vigil (Hay). saddleback darter. **CS.** 15–26, 29, 39, 40, 43.
Stizostedion canadense (Smith). sauger. **CS.** (7?), (9), (14), 20, 22–33, 35–40, (44).
Stizostedion vitreum (Mitchill). walleye. **CS.** (1–3), (4?), (6, 7), (9, 10), (14, 15), 16–18, 20, 23, 25–33, (34), 35–40, (41, 42), 43, (44), (46), (48, 49).

Percopsidae–trout-perches

Percopsis omiscomaycus (Walbaum). trout-perch. **V.** 1, 25, 29–33, 37.

Petromyzontidae–lampreys

Ichthyomyzon bdellium (Jordan). Ohio lamprey. **CS.** 27–33.
Ichthyomyzon castaneus Girard. chestnut lamprey. **CS.** 16–18, 20–23, 25–29, 33, 35–44, 45?, 46.
Ichthyomyzon fossor Reighard & Cummins. northern brook lamprey. **CS.** 30, 31, 36-38.
Ichthyomyzon gagei Hubbs & Trautman. southern brook lamprey. **CS.** [9], 13–24, 26, 37, 39–47.
Ichthyomyzon greeleyi Hubbs & Trautman. mountain brook lamprey. **CS.** 9, 26–29.
Ichthyomyzon unicuspis Hubbs & Trautman. silver lamprey. **CS.** 22, 25, 26, 28–31, 33.
Lampetra aepyptera (Abbott). least brook lamprey. **CS.** 1, 2, 4, 15–20, 22–24, 26, 28–34, 38–40.
Lampetra appendix (DeKay). American brook lamprey. **CS.** 1–3, 26–31, 34, 39, 40.
Petromyzon marinus Linnaeus. sea lamprey (M). **CS.** 1–11, 34.

Poeciliidae–livebearers

Gambusia affinis (Baird & Girard). western mosquitofish. **CS.** 16–26, [27], 28, 29, (30, 31), 33, (35–38), 39–41, (42), 43–51.
Gambusia affinis x *G. holbrooki*. 16–19.
Gambusia holbrooki Girard. eastern mosquitofish. **CS.** 1–15, (16), [19], (27), [34].
Gambusia geiseri Hubbs & Hubbs. largespring gambusia. **CS.** (49), 50.
Gambusia georgei Hubbs & Peden. San Marcos gambusia. **X.** 50.
Gambusia heterochir Hubbs. Clear Creek gambusia. **E.** 49.
Heterandria formosa Agassiz. least killifish. **CS.** [5], 6–15, 17–21, 45.
Poecilia latipinna (Lesueur). sailfin molly. **CS.** 5–15, 17, 19–21, 45–51.

Polyodontidae–paddlefishes

Polyodon spathula (Walbaum). paddlefish. **V.** (14?), 16–21, 23–33, 35–38, 40–45.

Salmonidae–trouts

Salvelinus fontinalis (Mitchill). brook trout. **CS.** 1, 2, [3], (6), [7], 9, (14), (16), 27, (28), (30), 32, (34), (40).

Sciaenidae–drums

Aplodinotus grunniens Rafinesque. freshwater drum. **CS.** (3), 16–33, 35–51.

Syngnathidae–pipefishes

Microphis brachyurus lineatus (Valenciennes). Opossum pipefish (M). **V.** 7, 10–12, 15, 17, 19.
Syngnathus scovelli (Evermann & Kendall). Gulf pipefish (M). **CS.** 11–15, 17, 19, 21, 25, 45, 47, 51.

Umbridae–mudminnows

Umbra limi (Kirtland). central mudminnow. **CS.** 24, 26, 39.
Umbra pygmaea (DeKay). eastern mudminnow. **CS.** 1–11, 13, 34.

Summary and conclusions

In this document we have synthesized for the first time the entire known native fish fauna across all major drainages of the southern United States, including realized (i.e., all described species and subspecies) and potential (i.e., undescribed fish taxa) diversity, distribution, and conservation status. The list includes 662 native freshwater and diadromous fishes and 24 marine fishes that are significant components of freshwater ecosystems. Of this total, 560 described, freshwater fish species are documented, and 49 undescribed species are included provisionally pending formal description. Described subspecies (86) are recognized within 43 freshwater species, 6 fishes contain undescribed subspecies, and 9 fishes are recognized as complexes of undescribed taxa. Notably, 28% of southern fishes (183 taxa) have their range restricted to only one drainage unit, and 37 of 51 drainage units had at least one unique fish taxon. Even at the large scale of the drainage units used here, high numbers of range-restricted fishes emphasize the magnitude of the threat of range fragmentation and isolation for southern fishes.

We deliberately included subspecific categories and undescribed taxa in an attempt to give a full accounting of both realized and potential fish diversity in the region.

Upon further analysis, some of these potential units of diversity may be found to not warrant taxonomic recognition nor deserve conservation consideration. We expect, however, that validation of many potential units of diversity simply awaits application of phylogenetic analysis to the species discovery potential afforded by rapidly developing biotechnology (Mayden and Wood 1995). Undescribed taxa, subspecies, and complexes may ultimately reveal additional distinct population segments or evolutionarily significant units. From this perspective, our accounting of diversity of southern U.S. fishes is conservative. We challenge the ichthyological community to pursue and complete analyses of undescribed taxa and critically examine subspecific taxa and species complexes documented herein. Accounting for diversity is critical to the informed management, maintenance, and recovery of this extraordinary fish fauna (Mayden and Wood 1995; Angermeier and Winston 1999).

Extinct, endangered, threatened, or vulnerable status is recognized for 28% (187 taxa) of southern freshwater and diadromous fishes. To date, three southern fishes (whiteline topminnow, *Fundulus albolineatus*; San Marcos gambusia, *Gambusia georgei*; and harelip sucker, *Moxostoma lacerum*) are known to be extinct throughout their ranges (Miller et al. 1989; Hubbs et al. 1991), and the greater redhorse (*Moxostoma valenciennesi*) (Burr and Warren 1986) and headwater catfish (*Ictalurus lupus*) (Kelsch and Hendricks 1990; Hubbs et al. 1991) are extirpated from the study region. Two others, the Maryland darter (*Etheostoma sellare*) (Etnier 1994, 1997) and smalleye shiner (*Notropis buccula*) (Hubbs et al. 1991), may be extinct but are classified here as endangered. Of the extant southern fishes, 41 (6%) are regarded as endangered, 46 (7%) as threatened, and 101 (15%) as vulnerable. Five marine fishes that frequent fresh water are regarded as vulnerable.

The list of jeopardized southern fishes has increased continually and rapidly since the first AFS assessment was published two decades ago (Deacon et al. 1979). In 1979, 85 fishes from the region were regarded as endangered, threatened, or of special concern (Deacon et al. 1979). Williams et al. (1989) placed 109 southern fishes in jeopardized categories, a 28% increase in ten years. Our assessment represents a 75% increase since Williams et al. (1989) and a 125% increase in 20 years. Although this increase has involved addition of many fishes to the vulnerable category, southern fishes ranked as endangered in these assessments have more than doubled over this time period. Overall, the trend in the southern United States is clear. Jeopardized fishes are successively being moved from the vulnerable category to that of imminent threat of extinction.

We recognize that fishes are not the only taxa in the conservation crisis documented for southern waters. For example, of 269 freshwater mussel species of the southeastern United States, 13% are extinct and 60% are jeopardized (Williams et al. 1993, Neves et al. 1997). Likewise, other groups of organisms dependent on southern aquatic systems show high levels of extinction (e.g., gastropods, Neves et al. 1997) and imperilment (e.g., crayfishes, Taylor et al. 1996; aquatic reptiles, Buhlmann and Gibbons 1997). These large-scale biotic declines are vital signals of a pervasive degradation of southern watersheds and of society's failure to recognize the interactive nature of land and water management. Given an estimated future extinction rate of 2.4% per decade for freshwater fish species in the United States (Ricciardi and Rasmussen 1999), about 10% of the southern fish fauna could be extinct by 2050. The realization of this projection is largely contingent on societal will to implement effective conservation actions. The question is, how do we as fisheries and aquatic resource professionals make the public, politicians, and policy makers hear the critical biological signals of water resource degradation amid the noisy chaos of short-term economic gain and unsustainable development?

In publishing this list, the Southeastern Fishes Council has summarized for the professional fishery community, conservation organizations, the public, and law makers, the very high diversity of southern fishes, their distribution across the landscape, and their conservation status. We urge all readers to critically examine our findings and bring to our attention any additional information. We recognize that with new information, some of our conservation

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status assignments may be unwarranted. We intend the list to serve as a planning tool to help set priorities for conducting recovery efforts, status surveys, and biological research on jeopardized southern fishes. Our results clearly demonstrate that conservation of southern fishes cannot be achieved one species at a time, but will require management for biological integrity of land and water resources of the southern United States.

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