The Fishes of Oklahoma, Their Gross Habitats, and Their Tolerance of Degradation in Water Quality and Habitat

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This paper lists 179 species of fishes known in Oklahoma, two species which have been reported but may not occur, and two abundant stocked hybrids. Nomenclature conforms with recent taxonomic revisions. Gross habitats for each species are listed in order of preference for rivers, creeks, lakes, ponds, and swamps and sloughs. In order of occurrence in habitat, 170 species and the two hybrids occur in rivers, 154 species in creeks, 88 species and the hybrids in lakes, 52 species in swamps and sloughs, and 32 species in ponds. In terms of diversity, nine species occur in only one habitat, 81 species and two hybrids in two habitats, 58 species in three habitats, 16 species in four habitats, and 17 species occur in all five habitats. Mean numerical scores tested against $\bar{x}\pm 2S_x$, are used to classify all species as Intolerant, Moderately Intolerant, Moderately Tolerant, or Tolerant of water quality changes and habitat alterations. The two intolerant categories contain 47 and 60 species respectively for water quality and 84 and 43 species respectively for habitat. The tolerant categories contain 48 and 28 species respectively for water quality and 41 and 15 species respectively for habitat. Forty-five species are equally tolerant or intolerant of degradation of both water quality and habitat. Only 11 species are more intolerant of water quality degradation and 127 species are more intolerant of habitat degradation. This list will become the official tolerance classification for regulatory purposes in Oklahoma upon adoption in the state water quality standards.

INTRODUCTION

Fish populations and community structure are important biological features analyzed for a variety of regulatory, management, and academic reasons. Population size and community composition depend upon ranges of tolerance of species to trophic and competitive interactions among organisms and to various habitat and physical-chemical water quality factors. Analysis requires that habitat and water quality be defined and judged with respect to the organisms indigenous to the regions of concern rather than to preconceived human aesthetic concepts. For example, a fish that requires sand-silt substrate, alkaline pH, and gypsum or saline waters in western Oklahoma may be just as limited by its ranges of tolerance as a fish that requires cool, clear, gravel-bottom, mild pH, and soft waters in the highlands of eastern Oklahoma.

If a species is characterized by narrow ranges of tolerance, it is inherently sensitive to major natural or anthropogenic changes in habitat or water quality factors, and its population will be reduced or disappear from the community following such changes. Therefore, the species may be described as "sensitive" for purposes of ecological analysis, and "intolerant" of habitat or water quality degradation for regulatory and management purposes. The terms "sensitive" and "intolerant" are interchangeable, and we have opted to classify species herein as "intolerant" or "tolerant" on the basis of their relative "sensitivity" and reactions to changes or degradation of habitat or water quality.

Previously, ecologists have applied Shelford's Law of Tolerance (*1*) to one or a few factors for one or a few species of fishes as appropriate for a specific investigation or commentary. When the U.S. Environmental Protection Agency (EPA) began funding ecological surveys under the federal Clean Water Act of 1972 to assess attainable and attained uses of waters, it became useful to classify fishes as intolerant and tolerant in assessments of environmental quality. The EPA provided a Technical Support Manual (*2*) which contains national lists of 68 species that are intolerant and 36 species that are tolerant of, or prefer, bottom sediments or high levels of turbidity as a reflection of habitat requirements, and a national list of 102 species and four genera comprising 56 species that are intolerant of "water quality changes," "habitat alterations," or both. The latter list includes 31 named species and the four genera include 32 species known to occur in Oklahoma. The EPA does not intend the lists to be definitive but, rather, stated that "The list ... is intended to be used by knowledgeable biologists as a rough guide to the relatively-intolerant fish species in their state." They also stated in another context that "The list is intended to be used by knowledgeable biologists who are capable of adding and deleting species where necessary to produce a list which is appropriate for the particular area of study."

Use-attainability assessments, ecological investigations, and perusal of relevant reference material revealed that the national lists are incomplete for Oklahoma, at least one species is listed erroneously, and opinions vary among fishery workers concerning intolerance of several species. For other species, no written opinions are available. Our primary objective was to establish a standardized classification of all the known fishes of Oklahoma with regard to their overall ranges of tolerance of habitat and water quality factors for regulatory, management, and academic purposes.

METHODS

The first requirement of the study was to establish an official list of the fishes of Oklahoma, identify their gross habitats, and standardize tolerance classifications so as to record judgment of a collective "knowledgeable biologist" as required by EPA guidance (*2*) above. This was accomplished by enlisting the authors whose individual and collective experiences have included collecting fishes and noting the conditions in which they occur throughout Oklahoma and in all adjacent states.

Upgrading the list of fishes known in the state consisted of reconciling older and recent literature and authors' unpublished lists, adding four species, and reconciling family and species nomenclature with recent taxonomic revisions.

The updated list of fishes was provided to each author with instructions to list known habitats of each species as lakes or reservoirs (L), ponds (P), rivers (R), creeks (C), and swamps or sloughs (S) in order of frequency of collections or known preferences. Analysis consisted of listing all of the habitats reported, with order of occurrence or "preference" determined by the number of authors reporting the habitat, refined further by the order in which they were reported.

Instructions to the authors for classifying species in terms of tolerance of changes in habitat and water quality required that quality be considered from the viewpoint of the species as discussed in the Introduction and that tolerance or intolerance be judged in terms of a general application of Shelford's Law (*1*). The aforementioned problem of occasional differences of opinion appeared to occur when one author believed that a species was moderately intolerant while another believed it to be moderately tolerant, a much smaller difference than indicated by the unmodified terms, tolerant and intolerant. This problem was solved by expanding the classification to four categories — Intolerant (I), Moderately

Intolerant (MI), Moderately Tolerant (MT), and Tolerant (T) — with sensitivity decreasing or tolerance increasing ordinally. Concurrently, the expanded classification appears to provide more accurate description for ecological commentary.

Each author ranked each species separately for habitat and water quality by using a choice of abbreviated terms or numerical order, depending upon personal preference. The rankings were reduced to numerical data to determine statistically tested means for consensus classifications of each species. To equalize the range of values for each category, the difference between Intolerant (I = 1) and Tolerant (T = 4) (4 - 1 = 3) was divided into four equal parts so that I = 1.0 to 1.7, MI = 1.8 to 2.5, MT = 2.6 to 3.3, and T = 3.4 to 4.0. Three to six authors, mostly five or six, ranked each species. Standard deviation was computed for each set of data and each set was compared with $\bar{x} \pm 2S_x$. Data points that exceeded this range were deleted and $\bar{x}$ and S_x were recomputed. Few data points were rejected. Therefore, all species were classified without requiring resolution of any statistical uncertainty.

RESULTS AND DISCUSSION

Fishes of Oklahoma

Two comprehensive works published in 1973 included lists of the fishes of Oklahoma known at that time. As might be expected, searches of more than a century of literature and sometimes-obscure taxonomic revisions resulted in minor discrepancies between the two lists. Miller and Robison (*3*) provided taxonomic keys, photographs of preserved specimens, and Oklahoma range maps for 165 species. They also cited two species added by recent collections (total of 167 species). Moore's (*4*) historical perspective included discovery and the earliest literature references to 166 species but stated that 168 species occurred in the state. The disparity involved seven species, three in Moore's list and four in Miller and Robison's list. Cashner and Matthews (*5*) resolved the differences between the lists and summarized the subsequent literature to verify documentation of 168 species in 1973 and 175 species reported in the state as of 1988.

Jester's and Pigg's continuously updated unpublished lists consist of 181 species which conform with Cashner and Matthews' update of Moore's and Miller and Robison's lists with six exceptions. Cashner and Matthews did not list the Ozark shiner which was reported by Burr et al. (*6*) in 1979 with subsequent collections confirmed by Pigg (unpublished). Another addition is the rudd, reported by Pigg and Pham (*7*) after Cashner and Matthew's paper was published. Two additional species were introduced into the state, both apparently in 1991. The Oklahoma Department of Wildlife Conservation stocked mature or near-mature brown trout in a lake and a river, and sport fishermen are catching the exotic bighead carp in one river into which it is believed to have escaped from a flood-damaged privately owned fish hatchery in Kansas. The remaining two exceptions are precautionary retention of the Mexican tetra and the stargazing darter by Jester and Pigg vs. deletion by Cashner and Matthews because the latter authors believed the tetra to be extinct in the state and the darter to be extinct or reported erroneously (*5*).

Reproduction and, therefore, possible naturalization of the two recently introduced species has not been confirmed. Brown trout stocked in Lake Carl Etling at the western edge of the Oklahoma panhandle apparently did not persist in the fish community, which usually is the case for brown trout in lakes and reservoirs. However, it is surviving and growing rapidly in the Mountain Fork River tailwater of Broken Bow Reservoir in southeastern Oklahoma. Whether it will spawn successfully and become self-sustaining is not known (Barry Bolton, Oklahoma Department of Wildlife Conservation, personal communication).

The bighead carp is known in Oklahoma only from recent relatively numerous sport fishing catches immediately downstream from a low-water dam in the Neosho River at Miami, Oklahoma (J. Pigg, manuscript in preparation). All specimens reported to date are large, mostly 30 to 35 pounds (13.5-16 kg), and may represent only an ephemeral immigrant population unless they spawn successfully. They spawn only in rivers but may inhabit mainstream reservoirs downstream from spawning sites and ponds when they are stocked.

The list of fishes known or authoritatively reported to occur in Oklahoma at the present time consists of 181 species (Table 1). However, the Mexican tetra and stargazing darter probably do not occur in the state, suggesting that the extant ichthyofauna consists of 179 species.

Wild hybrids, mostly small sunfishes *(Lepomis)* and shiners *(Notropis),* are reported occasionally and are primarily of novelty interest. None of these are listed here. However, two hybrids, *Morone* and *Stizostedion* crosses, are cultured and stocked in large numbers for sport fishing. These are listed for habitats occupied and tolerance classifications in Table 1 because they are abundant and have major economic and ecological importance where they occur.

Another feature of this list is conformity with recent taxonomic revisions and nomenclatural changes that have been accepted in papers by the journal *Copeia* and by the *Names of Fishes Committee of the American Fisheries Society.* These were summarized by Cashner and Matthews (*5*) and are not repeated here except to resolve one difference between Cashner and Matthews and the American Fisheries Society. Mayden (*8*) proposed elevating subgenus *Extrarius* of genus *Hybopsis* to a new genus which, combined with other changes, causes *Hybopsis* to disappear. Cashner and Matthews listed *Extrarius* among their nomenclatural changes. The American Fisheries Society (*9*) accepted disappearance of *Hybopsis* but rejected *Extrarius.* In Oklahoma, this affected only *Hybopsis aestivalis,* which is referred to *Macrhybopsis* by the American Fisheries Society. We follow AFS because their widely available published list (*9*) will result in wide acceptance of the name *Macrhybopsis aestivalis* for the speckled chub for at least a decade.

Gross Habitats

Different species of fishes may thrive in a variety of aquatic habitats. Some species are specialized, requiring narrowly defined microhabitats within a single gross habitat such as coarse-gravel riffles in cool headwaters of highland creeks. Others are generalist and are found in several or all of our categories of habitat: rivers, creeks, lakes, ponds, and swamps and sloughs. Descriptions of microhabitat requirements are beyond the scope of this paper and unknown for many species. However, use of literature and extensive collections statewide by these authors have provided knowledge of the gross habitats utilized by the species in the state and trends of requirements or preferences for these habitats. Miller and Robison (*3*) listed the habitats from which species on their list were collected. Their data serve as a point of departure for expanding the known list of habitats occupied and preferred by the fishes of the state.

The Habitat column in Table 1 represents the authors' cumulative knowledge of gross habitats that are used and the approximate order of preference for all species of fishes known to occur in Oklahoma. The order of use or preference is shown by the order in which the habitats are listed where the habitat symbols are separated by a space. The habitat symbols are separated by a slash where use or preference for two or more habitats is approximately equal.

Sensitivity or Tolerance

Two columns under Tolerance in Table 1 are used to classify each species of fish in terms of its general ranges of tolerance of water quality and habitat factors. Intolerance may consist of a high degree of sensitivity to one, a few, or several factors which, separately or combined, have a major effect on the population. Conversely, tolerance implies a low degree of sensitivity to a broad range of factors so that major changes are required in order to have appreciable effects on the population.

Occurrence of a species in several gross habitats does not necessarily imply that the species should be classified as tolerant of habitat degradation. While there may be some correlation, there are too many exceptions for a rule. Therefore, gross habitats in which a species occurs is a separate and distinct characteristic from its tolerance of changes in specific factors.

Notation in Table 1 which describes the sensitivity or tolerance of each species consists of a letter abbreviation and two numerical values. The abbreviations represent classification of the species as intolerant or moderately intolerant (I and MI) or as moderately tolerant or tolerant (MT or T) in descending order of sensitivity to changes in water quality and habitat. The first number, without parentheses, is the mean score $\bar{x}$ computed from the individual ratings provided by the authors. It is the basis described under Methods for the categories represented by the letter abbreviations.

The second number, in parentheses, is the standard deviation S_x of the individual ratings. It was used in $\bar{x} \pm 2S_x$ to determine acceptability of individual scores for use in computations and is shown in Table 1 as S_x to indicate consistency of opinions among authors. Smaller values indicate greater consistency, to the end point of $S_x = 0.000$ for a unanimous score. However, in some instances, a larger value may not necessarily represent a greater range of individual scores. For example, the scores for one species may consist entirely of 1.0 and 2.0 but a larger standard deviation would occur if the scores were submitted by three authors than if they were submitted by five or six authors.

An artifact of the use of numerical scores to classify fishes in the four categories is that mean numerical scores with relatively small standard deviations may be used with considerable confidence to rank species within each category, both overall and within families. The numerical scores reveal a few species that might be considered to be "extremely" tolerant or intolerant. Six species received unanimous scores of 1.0 for intolerance of changes in water quality and 15 species received unanimous scores of 1.0 for intolerance of habitat alteration. However, only five species; the cypress minnow, duskystripe or cardinal shiner, peppered shiner, Ozark cavefish, and banded sculpin, were rated 1.0 for intolerance of degradation of both water quality and habitat. It appears, then, that these five species are the most intolerant fishes in Oklahoma.

Five species received mean scores of 4.0 for tolerance of water quality degradation and five species received mean scores of 4.0 for tolerance of habitat degradation. Four of these, the rudd, black bullhead catfish, mosquitofish, and green sunfish, were rated 4.0 for both water quality and habitat degradation. Among these, the mosquitofish and the black bullhead are considered by many fishery workers to be the most tolerant freshwater fishes in North America**,** and the four species certainly are the most tolerant fishes in Oklahoma.

The brown trout and bighead carp were introduced or discovered in the state after numerical analysis of tolerance was completed and were incorporated into this paper after the manuscript was reviewed. Their classifications without numbers in Table 1 represent consensus of the authors and the literature in general.

The longear sunfish is listed erroneously by EPA (*2*) as intolerant. It is classified as Moderately Tolerant of both water quality and habitat degradation, with mean scores of 3.3 and 3.0, respectively, for the two types of degradation. Also, numerous specimens have been collected from mildly polluted creeks (*11).*

Another fish deserving specific mention is the fathead minnow. This species is used extensively as the subject for testing toxicity of water. Its mean scores of 3.7 for water quality and 3.5 for habitat degradation (Table 1) demonstrate that it is among the more tolerant species and, thus, is of questionable value for testing toxicity of water for less tolerant species.

Another conclusion drawn from these data is that many more species and, therefore, Oklahoma fishes in general, are much more sensitive to, or intolerant of, habitat degradation than they are of water quality degradation. Forty-five species, 24.6%, were judged to be equally tolerant or intolerant of degradation of both water quality and habitat. Only 11 species, or 6.0%, are more intolerant of water quality degradation while 125 species and the two hybrids, or 69.4%, are more intolerant of habitat degradation.

CONCLUSIONS

The known ichthyofauna of Oklahoma consists of 179 species and two abundant hybrids in 27 families. Two other species have been reported but probably are extinct or one of them was misidentified (*5*).

In order of occurrence of fishes in each type of gross habitat; 170 species and the two hybrids (172 = 94.0%) occur in rivers, 154 species or 84.2% in creeks, 88 species and the hybrids (90 = 49.2%) in lakes, 52 species or 28.4% in swamps and sloughs, and 32 species or 17.5% in ponds.

A great amount of diversity was found within species in use of the different types of gross habitat. Nine species (4.9%) occur in only one habitat, with the Ozark cavefish the most limited, occurring only in coolwater creeks in some Ozark caves. No species is known to occur only in springs. The largest number of species, 81, and the two hybrids (45.4%), occur in two types of habitat and the second largest number, 58 (31.7%), occur in three types of habitat. Sixteen species (8.7%) occur in four types of habitat and 17 species (9.3%) occur in all five of the types of habitat reported.

Several general conclusions were drawn under the discussion of sensitivity and tolerance above, and many more general and specific conclusions could be drawn here concerning tolerance classifications of species and arbitrary or natural groups of species. However, the objective of the study was to classify the fishes of Oklahoma for regulatory, management, and academic purposes, which has been accomplished. Beyond this, we have simply provided a list from which others may draw conclusions appropriate for their objectives.

In practice, fishes classified as I and MI should be categorized as Intolerant and fishes classified as MT and T should be categorized as Tolerant in a general sense, with the four categories available for discussion of relative degrees of intolerance or tolerance.

We do not intend to deny differences of opinion concerning sensitivity or ranges of tolerance of these fishes to water quality or habitat factors, or in some taxonomic and nomenclatural questions. However, differences in tolerance classification must be justified for regulatory purposes just as we have justified deletion of the longear sunfish from the EPA list (*2*) and suggested that the fathead minnow is too tolerant for use as an indicator of environmental quality.

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REFERENCES

1. Shelford, V.E., Ecological Succession. *Biol. Bull.* **21**, 127 (1912) and **22**, 1 (1913).
2. EPA. *Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analysis.* U.S. Envir. Prot. Agency, Washington, D.C. viii + 213 pp. (1983).
3. Miller, R.J., and Robison, H.W., *The Fishes of Oklahoma.* Oklahoma State Univ. Press, Stillwater. xii + 246 pp. (1973).
4. Moore, G.A., Discovery of Fishes in Oklahoma (1852-1972). *Proc. Okla. Acad. Sci.* **53**, 1-26 (1973).
5. Cashner, R.C., and Matthews, W.J., Changes in the Known Oklahoma Fish Fauna From 1973 to 1988. *Proc. Okla. Acad. Sci.* **68**, 1-7 (1988).
6. Burr, B.M., Cashner, R.C., and Pflieger, W.L., *Campostoma oligolepis* and *Notropis ozarcanus* (Pisces: Cyprinidae), two additions to the known fish fauna of the Illinois River, Arkansas and Oklahoma. *Southwest. Nat.* **24**, 381-383 (1979).
7. Pigg, J., and Pham, T., The Rudd, *Scardinius erythropthalamus,* a New Fish in Oklahoma Waters. *Proc. Okla. Acad. Sci.* **70**, 37 (1990).
8. Mayden, R.L., *Phylogenetic Studies of North American Minnows, With Emphasis on the Genus* Cyprinella *(Teleostei:-Cypriniformes).* Misc. Pub. No. 80. Univ. Kansas Mus. Nat. Hist., Lawrence, KS (1989).
9. AFS. *Common and Scientific Names of Fishes from the United States and Canada.* 5th ed. Am. Fish. Soc. Special Publ. 20 (1991).
10. Branson, B.A., Fishes of the Neosho River System in Oklahoma. *Am. Midi, Nat.* **78**, 126-154 (1967).
11. Jester, D.B., Grigsby, E.M., Carroll, B., Fowlkes, J., Gordon, J., Lindley, L., Lowery, M., and Trumbull, E., *Ecology of Tahlequah Creek, a Small Ozark Creek in Oklahoma.* TR88-2. Oklahoma Water Resources Board, Oklahoma City (1988).

TABLE 1. The fishes of Oklahoma, gross habitats in which they occur, and classification in terms of tolerance of degradation of water quality and habitat. Names are those specified by the American Fisheries Society (*9*). Notation for Habitat: R=river, C=creek, L=lake or reservoir, P=pond, S=swamp or slough; notation for Tolerance: I=intolerant, MI=moderately intolerant, MT=moderately tolerant, T=tolerant. Numbers are values of: $\bar{x}(S_x)$.

FAMILY *Species*	Vernacular Name	Habitat	Tolerance: Water Quality	Tolerance: Habitat
PETROMYZONTIDAE–Lampreys				
1. *Ichthyomyzon castaneus*	Chestnut lamprey	R C L	MI 2.0(0.71)	I 1.5(0.58)
2. *Ichthyomyzon gagei*	Southern brook lamprey	C R	I 1.6(0.30)	I 1.6(0.80)
ACIPENSERIDAE–Sturgeons				
3. *Scaphirhynchus platorynchus*	Shovelnose sturgeon	R	MI 2.0(0.00)	I 1.6(0.89)
POLYODONTIDAE–Paddlefish				
4. *Polyodon spathula*	Paddlefish	R L	MI 2.2(0.41)	I 1.3(0.42)
LEPISOSTEIDAE–Gars				
5. *Atroctosteus (=Lepisosteus) spatula*	Alligator gar	R L S	T 3.5(0.98)	MT 2.7(1.03)
6. *Lepisosteus oculatus*	Spotted gar	R/L S C	T 3.5(0.55)	MT 2.7(0.52)
7. *Lepisosteus osseus*	Longnose gar	R/L C S	T 4.0(0.00)	T 3.7(0.52)
8. *Lepisosteus platostomus*	Shortnose gar	L R S	T 3.8(0.41)	MT 3.3(0.52)
AMIIDAE–Bowfin				
9. *Amia calva*	Bowfin	S R/P L/C	T 3.7(0.52)	MT 2.7(0.82)
ANGUILLIDAE–Eels				
10. *Anguilla rostrata*	American eel	R C S	I 1.5(0.58)	I 1.7(0.52)
CLUPEIDAE–Shads and herrings				
11. *Alosa alabamae*	Alabama shad	R	MI 2.3(1.52)	MI 2.2(1.00)
12. *Alosa chrysochloris*	Skipjack herring	R C/L	MI 2.3(1.52)	MI 2.0(1.00)
13. *Dorosoma cepedianum*	Gizzard shad	R/L C P S	MT 3.3(0.82)	T 3.5(0.55)
14. *Dorosoma petenense*	Threadfin shad	R/L C	MI 2.3(0.82)	MT 2.8(0.75)
HIODONTIDAE–Mooneyes				
15. *Hiodon alosoides*	Goldeye	L R	MT 2.8(0.96)	MI 2.0(1.41)
16. *Hiodon tergisus*	Mooneye	R L C	MI 2.5(0.82)	MI 2.0(1.41)
SALMONIDAE–Trouts				
17. *Oncorhynchus mykiss*	Rainbow trout	R L	I 1.2(0.05)	I 1.2(0.05)
18. *Salmo trutta*	Brown trout	R/C	I N.Q.	I N.Q.[a]
ESOCIDAE–Pikes and pickerels				
19. *Esox americanus*	Grass pickerel	C/S R/L P	MI 2.3(0.82)	MI 2.2(0.75)
20. *Esox lucius*	Northern pike	L	MI 2.2(0.49)	MI 2.0(0.00)
21. *Esox niger*	Chain pickerel	S C L	MT 2.8(0.87)	I 1.7(0.50)
CHARACIDAE–Characins				
22. *Astyanax mexicanus* (last collected in 1954)	Mexican tetra	L R	MT 3.3(0.58)	MT 3.3(0.58)

FAMILY Species	Vernacular Name	Habitat	Tolerance Water Quality	Tolerance Habitat
CYPRINIDAE–Carps and minnows				
23. *Campostoma anomalum*	Central stoneroller	C R	MI 2.2(0.75)	MI 2.0(0.89)
24. *Campostoma oligolepis*	Largescale stoneroller	C R	I 1.5(0.58)	I 1.5(0.58)
25. *Carassius auratus*	Goldfish	P L R/C/S	T 3.8(0.50)	T 3.8(0.50)
26. *Ctenopharyngodon idella*	Grass carp or white amur	R/P L	MT 3.3(0.58)	MT 2.7(0.58)
27. *Cyprinella camura*	Bluntface shiner	R C	I 1.3(0.50)	I 1.3(0.50)
28. *Cyprinella lutrensis*	Red shiner	R/C L	T 4.0(0.00)	T 3.7(0.43)
29. *Cyprinella spiloptera*	Spotfin shiner	R/C	I 1.3(0.59)	I 1.3(0.59)
30. *Cyprinella venusta*	Blacktail shiner	C R L	MT 2.8(0.50)	MT 3.0(0.82)
31. *Cyprinella whipplei*	Steelcolor shiner	C R L	MI 2.0(0.00)	MI 1.8(0.41)
32. *Cyprinus carpio*	Common carp	R/L C P S	T 4.0(0.00)	T 3.8(0.41)
33. *Erimystax x-punctatus*	Gravel chub	C R	I 1.5(0.58)	I 1.5(0.58)
34. *Hybognathus hayi*	Cypress minnow	C/S R	I 1.0(0.00)	I 1.0(0.00)
35. *Hybognathus nuchalis*	Silvery minnow	R C S	MT 3.0(0.00)	I 1.7(1.16)
36. *Hybognathus placitus*	Plains minnow	R C	T 3.6(0.89)	MT 3.0(0.00)
37. *Hypophthalmichthyes nobilis*	Bighead carp	R L P	T N.Q.	T N.Q.[a]
38. *Luxilus chrysocephalus*	Striped shiner	C R	MI 1.8(0.84)	MI 1.8(0.84)
39. *Luxilus pilsbryi*[b] or *Luxilus cardinalis*	Duskystripe shiner Cardinal shiner	R/C	I 1.0(0.00)	I 1.0(0.00)
40. *Lythrurus fumeus*	Ribbon shiner	C R	MI 2.3(0.50)	I 1.7(0.50)
41. *Lythrurus snelsoni*	Ouachita Mountain shiner	C R L	I 1.5(0.55)	I 1.5(0.55)
42. *Lythrurus umbratilis*	Redfin shiner	R/C L	MI 2.0(0.00)	MI 2.0(0.00)
43. *Macrhybopsis aestivalis*	Speckled chub	R/C	MI 2.2(0.84)	I 1.5(0.58)
44. *Macrhybopsis storeriana*	Silver chub	R L	MT 3.3(0.50)	MT 3.0(0.00)
45. *Nocomis asper*	Redspot chub	C R	I 1.5(0.58)	I 1.5(0.58)
46. *Notemigonus crysoleucas*	Golden shiner	C R/L S P	T 3.8(0.50)	T 3.8(0.50)
47. *Notropis amblops*	Bigeye chub	C R	I 1.7(0.50)	I 1.3(0.50)
48. *Notropis amnis*	Pallid shiner	R/C S	I 1.7(0.96)	I 1.3(0.50)
49. *Notropis atherinoides*	Emerald shiner	R C L	MT 3.2(0.84)	MT 3.2(0.84)
50. *Notropis atrocaudalis*	Blackspot shiner	R/C S	MT 2.8(1.15)	MI 2.0(1.16)
51. *Notropis bairdi*	Red River shiner	R C	MT 3.2(0.45)	MT 2.8(0.84)

FAMILY *Species*	Vernacular Name	Habitat	Tolerance Water Quality	Tolerance Habitat
52. *Notropis blennius*	River shiner	R	MI 2.5(1.00)	MI 2.3(0.50)
53. *Notropis boops*	Bigeye shiner	R/C	MI 2.0(0.63)	I 1.5(0.55)
54. *Notropis buchanani*	Ghost shiner	C R S	MT 2.6(0.89)	MT 2.6(0.89)
55. *Notropis chalybaeus*	Ironcolor shiner	S R/C	I 1.6(0.73)	I 1.6(1.45)
56. *Notropis emiliae*	Pugnose shiner	R/C L	MI 2.0(0.00)	MI 2.0(0.00)
57. *Notropis girardi*	Arkansas River shiner	R C	MI 1.8(0.84)	I 1.4(0.55)
58. *Notropis greenei*	Wedgespot shiner	C R	I 1.2(0.50)	I 1.2(1.50)
59. *Notropis hubbsi*	Bluehead shiner	S C L	I 1.0(0.00)	I 1.4(0.55)
60. *Notropis maculatus*	Taillight shiner	C/S R L	MI 2.2(1.30)	I 1.4(0.55)
61. *Notropis nubilus*	Ozark minnow	R/C	I 1.6(0.55)	I 1.2(0.45)
62. *Notropis ortenbergeri*	Kiamichi shiner	R C	I 1.3(0.52)	I 1.2(0.41)
63. *Notropis ozarcanus*	Ozark shiner	R/C	I 1.2(0.31)	I 1.2(0.31)
64. *Notropis perpallidus*	Peppered shiner	R C	I 1.0(0.00)	I 1.0(0.00)
65. *Notropis potteri*	Chub shiner	R L	MT 3.0(0.00)	MI 2.3(0.58)
66. *Notropis rubellus*	Rosyface shiner	R C	I 1.6(0.55)	I 1.6(0.55)
67. *Notropis shumardi*	Silverband shiner	R	I 1.7(0.58)	I 1.7(0.58)
68. *Notropis stramineus*	Sand shiner	C R L	MT 2.7(0.82)	MI 2.5(0.55)
69. *Notropis volucellus*	Mimic shiner	R C	MI 2.2(0.43)	MI 2.0(0.00)
70. *Phenacobius mirabilis*	Suckermouth minnow	C R	MI 2.3(0.45)	I 1.3(0.45)
71. *Phoxinus erythrogaster*	Southern redbelly dace	C R	I 1.2(0.18)	I 1.2(0.18)
72. *Pimephales notatus*	Bluntnose minnow	C R L P	MT 3.0(0.89)	MT 2.7(1.01)
73. *Pimephales promelas*	Fathead minnow	C R/P L	T 3.7(0.52)	T 3.5(0.55)
74. *Pimephales tenellus*	Slim minnow	C R	MI 2.0(0.82)	I 1.5(0.58)
75. *Pimephales vigilax*	Bullhead minnow	R C/L P	T 3.6(0.55)	T 3.4(0.55)
76. *Platygobio gracilis*	Flathead chub	R	MI 2.3(1.16)	I 1.7(0.58)
77. *Scardinius erythropthalamus*	Rudd	R/P C/L	T 4.0(0.00)	T 4.0(0.00)
78. *Semotilus atromaculatus*	Creek chub	C R	MI 2.0(0.00)	MI 2.0(0.63)
CATOSTOMIDAE–Suckers				
79. *Carpiodes carpio*	River carpsucker	R L C P/S	T 3.5(0.55)	T 3.5(0.55)
80. *Carpiodes cyprinus*	Quillback	R/L	MT 3.0(1.00)	MT 3.0(1.00)

FAMILY *Species*	Vernacular Name	Habitat	Tolerance Water Quality	Tolerance Habitat
81. *Carpiodes velifer*	Highfin carpsucker	R/L	MT 3.0(1.00)	MT 2.7(0.58)
82. *Catostomus commersoni*	White sucker	R/C	MI 1.8(0.45)	I 1.6(0.55)
83. *Cycleptus elongatus*	Blue sucker	R C/L	MI 2.0(0.71)	I 1.2(0.45)
84. *Erimyzon oblongus*	Creek chubsucker	C R S	MI 2.0(0.00)	I 1.5(0.55)
85. *Erimyzon sucetta*	Lake chubsucker	C R S	MI 2.0(0.00)	MI 1.8(0.45)
86. *Hypentelium nigricans*	Northern hog sucker	R/C	I 1.3(0.52)	I 1.0(0.00)
87. *Ictiobus bubalus*	Smallmouth buffalo	R/L C	MT 3.2(0.75)	MT 3.3(0.52)
88. *Ictiobus cyprinellus*	Largemouth buffalo	L R	MT 3.2(0.55)	MT 3.0(0.89)
89. *Ictiobus niger*	Black buffalo	R/L	MT 3.0(1.16)	MT 3.0(1.16)
90. *Minytrema melanops*	Spotted sucker	R C L	MI 2.0(0.82)	I 1.5(0.82)
91. *Moxostoma carinatum*	River redhorse	R C L	I 1.6(0.89)	MI 1.8(0.84)
92. *Moxostoma duquesnei*	Black redhorse	C R L	MI 1.8(0.58)	MI 2.0(0.00)
93. *Moxostoma erythrurum*	Golden redhorse	R/C L	MI 2.3(0.82)	MI 2.0(0.00)
94. *Moxostoma macrolepidotum*	Shorthead redhorse	R C	I 1.7(0.58)	I 1.3(0.58)
ICTALURIDAE–Catfishes				
95. *Ictalurus furcatus*	Blue catfish	R/L C/P	T 3.4(0.55)	MT 3.2(0.84)
96. *Ictalurus melas*	Black bullhead	C L/P R S	T 4.0(0.00)	T 4.0(0.00)
97. *Ictalurus natalis*	Yellow bullhead	C R P L	T 3.6(0.55)	MT 3.2(0.84)
98. *Ictalurus nebulosus*	Brown bullhead	P C/S L	MT 3.3(0.96)	MI 2.3(0.50)
99. *Ictalurus punctatus*	Channel catfish	R/L C P	MT 3.2(0.55)	MT 3.3(0.52)
100. *Noturus eleutherus*	Mountain madtom	R/C	I 1.3(0.58)	I 1.0(0.00)
101. *Noturus exilis*	Slender madtom	C R	MI 2.0(0.00)	I 1.0(0.00)
102. *Noturus flavus*	Stonecat	R/C	I 1.7(0.50)	I 1.3(0.50)
103. *Noturus gyrinus*	Tadpole madtom	R/C L	MI 2.0(0.82)	I 1.5(1.00)
104. *Noturus miurus*	Brindled madtom	R/C	I 1.7(0.58)	I 1.3(0.58)
105. *Noturus nocturnus*	Freckled madtom	R/C	MI 2.5(0.55)	MI 1.8(0.98)
106. *Noturus placidus*	Neosho madtom	R C	I 1.3(0.50)	I 1.0(0.00)
107. *Pylodictis olivaris*	Flathead catfish	R/L C	MT 3.3(0.52)	MT 3.0(0.89)
AMBLYOPSIDAE–Cavefishes				
108. *Amblyopsis rosae*	Ozark cavefish	C (caves)	I 1.0(0.00)	I 1.0(0.00)

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FAMILY *Species*	Vernacular Name	Habitat	Tolerance Water Quality	 Habitat
APHREDODERIDAE–Pirateperch				
109. *Aphredoderus sayanus*	Pirate perch	C/S P	MT 3.0(0.00)	MI 1.8(0.75)
CYPRINODONTIDAE–Pupfishes				
110. *Cyprinodon rubrofluviatilis*	Red River pupfish	C R	MT 2.6(0.89)	MI 2.0(0.00)
FUNDULIDAE–Topminnows				
111. *Fundulus blairae*	Blair's starhead topminnow	S C R	T 3.5(0.58)	I 1.7(0.96)
112. *Fundulus catenatus*	Northern studfish	C R	MI 1.8(0.84)	I 1.6(0.55)
113. *Fundulus chrysotus*	Golden topminnow	C/S	MT 3.3(0.58)	I 1.7(0.50)
114. *Fundulus notatus*	Blackstripe topminnow	C R	MT 2.7(0.52)	MI 2.3(0.52)
115. *Fundulus olivaceus*	Blackspotted topminnow	C R	MT 2.7(0.52)	MI 2.3(0.52)
116. *Fundulus sciadicus*	Plains topminnow	C R	MT 2.6(0.89)	MI 2.2(0.63)
117. *Fundulus zebrinus*	Plains killifish	R/C L	MT 3.3(0.82)	MT 3.2(0.41)
POECILIIDAE–Livebearers				
118. *Gambusia affinis*	Mosquitofish	L/P/C S R	T 4.0(0.00)	T 4.0(0.00)
ATHERINIDAE–Silversides				
119. *Labidesthes sicculus*	Brook silver side	R/C L S	MT 2.7(0.52)	MI 2.0(0.89)
120. *Menidia beryllina*	Inland silverside	R/L C	T 3.5(0.55)	MT 3.2(0.41)
COTTIDAE–Sculpins				
121. *Cottus carolinae*	Banded sculpin	C R	I 1.0(0.00)	I 1.0(0.00)
PERCICHTHYIDAE–Temperate basses				
122. *Morone chrysops*	White bass	R/L C	MT 3.3(0.52)	MT 3.0(0.00)
123. *Morone mississippiensis*	Yellow bass	L R	T 3.5(0.58)	MT 3.0(0.00)
124. *Morone saxatilis*	Striped bass	R/L	MT 3.2(0.84)	MT 2.6(0.89)
CENTRARCHIDAE–Sunfishes				
125. *Ambloplites ariommus*	Shadow bass	R/C	MI 2.0(0.00)	I 1.5(0.58)
126. *Ambloplites rupestris*	Rock bass	R/C	MI 2.0(0.00)	I 1.4(0.55)
127. *Centrarchus macropterus*	Flier	C/S P	I 1.4(0.89)	I 1.4(0.89)
128. *Elassoma zonatum*	Banded pygmy sunfish	S C	I 1.3(0.73)	I 1.2(0.58)
129. *Lepomis auritus*	Redbreast sunfish	C S L R	MT 3.0(0.58)	MT 2.8(0.50)
130. *Lepomis cyanellus*	Green sunfish	R C/L P S	T 4.0(0.00)	T 4.0(0.00)
131. *Lepomis gulosus*	Warmouth	C L/P/S R	MT 3.2(0.84)	MT 3.0(0.71)
132. *Lepomis humilis*	Orangespotted sunfish	C R P/S L	T 3.5(0.55)	MT 3.3(0.52)
133. *Lepomis macrochirus*	Bluegill	L/P/C R S	MT 3.2(0.41)	MT 3.2(0.41)

FAMILY *Species*	Vernacular Name	Habitat	Tolerance: Water Quality	Tolerance: Habitat
134. *Lepomis marginatus*	Dollar sunfish	C R/S	MT 2.6(1.14)	MI 1.8(0.45)
135. *Lepomis megalotis*	Longear sunfish	R/C L	MT 3.3(0.52)	MT 3.0(0.78)
136. *Lepomis microlophus*	Redear sunfish	P L/S R/C	MT 3.0(0.63)	MT 2.8(0.75)
137. *Lepomis punctatus*	Spotted sunfish	S R/C/P	MT 2.8(0.84)	I 1.4(0.55)
138. *Lepomis symmetricus*	Bantam sunfish	S P	I 1.5(0.58)	I 1.2(0.45)
139. *Micropterus dolomieui*	Smallmouth bass	R/C L	I 1.5(0.55)	I 1.5(0.55)
140. *Micropterus punctulatus*	Spotted bass	R/C/L	MI 2.3(0.55)	MI 2.5(0.49)
141. *Micropterus salmoides*	Largemouth bass	L/R/C P S	MT 3.2(0.98)	MT 3.2(0.41)
142. *Pomoxis annularis*	White crappie	L/R P/C S	T 3.4(0.55)	MT 3.2(0.84)
143. *Pomoxis nigromaculatus*	Black crappie	L/R P/C S	MT 3.2(0.45)	MT 2.8(0.84)
PERCIDAE–Perches				
144. *Ammocrypta (=Crystallaria) asprella*	Crystal darter	R C	I 1.5(0.55)	I 1.0(0.00)
145. *Ammocrypta clara*	Western sand darter	R C	I 1.5(1.00)	I 1.2(0.50)
146. *Ammocrypta vivax*	Scaly sand darter	R C	MI 2.0(0.82)	I 1.5(1.00)
147. *Etheostoma asprigene*	Mud darter	R/C S/L	MI 2.3(0.50)	MI 2.0(0.82)
148. *Etheostoma blennioides*	Greenside darter	C R	I 1.6(0.55)	I 1.4(0.55)
149. *Etheostoma chlorosomum*	Bluntnose darter	R/C S L	MI 1.8(0.45)	I 1.6(0.55)
150. *Etheostoma collettei*	Creole darter	C R	MI 2.2(0.45)	I 1.4(0.55)
151. *Etheostoma cragini*	Arkansas darter	C R	MI 2.2(0.85)	I 1.4(0.48)
152. *Etheostoma flabellare*	Fantail darter	C R	MI 2.0(0.82)	I 1.3(0.50)
153. *Etheostoma fusiforme*	Swamp darter	C/S L	MI 2.5(0.58)	I 1.5(0.58)
154. *Etheostoma gracile*	Slough darter	C/S R	MT 2.6(0.55)	I 1.6(0.89)
155. *Etheostoma histrio*	Harlequin darter	R C	I 1.6(0.55)	I 1.2(0.45)
156. *Etheostoma microperca*	Least darter	C R/S	I 1.2(0.45)	I 1.0(0.00)
157. *Etheostoma nigrum*	Johnny darter	C R S	MI 2.0(0.00)	I 1.5(0.58)
158. *Etheostoma parvipinne*	Goldstripe darter	C R	I 1.7(0.45)	I 1.0(0.00)
159. *Etheostoma proeliare*	Cypress darter	C R/S	MI 1.8(0.45)	I 1.6(0.89)
160. *Etheostoma punctulatum*	Stippled darter	C R	I 1.7(0.50)	I 1.3(0.50)
161. *Etheostoma radiosum*	Orangebelly darter	R/C	MI 2.3(0.52)	MI 1.8(0.41)
162. *Etheostoma spectabile*	Orangethroat darter	C R L	MI 2.4(0.55)	MI 2.0(0.00)

FAMILY *Species*	Vernacular Name	Habitat	Tolerance Water Quality	Tolerance Habitat
163. *Etheostoma stigmaeum*	Speckled darter	C R	MI 1.8(0.50)	MI 1.8(0.96)
164. *Etheostoma whipplei*	Redfin darter	C R	MI 2.0(0.00)	MI 1.8(0.42)
165. *Ethestoma zonale*	Banded darter	C R	I 1.6(0.59)	I 1.2(0.45)
166. *Perca flavescens*	Yellow perch	R C/L	T 3.7(0.58)	MT 3.0(1.00)
167. *Percina caprodes*	Logperch	R C/L	MI 2.3(0.52)	MI 2.3(0.52)
168. *Percina copelandi*	Channel darter	R/C L	MI 1.8(0.41)	I 1.7(0.52)
169. *Percina macrolepida*	Bigscale logperch	R/L C	MI 2.5(0.58)	MI 2.3(0.50)
170. *Percina maculata*	Blackside darter	R/C S	MI 2.0(0.00)	I 1.0(0.00)
171. *Percina nasuta*	Longnose darter	C R	I 1.3(0.52)	I 1.0(0.00)
172. *Percina pantherina*	Leopard darter	R/C	I 1.5(0.55)	I 1.0(0.00)
173. *Percina phoxocephala*	Slenderhead darter	R/C	MI 2.2(0.41)	MI 1.8(0.75)
174. *Percina sciera*	Dusky darter	R C	MI 2.2(0.41)	MI 2.2(0.41)
175. *Percina shumardi*	River darter	R C/L	MI 2.3(0.58)	I 1.3(0.58)
176. *Percina uranidea* (reported once,in 1896)	Stargazing darter	R C	MI 2.0(1.00)	I 1.7(1.16)
177. *Stizostedion canadense*	Sauger	R L	MT 2.8(0.96)	MI 2.3(0.50)
178. *Stizostedion vitreum*	Walleye	L R	MT 2.8(0.96)	MI 2.3(0.50)
SCIAENIDAE–Drums				
179. *Aplodinotus grunniens*	Freshwater drum	R/L C	MT 3.2(0.41)	MT 3.2(0.41)
CICHLIDAE–Cichlids				
180. *Tilapia aurea*	Blue tilapia	P L/R	T 3.7(0.58)	T 4.0(0.00)
MUGILIDAE–Mullets				
181. *Mugil cephalus*	Striped mullet	R	T 4.0(0.00)	MI 2.3(0.58)
ABUNDANT HYBRIDS (Stocked for sport fishing)				
182. *M. chrysops* x *M. saxatilis* (*M.* =*Morone*)	Wiper	R/L	MT 3.3(0.58)	MT 3.0(0.00)
183. *S. canadense* x *S. vitreum* (*S.* =*Stizostedion*)	Saugeye	R/L	MT 3.0(1.00)	MT 2.7(0.58)

[a] Not quantified.

[b] Mayden (*8*) referred *Notropis pilsbryi* to his new genus, *Luxilus*, then described the populations in the Arkansas and Red River drainages as a new species, *Luxilus cardinalis*. He stated that *L. pilsbryi* is limited to the White River drainage in Missouri and Arkansas. The history of stream piracy between the Neosho River drainage in Oklahoma and the White River drainage in Missouri (*10*) renders it difficult to remove *L. pilsbryi* from Oklahoma without examinations of numerous populations in the Neosho drainage. Our entry of both names here indicates uncertainty about distribution because not all of the populations in Neosho tributaries have been re-examined.