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AN ANALYSIS OF TENNESSEE'S JEOPARDIZED FISH TAXA

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ABSTRACT

Tennessee's fauna of approximately 290 species and 313 taxa of native fishes includes 83 taxa that warrant protection by the state. Of these, 27 are peripheral to Tennessee and are not currently jeopardized throughout their range. Of the remaining 56 jeopardized taxa, relatively large numbers occur in medium–sized rivers and springs; none occur in lentic habitats. At the family level, darters (Percidae) and madtom catfish (Ictaluridae) have disproportionately high representation. The specialized reproductive habits and high number of taxa restricted to the jeopardized habitats of medium–sized rivers plus springs may best explain the plight of darters. Explanations for the many jeopardized madtom taxa are less obvious. Endemic taxa are far more likely to be jeopardized than are more wide ranging taxa. Five taxa of jeopardized fishes have distributions that appear to coincide with junctions between physiographic provinces.

INTRODUCTION

Tennessee's native fish fauna of approximately 290 species and 313 taxa (species, subspecies, or unique local races) contains numerous taxa that deserve state or federal jeopardized status. Starnes and Etnier (1980) included 65 fish taxa as jeopardized (Endangered, Threatened, of Special Concern, or Deemed in Need of Management) in Tennessee. A thorough update of that listing is underway, but in its absence we have repeated the exercise and find 83 taxa of native fishes warranting protected status in the state. Of these, 27 have ranges that barely include Tennessee, and they do not appear to warrant protected status throughout their range (Table 1). These taxa contribute greatly to Tennessee's biodiversity, and in some cases (e.g., the Appalachian brook trout, *Salvelinus fontinalis* ssp.?, and the nearly blind form of the stonecat, *Noturus flavus*, in the Mississippi River), the Tennessee populations may represent valid local taxa that will warrant federal protection when their taxonomic status is better understood. Five species restricted to the Barren River system of the Ohio River drainage in Tennessee (blackfin sucker, teardrop darter, splendid darter, orangefin darter, "blackfin darter") are restricted to small areas of Tennessee and Kentucky, and might be treated as truly jeopardized, but they are included here with the peripheral taxa. For the purposes of this paper, we will dispense with these peripheral taxa and search for patterns among the remaining 56 taxa which appear to be jeopardized throughout their entire range.

Table 1. Peripheral taxa warranting protected status in Tennessee, but not throughout their range.

Ichthyomyzon gagei, southern brook lamprey
Ichthyomyzon unicuspis, silver lamprey
Anguilla rostrata, American eel
Ericymba buccata, silverjaw minnow
Hybognathus placitus, plains minnow
Hybopsis lineapunctata, lined chub
Macrhybopsis gelida, sturgeon chub
Macrhybopsis meeki, sicklefin chub
Notropis dorsalis, bigmouth shiner
Notropis rubellus rubellus, northern rosyface shiner
Platygobio gracilis, flathead chub
Moxostoma atripinne, blackfin sucker
Noturus flavus, stonecat
Salvelinus fontinalis, brook trout
Typhlichthys subterraneus, southern cavefish
Fundulus chrysotus, golden topminnow
Ammocrypta beani, naked sand darter
Ammocrypta clara, western sand darter
Ammocrypta vivax, scaly sand darter
Etheostoma barbouri, teardrop darter
Etheostoma barrenense, splendid darter
Etheostoma bellum, orangefin darter
Etheostoma blennioides gutselli, Tuckaseegee darter
Etheostoma squamiceps, spottail darter
Percina copelandi, channel darter
Percina phoxocephala, slenderhead darter
Percina (Odontopholis) sp., "blackfin darter"

METHODS AND DEFINITIONS

Endangered taxa are those likely to disappear throughout all or a significant portion of their range unless positive action is taken to prevent existing trends. Threatened taxa are those likely to become Endangered in the near future based on existing trends, but their populations are sufficiently large, numerous, and widespread that loss of a single population would not pose a catastrophic threat to the

Table 2. Tennessee's jeopardized fish taxa according to habitats in which they typically occur.

BIG RIVERS
- *Acipenser fulvescens*, lake sturgeon
- *Scaphirhynchus albus*, pallid sturgeon
- *Atractosteus spathula*, alligator gar
- *Alosa alabamae*, Alabama shad
- *Cycleptus elongatus*, blue sucker

MEDIUM RIVERS
- *Cyprinella caerulea*, blue shiner
- *Cyprinella monacha*, spotfin chub
- *Erimystax cahni*, slender chub
- *Macrhybopsis* sp. cf. *M. aestivalis*, speckled chub
- *Notropis* sp. cf. *N. procne*, "palezone shiner"
- *Carpiodes velifer*, highfin carpsucker
- *Lagochila lacera*, harelip sucker
- *Noturus munitus*, frecklebelly madtom
- *Noturus stanauli*, pygmy madtom
- *Noturus stigmosus*, northern madtom
- *Esox masquinongy ohiensis*, "river" muskellunge
- *Ammocrypta asprella*, crystal darter
- *Etheostoma acuticeps*, sharphead darter
- *Etheostoma aquali*, coppercheek darter
- *Etheostoma cinereum*, ashy darter
- *Etheostoma microlepidum*, finescale darter
- *Etheostoma tippecanoe*, Tippecanoe darter
- *Etheostoma wapiti*, boulder darter
- *Etheostoma (Catonotus)* sp., "duskytail darter"
- *Etheostoma (Doration)* sp., Stones River darter
- *Percina antesella*, amber darter
- *Percina jenkinsi*, Conasauga logperch
- *Percina tanasi*, snail darter

LARGE CREEKS AND SMALL RIVERS
- *Clinostomus* sp. cf. *C. funduloides*, "Smoky dace"
- *Notropis rupestris*, bedrock shiner
- *Noturus baileyi*, Smoky madtom
- *Noturus flavipinnis*, yellowfin madtom
- *Noturus* sp. cf. *N. elegans*, "Duck River madtom"
- *Etheostoma striatulum*, striated darter
- *Etheostoma (Doration)* sp., "jewel darter"
- *Etheostoma (Ulocentra)* sp., "holiday darter"
- *Percina aurantiaca*, tangerine darter
- *Percina burtoni*, blotchside logperch
- *Percina macrocephala*, longhead darter
- *Percina (Alvordius)* sp., "bridled darter"

STREAMS OF ORDERS ONE THROUGH THREE
- *Phoxinus cumberlandensis*, blackside dace
- *Etheostoma nigrum susanae*, Cumberland johnny darter
- *Etheostoma neopterum*, lollypop darter
- *Etheostoma olivaceum*, dirty darter
- *Etheostoma pyrrhogaster*, firebelly darter
- *Etheostoma sagitta*, arrow darter
- *Etheostoma (Catonotus)* sp., "Barrens darter"
- *Etheostoma (Catonotus)* sp., "egg-mimic darter"
- *Etheostoma (Catonotus)* sp., "crown darter"

SPRINGS AND SEEPAGE AREAS
- *Hemitremia flammea*, flame chub
- *Phoxinus tennesseensis*, Tennessee dace
- *Fundulus julisia*, Barrens topminnow
- *Etheostoma boschungi*, slackwater darter
- *Etheostoma ditrema*, coldwater darter
- *Etheostoma trisella*, trispot darter
- *Etheostoma tuscumbia*, Tuscumbia darter

continued existence of the taxon. We also treat taxa as jeopardized if they occupy extremely small ranges, even if there are no current threats to the populations, since a single event or project could result in Endangered status or even extinction. Taxa with wider ranges but experiencing extirpations and decreased abundance throughout their range also are considered as jeopardized (e.g., longhead darter). These definitions are essentially identical to those used in the U.S. Endangered Species Act. For the section on habitat analysis, we have considered the Mississippi River and the lower reaches of the Tennessee and Cumberland rivers as Tennessee's only big rivers. Information on ranges and habitats occupied by Tennessee fishes was taken largely from Etnier and Starnes (in press).

Results and Discussion

An obvious starting point is to separate Tennessee's jeopardized fish taxa by the habitats in which they typically occur (Table 2). We characterize five taxa as occupying big rivers, 23 taxa as typical of medium–sized rivers, 12 taxa as occurring primarily in large creeks and small rivers, nine taxa as inhabitants of first– to third–order streams, and seven taxa as associated with springs or seepage areas. If we make the same sort of analysis for the entire native fish fauna of Tennessee (Table 3), we find that only 14% of our native fish taxa are typical of medium rivers, but the 23 jeopardized fishes of these habitats make up 41% of our 56 jeopardized fish taxa. In contrast, smaller streams (first– to third–order streams plus large creeks and small rivers, Table 3) are the typical habitat of 61% (189) of our native taxa, but only harbor 37% (21) of our jeopardized taxa. The analogy of comparing a river system to a tree and noting that there are many more small branches (large and small creeks) than limbs (medium rivers), and many more limbs than trunks (big rivers), is only partly successful (fewer jeopardized taxa should occur in progressively smaller and more numerous parts of the tree) in explaining the disproportionately high percentage of jeopardized taxa in medium rivers, as big rivers (Table 3) contain 13% (42) of our fish taxa but only 9% (5) of our jeopardized taxa. We feel that the more complete explanation involves the maturity of these big rivers and their degree of modification relative to medium–sized rivers. In rivers, increasing maturity is associated with decreased gradient and a shift from coarse erosional to fine–grained depositional substrates. Fishes typical of big rivers al-

Table 3. Statistics on Tennessee's jeopardized fish taxa separated by habitats.

Habitats	Total taxa	Percent of state's total	Jeopardized taxa	Percent of state's total jeopardized
Big rivers	42	13	5	9
Medium rivers	43	14	23	41
Large creeks and small rivers	153	49	12	21
Streams (orders1-3)	36	12	9	16
Springs	10	3	7	13
Lentic	28	9	0	0
Caves	1	0	0	0
Totals	313	100	56	100

ready are adapted to habitats with little if any rock, cobble, or gravel substrate, and impoundments result in only moderate habitat changes. In contrast, in less mature medium rivers, impoundments result in tremendous changes in gradient, and coarse substrates are soon blanketed with silt.

Springs and seepage areas are an additional area where jeopardized taxa occur with relatively high frequency (Table 3). Only 10 Tennessee fishes (3% of our fauna) are restricted to these habitats but seven of these are jeopardized (13% of our jeopardized taxa). None of the 28 Tennessee fish taxa associated with lentic habitats (natural lakes and swamps) is jeopardized, nor is our single cave inhabitant.

If jeopardized fishes are segregated by families (Table 4), we note the unsurprising result that percids and ictalurids (specifically darters and madtoms since none of the larger species in either family is jeopardized) make up a disproportionately high number of our jeopardized taxa. Percids (101 taxa) represent 32% of Tennessee's fish fauna but the 31 jeopardized percids represent 55% of the jeopardized taxa. Eleven of the jeopardized darters are from the *Etheostoma* subgenera *Boleosoma*, *Catonotus*, and the *maculatum* species group of *Nothonotus*. All of these taxa have specialized reproductive behavior with males guarding eggs deposited on the underside of a slabrock or similar object. They are thus unable to colonize or even disperse readily through areas lacking suitable nest cover. Endemism is high in these groups, and speciation is probably relatively rapid. In addition, many of Tennessee's darters (12) are restricted to medium–sized rivers, and four of Tennessee's 10 fish taxa primarily associated with springs are darters. We argue that the disproportionate numbers of jeopardized taxa in these two habitats is not the result of their heavy population by darters, but that the habitats themselves are jeopardized, since 53% (23 of 43) of taxa of medium rivers and 70% (7 of 10) of taxa of springs (Table 3) are jeopardized. In other habitats, jeopardized taxa represent a maximum of 25% (9 of 36) of taxa associated with streams of order one through three.

Ictalurids comprise 7% of Tennessee's native fish fauna and 11% of those jeopardized. All six jeopardized ictalurids are madtoms (genus *Noturus*), and madtoms comprise 17 of Tennessee's 23 native catfish taxa. Thus, 35% of madtoms are jeopardized; the comparable figure for darters, 31 of 98 or 32%, is virtually identical. Madtoms are neither highly endemic (only 5 of 17 in Tennessee) nor largely confined to jeopardized habitats (5 of 17 live in medium rivers, none in springs, and 11 live in the large creek/small river habitat where only 12 of 153 taxa are jeopardized). Madtoms do have rather specialized reproductive habits, similar to those mentioned above for several groups of darters. Males guard eggs and young in a cavity, typically under a slab rock, where the female deposits the eggs. They appear to be considerably more flexible than egg–guarding darters in their choice of nesting cover. Several species are known to use discarded cans and bottles, and several species that occur on the Coastal Plain presumably use logs or undercut banks in areas where slab rocks are absent. Perhaps the suggestion of Etnier and Jenkins (1980) that madtoms may be "unable to cope with the olfactory 'noise' being added to riverine ecosystems in the form of a wide variety of complex organic chemicals that may occur in only trace amounts" has some merit.

An additional expected result is that endemic taxa are far more likely to be jeopardized than widespread taxa (Table 5). By definition, endemic taxa have smaller geographical ranges than non–endemics, and we probably need no additional interpretation. We note, however, that 44% (35 of 81) of taxa endemic to the Tennessee or Cumberland rivers or exclusively shared by these drainages are jeopardized, but only 26% (7 of 27) of Mobile Basin taxa are jeopardized. The absence of darters of subgenus *Catonotus* and the *maculatum* species group of subgenus *Nothonotus* from the Mobile Basin is sufficient to account for this difference, since taxa from these groups account for 11 of the 35 jeopardized Tennessee/Cumberland endemics.

It is common knowledge that there is a powerful physiographic component to distributions of North American freshwater fishes (see papers in Hocutt and Wiley 1986), with many species having nearly perfect fidelity to a single physiographic province. In compiling a table of Tennessee fish species versus the physiographic province(s) they occupy (Etnier and Starnes, in press), we were surprised to note that several species had their distributions virtually restricted to the boundary between adjacent provinces. This appears to be more than coincidence. Possible explanations might be that these species require resources such as substrates from both provinces or that they face reduced competition from one or several species that show fidelity to a single province. Tennessee taxa that appear to have this sort of distribution (Figure 1) include the spotfin chub, palezone shiner, smoky madtom, sharphead darter, and "duskytail darter". This scarcely is noticeable in *Cyprinella monacha* (Figure 1A), as Tennessee populations occur well within the western Highland Rim, Cumberland Pla-

Table 4. Statistics on Tennessee's jeopardized fish taxa segregated by families.

Family	Total taxa	Percent of state's total	Jeopardized taxa	Percent of state's total jeopardized
Cyprinidae	91	29	10	18
Catostomidae	21	7	3	5
Ictaluridae	23	7	6	11
Centrarchidae	19	6	0	0
Percidae	101	32	31	55
Small families	58	19	6	11
Total	313	100	56	100

Table 5. Statistics comparing jeopardized and endemic fish taxa in Tennessee's drainages.

River(s)	Endemic taxa	Percent of state's fish fauna	Jeopardized taxa	Percent of endemic taxa jeopardized
Tennessee R.	44	14	19	43
Cumberland R.	15	5	9	60
Tenn./Cumb. R. shared	22	7	7	32
Subtotal	81	26	35	49
Mobile Basin	27	9	7	26
Ohio R.	5	2	0	0
All others	200	64	14	7

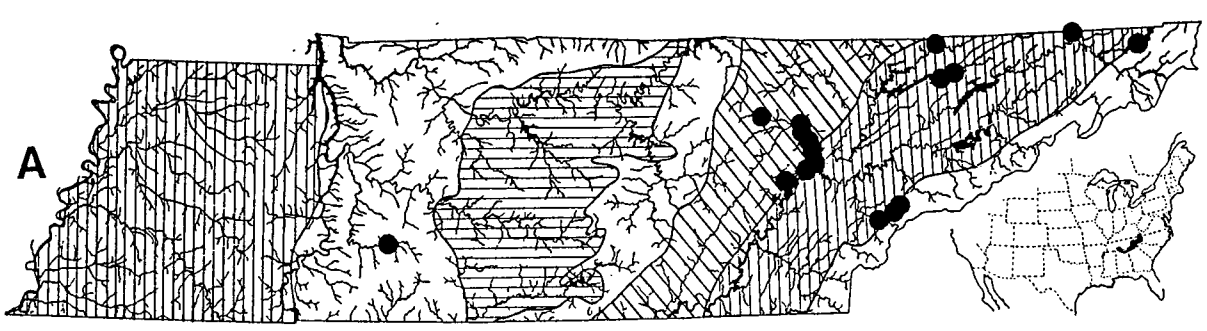

Figure 1. Tennessee distribution of fishes relative to physiographic provinces (alternately hatched and unhatched areas, from east to west, Blue Ridge, Ridge and Valley, Cumberland Plateau, unhatched Highland Rim surrounding horizontally hatched Nashville Basin, and Coastal Plain).
A = *Cyprinella monacha*

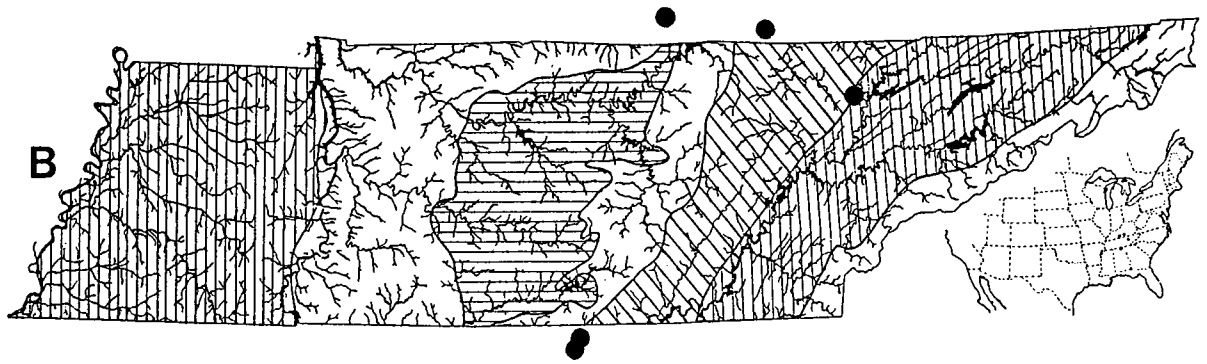

Figure 1. B = *Notropis* sp. cf. *N. procne*

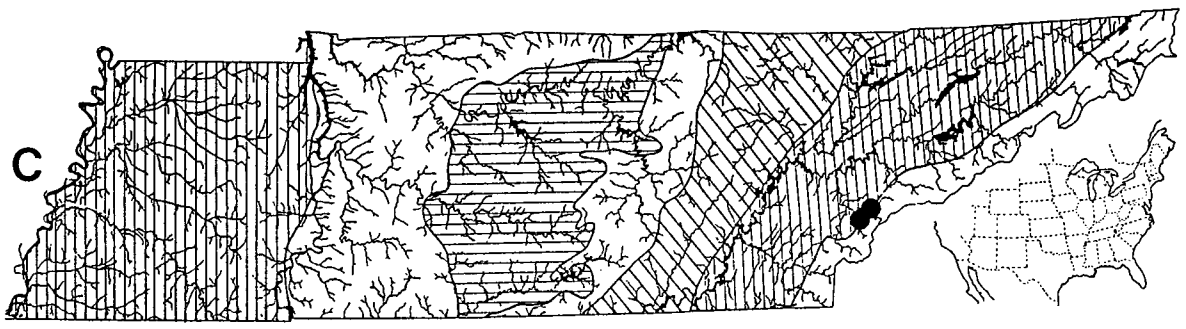

Figure 1. C = *Noturus baileyi*

teau, and Ridge and Valley provinces, and extralimital populations (Jenkins and Burkhead 1984) are from the Ridge and Valley (North Fork Holston River) of Virginia, the Blue Ridge (French Broad and Little Tennessee river systems) of North Carolina, the Ridge and Valley of north Georgia (South Chickamauga Creek), and the southern Highland Rim (lower Shoal Creek and adjacent Tennessee River) of north Alabama. In the undescribed "palezone shiner" (Figure 1B), the single Tennessee locality and two of the extralimital localities are precisely on the interface between adjacent provinces, but the most westerly locality in Kentucky (Burr and Warren 1986) is well within the Mississippian or Pennyroyal Plateau of the northern Highland Rim. The only two localities for *Noturus baileyi* (Figure 1C) are at the Blue Ridge/Ridge and Valley interface (Bauer et al. 1983). *Etheostoma acuticeps* localities are also concentrated near the Blue Ridge/Ridge and Valley interface (Figure 1D), but the range extends well into the Ridge and Valley and Blue Ridge (Haxo and Neves 1984). Four of the five localities from which the "duskytail darter" is known (R. E. Jenkins, in litt.) are at the interfaces between physiographic provinces (Figure 1E), and the remaining locality (lower Big South Fork of the Cumberland River near the Tennessee/Kentucky border) is in an area where

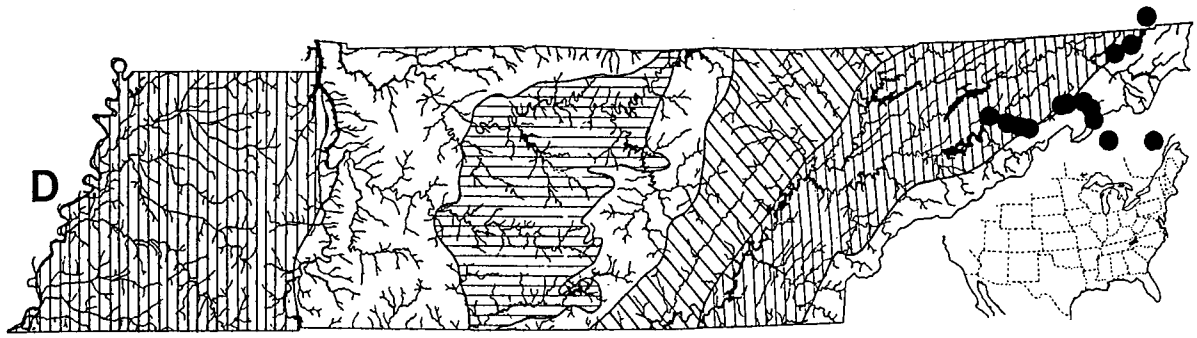

Figure 1. D = *Etheostoma acuticeps*

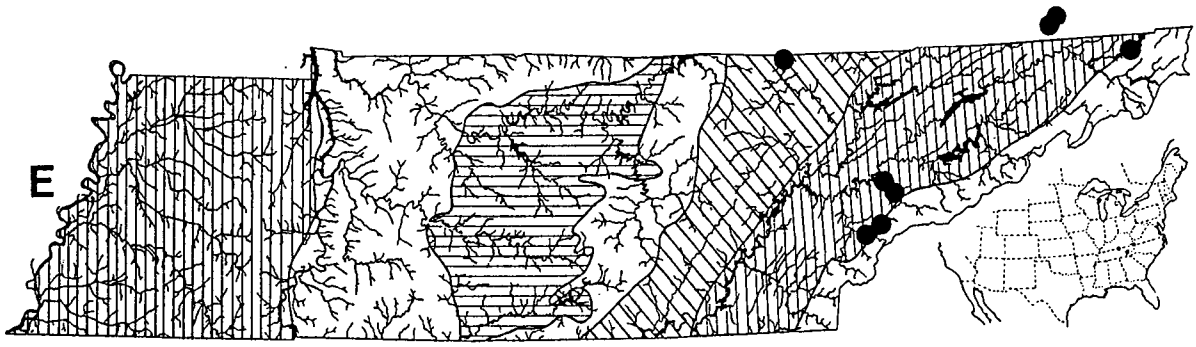

Figure 1. E = *Etheostoma* sp., "duskytail darter"

the river is so deeply incised that the species essentially is occupying a narrow finger of Highland Rim within the Cumberland Plateau.

Our analysis of Tennessee's jeopardized fishes indicates that our most severely abused aquatic habitats are medium–sized rivers and springs, where human use (impoundments and water supplies) has resulted in drastic changes in the habitats. With the possible exception of the "river" muskellunge, where overexploitation by fishermen using a variety of conventional and unconventional (e.g., dynamite, high–powered rifles) techniques may be a significant factor, the jeopardized status of our fishes is almost surely attributable to habitat alteration. It seems likely that an analysis of jeopardized species of mussels relative to their habitat preferences would corroborate human abuse of medium–sized rivers. Our knowledge concerning the distribution and status of other groups of aquatic organisms is less complete, but we project that future work will reveal a disproportionately large number of jeopardized taxa of other groups occurring in medium–sized rivers and springs.

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