Imperiled Fishes of the Southern Appalachian Ecosystem, with Emphasis on the Non-Federally Listed Fauna

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by

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Introduction

Freshwater fish diversity in the southern United States is unparalleled in the Temperate World. According to the American Fisheries Society (AFS), about 662 native freshwater fishes are known from drainages spanning the southern U.S. from Virginia to southeastern Kansas to Texas excluding the Rio Grande (Warren et al. 2000). This area is completely within the U.S. Fish and Wildlife Service's (Service) Southeast Region (Region 4). Well over 600 fishes are estimated to occur in Region 4 drainages.

Conservation status of southeastern fishes has been assessed by Deacon et al. (1979) and Williams et al. (1989). Warren et al. (2000) took status assessment a step further. They determined distributions of fishes within 51 regional drainage units, as well as assigned conservation status for all recognized taxa, and those formally undescribed taxa for which there was compelling evidence for taxonomic distinction. Approximately 28% of the southern fish fauna was deemed in need of conservation (Warren et al. 2000). This level of imperilment represents a 75% increase in jeopardized fishes from 1989 (Williams et al. 1989), and a 125% increase since 1979 (Deacon 1979). Interestingly, 28% of the fish fauna were also shown to have native ranges restricted to a single drainage unit. Despite the relatively large size of their drainage units, distributional data for southern fishes indicates the profound threat from range fragmentation and isolation (Warren et al. 2000). The high degree of relatively narrow endemicity in southern fishes (Warren and Burr 1994) not only makes the Southeastern fish fauna among the most unique in the world, but also a highly jeopardized one (Etnier 1997, Warren et al. 1997, Warren et al. 2000).

Recognized diversity among fishes is rapidly expanding, even in light of a century and a half of periodically intensive taxonomic investigations (Warren et al. 2000). Nearly 40 fishes have been discovered and/or described in the past 12 years alone in the Southeast, of which about two-thirds are darters (Burkhead and Jelks 2000). Ichthyologists recognize several other fishes whose present species concept includes a complex of putative (regarded as valid) taxa (Warren et al. 2000). Uncovering "cryptic biodiversity" among fishes continues to progress at an astounding level with advancing biotechnology and the application of phylogenetic analyses

(Mayden and Wood 1995). Complexes of fishes await rigorous taxonomic investigation (Warren et al. 2000). However, the number of formally described fish species is expected to continue to rise in this remarkably rich geographic region (Burkhead and Jelks 2000). Newly discovered fishes are oftentimes narrowly endemic and imperiled (Burkhead and Jelks 2000), making sound management efforts exceedingly difficult considering the dearth of ecological information requisite for their protection or recovery (Warren et al. 2000).

The inclusion of numerous putative (assumed to be valid), but undescribed, taxa by Warren et al. (2000) in their status assessment was an attempt at tallying total fish diversity from the region. Acceptance of undescribed forms by the conservation community awaits peer review and publication of formal taxonomic descriptions. An accurate accounting of diversity is imperative for the wise management, preservation, and recovery of regional fishes (Mayden and Wood 1995, Angermeier and Winston 1999).

Landscape scale habitat degradation has resulted in range reduction, fragmentation, and increasing isolation of southern fishes (Angermeier 1995, Warren et al. 1997). The high rate of human population growth in the "Sunbelt" coupled with increasing natural resource consumption is the foundation of significant threats to regional aquatic resources (Noss and Peters 1995, Folkerts 1997). Population growth increases the demand for dam construction, navigation channel maintenance, inter-basin water transfers for metropolitan areas, and aquifer depletion (Warren et al. 2000). These pervasive threats to aquatic habitats throughout the region (Walsh et al. 1995), coupled with the highly endemic fauna (Warren and Burr 1994), exacerbate the level of faunal imperilment. Clearly, the trend for fishes in recent decades has been the increasing threat of imminent extinction (Warren et al. 2000). Other aquatic faunal groups have also been determined to suffer even higher levels of imperilment (e.g., freshwater mussels, Williams et al. 1993; crayfishes, Taylor et al. 1996). The challenge to aquatic resource managers charged with their conservation is therefore both obvious and daunting.

In Region 4, 35 fishes are protected under the Endangered Species Act (ESA) and have recovery plans. Federally listed species represent less than 5% of southeastern fishes, but over 25% of the Region 4 fauna is deemed in need of conservation (Warren et al. 2000). The large number of

jeopardized, but unlisted, fishes in our region emphasizes the need to manage and conserve this fauna before listing becomes necessary. If present trends continue, the extreme rarity and imperilment of some taxa will likely require Federal protection. The immediate implementation of sound, scientifically-based conservation actions may preclude the need to list an increasingly large percentage of the regional fish fauna.

Since the early 1970's, aquatic resource managers have slowly made the transition from single-species to ecosystem management, which is a more holistic manner of managing all but the most highly endemic taxa (Shute et al. 1997). Unfortunately, many fishes are becoming so rare that propagation technology and the holding of captive populations is increasingly necessary, particularly among the highly endemic fauna (Rakes et al. 1999). Shute et al. (1997) presented a general outline for the sound holistic management of aquatic resources at the ecosystem scale. They stressed the role of multiple partners and the importance of implementing various aspects of sound science (e.g., managing habitat and water quality, life history requirements, population dynamics, genetic information, propagation/reintroduction technologies, monitoring). These steps are necessary to manage the increasingly large imperiled fish fauna.

The intent of this report is to enhance our knowledge and understanding of the Service's Southern Appalachian Ecosystem (SAE) imperiled fish fauna and to answer the call by Shute et al. (1997), Warren et al. (2000), and others to help manage aquatic faunas on an ecosystem scale. Objectives include: 1) generating an annotated table of potentially imperiled fishes, including putative taxa; 2) compiling a list of fishes protected under the ESA; 3) compiling a comprehensive list of fishes considered currently stable; 4) determining single drainage endemics and those fishes that occur exclusively in the SAE; 5) providing a list of fishes recommended for addition to the Service's Region 4 "species of concern" list; 6) prioritizing a list of stream systems having extant populations of imperiled taxa; and 7) creating a "short list" of fishes with a relatively high potential for imperilment and deemed to have the greatest need for current conservation status assessment; and 8) suggesting critical research and conservation needs for those fishes. Throughout the report, emphasis is placed on the non-federally listed fish fauna of the SAE. This focus in no way implies that listed forms should not be the recipient of concerted conservation attention. Rather the implication is that numerous non-listed SAE fishes

need to be on conservation manager's "radar screens" if we are to manage and effect recovery for an ever larger portion of the imperiled southeastern fish fauna.

Study Area

The Southern Appalachian Ecosystem encompasses 13,489,855 hectares (33,334,023 acres), and includes portions of six states and two Service Regions (4 and 5) (Figure 1). Approximately two-thirds of the ecosystem lies within Region 4, including eastern Tennessee, western North Carolina, northeast Alabama, northern Georgia, and extreme northwest South Carolina. Western Virginia comprises the Region 5 portion of the ecosystem. The core of the SAE is formed by the Blue Ridge Mountains. Unlike other regional ecosystem delineations, the SAE was established on county boundaries, and not on drainage divides. Therefore, the headwaters of numerous Interior Basin, eastern Gulf Slope, and southern Atlantic Slope drainages originate in the Blue Ridge portion of the SAE. These include significant portions of the Tennessee, New (both Interior Basin), and Coosa (Mobile Basin, eastern Gulf Slope) River systems. Considerably lesser portions of the Potomac, James, Roanoke, Pee Dee, Santee, Savannah, Altamaha (all southern Atlantic Slope), Apalachicola, and Tallapoosa (both eastern Gulf Slope) River systems comprise the remainder of the SAE.

The entire upper Tennessee River system above Walden Gorge (near Chattanooga, Tennessee) is wholly contained within the SAE and is by far the largest component drainage system. This system drains eastern Tennessee, southwestern Virginia, western North Carolina, and northern Georgia. Roughly the upper two-thirds of the Coosa River system is part of the SAE (northern and northwestern Georgia, northeastern Alabama, and southeastern Tennessee), as is the New River system (west-central Virginia and northwestern North Carolina).

Portions of four physiographic provinces are included in the SAE, the Blue Ridge (western Virginia, western North Carolina, eastern Tennessee, northern Georgia, northeastern Alabama, northwestern South Carolina), Ridge and Valley (western Virginia, eastern Tennessee, northwestern Georgia, northeastern Alabama), and small portions of the Cumberland Plateau

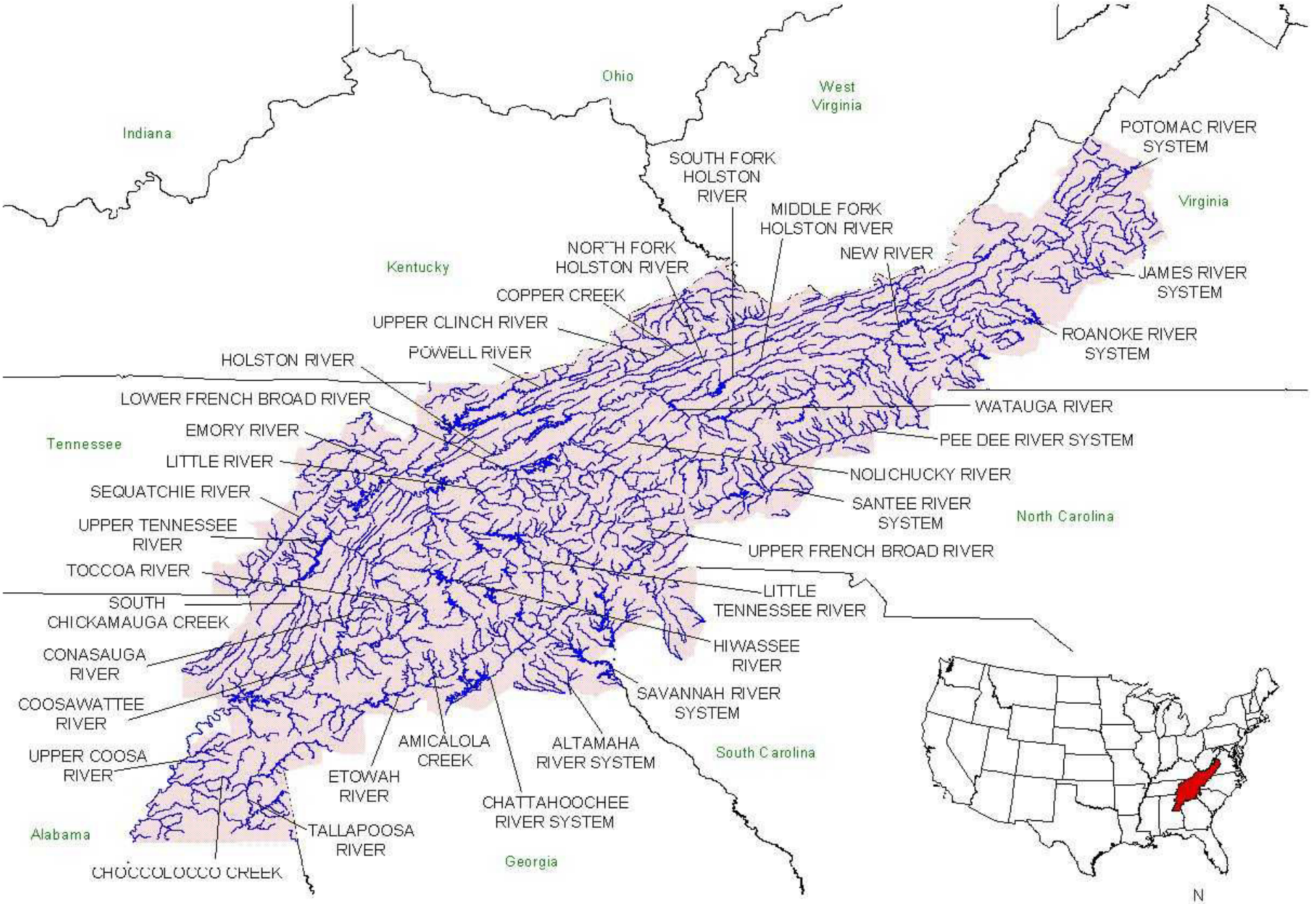

Figure 1. Southern Appalachian Ecosystem

(western Virginia, east-central Tennessee), and Piedmont (primarily north-central Georgia). The Blue Ridge is very old, dating to the Pre-Cambrian (over 570 million years old), although some rocks exposed in the province are as much as 1.1 billion years old. It is primarily composed of metamorphosed sedimentary rocks (e.g., gneiss, sandstone) and granite, with some exposures of shale, dolomite, and Ordovician (500 million years old) limestone. The Ridge and Valley is a northeast to southwest trending province formed by the extreme and complex folding and faulting of rock strata of the late Permian (about 250 million years old). Geology is primarily limestone and dolomite formations, with very limited sandstone exposure. These two provinces comprise the vast majority of the SAE.

The Cumberland Plateau and Piedmont provinces are of secondary importance on a geographic scale in the SAE. The Cumberland Plateau originated in the Permian (280 million years old), and represents a Pennsylvanian-aged (230 million years old) eroded plain composed of fairly erosion-resistant sandstones capping more erodable shales and limestones. There are scattered coal deposits in the SAE in southwestern Virginia and northeastern Tennessee. The primary feature throughout much of the Cumberland Plateau in the SAE is Walden Ridge, whose east face represents the Cumberland Escarpment. The Piedmont portion of the SAE occurs where metamorphic strata abut the upthrust Pre-Cambrian-aged Blue Ridge. It is a highly-eroded belt of the Appalachian Mountain group capped with saprolite featuring clay and silt soils. Etnier and Starnes (1993) and Jenkins and Burkhead (1993) provide more detailed discussions on these physiographic provinces and major river systems that drain the SAE.

Methods

Several literature sources were indispensable in the synthesis of conservation status information for fishes contained in this report. These included Lee et al. (1980), Menhinick (1991), Etnier and Starnes (1993), Jenkins and Burkhead (1993), Mettee et al. (1996), and Warren et al. (2000) for information on fish distributions, zoogeography, taxonomy, habitat, relative abundance, and threats. Original descriptions, taxonomic revisions, life histories, status survey reports, and personal communications with experts provided additional information. Robins et al. (1991) was the source for official AFS scientific and common names, while suggested common names

(depicted in quotations) were primarily provided by Warren et al. (2000). Scientific names are generally used throughout the text and tables, but common names are also given for those fish taxa mentioned in the text and in selected tables.

Table 1 lists those fish taxa that were assigned conservation status by the AFS and includes putative taxa that most likely warrant conservation status, but were not addressed by Warren et al. (2000). It should be noted that the endangered and threatened categories assigned by Warren et al. (2000) are relative and are not meant to imply that taxa assigned to these categories necessarily warrant Federal protection under the ESA. Taxa are listed alphabetically by family, genus, species, and subspecies; this order is maintained throughout all tables. Table 1 provides much of the specific information that was critical for the status assessments and recommendations made in subsequent tables in this report. Table 2 names fish taxa that are federally listed under the ESA. Table 3 includes those fishes deemed currently stable (Warren et al. 2000). Table 4 lists taxa that are endemic to both the SAE and specific river drainages. Table 5 includes those fishes that are recommended for addition to the Service's Region 4 species of concern list. Table 6 lists stream systems having the highest priority for conservation attention based on their extant imperiled fish fauna (based on a point system weighted towards the more imperiled and endemic fauna; see Table 6 "Notes"). Table 7 is a list of imperiled SAE fishes deemed to have the highest relative degree of imperilment and thus in the greatest need of additional conservation status assessment.

Basic research categories deemed requisite for prelisting and recovery actions are associated with taxa listed in Table 7. Status survey includes distributional and abundance data throughout the range. Life history research includes sex ratios, spawning season and habitat, fecundity estimates, early life history aspects, age and growth, food habits, and other aspects of biology that may be pertinent to recovery. Threat analysis includes habitat stressors, contaminants issues, potential adverse ecological interactions with native and introduced species, as well as remediation options (e.g., riparian habitat restoration). Taxonomic distinctiveness includes meristic and morphometric datasets (e.g., body proportions, coloration), genetic information (e.g., mitochondrial DNA, allozymes), phylogenetic analyses, and life history/ecological attributes that may prove useful for distinguishing taxa. Propagation technology includes any research necessary to successfully procure, transport, hold, spawn, and rear fishes in captivity to

an age suitable for return to the wild. Captive population is the knowledge and technology necessary to simply hold "Ark" population(s) of a species in captivity indefinitely, with the hope of someday returning it to suitable habitat.

Results and Discussion

A rough approximation of the total native fish fauna includes 298 taxa in 21 families (Tables 1-3). This total represents between one-fourth and one-third of the North American freshwater fish fauna north of Mexico (Lee et al. 1980; ~775 taxa, minus numerous introduced forms, plus allowances for dozens of subspecies unaddressed by them and the subsequent discovery of scores of additional taxa). No other Service-designated ecosystem nationwide comes close to having a fish fauna as rich as that of the SAE. For example, the adjacent Lower Tennessee Cumberland Ecosystem (LTCE), approximately two-thirds the size of the SAE, ranks a distant second with approximately 242 taxa (Butler 2002), while the Central Gulf Ecosystem (CGE) ranks third with roughly 190 taxa. As perspective, the CGE alone has more fish taxa than any other Service-designated ecosystem in the U.S. outside the SAE and LTCE. These three ecosystems represent the core of biodiversity among fishes in Region 4, and over half of the total U.S. fish fauna.

Zoogeography

The abundant fish fauna of the SAE can be attributed to several factors (Burkhead and Jelks 2000). Foremost among these factors is the large number of component drainages. Portions of 12 major drainages are included within the SAE (Figure 1, see "Study Area"). The multiple drainages, diversity of physiographic provinces, and variety of aquatic habitats provides tremendous potential for speciation, and collectively results in complex zoogeographic patterns (Hocutt and Wiley 1986). The majority of the SAE has neither been glaciated nor inundated by oceans since the Pre-Cambrian, thus its streams provided headwater refugia for fishes when these events covered adjacent, lower elevation drainages. This set of geologic and physiographic conditions, coupled with relative stability for eons, has provided ample opportunities for speciation. Unlike the Service's LTCE, allopatric (non-overlapping) distributions and narrow

endemicity in the SAE are primarily a function of its numerous discreet component drainages, rather than of the more complex physiography of the former (Butler 2002).

The Imperiled Fauna

Current Status of the Fauna

Conservation status has been assigned to, or is deemed warranted for (in the case of putative taxa), 58 (19%) of the 298 taxa (Table 1). The Alabama shad (*Alosa alabamae*) and "Chucky madtom" (*Noturus* sp. cf. *elegans*) are currently candidates for Federal listing (Table 1). Sixteen (5%) of the fishes known from the SAE are protected under the ESA (Table 2). The SAE has more listed fishes than any other ecosystem in the eastern U.S. The SAE and LTCE collectively have more listed fishes (21) than all of the other Service ecosystems in its three eastern U.S. regions (3, 4, and 5) combined. Eight taxa among the 58 listed in Table 1 have not been assigned conservation status by Warren et al. (2000), but are included here as putative undescribed taxa. Of the remaining 50 taxa, conservation status breakdown is as follows: 2 endangered, 11 threatened, and 37 vulnerable (Warren et al. 2000). The harelip sucker (*Moxostoma lacerum*), formerly known from the SAE, is considered extinct (Warren et al. 2000).

Historical Trends in the Status of the Fauna

Nineteen of the jeopardized fishes in Table 1 and two taxa in Table 3 have been assigned conservation status in previous assessments of the imperiled North American fauna. There appears to be no general positive or negative trend in status for most of those taxa appearing on the lists generated in 1979 (Deacon et al. 1979), 1989 (Williams et al. 1989), and 2000 (Warren et al. 2000). Two taxa saw their status decline (from special concern to threatened for *Etheostoma cinereum* and from threatened to endangered for *E. trisella*) from 1989 to 2000, while six others experienced positive changes in their status (from endangered or threatened to special concern or currently stable) over the 20-year period. Positive changes in status generally reflected better information, rather than actual recovery. Other trends are apparent for taxa in Table 1. Fourteen taxa described or recognized before 1989 appeared for the first time in Warren et al. (2000) as fishes warranting conservation status. Nineteen of 27 (70%) of the formally undescribed taxa in Tables 1 and 3 are considered imperiled, while 17 of 22 (77%) of the taxa described since approximately 1975 are also jeopardized.

Patterns of Imperilment

Recent studies have determined various predictors of imperilment in fishes that are useful for resource managers (Warren and Burr 1994, Angermeier 1995, Etnier 1997, Warren et al. 1997). Warren et al. (1997) assessed variables of imperilment (e.g., range size, unique taxa, taxa richness, fish families, stream-type diversity) in southeastern drainages included in SAE. Following are some factors associated with fishes and imperilment.

Newly Recognized Taxa and Imperilment

Newly recognized taxa tend to be imperiled at a higher rate than the general fish fauna, oftentimes due to narrow endemicity (Burkhead and Jelks 2000). This correlation is apparent from data in Table 1 and "Historical Trends in the Status of the Fauna" above. Nineteen of 28 (68%) of the formally undescribed taxa in Tables 1 and 3 are considered imperiled, while 65% of the taxa described since approximately 1975 are also imperiled. Reasons for this apparent correlation may include the fact that these taxa are generally cryptic, difficult to catch, and/or benthic in nature. Information on actual taxonomic richness of SAE fishes, including putative forms, is therefore critical for managing all components of the imperiled fauna.

Endemicity and Imperilment

A primary predictor of imperilment among fishes is range size, with the level of imperilment increasing with decreasing range size (Burkhead et al. 1997, Warren et al. 1997). Forty-one (14%) of SAE fishes are endemic to this ecosystem (Tables 1-3). Twenty-three of 58 (40%) SAE endemic taxa that have been assigned or deemed deserving of conservation status are endemic to single drainage systems (Table 4), as are all 8 of the SAE endemic fishes listed under the ESA (Table 2). Nearly 80% of the SAE and single drainage endemic fishes are jeopardized (including federally listed taxa). These fishes demonstrate the relationship between single drainage endemicity and imperilment.

Drainage Unit Correlates with Imperilment

Among the 31 jeopardized endemic taxa in Table 4, 17 are restricted to the upper Tennessee and 13 to the upper Coosa River systems (Table 4). Predictably, these drainages contain two of the

richest fish faunas in the Southeast (Warren et al. 1997, 2000). About 157 native taxa are known from the upper Tennessee River system (Warren et al. 2000, this report). Roughly 120 fishes are known from the Coosa River system (this report), although about a dozen or so are found only in the lower system and are thus absent from the SAE. Not surprisingly, native species richness and unique taxa within drainages were correlated significantly with faunal imperilment, while drainage-unit area and stream-type diversity showed weaker correlations with faunal imperilment (Warren et al. 1997).

Warren et al. (1997) assessed various imperilment data among 33 southeastern drainage units. These two SAE drainages have experienced the highest increase in imperilment of their native fish faunas between 1979 and 1989 when compared to other regional drainages (~3.5% *vs*. $\leq$2.0%, respectively). They also have the highest relative percentages (~13% *vs*. <10%, respectively) of imperiled fishes in the region (Warren et al. 1997).

Fish Family Correlates with Imperilment

Imperilment, manifest in range restriction and population declines, has been shown to occur across numerous taxonomic groups of fishes (Angermeier 1995, Warren et al. 1997). The families Ictaluridae (primarily madtoms) and Percidae (primarily darters), however, display disproportionate levels of imperilment than expected based on their representation of the total fauna (Etnier and Starnes 1991, Warren et al. 1997, Burkhead and Jelks 2000).

The pattern of imperilment associated with taxonomic groups also holds true for SAE ictalurids (6 of 11, or 55% imperiled *vs.* 24% among all SAE fishes) and darters (36 of 83, or 43%). Imperilment rates in the SAE were somewhat higher than estimates for madtoms (55% *vs.* 50%) and percids (43% *vs.* ~35%) known from throughout Region 4 (Warren et al. 2000).

Habitat Correlates with Imperilment

Among habitat types, benthic-dependent and spring habitat fishes experience a higher relative degree of imperilment than fishes found in other habitat types (Burkhead et al. 1997, Warren et al. 1997, 2000). Benthic dependency as used herein refers to fishes that spawn, feed, and shelter on the stream bottom (Burkhead et al. 1997). Benthic-dependent fishes, such as madtoms and

darters, have several attributes that contribute inordinately to their imperilment from substrata degradation and impoundments. These factors include small body size, low fecundity, benthic specialization, and rheophilic (current-loving) orientation (Burkhead and Jelks 2000).

The correlation of certain habitats with imperilment also holds true in the SAE, where all but 1 of the 16 federally listed fishes (Table 2) are benthic dependent, as are about 72% of those taxa in Table 1. The spring habitat fishes known from the SAE (i.e., pygmy sculpin, *Cottus paulus*; flame chub, *Hemitremia flammea*; coldwater darter, *Etheostoma ditrema* complex) are imperiled, with *C. paulus* being federally listed.

Species of Concern Status for Region 4 Fishes

Currently, 24 (8%) of the fishes known from the SAE are considered species of concern by the Service's Region 4. All 24 taxa, with the exception of the mountain blotched chub (*Erimystax insignis eristigma*), have been assigned conservation status (Table 1). After this assessment, this number appears to be artificially low, and not indicative of recent declines in several taxa.

I recommend that 25 additional taxa (Table 5) be added to the regional species of concern list. Among the forms herein recommended for species of concern status, three (e.g., lined chub, *Hybopsis lineapunctata*; frecklebelly madtom, *Noturus munitus*; freckled darter, *Percina lenticula*) were once assigned category 2 (C2) status on the Service's Animal Candidate Review for Listing. The C2 status meant that the Service had information that suggested listing was possibly appropriate, but conclusive evidence on biological vulnerability or threat was not available. Taxa on the now defunct C2 list formed the basis for Region 4's species of concern list. These fishes were subsequently dropped from C2 status due to updated status survey information (59 Federal Register 58982) before the Service officially did away with its C2 list in 1995.

All of the taxa in Table 5 have been assigned conservation status by Warren et al. (2000) or are deemed to warrant such (for putative taxa). In addition, they are generally considered "narrow endemics" (Table 1), and as such may be relatively more susceptible to habitat perturbations from human population growth than are more widespread forms (Gilpin and Soulé 1986,

Burkhead and Jelks 2000). For this reason alone, some taxa may perpetually be deserving of species of concern status. In general, the more wide-ranging forms (at least for the Region 4 portion of their range) have experienced multiple population extirpations, currently have disjunct populations, and are generally rare throughout much if not all of their respective ranges because of various anthropogenic factors.

High Priority Stream Systems

Stream systems having the highest priority for extant jeopardized fish taxa are listed in Table 6. This provides conservation managers with a list of prioritized drainages to direct conservation activities at the watershed scale (e.g., riparian restoration). The weighted point system (see Table 6 "Notes") indicated that the Etowah and Conasauga Rivers in the upper Coosa River system, and the Little Tennessee, Clinch, and Hiwassee Rivers in the upper Tennessee River system were the highest priority stream systems in the SAE. Other upper Coosa River tributaries were also important refugia for imperiled fishes, as were some streams in the uppermost Tennessee River system.

The number of imperiled fishes in the entire upper Coosa River system probably makes it the most important drainage for conservation and restoration efforts in all of Region 4. The uppermost Tennessee River system should not be far behind in these efforts. Two tributary systems, the South Fork Holston and French Broad Rivers, had low numbers of extant jeopardized fishes. Each stream has lost several taxa to habitat alteration and degradation as evidenced by the low number of extant fish taxa when compared to species of historical occurrence noted in Table 1.

The Critically Imperiled Fauna

Based on the status information gathered in this report, 21 taxa are relatively highly imperiled and are deemed to have the greatest need for current conservation status assessment (Table 7). The high priority Conasauga and Hiwassee Rivers harbor five, while the Etowah River has four, of these taxa (Table 6). Include the Coosawattee River, and the three major tributaries comprising the upper Coosa River system harbor populations of seven of the high priority fish for conservation assessment work. Sixteen of the 21 taxa are endemic to the SAE, and

considered “narrow” or “very narrow” endemics (see Table 1) that are restricted globally to a single drainage system (Warren et al. 2000, this report). As discussed above, narrow endemicity is a major predictor in identifying jeopardized fishes. More important is realizing that within the Service the SAE team has sole management responsibility for over 75% of these fishes.

The other three forms in Table 7 (i.e., ashy darter, *Etheostoma cinereum*; blotchside logperch, *Percina burtoni*; longhead darter *P. macrocephala*) have experienced stream extirpations, have highly disjunct remaining populations, and are generally rare rangewide (see Table 1). Two of them (i.e., *E. cinereum, P. macrocephala*) are considered threatened by Warren et al. (2000). As a cautionary note, this does not imply that any of the taxa in Table 6 should be immediately elevated to candidate status, with subsequent pursuit of Federal protection. It is only meant to imply that these taxa exhibit a higher relative degree of imperilment and additional information on their conservation status is warranted. That stated, many of the taxa Warren et al. (2000) considered to be threatened or endangered are currently protected under the ESA. The urgent need to implement status assessments for these taxa becomes obvious.

Research and Conservation Needs

An attempt has been made to identify broad categories of basic but critical research and conservation needs for the high priority fishes (Table 7). Recovery actions generally needed for most of these taxa include status survey, life history, threat analysis, and propagation technology. Taxonomic distinctiveness research is imperative to determine the validity of putative forms (Warren et al. 2000) (e.g., holiday darter complex, *Etheostoma* spp. cf. *brevirostrum*; redline darter complex, *E.* spp. cf. *rufilineatum*) and defining evolutionarily significant units (Mayden and Wood 1995) within species complexes (e.g., *E. ditrema*). Establishing captive populations becomes increasingly necessary for the most critically jeopardized fishes (e.g., *Noturus* sp. cf. *elegans*) (Rakes et al. 1999).

Summary

The SAE native fish fauna, with approximately 298 taxa, is the richest of any Service ecosystem nationwide. Fifty-eight (19%) of the non-federally listed fishes have been assigned, or are in need of, conservation status. An additional 16 fishes are federally listed, which represents nearly half of those occurring in Region 4. The drainage diversity of the SAE, coupled with its longtime stability, physiographic diversity, and wide range of stream habitat types has resulted in an incredibly diverse fish fauna. The SAE's two major drainages, the upper Tennessee and Coosa River systems, have the highest relative percentages of imperiled fishes (~13%), as well as the highest increase in rate of imperilment between 1979 and 1989 (~3.5%), among regional drainages. Forty-one (14%) of the fish taxa are endemic to the SAE.

Newly recognized taxa in the SAE, including those fishes described since ~1975 and putative forms, appear to be imperiled at a much higher rate (77 and 70%, respectively) than the general fish fauna (28%, Warren et al. 2000). Benthic-dependent fishes, particularly the madtoms and darters, are disproportionately jeopardized. Twenty-five taxa are recommended for addition to the Service's Region 4 species of concern list. This would bring the regional list total to 50 (17%) of the fish taxa known from the SAE, which is still below the regional imperilment rate of 28% (Warren et al. 2000). The Etowah, Conasauga, Little Tennessee, Clinch, and Hiwassee Rivers are determined to be the highest priority watersheds in the ecosystem for imperiled fish conservation. Twenty of the 58 imperiled fish taxa exhibit a relatively high degree of imperilment and are deemed to have the greatest need for current conservation status assessment. Seven of these high priority taxa currently occur in the upper Coosa and seven others occur in three upper Tennessee River system tributaries. The fact that 16 of these 20 highly imperiled fishes are ecosystem endemics places exclusive management and conservation responsibility on SAE team members. Continual status assessment work in SAE drainages is needed to keep the information in this report current and useful as a tool critical for imperiled fish conservation and recovery.

Presented with predicted future fish extinction rates of 2.4% per decade in the U.S. (Ricciardi and Rasmussen 1999), the task of resource managers in implementing recovery actions, to say nothing of societal changes, needed to reverse this trend is indeed overwhelming. Ongoing efforts to recover jeopardized species, coupled with this attempt to elucidate highly imperiled taxa in the SAE, help to promote the conservation of the Southeast's magnificent fish fauna.

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Table 1. Imperiled Non-Listed Fishes of the Southern Appalachian Ecosystem Accordingto the American Fisheries Society (Warren et al. 2000)

Family/ Species, Common Name	SAE Range	CS	Comments on Status, Distribution, Taxonomy, Etc.
Acipenseridae			
Acipenser fulvescens lake sturgeon	upper Tennessee R. system (Tennessee, French Broad Rs.), upper Coosa R. system (Coosa R; Oostanaula R. system (Conasauga, Etowah? Rs.))	T T T	**Currently R4 Species of Concern;** very widespread distribution mostly in the Midwest and known from 20 states and 7 Canadian provinces; 4 TN (Etnier & Starnes 1993), 2 AL, 1 GA (Mettee et al. 1996), and 1 NC site (Menhinick 1991); multi-partner reintroduction efforts underway in the lower French Broad R., soon to be implemented in upper Coosa R. system; probably extirpated from latter, which is a form that may have been distinct (B. Freeman, University of Georgia, pers. comm., 1999); warrants Federal protected status (Etnier 1997); also in LTCE, ORVE, and elsewhere
Amblyopsidae			
Typhlichthys subterraneus southern cavefish	upper Coosa system	V	**Currently R4 Species of Concern;** relatively widespread distribution east and west of the Mississippi R.; known only from Big Wills Valley caves in northeastern AL (3 sites, Mettee et al. 1996); low fecundity, coupled with reduced breeding female populations, presumably limits recruitment (Etnier & Starnes 1993); considered "in no immediate danger" as long as water quality is not threatened (*ibid.*); extralimital in SAE; also in LTCE, ORVE, and elsewhere
Catostomidae			
Cycleptus elongatus blue sucker	upper Tennessee R. system (Holston R.; French Broad R. system (French Broad, Nolichucky Rs.), Clinch, Hiwassee, Little Tennessee, Tennessee Rs.)	V SC	**Currently R4 Species of Concern;** very widespread distribution mostly west of the Mississippi R. and known from 23 states and Mexico; majority of occurrences in regulated rivers; 10 SAE sites, all in TN (Etnier & Starnes (1993); inhabits big swift rivers over firm substrata (*ibid.*); "[s]tatus assessment problematic due to difficulty in capture" (Burr & Warren 1986); warrants Federal protected status (Etnier 1997); also in LTCE, ORVE, and elsewhere
C. meridionalis southeastern blue sucker	upper Coosa R. system (Coosa R.)	V	**Currently R4 Species of Concern;** endemic to the Mobile Basin; newly described taxon; most remaining habitat in large, regulated rivers, where it occurs in swift currents over firm substrata (Etnier & Starnes 1993); warrants Federal protected status (Etnier 1997); extralimital and probably extirpated from SAE
Moxostoma sp. cf. *macrolepidotum* "sicklefin redhorse"	upper Tennessee R. system (Little Tennessee R. system (Tuckasegee R.), Hiwassee R. system (Nottely, Valley Rs.; Brasstown Creek), Tennessee R.)	T	**Currently R4 Species of Concern; Endemic (narrow) GA, TN;** well known putative taxon (R.E. Jenkins, Salem College, pers. comm., 1999) endemic to the upper Tennessee R. system in the Blue Ridge; generally rare and localized in clean streams with little sedimentation, generally in swift water over rocky substrata; status survey and description being conducted (*ibid.*); warrants Federal protected status (Etnier 1997)
Thoburnia hamiltoni	upper Roanoke R. system (upper Dan R. system (Dan R., Smith R.	V SC	**Endemic (very narrow) NC, VA;** endemic to the upper Dan R. system in the Blue Ridge; known from only 2

rustyside sucker	system (Rockcastle, Little Creeks), South Mayo R. system (7 tribs), Little Dan R. (2 tribs)))	SC	counties (Stokes, NC; Patrick., VA); 1 NC site (Little Dan R., Menhinick & Braswell 1997) is the only R4 occurrence (RTNCFE); considered "uncommon or common; quite rare in upper Dan [R.]" (Jenkins & Burkhead 1993), who plotted 30 VA sites, apparently sensitive to sedimentation (*ibid.*); restricted to R5 portion of SAE
Centrarchidae			
Ambloplites cavifrons Roanoke bass	upper Roanoke R. system (North Fork Roanoke R. system (Bradshaw Creek)), Dan R. system (Dan R.; Smith R. system (Town Creek))	V SC SC	Restricted in SAE to the upper Roanoke R. system; considered "generally rare" in VA, with its range decreasing and becoming more disjunct (Jenkins & Burkhead 1993); a sportfish that has been stocked in impoundments and other sites; extralimital in SAE, and restricted to R5 portion; mostly in RTNCFE
Clupeidae			
Alosa alabamae Alabama shad	upper Tennessee R. system (Clinch R.), upper Coosa R. system?	V	**Currently a Candidate** (National Marine Fisheries Service lead); widespread anadromous species; extralimital to, and now extirpated from, SAE due to dam construction
Cottidae			
Cottus sp. cf. "broadband sculpin" form 1 "Bluestone sculpin"	New R. system (upper Bluestone R. system (Bluestone R.; Wrights Valley Creek)	V	Newly recognized taxon endemic to the New R. system in the Ridge and Valley; restricted to extreme upper Bluestone R. system, VA and WV, with 6 SAE sites (Jenkins & Burkhead 1993); "generally common" in relatively silt-free, high gradient runs and riffles with larger rocky substrata (*ibid.*); once considered a category 2 candidate by the Service; restricted to R5 portion of SAE; also in ORVE
C. sp. cf. "broadband sculpin" form 2 "Clinch sculpin"	upper Tennessee R. system (Clinch R. system (Little, Clinch Rs.; Indian Creek system (Lowe Branch), Stony Creek))	V	**Endemic (very narrow) VA;** newly recognized taxon endemic to the Clinch R. system in the Ridge and Valley; known from ~10 sites, where it is common or abundant in relatively silt-free, swift spring runs and riffles with gravel and rubble substrata (Jenkins & Burkhead 1993); restricted to R5 portion of SAE
C. sp. cf. "broadband sculpin" form 3 "Holston sculpin"	upper Tennessee R. system (Holston R. system (South Fork Holston R. system (South Fork Holston R.; Watauga R. system (Doe R.), Middle Fork Holston R.)))	V	**Endemic (very narrow) TN, VA;** newly recognized taxon endemic to the Holston R. system in the Ridge and Valley; known from ~20 sites, and "generally uncommon" in relatively silt-free, higher gradient runs and riffles of streams with larger rocky substrata (Jenkins & Burkhead 1993); mostly in R5 portion of SAE
Cyprinidae			
Clinostomus funduloides ssp. "Smoky dace"	upper Tennessee R. system (Little Tennessee R. system, Hiwassee R. system?), Savannah R. system	V	**Endemic (narrow) NC, TN;** newly recognized taxon restricted to small montane Blue Ridge streams; considered "common" in NC by Menhinick (1991) at ~35 sites, but Menhinick & Braswell (1997) noted it to be "rare" at sites where is was "formerly common" (based on a 1987 survey), and only plotted ~24 sites; 7 TN sites, where "uncommon and of spotty occurrence" Etnier & Starnes 1993); occurs in sand and rock pools (Menhinick & Braswell 1997); Hiwassee R. system population (11 NC sites) may represent intergrades with *C. f. fossor* (*ibid.*)
Cyprinella callitaenia bluestripe shiner	upper Apalachicola R. system (upper Chattahoochee R. system)	V T T	**Currently R4 Species of Concern;** endemic to the Apalachicola R. system; only a couple of SAE records (Lee et al. 1980); much of the slower currents over sand and gravel habitat (Mettee et al. 1996) for this river species destroyed by impoundments (e.g., Lanier Reservoir) (*ibid.*); warrants Federal protected status (Etnier 1997);

			extralimital in SAE; mostly in NEGE
Cyprinella xaenura Altamaha shiner	upper Altamaha R. system (upper Oconee R. system)	V	**Currently R4 Species of Concern;** endemic to the Altamaha R. system; only a couple of SAE records at most (Lee et al. 1980); occurs in pools behind cover or undercut banks (*ibid.*); warrants Federal protected status (Etnier 1997); extralimital in SAE; mostly in AE
Hemitremia flammea flame chub	upper Tennessee R. system (various tribs of Clinch, Hiwassee, Little Tennessee, Sequatchie, Tennessee Rs.; Chickamauga Creek), middle Coosa R. system (Choccolocco Creek system (Cheaha, Choccolocco, Kelly Creeks), Blue Eye Creek)	V SC SC	**Currently R4 Species of Concern;** spring species primarily in the Ridge and Valley; known form 6 AL sites (Mettee et al. 1996), ~22 TN (Etnier & Starnes 1993), and ~5 extirpated GA sites (Burkhead et al. 2001; P.W. Shute, Tennessee Valley Authority, pers. comm., 2002); typically found in springs and spring runs in lush aquatic vegetation (Etnier & Starnes 1993); has decreased in range and abundance, and nearly disappeared from eastern TN (*ibid.*); "relatively rare" according to Lee et al. (1980); mostly in LTCE
Hybopsis lineapunctata lined chub	upper Coosa R. system (Oostanaula R. system (Conasauga R. system (Conasauga R.; Mill (TN), Rocky, Sumac, Swamp Creeks; Jacks R.), Coosawattee R. system (Salacoa Creek system (Cedar Creek; unnamed Little Pine Log Creek trib), Talking Rock Creek), Etowah R. system (Amicalola, Spring (Floyd Co.) Creeks), Oostanaula R. tribs (Armuchee, Rocky?, Woodward Creeks)), Chatooga R. system (Chappel?, Chesterfield, Duck, Mills Creeks), Coosa R. tribs (Beech, Cheaha, Crooked, Hatchet, Kings, Lake, Ohatchee Creeks; Little R. system (North Spring Creek)), upper Tallapoosa R. system (Little Tallapoosa, Tallapoosa Rs.; Bear, Cohobadiah, Cornhouse, Crooked, Cutnose, Enitachopco, Hurricane, Jones, Kelly (=Norman), Knokes, Lockchelooge, McClennan, Pineywood, Silas, Walker, Wedowee, White Oak, Wircher Creeks) several unnamed tribs throughout range)	V	Endemic to the Mobile Basin; widespread within its range, in small upland creeks over sand with gentile currents (Etnier & Starnes 1993); "common" in Tallapoosa R. system (dozens of SAE sites), but very sporadic and "less common" in upper Coosa R. system (~15 sites, Mettee et al. 1996; Walters (1997) recorded 10 Conasauga R. system sites; "common" in Tallapoosa R. system tribs (Pierson et al. 1986); most abundant in Piedmont streams (Burkhead et al. 2001); also in CGE, NEGE
Macrhybopsis sp. cf. *aestivalis* "Fall Line chub"	upper Coosa R. system (Oostanaula R. system (Conasauga R. system (Conasauga R.; Coahulla Creek)), Etowah R. system (Etowah R.; lower Shoal Creek)), Coosa R. tribs (Hatchet Creek), upper Tallapoosa R. system (Little Tallapoosa,	V	Newly recognized taxon endemic to the Mobile Basin; very sporadically distributed and nearly endemic to SAE; most occurrences in Conasauga (~20 sites, Walters 1997) and Etowah (~12 sites, Mettee et al. 1996) R. systems; "occasional to common" in Tallapoosa R. main stem (Pierson et al. 1986), but most of its occurrences are outside of SAE; warrants Federal protected status (Etnier 1997); also in CGE, NEGE

	Tallapoosa Rs.)		
Margariscus m. margarita pearl dace	upper Potomac R. system (Shenandoah R. system (upper South Fork Shenandoah R. system))	V	A northern species with but a few northern VA records; considered "generally uncommon" (Jenkins & Burkhead 1993); extralimital in SAE, and restricted to R5 portion
Notropis ariommus popeye shiner	upper Tennessee R. system (Holston R. system (Holston R. (North Fork Holston R., South Fork Holston R. system (Watauga R.), French Broad R. system (Nolichucky R.), Clinch R. system (Clinch R. (Copper Creek), Powell R. system (Powell, North Fork Powell Rs.)), Tennessee R. tribs (South Chickamauga Creek))	V	Primarily restricted to Ohio R. system (formerly in Maumee R., Lake Erie drainage), but sporadically distributed, rare or uncommon; extirpated from north of Ohio R. (Jenkins & Burkhead 1993) and some tribs (e.g., Watauga R., South Chickamauga Creek; C.F. Saylor, Tennessee Valley Authority, pers. comm., 2002); ~34 VA (*ibid*.) and ~15 TN sites (Etnier & Starnes 1993); "habitat restricted" in flowing pools over small gravel, and having an "apparent intolerance of silt" (*ibid*.), which may account for its relative rarity in many streams; abundance extremely variable from year to year (Gilbert 1969); generally uncommon in the upper Tennessee R. system, but 134 reported from Powell R., TN, in 1996 (*ibid.*); also in LTCE, ORVE
N. hypsilepis highfin shiner	upper Apalachicola R. system (upper Chattahoochee R. system), upper Savannah R. system	V	**Currently R4 Species of Concern;** primarily restricted to the Apalachicola R. system, with a few records from the Blue Ridge portion of the SAE, and the Savannah R. system; a benthic species closely associated with sand substrate, but "generally not very common" (Lee et al. 1980); extralimital in SAE; also in NEGE
N. semperasper roughhead shiner	upper James R. system (Cowpasture, Craig, Maury Rs., Jackson R. system (Back, Dunlap, Potts Creeks))	V SC T	Endemic to the upper James R. system in the VA Ridge and Valley; ~25 of 38 total sites in VA streams of the SAE (Jenkins & Burkhead 1993); its habitat of moderate runs and flowing pools in only the most high quality streams is constricting from impoundment and sedimentation; a "generally uncommon" species, that may also be competitively excluded by introduced *N. telescopus* (*ibid.*); restricted to R5 portion of SAE; also in ORVE
Phoxinus tennesseensis Tennessee dace	upper Tennessee R. system (Holston R. system (South Fork Holston R. system (Middle Fork Holston R. system (Middle Fork; Bear, Walker? Creeks, unnamed trib Bear Creek), Watauga R. system (Doe Creek), Beaverdam Creek), North Fork Holston R. system (Lick Creek), Holston R. tribs (Right Prong Hatcher, Surgoinsville, Terrill Creeks; Brice Branch)), French Broad R. system (Nolichucky R. system (unnamed trib Cherokee Creek), Pigeon R. system (unnamed trib Cosby Creek), Little R. system (Reed Creek, unnamed trib), Little Pigeon R. system (Coe Creek)), lower Clinch R. system (Flat Fork, Harness, Little Cow Creeks; Pinhook Branch; unnamed tribs of Brushy Fork,	V SC	**Endemic (narrow) TN, VA;** newly recognized taxon endemic to the upper Tennessee River system and virtually restricted to Ridge and Valley; "highly localized" and "rare," being known from ~28 small spring-fed tributaries, but with "several...extirpated" populations (Starnes & Jenkins 1988); <40 extant sites and "may be much less abundant than formerly," but "abundant" in East Fork Popular Creek system, on the Oak Ridge National Laboratory site (Etnier & Starnes 1993); Shute (pers. comm., 2002) documented 67 sites historically, but only 49 sites were ranked as being extant, however, maintaining that small stream habitat is undersurveyed and that more populations may be discovered; warrants Federal protected status (Etnier 1997)

	Bear Creek), Emory R. system (Beech Fork Creek), Hiwassee R. system (Candies, Chestuee, Indian, Smith Creeks; Madden Branch), Little Tennessee R. system (unnamed tribs Fourmile, Ninemile, Tabcat Creeks; Caney Branch), Sequatchie R. system (Little Brush Creek), Tennessee R. tribs (Duskin, Sandy Creeks; unnamed trib))		
P. saylori laurel dace	upper Tennessee R. system (Piney R. system (Bumbee, Moccasin, Youngs Creeks); Sale Creek system (Cupp Creek; Rock Creek system (Horn, Laurel Branches)), Soddy Creek)	E	**Currently R4 Species of Concern; Endemic (very narrow) TN;** recently described taxon endemic to the upper Tennessee R. system on Walden Ridge (Cumberland Plateau); 6 of 7 known sites (minus Laurel Branch) extant (Skelton 2001), all but Cupp Creek with distribution limited to 1-3 stream kms; considered "fairly common to abundant" in tiny stream pools and slow runs over large rocky substrata, and is apparently tolerant of some siltation and low pH (*ibid.*); warrants Federal protected status (Etnier 1997)

Fundulidae			
Fundulus bifax stippled studfish	upper Tallapoosa R. system (Little Tallapoosa R.; Corn House Creek)	V	Virtually endemic to Tallapoosa R. above the Fall Line (1 trib of Coosa R.); unknown from upper Tallapoosa R. mainstem; inhabits eddies at margins of riffles and runs over sand and gravel (Mettee et al. 1996); considered "rare" (Pierson et al. 1986); extralimital in SAE; majority of limited range in CGE, NEGE?
Ictaluridae			
Ameiurus brunneus snail bullhead	upper Coosa R. system (Etowah R.)	V	Fairly widespread; native to upper Etowah R. (4 GA sites, Mettee et al. 1996); threatened by piscivorous, non-native flathead catfish (J. Evans, Georgia Department of Natural Resources, pers. comm., 1995); extralimital in SAE; ranges from NEGE to RTNCFE
A. platycephalus flat bullhead	upper Roanoke R. system (upper Dan R. system)	V	Fairly widespread from Roanoke R. system south to GA; considered "generally uncommon" in VA (Jenkins & Burkhead 1993); native bullheads are threatened in at least the southern portion of this species' range by piscivorous, non-native flathead catfish (J. Evans, Georgia Department of Natural Resources, pers. comm., 1995); extralimital in SAE, where restricted to R5 portion; ranges from AE north to RTNCFE
Noturus sp. cf. *elegans* "Chucky madtom"	upper Tennessee R. system (lower French Broad R. system (Little Pigeon R. system (Dunn Creek)), (Nolichucky R. system (Little Chucky Creek)))	T	**Currently a candidate**; **Endemic (very narrow) TN;** newly recognized taxon endemic to the upper Tennessee R. system in the Ridge and Valley; disjunct distribution at 2 sites (Etnier & Starnes 1993), extremely rare, and not found live in several years at the Little Chucky Creek site and not since 1940 at the Dunn Creek site)
N. gilberti orangefin madtom	upper Roanoke R. system (Pigg R. system (Pigg R.; Big Chestnut Creek), Smith R., upper Roanoke R. (Bottom, Goose Creeks), North Fork, South Fork Roanoke Rs., Little Dan R.), upper Dan R. system (upper Dan R., South Mayo R. system (South Mayo R., North Fork South Mayo R.)), upper James R. system (Craigs Creek system (Craigs, Johns Creeks)	T T T	Endemic to the upper Roanoke R. system primarily in the Blue Ridge; very near endemic to the SAE; in VA known from ~23 sites in upper Roanoke R. system, while ~13 sites in upper James R. system is considered introduced (Jenkins & Burkhead 1993); 5 NC sites, all Little Dan R. (Menhinick & Braswell 1997); considered "rare or uncommon" (Jenkins & Burkhead 1993); native range may be constricting, while introduced populations expanding (*ibid.*); warrants Federal protected status (Etnier 1997); only in R5 portion of SAE; also in RTNCFE
N. sp. cf. *munitus* "Coosa madtom"	upper Coosa R. system (Oostanaula R. system (Conasauga, Etowah Rs.))	T	**Endemic (narrow) GA, TN;** newly recognized taxon endemic to the upper Coosa R. system (R.M. Mayden, Saint Louis University, pers. comm., 1999); known from ~17 Etowah R. and 6 Conasauga R. sites (Shepard et al. 1997); found in strong currents over coarse gravel to boulders (Etnier & Starnes 1993); very rare and localized in Conasauga R., locally common in disjunct Etowah R. population (Burkhead et al. 2001); warrants Federal protected status (Etnier 1997)
Percidae			
Ammocrypta clara western sand darter	upper Tennessee system (Clinch R. system (Clinch, Powell Rs.))	V	Widespread distribution mostly in the Midwest and known from 13 states, but very sporadic in the Southeast; seldom collected in SAE, with 4 sites each in TN (Etnier & Starnes 1993) and VA (Jenkins & Burkhead 1993); typically found in low to moderate gradient streams in sandy substrate, but

			it has been taken over gravel and rubble in VA; its rarity might indicate that its habitat appears to be marginal in the SAE (*ibid.*); extralimital in SAE; also in ORVE
Etheostoma acuticeps sharphead darter	upper Tennessee R. system (French Broad R. system (Nolichucky R. system (Nolichucky, North Toe, Cane Rs.)), (Holston R. system (South Fork Holston R.)))	V SC T	**Endemic (narrow) NC, TN, VA;** endemic to the upper Tennessee R. system in the Ridge and Valley and Blue Ridge; disjunct distribution, with 12 TN (Etnier & Starnes 1993), 5 NC (Menhinick 1991), and 2 VA sites (Jenkins & Burkhead 1993); densest populations in the Nolichucky R. system of this "extremely localized" species occur in areas with heavy riverweed (*Podostemon*) growths (Etnier & Starnes 1993); may be extirpated from the South Fork Holston R. (TN), but still occurs in that stream in VA; apparently has re-invaded once degraded habitats in upper Nolichucky R. system (*ibid.*), with recent records in the North Toe and lower Cane Rs. (Shute, pers. comm., 2002); warrants Federal protected status (Etnier 1997)
E. blennioides gutselli Tuckasegee darter	upper Tennessee R. system (French Broad R. system (Pigeon R. system (West Fork Pigeon R.; Jonathon, Richland Creeks))), (Little Tennessee R. system (Santeetlah, Tuckasegee Rs.; Cartoogechaye, Eagle, Hazel, Slick Rock Creeks), (Oconaluftee R. system (Deep, Forney, Noland Creeks; Bradley, Caney, West Forks), Cullasajah R. system (Ellijay Creek)))	V	**Endemic (narrow) NC, TN;** endemic to the upper Tennessee R. system in the Blue Ridge; found in Pigeon and Little Tennessee R. systems; ~46 NC (Menhinick 1991) and 1 TN site (Slick Rock Creek) (Etnier & Starnes 1993), although 3 recent Pigeon R. sites aound the state line are known (Shute, pers. comm., 2002); occurs in swift riffles with boulders and rubble (Etnier & Starnes 1993); a status survey is underway (K.L. Piller, University of Wisconsin, pers. comm., 2002); warrants full species status; although geographically restricted in range, populations are fairly large (*ibid.*), with several presumably on Forest Service lands
E. sp. cf. *blennioides* "Hiwassee form"	upper Tennessee R. system (upper Hiwassee R. system (upper Ocoee (Toccoa) R. system))	?	**Endemic (very narrow) GA, NC, TN;** putative form (H.L. Bart, Jr., Tulane University; K.L. Piller, University of Wisconsin, pers. comm., 2002) endemic to the upper Hiwassee R. system in the Blue Ridge; downstream range not delineated, but ~5 TN (*ibid.*) and ~18 NC sites (Menhinick 1991), and in GA at least in the Toccoa R.; population originally thought to be intergrades between *E. b. gutselli* and *E. b. newmani* (Etnier & Starnes 1993); occurs in swift riffles with boulders and rubble (Etnier and Starnes 1993); populations are highly fragmented due to several coldwater release reservoirs in the system; a status survey is underway (Piller, pers. comm., 2002)
E. blennius sequatchiense Sequatchie darter	upper Tennessee R. system (Sequatchie R. system (Sequatchie R.; Big Brush, Cannon, Coops, McWilliams, Skillern, Stone Creeks; Mill Branch; Little Sequatchie R?))	V	**Currently R4 Species of Concern; Endemic (very narrow) TN;** endemic to the Sequatchie R. system in the Cumberland Plateau; Etnier & Starnes (1993) plot 9 sites over most of the entire main stem; locally common or abundant in deep, swift riffles over gravel, with a museum collection of 101 specimens (Burr 1979); trib populations are generally small and only found in the lowermost mile (Saylor, pers. comm., 2002); despite relatively abundance, its virtual restriction to a single stream makes it highly susceptible to perturbations (e.g., toxic spills)
E. brevirostrum holiday darter	upper Coosa R. system (Choccolocco Creek system (Choccolocco, Shoal Creeks))	T	**Currently R4 Species of Concern; Endemic (very narrow) AL;** endemic to the upper Choccolocco Creek system in the Blue Ridge; general habitat is bedrock and gravel pools of small streams (Etnier & Starnes 1993); currently restricted to Shoal Creek (Burkhead et al. 2001) in the Talladega National Forest, which doesn't preclude

			potential threats to its continued existence (N.M. Burkhead, USGS-BRD, pers. comm., 2001); current restriction to a single stream makes it highly susceptible to perturbations (a busy Forest Service campground is on Shoal Creek); warrants Federal protected status (Etnier 1997)
E. sp. cf. *brevirostrum* holiday darter form 1 "Amicalola form"	upper Coosa R. system (lower Oostanaula R. system (upper Etowah R. system (Amicalola Creek system)))	?	**Endemic (very narrow) GA;** putative form (Burkhead et al. 2001) endemic to the Amicalola Creek system in the upper Etowah R. system in the Blue Ridge (7 sites); general habitat is bedrock and gravel pools (Etnier & Starnes 1993) of very small streams (Burkhead et al. 2001); may represent the most tolerant and abundant form in the *E. brevirostrum* complex, but still considered highly imperiled (*ibid*.); warrants Federal protected status (Etnier 1997)
E. sp. cf. *brevirostrum* holiday darter form 2 "Conasauga form"	upper Coosa R. system (upper Oostanaula R. system (upper Conasauga R. system (Conasauga, Jacks Rs.)))	?	**Endemic (very narrow) GA, TN;** putative form (Burkhead et al. 2001) endemic to the upper Conasauga R. system in the Blue Ridge; known in upper Conasauga R. main stem and Jacks R., where it occurs in bedrock and gravel pools (Etnier & Starnes 1993); Shute (pers. comm., 2002) notes their association with *Podostemon*-covered rocks in riffles, runs, and the ends of pools more often than in pools *per se*; virtually its entire range is in Chattahoochee and Cherokee National Forests; populations above Minnewauga Creek are considered stable, with others declining (Burkhead et al. 2001); warrants Federal protected status (Etnier 1997)
E. sp. cf. *brevirostrum* holiday darter form 3 "Coosawattee form"	upper Coosa R. system (upper Oostanaula R. system (Coosawattee R. system (Ellijay R. system (Bear, Big Turniptown, Little Turniptown, Rock Creeks)), Coosawattee tribs (Conasauga, Mountaintown Creeks))	?	**Endemic (very narrow) GA;** putative form (Burkhead et al. 2001) endemic to the upper Coosawattee R. system in the Blue Ridge; general habitat is bedrock and gravel pools in small streams (Etnier & Starnes 1993); "significantly declining" according to recent survey data (Burkhead et al. 2001), with several stream extirpations known; currently limited to a section of upper Mountaintown Creek and tribs, and represents 1 of the 2 most imperiled forms of the *E. brevirostrum* complex (N.M. Burkhead, USGS, pers. comm., 2002); restriction to a single stream makes it highly susceptible to perturbations (e.g., toxic spills); warrants Federal protected status (Etnier 1997)
E. sp. cf. *brevirostrum* holiday darter form 4 "Etowah form"	upper Coosa R. system (lower Oostanaula R. system (upper Etowah R.))	?	**Endemic (very narrow) GA;** putative form (Burkhead et al. 2001) endemic to the upper Etowah R. main stem in the Blue Ridge; apparently restricted to ~25 km reach of stream in vicinity of Chattahoochee National Forest, where there is "excessive sedimentation," and "population densities are low;" possibly represents "the most threatened" form of the *E. brevirostrum* complex (*ibid*.); restriction to a single stream makes it highly susceptible to perturbations (e.g., toxic spills); warrants Federal protected status (Etnier 1997)
E. chuckwachattae lipstick darter	upper Tallapoosa R. system (Tallapoosa R.; Beach?, Cane, Cornhouse, Crooked, Little Mississippi?, Walker? Creeks)	V	Endemic to the upper Tallapoosa R. system; occurs in larger streams, but is paradoxically absent from Little Tallapoosa R.; known from a total of ~10 streams rangewide; population clusters fragmented by Harris Reservoir; Mettee et al. (1996) plots ~8 SAE sites; "common" at most sites of occurrence (Pierson et al. 1986); warrants Federal protected status (Etnier 1997);

			most of limited range in CGE
E. sp. cf. *cinereum* ashy darter "upper Tennessee form"	upper Tennessee system (Clinch R. system (Clinch R.), Emory R. system (Emory, Obed Rs.), Tennessee R. tribs (Little R.; South Chickamauga Creek))	?	**Currently R4 Species of Concern; Endemic (narrow) GA, TN, VA:** putative form endemic to the upper Tennessee R. system (S.L. Powers, University of Alabama, pers. comm., 2002); mostly in the Ridge and Valley in SAE; 5 TN sites (Etnier & Starnes 1993) plus single extirpated sites for GA (1955) and VA (1964) (Shepard & Burr 1984); highly disjunct populations; in early 1980s, Little R. considered only viable upper Tennessee R. system population (*ibid.*), although still found in Emory R. (Saylor, pers. comm., 2002); Little R. population is now declining due to development, but its hanging on in Clinch R., TN (Powers, pers. comm., 2002) and VA (Shute, pers. comm., 2002); its requirement of silt-free pools (Etnier & Starnes 1993), an increasingly degraded habitat type, has probably exacerbated its imperilment (Shepard & Burr 1984); its pool habitat is difficult to collect due to boulders, which indicates that it may be "under-represented in collections" (Shute, pers. comm., 2002); due to warrants Federal protected status (Etnier 1997)
E. denoncourti golden darter	upper Tennessee R. system (Clinch R. system (Clinch R.; Copper Creek), Sequatchie R.)	V	Endemic to the Tennessee R. system; recently described taxon with very disjunct populations; 4 VA sites, where it varies from generally uncommon to common in Clinch R. depending on year (Jenkins & Burkhead 1993); ~6 TN sites (Etnier and Starnes 1993); occurs in large stream shoals over gravel (*ibid.*); Sequatchie R. population apparently restricted to lower 16 miles, but is fairly stable (Saylor, pers. comm., 2002); warrants Federal protected status (Etnier 1997); also in LTCE
E. ditrema complex coldwater darter	upper Coosa R. system (upper Oostanaula R. system (Conasauga R. system), Choccolocco Creek system; Coosa R. tribs)	T T T	**Currently R4 Species of Concern;** endemic to the Coosa R. system in the Ridge and Valley; considered a complex with 3 putative forms (Mayden and B.R. Kuhajda, University of Alabama, pers. comm., 2002); lack of clear distributional information precludes addition of component forms in this table; known from ~55 historical sites; 2 "spring" forms probably restricted to SAE, 1 centered in Conasauga R. system (~16 of 23 sites extant), another possibly endemic to Coldwater Spring, Choccolocco Creek system (which has an endemic sculpin; see Table 2), but affinity of additional populations in the system are undetermined; 3rd or "creek" form the most widespread, but it's extralimital, and mostly in lower Coosa R. tribs (CGE); warrants Federal protected status (Etnier 1997)
E. osburni candy darter	upper New R. system (New R.; Big Stony, Reed, Sinking Creeks; Wolf Creek system (Big Walker, Dismal, Laurel Creeks); Pine, Spruce Runs)	V SC T	Endemic to the upper Kanawha (New) R. system in VA and WV; ~20 VA sites Jenkins & Burkhead (1993); inhabits clear streams, in runs and riffles over rocky substrata; thought to be "generally...rare," with range reductions as well as some stream extirpations possible (*ibid.*); warrants Federal protected status (Etnier 1997); restricted to R5 portion of SAE; also in ORVE
E. sp. cf. *rufilineatum* redline darter "Hiwassee form 1"	upper Tennessee R. system (upper Hiwassee R. system (Brasstown Creek, elsewhere?))	?	**Endemic (very narrow) NC, GA?;** putative form (R.M. Wood, St. Louis University, pers. comm., 2002) endemic to the upper Hiwassee R. system; preliminary morphometric and genetic evidence supports taxonomic distinction; known with certainty from Brasstown Creek, where it occurs syntopically (together in the same habitat)

			with *E.* sp. cf. *rufilineatum* "Hiwassee form 2;" occurs in swift, shallow, rocky riffles in clear streams; total range and status unknown
E. sp. cf. *rufilineatum* redline darter "Hiwassee form 2"	upper Tennessee R. system (upper Hiwassee R. system Brasstown Creek, elsewhere?))	?	**Endemic (very narrow) NC, GA?;** putative form (R.M. Wood, St. Louis University, pers. comm., 2002) endemic to the upper Hiwassee R. system; preliminary morphometric and genetic evidence supports taxonomic distinction; known with certainty from Brasstown Creek, where it occurs syntopically (together in the same habitat) with *E.* sp. cf. *rufilineatum* "Hiwassee form 1;" occurs in swift, shallow, rocky riffles in clear streams; total range and status unknown
E. sp. cf. *rufilineatum* redline darter "Toccoa form"	upper Tennessee R. system (upper Hiwassee R. system (upper Ocoee (Toccoa) R. system (Toccoa R.; Fightingtown Creek)))	?	**Endemic (very narrow) GA;** putative form (R.M. Wood, St. Louis University, pers. comm., 2002) endemic to the upper Toccoa (Hiwassee) R. system, and virtually restricted to the main stem; preliminary morphometric and genetic evidence supports taxonomic distinction; occurs in swift, shallow, rocky riffles in clear streams; status unknown, but virtual restriction to a single stream makes it highly susceptible to perturbations (e.g., toxic spills)
E. trisella trispot darter	upper Coosa R. system (Oostanaula R. system (Conasauga R. system (Coahulla, Holly, Mill, Old Fort, Rock, Swamp Creeks; unnamed trib)), Coosawattee R. system (Coosawattee R. and tribs), Oostanaula R. tribs (Woodward Creek), Coosa R. tribs (Cowans Creek))	E T T	**Currently R4 Species of Concern; Endemic (narrow) AL, GA, TN;** endemic to the upper Coosa R. system in the Ridge and Valley; virtually restricted currently to Conasauga R. system (~36 sites, Walters 1997); type locality (Cowans Creek, Cherokee Co.) is only AL record, but now flooded by Weiss Reservoir (Mettee et al. 1996); Burkhead et al. (2001) recently took it in a lower Oostanaula R. trib; inhabits slack water stream margins with detritus or rooted vegetation (Etnier & Starnes 1993); unique winter spawning habitat of seasonally flooded seepages is highly vulnerable to disturbance; warrants Federal protected status (Etnier 1997)
E. vulneratum wounded darter	upper Tennessee R. system (Clinch R. system (Powell, Little? Rs.; Copper Creek; Emory R. system (Obed R.; Daddys Creek)), Holston R. system (North, Middle, South Forks), French Broad R. system (Nolichucky R., Little Pigeon R. system (West Prong Little Pigeon R.; Spring Creek)), Little R., Little Tennessee R. system (Tuckasegee, Oconaluftee, Cullasajah Rs.; Bradley Fork), Tennessee R. tribs (Whites Creek))	V	**Endemic NC, TN, VA;** endemic to the upper Tennessee R. system in the Ridge and Valley and Blue Ridge; widespread and disjunct; ~15 NC (Menhinick & Braswell 1997), ~35 VA (Jenkins & Burkhead 1993), and ~35 TN sites ("locally abundant" in upper Clinch, Little, and upper Little Tennessee Rs., but rare or uncommon elsewhere; Etnier & Starnes 1993); its habitat of deep, relatively silt-free, slow to moderate runs over slab rubble and boulders (Jenkins & Burkhead 1993) is difficult to collect, and it may be more common than believed (Etnier & Starnes 1993)
Percina brevicauda coal darter	lower Coosa R.	T T	**Currently R4 Species of Concern;** recently described taxon endemic to the Mobile Basin in the Ridge and Valley; only SAE records (2 AL sites, Mettee et al. 1996) are preimpoundment Coosa R.; found in swift shoal areas over gravel, cobble, and sand; warrants Federal protected status (Etnier 1997); extralimital to and probably extirpated from SAE; majority of range in CGE
P. burtoni blotchside	upper Tennessee R. system (Clinch R. system (Clinch, Little	V SC	**Currently R4 Species of Concern;** restricted to Tennessee and Cumberland R. systems; known from ~20

logperch	Rs.; Copper Creek), Holston R. system (North Fork Holston R. system (Big Moccasin, Laurel Creeks), South Fork Holston R.), French Broad R. system (upper Nolichucky R. system (South Toe, Cane Rs.), Swannanoa R.; Cane Creek), Little Tennessee R. system (Abrams Creek), Little R.)	SC	VA (Jenkins & Burkhead 1993), ~6 NC (Menhinick 1991), and ~10 TN sites (Etnier & Starnes 1993); occurs in larger streams in deep runs with gravel and cobble, is intolerant of silt, and is generally "rare and localized" (Etnier & Starnes 1993); many populations extirpated, including South Fork Holston R., upper French Broad R. system, and Cane R., but expanding in North Fork Holston R. below Saltville (Jenkins & Burkhead 1993); warrants Federal protected status (Etnier 1997); also in LTCE
P. lenticula freckled darter	upper Coosa R. system (Oostanaula R. system (Conasauga, Etowah Rs.)), Coosa R.)	T T T	Relatively widespread in Gulf Coast drainages, but very sporadic and uncommon; ~7 SAE sites in upper Coosa R. system (Mettee et al. 1996, Walters 1997); its distribution and occurrence is "the epitome of patchy," with only 3 collections from the SAE in the past decade (Burkhead et al. 2001); occurs in chutes formed by logs, boulders, or bedrock at the head of deep, swift runs, a habitat difficult to sample (*ibid.*); warrants Federal protected status (Etnier 1997); most of range in CGE
P. macrocephala longhead darter	upper Tennessee R. system (Holston R. system (North Fork Holston R., South Fork Holston R. system (middle Fork Holston, South Fork Holston, Watauga Rs.)), French Broad R. system (French Broad R. (NC), West Fork Little Pigeon R.), Clinch R. system (Little, Powell Rs.; Copper Creek; Emory R. system (Obed R.))	T T T	**Currently R4 Species of Concern;** endemic to the Ohio River system, where it is very disjunct; known from ~12 VA (where "quite rare," Jenkins & Burkhead 1993), 1 NC (1942, extirpated; Menhinick & Braswell 1997), and ~10 TN sites (Etnier & Starnes 1993); inhabits deep, flowing pools over clean sand and boulders, and its requirement of silt-free flowing pools (*ibid.*), an increasingly degraded habitat type, has probably exacerbated its imperilment; a large darter whose diet includes crayfish (Page 1978); may represent a complex with at least 3 putative forms, 1+ (possibly endemic) in SAE (*ibid.*); Emory R. specimens may be different from Little R. specimens (Saylor, pers. comm., 2002); Service is funding Mayden (Saint Louis University) to study this taxonomic issue; if valid, the SAE form(s) is highly imperiled; it "probably warrants Threatened status throughout its range" (*ibid.*); warrants Federal protected status (Etnier 1997); also in LTCE, ORVE
P. sp. cf. *macrocephala* form 1 "upland bridled darter"	upper Coosa R. system (upper Oostanaula R. system (Conasauga R. system (Conasauga, Jacks Rs.; Ball Play, Holly, Minnewauga? Creeks), Coosawattee R. system (Talking Rock Creek system), Etowah R. system (Etowah R.; Amicalola Creek)))	V	**Currently R4 Species of Concern; Endemic (narrow) GA, TN;** long known undescribed taxon endemic to the upper Coosa R. system; highly disjunct populations; known from ~22 sites, primarily in the Conasauga R. system (Mettee et al. 1996, Walters 1997); occurs in moderate stream pools over sand and gravel, where it occurs in "low densities" (Burkhead et al. 2001); its habitats are susceptible to sediment deposition (*ibid.*); considered "relatively common" in the national forest portion of the Conasauga R. system by Shute (pers. comm., 2002); warrants Federal protected status (Etnier 1997)
P. sp. cf. *macrocephala* form 2 "Muscadine bridled darter"	upper Tallapoosa R. system (Little Tallapoosa, Tallapoosa Rs.; Beach, Brooks, Bush, Cahulga, Cane (Tallapoosa R.), Cane (Little Tallapoosa R.), Chulafinnee, Cohobadiah, Cornhouse, Crooked, Dynne,	V	**Currently R4 Species of Concern;** long known undescribed taxon endemic to the Tallapoosa R. system where its widely distributed (dozens of sites, Mettee et al. 1996); inhabits areas below riffles and in runs over sand and gravel (*ibid.*); "usually common" in main stem and trib sites (Pierson et al. 1986); much more widespread than "upland bridled darter" (see above); also in CGE

	Hurricane, Ketchepedrakee, Little, Lockhelooge, Muscadine, Norman, Shoal, Silas, Snake, Thomason, Verdin, Walker, Watermill, Wedowee Creeks; Lake Gerald outlet; other small tribs)		
P. sp. cf. *palmaris* "Halloween darter"	upper Apalachicola R. system (upper Chattahoochee R. system (Chestatee, Chattahoochee Rs.; Sautee Creek))	V	**Currently R4 Species of Concern;** putative form (Freeman et al. 2002) endemic to, and with four disjunct populations in, the Apalachicola R. system in GA; occupies riffle and run habitats of medium to large streams (*ibid.*); may actually represent a species complex (B.J. Freeman, University of Georgia; M.C. Freeman, USGS, pers. comm., 1999), but data currently inconclusive; extralimital in SAE unless there is a putative upland or Blue Ridge form (considered "not abundant; *ibid.*), which would be endemic to the SAE; mostly in NEGE
P. squamata olive darter	upper Tennessee R. system (Holston R. system (South Fork Holston R. system (South Fork Holston, Watauga Rs.)), French Broad R. system (French Broad R. (Little, Pigeon Rs.), (Nolichucky R. system (Nolichucky, North Toe, South Toe, Cane Rs.; Cane Creek))),Clinch R. system (Emory R. system (Obed R. system (Daddys Creek)), Little Tennessee R. system (Tuckasegee, Oconaluftee, Cullasajah Rs., Little Tennessee R. tribs (Deep, Forney, Hazel, Noland Creeks), Hiwassee R. system (Hanging Dog, Wilscot Creeks))	V	**Currently R4 Species of Concern;** restricted to the Tennessee and Cumberland R. systems; highly disjunct populations; known from ~24 NC (Menhinick 1991) and ~11 TN sites (Etnier & Starnes 1993), but absent from VA and primarily absent from the Ridge and Valley; considered to be "often a very abundant and successful species in localized suitable habitat" of fast boulder and bedrock chutes, despite probably being "unusually sensitive" to silt and other pollutants (*ibid.*), but populations appear to be declining in recent years in the Big South Fork (LTCE) and possibly elsewhere (P.L. Rakes and J.R. Shute, Conservation Fisheries, Inc., pers. comm., 2002); also in LTCE
Polyodontidae			
Polyodon spathula paddlefish	upper Tennessee R. system (Tennessee, Clinch, Powell, Holston, French Broad, Little Tennessee, Hiwassee Rs.)	V SC SC	**Currently R4 Species of Concern;** very widespread distribution mostly in large rivers west of the Mississippi R. and known from 27 states; ~20 TN (Etnier & Starnes 1993), 4 VA (Jenkins et al. 1993), and 3 NC sites (Menhinick 1991); managed as a commercial and/or sportfish species throughout its' range; tolerant of impoundments (Etnier & Starnes 1993) if access to riverine spawning habitat present; also in ORVE, SAE, and elsewhere

NOTES

Column 1: Common names applied to undescribed taxa are generally from Warren et al. (2000), but are subject to change.

Column 2: Range (historical and current) within the SAE is generally given. Streams in parentheses refer to tributaries in the previously labeled "parent" stream system. Distributional data are generally derived from state treatises on fishes, original descriptions and revisions, other published papers, and unpublished status survey reports. Many of the streams are derived from dot distribution maps, with difficult stream identifications in question marks. These include:

Alabama and Georgia portion of the Mobile Basin (Mettee et al. 1996), North Carolina (Menhinick 1991, Menhinick & Braswell 1997), Tennessee (Etnier & Starnes 1993), Virginia (Jenkins & Burkhead 1993). However, for some taxa, such as cave (e.g., *Typhlichthys subterraneus*), spring habitat (e.g., *Hemitremia flammea*), and certain putative (e.g., *Etheostoma* sp. cf. *blennioides*) forms, caves/streams of occurrence are not provided. Small stream forms (e.g., *Hybopsis lineapunctata, Phoxinus tennesseensis, Percina* spp. cf. *macrocephala*) may have named streams of occurrence, but they may not be clustered as to subdrainages like they are for most larger stream forms. The Tallapoosa River system is highly fragmented by Service ecosystems. The upper portion of the entire system is in the SAE except for the Carroll County, Georgia, portion of the Little Tallapoosa River system, a small portion of the lower Little Tallapoosa watershed, and a tiny portion of the upper Tallapoosa River watershed, which are all in the NEGE. The southern portion of the Tallapoosa River system is in the CGE.
Column 3: Conservation status categories have been assigned for some fish taxa by the American Fisheries Society three times since 1979. In this column, Warren et al. (2000) is the first, Williams et al. (1989) is the second, and Deacon et al. (1979) is the third. "Special concern" status is equivalent to "vulnerable." A question mark in the column indicates a putative taxon not included in Warren et al. (2000), but deemed deserving of conservation status.
Column 4: Endemic in bold denotes a taxon that is endemic to the SAE (with relative degree of endemicity), and state(s) of occurrence (including historical).
General: A former SAE taxon, *Moxostoma lacerum* (harelip sucker), is considered extinct (Warren et al. 2000) and has been omitted from the table.

CODES
AE = Altamaha Ecosystem, CGE = Central Gulf Ecosystem, CS = conservation status, E = endangered, *ibid.* = same reference, LTCE = Lower Tennessee Cumberland Ecosystem, NEGE = Northeast Gulf Ecosystem, ORVE = Ohio River Valley Ecosystem, RTNCFE = Roanoke Tar Neuse Cape Fear Ecosystem, R4 = Service Region 4, SAE = Southern Appalachian Ecosystem, SC = special concern, sp. cf. = species to be compared with, T = threatened, USGS = U.S. Geological Survey, V = vulnerable

Table 2. Fish taxa of the Southern Appalachian Ecosystem federally protected under the Endangered Species Act.

Family/Species	Common Name	States	Non-SAE Ecosystems	T/E
Cottidae				
***Cottus paulus* (=*pygmaeus*)**	pygmy sculpin	AL	-	T
Cyprinidae				
Cyprinella caerulea	blue shiner	AL, GA, TN	LTCE	T
Erimystax cahni	slender chub	TN, VA	-	T
Erimonax monacha	spotfin chub	AL, GA, NC, TN, VA	LTCE	T
Notropis albizonatus	palezone shiner	AL, KY, TN	LTCE	E
Ictaluridae				
Noturus baileyi	smoky madtom	TN	-	E
N. flavipinnis	yellowfin madtom	TN, VA	-	T
N. stanauli	pygmy madtom	TN	LTCE	E
Percidae				
Etheostoma etowahae	Etowah darter	GA	-	E
E. percnurum	duskytail darter	TN, VA	LTCE	E
E. scotti	Cherokee darter	GA	-	T
Percina antesella	amber darter	GA, TN	-	E
P. aurolineata	goldline darter	AL, GA	CGE	T
P. jenkinsi	Conasauga logperch	GA, TN	-	E
P. rex	Roanoke logperch	VA	RTNCFE	E
P. tanasi	snail darter	AL, GA, TN	LTCE	T

NOTES

Column 1: Taxa in bold are endemic to the Southern Appalachian Ecosystem (SAE).

Column 2: Common names applied to undescribed taxa are generally from Warren et al. (2000), but are subject to change.

Columns 3 and 4: Includes historical occurrence.

General: *Notropis albizonatus* is extirpated from the SAE, and is now globally restricted to the LTCE. *Noturus flavipinnis* is considered to represent two taxa endemic to the SAE, one each restricted to Blue Ridge and Ridge and Valley streams, respectively (R.L. Mayden, Saint Louis University, pers. comm., 2001). *Etheostoma percnurum* is considered to represent two taxa, with one each restricted to LTCE (Big South Fork) and SAE (upper Tennessee R. system), respectively (B.M. Burr, Southern Illinois University, pers. comm., 2002).

CODES

CGE = Central Gulf Ecosystem, E = endangered, LTCE = Lower Tennessee Cumberland Ecosystem, RTNCFE = Roanoke Tar Neuse Cape Fear Ecosystem, T = threatened, T/E = Federal status

Table 3. Currently stable (Warren et al. 2000) native fishes of the Southern Appalachian Ecosystem.

Acipenseridae		
Scaphirhynchus platorynchus		
Amiidae		
Amia calva		
Anguillidae		
Anguilla rostrata		
Atherinopsidae		
Labidesthes sicculus		
Catostomidae		
Carpiodes carpio	*Minytrema melanops*	*M.* sp. cf. *poecilurum*
C. cyprinus complex	*Moxostoma anisurum*	*Scartomyzon ariommus*
C. velifer complex	*M. carinatum*	*S. cervinus*
Catostomus commersoni	*M. duquesnei*	*S. lachneri*
Hypentelium etowanum	*M. erythrurum*	*S.* sp. cf. *lachneri*
H. nigricans	*M. macrolepidotum breviceps*	*S. rupiscartes*
H. roanokense	*M. m. macrolepidotum*	*Thoburnia rhotheca*
Ictiobus bubalus complex	*M. pappillosum*	
I. niger	*M. poecilurum*	
Centrarchidae		
Ambloplites ariommus	*L. macrochirus*	*M. punctulatus*
A. rupestris	*L. megalotis* complex	*M. salmoides*
Lepomis cyanellus	*L. microlophus* complex	*Pomoxis annularis*
L. gibbosus	*L. miniatus*	*P. nigromaculatus*
L. gulosus	*Micropterus coosae*	
L. humilus	*M. dolomieu*	
Clupeidae		
Alosa chrysochloris	*A. sapidissima*	*Dorosoma cepedianum*
Cottidae		
Cottus baileyi	*C.* sp. cf. *bairdi* form 1	*C. c. zopherus*
C. b. bairdi	*C.* sp. cf. *bairdi* form 2	*C. girardi*
C. bairdi ssp. 1	*C. c. carolinae*	
Cyprinidae		
Campostoma a. anomalum	*L. c. isolepis*	*N. procne*
C. oligolepis	*L. coccogenis*	*N. rubellus micropteryx*
Clinostomus funduloides estor	*L. cornutus*	***N. rubricroceus***
Cyprinella analostana	*L. zonistius*	*N. scabriceps*
C. callistia	*Lythrurus ardens*	*N. scepticus*
C. chloristia	*L. fasciolaris*	*N. spectrunculus*
C. galactura	*L. lirus*	*N.* sp. cf. *spectrunculus*
C. gibbsi	*Macrhybopsis hyostoma*	*N. stilbius*
C. labrosa	*M. storeiana*	*N. telescopus*
C. nivea	*Nocomis leptocephalus bellicus*	*N. volucellus*

C. pyrrhomelas	*N. micropogon*	*N. wickliffi*
C. spiloptera	*N. platyrhynchus*	*N. xaenocephalus*
C. trichroistia	*N. raneyi*	*Opsopoeodus e. emiliae*
C. xaenura	*Notemigonus crysoleucas*	*Phenacobius catostomus*
C. zanema	*Notropis amoenus*	***P. crassilabrum***
Ericymba buccata	*N. asperifrons*	*P. teretulus*
Erimystax dissimilis	*N. atherinoides*	*P. uranops*
E. insignis eristigma	*N. buchanani*	*Phoxinus oreas*
Exoglossum laurae	*N. chiliticus*	*Pimephales notatus*
Hybognathus nuchalis	*N. chlorocephalus*	*P. vigilax*
H. regius	*N. chrosomus*	*Rhinichthys a. atratulus*
Hybopsis amblops	*N. cummingsae*	*R. a. obtusus*
H. hypsinotus	*N. hudsonius*	*R. cataractae*
H. rubrifrons	*N. leuciodus*	*Semotilus atromaculatus*
H. sp. cf. *winchelli*	*N. longirostris*	*S. corporalis*
Luxilus albeolus	*N. ludibundus*	*S. thoreauianus*
L. cerasinus	*N. lutipinnis*	
L. c. chrysocephalus	*N. photogenis*	
Esocidae		
Esox masquinongy	*E. niger*	
Fundulidae		
Fundulus catenatus	*F. notatus*	*F. rathbuni*
F. d. diaphanus	*F. olivaceus*	*F. stellifer*
Hiodontidae		
Hiodon alosoides	*Hiodon tergisus*	
Ictaluridae		
Ameiurus catus	*Ictalurus furcatus*	*N.* sp. cf. *flavus*
A. melas	*I. punctatus*	*N. funebris*
A. natalis	*Noturus eleutherus*	*N. leptacanthus*
A. nebulosus	*N. flavus*	*Pylodictis olivaris*
Lepisosteidae		
Lepisosteus oculatus	*L. osseus*	
Moronidae		
Morone chrysops	*M. mississippiensis*	*M. saxatilis*
Percidae		
Etheostoma blennioides complex	***E. mediae***	*P. evides*
E. b. newmanii	*E. n. nigrum*	***P. evides* ssp. 1**
E. c. caeruleum	*E. olmstedi* complex	*P. gymnocephala*
E. camurum	*E. podostemone*	*P. kathae*
E. chlorobranchium	*E. rufilineatum* complex	*P. maculata*
E. coosae	*E. rupestre*	*P. nevisense*
E.* sp. cf. *coosae	*E. s. simoterum*	*P. nigrofasciata*
E. duryi	*E. stigmaeum*	***P. notogramma montuosa***

E. flabellare brevispina	*E. swannanoa*	*P. oxyrhynchus*
E. f. humerale	*E. tallapoosae*	*P. palmaris*
E. flabellare complex	*E. thallasinum*	*P. peltata*
E. inscriptum	*E. vitreum*	*P. roanoka*
E. jessiae	*E. zonale*	*P. s. sciera*
E. jordani	*P. aurantiaca*	*P. shumardi*
E. kanawhae	*P. c. caprodes*	*Stizostedion canadense*
E. kennicotti	*P. copelandi*	*S. vitreum*
E. longimanum	*P. crassa*	
Petromyzontidae		
Ichthyomyzon bdellium	*I. gagei*	*Lampetra aepyptera*
I. castaneus	*I. greeleyi*	*L. appendix*
Poecilidae		
Gambusia affinis		
Salmonidae		
Salvelinus fontinalis		
Sciaenidae		
Aplodinotus grunniens		

NOTES

Columns 1-3: Taxa in bold are endemic to the SAE. A question mark denotes a taxon whose native or introduced status is uncertain. Numbered undescribed "forms" and complexes are from Warren et al. (2000), except *Ictiobus bubalus* (H.L. Bart, Jr., Tulane University, pers. comm., 2002), *Etheostoma blennioides* (K.L. Piller, University of Wisconsin, pers. comm., 2002), and *E. rufilineatum* (R.M. Wood, St. Louis University, pers. comm., 2002).

General: *Erimystax insignis eristigma* is the only Region 4 species of concern not assigned a conservation status by Warren et al. (2000). *Phenacobius teretulus* and *Etheostoma kanawhae* were assigned threatened status in 1979 (Deacon et al. 1979) and special concern status in 1989 (Williams et al. 1989). The following are native eastern North American fishes introduced into SAE streams from adjacent drainages: *Dorosoma petenense, Cyprinella lutrensis, Exoglossum maxillingua, Nocomis l. leptocaphalus, Phoxinus erythrogaster, Pimephales promelas, Noturus i. insignis,* and *Gambusia holbrooki.* Numerous other fishes have been introduced into the SAE from western states (e.g., salmonids) and foreign countries (e.g., carps).

CODES

SAE = Southern Appalachian Ecosystem, sp. cf. = species to be compared with

Table 4. Jeopardized fish taxa (those assigned or deemed deserving of conservation status, and federally listed species) that are endemic to both the Southern Appalachian Ecosystem and specific river drainages.

Species	CS	Drainage System		
		Tennessee	Coosa	Roanoke
Moxostoma sp. cf. *macrolepidotum*	T	X		
Thoburnia hamiltoni	V			X
Cottus paulus	FT		X	
C. sp. cf. "broadband sculpin" form 2	V	X		
C. sp. cf. "broadband sculpin" form 3	V	X		
Erimystax cahni	FT	X		
Phoxinus tennesseensis	V	X		
P. saylori	E	X		
Noturus baileyi	FE	X		
N. sp. cf. *elegans*	T	X		
N. flavipinnis	FT	X		
N. sp. cf. *munitus*	T		X	
Etheostoma acuticeps	V	X		
E. blennioides gutselli	V	X		
E. sp. cf. *blennioides*	?	X		
E. blennius sequatchiense	V	X		
E. brevirostrum	T		X	
E. sp. cf. *brevirostrum* form 1	?		X	
E. sp. cf. *brevirostrum* form 2	?		X	
E. sp. cf. *brevirostrum* form 3	?		X	
E. sp. cf. *brevirostrum* form 4	?		X	
E. sp. cf. *cinereum*	?	X		
E. etowahae	FE		X	
E. sp. cf. *rufilineatum* form 1	?	X		
E. sp. cf. *rufilineatum* form 2	?	X		
E. sp. cf. *rufilineatum* form 3	?	X		
E. scotti	FT		X	
E. trisella	E		X	
E. vulneratum	V	X		
Percina antesella	FE		X	
P. jenkinsi	FE		X	
P. sp. cf. *macrocephala* form 1	V		X	
TOTAL	-	18	13	1

NOTES

Column 2: Conservation status categories assigned by the American Fisheries Society (Warren et al. 2000). A question mark in this column indicates that the putative taxon was not recognized by Warren et al. (2000) and has not been given American Fisheries Society conservation status.

General: *Noturus gilberti* is very near being endemic to the SAE, but barely occurs in the Roanoke Tar Neuse Cape Fear Ecosystem (see Table 1). *Etheostoma ditrema* is endemic to the

Coosa R. system, but also extends into the Central Gulf Ecosystem portion of that drainage. However, two putative forms of this complex may in fact be endemic to the SAE (see Table 1).

CODES

CS = conservation status, E = endangered, FE = federally endangered, FT = federally threatened, SAE = Southern Appalachian Ecosystem, T = threatened, V = vulnerable

Table 5. Fish taxa from the Southern Appalachian Ecosystem recommended for addition to Region 4's Species of Concern list.

Species	Common Name	Region 4 States
***Cottus* sp. cf. "broadband sculpin"**	"Holston sculpin"	TN
***Clinostomus funduloides* ssp.**	"Smoky dace"	NC, TN
Hybopsis lineapunctata	lined chub	AL, GA, TN
Macrhybopsis sp. cf. *aestivalis*	"Fall Line chub"	AL, GA. TN
Notropis ariommus	popeye shiner	KY, TN
Phoxinus tennesseensis	Tennessee dace	TN
Fundulus bifax	stippled studfish	AL, GA
Ameiurus brunneus	snail bullhead	AL, FL, GA, NC, SC
A. platycephalus	flat bullhead	GA, NC, SC
Noturus* sp. cf. *munitus	"Coosa madtom"	AL, GA, TN
Ammocrypta clara	western sand darter	KY, TN
Etheostoma acuticeps	sharphead darter	NC, TN
E. blennioides gutselli	Tuckasegee darter	NC, TN
E. sp. cf. *blennioides*	"Hiwassee form"	GA, NC, TN
E. sp. cf. *brevirostrum* form 1	"Amicalola form"	GA
E. sp. cf. *brevirostrum* form 2	"Conasauga form"	GA, TN
E. sp. cf. *brevirostrum* form 3	"Coosawattee form"	GA
E. sp. cf. *brevirostrum* form 4	"Etowah form"	GA
E. chuckwachatte	lipstick darter	AL, GA
E. sp. cf. *cinereum*	"Upper Tennessee form"	GA, TN, VA
E. denoncourti	golden darter	TN
E. sp. cf. *rufilineatum* form 1	"Hiwassee form 1"	NC, GA?
E. sp. cf. *rufilineatum* form 2	"Hiwassee form 2"	NC, GA?
E. sp. cf. *rufilineatum* form 3	"Toccoa form"	GA
E. vulneratum	wounded darter	GA, NC, TN
Percina lenticula	freckled darter	AL, GA, LA, MS, TN

NOTES

Column 1: Taxa in bold are endemic to the SAE.

Column 2: Common names according to American Fisheries Society (Robins et al. 1991), except where quotation marks indicate a suggested, but "unofficial," common name for putative taxa (see "Methods").

Table 6. Priority drainages for imperiled fishes in the Southern Appalachian Ecosystem.

Drainage (Parent System) States	Pts.	Extant Taxa
Drainages Exclusive to the Southern Appalachian Ecosystem		
Etowah River (Coosa R. system) GA	33	*Hybopsis lineapunctata, Macrhybopsis* sp. cf. *aestivalis, Ameiurus brunneus,* ***Noturus* sp. cf. *munitus, Etheostoma* spp. cf. *brevirostrum* forms 1 and 4***, E. etowahae, E. scotti, Percina antesella, P. lenticula,* ***P.* sp. cf. *macrocephala* form 1**
Conasauga River (Coosa R. system) GA, TN	33	*Cyprinella caerulea, Hybopsis lineapunctata, Macrhybopsis* sp. cf. *aestivalis,* ***Noturus* sp. cf. *munitus, Etheostoma* sp. cf. *brevirostrum* form 2*, E. ditrema, E. trisella****, Percina antesella, P. jenkinsi, P. lenticula,* ***P.* sp. cf. *macrocephala* form 1**
lower Little Tennessee River (Tennessee R. system) TN	23	*Clinostomus funduloides* ssp., *Erimonax monacha, Hemitremia flammea, Phoxinus tennesseensis, Noturus baileyi, N. flavipinnis, Etheostoma blennioides gutselli, E. percnurum,* ***E. vulneratum***
upper Clinch River above Norris Reservoir (Tennessee R. system) VA, TN	21	*Cottus* sp. cf. "broadband sculpin" form 1, *Erimystax cahni, Notropis ariommus, Noturus stanauli, Ammocrypta clara,* ***Etheostoma* sp. cf. *cinereum****, E. denoncourti,* ***E. vulneratum, Percina burtoni***
Hiwassee River (Tennessee R. system) TN, GA, NC	19	***Moxostoma* sp. cf. *macrolepidotum****, Phoxinus tennesseensis, Etheostoma* sp. cf. *blennioides,* ***E.* spp. cf. *rufilineatum* forms 1, 2, and 3; *Percina squamata***
Copper Creek (upper Clinch R. system) VA	16	*Notropis ariommus, Noturus flavipinnis, E. percnurum,* ***E. vulneratum, Percina burtoni, P. macrocephala***
Little River (Tennessee R. system) TN	15	*Phoxinus tennesseensis,* ***Etheostoma* sp. cf. *cinereum****, E. percnurum,* ***E. vulneratum, Percina burtoni, P. macrocephala***
Emory River (lower Clinch R. system) TN	15	*Erimonax monacha, Phoxinus tennesseensis,* ***Etheostoma* sp. cf. *cinereum, E. vulneratum, P. macrocephala, P. squamata***
Coosawattee River (Coosa R. system) GA	15	*Hybopsis lineapunctata, Etheostoma aurolineata,* ***E.* sp. cf. *brevirostrum* form 3*, E. trisella, P.* sp. cf. *macrocephala***
Choccolocco Creek (Coosa R. system) AL	15	*Cottus paulus, Cyprinella caerulea,* ***Etheostoma brevirostrum****, E. ditrema*
North Fork Holston River (Holston R. system) VA, TN	14	*Cottus* sp. cf. "broadband sculpin" form 3, *Erimonax monacha, Notropis ariommus, Phoxinus tennesseensis,* ***Etheostoma vulneratum, Percina burtoni, P. macrocephala***
upper Tennessee River (mainstem, other tribs) TN	14	*Cycleptus elongatus, Hemitremia flammea,* ***Phoxinus saylori****, P. tennesseensis,* ***Etheostoma vulneratum****, Percina tanasi*
Nolichucky River (French Broad R. system) TN, NC	12	*Cycleptus elongatus, Hemitremia flammea, Notropis ariommus, Phoxinus tennesseensis,* ***Noturus* sp. cf. *elegans****, Etheostoma acuticeps,* ***E. vulneratum****, Percina squamata*
upper Little Tennessee River (Tennessee R. system) NC, GA	12	***Moxostoma* sp. cf. *macrolepidotum****, Clinostomus funduloides* ssp., *Erimonax monacha, Etheostoma blennioides gutselli,* ***E. vulneratum, Percina squamata***
Sequatchie River	10	*Hemitremia flammea, Phoxinus tennesseensis,* ***Etheostoma***

(Tennessee R. system) TN		***blennius sequatchiensis,*** *E. denoncourti, Percina tanasi*
Powell River (upper Clinch R. system) VA, TN	9	*Hemitremia flammea, Notropis ariommus, Noturus flavipinnis, Ammocrypta clara,* ***Etheostoma vulneratum***
Middle Fork Holston River (South Fork Holston R. system) VA	8	*Cottus* sp. cf. "broadband sculpin" form 3, *Erimonax monacha, Phoxinus tennesseensis,* ***Etheostoma vulneratum***
French Broad River (Tennessee R. system) TN	7	*Hemitremia flammea, Phoxinus tennesseensis, Etheostoma blennioides gutselli,* ***E. vulneratum, Percina squamata***
Watauga River (South Fork Holston R. system) TN, NC	7	*Cottus* sp. cf. "broadband sculpin" form 3, *Hemitremia flammea, Notropis ariommus, Phoxinus tennesseensis, Etheostoma acuticeps,* ***Percina squamata***
South Fork Holston River (Holston R. system) VA, TN	5	*Cottus* sp. cf. "broadband sculpin" form 3, *Hemitremia flammea, Phoxinus tennesseensis,* ***Etheostoma vulneratum***
Oostanaula River (other tribs) GA	5	*Hybopsis lineapunctata,* ***Etheostoma trisella***
Drainages Shared with Other Ecosystems		
upper Roanoke River (Atlantic Slope) VA, NC	11	*Thoburnia hamiltoni, Ambloplites cavifrons, Ameiurus platycephalus, Noturus gilberti, Percina rex*
Tallapoosa River (Mobile Basin) AL, GA	7	*Hybopsis lineapunctata, Macrhybopsis* sp. cf. *aestivalis, Fundulus bifax, Etheostoma chuckwachattae, Percina* sp. cf. *macrocephala* form 2
upper Chattahoochee River (Apalachicola R. system) GA	5	*Cyprinella callitaenia, Notropis hypsilepis, Percina* sp. cf. *nigrofasciata*
New River (Ohio R. system) VA, NC	4	*Cottus* sp. cf. "broadband sculpin" form 1, *Etheostoma osburni*
upper Savannah River (Atlantic Slope) SC, GA, NC	2	*Clinostomus funduloides* ssp., *Notropis hypsilepis*
upper James River (Atlantic Slope) VA	2	*Notropis semperasper*

NOTES

Column 1: Priority stream systems are derived from a point system (see Column 2). They are listed in priority order in the two drainage categories presented. Drainages are treated independently in this table, despite the fact that some are tributaries or parent drainages of others. States are given in order of largest approximate portion of the drainage contained within. Ties are arbitrarily listed.

Column 2: The point system used to prioritize drainages in this table is weighted towards the more imperiled fishes and includes only those taxa thought to be extant. The point system is as follows: 4 for federally listed taxa, 3 for endangered status (Warren et al. 2000), 2 for threatened status (Warren et al. 2000) and putative taxa not assigned conservation status, and 1 for vulnerable status (Warren et al. 2000). An extra point is awarded for those taxa endemic to a single drainage system (that appears as a single row in this table), for the last known extant population of a taxon, or for a critically imperiled taxon appearing in Table 7. Five is thus the highest point total per fish.

Column 3: Taxa in bold are those non-listed fishes deemed to have the greatest need for current conservation status assessment in the ecosystem (see Table 7). A question mark indicates a taxon that may or may not be extant in that drainage, but whose points are included in the drainage totals.
General: Introduced (e.g., *Noturus gilberti* in James R., *Percina tanasi* in Hiwassee R.), reintroduced (e.g., *Acipenser fulvescens* in French Broad R.), and commercial taxa (e.g., *Polyodon spathula*) are not included in this table. Drainages with only a single "one point" taxon are also omitted.

Table 7. Fish taxa of the Southern Appalachian Ecosystem deemed to have the greatest need for current conservation status assessment.

Species	Needs	SAE Range (States)
Moxostoma sp. cf. *macrolepidotum*	2,3	Little Tennessee, Hiwassee R. systems (GA, TN)
Phoxinus saylori	2,3,5	Walden Ridge tribs (TN)
Noturus sp. cf. *munitus*	2,3,4,5	Conasauga, Etowah Rs. (GA, TN)
Noturus sp. cf. *elegans*	1,2,3,5,6	lower French Broad R. system (TN)
Etheostoma blennius sequatchiense	1,2,3,5	Sequatchie R. (TN)
E. brevirostrum	2,3,5	upper Choccolocco Creek system (AL)
E. sp. cf. *brevirostrum* form 1	2,3,5	Amicacola Creek system (GA)
E. sp. cf. *brevirostrum* form 2	2,3,5	upper Conasauga R. system (GA, TN)
E. sp. cf. *brevirostrum* form 3	2,3,5	Mountaintown Creek (GA)
E. sp. cf. *brevirostrum* form 4	2,3,5	upper Etowah R. (GA)upper Tennessee R. system (GA, TN, VA)
E. sp. cf. *cinereum*	3,4,5	upper Tennessee R. system (GA, TN, VA)
E. ditrema	2,3,4,5	upper Coosa R. system (AL, GA, TN)
E. sp. cf. *rufilineatum* form 1	1,2,3,4,5	Hiwassee R. system (NC, GA?)
E. sp. cf. *rufilineatum* form 2	1,2,3,4,5	Hiwassee R. system (NC, GA?)
E. sp. cf. *rufilineatum* form 3	1,2,3,4,5	Toccoa R. (GA)
E. trisella	3,5	upper Coosa R. system (AL, GA, TN)
E. vulneratum	3,4,5	upper Tennessee R. system (NC, TN, VA)
Percina burtoni	1,2,3,4,5	upper Tennessee R. system (NC, TN, VA)
P. macrocephala	1,2,3,4,5	upper Tennessee R. system (NC, TN, VA)
***P.* sp. cf. *macrocephala* form 1**	1,2,3,4,5	upper Coosa R. system (GA, TN)
P. squamata	1,2,3,4,5	upper Tennessee R. system (NC, TN)

NOTES

Column 1: Taxa in bold are endemic to the SAE.

Column 2: Refers to those research activities that are necessary for prelisting and recovery actions (coded below).

Column 3: Includes historical states and drainages of occurrence.

CODES

1 = status survey, 2 = life history, 3 = threat analysis, 4 = taxonomic distinctiveness, 5 = propagation technology, 6 = captive population