

The majority of the area in these forests drains to the Gulf of Mexico via the Mississippi, Ohio and Tennessee Rivers. However, portions (including the entirety of the areas covered for the states of Alabama, South Carolina and Kentucky) drain into the Atlantic Ocean, the Ohio River or the Gulf of Mexico east of the Mississippi River. Table 1 summarizes the drainage basins and watersheds covered by this report.

Aquatic Diversity Areas (ADAs)

For purposes of this report, key watersheds are classified as Aquatic Diversity Areas (ADAs), judged from a synthesis of information regarding the diversity and imperilment of native aquatic organisms. ADAs are defined as watersheds or portions of watersheds containing significant national forest ownership or lands within national forest purchase boundaries. ADAs are primarily large watersheds or portions of watersheds 200 square miles and larger. The ADAs are prioritized in this report based on the degree to which they provide habitat for clusters of imperiled aquatic species, or the degree that they represent the best examples of aquatic diversity in major drainage basins. Streams listed in parentheses in table 1 are tributaries within each ADA. The selection of tributaries listed in Table 1 is somewhat arbitrary; it represents an attempt to include the largest and best-known streams, plus those of particular conservation importance, e.g., because they contain occurrences of rare organisms, or are more or less intact (free of impoundments and other alterations).

Some of the Aquatic Diversity Areas (ADAs) outlined in this report conform to the boundaries of hydrologic units, as defined by TVA and other agencies, but they have no intrinsic relation with these or any other published system of subdividing drainage areas. ADAs are drawn specifically so as to facilitate discussion in the present context. Each ADA is defined by a "main stem" with a characteristic biotic community. The lower limit of each ADA is defined by a point on the main stem below which the biotic community changes and/or the effect of actions on the National Forest portion of the watershed becomes insignificant or highly diluted. In each case this point was defined by one or more of the following factors:

- Point below which "imperiled" species (defined below) are not known to occur with any regularity
- Confluence with a larger stream with different biotic characteristics
- Confluence of a tributary stream large and/or distinctive enough to profoundly alter the biotic community of the main stem.
- Interruption by a reservoir lake (in some cases small reservoirs may be included in the ADA)
- Entry of a known major pollution source

As further refinements, some ADAs are defined so as to "break out" significantly different tributaries. For example, the South Toe River is treated as a separate entity (ADA 39) within the Nolichucky River watershed. Still other watersheds are divided in the middle of the main stem. The clearest example is the Pigeon River (ADAs 35 and 36), which is markedly different above and below a major pollution source (Champion Paper) in Canton, NC.

Some important streams which clearly fit into the geographic area treated are not considered because no portion of their watersheds occurs within the National Forest system lands or purchase boundaries. The largest examples, all from Tennessee, are the Little River (in this case the Little River which drains into the Tennessee River at Maryville, Tennessee - there are at least 5 Little Rivers in the report area), the Emory River and the Sequatchie River. Many smaller streams are omitted for the same reason. Since this report demonstrates that the conservation of the southeastern aquatic fauna will not be achieved by focusing exclusively or even primarily on the National Forests, it is clear that these and other streams must be considered in efforts to follow.

Selection of biodiversity "targets" sometimes focuses on single imperiled species. In some instances, this can be effective. (An example from just outside the area of this report is provided by the pygmy sculpin (*Cottus pygmaeus*), which inhabits a single coldwater spring, within a small watershed, in the Coosa Basin of Alabama.) More often, a single species focus is either shown to be ineffectual or involves protecting large areas of habitat used by many other species. Or conservation advocates may apply the "more bang for the buck" approach by selecting sites notable for sheer diversity, expressed as high number of species. This approach makes an implicit and incorrect value judgement of Nature by favoring places with high numbers of common and exotic species, or otherwise selecting against systems which may be intact and perfectly functional, but naturally relatively less diverse.

In prioritizing sites for this report, I have tried not to make value judgements based on species diversity, even though some of the biotic communities of Southern Appalachian watersheds in their natural condition are extremely diverse. (This is equally true for the major drainage basins. Consider that while 147 species of fish have been recorded for the Tennessee River basin above the mouth of the Sequatchie River, all of which is covered in this report, the neighboring Apalachicola Basin, only a fraction of which falls into the report area, and which includes a coastal plain component lacking from the Tennessee, is home to just 99 native species.) The task of prioritizing ADAs is facilitated by using two preliminary methods which, taken together, tend to combine protection of the greatest number of species, particularly imperiled forms, with protection of a diversity of intact, functional aquatic ecosystems.

Priority ADAs

The first approach taken in prioritizing sites focuses on 28 ADAs with watershed areas of 200 square miles or more. From these, 15 are suggested as "Priority ADAs". The primary criterion for selection of the priority ADAs is a high number of imperiled species. (See following section for working definition of "imperiled species".) This list is adjusted for natural levels of diversity by including the best examples from each of the 4 major drainage basins represented (Tennessee, Atlantic, eastern Gulf and Ohio). A second criteria for selection of priority ADAs is the presence of a significant amount of area within national forest purchase boundaries. Actual Forest Service ownership was also taken into account.

Critical Refugia

A second selection of sites, termed Critical Refugia, was made by focusing primarily on integrity of ecosystems. Diversity or presence of imperiled species was also a criteria for selection of these watersheds. These Critical Refugia are also located on watersheds satisfying one of the following criteria: (1) a relatively high percentage of land in Forest Service ownership, particularly along stream reaches, or (2) a high percentage of land within Forest Service purchase boundaries. In this selection, all watersheds draining more than 4 square miles were potential candidates, and some of the sites are selected from the 15 original ADAs with watershed areas of less than 200 sq. mi. Most of the Critical Refugia represent small watersheds, but a few of the large ADAs qualify under these criteria. When available, Index of Biotic Integrity (IBI) scores were used as the primary determining factor for inclusion in this selection. Only sites receiving IBI scores of 54 or higher (Bioclass Good-Excellent) were considered. A limitation on this approach is that outside of the Tennessee Basin watersheds (where TVA maintains a regular biomonitoring program), IBI data are available only for North Carolina streams. For Alabama, South Carolina, Kentucky and the non-Tennessee Basin watersheds of Georgia and Virginia, more subjective criteria were used. Streams from these areas were selected based on lack of evidence that extirpations had occurred in modern times, evidence of little disturbance in the watershed, clues provided by other water quality indicators (macroinvertebrate monitoring, persistence of imperiled or known intolerant species, Outstanding Resource Water and similar designations) and recommendations by individuals familiar with the various watersheds.

For each of the sites selected in both categories, information is provided on the relation of the biotic community to the National Forests. Briefer descriptions of non-priority ADAs are also provided. A final section outlines very brief and general conclusions, with a few suggestions for conservation objectives and strategies. In this section a few special cases are discussed.

TABLE 1: Drainage Basins (UPPER CASE), Watershed Units (lower case), and tributary streams (in parentheses) of the Southern Appalachian National Forests. For each drainage basin, components are arranged roughly in ascending order.

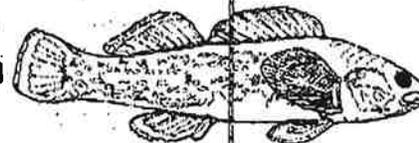


	Lower Limit of ADA
ATLANTIC OCEAN	
01 JAMES RIVER	
James R.	Goochland County
46 (Craig Cr.) (with Johns Creek) (Maury R.) (Jackson R.) (Cowpasture R.) (Pedlar R.)	
SANTEE/COOPER RIVERS	
02 Catawba R.	L. James
(Johns R.) (Linville R.) (Wattior Fork)	
SAVANNAH RIVER	
03 Tugaloo River	L. Tugaloo
(Chattooga R. - east) (Tallulah R.)	
04 Seneca River - Lakes Hartwell & Jocassee	L. Hartwell or L. Jocassee (per individual tributary)
(Chauga R.) (Ramsey Cr.) (Toccoa Cr.) (Horsepasture R.) (Keowee R.) (Whitewater R.)	
05 Broad River	Chattahoochee National Forest boundary
EASTERN GULF OF MEXICO	
APALACHICOLA RIVER	
06 Chattahoochee River	L. Lanier
(Chesatee R.) (Soquee R.) (Chickamauga Cr. - south)	
MOBILE BAY	
COOSA/ALABAMA RIVER	
07 Chattooga River (west)	Weiss L.
08 Oostanaula River	mouth at Coosa R.
09 Conasauga River	mouth at Oostanaula R.
10 Coosawattee River	mouth at Oostanaula R.
(Cartersy R.) (Ellijay R.)	
11 Etowah River	Allagoona L.
12 Tallapoosa R.	Martin L.
(Turner R.)	
13 Choccolocco Cr.	mouth at Coosa R.
(Shoal Cr.) (Cheaha Cr.) (Clearwater Spring Run)	
14 Small Coosa R. tributaries	mouths at Coosa R.
(S. Terrapin Cr.) (Little R.)	
44 Sipsy Fork, Black Warrior River	
TENNESSEE RIVER	
15 Chickamauga Creek - north	Chickamauga L.
16 lower Hiwassee River	mouth of Ocoee R.
(Childers Cr.)	
17 Ocoee River	mouth at Hiwassee R.
18 Toccoa River	Tennessee state line
(Suches Cr.)	
19 Nottely River	Hiwassee L.
Valley River	Hiwassee L.
(Vengeance Cr.)	
20 Upper Hiwassee River	Appalachia dam
(Brasstown Cr.)	

22 Powell River	Norris L.
23 Clinch River (Copper Cr.) (Little R.) (lower Little Tennessee River reservoirs)	Norris L.
24 Tellico River	Tellico L.
25 Citico Creek	Tellico L.
26 Other lower Little Tennessee River reservoir tributaries (Slickrock Cr.) (Abrams Cr.) (Cheoah R.) (Nantahala R.) (Alarka Cr.)	Calderwood, Cheoah & Fontana Lakes (per individual tributary)
27 Middle Little Tennessee River (Cowee Cr.)	Fontana L.
28 Tuckasegee River	Fontana L.
29 Upper Little Tennessee River (Cullasaja R.) (Cartoogechaye Cr.) (Betty Cr.)	L. Emory
30 Holston River	Cherokee L. Kingsport, Tennessee
31 North Fork Holston River (Big Moccasin Cr.) (Little Cr.)	
32 South Fork Holston River (Middle Fork Holston R.) (Possum Cr.) (Thomas Cr.)	S. Holston L. & NF boundary downstream
33 Watauga River	Watauga L.
34 lower French Broad River (Ivy R.) (Swannanoa R.) (Spring Cr.)	Douglas L.
35 lower Pigeon River (Cataloochee Cr.)	mouth at French Broad R.
36 upper Pigeon River	Canton, North Carolina
37 upper French Broad River (Mills R.) (Little R.) (Davidson R.)	Asheville, North Carolina
38 Nolichucky River (Cane R.) (N. Toe R.) (Chucky Cr.)	Douglas L.
39 South Toe River	mouth at N. Toe R.
OHIO RIVER	
CUMBERLAND RIVER	
40 Poor Fork Cumberland River Bad Branch	Jefferson NF boundary?
KENTUCKY RIVER	
41 North Fork Kentucky River	Jefferson NF boundary
BIG SANDY RIVER	
42 Russell Fork (Pound R.) (Elkhorn Cr.) (Levisa Fork)	Jefferson NF boundary
NEW RIVER	
43 New River (Bluestone R.) (Little R. - New) (N. Fork New R.) (S. Fork New R.)	West Virginia state line

¹ Since the entire lower Little Tennessee River, from Fontana Reservoir to the junction with the Tennessee River has been converted to a continuous string of reservoir lakes, this portion of the mainstem is not considered as an ADA. However, tributaries to this reach merit consideration. Because of its particular importance to biodiversity conservation, Citico Creek is assigned its own ADA number (25). The other tributaries are taken together as ADA 26.

Imperiled Species And Their Distribution



This section is not intended to take issue with any experts who have attempted to catalog the degree of endangerment of various taxa, to propose any sort of alternative system, or to add still more categories and jargon to an already confusing panorama. My working definition of "imperiled" was adopted for the sole purpose of providing a framework for discussion of how to prioritize aquatic conservation targets in the Southern Appalachian National Forest areas; it is my fervent hope that it will not survive this paper. The practical goal is to include a number of taxa adequate to clearly differentiate among the watershed units (or ADAs) without creating massive, unwieldy and ultimately confusing lists. For this purpose, three groups of organisms were selected:

Fish are the best studied group of aquatic organisms in the region and exhibit a wide range of tolerances, habitat preferences and distribution patterns.

Crayfish could be included if there were no references other than the monumental work of Hobbs (1989). While crayfish are on the whole less sensitive to environmental perturbations than fish, there is a more pronounced tendency to endemism.

Unionid and margaritiferid mussels are an unusually diverse group in the southeastern U.S. and exhibit an unusually high degree of imperilment here as elsewhere. In addition, the mussel fauna of southern waters is relatively well studied.

Other groups of organisms were considered for inclusion in this assessment, but rejected. The following comments will serve to illustrate the rationales employed:

Insects: Although only a handful of aquatic insects are officially listed as such, a number are recognized as imperiled. However, data on their populations are not available for much of the region. (A notable exception is work done to identify high quality waters by the North Carolina Department of Water Quality, which uses benthic macroinvertebrate data to classify sites having "Excellent" or "Good" water quality, using benthos data. We have used these data where available to nominate Critical Refugia.)

Salamanders: The fame of the southeast as the "salamander capitol of the world" notwithstanding, most of the imperiled salamanders of the region are terrestrial; however, a few notable exceptions exist and are noted in the narrative below (under their respective Critical Refuge).

Gastropods (snails) are probably the next "hot" group for biodiversity studies. The southeast has lost four known genera of aquatic snails—this is significant because, although many *species* have been lost to various groups, no other group of aquatic organisms has lost a series of *genera*. It is sobering to consider what may have been lost before it could even be described by science. At present, the data are still too spotty to justify inclusion in this effort; however, future iterations of this paper may include them. In some cases (notably Choccolocco Creek in the Coosa watershed), presence of imperiled snails was used as one reason for nominating a priority ADA.

"Imperiled" species of fish, crayfish and molluscs (see Table 2) were selected for inclusion in this analysis based on the following criteria:

- Official recognition by the U.S. Fish and Wildlife Service or (in the case of fish) the American Fisheries

Society: Fish were included only if listed as "Endangered". For mussels, "Threatened" and "Candidate" species were also included. This decision reflects the need to limit what could have been an unwieldy number of fishes, but also reflects the general belief that "Many mussel species are more depleted than federal lists indicate." (Neves, et al., 1997). (A rapid review of the USFWS and AFS lists for Threatened, Special Concern and Candidate species indicates that their exclusion was justified.) State listings were not considered for any group, because the emphasis was regional, and because frequent state listing of "peripheral" species would have created a significant amount of "noise."

- Global ranking by The Nature Conservancy (TNC). All forms ranked as G1 (globally imperiled) were included.
- Results of the November, 1997 SAFC/TNC experts' meeting at Valle Crucis, NC. All forms which made the experts' "A" list for conservation targets for the Southern Blue Ridge ecoregion were included.
- Endemism: All forms endemic to a particular ADA or other small component were included. "Small component" was not defined, but depended on the author's judgement. Exceptions were made for some of the endemic fauna of the New River watershed (ADA 43). Of 6 New River endemic fishes, 4 are largely restricted to the upper portion of the watershed in North Carolina and southernmost Virginia, where there is no National Forest land. They thus fall outside the report area. The same applies to the crayfish *Cambarus chasmodactylus*, a New River endemic widely distributed throughout the watershed.
- Undescribed forms were given the benefit of the doubt as probable new, rare taxa with limited distributions.

The final list of imperiled aquatic fauna comes to 51 fishes, 14 crayfish and 43 mussels, for a total of 108 forms. They are listed in Table 2, together with the criteria for their inclusion and the ADAs in which they are found. Table 3 shows the number of forms within each group which occur in the 43 ADAs defined.

TABLE 2: Imperiled fish, crayfish and mussels of the Southern Appalachian National Forests and their watersheds.



Taxon	Criteria for inclusion	ADAs	Found on National Forest System Lands (SL) within Purchase Boundaries (PB) or off the Forests (X)
Fish:			
<i>Acipenser fulvescens</i>	LE, A	30,34	X
<i>Clinostomus funduloides</i> sp.	En, Und	24, 25,26,27,28,29	X,PB,SL
<i>Cyprinella caeruleas</i>	A, LT	08,09,10,13,14	X, PB, SL
<i>Cyprinella monacha</i>	A, LT	27,30,31,32	PB, X
<i>Erimystax cahni</i>	En	22,23	X
<i>Etheostoma acuticeps</i>	X	22,23,32,38	X,PB
<i>Etheostoma bellator</i> ***	En	44A	SL
<i>Etheostoma brevirostrum</i>	A, En	09,13	X,PB,SL
<i>Etheostoma chuckwachattae</i>	G2	12	X
<i>Etheostoma coosae</i>	En	07,08,09,10,11,13,14	X,PB,SL
<i>Etheostoma ditrema</i>	A,G1,En	07,09,13,14	X,PB,SL
<i>Etheostoma esowahae</i>	G1,En	11	X
<i>Etheostoma longimanum</i>	En	01	X,PB,SL

<i>Etheostoma osburni</i>	En	43	X,PB
<i>Etheostoma percnurum</i>	LE,A,G1	23,25	X,SL
<i>Etheostoma sagitta</i>	En	40	X,PB,SL
<i>Etheostoma scotti</i>	En	11	X
<i>Etheostoma stigmatum meadci</i>	En	22,23	X,PB,SL
<i>Etheostoma triella</i>	G1,En	09,14	X,PB,SL
<i>Etheostoma sp. 2***</i>	Und	44A	SL
<i>Etheostoma sp. 3***</i>	En, Und	44A	SL
<i>Undescribed darter A</i>	En, Und	11	X
<i>Undescribed darter B</i>	En, Und	11	X
<i>Sicklefin redbhorse</i>	A,G1,Und	16,20,21,27	X,PB
<i>Notropis albizonarus</i>	LE,En	Paint Rock R; AL	X
<i>Notropis bellus alegendis</i>	En	44B	SL
<i>Cyprinella gibbsi</i>	En	12	X,PB,SL
<i>Notropis temperasper</i>	En	01	X,PB,SL
<i>Notropis xanucocephalus</i>	En	07,08,09,10,11,12,13,14	X,PB,SL
<i>Noturus baileyi</i>	LE,A,G1	25	SL
<i>Noturus flavipinnis</i>	A,G1	22,23,25	X,PB,SL
<i>Noturus munius</i>	En	09,11	X,PB,SL
<i>Noturus uanahli</i>	LE, En	23	X
<i>Percina antetella</i>	LE	09	PB,SL
<i>Percina anrolineata</i>	LE	10	?
<i>Percina burtoni</i>	A	16?,23,30,31,32,38,39	X,PB,SL
<i>Percina gymnocephala</i>	En	43	X,PB
<i>Percina jenkinsi</i>	A,G1,En, LE	09	PB,SL
<i>Percina macrocephala</i>	A	22,23,31,32,33	X,PB,SL
<i>Percina palmaris</i>	En	09,11,12,13,14	X,PB,SL
<i>Percina squamata</i>	A	16?,20,21?,23,27,28,29 30,32,33,34,35,37,38,39	X,PB,SL
<i>Percina tanasi</i>	En, LT	16,30	X,PB,SL
<i>Percina sp. ***</i>	Und	44A	SL
<i>Bridled or muscadine darter</i>	A,En,Und	09	PB,SL
<i>Phoxinus cumberlandensis</i>	En	40	PB, SL
<i>Phoxinus tennesseensis</i>	A	16,17,21,23,30, 31,32,33,35,38	X,PB,SL
<i>Costus baileyismokei sculpin</i>	En,Und	22,23,31,32	X,PB,SL
<i>Bluestone sculpin</i>	En,Und	43	X,PB
<i>Holston sculpin</i>	En,Und	32	X,PB,SL
<i>Clinch sculpin</i>	En, Und	23	X
<i>Tallapoosa sculpin</i>	En, Und	12	X,PB?,SL?

Crayfish

<i>Cambarus cymatilus</i>	En	09	X
<i>Cambarus englishi</i>	En	12	X,PB
<i>Cambarus halli</i>	En	12	X,PB
<i>Cambarus coosawatae</i>	En	10	X
<i>Cambarus fasciatus</i>	En	11	X,PB,SL
<i>Cambarus manningi</i>	En	07,08,09,10,11,12,13,14?	X,PB,SL
<i>Cambarus obsitipus****</i>	En	45, 44A?, 44B?*	X, PB?, SL?
<i>Cambarus speciosus</i>	En	10	X
<i>Cambarus conasaugensis</i>	En	09,10,11,16	X,PB,SL
<i>Cambarus cheugaensis</i>	En	03,04	X,PB,SL
<i>Cambarus georgiae</i>	A,G1,En,C	27,28	PB
<i>Cambarus hiwasseeensis</i>	En	21	X,PB,SL
<i>Cambarus parrishi</i>	A,G1,En	21	X,PB
<i>Cambarus riburru</i>	En?	04,34,37	X,PB

Mussels:

<i>Alasmidonta raveneliana</i>	A,G1,LE	27,28,38,39	X,PB,SL
<i>Cumberlandia monodonta</i>	C	22,23,38	X
<i>Cyprogenia stegaria</i>	LE,En?	22,23	X
<i>Dromus dromas</i>	LE	16,22,23	X,PB,SL
<i>Epioblasma brevidens</i>	LE	22,23	X,PB,SL

<i>Epioblasma capiatiformis</i>	LE	16,22,23,31,38	X
<i>Epioblasma florentina walkeri</i>	A,G1,LE	16,23,32	X,PB,SL
<i>Epioblasma metastriata*</i>	LE,En	09,11	X
<i>Epioblasma oibcaloogensis*</i>	LE,En	09,11	X,PB,SL
<i>E. torulosa gubernaculum</i>	LE,En	23	X
<i>Fusconaia barnesiana</i>	A	16,22,23,27,28,31,32,33	X,PB
<i>Fusconaia cor</i>	LE	22,23,31	X,PB,SL
<i>Fusconaia cuneolus</i>	LE	22,23,31	X
<i>Hemistena lata</i>	LE	22,23	X
<i>Lampsilis abrupta</i>	LE	23	X
<i>Lampsilis altilis</i>	A,LT,En	09,11,12,13	X,PB,SL
<i>Lampsilis perovalus</i>	LT	44A, 44B, 45	X,PB,SL
<i>Lasmigona subviridis</i>	A	33,43	X,PB,SL
<i>Lasmigona holstonia</i>	C	11,13,14,16,23,31,32	X,PB,SL
<i>Lemiox rimonus</i>	LE	22,23,31	X
<i>Lexingtonia dolabelloides</i>	A,C	16,22,23,31,32	X,PB,SL
<i>Medionidus acutissimus</i>	LT	9,11,13,44A,44B,45	X,PB,SL
<i>Medionidus parvulus</i>	A,G1,LE	09,11	X,PB,SL
<i>Pezias fabula</i>	A,G1,LE	23,27,31,32	X,PB
<i>Pleurobema collina</i>	LE,En	01	X,PB,SL
<i>Pleurobema decisum</i>	LE,En	09,11,14	X
<i>Pleurobema furvum</i>	LE, En	44A, 44B,	SL
<i>Pleurobema georgianum</i>	A,G1	09,11,13	X,PB,SL
<i>Pleurobema oviforme</i>	A,C	16,22,23,31,32	X
<i>Pleurobema perovalus</i>	LE,En	11	X
<i>Pleurobema plenum</i>	LE	23	X
<i>Pleurobema rubellum*</i>	C	11	X
<i>Pleurobema rubrum</i>	C	23	X
<i>Psychobranchus greeni</i>	LE,En	07,09,11,44A,44B	X
<i>Quadrula cylindrica strigillata</i>	LE	22,23	X
<i>Quadrula intermedia</i>	LE	22,23	X
<i>Quadrula sparsa</i>	LE	22,23	X
<i>Strophinus subvexus</i>	G2	44A, 44B	X,PB,SL
<i>Toxolasma lividus</i>	C	23,24,31	X,PB
<i>Villosa nebulosa</i>	En	09	X,PB,SL
<i>Villosa perpurpurea</i>	LE,En	23	X
<i>Villosa trabalis</i>	A,G1,LE	16,23	X
<i>Villosa vanuxemensis umbrans</i>	En	13	PB,SL

- A - SAFC/TNC Conservation Target Species (see References Cited)
- C - Candidate for listing
- En - Endemic
- G1 - Critically imperiled (TNC)
- G2 - Imperiled (TNC)
- LE - Listed endangered
- LT - Listed threatened
- X - Not formally listed but probably will be, was considered to be extinct until its rediscovery in 1975
- Und - Undescribed form

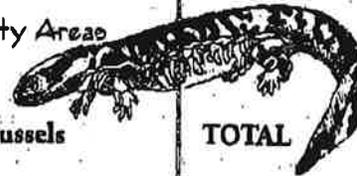
* This species may be extinct; no recent collections known.

** 44A indicates Sipsey Fork watershed above area impounded by Lewis Smith Lake
44B indicates Brushy Creek watershed

*** Complete information was not available for several darter species occurring in Alabama. What is certain is that there is one described endemic (*Etheostoma bellator*), 2 undescribed *Etheostoma* spp. (one of which appears to be endemic to the Bankhead NF), and one undescribed *Percina* sp., which appears to have an endemic subspecies.

**** Distribution information on *Cambarus obsipus* is fragmentary. It is endemic to the Black Warrior system and definitely occurs downstream of Lewis Smith Lake. Occurrence upstream (in ADA 44) is likely, but not confirmed for this report.

TABLE 3: Known occurrences of 108 imperiled species in 44 Aquatic Diversity Areas (ADAs)* draining the Southern Appalachian National Forests



ADA	Fish	Crayfish	Mussels	TOTAL
ATLANTIC DRAINAGES				
01 Craig / Johns Creeks	2	0	1	3
02 Catawba River*	0	0	0	0
03 Tugaloo River*	0	1	0	1
04 Seneca River	0	2	0	2
05 Broad River	0	0	0	0
EASTERN GULF OF MEXICO DRAINAGES				
06 Chattahoochee River*	0	0	0	0
07 Chattooga River -- west	3	1	1	5
08 Oostanaula River*	3	1	0	4
09 Conasauga River*	11	3	10	24
10 Coosawatee River*	4	4	0	8
11 Etowah River*	8	3	11	22
12 Tallapoosa River*	4	3	1	8
13 Choccolocco Creek	5	1	5	11
14 small Coosa River tributaries	6	1	2	9
44 Sipsy Fork / Brushy Creek	5	1	4	10
TENNESSEE RIVER DRAINAGES				
15 Chickamauga Creek (north)	0	0	0	0
16 lower Hiwassee River*	4	1	8	13
17 Ocoee River*	1	0	0	1
18 Toccoa River	0	0	0	0
19 Nottely River*	0	0	0	0
20 Valley River	2	0	0	2
21 upper Hiwassee River*	3	2	0	5
22 Powell River*	7	0	15	22
23 Clinch River*	13	0	25	38
24 Tellico River*	1	0	1	1
25 Citico Creek	4	0	0	4
26 tributaries to Little Tennessee River reservoirs	1	0	0	1
27 Tuckasegee River*	2	1	2	5
28 middle Little Tennessee River	4	1	3	8
29 upper Little Tennessee River*	2	1	0	3
30 Holston River*	7	0	0	7
31 N. Fork Holston River*	6	0	10	16
32 S. Fork Holston River*	8	0	6	14
33 Watauga River*	3	0	2	5
34 lower French Broad River*	2	1	0	3
35 lower Pigeon River*	2	0	0	2
36 upper Pigeon River	0	0	0	0
37 upper French Broad River*	1	1	0	2
38 Nolichucky River*	4	0	3	7
39 South Toe River	2	0	1	3
OHIO RIVER DRAINAGES				
40 Poor Fork Cumberland River	2	0	0	2
41 N. Fork Kentucky River	0	0	0	0
42 Russell Fork	0	0	0	0
43 New River*	3	0	1	4

*Indicates 28 large ADAs (defined as having a drainage area of 200 sq. mi. or more).

Of the 44 ADAs, 15 have been selected as priority areas for conservation of aquatic biodiversity, including at least one example from each of the 4 major drainage basins represented, as shown below:

Atlantic drainages (1 ADA): Most of the watersheds draining the eastern slope of the Southern Appalachians have very small mountain components, compared with their west slope counterparts. A conspicuous exception is the James River (whose tributaries, Craig Creek and Johns Creek form ADA 01), which in addition to being the only Atlantic slope river represented in the Ridge and Valley Biogeographic Province, also has a significant extension in the Blue Ridge. It is thus not surprising that although the James watershed fauna is not the most diverse among the Atlantic drainages from Virginia south, it harbors more upland species. Craig Creek and Johns Creek contain at least 3 imperiled species not protectable elsewhere.

Eastern Gulf of Mexico drainages (6 ADAs)²: Of the two Gulf drainages east of the Mississippi which have headwaters in the Southern Appalachians, the Apalachicola River watershed is characterized by relatively low natural diversity, while the diversity of the Mobile Bay drainages, including the Coosa River, is unusually high (e.g., 99 vs. 144 native fish species). The Coosa River fauna was seriously depleted when the entire main stem in Alabama was converted to a chain of reservoir lakes. Neves et al. (1997) argue that "the Coosa River and its major tributaries . . . may hold the dubious distinction of having more recent extirpations and extinctions of aquatic organisms than any other equally-sized river in the United States." Considered in this light, virtually all the upper Coosa tributary systems in Alabama, Georgia and Tennessee deserve attention as conservation priorities. In Table 3, the Conasauga River (ADA 09) and Etowah River (ADA 11) stand out as having unusually high numbers of imperiled taxa. Addition to the list of the Coosawattee River (ADA 10), the Tallapoosa River (ADA 12), and Choccolocco Creek (ADA 13) adds four crayfish, one mussel and one fish to the list of imperiled fauna of the upper Coosa basin.

Most of the Mobile Bay drainage portion of the Bankhead NF is contained within the watershed of the Sipsey Fork of the Black Warrior (not to be confused with the Sipsey River, which arises about 5 miles west of the southwest corner of the Bankhead NF and eventually also finds its way to Mobile Bay via the Black Warrior - Tombigbee drainage). A significant portion of the biodiversity of the Sipsey Fork was undoubtedly lost with the construction of Lewis Smith Lake, which impounds nearly half of the mainstem within the purchase boundaries (plus a large area downstream). The head of impoundment of Lewis Smith Lake corresponds roughly with the greatest concentration of system lands in the Bankhead NF, and both the ca. 40 sq. mi. Sipsey Wilderness and the Sipsey Fork/West Fork Wild and Scenic River Corridor are located entirely above this point.

One major tributary to the impounded portion of the Sipsey Fork, Brushy Creek, also contains a high percentage of system lands in its watershed. For purposes of this discussion, the contiguous watersheds of Brushy Creek and the Sipsey Fork above the impounded area are treated as ADA 44, while the rest of the area draining into the Sipsey Fork upstream of the southern National Forest boundary is designated ADA 45. There are also two minor watershed areas within the purchase boundary which drain, respectively, into the East Fork at Lewis Smith Lake and the Sipsey Fork downstream of the dam. Neither appears to be significant in the context of this effort, and they are not discussed here.

Tennessee River drainages (7 ADAs): The extraordinary diversity of the Clinch and Powell River watersheds (ADAs 22 and 23, respectively) is immediately apparent from inspection of Table 2. While no species currently known from the Powell are missing from the Clinch, it is customary to speak of the two rivers as one system (the Clinch-Powell). In view of this fact, and also because of the extreme rarity of some of the mussel species in the Clinch-Powell, both ADAs are listed as priorities. A similar logic applies to the inclusion of the somewhat less diverse North Fork Holston and South Fork Holston Rivers (ADAs 31 and 32, respectively). If it were necessary to strictly prioritize, these two could be eliminated in favor of the Clinch-Powell, but for now they are included on the basis of high numbers of imperiled species.

²The Bankhead National Forest in Alabama straddles the divide between 2 of the 10 river basins covered in this report (Mobile Bay and Tennessee River). Approximately 95% of the area within the purchase boundary (all but the northern extreme) drains toward the Gulf of Mexico (Mobile Bay) via the Black Warrior River. The portion of the Bankhead NF within the Tennessee River basin is drained by small headwater streams and does not appear to contain any fauna of special conservation interest within the three groups considered in this report (fish, crayfish and mussel). Therefore, it will not be discussed further here.

At first glance, this would seem to cover the Tennessee River drainages. However, all 4 of the rivers mentioned flow from Virginia into Tennessee and have their drainages largely in the Ridge and Valley Province. There is a distinctive, if somewhat less diverse, Blue Ridge fauna in the upper Tennessee River drainage. (Note the absence of crayfishes from the imperiled species counts for the Ridge and Valley watersheds.) To include it, it is necessary to take into consideration those rivers which flow into the east bank of the Tennessee River and/or drain southeastern Tennessee, western North Carolina and north Georgia. In this area, the highest numbers of imperiled species are found in the lower Hiwassee River, middle Little Tennessee River and Nolichucky River watersheds (ADAs 16, 27 and 38, respectively), and these are designated as priorities.

Ohio River drainages (1 ADA): The Cumberland and Kentucky River drainages have important faunas worthy of protection, but here I have only considered those areas of these Ohio River watersheds (plus the Russell Fork) which are within or in proximity to the Jefferson National Forest. (An adequate review of the fauna of the state of Kentucky might lead to revision of this section, but the information was not available in time for this assessment.)

If it were possible to adequately protect these 15 ADAs, 96 of the 108 species in Table 2 would be protected in at least one watershed, including all of the mussels. (Note that 38 imperiled species are listed for a single ADA, the Clinch River.) The exceptions are:

Acipenser fulvescens (lake sturgeon), known from the Holston River (ADA 30) and lower French Broad River (ADA 34) is a special case. Once fairly widespread in the Southern Appalachian Rivers, it has been depleted by a variety of factors, not the least being the construction of dams. If the metapopulation of this species is to be preserved, the task will be accomplished on the mainstems of the larger rivers. Protection of watersheds in the mountains and the National Forests will be a minor factor.

Etheostoma sagitta sagitta (arrow darter), suggests the need for a fuller review of the 3 watersheds downstream from the Jefferson National Forest in the state of Kentucky. It is here listed only from the Poor Fork of the Cumberland River in Kentucky (ADA 40), but is also known (as a subspecies, *E. sagitta spilotum*) from the Kentucky River watershed downstream of our area. (Poor Fork is suggested for protection here under Critical Refugia.)

Nocomis baileyi (smoky madtom), is not known from any mainstem rivers, and is presently known from only one site, Citico Creek (ADA 25). Citico Creek is proposed for protection under Critical Refugia.

Cambarus chaugaensis (Oconee stream crayfish), inhabits the upper Savannah River basin, including portions of the Chattooga, Chauga, Keowee and Whitewater watersheds (ADAs 03 and 04). It is the only form here listed as imperiled which is known to inhabit the Chattooga and Chauga, both of which are here proposed as Critical Refugia.

Cambarus hiwasseeensis (Hiwassee crayfish) and *Cambarus parrishi* (Hiwassee headwaters crayfish) are both endemic to the upper Hiwassee River watershed (ADA 21). If the entire Hiwassee River watershed were considered as one unit, they would be "protected." Neither species is primarily a main stem inhabitant, and alternatives for their protection are discussed under Critical Refugia.

Cambarus reburri (French Broad crayfish) has an odd disjunct distribution. It is known from the type locality in a small tributary to the Horsepasture River (ADA 04), where it is suspected of having been introduced. All other populations are from tributaries to the French Broad River (ADAs 34 and 37). The type locality is entirely off National Forest land, though within the purchase boundaries of the Pisgah NF. Virtually the entirety of the rest of the range of this species falls outside the purchase boundary. The northern limit of its range is reported as "the vicinity of Hot Springs, Madison County" (NC), which raises the probability that it occurs barely within the Pisgah NF purchase boundary, and the possibility of finding it on system lands. If *C. reburri* were to be found in Spring Creek, tributary to the French Broad at Hot Springs, it might be prudent to propose Spring Creek as a Critical Refugia.

Etheostoma osburni (candy darter), the *Cottus* sp. bluestone sculpin, and *Percina gymnocephala* (Appalachia darter), which occur in the New River (ADA 43). The mussel *Lasmigona subvividis*, or green floater, occurs in the New River, as well as the Watauga River.

Phoxinus cumberlandensis (blackside dace) occurs in Poor Fork of the Cumberland River (ADA 40).

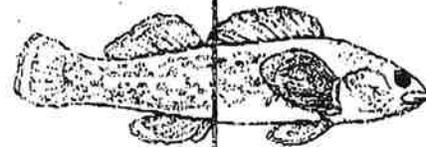
As for fishes listed at a lower level than Endangered, all are found in at least one of the priority ADAs, with two marginal exceptions:

Cyprinella caltraenia, the bluestripe shiner, listed as a Candidate 2 species by the USFWS and as Threatened by the APS, is an Apalachicola-Flint watershed endemic which has been recorded from the Chattahoochee River, Georgia, upstream of Lake Lanier (ADA 06). However, the great majority of the range of this species is downstream of Lake Lanier and in the Flint River watershed, which does not extend into the report area.

There is one record of the robust redborse (*Moxostoma robustum*) which appears to be from the Linville River, North Carolina, in the Catawba River watershed (ADA 02), and this species may have been able to survive impoundment of Lake James. However, it is essentially a Piedmont and coastal plain species, found below Lake James in the Catawba system. Listing is as for the bluestripe shiner.

In the same context, mention should perhaps be made of *Cambarus howardi* (Chattahoochee crayfish), which may ultimately be considered a Chattahoochee watershed (ADA 06) endemic. However, as in the case of the two fishes mentioned above, it is found far down the Chattahoochee system, below Lake Lanier and the city of Atlanta. In addition, its taxonomy is unclear. Possible conspecific forms are reported from various watersheds on both slopes of the Appalachians from Virginia to Alabama.

RELATION OF ADAs TO THE NATIONAL FOREST SYSTEM



Before revision of the Forest Plans or other actions involving the National Forests and the Forest Service can be properly considered as part of the larger goal of conserving Southern Appalachian aquatic biodiversity, there is one other aspect which must be considered before each of the ADAs can be given its proper priority: What is the relation of each ADA and its imperiled species to the National Forests?

While the information in the last column of Table 4 is subject to considerable inaccuracy, since much of it is interpolated from maps at a scale larger than appropriate for this work, it makes the point that aquatic biodiversity in the Southern Appalachian region is not going to be protected by focusing mainly on the National Forests. Only one of the 95 imperiled species (*Noturus baileys*) is found exclusively within the National Forest system (Citico Creek, ADA 25, Cherokee NF) – and it is being reintroduced to Abrams Creek in the Great Smoky Mountains National Park. *Cambarus georgiae*, endemic to the Little Tennessee River above Fontana Reservoir, occurs exclusively within the purchase boundaries (Nantahala NF, ADAs 27 and 29). The same may be true of 3 of the endemic darters of the Conasauga River (ADA 09, Cherokee and Chattahoochee NFs) and the mussel *Villosa vanuxemensis* of Choccolocco Creek (ADA 13, Talladega NF). However, for none of the latter 4 species is the downstream range limit known with precision and they may well occur outside the purchase boundaries.

Thirty-four of the imperiled species, including 21 of 40 mussels, apparently do not occur anywhere within the national forest purchase boundaries. However, since national forest lands are generally upstream of this habitat, all 108 imperiled species, in common with all aquatic species inhabiting the 44 ADAs, are influenced, for better or for worse, by land management decisions and actions on the national forests. Nevertheless, in the present context there may be an argument for assigning higher priorities to those species which maintain significant populations within the national forest system or purchase boundaries.

There is also an argument for assigning a higher priority to ADAs where the National Forest has the greatest potential influence, as measured by watershed areas or stream miles within the system and purchase boundaries. Tables 4 and 5 are intended to enrich this discussion. For each of the 13 large priority ADAs, Table 4 quantifies the proportion of National Forest land in terms of watershed area and stream miles. Table 5 shows selected portions of this data in percentage form.

TABLE 4: Watershed areas and stream miles in and out of the National Forests for 13 large Priority ADAs selected (selected tributaries and subdivisions included as appropriate). Bank length is double stream length, e.g. the sum of the two banks.



ADA	States and National Forests	Bank length (miles)			Watershed area (sq. mi.)		
		Within ADA	Within NF System	Within Purchase Boundary	Within ADA	Within NF System	Within Purchase Boundary
09 Conasauga R. upper GA portion TN portion Lower GA portion	TN/Chc, GA/Cha	138	34	50	470	90	140
		24	18	24	80	75	80
		38	8	26	45	15	30
		76	2	8	345	0	210
10 Coosawatee R. Cartecay R.	GA/Cha	36	0	0	537	70	274
		38	0	30	80	15	50
11 R.	GA/Cha	70	0	0	1,600	240	310
12 Tallapoosa R. to R.L. Harris L.	AL/T, GA/Cha	270	0	0	1,700	40	155
		110	0	0	600	40	120
13 Choccolocco Cr.	AL/T	100	6	8	507	120	150
16 lower Hiwassee R. plus upper Hiwassee River (ADA 21)	TN/Chc, NC/N	72	38	45	360	90	220
		226	97	200	1,200	520	760
22 Powell R.	VA/J, TN	400	4	10	950	30	140
23 Clinch R. Copper Cr. Little R.	VA/J, TN VA VA	400	0	5	1,960	100	210
		160	0	0	0	0	0
		180	0	0	0	0	0
28/29 middle Little Tennessee R. plus upper Little Tennessee R.	NC/N	50	0	50	693	120	693
		NC/N, GA/Cha	112	0	112	690	120
31 N. Fork Holston R. Big Moccasin Cr.	VA/J, TN VA	250	0	3	730	60	280
		80	0	0	100	0	0
32 S. Fork Holston R. Middle Fork Holston R.	VA/J, TN VA/J	74	9	18	530	190	290
		112	0	0	244	20	30
38 Nolichucky R.	TN/Chc, NC/P	186	20	49	1,750	270	710
44 44A and 44B combined	AL/B	96	82 (85%)	96 (100%)	289	216 (75%)	284 (98%)
44A Sipsey Fork above Lewis Smith Lake		34	24 (71%)	34 (100%)	154	124 (81%)	153 (99%)
44B Brushy Creek		62	58 (94%)	62 (100%)	135	92 (68%)	131 (97%)
46 Craig Cr / Johns Cr.	VA/J	80	20	76	350	180	330

*Not calculated: entirety of mainstem is impounded by Lewis Smith Lake

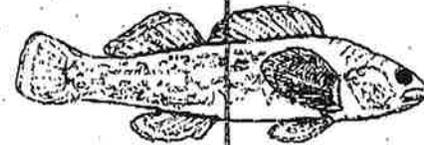
B = Bankhead NF
 Cha = Chattahoochee NF
 Chc = Cherokee NF
 J = Jefferson NF
 N = Nantahala NF
 P = Pisgah NF

TABLE 5: Percentages of mainstem river length and watershed area in the National Forests for 15 priority ADAs in the Southern Appalachians



Watershed Unit	% of Mainstem System Lands	Bank Mi. within: Purchase Boundaries	% of Watershed System Lands	Area within: Purchase Boundaries
16 + 21 Hiwassee R.	43	88	43	63
28 + 29 Little Tennessee R.	0	100	20	100
09 Conasauga R.	25	36	19	30
32 S. Fork Holston R.	12	24	41	50
38 Nolichucky R.	11	26	15	41
46 Craig / Johns Cr.	2	95	51	95
10 Coosawatee R.	0	0	13	45
43 New R.	0	6	10	20
31 N. Fork Holston R.	0	1	8	38
11 Etowah R.	0	0	15	19
22 Powell R.	1	2	3	15
23 Clinch R.	0	1	5	11
12 Tallapoosa R.	0	0	2	9

Brief descriptions of the priority ADAs



09 Conasauga River: The Conasauga is the most nearly pristine of the major streams of the Coosa Basin, and it leaves much to be desired. As Table 5 suggests, it presents one of the best opportunities to effect improvement of habitat in an ADA by working with the Forest Service. However, National Forest lands are heavily concentrated in the upper portion of the watershed. In the upper Georgia sector, 100% of the river bank and 94% of the watershed is in system lands. Proceeding downstream into the Tennessee sector, these figures drop to 21 and 60%, respectively, virtually all of it concentrated in the upper reaches just north of the Georgia line. Once the river loops back into Georgia, there are no system lands in the watershed. There is however, a sizable purchase unit containing 8 miles of the right bank of the Conasauga. Since SAFC has already participated in reaching an agreement with the Forest Service re management in the Conasauga watershed, there might be a temptation to lower the priority of this ADA. This would be a mistake, particularly with respect to the lower reaches of the river. A recent visitor to the area (Steve Ahlstedt, of the USGS) reports alarming decreases in numbers of mussels, and heavy sediment bedloads. The latter problem is worse downstream of the National Forest lands, but significant within the Forests. Of the imperiled species listed 6, (4 fish, 1 crayfish and 1 mussel) are not presently known to survive elsewhere in the Southern Appalachians.

10 Coosawatee River: The Coosawatee River watershed is home to no imperiled mussels, and its 3 imperiled fish species are all protectable elsewhere. However, it has the greatest number of imperiled crayfish species (4) of any of the ADAs. Two of these are endemic to the Coosawatee watershed. One, *Cambarus coosawatae*, appears to be restricted to the area upstream of Carters Lake, and the other may be. No portion of the Coosawatee River is within the Chattahoochee National Forest purchase boundaries. However, nearly half of the ADA is within the purchase boundaries, with 13% in System lands. The other 2 imperiled crayfish and the fish likely occur downstream of Carters Lake, and a case could be made for extending the ADA downstream to its confluence with the Oostanaula River, particularly given its position upstream from the Etowah River (see below.)

11 Etowah River: According to either the definition of "imperiled" used in this document or the more conventional one of all federally listed species, the Etowah River ranks slightly ahead of the Conasauga as a biodiversity conservation "hot spot" within the Coosa Basin. It has the apparent disadvantage of having no portion of the mainstem and less than 20% of its watershed within the Chattahoochee NF purchase boundaries (all of it in the extreme headwaters). However, it ranks as a conservation imperative. Of the species appearing in Table 2, 4 fish, 1 crayfish and 5 mussels are not known to persist anywhere else at this time. And, as the presence of 2 undescribed *Percina* darters suggests, much remains to be learned about the fauna of the Etowah.

12 Tallapoosa River: The Tallapoosa River originates in Haralson County, Georgia, crosses into Alabama, and runs parallel to the Coosa River until it reaches what is now Martin Lake, then turns west and joins the Coosa just upstream of Montgomery. The

Talladega and Shoal Creek Ranger Districts of the Talladega NF occupy the divide between the two rivers. As a consequence, such Critical Refuge areas as are protectable within the Talladega NF are limited to small tributary streams. Most, if not all of the 7 imperiled species listed for ADA 12 can be found in such environments. Even so, the Tallapoosa has the lowest percentage of land within the National Forest system or purchase boundaries of any of the 13 ADAs identified. Four of the species listed (the Tallapoosa shiner, *Notropis gibbsii*; the Tallapoosa sculpin, *Cottus carolinac*; and the crayfishes *Cambarus englishi* and *Cambarus halli*) are endemic to the Tallapoosa watershed.

13 Choccolocco Creek: Nine imperiled species are found in this relatively small watershed of the Coosa drainage. It should be noted that while gastropods have not been a focus of this report, an endangered snail is found in the watershed and the Coosa drainage is considered a world center of snail diversity. Particular attention should perhaps be paid to some of the streams within the Coosa drainage in terms of protecting species characteristic of small streams. Of the small streams within the Coosa drainage, Choccolocco Creek is probably the most significant in terms of species diversity and presence of imperiled species. System lands on the Talladega NF should receive particular attention. One Choccolocco Creek tributary (Shoal Creek) is proposed as a Critical Refuge.

16 lower Hiwassee River: Most of the imperiled fauna (with the notable exception of 2 endemic small stream crayfish, discussed above and under Critical Refugia) are to be found downstream of the series of reservoir lakes which begins with Appalachia Dam, just upstream of the Tennessee - North Carolina line. "At Appalachia Dam most of the water in the stream is diverted downstream to the Appalachia Powerhouse at river mile 53, altering the river downstream from Appalachia Dam from a medium-sized river to a first order stream, thereby altering the river below the Powerhouse to a trout stream for 27.3 miles" (Parmalee and Hughes, 1994, cited in Ahlstedt and Rashleigh, unpublished ms). The ecological damage thus done is apparent, but surprisingly, the molluscan fauna of the Hiwassee (including 8 species of mussels here cited as imperiled) finds its fullest expression in the cut-off reach between the dam and the powerhouse and this was also the site for an IBI sample which received a high score. Parmalee and Hughes (1994) recommend that this reach be considered for federal protection and for possible mussel transplants. (It has already been used as a transplant site for the snail darter, *Percina tanasi*, displaced from its original endemic range by construction of the Tellico Dam on the Little Tennessee River.) The total known mussel fauna of the Hiwassee comprises 35 species, rivaling the better known mussel "hot spots" of the upper Tennessee Valley. The lower Hiwassee is unique in the area in having over half its riparian lands within the National Forest system.

22 and 23 Powell and Clinch Rivers: Originally, the Powell was tributary to the Clinch. Now both flow into Norris Lake, and it is customary to refer to the "Clinch-Powell System". The parallel rivers share a number of other traits. Both are characteristically straight Ridge and Valley rivers which arise in Virginia and flow into Tennessee. National Forest lands play a minor role on both rivers, and there is no National Forest land in either watershed in Tennessee. Both rivers have suffered major pollution episodes in the past, but maintain impressive fish and mussel faunas, with high numbers of imperiled species. The fauna of the Clinch is more diverse, and there are no species unique to the Powell. However, some fish species, notably the slender chub (*Erimystax cahnii*), may be better represented in the Powell. It should also be mentioned that the Powell has consistently received high IBI scores over more than 100 miles of its length, in both states. Two tributaries of the Clinch with no relation to the National Forest, the Little River and Copper Creek, constitute Critical Refugia. Discussion of the ranges of the various species in the Clinch/Powell could take up many pages. However, for practical purposes conservation effort needs to be focused on the entirety of the ADAs for both Rivers - from the headwaters to Cherokee Lake.

28 Middle Little Tennessee River: The middle (ADA 28) and upper (ADA 29) Little Tennessee represent a unique situation. Only about 500 ft. of one bank of the mainstem, and no other large, low elevation stream reaches are on National Forest system lands, but 100% of the watershed is within the purchase boundaries of the Nantahala and (for ADA 29) Chattoohocchee National Forests. Of particular note in this regard is the Needmore Tract, comprising about 12 miles of undeveloped riparian lands on both banks beginning immediately upstream of Fontana Lake. While the total number of species or imperiled species in the Little Tennessee is not impressive when compared to some of the Mobile Bay or upper Tennessee River tributaries, it is the only major river in the Blue Ridge for which no modern extirpations are documented. A TVA fixed station at Needmore continually receives an Excellent IBI score. In contrast to the middle Little Tennessee, the upper river in ADA 29 is severely degraded, especially by nonpoint sources. The division between the two sectors is marked by Lake Emory, a small run-of-the-river impoundment located at Franklin, North Carolina. While a case can be made for any stream reach that conservation of the biota hinges on protecting the upstream watershed, this is particularly true in the case of the Little Tennessee, since Lake Emory, which was once an effective sediment trap, is effectively filled. An added argument for considering ADAs 27 and 29 together is that the Little Tennessee's only endemic (the Little Tennessee River crayfish, *Cambarus georgiae*), present only in 1 or 2 tributary streams on ADA 27, is widespread and abundant above Lake Emory.

31 and 32 North Fork Holston River and South Fork Holston River: These two streams present a situation similar to that of the Clinch-Powell. At Kingsport, Tennessee they join to form the Holston River (ADA 30). However, movement of animals between the two rivers is limited by the presence of S. Holston dam on the South Fork Holston, upstream of the confluence. Both rivers flow out of Virginia into Tennessee and both have histories of industrial pollution dating back into the 19th century, from which they have recovered to a significant degree. There are slight differences between the faunas of the two rivers, but both are less diverse than the Clinch or the Powell, and neither contains any imperiled species which cannot be protected in the Clinch-Powell. The North Fork Holston routinely receives Good IBI scores, but one site (at river mile 97.8, just above Saltville, Virginia) scored high enough to merit mention here. Unlike the case of the Clinch and the Powell, there are significant portions of the Jefferson NF in the Virginia portion of both watersheds, including a limited amount of riparian lands on the South Holston. (The ADA boundary is extended along the east

bank of S. Holston L. to include all the national forest lands in the watershed.) However, the major justification for considering them as conservation priorities is that, among the 43 ADAs they rank 5th and 6th in total number of imperiled species, after the Clinch, Powell, Etowah and Conasauga.

38 Nolichucky River: The Nolichucky can be said to be in a process of recovery from a period of severe sedimentation related principally to mica mining. While there are presently no imperiled species known from the Nolichucky which cannot be protected elsewhere in the region, its lower reaches may represent the best chance to recover some of the original French Broad River fauna, and it can be said to be the healthiest major stream in the upper Tennessee River watershed. Its recovery is also presumably assisted by downstream movement of organisms from the small (90 square mile), but unusually healthy South Toe System (ADA 39). The Nolichucky River is particularly important as a site for the sharphead darter (*Etheostoma acuticeps*), considered extinct prior to its rediscovery in the river in 1975.

44 and 45 Sipsey Fork/Brushy Creek: ADA 44, defined here as Sipsey Fork above Lewis Smith Lake (44A), together with Brushy Creek (44B), contains a total of 5 fish forms, 4 mussels, and possibly 1 crayfish here considered to be imperiled, for a total of 10 imperiled forms. It also contains the rare and endemic amphibian *Necturus alabamensis*, and musk turtle *Sternotherus depressus*. (Brushy Creek must be included to protect the endemic subspecies of the pretty shiner, *Notropis bellus alleghensis*.) The importance of the upper Sipsey Fork/Brushy Creek watershed is even more clear if one considers that of the 10 imperiled species, only one (*Psychrobanchus greeni*, also known from the Etowah River system) is protectable in the other 43 ADAs. It appears likely that this fish will soon be determined to be a distinct species. Interestingly, and atypically for the region, 6 of the 10 imperiled forms in ADA 44 are known exclusively from system lands. In addition, there is doubt that *Lampsilis perovalis* persisting outside ADA 44 constitute viable populations.

46 Craig Creek / Johns Creek: Craig Creek is a Ridge and Valley tributary of the James River (ADA 1), Johns Creek runs parallel to and is a tributary of the Craig. Almost the entire watershed is contained within the Jefferson NF purchase boundaries (approximately 50% in System Lands). However, very little of the main stem is in national forest ownership. Craig Creek / Johns Creek supports all 3 of the imperiled species in the James River watershed. One of these species (*Notropis semperasper*, roughhead shiner) is notable as being a pure Ridge and Valley endemic, virtually unknown from either the upstream Blue Ridge or downstream Piedmont areas of the watershed. While 3 imperiled species is a relatively low number as compared to some of the Gulf of Mexico and Tennessee drainage streams, all 3 are endemics to the James River watershed. Because most of the watershed is within Forest Service purchase boundaries but little of the riparian area of the main stem is in Forest Service ownership, priority should be given to key Forest Service acquisitions along the main stem, riparian easements by federal and state programs, and outreach to landowners to improve riparian management.

If the information presented in Table 2 is compared with that in Table 5, the very strong relation of the upper Sipsey Fork/Brushy Creek ADA to the Bankhead NF stands out. Of the 13 other priority ADAs analyzed in the main document, none has the majority of its mainstem bank length or watershed area within National Forest system lands, and 7 have no mainstem riparian area whatsoever in Forest Service ownership. For only one of the other priority ADAs (the Little Tennessee River) is the entire mainstem bank length within National Forest purchase boundaries (and in that case virtually 0% is within system lands). All but one of the other ADAs have less than 50% of their mainstem bank length within purchase boundaries.

Not only is the upper Sipsey Fork/Brushy Creek watershed biologically unique within the context of the Southern Appalachian National Forests, it also provides one of the best opportunities for effecting conservation of aquatic biodiversity through working with the Forest Service.

Other ADAs:

01 James River: Most of the mainstem James River is in the Ridge and Valley Province, but many tributaries drop from the Blue Ridge. The James River has three imperiled species. One of these species (*Notropis semperasper*, roughhead shiner) is notable as being a pure Ridge and Valley endemic, virtually unknown from either the upstream Blue Ridge or downstream Piedmont areas of the watershed. While 3 imperiled species is a relatively low number as compared to some of the Gulf of Mexico and Tennessee drainage streams, all 3 are endemics to the watershed, which also harbors an unusually high percentage of species of high concern at the state level. A major portion of the James watershed, including the 3 largest mountain tributaries (the Maury, Cowpasture and Jackson Rivers) is in the George Washington NF, and a complete discussion of conservation priorities for the watershed cannot be entertained without raking that area into consideration. The Craig / Johns Creek which has a significant amount of national forest ownership is listed as a priority watershed, ADA 46. The Pedlar River watershed is a biologically important James River tributary that is included as a Critical Refuge.

02 Catawba River: Recent investigations of several Catawba tributaries (Johns River, Linville River and Warrior Fork) have turned up unexpected populations of state listed mussels, and the area merits further investigation for both mussels and fish. The Linville River is proposed as a Critical Refuge.

03 and 04, Tugaloo River and Seneca River: These watersheds represent the only opportunity to protect the crayfish *Cambarus chaugaensis*. One tributary to each ADA is discussed under Critical Refugia.

05 Broad River: No distinctive or imperiled elements are known from this Broad River watershed (not to be confused with the much larger Broad River of the North and South Carolina piedmont.) This ADA is represented within the Chattahoochee National Forest purchase boundaries only by small tributary streams.

06 Chattahoochee River: Despite its recreational and esthetic significance, few distinctive or imperiled elements are known from the Chattahoochee, which serves as a headwater example of the rather unexceptional Apalachicola Basin biotic community. One Threatened fish, the blueshrike shiner (*Cyprinella caltaeniae*) can probably better be protected in the lower watershed, outside the area covered by this report. The same is true for the one arguable Chattahoochee watershed endemic, the Chattahoochee crayfish (*Cambarus howardi*), discussed above.

07 and 08 Chattooga River (west) and Oostanaula River: This Chattooga River should not be confused with the famed Chattooga River (east), which forms part of ADA 03.

13 and 14 Choccolocco Creek and small Coosa River tributaries: As for ADAs 07 and 08, but particular attention should perhaps be paid to some of these streams in terms of protecting species characteristic of small streams. System lands on the Talladega NF should receive particular attention. One Choccolocco Creek tributary (Shoal Creek) is proposed as a Critical Refuge).

15 Chickamauga Creek (north): Not to be confused with Chickamauga Creek (south), tributary to the Chattahoochee River. *Percina tanasi* may be found in this ADA (?).

17 Ocoee River: While a popular recreational river, the Ocoee is still recovering from severe copper pollution, and may fairly be called a biological desert. The one imperiled form listed for ADA 17 is the Tennessee dace (*Phoxinus tennesseensis*) found in tributary streams.

18 and 19 Toccoa and Nolichucky Rivers: Toccoa River is the name applied to the Ocoee River upstream of the Georgia - Tennessee state line (and the historic pollutin source). No distinctive or imperiled elements are known for either of these rivers, but a Critical Refuge area is designated for the upper Toccoa watershed, based on IBI scores from the Toccoa and a tributary (Suches Creek).

20 Valley River: This river has recently been found to sustain unusually good populations of redhorse suckers (*Moxostoma* spp.), including the undescribed sicklefin redhorse. Robert Jenkins (personal communication) notes unusual concentrations of large bodied fishes for a relatively small stream, and the river may bear further study for unusual elements. One Valley River tributary (Vengeance Creek) is proposed as a Critical Refuge area, based on IBI.

21 upper Hiwassee River: The Hiwassee River above Apalachia Dam presents no special elements except for 2 tributary stream crayfishes (See discussion under Critical Refugia). Most of the National Forest lands in ADA 21 are concentrated around Appalachia and Hiwassee Lakes, so that their value to biodiversity concentration is less than might be expected. Due to the several reservoir lakes, sedimentation from ADA 21 to ADA 16 (a priority ADA) is less than would normally be the case.

24 Tellico River: Much of the lower Tellico River was drowned when Tellico Lake was filled, and it presently has no unique or imperiled fauna apart from the smoky dace, a presumed subspecies of the rosyside dace (*Clinostomus funduloides*), shared with many other Little Tennessee River tributaries.

25 Citico Creek: Despite sharing the fate of the Tellico River in having its lower reaches impounded, Citico Creek is one of the most important small stream biodiversity sites in the southern Appalachians. See Critical Refugia.

26 lower Little Tennessee River reservoir tributaries: The lowermost 61 miles of the Little Tennessee River has been effectively removed from consideration in this context by conversion to a series of reservoir lakes (Fontana, Cheoah, Calderwood, Chilhowie and Tellico). However, several significant tributaries remain. Apart from Citico Creek (ADA 25) none of them is of outstanding conservation interest in this context. However, mention should be made of the Nantahala River. It is unusual among rivers of its size in this region (watershed area approximately 150 sq. mi.) in maintaining water cold enough for trout along its entire length. It maintains high water quality, and the Nantahala Gorge is known as an important biodiversity site for snails. Data on benthic macroinvertebrates from six sites show that this river has high benthos diversity (NCDWQ):

28 Tuckaseegee River: In recent years, water quality in the Tuckaseegee has improved, high IBI scores have been recorded from a monitoring site at RM 14.7 near Bryson City, North Carolina, and populations of 2 mussel species, *Altimodonta tennesliana* and *Fusconia barnesiiana*, have been discovered. However, it is presumed that populations of other imperiled species remain extirpated in the Tuckaseegee.

29 upper Little Tennessee River: Discussed under ADA 27, middle Little Tennessee River, above.

30 Holston River: This watershed is effectively separated from the upper reaches of its two main tributaries by urban pollution (North Fork) and South Holston Dam (South Fork). It is included here as an area where several fishes (and no mussels) from ADAs 31 and 32 extend their range.

33 Watauga River: The Watauga River is a Holston tributary with some of the species found in the upper Tennessee River tributaries draining out of Virginia (ADAs 22, 23, 31 and 32).

35 and 37: lower and Upper French Broad River: The French Broad is the largest of the upper Tennessee River tributaries and undoubtedly once supported a rich fish and mussel fauna. However, it has been the site of numerous extirpations over the years. It is divided into lower and upper sectors on the basis of the presence of a major urban center (Asheville, North Carolina), but neither sector currently contains unique or imperiled elements nor protectable elsewhere, with the probable exception of the French Broad crayfish (*Cambarus reburus*). Over time, if water quality improves, some important species may expand back into the French Broad from the Nolichucky River (ADA 38).

39 South Toe River: This tributary to the Nolichucky system (ADA 38) is an important biodiversity "hot spot" in its own right. See Critical Refugia.

40, 41 and 42: Poor Fork Cumberland River, N. Fork Kentucky River and Russell Fork: If portions of these watersheds downstream of the Jefferson NF boundary in Kentucky were taken into consideration, these streams would be added to the list of 28 large ADAs. However, for our present purposes they are considered as headwater environments, one of which (Poor Fork Cumberland River) is discussed under Critical Refugia.

43 New River: The New River arises in northwestern North Carolina, but there is no influence of the National Forest until it crosses into Virginia, and most of the drainage into the watershed off the Jefferson National Forest reaches the mainstem downstream (north) of Claytor Lake. The New River contains numerous endemic species, however, most are not considered here, since they are confined to or concentrated in the area of the watershed above any National Forest influence. The 4 species listed in Table 2 are all found predominantly downstream of Claytor Lake (and on into the West Virginia waters of the New River watershed, which are not considered here). The New River ADA is not without serious problems, mainly due to non-point source pollution and exotic species. On the basis of endemism alone, the New, including the upper reaches, deserves the attention of conservationists.

45 Lower Sipsy Fork: This ADA is defined as Sipsy Fork between the head of Lewis Smith lake and continuing downstream in the NF purchase boundary, and it contains 1 crayfish and 2 mussels, totaling 3 imperiled forms. On this basis, its neighbor ADA 44 qualifies as a "priority" ADA, while ADA 45 does not. (See page 24 for more on ADA 44, Sipsy Fork/Brushy Creek.)

Critical Refugia



A total of 22 sites, scattered throughout the area, were selected under the Critical Refuge criteria. They are here broken into 8 categories for discussion. All sites discussed in this report have a minimum watershed drainage area of 4 square miles.

A. High IBI scores on large ADAs: IBI scores of 54 or better were achieved on mainstem sites in the lower reaches of 5 of the 28 large ADAs. Four of these ADAs (16 - lower Hiwassee River, 22 - Powell River, 27 - middle Little Tennessee River and 31 - North Fork Holston River, are discussed as priority protection sites above. High IBI scores are also routinely recorded for a site on the Tuckasegee River (ADA 28) at river mile 15, not far above Bryson City, North Carolina. Before construction of Fontana Lake the Tuckasegee was a tributary of the Little Tennessee and probably shared all of the native fauna. However, numerous species were extirpated as a consequence of dam construction and industrial pollution. With the latter problem largely corrected, some species, notably some of the mussels, are coming back in the 20 miles of the river between Cullowhee and Fontana Lake, and 5 imperiled species are currently known from the river. However, important elements are still missing and there is nothing protectable in the Tuckasegee that is not protectable, and more abundant, in the Little Tennessee. The Nantahala NF is a less significant factor than in the case of the Little Tennessee, with perhaps 20% of the watershed in system lands, all of it at higher elevations. However, as in the case of the Little Tennessee, 100% of both banks of the mainstem (and other important streams) is within the purchase boundary. The lower

Tuckasegee has been considered as a possible reintroduction site for the spotfin chub (*Cyprinella monacha*) and its rating as a conservation priority may continue to rise.

B. Small ADAs: Three smaller watersheds separated as distinct ADAs merit special protection – Citico Creek (ADA 25), the South Toe River (ADA 39) and Poor Fork Cumberland River (ADA 40).

Citico Creek likely supported a significant mussel population before its lower reaches were drowned by the construction of Tellico Lake. Even so it still harbors 4 imperiled fish species. Citico Creek is the only currently known natural occurrence of the smoky madtom (*Noturus bailey*). About 95% of the watershed, and all of the riparian area, forms part of the Cherokee NF system lands, and the upper half of the watershed forms the Citico Creek Wilderness. However, some of the most significant stream areas for fish diversity lack wilderness protection.

The South Toe River is known to support 3 imperiled species and, as conditions improve downstream in the North Toe and Nolichucky Rivers, it is to be presumed that these species will spread. Approximately 75% of the watershed is within the purchase boundary of the Pisgah NF, and the upper 70% of that, including most of the riparian area, is within system lands. Throughout this reach and for several miles below, the South Toe is designated Outstanding Resource Waters by the state of North Carolina. However, the protected area corresponds closely to cold water habitat, and it is precisely the downstream, warm water sector, unprotected by either federal ownership or state regulation, where the imperiled species reside. This is undoubtedly in part a consequence of upstream protection, but suggests a need for further safeguards, at least for the 50% of the riparian area corresponding to the habitat for imperiled species.

Poor Fork Cumberland River arises and flows for about 8 miles within the Kentucky portion of the Jefferson NF. Most of the watershed is also within the purchase boundary, but there are no system lands within the watershed. This stream and its tributary Bad Branch provide the only opportunity within the report area to protect the arrow darter (*Etheostoma sagitta*) endemic to the Cumberland and Kentucky River systems (The subspecies *E. sagitta sagitta* is restricted to the Cumberland system.) and the blackside dace (*Phoxinus cumberlandensis*), a Cumberland watershed endemic. The Cumberland and the Kentucky, along with the Russell Fork, probably merit inclusion as larger ADAs with all or most of their area in the state of Kentucky.

C. Endemic species sites: The Poor Fork Cumberland River (above) qualifies for inclusion under this category as well.

Mention should also be made here of 3 endemic crayfishes. The Hiwassee crayfish (*Cambarus hiwasseeensis*) and Hiwassee headwater crayfish (*Cambarus parryi*) are widespread (but apparently never sympatric) in the upper Hiwassee River watershed (ADA 21), while the French Broad crayfish (*Cambarus reburus*) is known from a single stream (outlet to Sapphire Lake, Horsepasture River watershed) in ADA 04, and "tributaries of the French Broad River in Buncombe, Henderson, Jackson, Madison and Transylvania Counties, North Carolina" (Hobbs, 1989.) It would be premature to designate sites for these species, and it is to be hoped that their range will be captured within some conservation initiative with a larger focus.

D. Best examples of small warmwater streams in Atlantic drainages: It was hoped that North Carolina IBI data would provide streams in this category from the Catawba watershed. However, all of the available Catawba watershed IBI data was from the Piedmont sector downstream of Lake James. Consequently a selection of 4 widely separated and distinctive Atlantic drainage streams was made, using the limited available information. A common factor uniting these streams is relative ease of protecting them.

Linville River is one of 3 streams in the Catawba watershed (the others are Johns River and Warrior Fork) where several state endangered mussel species have recently been discovered (McGrath, personal communication). While no imperiled species, as defined here, are known from the Linville (or the upper Catawba system), the area has not been adequately explored for most groups of organisms. Of the 3 streams mentioned, the Linville presents

the most nearly pristine conditions and is the most protectable. All of its length as a warm water stream (from Linville Falls downstream) is within the Pisgah NF purchase boundary and 87% of the riparian area is on system lands, most of it within the Linville Gorge Wilderness. The upper half of the watershed is mostly within the purchase boundary, but there are no system lands.

The Chattooga River (east) is so designated to prevent confusion with the lesser known Chattooga River (west) (ADA 07), which forms part of the Coosa system. The Chattooga (east) forms part of ADA 03. The Chattooga (east) and the Chauga River (see below) provide the best opportunities to protect one imperiled species not found in any of the Priority ADAs, the Oconee stream crayfish *Cambarus chaugaensis*. The North Carolina portion of the Chattooga (east) qualifies as a cold water stream; because the transition occurs gradually over the reach which forms the Georgia/South Carolina border, the river is here treated as a warm water system. All of the Chattooga (east) outside its extreme upper reaches is on system lands (Nantahala, Chattahoochee and Sumter NF's), most of it as part of a Wild and Scenic Corridor. The entire watershed lies within the purchase boundaries of the 3 forests, with a high percentage of system land. Above Stekoa Creek, which drains the city of Clayton, Georgia and is a significant pollution source, the ecosystem is essentially unaltered, except for replacement of the native brook trout (*Salvelinus fontinalis*) by exotic salmonids. Brook trout persist in many tributary systems. Major efforts are already underway, both within and outside the Forest Service, to address the need to maintain the Chattooga watershed in as nearly unaltered a state as possible.

The Chauga River flows parallel to the Chattooga, entirely in the state of South Carolina, and drains into Lake Hartwell (part of ADA 04). Although close in miles to the Chattooga, it is very different - essentially a warmwater foothill stream of a type which may not otherwise be protectable within the area of this report. In addition to harboring *Cambarus chaugaensis*, it is suggested that it may be a diversity center for caddisflies (*Trichoptera*), with possible endemics. (Campbell, personal communication). The three quarters of the riparian lands above the suggested lower limit (mouth of Ramsey Creek at Chau-Ram County Park, below which various forms of pollution become a problem) and 75% of the watershed are on system lands. One hundred percent of the riparian lands and 90% of the watershed are within the Sumter NF purchase boundary. Turkey Creek, featuring broken topography and a mix of plants typical of the mountains (e.g. mountain laurel) and coastal plain (bald cypress) is considered the outstanding diversity site for mussels in the state of South Carolina or the Savannah River watershed. It should be considered as a Critical Refuge.

E. Best example of a warmwater small stream in the Mobile Bay/Coosa drainage. Many members of the distinctive Coosa fauna inhabit small streams; however these streams are characteristically quite degraded. Perhaps the best example is Shoal Creek, tributary to Choccolocco Creek (ADA 13). Three of four imperiled mussel species known from the Alabama portion of the Coosa system have been found in Shoal Creek, and "there is potential for additional species of proposed threatened or endangered mussels" (Pierson, 1992). In addition, there are four species of critically imperiled snail species, at least one of which is known to occur on national forest ownership (*Elimia bellula*, *E. crenatella*, *Leptoxis taeniata*, and *Tulotoma magnifica*). All but the lowermost 2 miles of Shoal Creek and its watershed lie within system lands of the Talladega NF. Given the fragmented nature of the northern Talladega NF and the concentration of system lands on the ridges, Shoal Creek is undoubtedly the outstanding opportunity to accomplish something for aquatic biodiversity conservation in the portion of Alabama covered by this report.

F. Best examples of warmwater small streams in the Tennessee drainages.

Brasstown Creek, tributary to the upper Hiwassee River (ADA 21) in North Carolina, received a high IBI score from TVA at a site I am unable to locate. The site is listed as "river mile 0", which would be at the mouth in North Carolina, but a location is given in Towns County, Georgia, which would have to be at least river mile 6. Nor does the information available list fish species or designate a temperature type. Brasstown Creek is known to be a warm water stream in North Carolina (and the only known small stream habitat for the undescribed sicklefin darters), and it is so designated here. The entire Georgia portion of the watershed is within the purchase

boundary of the Chattahoochee NF.

South Fork Holston Tributaries: A tributary to the South Fork Holston River downstream of South Holston Dam, Possum Creek received high IBI scores in 1997. Possum Creek showed tremendous improvement, for unknown reasons, between 1993 (IBI 40 - Fair) and 1997 (58 - Excellent). All but the lower reaches of Possum Creek are within the purchase boundary, and much of the watershed is in Forest Service ownership. Another tributary of the S. Fork Holston, Whitetop Laurel, has a high diversity of species, including rare fish, aquatic insects, hellbenders, the spiny river snail, and bog turtles.

Cowee Creek, tributary to the middle Tennessee River (ADA 27), received a surprising IBI score of 58 in 1997. No imperiled species are known from Cowee Creek with certainty, but it is the only stream in the Little Tennessee watershed known to contain all 4 species of darters associated with smaller streams. There is also a somewhat doubtful report of the Little Tennessee River crayfish (*Cambarus georgiae*, largely confined to the upper Little Tennessee River watershed - ADA 29) from Cowee Creek. The entire Cowee Creek watershed is within the Nantahala NF purchase boundary; approximately half, all of it at higher elevations, is included in system lands.

Betty Creek routinely scores an IBI of about 52 at several sites, but 2 higher scores merit its inclusion, as does the fact that it provides habitat for 2 imperiled species (the smoky dace, *Clinostomus funduloides* ssp., and the Little Tennessee River crayfish (*Cambarus georgiae*), plus several Georgia state listed fish species. Betty Creek is the largest tributary to the upper Little Tennessee River (ADA 29) in Georgia. The entire watershed is within the purchase boundaries of the Chattahoochee and Nantahala NF's. None of the riparian area in the warm water reaches is on system lands, which make up perhaps half of the total watershed. However, the extreme headwaters, are protected within the Southern Nantahala Wilderness. This reach is an important brook trout (*Salvelinus fontinalis*) water, harboring what is considered to be one of the strongest populations of the putative southern strain of this species. (See Suggestions.) Most of the riparian area belongs to 3 large landowners, suggesting an excellent purchase opportunity. In my opinion, this stream is critical to maintenance of water quality in the upper Little Tennessee River.

G. Best example of small warmwater streams in the Ohio drainage: This is Poor Fork Cumberland River, discussed under B and C above, respectively.

H. Trout streams: Coldwater streams draining more than 4 square miles have been well surveyed for trout, but not generally well evaluated for diversity or biotic integrity. Following are 6 such streams; TVA has assigned high IBI scores to four of these (see Table 7). These streams, concentrated in the greater Hiwassee watershed, should be considered as examples. More thorough survey work and proper attention to macroinvertebrates would surely multiply this list.

Childers Creek is tributary to the lower Hiwassee River (ADA 16) in Tennessee. Most of its watershed is within the purchase boundary of the Cherokee NF. There is not much system land, but it does include 2 miles of stream bank.

Toccoa River is the name applied to the Ocoee River upstream of the North Carolina/Georgia line. Since this is also the point at which pollution from past copper mining and processing ceases to be a concern, it is designated as a separate ADA (ADA 18). The site at which a high IBI score is indicated is identified as a cold water stream, and located at river mile 92 (presumably this is Ocoee River mile 92), at which point it drains 4.6 square miles. This would locate it near the mouth of Suches Creek, which also received a high IBI score, and I have combined the two watersheds in a single Critical Refuge area. All of this area is within the Chattahoochee NF purchase boundary, but only small headwater portions are on System Lands.

Vengeance Creek is located in the Valley River watershed (ADA 20), which is not noted for high quality trout streams. The entire watershed is within the Nantahala NF purchase boundary, with the entire upper half on system lands.

The Pedlar River in the James River watershed has high quality waters with consistently high IBI scores. The river contains habitat for the James spiny mussel. The Pedlar River has a large percentage of its area within the national forest purchase boundaries and most of this is in national forest ownership.

The Stony and Little Stony Creeks in the New River watershed both contain high insect diversity. The streams are the last strong-hold of the candy darter. Much of the streams are within national forest purchase boundaries and in national forest ownership.

Finally, Table 6 is a list of additional small stream sites which have no relation to the National Forest system, but which would bear consideration in future efforts. Each site is identified by state(s), nearest ADA and criteria for inclusion.

TABLE 6: Known Critical Refuge sites with no portion of the watershed within National Forest purchase boundaries.



Stream	State	Nearest ADA	Criteria for inclusion
Coldwater Spring Run	AL	13	endemic species (unique to site)
Little River	AL,GA	14	imperiled species
Copper Creek	VA	23	imperiled species
Little River	VA	23	imperiled species
Abrams Creek	TN	26	imperiled species, reintroduction site, in National Park
Big Moccasin Creek	VA	31	imperiled species
Little Creek	VA	31	high IBI
Cataloochee Cr.	NC	35	known high quality waters, in National Park
Little River	NC	37	high IBI
Chucky Creek	TN	38	endemic species (unique to site)
Levisa Fork	VA,KY	41	imperiled species

Conclusions And Recommendations



A number of recommendations are suggested from a review of the information presented here. The goal of this exercise was to identify the best examples of intact aquatic systems on public lands—or the functional portions of such biologically/functionally intact watersheds (where it would be possible to create or protect conditions for restoration of their diversity). We have prioritized these places not so much on the basis of species count as on their aquatic uniqueness, and how well they capture, as a group, the diversity of aquatic species that make the region biologically special. Such an effort should also aid good restoration: namely, restoration that recovers the natural functions and processes that support these creatures in places where the likelihood of success is the greatest. It is important to protect the best areas and begin restoration, not in the worst areas, but in the "next best" areas -- the ones most likely to recover, those where all or nearly all the biological and physical elements may still be found.

Clearly, conservation attention is critical for the lands and waters outside the national forest system. Many imperiled aquatic fauna are found on private lands downstream from the public forests. If conservation actions were focused only on public lands, we would lose an incalculable portion of our biological richness. However, the data presented also make it clear that improving the management of the national forest lands will benefit habitats downstream, and some critical sites and species can be protected by focusing on improving national forest management. At the same time, we do not intend to neglect the public lands outside of the critical watersheds. On those lands, it is important to work for improvements in riparian protection, using an ecologically meaningful definition of riparian areas, and improvements in the protection of roadless areas the restoration of poorly constructed roads, for instance.

Chances are, the battle for the conservation and restoration of aquatic biodiversity will be won or lost on private lands. But our focus on the public lands is further justified by the relative costs and benefits of the work we propose. Our meager resources stand a realistic chance of making a real difference on the public forests. By contrast, private lands, with their highly differentiated ownership, require enormous resources to make similar changes. We do have the resources to make potentially large changes on the 10% of the battle that is public, even though it is the smaller part of the problem. It is a biologically important part of the battle to protect our aquatic diversity that can actually be won.

In 1998, the Environmental Protection Agency released its Clean Water Action Plan, which provides a blueprint for restoring and protecting the nation's water resources. A key element of the Action Plan is a cooperative approach to watershed protection in which state, federal, and local governments work with the public to identify the watersheds with the most urgent needs, and focus on effective strategies for those watersheds. This report represents the kind of effort that is called for in the Action Plan, and the sites it nominates on federal land, along with their downstream reaches, are good candidates for the recommendations it makes for stream buffer management, the purchase of easements from willing sellers, and other kinds of stewardship. The sites nominated here will support acquisition priorities for land trusts in the region, especially in places that are linked to key national forest land by virtue of a stream that flows through them from public lands upstream. Our assessment can also support acquisition goals for the Forest Service in their efforts to consolidate their ownership (see below).

On public lands, the sites nominated as Aquatic Diversity Areas in this report deserve careful management through the forest plan revision to protect, restore and maintain the ecological elements and processes essential to the survival of native aquatic species. Management activities should emphasize rapid reduction of threats to ecosystem integrity caused by past road-building, off-highway vehicle crossings, timber harvest, and other such activities, followed by restoration. All activities in these places would occur within a context of planning at the scale of that ADA to ensure the protection or restoration of riparian and watershed-related ecosystem processes.

Sites nominated as Critical Refugia could serve as benchmark or reference waters that would capture the full range of diversity characteristic of our regional aquatic ecosystems. Appropriate management would feature no new road construction, and all roads and crossings should be evaluated for decommissioning or upgrading, depending upon the risk they present to the aquatic ecosystems. High-risk roads unsuitable for upgrade should be decommissioned. Maintenance of retained roads and crossings would be robust and continuous. Recreation is often an important feature of public streams and rivers, but when feasible, recreational pressures should be diverted up-slope or downstream of Critical Refugia. Toxic, bioaccumulative, or persistent pesticides and herbicides should not be used in Critical Refugia. These areas would not be suitable for hard rock or common mineral extraction.

A. Forest Service land purchase: In many instances, ranging from the spectacular case of the middle and upper Little Tennessee River watersheds (ADAs 27 and 29) to discrete sites like Craig Creek (ADA 01) in the James River watershed, important riparian zones, even of large rivers, lie within the National Forest purchase boundaries, but not on system lands. As our area has evolved, it would be naive to assume that the Forest Service will ever acquire most of these lands, which are often the most developed portions of our watersheds—to do so would more often than not be impractical, uneconomical or unjust. Furthermore, Forest Service criteria for land acquisition work against the outright purchase of streamside buffer zones; the agency tends to take advantage of opportunities that present themselves for consolidation of their ownership. Even so, it would be in keeping with the currently expressed purpose of the Forest Service to seek opportunities to acquire riparian buffer strips; at the very least, this may offer private landowners a palatable alternative to regulation of riparian zone management.

B. Restorations: Stream bank restoration is an urgent need in many watersheds. A spectacular example is provided by the banks of the Little Tennessee River upstream of Franklin, North Carolina (ADA 29), where deforested and eroding banks are the primary stress on the aquatic community not only locally, but downstream through the entire length of the mainstem in a priority conservation area, ADA 27. The Little Tennessee Watershed Association is implementing a program of fencing out livestock and restoring riparian vegetation in the North Carolina portion of this reach, but there is a need to extend upstream into the Georgia waters of the Little Tennessee and into other watersheds. In the cited example, the stream banks in question are within the Nantahala NF purchase boundary and could be purchased, but it may be that ownership is not a prerequisite for Forest Service participation; programs may exist where Forest Service money and expertise could be applied to stream bank restoration outside the National Forest system. With or without the Forest Service, stream bank restoration is probably the single greatest biodiversity conservation need in many of our watersheds.

C. Brook trout: The brook trout (*Salvelinus fontinalis*) is found in all of our National Forests except the Talladega and Bankhead of Alabama. In recent years, the hypothesis that there are one or more distinct Southern Appalachian strains, or subspecies ("speckled trout") (Lennon, 1967, McCracken, et al., 1993) has gained acceptance. If so, given the historic shrinkage of brook trout range, it would merit designation as imperiled. (Brook trout are already state listed in South Carolina.) While the brook trout is a "negative indicator" of fish diversity (it is found in small streams where few other fish species co-occur), it is *prima facie* evidence of high water quality.

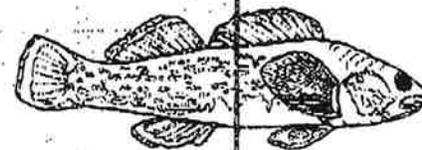
TABLE 7: Priority sites for conservation of aquatic biodiversity in the Southern Appalachians as determined by the "Critical Refuge" criteria.



ADA	Name of stream	Criteria for selection	Imperiled Species	Relation to National Forest
01	Craig/Johns Creeks, VA/J Pedlar River, VA/GW	imperiled species reputation imperiled species, insect diversity	3 1	entire watershed within PB of Jefferson 2 mi. of stream bank in SL mostly within PB, much in SL
02	Linville River NC/P	state listed mussels need for further study	0	most of lower low gradient section in Pisgah NF (Linville Gorge Wilderness)
03	Chattooga River (east) SC/S, GA/Cha, NC/N	special status known for high quality	1	93% of riparian lands in SL (Wild and Scenic)
04	Chauga River SC/S	no known extirpations unusual foothills stream known for endangered Trichoptera	1	75% of watershed and riparian areas in Sumter NF SL
14	Shoal Cr. AL/T	imperiled mussels best example of Coosa Basin trib	3	all but lower end of watershed and riparian zones in Talladega NF SL
16	Hiwassee R. NC/N, TN/Che, GA/Cha	fish IBI	(13)	high IBI sector not on NP; See below and ADA 16
	Childers Cr. TN/Che	fish IBI	?	most of watershed is within PB, not SL About 1 mi. of bank in SL
18	Toccoa R. GA/Cha, NC/N?	fish IBI	?	small tributary area in PB rest of NF area (SL & PB) in watershed is upstream of Blue Ridge L.
19	Suches Cr. GA/Cha	fish IBI	?	could not locate, but high probability of significant SL area.
20	Vengeance Cr. NC/N	fish IBI	?	all within PB, upper half of watershed and stream within SL
21	Brasstown Cr. GA/Cha, NC/N?	fish IBI	11 or more	watershed is within PB in GA, no SL runs along PB in NC
22	Powell R. VAJ	fish IBI	(21)	See ADA 22
25	Citico Cr. TN/Che	fish IBI imperiled species reputation reintroduction site	4	Over 90% of watershed and all of riparian zone in SL Half in Citico Cr. Wilderness
27	Little Tennessee R. NC/N, GA/Cha	IBI imperiled species No extirpations	8	100% of watershed & riparian area in PB, No riparian areas in SL

	Cowee Cr. NCN	IBI darter diversity	0	Most of upper watershed in SL, all in PB No riparian lands in SL
	Betty Cr. NCN, GA/Cha	IBI	0	Almost all of watershed in NC in SL; most in Southern Nantahala Wilderness
28	Tuckasegee R. NC/N	IBI	5	
31	N. Fork Holston R. VA/J	IBI imperiled species	16	See ADA 31
	Possum Cr. TN/Che	fish IBI	0	
32	Whitetop Laurel	species diversity	?	Approx. 60% of watershed in PB and also SL
37	Little R. (French Broad) NC/P	fish IBI	?	
39	S. Toe R. NC/P	fish IBI imperiled species ORW	3	Upper half of watershed in PB and much of riparian area in SL
40	Poor Fork Cumberland R. KE/J	imperiled species	1	
43	Stony/Little Stony	endemic species		Most of watershed, in PB, majority within SL

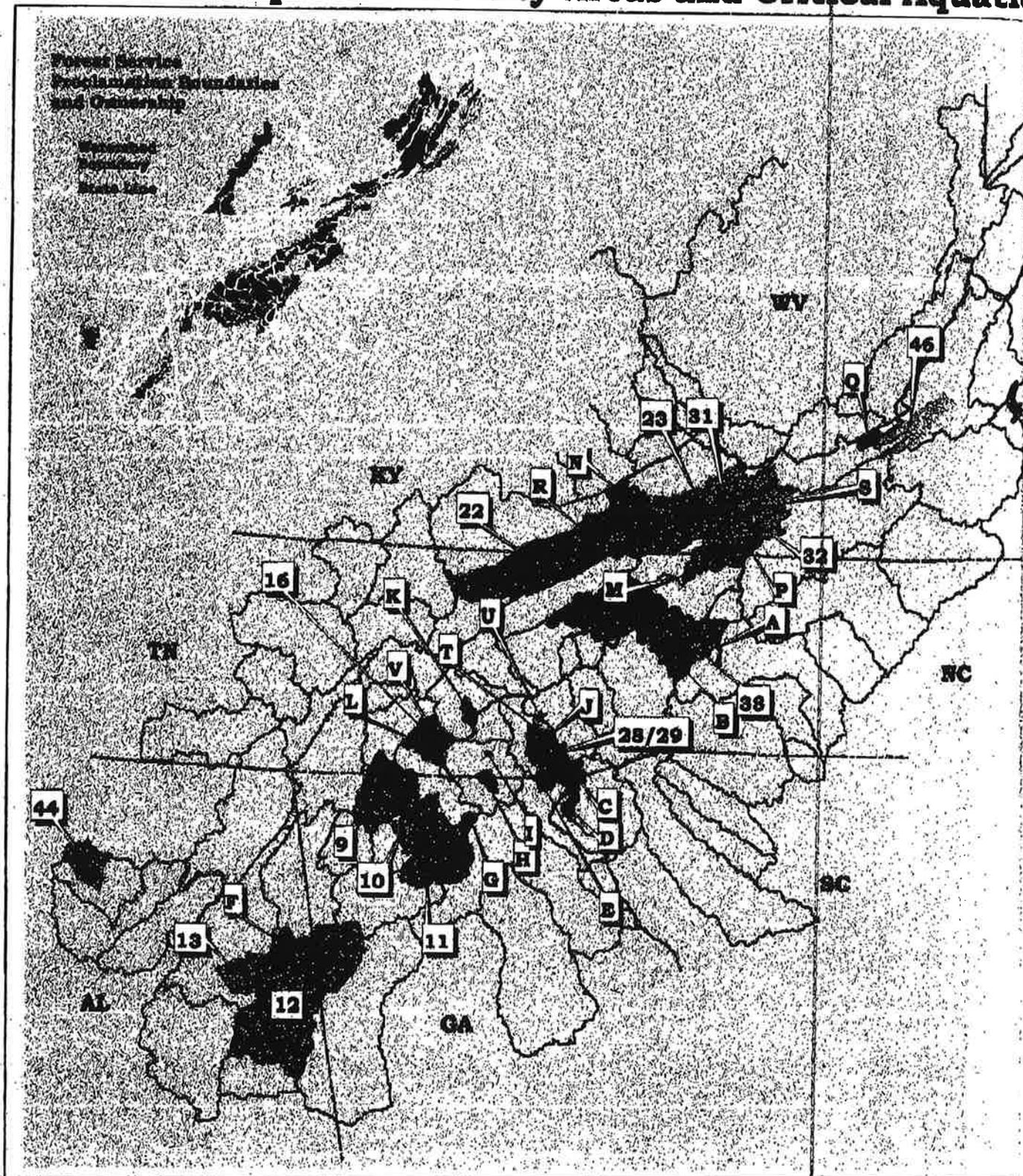
References consulted



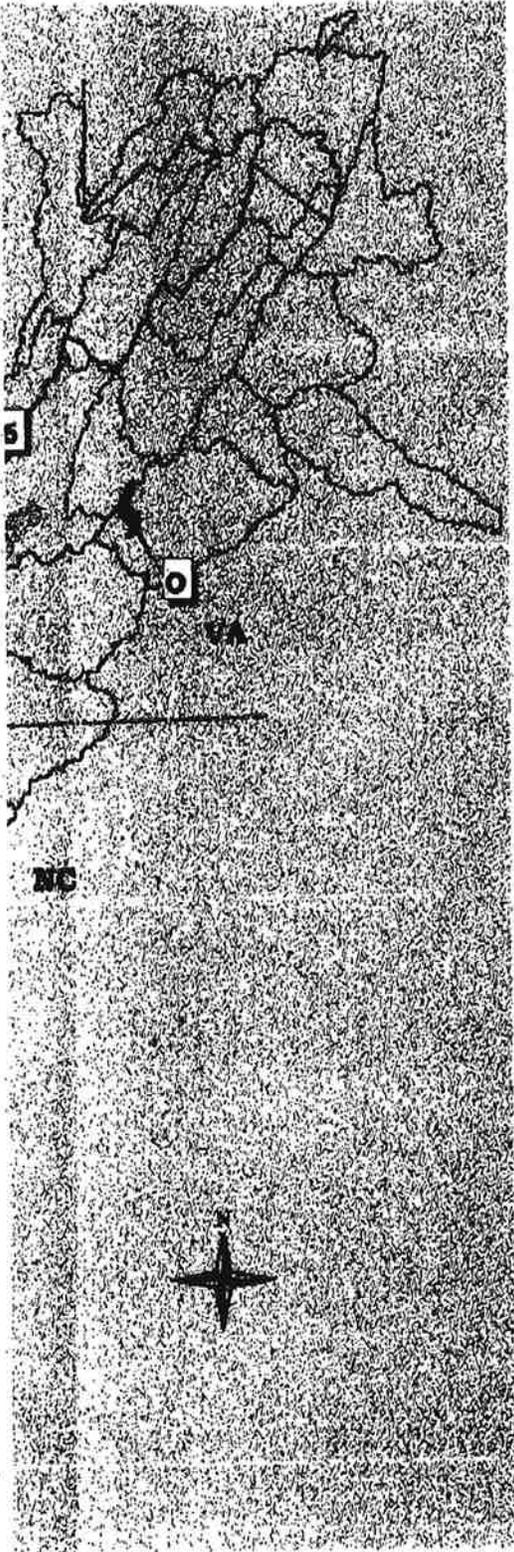
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Aquatic Diversity Areas and Critical Aquatic



quatic Refuges in the Southern Appalachians



SOUTHERN APPALACHIAN
F O R E S T
C O A L I T I O N



Pacific Rivers Council

- National Forest Ownership
- National Forest Purchase Boundary
- National Park Lands
- Watershed Boundary
- State Line

Aquatic Diversity Areas

- 9 Conasauga River
- 10 Coosawatee River
- 11 Etowah River
- 12 Tallapoosa River
- 13 Checcolocco Creek
- 16 lower Hiwassee River
- 22 Powell River
- 23 Clinch River
- 28/29 middle/upper Little Tennessee River
- 31 North Fork Holston River
- 32 South Fork Holston River
- 38 Nolichucky River
- 44 Wapsy Fork Black Warrior River
- 46 Craig/Johns Creek

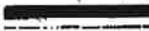
Critical Aquatic Refugia

- A Linville River
- B South Toe River
- C Chattooga River
- D Chauga River
- E Betty Creek
- F Shoal Creek
- G Toccoa River/Suches Creek
- H Brasstown Creek
- I Vengeance Creek
- J Cowee Creek
- K Citico Creek
- L Childers Creek
- M Possum Creek
- N Poor Fork Cumberland River
- O Pedlar River
- P Whitetop Laurel Creek
- Q Stony/Little Stony Creeks

★ **Critical Refuge IBI Sites**

- R Powell River
- S Holston River
- T Little Tennessee River
- U Tuckasegee River
- V Hiwassee River

200 Miles



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ATTACHMENT B

Alabama's Mountain Treasures



THE WILDERNESS SOCIETY

*The Unprotected Wildlands of the
Bankhead and Talladega National Forests*

by
Lamar Marshall and Ken Wills
for
The Wilderness Society®

Cover photo: Lamar Marshall

Little Hiker: Sabrina Balch, daughter of Keith and Zilpah Balch

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Founded in 1935, The Wilderness Society works to protect America's wilderness and to develop a nationwide network of wildlands through public education, scientific analysis and advocacy. Our goal is to ensure that future generations will enjoy the clean air and water, wildlife, beauty and opportunities for recreation and renewal that pristine forests, rivers, deserts and mountains provide.

Our membership of more than 200,000 people is a potent force that gets the attention of Congress, the White House, and federal agencies who manage our public lands.

You can join the growing number of Americans who believe that preserving wilderness is essential by calling 1-800-THE WILD (1-800-843-9453) to speak with a representative of our membership services. Or, you can join online at our website - www.wilderness.org

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