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(May 1996) - Geographic Distribution of Eastern and Western Mosquitofishes (Poeciliidae: Gambusia): Delineation of Ranges using Fin Ray Counts. By Robert A. Angus, W. Mike Howell

Imperiled Fishes and Aquatic Communities Across The Southern Landscape: Spatiotemporal Data Bases For The 21st Century. By Melvin L. Warren, JP.

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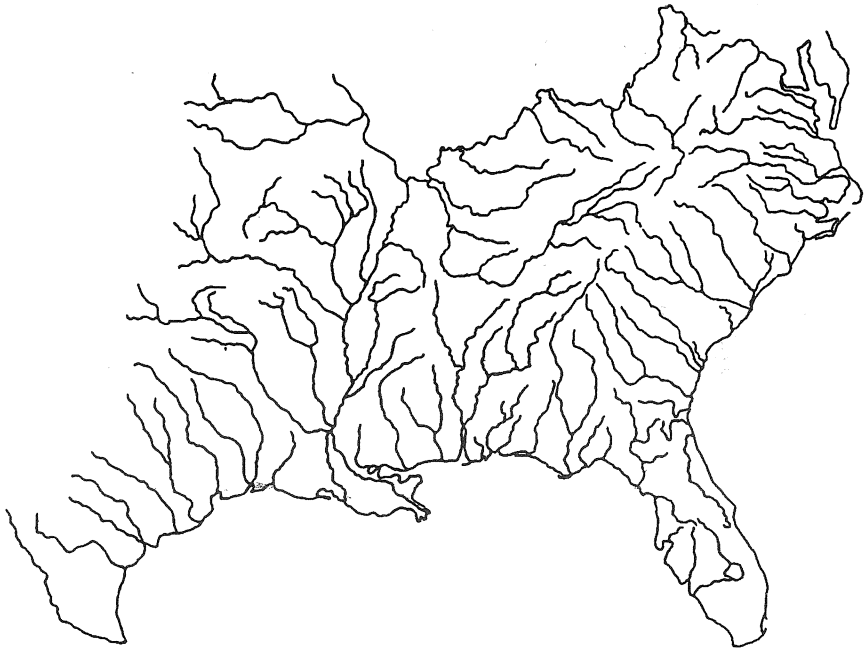

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ATTENTION

SFC Business Meeting

The Southeastern Fishes Council will meet jointly with the American Society of Ichthyologists and Herpetologists during the ASIH annual meeting in New Orleans, 13-19 June 1996. The SFC Business Meeting will be held on Friday, 14 June, at 5:00PM, in the Poydras Room.

GEOGRAPHIC DISTRIBUTIONS OF EASTERN AND WESTERN MOSQUITOFISHES (POECILIIDAE: *GAMBUSIA*): DELINEATION OF RANGES USING FIN RAY COUNTS

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ABSTRACT

Dorsal and anal fin ray counts were made on preserved specimens from 104 sites throughout the southeastern United States to delineate the ranges of the eastern (*Gambusia holbrooki*) and western (*G. affinis*) mosquitofishes. These meristic characters differentiate the species quite well, although not absolutely. Hybrid zones were detected in tributaries to the Mobile River and Gulf of Mexico in the vicinity of Mobile, Alabama and in the mid- and upper-Chattahoochee River drainage. Eastern and western mosquitofishes do not mix randomly, even in populations where hybrids occur. This implies behavioral and/or ecological differentiation between the species. We propose a biogeographic model for the current distributions of *G. affinis* and *G. holbrooki*.

INTRODUCTION

The mosquitofishes, formerly considered to be a single species, *Gambusia affinis* (Poeciliidae), range widely over the southeastern Unites States. The fact that they are differentiated into eastern and western forms has been known for years (e.g. Hubbs, 1955); however, the taxonomic significance of the differentiation has been subject to different opinions (see Wooten et al., 1988, for a summary). In recent years, various studies have provided genetic data indicating that the western mosquitofish, *G. affinis* (Baird and Girard) and eastern mosquitofish, *G. holbrooki* (Girard) are distinct species (Wooten et al., 1988; Scribner and Avise, 1993).

The distributions of the eastern and western mosquitofishes often have been discussed in general terms, but have not been accurately delimited. For example, Rivas (1963), who considered the two forms to be subspecies, stated that the range of *G. affinis* extended from southern Illinois and Indiana into Alabama, through Louisiana and southern Texas to the Rio Grande. The range of *G. holbrooki* extended from the Delaware River system of New Jersey and Pennsylvania southward and westward along the Atlantic and Gulf drainages of Georgia, Florida and Alabama.

The existence of areas of hybridization also has been long recognized but the precise locations of these populations have not been described. Krumholz (1948) indicated that hybrids occur "between Bay St. Louis, Mississippi and Apalachicola, Florida." Hubbs (1955) mentioned "intergrades, obviously produced through hybridization near the Gulf of Mexico in Mississippi and Alabama." In another paper in which he discussed the long-term stability of intergrade populations, Hubbs (1961) did not specifically identify their location. Hubbs and Lagler (1964: p. 97) referred to *G. affinis* "intergrading in Alabama with *G. holbrooki*." Black and Howell (1979: p. 509) stated that *G. a. affinis* "intergrades in south Alabama and northwest Florida with the subspecies *G. a. holbrooki*." Studies of geographic trends in genetic variation by Wooten et al. (1988) and Scribner and Avise (1993) did not include enough sites in enough drainages to permit accurate resolution of species' boundaries.

Accurate characterization of the distributions of the eastern and western mosquitofishes, as well as regions of hybridization, would be useful (1) in identifying hybrid zones, where further studies may concentrate on the extent of reproductive and genetic isolation between the species, and (2) in providing information that may contribute to our understanding of the biogeography and evolution of southeastern fishes in general. Whereas previous genetic studies have provided extremely useful information about variation between and within the species, time and cost constraints have necessarily limited the number of sites per study and the sample sizes which could be accommodated. In contrast, this study utilized a relatively "quick and dirty" method - based on readily observable meristic characters - to differentiate the two species. Our goal was to keep the means of identification simple so that we could include many more sites, and larger sample sizes per site, than had been possible in the genetic studies. This would allow us to provide more detailed information on the distributions of the two species of mosquitofishes, and their areas of hybridization, than has been available.

MATERIALS AND METHODS

Meristic characters

This investigation utilized dorsal and anal fin ray counts to distinguish between *G. affinis* and *G. holbrooki* and their hybrids. These characters discriminate the eastern and western mosquitofishes quite well: *G. affinis* typically has 6 dorsal and 9 anal rays (following the methods of Hubbs and Lagler, 1964); *G. holbrooki* typically has 7 dorsal and 10 anal rays. For both the dorsal and anal fins, Hubbs and Lagler (1964) considered the (apparent) last two rays to be a single branched ray and accordingly suggested that they be counted as one. These species also differ in characteristics of the gonopodium (D'Ancona, 1939; Rosen and Bailey, 1963). We did not routinely use these characters because (1) gonopodia are present only in males, and (2) the dorsal and anal fin ray counts were sufficient to serve our needs.

A fish was classed as having a "hybrid" ray count if it had a dorsal ray count characteristic of one species and an anal ray count characteristic of the other. This method of characterization was not expected to identify all hybrid individuals, but the presence of significant numbers of individuals with hybrid ray counts was considered indicative of a population where hybridization was occurring. Often, when mature males were identified as hybrids on the basis of dorsal and anal ray counts, the hybrid nature of these individuals was supported by their gonopodium, which was intermediate in characteristics that distinguish the two species. Dorsal and anal fin ray counts were made on 20 specimens or more (males, females and juveniles) from most sites although some collections (mostly from the Mobile, AL area) consisted of fewer specimens.

Collection sites

Fishes used for this study were obtained from a total of 104 sites throughout the southeastern United States. Sources of the preserved fishes include 52 collections made from 1 June - 15 July 1983 as part of an electrophoretic study of biochemical variation (Wooten, et al., 1988). Other preserved specimens were provided on loan from museum collections: University of Alabama Ichthyological Collection (29 sites shown in this paper), Mississippi State University Ichthyological Collection (eight sites), and Clemson University Vertebrate Collection (12 sites). Collections at three sites were personally made by the authors. Dates of collection ranged from 1951 to 1991. Because a hybrid zone has long been recognized to exist in the Mobile, Alabama area, numerous sites from that region were included. In fact, fin rays were counted on fish from more sites in the Mobile vicinity than could be shown in Fig. 1. Results for all sites included in this study are available in tabular form from the authors.

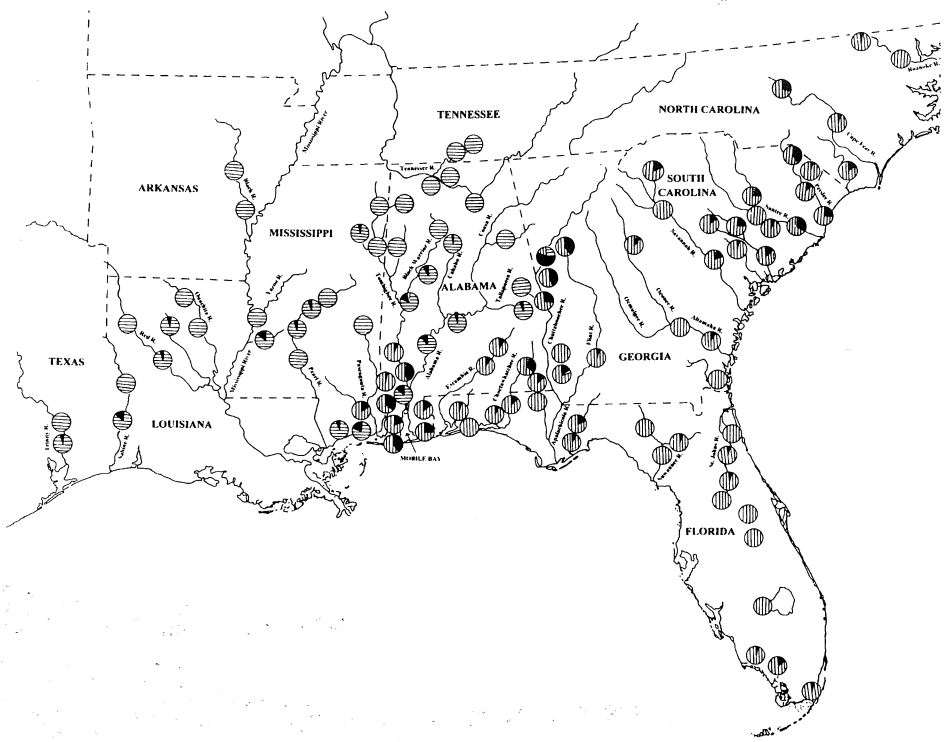

Figure 1. Composition of mosquitofish populations from throughout the southeastern United States. The proportion of *Gambusia affinis* in each population is indicated by the circle sector with horizontal striping, the proportion of *G. holbrooki* by vertical striping, and the proportion of hybrid fin ray phenotypes by black shading.

RESULTS

Fig. 1 illustrates the fin ray counts obtained for mosquitofish populations from throughout the southeastern United States. In the figure, each collection site is represented by a circle. Within each circle, the fraction of the fish with both dorsal and anal counts typical of *G. affinis* is shown by a sector with horizontal stripes. The fraction of the fish with both dorsal and anal counts typical of *G. holbrooki* is shown by a sector with vertical stripes. The fraction of the fish with a dorsal count typical of one species and an anal count typical of the other (e.g. a "hybrid" combination) is shown by a shaded sector.

The long-recognized hybrid zone in the vicinity of Mobile, Alabama can be readily discerned in Fig. 1 by the presence of numerous individuals with hybrid ray counts in those populations. A second hybrid zone is also apparent in the Chattahoochee River drainage from the point where the river meets the Alabama-Georgia state line northeast toward the headwaters. This zone was recently described by Lydeard, et al. (1991).

Many of the populations in the rivers draining into the Atlantic north of the Altamaha also contained substantial numbers of individuals with "hybrid" ray counts. These do not represent the products of recent hybridization; *G. affinis* has not been collected in most of these drainages. For possible explanations of this phenomenon, see the Discussion.

Other sites throughout the southern and southeastern U.S. infrequently contain individuals with "hybrid" ray counts. We consider these to represent variation within species because the populations are remote from any areas of known contact between species.

DISCUSSION

Dorsal and anal ray counts differentiate the eastern and western mosquitofishes well, although not absolutely as some variability occurs within species. Thus, not all fish with "hybrid" ray counts represent the products of interspecific hybridization (at least not recent hybridization). Nevertheless, these characters are consistent enough to be useful in identifying the ranges of *G. affinis* and *G. holbrooki* and areas where hybridization is occurring. A hybrid zone is identifiable as a cluster of populations, all with significant numbers of individuals with hybrid ray counts.

Genetics

Analysis of the fin ray counts in hybrid zones provides information on the genetic basis of these traits. It appears that the genetic bases of fin ray counts are more complex than previously thought. Hubbs (1955) observed that F_1 hybrids between *G. affinis* and *G. holbrooki* always had 7 dorsal and 10 anal rays, indicating that *G. holbrooki* is "completely dominant in this regard." Although he made no mention of observing typical Mendelian ratios in backcross or F_2 progeny, Hubbs concluded that the dorsal and anal fin ray differences were due to single genes. One might expect that, if the genes for *G. holbrooki* ray counts are dominant, the result would be an abundance of *G. holbrooki* phenotypes in hybrid zone populations. However, this is not seen.

There are two common "hybrid" combinations of dorsal and anal ray counts (6,10 or 7,9). In populations where *G. holbrooki* was the predominate species, a highly significant majority of hybrid counts fell into the 6,10 category (Table 1). In the relatively few populations where *G. affinis* predominated, a significant majority fell into the 7,9 category (Table 1). In hybrid populations, the anal ray count tends to be that of the parental species that predominates, but the dorsal ray count tends to be that of the species that is rare or absent. A simple single-gene Mendelian model will not explain this situation. Additionally, this unbalanced distribution of ray counts indicates that random two-way introgression of genes is not occurring within hybrid populations. This is consistent with results obtained in a recent molecular genetic study (Scribner and Avise, 1993).

One *G. affinis* population included in this study had a notable tendency toward a reduced number of dorsal rays. Half (10/20) of the fish from a population in the Elk River in Lincoln County, Tennessee (UAIC 1981) had 5 dorsal rays instead of the normal 6. Because this variation is away from the *G. holbrooki* condition, this variation would not produce pseudo-hybrid phenotypes. Nearby populations from the same drainage did not show this trend. It thus appears that the population has experienced rather unique alteration in frequency of the genes influencing dorsal ray count. At present, it is not possible to determine whether this has been due to local selective forces or whether random genetic drift in a somewhat isolated deme is responsible for the variation in this character.

Table 1. Total numbers of fish with each of the two possible hybrid phenotypes. Collection sites were divided into two groups according to the species that was numerically dominant at the site. Chi-square values were calculated based on the hypothesis of equal numbers of hybrid types in each species. Contingency table analysis supports the hypothesis that the distribution of fin ray counts differs significantly between species ($\chi^2 = 40.9$, $p << 0.001$).

Numerically Dominant Species	Fin Ray Counts (dorsal, anal) 6,10	7,9	χ^2	Probability
G. holbrooki	190	48	83.5	$<<0.001$
G. affinis	10	25	5.6	0.018

Geographic Patterns

Geographic patterns of variation in meristic characters (this study) correlate well with patterns of biochemical variation observed in mosquitofishes in other studies. Wooten et al. (1988) surveyed allozyme-encoding genetic variation in mosquitofish populations throughout the southeastern United States. They observed a major disjunction in the Mobile Bay, Alabama area. To the north and west, the populations were primarily *G. affinis*, whereas to the east, along the Gulf coast, the populations were primarily *G. holbrooki*. Scribner and Avise (1993) surveyed mitochondrial DNA and allozyme genetic markers in populations throughout the southeastern U.S. They found a pronounced genetic discontinuity along a line extending from southeastern Mississippi to northeastern Georgia demarking the area where the distributions of *G. affinis* and *G. holbrooki* abut.

Wooten, et al. (1988) detected a zone of hybridization in the Mobile area that has been recognized for years (e.g. Hubbs, 1955). The zone is also reflected morphologically by an abundance of hybrid ray counts in populations in the Mobile area. The geographic extent of the hybrid zone is well delineated in Fig. 1.

Wooten et al. (1988) distinguished a secondary genetic subdivision along the Atlantic coastal region of Georgia between the Savannah and Altamaha rivers in a region inhabited by *G. holbrooki*. One form was found in North and South Carolina and Georgia, the other from the Altamaha river drainage in Georgia, west to the Mobile Bay region. Scribner and Avise (1993) also detected a genetic subdivision among *G. holbrooki* populations which distinguished many (but not all) populations from the Gulf coastal plain from those to the east in peninsular Florida, Georgia, and the Carolinas.

Our data support the idea of geographic genetic subdivision in *G. holbrooki*. Populations north of the Altamaha show much more variation in fin ray counts than do populations to the south (Fig. 1). In some of the Atlantic coast populations, as many as one third of the individuals had "hybrid" ray counts. These sites do not appear to represent a hybrid zone since *G. affinis* has not been found in the region. The extent and taxonomic significance of the genetic differentiation in *G. holbrooki* remains uncertain. In fact, not all studies reveal this subdivision. For example, Hernandez (1988) did not find genetic evidence indicative of two forms of Atlantic coast *G. holbrooki*.

Other zones of contact and hybridization between *G. affinis* and *G. holbrooki* have been recently identified. Lydeard et al. (1991) used both allozyme and fin ray count data to demonstrate the presence of *G. affinis* in the Savannah and Chattahoochee drainages, previously thought to be entirely within the range of *G. holbrooki*. Based on comparisons between fin ray counts and allozyme genotypes, they concluded that intergradation in hybrid zones has apparently gone beyond the F_1 stage.

The present study confirms and extends the findings of Lydeard et al. (1991). In the Chattahoochee (Fig. 1), a zone of hybridization is evident in the collections from the middle regions of the river in the vicinity of Auburn, AL. Although this study includes few collections from the headwaters of the Savannah, one of them shows about 20% of the individuals having hybrid ray counts.

Systematics

Rivas (1963) considered the eastern and western mosquitofishes to be subspecific, based primarily on the presence of areas of intergradation. However, data from subsequent studies have indicated that the two forms are distinct species. Both Black and Howell (1979) and Reznick (1981) identified a degree of reproductive isolation between the eastern and western mosquitofishes. Wooten et al. (1988) identified "substantial genetic differentiation between the two forms...indicative of differentiation at the species level." Their genetic survey also indicated that, although hybrid zones exist, the two forms of mosquitofish do not appear to be merging as a result of introgression of genes. Overall, Wooten et al. (1988) found little evidence of significant gene flow between *G. affinis* and *G. holbrooki*. Based on the previous reports of reproductive isolation and on their own observations of abrupt shifts in gene frequencies between the forms, Wooten et al. (1988) recommended restoration of D'Ancona's (1939) taxonomic designations for southern U.S. mosquitofishes as separate species: *G. holbrooki* and *G. affinis*.

Scribner and Avise (1993) used both nuclear and mitochondrial genetic data in their study. They also found a pronounced genetic discontinuity between *G. holbrooki* and *G. affinis*. Although they found evidence of hybridization, they saw pronounced gametic disequilibria among nuclear genotypes in hybrids, indicating that randomization of genotypes under hybridization was not occurring.

Results of the present study support the conclusion that the eastern and western mosquitofishes are separate species. Behaviorally or ecologically they appear to avoid each other. Even in areas of sympatry where hybridization has occurred, we found a strong degree of segregation. At none of our sample sites did eastern and western mosquitofishes occur in frequencies typical of haphazardly mixed groups, as would be expected of conspecifics. At each site, even if hybrids were present, one species overwhelmingly predominated and the other was rare or (usually) absent. It was also clear that random factors alone did not determine which species would predominate in a sympatric population. Of 39 sites in the Mobile, AL area that contained fish with hybrid ray counts, *G. holbrooki* was the numerically dominant species in 33 of them. This is significantly different from a 50:50 ratio ($p < 0.001$, G test) and is consistent with the idea that *G. holbrooki* is a superior competitor to *G. affinis* and is presently expanding its range by displacing *G. affinis* (see below).

Biogeographic Scenarios

Swift et al. (1986) studied the geographic distribution limits of numerous fish species in the southeastern U.S. The major features of distributional limits summarized in that report were highly concordant with those of Bermingham and Avise (1986) who investigated geographic patterns of mtDNA

phylogenies. Both studies identified three major geographic boundary areas in the southeastern United States: the Apalachicola River, the Alabama/Tombigbee and north Florida.

Based on genetic differentiation between four species of *Lepomis*, Bermingham and Avise (1986) proposed a biogeographic scenario in which major genetic differentiation occurred in the Pliocene interglacial, when sea level was 50-80 m higher than at present. Under such conditions, they considered it likely that many of the major southern drainages, with headwaters above the physiographic Fall Line, were well isolated. The Ocala highlands region in north-central peninsular Florida offered another potential refuge area for freshwater fish. The major genetic effects of the high sea-level stand were hypothesized to be the extinction of populations in smaller Coastal Plain rivers and the opportunity for significant genetic divergence between populations in the headwaters and/or Florida refuge areas. Bermingham and Avise (1986) considered the present day distributions and boundaries as reflecting dispersal subsequent to the receding of sea level after the Pliocene high sea-level stand.

For mosquitofish, both Wooten et al. (1988) and Scribner and Avise (1993) advocated an evolutionary scenario that involves two major phylogenetic events: (1) divergence of *G. affinis* and *G. holbrooki*, perhaps as a result of isolation on opposite sides of the Appalachians during seawater elevations of the Pliocene or late Miocene, and (2) later derivation of a somewhat distinct Atlantic coastal form of *G. holbrooki*, probably from a Florida population.

We propose the following biogeographic model for the current distribution of *G. affinis* and *G. holbrooki* which is consistent with the data and conclusions of Wooten et al. (1988) and Scribner and Avise (1993). Prior to the Pliocene interglacial, *G. affinis* was widely distributed throughout the southeastern U.S. During the Pliocene high sea-level stand, *G. holbrooki* evolved in a Florida refuge area from *G. affinis* stock. Thus, *G. affinis* genetic markers can still be found in *G. holbrooki* populations (Scribner and Avise, 1993). After sea level receded, *G. holbrooki*, which appears to be a better competitor than *G. affinis* (Scribner, 1993; Scribner and Avise 1994a, 1994b), expanded its range and displaced *G. affinis*. The present distribution reflects the invasion of *G. affinis* territory by *G. holbrooki* as it dispersed from Florida northward along the Atlantic coast and westward along the Gulf coast. Because *G. holbrooki* tends to displace *G. affinis*, the only locations where both species occur are at the front edges of the current line of advance of *G. holbrooki*. Such sites include the Mobile, AL area and the Chattahoochee River near Auburn, AL.

Although populations of pure *G. affinis* apparently no longer exist in the coastal Atlantic drainages, the presence of significant numbers of fish with hybrid ray counts is consistent with the idea of the persistence of at least some *G. affinis* genes in populations of *G. holbrooki* that have since replaced them. If this model is correct, it might be possible to find relict populations of *G. affinis* in the headwaters of the streams east of the Mobile drainage. In fact, this has been done. Lydeard et al. (1991) found *G. affinis* in the middle Chattahoochee and upper Savannah. The present study also found fish with pure *G. affinis* ray counts in the upper Chattahoochee. Lydeard et al. (1991) speculated that these *G. affinis* came either (1) from the Mobile or Tennessee River drainages via stream capture, or (2) were transplanted by humans. We think it is also possible that they represent surviving isolates from a time when *G. affinis* was distributed widely throughout streams in the southeastern U.S. If this hypothesis is correct, further collecting in the upper reaches of other southeast Atlantic drainages may also identify populations of *G. affinis* that could not have gotten there by stream capture from drainages where they presently occur.

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LITERATURE CITED

Bermingham, E., and J.C. Avise. 1986. Molecular zoogeography of freshwater fishes in the southeastern United States. Genetics 113:939-965.

Black, D.A., and W.M. Howell. 1979. The north American mosquitofish, *Gambusia affinis*: a unique case in sex chromosome evolution. Copeia 1979:509-513.

D'Ancona, U. 1939. A proposito di Gambusie. Bollettino di Zoologia 10:75-79.

Hernandez, J.D. 1988. Genetic variation in eastern mosquitofish (*Gambusia holbrooki* Girard) from the piedmont and coastal plain of the Altamaha, Broad-Santee and Pee Dee drainages. Master's Thesis, University of Georgia, Athens, Georgia. 141pp.

Hubbs, C.L. 1955. Hybridization between fish species in nature. Systematic Zoology 4:1-20.

Hubbs, C.L. 1961. Isolating mechanisms in the speciation of fishes, pp. 5-23. *In* Vertebrate speciation, W.F. Blair (ed.). University of Texas Press, Austin.

Hubbs, C.L., and K.F. Lagler. 1964. Fishes of the great lakes region. University of Michigan Press, Ann Arbor.

Krumholz, L.A. 1948. Reproduction in the western mosquitofish, *Gambusia affinis affinis* (Baird & Girard), and its use in mosquito control. Ecological Monographs 18:1-43.

Lydeard, C., M.C. Wooten, and M.H. Smith. 1991. Occurrence of *Gambusia affinis* in the Savannah and Chattahoochee drainages: previously undescribed geographic contacts between *G. affinis* and *G. holbrooki*. Copeia 1991:1111-1116.

Reznick, D. 1981. "Grandfather effects": the genetics of interpopulation differences in offspring size in the mosquito fish. Evolution 35:941-953.

Rivas, L.R. 1963. Subgenera and species groups in the poeciliid fish genus *Gambusia* Poey. Copeia 1963:331-347.

Rosen, D.E., and R.M. Bailey. 1963. The poeciliid fishes (Cyprinodontiformes), their structure, zoogeography, and systematics. Bulletin of the American Museum of Natural History 126:1-176.

Scribner, K.T. 1993. Hybrid zone dynamics are influenced by genotype-specific variation in life-history traits: experimental evidence from hybridizing *Gambusia* species. Evolution 47:632-646.

Scribner, K.T., and J.C. Avise. 1993. Cytonuclear genetic architecture in mosquitofish populations and the possible roles of introgressive hybridization. Molecular Ecology 2:139-149.

Scribner, K.T., and J.C. Avise. 1994a. Population cage experiments with a vertebrate: the temporal demography and cytonuclear genetics of hybridization in *Gambusia* fishes. Evolution 48:155-171.

Scribner, K.T., and J.C. Avise. 1994b. Cytonuclear genetics of experimental fish hybrid zones inside Biosphere 2. Proceedings of the National Academy of Sciences USA. 91:5066-5069.

Swift, C.C., C.R. Gilbert, S.A. Bortone, G.H. Burgess and R.W. Yerger. 1986. Zoogeography of the freshwater fishes of the southeastern United States: Savannah River to Lake Ponchartrain, pp. 213-265. *In*: Zoogeography of North American freshwater fishes. C.H. Hocutt and E.O. Wiley (eds.). John Wiley & Sons, New York.

Wooten, M.C., K.T. Scribner, and M.H. Smith. 1988. Genetic variability and systematics of *Gambusia* in the southeastern United States. Copeia 1988:283-289.

IMPERILED FISHES AND AQUATIC COMMUNITIES ACROSS THE SOUTHERN LANDSCAPE: SPATIOTEMPORAL DATA BASES FOR THE 21ST CENTURY*

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The southern United States harbors the richest freshwater fauna of any similar-sized region in North America and supports a large portion of the endemic fishes and other aquatic organisms known on the continent. Concomitant with high diversity and endemicity is a growing list of imperiled aquatic organisms; 20 or more fish species are in need of conservation management in Alabama, Georgia, North Carolina, Virginia, and Tennessee. This diverse fauna and its setting within a rapidly changing landscape present numerous future and ongoing challenges to aquatic resource managers, especially those associated with conservation of individual species, aquatic communities, and flowing water habitats. Over the past century a vast body of knowledge has accumulated on the zoogeography, distribution, and biology of the southeastern fish fauna and to a lesser extent other aquatic organisms, but to date little of this information has been synthesized in an analyzable format capable of addressing long-term, site-specific changes (potential or realized) or affects across large spatial scales (reaches to watersheds to drainage basins). This information is paramount to formulation of sound management decisions and planning in both the long and short-term, especially as management inevitably moves from individual species to whole communities and watersheds. An important challenge facing researchers and managers in the southeast is to creatively use and expand this body of knowledge in a coordinated fashion for the benefit of fishes, aquatic communities, and habitats.

To address these needs, a symposium, jointly sponsored by the American Fisheries Society Endangered Species Committee and Southeastern Fishes Council, was organized and presented at the annual meeting of the American Fisheries Society, Tampa, Florida, 29 August 1995. The primary purpose of the symposium was to highlight the application of long-term or large-scale aquatic data sets and present creative approaches to illuminating factors at multiple spatial and temporal scales that interact to affect species diversity, ecological function of aquatic communities, and habitat in southern running waters. Specific objectives were to: (1) create a forum for scientists to share with managers the availability and potential applications of existing data and computationally intensive methods, including contemporary systematics, historical ecology, and GIS applications; (2) enhance communication between resource agencies and researchers concerning creation, maintenance, and use of large data bases for planning and management of endangered fishes, other imperiled aquatic fauna, aquatic communities, and sensitive aquatic habitats; and (3) focus on realized and potential problems attendant to the future of the southern aquatic fauna and germinate coordinated efforts at using the data in hand for betterment of the fisheries resource of the future.

We present in this issue of the SFC *PROCEEDINGS* brief summaries from the symposium presentations. We do so realizing that many members of SFC were unable to attend the AFS meeting and in an effort to share with members ongoing research on the great aquatic fauna of the southern United States.

STATUS OF FISH COLLECTIONS IN THE SOUTH: THEIR VALUE AND USES AS DOCUMENTATION CENTERS OF DIVERSITY

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Many biologists and resource managers are unaware that a wealth of data on fish communities, jeopardized species, and sites of aquatic diversity already exists in permanent fish collections located throughout the southern United States. Among the most significant in terms of size, historical data, and geographic coverage are the national centers at Tulane University and Florida State Museum and the regional centers at Northeast Louisiana University and University of Alabama.

*Editors Note: This introduction and the abstracts that follow are from a Symposium on Imperiled Fishes and Aquatic Communities Across the Southern Landscape: Spatiotemporal Data Bases for the 21st Century, held in Tampa, FL on 29 September 1995 as a joint effort of the American Fisheries Society Endangered Species Committee and the SFC. It was felt by the organizer, Mel Warren and concurred by the Editor that this information would be of interest to the membership of the SFC.

Together with more parochial collections these institutions are depositories of over 12 million fish specimens representing samples taken over the entire southern landscape. Most important to resource managers are the long-term data bases on stream-fish communities from several of the major southern drainages as well as preserved series of jeopardized species collected prior to their present threatened status. Most of these data have not been synthesized in any available format to allow convenient access. Crucial needs of fish collections include computerization, geo-referencing, adequate staffing, and space for growth. We recommend that a consortium of state agencies, universities, and private foundations be formed to provide the support and funding that will allow the historical aquatic resource information already available in collections to be utilized to its maximum level in the 21st Century.

BIODIVERSITY AND CONSERVATION OF FISHES IN THE SOUTH: LESSONS FROM HISTORICAL ECOLOGY

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The southeastern ichthyofauna is one of the most diverse faunas in North America. This region has suffered fewer dramatic paleoclimatic changes since the Cretaceous than other regions. Sampling by ichthyological parties have not only revealed a significant number of taxa with restricted distributions but have yielded substantial museum data to document temporal and spatial changes in the fauna. Recent advances into systematic (evolutionary) relationships within this fauna, using these museum data, have revealed numerous replicated and highly predictable historical patterns of diversification within the region. Historical Ecology incorporates systematic hypotheses of organisms into efforts to better understand the origins of not only their distributions but their ecologies, physiologies, behaviors, etc. This novel research program promises to enhance our abilities to accomplish objectives frequently outlined in management and conservation plans. Phylogenetic hypotheses are historical templates onto which distributions and biological attributes of organisms may be superimposed to reveal origins of traits important in conservation and management. For some taxa these traits are unique; for others they are historically constraining (inflexible) elements of imperiled faunas. Recent advances in this program also offer assistance to managers in the decision making process of prioritizing and targeting species and/or communities for protection.

A GIS DATABASE OF MISSISSIPPI FISHES: APPROACH, PROBLEMS, AND APPLICATION TO CONSERVATION ISSUES

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The ichthyofauna of the southeastern United States has been sampled for several hundred years but most intensively since the 1900's. To understand Mississippi's inland fish fauna, I first constructed a computer database of museum material and then used the information to identify regions requiring further collecting. Museum data are advantageous in offering both temporal and spatial coverage, and the potential for examination of specimens and original field records. Each locality was identified on USGS 1:100,000 maps using universal, transverse, Mercator Coordinates, and the coordinates were added to the database. Since 1986, over 30 fish museum collections in the eastern United States have been accessed, and the current database contains 89,000 records. Data for each species are plotted on State drainage maps using Atlas GIS. Overall, 282 species are recorded, with 202 native, freshwater, 10 non-native, and 70 estuarine/marine species. Most of the 10 drainages have 100 or more species, exceptions being the Lake Pontchartrain and Coastal Rivers. However, a GIS plot of taxon density indicates that centers of species richness are grouped across drainage patterns with a broad band running diagonally from the northeast to southwest corner of the state. Diversity is also high in coastal areas due to the influx of estuarine/marine species.

DUSTING OFF THE JARS: USING MUSEUM COLLECTIONS IN STUDIES OF FISH ECOLOGY AND FISHERIES MANAGEMENT

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Although the systematic importance of fish research collections is well understood, they are underused in ecological and fisheries research. Recent thesis projects undertaken by students at Northeast Louisiana University illustrate the application of research collection data to three different ecological and management problems. One project focused on the life history of the crystal darter, *Crystallaria asprella*, a species classified as "Of Special Concern" by AFS. Specimens used were collected over a two-decade period. The

use of museum specimens reduced the need to obtain large samples of an imperiled species. A second project described the reproductive cycle and life span of the cypress darter, *Etheostoma proeliare*. Although this species is common in the Ouachita River watershed, it is usually collected in small numbers. As in the crystal darter study, data were pooled by month across years to develop sufficient samples for analysis of annual trends. The objective of the third study was to design an IBI to assess impacts of timber management on relatively undisturbed headwater streams of the Ouachita Mountains. Historical fish collections from the region were used as reference data sets for constructing the IBI. Museum specimens provided a supplementary data set that was not otherwise available because of logistical limitations.

ECOLOGICAL AND TAXONOMIC APPROACHES TO RECOGNIZING THE DIVERSITY OF FISH ASSEMBLAGES IN VIRGINIA

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The majority of biological conservation focuses on imperiled populations or species. This strategy is not effective at protecting aquatic populations or biodiversity in general, which encompasses a wide range of organizational levels (e.g., genes, species, landscapes). Conservation can become more effective by expanding its focus to include preventive measures and large-scale ecological elements (i.e., assemblages). Species-specific approaches should be complemented by protection of assemblages, including guilds, communities, and landscapes. Before policy to protect assemblages can be established, ecologists must develop an objective framework for taking stock of the variability in assemblage composition and organization. Such a framework (or assemblage classification) is likely to be based on taxonomic and/or ecological attributes of the biota. We used fish collections from Virginia to assess the comparability of assemblage classifications based on taxonomic versus ecological and life-history attributes of component species. Classifications were developed through multi-variate clustering and ordination procedures. Drainage basin, physiography, and stream size distinguished assemblage "types" at coarse levels in hierarchies developed from both classification approaches. Assemblage types recognized at finer levels were inconsistent between approaches, and reflected patterns of endemism and human impacts (e.g., dams). Taxonomic and ecological information are complementary; both should be incorporated into assemblage classifications.

TEXAS FRESHWATER FISH ASSEMBLAGES FOLLOWING THREE DECADES OF ENVIRONMENTAL CHANGE

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In 1953, C. Hubbs and colleagues surveyed fishes from a large number of freshwater habitats throughout the state of Texas. Thirty-three years later, he replicated sampling at 129 sites within the Red, Sabine, Neches, Trinity, Brazos, Colorado, Guadalupe, San Antonio, Nueces, and Rio Grande drainages. Great care was taken to reproduce fishing effort, sampling times, and dates at each location. Relative proportional abundances of families showed numerous changes from 1953 to 1986 within the ten basins. Mantel tests comparing family abundances in early (1953) and recent (1986) datasets showed little overall change statewide. Sites in the eastern half of the state that excluded marine species showed less significant positive covariation between early and recent datasets than those in the western Texas. Rank plots of species diversity (H') for the two regions of the state showed a consistent trend of decreased diversity over time in eastern Texas. The analyses reveal reductions in diversity on a local scale but also reveal relative stability in the statewide and regional ichthyofaunas. Despite the encouraging large-scale trends, several Texas fishes have gone extinct and others are threatened as a result of disturbances, including alteration of instream flow, eutrophication, and exotic species introductions.

STREAM FISH ASSEMBLAGES IN ARKANSAS UPLANDS: QUANTIFYING VARIANCE IN SPACE AND TIME BY USE OF HISTORICAL COLLECTIONS

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Ichthyological collections made by the authors and others provide a robust data base of information on fish distributions and abundances at sites on streams throughout the Ozark and Ouachita mountains of Arkansas. Collections over time at multiple sites in Piney Creek, Izard County, indicate the magnitude of differences in fish assemblages within one well-studied watershed over space (12 locations), time (20+ years), and disturbances (100-year flood). Geographically broad collections throughout the uplands are used to identify centers of local diversity, to relate local diversity to regional diversity, and to suggest use of "hot spots" of biodiversity as a core for conservation of non-game fishes in the state.

CORRELATES OF DEMISE: CASE OF THE SOUTHERN APPALACHIA FISH FAUNA

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The southeastern United States has the greatest species richness of temperate freshwater fishes in North America, with about 61% of the estimated 800 continental species north of Mexico. Encompassing 70% of the southeastern fish fauna, the southern Appalachian highlands represents the center of this diversity. Serious environmental threats have lead to decline and imperilment of approximately 23% of the species within the region. Generalized patterns of faunal decline correspond to common, widespread forms of habitat degradation, but the ecological correlates of imperilment have not been adequately determined. We analyzed patterns of imperilment using 45 variables representing nine general distributional, habitat, and life history criteria: range size; habitat size; vertical orientation; trophic guilds; longevity; maximum body size; spawning guilds; spawning substrates; and reproductive output. Variables for each taxon were scored using published information, museum records, and unpublished data. The most significant correlates of imperilment were range size, body size, and benthic habitat association; the most jeopardized species were those with relict or endemic distributions, small body size (< 150 mm TL), and/or a strongly benthic spawning orientation. Refined analyses of ecological parameters combined with spatiotemporal data provide improved understanding of imperilment trends and will facilitate greater proactive management of the native southern Appalachian fish fauna.

NAVIGATION-RELATED CHANGES IN THE ALABAMA RIVER FISH COMMUNITY OVER A 20-YEAR INTERVAL

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In 1967, Royal D. Suttkus and the late Gerald E. Gunning initiated a survey to monitor the effects of effluents from a pulp and paper mill on the Alabama River fish community. Suttkus is continuing the survey to this day. Work on the second of two navigation "locks and dams" on the Alabama River was completed in 1970, impounding all but two of the survey sites and creating a narrow, 62-mile reservoir (Claiborne Lake). Completion of the dams resulted in a significant increase in daily flow variability within the impoundment as compared to the unimpounded river. Extensive dredging during construction and afterwards for channel maintenance is believed to have contributed to the heavy sediment accumulations that are now evident along the shore. All specimens and data from the Alabama River fishes survey are archived in the fish collection at the Tulane University Museum of Natural History, providing a unique opportunity to examine fish community changes in relation to navigation. The present study involves data from semiannual (winter and summer) collections made at 15 sites over the period 1968 to 1985. Collections were pooled in six, -yr blocks. Regression analysis was used to establish trends (increase or decrease) in species occurrence and sample-time-adjusted abundance across time blocks at individual collection sites. Binomial tests were used to assess overall trends in abundance across sites. Species abundance were adjusted for total sampling time within blocks. We hypothesized that: a) species richness would decline post-impoundment reflecting the change from lotic to more lentic habitat; b) diadromous and euryhaline species would decline in impounded portions of the river; and c) species classified in the literature as silt-intolerant or preferring gravel as spawning substrate would decline due to dredging activity. Richness declined at non-tributary sites, but showed little change at tributary sites, suggesting a refugium effect. Examined over all sites, richness decreased from 85 species in 1968 to 60 species in 1994. The strongest decline in average richness involved percids. Most diadromous/euryhaline species declined at impounded sites and showed little change at unimpounded sites; needlefish, however, tended to increase. Species classified as silt-intolerant or gravel spawners (e.g. speckled chub, crystal darter) declined over most sites, but persisted at sites midway between the dams, where the river most resembled preimpoundment conditions. Significant declines also were noted for silver chub, weed shiner, and moxostomine suckers. Species such as the silverband shiner, emerald shiner, weed shiner, and silvery minnow increased in abundance across sites. The results suggest that modification of streams for navigation-an activity that now effects virtually every major stream course in United States-can have dramatic consequences for fish community composition and structure. Museum collections such as the Tulane Fish Collection contain valuable historical (pre-navigation) data for assessing these impacts.

FISH COMMUNITY STRUCTURE AND LAND-USE IN AN ALABAMA WATERSHED (CHATTAHOOCHEE RIVER SYSTEM): METHODOLOGY AND RESULTS FROM HALAWAKEE CREEK

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We analyzed historical and present-day effects of land-use on fish community composition and present-day effects of land-use on in-stream habitat heterogeneity and sediment loading in the Halawakee Creek watershed, Alabama. Historical fish collection data (museum records) were arranged in five-year time intervals from 1966-1995 to represent historical trends in ichthyofaunal diversity and community structure. In 1995, 12 historical sampling localities were revisited by the first author to supplement the historical fish data and to measure sediment loading and in-stream habitat heterogeneity. At each locality, a 100-meter reach of stream was sampled; fish were captured by seine and back-pack

electroshocker. Historical and present-day land-use patterns (hardwood/pine forest, agriculture/pasture, pine monoculture, cleared pine, selective cut, and urban) were interpreted from aerial photographs and digitized into a Geographic Information System (GIS). Fish collection data, habitat data, and land-use information were incorporated into a GIS database for analysis. GIS technology was used to determine areas of coverage above each sample locality for each land-use category and to model fish species distributions along gradients of forest cover and stream size.

Stream size was an important predictor of fish species richness and fish community structure. Controlling for stream size, there was a significant decrease ($p<0.05$) in species richness (adjusted for sample size) with an increase in agriculture/pasture cover. Relative abundances of *Ericymba buccata*, the silverjaw minnow, and *Luxilus zonistius*, the bandfin shiner, were lower in tributaries draining deforested areas. Ordination analysis of sample sites based on fish species representation (all species $>1.0\%$ relative abundance) suggested that land cover (agriculture/pasture) is an important predictor of fish community structure.

Local habitat conditions (substrate complexity and structure availability) were lower in streams draining deforested watersheds. There was a significant positive relationship ($p<0.05$) between the percent of stream bottom covered in sediment and percent of the watershed in agriculture/pasture. Streams prone to high rates of sedimentation were of uniform depth and substrate.

There was no significant difference ($p>0.05$) in percent forest cover within the Halawakee Creek watershed between 1966 and 1995. Overall species richness and fish community structure in Halawakee Creek have not changed significantly over time. However, populations of *Notropis hypsilepis*, the highscale shiner, and *Notropis texanus*, the weed shiner, have undergone dramatic declines since 1966. The decline of these two cyprinids may be due to the increase in populations of *Notropis baileyi* following the introduction of this species to Halawakee Creek in 1960.

Our results suggest that watershed land-use practices affect species distributions and community structure within a watershed via alteration of in-stream habitat characteristics. Additional work by the authors on five neighboring watersheds will aid in the interpretation of results found for Halawakee Creek.

USE OF HISTORIC FRESHWATER MUSSEL DATA IN THE MANAGEMENT OF AQUATIC RESOURCES OF THE APALACHICOLA RIVER BASIN

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North America, north of Mexico, harbors the greatest freshwater mussel biodiversity in the world, and the southeastern United States has more freshwater mussel species than any other region of the country. However, results of a recent National Biological Service (NBS) freshwater mussel survey of a large drainage basin in the southeastern U.S. suggest a very imperiled fauna. Unfortunately, little is known about the biology and ecology of freshwater mussels. Even less is known about how landscape changes affect them. Because of this tremendous need for landscape-scale information, we conducted computer-based spatial analyses (using ARC/INFO GIS) of the data collected during the NBS freshwater mussel survey of the Apalachicola-Chattahoochee-Flint (ACF) basin. These data include more than 9,000 records from collections made from 1991-1993 and more than 2,000 historic records obtained from museum collections, literature records, and technical reports. Our goals were to: (1) illustrate the present and historic distribution of freshwater mussels in the ACF basin; (2) illuminate basin-wide mussel population trends; and (3) identify anthropogenic and natural factors that have impacted mussel populations and distribution. The resultant spatio-temporal databases and maps will help ACF aquatic resource managers proactively manage the basin's resources to protect its fauna.

TRACKING INTRODUCED FISHES IN THE SOUTHEASTERN UNITED STATES

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Since 1978, the Southeastern Biological Science Center (SBSC), National Biological Service, Gainesville, Florida, has monitored the status and distribution of nonindigenous fish species in open waters of the U.S. The SBSC database now contains over 12,000 records representing over 400 nonindigenous fish species. The SBSC database documents authorized and unauthorized introductions of over 160 nonindigenous fish species into inland waters of Alabama, Florida, Georgia, and South Carolina. Of these, at least 30 foreign fish species and more than 30 transplanted species have established, reproducing populations. Continued maintenance of the database is extremely important because of the dynamics associated with introduced fish populations and the potential impacts certain introduced species may have on native aquatic species and ecosystems. Many problem fishes introduced into U.S. waters transcend political or state boundaries. A national database contains information that is vital in providing policy-makers and resource managers a more comprehensive and factual view of introduced fishes. Because any database is only as good as the information that goes into it, we continue review of older records of introductions to verify past identifications and associated information. As part of this process, we are contacting U.S. museums to document previously unreported records and to determine if historical records are supported by voucher specimens.

REGIONAL SFC REPORTS

REGION I - Northeast

It should come as no surprise that Bob Jenkins at Roanoke College is consumed once again by redhorses. His systematic studies of all species of *Moxostoma* and several of *Scartomyzon* progressed amply in 1995, from much field, museum, and home-lab studies. Earliest manuscripts are likely in late fall 1996. *Moxostoma* n. sp., thinlip redhorse (tentative name), sister species of *M. erythrurum*, is now known from nine specimens from the Pee Dee drainage (mid to upper Coastal Plain), and in the Cape Fear drainage, in the upper Cape Fear river and lower Deep and Haw rivers. It is rare in the Pee Dee, maybe less so in the Cape Fear; however, sampling is planned in 1996. Range of sicklefin redhorse, *Moxostoma* sp., is now known as middle Hiwassee and Little Tennessee systems; five counties in NC, one in GA. This species is known from small streams to medium rivers, and was taken in Hiwassee and Fontana reservoirs near the dam of each. Beyond the middle Oconee River population of robust redhorse, *M. robustum*, searches in 1995 failed to find it in the Pee Dee and Yadkin rivers or the Little River of the Pee Dee system. Further sleuthing of the itinerary of E.D. Cope during 1869 in NC, from which he described *M. robustum*, located the house (being restored) from which Cope sampled the Yadkin. Three weeks later, Hank Bart, Joe Buckley, Bud Freeman, Lee Hartle, and Jenkins boat-electrofished Cope's Yadkin site, and in a boating accident, Lee was almost lost to the river. They figured the ghost of Cope caused this. Among zooarchaeological material at Wake Forest University, Jenkins identified bones of *M. robustum* from two sites, one in the Yadkin River well above Cope's type locality, the other from Hunting Creek, a tributary of the South Yadkin River. Possibly the latter bones are remains of fish brought to the Hunting Creek Indian village after capture in the Yadkin or South Yadkin rivers. Striped jumprock, *Scartomyzon rupiscartes*, shows apparently rapid dispersal after introduction in the upper Yadkin system. Menhinick (1991) plotted valid records for the upper South Yadkin River, the fish taken in mid-1970s. Far above the South Yadkin, striped jumprock were found in the uppermost Yadkin River in 1988, and much downstream, at the head of the Great Bend of the Yadkin River in 1995. Perhaps two introductions occurred in the Yadkin River and South Yadkin River.

Mike Pinder at Virginia Department of Game and Inland Fisheries conducted surveys for *Phoxinus tennesseensis* by reexamining documented sites for *P. oreas* in western VA. He found one new population and two highly probables (fish not in color). This raises its known occurrence from two streams to five. He plans on conducting a habitat inventory in 1996. Mike re-surveyed *Etheostoma acuticeps* in the South Fork Holston River. It is still present. Funding has been obtained to do a life history study of *E. osburni*. The Forest Service conducted a basin wide survey of Big Stony Creek to quantify habitat and numbers for the candy darter. Mike plans on revisiting all known sites of *E. osburni* and doing basin-wide habitat inventories in 1996. Stream restoration work was done in *Percina rex* streams.

The North Carolina Museum of Natural Sciences finally has a Curator of Fishes. Welcome back south, Wayne Starnes. Wayne has his work cut out for him since the Museum still hasn't published the endangered and threatened freshwater fishes report. It is already dated since many of the accounts were written 10 years ago.

Peter Ruhl, USGS NAWQA Program in NC, has been conducting stream surveys in the Albemarle-Pamlico drainage in eastern NC the past several years. Fish community data are being analyzed to explore relations among fish community structure and land use, habitat, and water chemistry.

Mary Moser at the University of North Carolina at Wilmington is surveying NC coastal rivers for additional populations of shortnose sturgeon. She and Fritz Rohde (FCR) of the NC Division of Marine Fisheries are sampling fish populations of the Waccamaw River drainage in a gear comparison study. They collected (as did Wildlife Resources Commission biologists) the first state records of *Labidesthes sicculus*.

Rudy Arndt of the Richard Stockton College of New Jersey and FCR are continuing their study of South Carolina's freshwater fishes. Last year, a "brook lamprey" ammocoetes was collected in north-central SC. Upon examination, it turned out to be *Petromyzon marinus*.

Tom Abrahamsen of the USGS NAWQA Program in SC will be surveying (with assistance from FCR) streams in the Santee drainage in the fall of 1996.

John Dean of the University of South Carolina will be surveying fishes in Francis Marion National Forest in 1996. Joe Quattro of the same university has been studying the mtDNA of *Noturus*.

F. Rohde

REGION II - Southeast

Conservation and Research Activities

South Carolina—Gary Meffe, Savannah River Ecology Laboratory, has just completed a book manuscript for the Department of Defense entitled "Conserving Biodiversity on Military Lands." As difficult as it is to imagine the DOD being "green," in the past five years the DOD (in cooperation with the Nature Conservancy, Department of Interior agencies, and academia), has demonstrated a serious commitment to inventory, monitoring, and conservation of biodiversity on military reservations. With a few exceptions, however, much of the emphasis has been on terrestrial components of ecosystems. Gary also noted that he has been teaching ecosystem management courses to U.S. Fish and Wildlife personnel.

Georgia—Steve Vives, Georgia Southern University, is one of the relatively few researchers to receive funding to work on fishes on a military reservation. He is completing a fish survey of Fort Stewart Military Reservation in southeastern Georgia. Fort Stewart is located on the Coastal Plain in the Ogeechee River drainage. To date, Steve and his students have recorded 55 fish species but has been unable to discover any populations of the illusive and patchily-distributed *Enneacanthus chaetodon.*

The eclectic robust redhorse research group (Jimmy Evans and Les Ager from Georgia DNR, Bud Freeman and Cecil Jennings plus students from University of Georgia, and Bob Jenkins from Roanoke College) had a successful year in 1995 observing the reproductive behavior and habitat of this great river beast, and were again able to successfully strip adults and rear young for reintroduction into formerly occupied rivers. The artificial propagation efforts again will be repeated in May 1996. Papers on the robust redhorse dominated the first day of meetings of the Georgia Chapter of the American Fisheries Society, surely a first for anything ending in "ucker" to beat out anything ending in "ass" or "out." The discovery of the robust redhorse has lifted Bob Jenkins to a new level of sucker euphoria, not seen since those halcyon days at Cornell. Bud Freeman is collaborating with Bob on much of the sucker research and now Bud imagines to identify small *Moxostoma* in the field.

Mary Freeman, recently transferred to a National Biological Service lab at the University of Georgia, is hoping to garner that illusive block of time needed to finish the description of the Halloween darter, an Apalachicola endemic cryptic to *Percina nigrofaciata*. Mary and Bud have discovered yet another *nigrofaciata*-look-alike in the upper Chattahoochee River system. Mary has a manuscript in press with a former masters student, Lane Hill, an Auburn graduate, on the life history of the Halloween darter. For the past four years, Mary and Ph.D. student Zachary Bowen, have been studying fish communities in the regulated reaches of the Tallapoosa River and in the unregulated river above Harris Dam. One of the most interesting preliminary results is that sustained periods of low flow appear to be very important for recruitment of certain species. If this tentative observation bears out, it has portentous implications for management of regulated river reaches.

A citizens environmental group, the Coosa River Basin Initiative, based in Rome, Georgia, was instrumental in temporarily blocking an interbasin transfer of treated sewage water from the upper Chattahoochee River to the upper Etowah River. The Etowah River has been selected by the national conservation group American Rivers, Inc. as one of the ten most endangered rivers in the United States. Perhaps this dubious notoriety will assist in attracting much needed funding for conservation research on the Etowah River.

Florida—Carter Gilbert, University of Florida, swears that he and Jim Williams, Southeastern Biological Science Center, Gainesville, are making progress on the fishes of Florida book. Carter also swears that his keep-you-riveted-to-your-chair type catalog manuscript is 95% complete. Realizing the golden years are now enfolding him, Carter has opted to form partnerships with "stakeholders" (a new word in federal lexicon) and has asked Rick Mayden, University of Alabama, to coauthor the descriptions of the *Macrhybopsis aestivalis* species group.

It has been a difficult year for the folks at the Southeastern Biological Science Center (SBSC), National Biological Service, and soon to become part of the U.S. Geological Survey. Despite timely layoffs (like Christmas) or the abrupt closing of programs and loss of personnel (e.g., cancellation of Steve Walsh's Global Climate Change program), nonessential research by nonessential personnel has continued at a steady pace. Steve has a manuscript in press, with Dennis Haney and Cindy Timmerman, entitled "Variation in thermal tolerance and routine metabolism among spring and stream-inhabiting freshwater sculpins (Teleostei: Cottidae) of the southeastern United States." Jim Williams swears that he and George Burgess, University of Florida, are going to finish the description of the shoal bass before the ASIH meetings in New Orleans. (I think bald guys swear too much). Leo Nico and Rob Robins of the Nonindigenous Species Section (SBSC), along with Jim Williams, are conducting a survey of the aquatic fauna of Avon Park, an Air Force bombing range in south central Florida. Jim, Leo, plus Pam Fuller and Charles Boydston, have labored on a large manuscript on the nonindigenous fishes of the United States; it may be out by early fall 1996. Leo and Steve have a manuscript in *Florida Scientist* on a record of a new population of the catfish *Hoplosternum littorale* (Callichthyidae) from Florida. Noel Burkhead, Steve Walsh, and Bob Dorazio (the biometrician who will tell us what it all means) have finally completed the matrix for an analyses of patterns of imperilment of southern Appalachian Fishes. Noel, Steve, and Bud Freeman are continuing to collect data on putative new forms of the *Etheostoma brevirostrum* species group. Howard Jelks recently completed a revised draft of the new recovery plan for *Etheostoma okaloosae*, a species that the Fish and Wildlife Service may push to have delisted.

Bruce Bauer, Dames & Moore, Inc. of Orlando, with Dave Etnier, University of Tennessee, and Noel Burkhead just published the description of *Etheostoma scotti*, a new snubnose darter from north Georgia. With the Presidential moratorium still in effect, *Etheostoma scotti* and *Etheostoma (Nothonotus) etowahae* were the last vertebrates to be placed on the federal endangered species list (as Threatened and Endangered, respectively); both are endemic to the Etowah River system. Incidently, Bruce successfully underwent triple bypass surgery in March 1996 and I am sure the membership of SFC wishes him a full and speedy recovery.

Both Buck Snelson, University of Central Florida, and Walt Courtenay, Florida Atlantic University, both report they are presently inactive in freshwater, overworked, and must get all their research thrills vicariously from students.

Noel Burkhead

REGION III - North-Central

New Recovery plans and other important publications

The proceedings of the 1994 symposium hosted by the Tennessee Aquarium, "Aquatic fauna in peril--the southeastern perspective," is soon to be published. Also, Chris Coco, Associate Curator of Fishes, recently circulated a draft recovery plan for Lake Sturgeon, *Acipenser fulvescens*, in the Clinch River. This is a cooperative effort with several state and federal agencies and universities. These include the Tennessee Wildlife Resources Agency, U.S. Fish & Wildlife Service, Tennessee Valley Authority, the U.S. Geological Survey, the University of Georgia, and Kentucky State University.

TWRA will soon publish a revision of "Tennessee's Rare Vertebrates," that was originally published in 1983. Peggy Shute, Dave Etnier, Charlie Saylor and Rick Bivens are updating the fish section.

Recovery plans that are available since our last SFC regional report include: final pygmy madtom, *Noturus stanauli*, plan; technical draft for palezone shiner, *Notropis albizonatus*; and technical draft for bluemask darter, *Etheostoma* (*Doration*) sp. All of these are available from the Asheville, NC U.S. Fish & Wildlife Service (FWS) office.

Status surveys and other interesting finds

Although there is currently a moratorium on listing of Endangered and Threatened species under the federal Endangered Species Act, several status surveys have been completed, or are ongoing. These projects are funded by the Asheville, NC and Jackson, MS Field Offices of the FWS, as secured by the Tennessee Wildlife Resources Agency and Alabama Department of Game & Fish, and are described below. Pat Ceas and Larry Page (INHS) produced a final report on the status of three Tennessee River drainage endemics: the crown darter, *Etheostoma corona*; lollipop darter, *E. neopterum*; and egg-mimic darter, *E. pseudovulatum*. They did not make specific recommendations about possible federal listing of any of these species. However, they concluded that because all three species inhabit relatively small streams that are easily impacted, and because the ranges are small, they are all in danger of population extirpations or extinction. They reported only 13 breeding sites for *E. neopterum* and commented that if the populations in the Shoal Creek system were to become extirpated, the species is likely to become extinct. *Etheostoma corona* was considered relatively common throughout its small range (Lauderdale Co., AL and Wayne Co., TN), and in no immediate danger of extinction. New localities were documented for *E. pseudovulatum* in two new stream systems within the Duck River system. However, despite these new populations, several populations were considered tenuous, and Ceas and Page considered the conservation status of *E. pseudovulatum* to be intermediate between *E. neopterum* and *E. corona*.

Lesa Madison (Tennessee Cooperative Fishery Research Unit, Tennessee Technological University) published the results of her status survey for the Barrens darter, *E. forbesi*. She reported the species from eight streams in the upper Caney Fork River system, and described its continued existence as threatened by various activities, mostly agricultural, on the Barrens Plateau.

Chris Skelton (UTK student) is currently investigating the taxonomic and distributional status of the undescribed *Phoxinus*, recently known as "laurel dace". The "laurel dace" is currently known from three Tennessee River tributaries on the Walden Ridge portion of the Cumberland Plateau, in Bledsoe County, TN.

Pat Rakes is continuing his status survey of Barrens topminnow, *Fundulus julisia*. In 1995, *F. julisia* was initially observed at eight localities. Rakes also reported two new distribution records for the species: a North Prong Barren Fork tributary (Miller Branch, Warren Co., TN); and a Collins River tributary (Charles Creek, Warren Co., TN). On subsequent visits to two of these eight localities in 1995, no *F. julisia* were observed, however. Rakes reported the abundance of all previously known populations was greatly reduced over that estimated in the early 1980s, that all populations are vulnerable to extirpation, and that the survival of the species is tenuous. During 1996, this survey will continue; in addition to FWS funding, the project has been supplemented through a contract secured from Arnold Engineering and Development Center (AEDC) by the Tennessee Field Office of The Nature Conservancy. As a result of this funding, captive populations on AEDC property, additional to those currently maintained by Rakes at Conservation Fisheries Inc. (CFI) facilities, may be arranged.

During 1995, J. R. Shute and Pat Rakes (CFI) continued work begun by Brooks Burr (SIUC) to determine the status of the undescribed "chucky madtom". The "chucky madtom" is currently known only from Little Chucky Creek, Nolichucky River system of the Tennessee River drainage (Greene, Co., TN). Preliminary genetic analyses by Brooks Burr and Jim Grady indicate that the "chucky madtom" is a distinct species. However, its taxonomic relationship to topotypic *Noturus elegans* and other *N. elegans*-like specimens from elsewhere in the Ohio River basin remains unclear; this is unlikely to be resolved soon, because of the inability to secure additional specimens from most of these areas. The Dunn Creek (Sevier Co., TN) locality in the Pigeon River system that may have historically produced specimens of this taxon was surveyed by CFI. Taylor listed these earlier specimens as *N. elegans*. Several other streams in the Nolichucky River system were also surveyed. During the 1995 surveys, no "chucky madtoms" were observed at any localities, including Little Chucky Creek. Burr and Grady are continuing the taxonomic work, and CFI will continue field surveys in 1996.

Rick Mayden, Bernie Kuhajda, and students at UAIC are concluding a three-year status survey of Tuscumbia darter, *Etheostoma tuscumbia*. In addition to estimating abundance at the various spring and spring-run populations and surveying for additional populations, student Jessica Boyce is comparing behaviors of the various populations. E.B. Jones (UAIC student) is also currently analyzing and comparing the genetic

composition of the various populations.

Kuhajda and Mayden are continuing a status survey for the Alabama cavefish, *Speoplatyrhinus poulsoni*. Their objectives are to determine methodology to estimate population size and trends and to document the range of the species within the cave system. As reported previously, they continue to observe what is believed to be a single specimen of the southern cavefish, *Typhlichthyes subterraneous* at the same locality in Key Cave. They reported that numbers of *S. poulsoni* observed 1992-1995 were comparable to those observed during earlier FWS surveys, indicating a relatively stable population size. During the initial survey to discover additional populations of *S. poulsoni*, caves that contained *T. subterraneous* were not considered likely to contain populations of *S. poulsoni*, and were not thoroughly surveyed. They plan to more thoroughly survey other nearby caves for *S. poulsoni*.

A survey, funded by the National Park Service (NPS), for duskytail darters, *Etheostoma percnurum*, in the Big South Fork system of the Cumberland River has substantially extended the range of this species. Previously, specimens only existed from the Big South Fork at the mouth of Station Camp Creek (Scott Co., TN). Individuals from CFI, SIUC, Kentucky Division of Game & Fish and NPS surveyed 14 localities over nearly 22 river km by seine and snorkel. As a result, *E. percnurum* is currently known to occur in appropriate habitat between the mouth of Station Camp Creek as far downstream as the mouth of Bear Creek (McCreary Co., KY). This is the first record of the species in Kentucky. At most sites where they occurred, they were moderately abundant, and abundances indices (calculated from fish observed per unit effort) compare with those observed in the Citico Creek (Monroe, Co., TN) population. No additional specimens of the unusual *E.* (*Catonotus*) sp. previously reported from the Big South Fork were observed during this survey. This survey is continuing in 1996.

We report another interesting finding as result of 1995 CFI Big South Fork snorkel surveys. Ashy darters, *Etheostoma cinereum*, were abundant at several localities in the New River, tributary of the Big South Fork. *Etheostoma cinereum* is known historically and currently from several localities along the main channel of the Big South Fork. Although the localities surveyed by CFI were previously sampled (Comiskey and Etnier, O'Bara, etc.), *E. cinereum* was not documented there. At the time of the earlier surveys, aquatic habitats in the New River were described as significantly degraded as a result of coal mining. Considering these earlier assessments, our qualitative observations indicate that benthic habitats in the New River have considerably improved, perhaps as a result of mine reclamation. Brian Evans, a UTK student is planning to resurvey the fishes of this system. This will take place in conjunction with John T. (Bo) Baxter's survey of the fishes of the upper Cumberland System.

Rex Strange and Brooks Burr (SIUC) produced a final report on genetic variability and metapopulation dynamics for the blackside dace, *Phoxinus cumberlandensis*. They described some variation between metapopulations and made recommendations about possible future reintroductions for conserving the species. A major consideration reported by Strange and Burr was the importance of dispersal corridors to the long-term maintenance of the species.

The SATURN Corporation has provided funding for a life history survey of the redband darter, *Etheostoma luteovinctum*, listed by TWRA as "Deemed in Need of Management." Redband darters occur in two streams on the SATURN property, and its numbers have been monitored by SATURN since they broke ground for their factory in 1986. This study is being conducted by Chris Paxton, UTK student, under the supervision of Dave Etnier.

Champion International's efforts to improve water quality in the Pigeon River are apparently showing some success. Greg Seegert, Ecological Analysts, collected *Etheostoma gutselli* at several localities in the Pigeon in North Carolina and Tennessee below their notorious mill in Canto, NC. According to Greg, they were syntopic with *E. blennioides newmani*. We have not seen the specimens yet.

Etnier's regional faunas class revisited the Bear Creek site in west Tennessee that represents the only TN locality for *Notropis dorsalis*. It continues to be present there--along with numerous y-o-y *Ctenopharyngodon* and *Hypophthalmichthys*.

Negative data from 1995 field surveys: no pygmy madtoms, *Noturus stanauli*, were observed or collected in the Clinch or Duck rivers; no slender chubs, *Erimystax cahni*, were collected, despite the efforts of Etnier's ichthyology classes, TVA River Action Team (RAT) crews, and others.

Captive propagation and reintroduction

Boulder darters, *E. wapiti*, were successfully spawned and reared in CFI aquaria, using techniques developed using bloodfin darters, *E. sanguifluum*, as surrogates. A single pair spawned three times in captivity, producing 8-10 viable eggs and five hardy offspring; a pair of adults is currently being maintained at CFI. In addition to the adults currently at CFI we will attempt to collect a few more adults in 1996, and hope to produce more offspring. These may eventually be used to bolster the Elk River populations, or to reintroduce the species into Shoal Creek (Lawrence Co., TN and Lauderdale Co., AL). Upgraded waste-water treatment facilities have improved water quality in Shoal Creek. As part of an "ecosystem management" project, Jim Layzer (NBS Cooperative Fisheries Unit at Tennessee Technological University) has a student surveying habitat stability and the fish community currently present in Shoal Creek. In addition, Layzer and other students are investigating the stability of substrate in the stream, and have reintroduced some common mussel species. If the results of these surveys are favorable, the reintroduction of *E. wapiti*, *Cyprinella monacha*, and several species of endangered mussels may be attempted.

As previously reported, smoky and yellowfin madtoms, *Noturus baileyi* and *N. flavipinnis*, and duskytail darters, *E. percnurum*, (Citico Creek parental stock) were again successfully captively propagated. To date, a cumulative total of nearly 1000 *N. bailey*, 500 *N. flavipinnis*, and 250 *E. percnurum*have been reintroduced into Abrams Creek in the

Great Smoky Mountains National Park, (Blount County, TN). More than 2500 spotfin chubs, *Cyprinella monacha*, have also been reintroduced into Abrams Creek.

Individuals of all four reintroduced species (*N. baileyi*, *N. flavipinnis*, *E. percnurum*, and *C. monacha*) were observed in Abrams Creek during the 1995 field season. Reproduction was documented for *E. percnurum* and *N. flavipinnis* and inferred for *N. baileyi*.

Two-year-old captively spawned blackside dace, *Phoxinus cumberlandensis*, spawned in CFI aquaria. Offspring reared from this effort will be maintained as a captive population; no reintroductions are planned for this species at present. Although the No Business Branch locality (Campbell Co., TN) where *P. cumberlandensis* had been translocated in 1993 has been surveyed several times since 1993, no *P. cumberlandensis* have been seen there. Ron Cicerello and Ellis Laudermilk (Kentucky State Nature Preserves Commission) and Rick Bivens (Tennessee Wildlife Resources Commission) have recently resurveyed historical and new localities for *P. cumberlandensis*. The status of the species is apparently stable at present, and several new populations have been discovered. As described above, Rex Strange and Brooks Burr (SIUC) have made recommendations for conserving these populations.

The Tennessee Aquarium has become more involved in cooperative efforts for conserving regional biodiversity. In cooperation with CFI, they may become involved in captive propagation and reintroduction projects by rearing *C. monacha* produced by CFI to stocking size. The number of individuals that can be produced in the current CFI facility is limited. TWRA permits allowing the Aquarium to hold this state and federally listed species are currently pending.

Local and regional watershed activities

The USGS has designated the upper Tennessee River (from southwestern Virginia downstream to about the Chattanooga, TN area) as one of their National Water Quality Assessment (NAWQUA) areas. As a result, Steve Ahlstedt is in the process of producing a historical retrospective of the aquatic fauna of the streams of the area. They will also establish long-term sampling sites and conduct biological and water quality samples in this area.

The TVA RATs continue to collect biological, water quality, and other data on the streams within their area of interest. They are also working with organizations and individuals to protect sensitive resources. Much of their work involves working with landowners to improve agricultural practices that have resulted in degraded aquatic habitats. This coordination greatly improves our abilities to conserve and restore our rare aquatic resources. For example, the activities of the USGS, the Clinch/Powell RAT, the Tennessee Field office of The Nature Conservancy, and the recently formed Upper Tennessee River Protection Planning Committee has resulted in increased awareness of the local public to the importance of the resources of their area.

Other multi-agency cooperative projects in our region include the activities of the Upper Tennessee River Protection Planning Committee, Little Tennessee Watershed Association, and the Paint Rock River Initiative. The Upper Tennessee River Protection Planning Committee is composed of state and federal agency personnel and other organizations interested in conserving important aquatic habitats in the upper Tennessee River drainage in Virginia and Tennessee. Regular meetings keep all participants informed and involved in activities occurring in the area of concern. The Little Tennessee River Watershed Association is also supported by federal, state, and local agencies, but the membership is also largely composed of an enthusiastic grass-roots organization led by Bill McLarney. The Paint Rock River Initiative has a broader mission to "conserve and improve the quality of life and natural resources of the Paint Rock River through voluntary participation." This relatively new group is currently in the process of planning and prioritizing and acquiring funding for their activities.

The Tennessee office of The Nature Conservancy has established a local office in the Clinch River. Their work involves helping farmers to restore riparian vegetation, and fencing cattle or other livestock from streams; target areas for this work were chosen based on biological resources. In addition to the Clinch/Powell activities, the Tennessee and Georgia field offices of The Nature Conservancy are currently cooperating on a similar project in the upper Conasauga River watershed in Tennessee and Georgia.

Peggy W. Shute and David A. Etnier

REGION IV - South-Central

Jim Williams of the National Biological Survey in Gainesville, Florida continues to work on the description of *Percina* (*Alvordius*) sp. along with William Smith-Vaniz; it appears that this is a complex of several species. Jim is also describing, along with Rick Mayden at the University of Alabama, a new species of *Cottus* confined to the Tallapoosa River above the Fall Line in Alabama and Georgia.

Noel Burkhead, also at NBS in Gainesville, reports that the organization American Rivers has listed the Etowah River as one of the ten most imperiled rivers in the United States. This infamous rating was based largely on a manuscript by Noel, Steve Walsh, Jim Williams, and Bud Freeman, which outlines the severe pressure the Etowah is under. This habitat deterioration has resulted in over a dozen species of fishes and almost all of the mussel fauna becoming extirpated. The Etowah also contains more endemic endangered species than any other system in the U.S.

Mary Freeman of NBS is studying the effect of regulated flows on fish assemblages in the Tallapoosa River below Harris Dam. She is also nearing completion (this summer) of a broad scale measure of stream habitat quality, which will be used in the Tri-State Comprehensive Basin-Wide Management Plan. The NBS office at Auburn, Alabama was officially closed in February, and Mary will relocate to Athens, Georgia

in June.

Jan Hoover at the Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi reports that he and Jack Killgore are describing faunas and identifying physical variables associated with abundance and reproduction of individual species in the Yazoo and Big Sunflower rivers in Mississippi. They are also studying the biology of paddlefish in the Big Sunflower River along with Steven George, a student at Northeast Louisiana University. Sherry Harrel, a student at the University of Kansas, is studying fish foraging behavior in a tributary of Bayou Pierre, Mississippi. Additionally, Jan has just finished a study on paddlefish rostrum morphology, and is beginning a morphological study on shovelnose sturgeon to examine variation within a population in the Mississippi River.

Bob Cashner at University of New Orleans reports that graduate student Chris Schieble is working on life history aspects of *Ambloplites ariommus*, the shadow bass. Bob and another student, Jeff Stewart, are conducting a comprehensive survey of the Bogue Chitto River (Pearl River) in Mississippi and Louisiana. Past surveys by students at Northeast Louisiana University 10 and 20 years ago and by Bob on a single creek within the system (yearly, for 18 years) provides baseline data for examining changes in fish community structure. Lastly, Bob is examining the disappearance of *Cyprinella venusta*, the blacktail shiner, from Bayou LaCombe (Lake Pontchartrain), which was the predominant fish species in a early 1970's survey of the Bayou by a Tulane student. UNO surveys in 1989-90 and 1995-96 have not produced a single specimen.

Hank Bart at Tulane University is writing the final report on a status survey of *Percina aurora*, the pearl darter, in the Pascagoula River Drainage, funded by the Mississippi Museum of Natural Sciences. Sampling during 1995 at 19 historic and 11 new sites did not produce a single specimen. The last specimens taken in the drainage were by students at the University of Southern Mississippi in 1994. Hank and others believes that *P. aurora* is likely extirpated from the Pearl River, the only other drainage this species is known to occur within. Since most of the records from the Pascagoula are from the late 1980's and early 90's, it still likely survives, but is clearly very rare. Hank also plans status surveys of *Percina brevicauda*, the coal darter, and the undescribed rush darter, both in the Mobile Basin in Alabama. Along with his students, Hank is continuing to uncover new distributional records for eastern Gulf Slope fishes. The latest is *Etheostoma whipplei*, the redfin darter, in the Apalachicola River Drainage, which will be the subject of a future note in the SFC *PROCEEDINGS*.

Mark Peterson at the Gulf Coast Research Lab in Ocean Springs, Mississippi has recently started a status survey of *Cycleptus elongatus*, the blue sucker, in the Pearl and Pascagoula rivers in Mississippi. Mark is also starting to look at the use of marsh habitat by larval fishes and invertebrates in Biloxi Bay, and how the destruction of this habitat affects the success of these organisms. He has a paper ready to go on the distribution, habitat requirements, and reproduction of *Enneacanthus gloriosus*, the bluespotted sunfish, in Mississippi. Lastly Mark reports that Larry Nicholson has received funding from the U.S. Fish & Wildlife to study striped bass restoration in Gulf coast waters, which focuses on the performance of the Gulf versus the Atlantic race of stripers.

Stuart Poss at the museum at the Gulf Coast Lab, along with David Besancon and Meg O'Connell, are currently compiling a database to determine if endangered Gulf of Mexico fishes show a decline in numbers through museum records. If they do, then similar declines in other species suggests comparable imperilment. They are also amassing historic and present photos of Gulf coast habitats (including aerial photos) to assess habitat decline. Stuart is continuing to study scorpionfishes, and has been using three dimensional imagery to look at skull morphology.

Steve Ross at the University of Southern Mississippi reports that his book on inland fishes of Mississippi should be sent off to University Press of Mississippi this spring. He is also starting a distributional study of *Leptolucania ommata*, the pygmy killifish, in Mississippi. Todd Slack is completing his dissertation on floodplain-stream interactions in a small tributary of Black Creek, Pascagoula Drainage. Martin O'Connell is pursuing his dissertation research on use of floodplains by fishes, focusing on foraging benefits and predation risk. Lastly, Brett Albanese is studying the life history of *Pteronotropis signipinnis*, the flagfin shiner.

Carol Johnson at the U.S. Forest Service Hydrology Lab in Oxford, Mississippi reports that she and Charles Knight of the Mississippi Museum of Natural Science have completed their life history and behavioral ecology study of *Pteronotropis welaka*, the bluenose shiner. Carol is still working on sound production in stream fishes, especially *Cyprinella* and their hybrids. She is also looking at fish community structure in several incised streams. Mel Warren and Wendell Haag continue to examine mussel and fish community structure in the Bankhead National Forest in Alabama.

Malcolm Pierson of Alabama Power Company in Birmingham reports that he and Terri L. Ballard have a soon-to-be published paper on the fishes of the Little River Drainage. This study was Terri's master's research at Jacksonville State University in Alabama. Ed Tyberghein and colleagues are completing the final year of a three year biotelemetry study in the Coosa, Tallapoosa, and Alabama rivers on adult paddlefish. Weekly monitoring indicate that most paddlefish move upstream into the Tallapoosa River to spawn.

Randy Haddock of the Cahaba River Society in Birmingham is currently circulating among various agencies a draft of the Cahaba River Protection Plan, which was prepared along with The Nature Conservancy. This plan involves educating the public about the problems in the watershed, and presents possible solutions to these problems. An agreement with Jefferson County to implement watershed protection via creating greenways along the Cahaba and Black Warrior rivers may not happen due to lack of cooperation from the county. This may force the Society to go back to court and force the county into implementing these programs. Lastly, the Society is working with the Alabama Department of Environmental

Management and Region 4 of EPA on a Cahaba River Basin Management Plan, which would consolidate issuance of permits, thus allowing these agencies to assess non-point pollution in the Basin.

Scott Mettee and colleagues at the Geological Survey of Alabama in Tuscaloosa have completed status surveys on *Alosa alabamae*, the Alabama shad, and *Cyprinella callitaenia*, the bluestripe shiner, and are continuing studies on *Cycleptus elongatus*, the blue sucker, and *Noturus munitus*, the frecklebelly madtom, in the Mobile Basin, and on Tennessee River fishes. They are also starting a survey of mussels in the Tennessee, Alabama, and lower Tombigbee rivers, as well as a fairly large biological water study of the lower Cahaba River. Scott is hopeful that the state fish book for Alabama will be out near the end of this year.

Bob Stiles at Samford University in Birmingham has been studying the courting behaviors of male darters in the subgenera *Etheostoma* and *Ulocentra*. Bob also reports that while snorkeling in the Little Cahaba River at Bulldog Bend, he has seen many young *Percina aurolineata*, the goldline darter, more than in recent years. Mike Howell continues to study the masculinization of *Gambusia*, and is looking at variation (including chromosomes) in *Cyprinella venusta*, the blacktail shiner, from the Cahaba River.

Chuck Lydeard at the University of Alabama continues to study the molecular systematics and conservation genetics of freshwater mussels and snails in the southeast. Herb Boschung and Rick Mayden will soon be submitting to a publisher a manuscript on their state fish book for Alabama. Rick is continuing status studies of *Etheostoma ditrema*, the coldwater darter, *E. chermocki*, the vermilion darter, and *Speoplatyrhinus poulsoni*, the Alabama cavefish, as well as a study on the effects of malathion on an upper Tombigbee River tributary.

Frank Parauka at the U.S. Fish and Wildlife Service in Panama City, Florida reports that his office has just received fund for an outreach program - Watchable Wildlife. In a joint effort with state agencies and state chapters of the Wildlife Federation, signs will be erected at boat launches on rivers along the Gulf coast that harbor Gulf sturgeon, informing readers on basic life history traits. Frank also reports that the Gulf sturgeon recovery plan has been finalized, which was coordinated by Lorna Patrick. Additionally, a graduate student at North Carolina State, DeWayne Fox, has been working with the Service on capturing Gulf sturgeon in Choctawhatchee Bay and using telemetry to locate spawning beds. Once located, eggs will hopefully be found in the artificial spawning substrate, thus validating spawning sites.

Carl Couret at the Service's office in Daphne, Alabama reports the staff has completed a Biological Opinion on the proposed Bevill Reservoir in Fayette County, Alabama, which addresses the minimum flows and IBI monitoring necessary to protect two federally listed mussels in the North River. Another opinion is nearing completion on the effects of Alabama's water quality standards on federally listed aquatic species for EPA's southeast regional office; this precedent-setting effort will affect how EPA approves water quality standards in other southeastern states.

Ron Larson at the Service's office in Jackson, Mississippi is reviewing the status of southern walleye, which is now confined to five small populations in the Mobile Basin. He is also working with Jefferson County, Alabama in establishing a watershed management program for Turkey Creek, a tributary to Locust Fork of the Black Warrior River. Turkey Creek contains the federally endangered *Etheostoma nuchale*, the watercress darter, one of two know populations of the undescribed *Etheostoma* sp. c.f. *parvipinne*, the rush darter, and the only population of *Etheostoma chermocki*, the vermilion darter. Ron is also involved in modifying construction of weir dams in Bayou Pierre, Mississippi, which may adversely affect the threatened *Etheostoma rubrum*, the bayou darter.

Lastly, I would like to report on *Scaphirhynchus suttkusi*, the Alabama sturgeon, and the efforts to protect this vanishing species. As a reminder of past events, in December 1994 the U.S. Fish and Wildlife Service withdrew the listing of the Alabama sturgeon, citing that it was either extinct or too rare to protect, even though an individual was captured in the Alabama River below Claiborne Lock and Dam in December 1993. On 18 April 1995 a second Alabama sturgeon was caught by a fisherman on a weighted trotline, also below Claiborne. This fish was radio-tagged and followed by personnel from the Panama City FWS office, who also managed to capture a third sturgeon on 19 May 1995 in a gill net, again below Claiborne Lock and Dam. Shortly after these discoveries, Rick Mayden and I submitted our revised manuscript on the systematics, taxonomy, and conservation status of the Alabama sturgeon, which will be published in Copeia 1996(2).

Although these events would lead one to conclude that the FWS would reverse their decision, this has not happened due in part to a moratorium being placed on listing species. Furthermore, a House resolution eliminating any funding toward searching for additional Alabama sturgeon was passed by Congress as a rider to another unrelated bill. This past winter, the Corps of Engineers (Mobile District) has proposed a new lock and dam about 40 miles downstream from Claiborne, which would impound the area where these three sturgeon have recently been captured. And lastly, business coalitions in Alabama continue to strongly oppose the scientific validity of this species. Currently, the future looks rather bleak for this endangered species!

Bernie Kuhajda

REGION V - Northwest

Henry Robison and Bruce Thompson continue to work on the description of the longnose darter form in the Ouachita River system, Arkansas. Robison and Thompson hope to complete their description and submit a manuscript in 1996.

Henry Robison has completed his status survey and report on *Notropis ozarcanus* in the Arkansas portion of its range. Bill Pflieger has also completed a similar survey in Missouri.

Jim Johnson and students continue to work with *Amblyopsis rosae* in the Logan Cave system in northwest Arkansas. Two M.S. theses involving population dynamics and movement, and population dynamics and growth have been completed. A third thesis studying metabolic rates of both cave crayfish and the Ozark cavefish has just been started. The Northwest Arkansas Regional Airport is under construction. Clearing and grubbing of the airport site is underway, and a contract has been let for water and sewer lines. Johnson feels there is a strong possibility of adverse impacts to cave systems from petroleum and deicing components in runoff.

A Little Rock environmental consulting firm (Ford, Thornton, and Norton, Inc. = FTN, Inc.) is coordinating efforts of the Arkansas Mercury Task Force. Mercury advisories continue to be in effect for lakes and streams in portions of south and central Arkansas. Some Lower Ouachita River Work Group reports regarding: 1) water and sediment quality, 2) ambient toxicity screening, 3) surveys of fish communities, and 4) instream monitoring of sediment-associated impairment are now available in Executive Summary format.

Business interests and citizens groups continue to promote development of commercial shipping on the White River upstream to Newport, Arkansas. Currently the Corps of Engineers maintains a 100-ft wide, nine-foot deep navigation channel. Proponents of additional improvements are promoting a 200-ft wide navigation channel, which in some upstream would encompass almost the full channel width. Several public information sessions and promotional literature have been provided by the White River Valley Association and the Arkansas Waterways Commission to citizens in the proposed project area.

The Grand Prairie Pumped Storage project is being developed to remove White River water during high stages for storage and use in irrigation. Eastern Arkansas has experienced chronic groundwater level depletion over the last 20 years due to withdrawals for irrigation. This project is sought by the agricultural community, and EIS information is being developed by the Corps of Engineers. Fish community impact concerns voiced by the Arkansas Game and Fish Commission include: 1) withdrawals might reduce spring water levels to flooded bottomland hardwood spawning/feeding grounds; and 2) introduction of the zebra mussel, which occurs in the White River, to tributary streams which will receive runoff from fields irrigated with stored water.

The Arkansas Legislature passed Arkansas Pollution Control and Ecology Regulation 15 which prohibits instream gravel mining in 24 high quality Arkansas streams. These streams have been designated as extraordinary resource waters and include many of the Ozarks least disturbed water bodies. The Arkansas Game and Fish Commission and Arkansas Department of Pollution Control and Ecology are advocating inclusion of Crooked Creek, a long-time premier smallmouth bass stream, as an extraordinary resource water. Opposition from gravel miners and locals is intense, and a state Gravel Mining Task Force has been established to bring a recommendation to the Governor's Office.

John L. Harris

REGION VI - Southwest

H.W. Robison (Southern Arkansas University) is completing the computerization of the fishes of the Ouachita National Forest using 26 years of field notes and miscellaneous literature/museum records, funded by the Ouachita National Forest and the Oxford Research Lab. He is also starting a biodiversity study of 52 springs and seeps in the Ouachita Mountains, continuing a description of the longnose darter in the Ouachita River system and has just finished a book on the endemic animals and plants of Arkansas, called "Only In Arkansas," which can be purchased through the University of Arkansas Press at Fayetteville, AR or through HWR at P.O. Box 1354 SAU, Magnolia AR 71753. Jack Killgore (US Army Corps of Engineers, Waterways Experiment Station [WES]) has completed a study of velocity preferences and swimming performance of the cypress darter and along with graduate students Jim Morrow and Matt Chan, is monitoring Gulf sturgeon in the West Pearl River system, LA. Jan Hoover (WES) is analyzing data on fish-habitat relationships in the Cypress Bayou system of east Texas. Phil Kirk (WES) has initiated studies of effects of reservoir operations on fish recruitment in Hugo Lake, OK. Eric Dibble (WES) is collaborating with Ray Drenner to study relationships between fish and aquatic plants in experimental ponds at Texas Christian University. Neil Douglas (NLU) is revising his key to Louisiana fishes with Mike Fitzsimons (LSU), Bob Wallus (TVA) and Dick Hoese. The updated version will include all fishes, marine and freshwater, and offer information on behavior and ecology and keys to larval stages. Frank Pezold (NLU) has just completed a study of fish production in an isolated floodplain swamp. He is also directing student research projects examining habitat partitioning by darters in a central Louisiana creek (with Steven Dupré), diet selectivity by saddleback darters (with Lisa Loe), multivariate analysis of fish-habitat associations in Ouachita Mountain headwater creeks (with Luzette Kincaid) and construction of an IBI for headwater streams of the Ouachita Mountains (with Chris Metcalf, Federal Energy Regulatory Commission).

Frank Pezold

Southeastern Fishes Council
PROCEEDINGS

Information For Contributors

The primary purpose of the *PROCEEDINGS* is to publish research papers, critical reviews of activities, area reports and other pertinent information pertaining to the biology and conservation of Southeastern fishes

Manuscripts should be submitted in duplicate. A good guide for manuscript preparation is the Fifth Edition of the *CBE Style Manual* available form the Council of Biology Editors, One Illinois Center, Suite 200, 111 East Wacker Drive, Chicago, IL 60601-4298.

The entire manuscript including the abstract (required for feature articles only), text, Literature Cited, tables, headings and legends must be double-spaced. The title, author's name and author's address (including fax number and email address for corresponding author) should be centered on the first page. Indicate a suggested running head of less than ten words at the bottom of the first page. An abstract (if necessary) will be placed at the beginning of the text. Acknowledgments will be cited in the text immediately before the Literature Cited. All references cited in the paper will follow the standard format of using the last name of the author(s) followed by the year of publication of the paper. In the Literature Cited, the references will be alphabetical by the author's last name and chronological under a single authorship. The entire reference should be given with the complete name of the journal spelled out if possible.

Tables should be typed on a separate page, consecutively numbered and should have a short descriptive heading. Figures (to include maps, graphs, charts, drawings and photographs) should be consecutively numbered and if grouped as one figure each part block lettered in the lower left corner. Computer-generated graphics should be high quality prints; for drawings, high quality prints or photocopies are preferred to the original line art. Legends for figures must be on a separate sheet and each figure must be identified on the back. The desired location of each table or figure should be indicated in the margin of the manuscript.

Manuscripts will subject to editing and will be reviewed by at least two anonymous persons knowledgeable in the subject matter. The edited manuscript and page proofs ("galley") will be furnished to the author. Upon returning the reviewed and corrected manuscript to the editor, a PC disk copy of the final form of the text, tables and computer-generated graphics is also requested. Specific formatting information for the disk will be sent to the author with the edited manuscript. Reprints will be available at a nominal cost.

Regional reports, news notes and other short communications will also be edited and included when possible in the next number.

Only manuscripts from members of The Southeastern Fishes Council will be considered for publication. There is no charge for publishing in the *PROCEEDINGS*. All manuscripts and short communications should be sent to the editor:

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