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Abstract

(June 2004) - Observations of watersnake (*Nerodia*, Colubridae) predation on darters (*Percidae*). By Melvin L. Warren, Jr., Wendell R. Haag, and Amy M. Commens

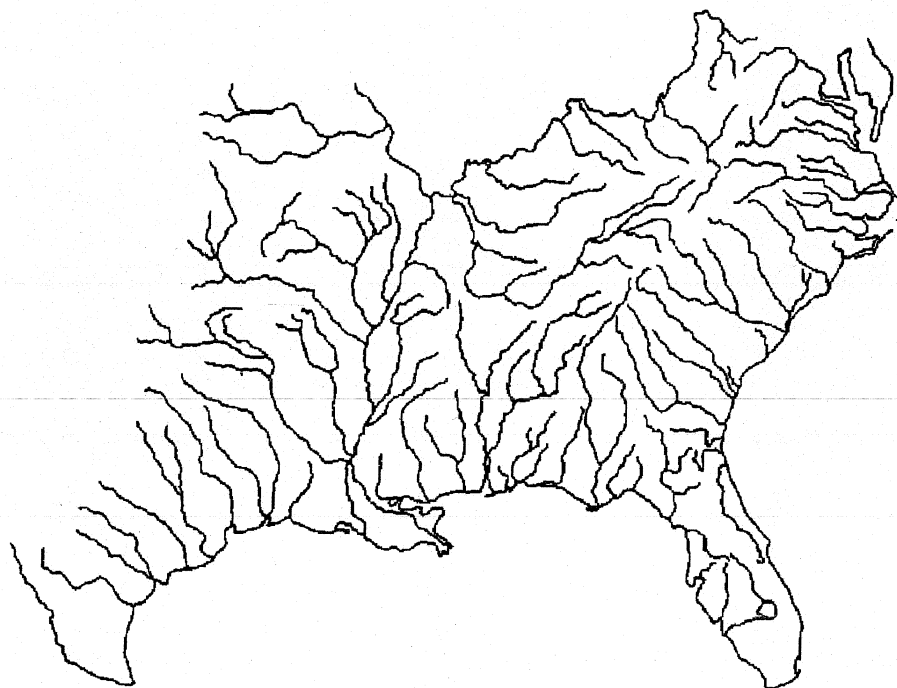
Regional Southeastern Fishes Council Reports

Keywords

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Southeastern Fishes Council Proceedings

Dedicated to the Conservation of Southeastern Fishes



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Observations of Watersnake (*Nerodia*, Colubridae) Predation on Darters (Percidae)

MELVIN L. WARREN, Jr.

WENDELL R. HAAG

AMY M. COMMENS

Center for Bottomland Hardwoods Research, Southern Research Station,
USDA Forest Service, 1000 Front Street, Oxford, MS 38655
E-mail: fswarren@olemiss.edu

ABSTRACT

We report observations of predation by watersnakes (*Nerodia*, Colubridae) on darters (Percidae) and summarize other literature documenting this relationship. We observed two midland watersnakes, *Nerodia sipedon pleuralis*, preying on darters (Percidae) in the Sipsey Fork of the Black Warrior River (Mobile Basin), Bankhead National Forest, Winston County, AL on 7 and 8 August 2002. We observed the snakes (about 250 and 500 mm total length) with their captured darters in separate, shallow (<0.6 m) runs. We identified the darters as an adult river darter, *Percina shumardi*, and an adult Tuskaloosa darter, *Etheostoma douglasi*, two of the most abundant benthic fishes in shallow flowing waters of the river. Compilation of our observations and the literature on *Nerodia* diets revealed 12 species of darters (seven *Etheostoma* and five *Percina*) are documented prey of *Nerodia*. Our results suggest watersnake predation is a frequent, but relatively poorly known, source of mortality for darters.

INTRODUCTION

Watersnakes of the genus *Nerodia* (Colubridae) are among the most widespread and conspicuous vertebrates along shorelines of streams, wetlands, and lakes of the eastern United States (Conant and Collins, 1998; Ernst et al., 2003). Darters of the genera *Etheostoma* and *Percina* (Percidae) are the most diverse and abundant benthic fishes in shallow-water habitats of eastern streams (Page and Burr, 1991). *Nerodia* frequently forage in these habitats (Brown, 1958; Drummond, 1983; Savitzky and Burghardt, 2000). *Nerodia* rely primarily on aquatic organisms as prey, and fishes are the predominant dietary component during at least one life stage of the snakes (Brown, 1958; Greene et al., 1994; King, 1986; Mushinsky and Hebrard, 1977; Mushinsky et al., 1982). We document field observa-

tions of predation by small *Nerodia* on darters in a southeastern river and summarize other literature documenting the predator-prey relationship of *Nerodia* and darters.

RESULTS

We observed two midland watersnakes, *Nerodia sipedon pleuralis*, preying on darters (Percidae) in the Sipsey Fork of the Black Warrior River, Bankhead National Forest, near the mouth of Hurricane Creek, Winston County, AL (34°15'09"N, 87°22'00"). We observed one snake (about 250 mm total length) at mid-morning (1000 h, 7 August 2002) and another, larger snake (about 500 mm total length) in mid-afternoon (1400 h, 8 August 2002) in habitats separated by about 300 m. In both cases, we observed the snakes swimming across shallow (<0.6 m), flowing, rocky runs with live fish in their mouths. After the snakes reached shore and repositioned the prey in their mouths, we identified the fishes as an adult river darter (*Percina shumardi*, about 70 mm total length) and an adult Tuskaloosa darter (*Etheostoma douglasi*, about 50 mm total length). The snakes swallowed the live darters head first shortly after reaching shore. These two darter species are among the most abundant, small benthic fishes in flowing waters of this section of the river (Powers et al., 2003; unpublished data, M. Warren and W. Haag). Ours is the first detailed, published field observation of watersnakes consuming live darters, although Page (1983:172) noted an unpublished observation (by P.W. Smith) of *Nerodia* feeding on *Percina sciera* in the Brazos River, TX.

Compilation of literature and our observations revealed that 12 darter species consisting of seven species of *Etheostoma* and five species of *Percina* are known prey of *Nerodia* (Table 1). We found three additional reports that did not identify darters to species (i.e., Brown, 1958; Hamilton, 1951; King, 1986). Occurrence of darters in the diets of *Nerodia* are reported in a variety of aquatic habi-

tats from New York and the Great Lakes states south to Texas, Georgia, and Alabama and involve at least three species of *Nerodia* (Table 1).

DISCUSSION

The importance of *Nerodia* predation as a source of darter mortality is not well-documented, but the data we compiled suggest frequent predation on darters, particularly by small snakes. In New York, Ohio, and Michigan, darters occurred in 13.6 to 22.3% of all *Nerodia sipedon* stomachs examined (Brown, 1958; Hamilton, 1951; Raney and Roecker, 1947), but percentages were higher (31.5%) when only smaller snakes (<380 mm total length) were included (Brown, 1958). In Georgia streams, 7.1% of *Nerodia taxispilota* stomachs contained darters (Camp et al., 1980). The orangethroat darter, *Etheostoma spectabile*, occurred in 3.4% of the stomachs of neonates (snout-vent length <300 mm) of riverine *Nerodia harteri*, but did not occur in stomachs of juveniles or adults (Greene et al., 1994). In a reservoir population of *N. harteri*, the bigscale logperch (*Percina macrolepidia*), occurred more frequently (35.4%) than any other organism despite being among the least abundant potential prey (Greene et al., 1994).

The small size and benthic habits of darters and their general association with shallow, flowing water and complex cover are all attributes considered to limit success of piscivorous predators in streams (Matthews, 1998). In most cases, darters comprise an almost incidental component in the diet of their predators (mostly other fishes, occasionally mammals or birds) (Page, 1983), but our observations and review suggest watersnake predation on darters is not incidental. Foraging strategies of *Nerodia* include underwater substrate crawling with frequent crevice probing in shallow, structurally-complex habitats (Drummond, 1983; Savitzky and Burghardt, 2000). These tactics are likely highly effective for locating and capturing darters, suggesting that predation by watersnakes is an underappreciated source of mortality for darters.

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Table 1. Darters (Percidae) reported as prey of watersnakes (*Nerodia*) and the habitat type where predation occurred. *Nerodia sipedon* includes: *N. s. sipedon* (northern watersnake), *N. s. insularum* (Lake Erie watersnake), and *N. s. pleuralis* (midland watersnake).

SPECIES	REFERENCE (HABITAT, STATE)
<i>Nerodia sipedon</i> ssp.	
northern, Lake Erie, and midland watersnakes	
<i>Etheostoma blennioides</i> greenside darter	King et al. 1999 (lake, OH)
<i>Etheostoma caeruleum</i> rainbow darter	Raney and Roecker 1947 (stream, NY)
<i>Etheostoma douglasi</i> Tuskaloosa darter	This study (stream, AL)
<i>Etheostoma flabellare</i> fantail darter	King 1993 (lake, OH), Raney and Roecker 1947 (stream, NY)
<i>Etheostoma nigrum</i> johnny darter	Lagler and Salyer 1945 (stream, lake, MI), Raney and Roecker 1947 (stream, NY)
<i>Etheostoma spectabile</i> orangethroat darter	Diener 1957 (stream, AR, MO, OK)
<i>Percina caprodes</i> logperch	King 1993 (lake, OH), King et al. 1999 (lake, OH), Lagler and Salyer 1945 (stream, lake, MI)
<i>Percina nigrofasciata</i> blackbanded darter	Camp et al. 1980 (stream, GA)
<i>Percina shumardi</i> river darter	This study (stream, AL)
<i>Nerodia harteri paucimaculata</i> Concho watersnake	
<i>Etheostoma spectabile</i> orangethroat darter	Greene et al. 1994 (stream, TX)
<i>Percina macrolepida</i> bigscale logperch	Greene et al. 1994 (reservoir, TX)
<i>Nerodia taxispilota</i> brown watersnake	
<i>Etheostoma swaini</i> Gulf darter	Camp et al. 1980 (stream, GA)
<i>Percina nigrofasciata</i> blackbanded darter	Camp et al. 1980 (stream, GA)
<i>Nerodia</i> sp.	
<i>Percina sciera</i> dusky darter	Page 1983 (stream, TX)

REGIONAL SFC REPORTS

REGION I – Northeast

News to report from the North Carolina Museum of Natural Sciences this year includes, first and foremost, recent notification of award of an NSF grant for \$170,000 for data basing of the fish collection. These funds will mainly be used to hire personnel to upgrade and enter data and to prep collections where necessary for cataloging into the collection. Currently, about twelve percent of the estimated 90,000 or so lots of fish is databased. Curator Wayne Starnes and collection manager Gabriela Hogue will have their hands very full directing and assuring quality control in this effort. It is intended to make the Museum's holdings web accessible as significant increments are added to the database and the first installment may be online in the fairly near future.

Usage of the collection by researchers and agency biologists has increased markedly over the past year. There have been a large number of visitations to the collection for a variety of purposes, including studies of both freshwater and marine assemblages and taxonomic groups. A significant achievement within the past year was the complete cataloging and databasing of the NC Division of Water Quality's voucher materials for all IBI studies conducted over the past eight years or so. These provide a rather thorough representation of wadeable streams in most basins throughout the state, which are re-sampled on a 5-year rotating basis and give good insight as to faunal compositions in those streams through the 90s and currently. These collections thus nicely complement the NC Wildlife Commission's stream surveys of the early 60s which are also vouchered at the Museum. Older DWQ collections, which are currently ledger cataloged, will be added to the database in the course of the overall databasing effort discussed above. More information about NCDWQ's IBI program can be had from Bryn Tracy (bryn.tracy@ncmail.net) who directs the fish portion of that program.

Last year it was reported that NCSM received funding from Progress Energy to study the rare and undescribed Carolina Redhorse. Those funds were to be used mainly for further survey work and for some preliminary genetic studies. Repeated rains and consistently high waters and other circumstances beyond control thwarted much of the intentions to mount further surveys for this fish in 2003. However, one very significant discovery in late April-early May of 2003, aided with electroshocking boats and help from John Crutchfield, Mike Swing, and Vann Stancil of Progress Energy, was that of an apparent established population in the upper Little River (tributary to the Pee Dee R.) just south of Troy in Montgomery County, NC. Two small impoundments appear to harbor a possibly sizeable population. Here, it was discovered that the species reaches much larger size than previously considered, with one

female weighing in at 6.6 lbs.! The capture of ten specimens, including several juveniles, in the upper portion of Blewett Falls Reservoir on the mainstem Pee Dee by Progress Energy biologists over the past couple years led to the investigation of the Little River which feeds into that reach. High waters were actually beneficial in allowing electroshocking boats to enter and navigate up Little River from the Pee Dee, traversing 5-6 miles to shoal areas where four Carolinas were eventually captured, presumably having staged for spawning in that area. Knowledge that Carolinas seem fond of small impoundments based on circumstances of the best population currently known, in a segment of the Deep River of the Cape Fear basin, prompted exploration of those small impoundments further up the Little River and discovery of an additional potential stronghold for the species. However, no young fish have as yet been collected from the impounded reaches. Further surveys will be needed to establish whether this upstream population is currently recruiting well. It is assumed that this population probably contributes significant recruitment to downstream reaches of Little River and/or perhaps the Pee Dee River proper. Thus far, based on all known museum specimens (now numbering 77) and released specimens, the Carolina seems to have a range confined to the upper Coastal Plain-lower Piedmont portions of the Pee Dee and Cape Fear basins, mainly in North Carolina, with some mainstem Pee Dee records in South Carolina. However, surveys for this hard-to-collect fish will continue to see if that range can possibly be expanded. Unfortunately, it is likely that this redhorse has been nearly or completely extirpated from several portions of its former range.

Preliminary genetic evidence, based only on cyt-b of the mitochondrial genome indicates the Carolina Redhorse to be well differentiated from its hypothesized close relative, the Golden Redhorse, which occurs to the north in the Roanoke-Dan basin, as well as the Tennessee and other basins to the west. Evidence further suggests quite a bottleneck in the history of the Carolina, as 43 specimens were essentially invariant over both the Pee Dee and Cape Fear basins based on the single sequence examined. There is also puzzling evidence of possible introgression with the sympatric *Moxostoma collapsum* and/or *M. pappilosum* that must be sorted out. Morgan Raley and Wayne Starnes have plans for much more study of Carolinas with other approaches, including possibly microsatellites, for a more rigorous genetic analysis. Morphological analyses aimed at the future description of this species, as well as accurate determination of age and growth characteristics and reproductive states, have recently been diligently pursued by Bob Jenkins on the above mentioned 77 specimens at NCSM and Roanoke College.

Efforts by the Robust Redhorse Conservation Committee on the Pee Dee River in 2003 were hampered by high waters in both spring and fall. A spring "roundup", attempting to collect, tag, and tissue sample additional

specimens of this very large redhorse was mounted employing several electrofishing boats from Progress Energy, the NCWRC, SCDNR, and Duke Energy. A special effort was made to concentrate on potential spawning shoal areas that had been identified and marked via GPS during low flows in 2002. However, high flows due to heavy rains minimized the effectiveness of this effort and no Robust Redhorse were encountered. A fall roundup was also mounted but, likewise, high releases from upstream dams hampered collecting. This redhorse is exceedingly rare in the Pee Dee and the total collected since 2000 numbers only five, despite intense targeted effort over the past three years and extensive sampling by Progress Energy over the past five years in connection with dam relicensing. While it was disappointing not to be able to add to this total in 2003, new efforts will be made in 2004.

However, one side benefit to the Robust Redhorse sampling in 2003 was the thrilling discovery of several Atlantic Sturgeon well up the Pee Dee River nearly to North Carolina. Two sturgeon had been spotted during shocking efforts of fall 2002 and it was thought perhaps these encounters were due to the extremely low flows of that year which may have trapped these large fish in pools and perhaps also made them more vulnerable to electroshocking. Extensive sampling of the Pee Dee over four previous years had failed to yield any sturgeon specimens. However, during previously mentioned high flow sampling of fall (8-11 October) 2003, possibly five different Atlantic Sturgeon individuals were sighted by electrofishing crews and one was captured. This specimen was a male, flowing milt, measuring 1645 mm TL, captured near Tom Blue Landing, SC, about 25 air miles south of the NC line. Based on these occurrences, and a previous large September specimen documented from near Rockingham, NC, in about 1990, it would appear there is some sort of fall immigration into the river, or an extended residency period. The implications of the captured male's apparent fall or early winter reproductive condition may bear further consideration by "sturgeonologists" in the future. There are very few documented occurrences of sturgeons from the Pee Dee (one Shortnose in 1985 near Rockingham, NC) in recent decades and therefore this season's results were a happy revelation.

NCSM personnel made an incursion far to the west, into Region VI, to attempt another installment on the two-decades-old study of *Lythrurus umbratilis* forms in the Ouachita River and adjacent basins. This study was begun by Wayne Starnes, Henry Robison, and Dick Bryant in the early 80s and, so far, has managed to get revisited only about every ten years. In May-June, 2003, Starnes, Gabriela Hogue, Morgan Raley, and Mandy and Dave Hewitt teamed up with Dick Bryant to collect and photograph breeding material from well below the fall line and extending to the headwaters to permit an in-depth analysis of the stark differences in pigmentation that occur between those two areas. Series were also collected for a

collateral study of DNA variation in these and adjacent populations. Morgan has begun these studies and he and Wayne plan to present preliminary implications of genetic data at this year's ASIH meetings in Norman, Oklahoma.

As for erstwhile NCSM technicians Mandy (formerly Howard) and Dave Hewitt, they have now moved on to the Virginia Institute of Marine Science as Dave pursues a Ph.D. and Mandy involves herself with projects at the institute. They are congratulated, though it was sad to see them move on, as it was their replacement of a few months, Kim Foley. Kim is a masters degree graduate of the University of Puerto Rico-Mayaguez who served in this position several months until joining Progress Energy's staff of biologists in early February.

Fritz Rohde, Rudy Arndt, Jeff Foltz and Joe Quattro finally have a contract with USC Press to produce a book on the freshwater fishes of SC. Manuscript is due within two years. Rohde is still, slowly working on the description(s) of the broadtail madtom. He, Joe Quattro, and students are working on genetics of Lake Waccamaw fishes and other southeastern species.

Jamie Roberts, graduate student studying with Paul Angermeier at Virginia Tech, reports they continue to conduct monitoring (now seven years' worth) of endangered Roanoke logperch population levels in the upper Roanoke River in and around the city of Roanoke. This data is to provide baseline information on natural variability, to be compared to any fluctuations that may occur following an \$80 million Army Corps channelization project within the city limits. The project is set to start in summer 2004, but recent scrutiny of the potential hydrologic impacts and the marginal benefit:cost ratio has sparked a new wave of controversy and doubt over whether the project should proceed as planned, or at all. A fascinating and complex case study is in the making involving the Corps, USFWS, city engineers and councilmen, and vocal citizen groups. We'll keep SFC posted as things develop.

Part of Jamie's Master's research (finally completed last August) include the study of summer dispersal patterns of fantail, Roanoke, and riverweed darters throughout the upper Roanoke watershed. Over-summer dispersal from home riffles was low (6%), but inter-annual dispersal was surprisingly high (38%). Also, some interesting patterns emerged related to attributes of the fishes (e.g., degree of specialization and endemism, body size) and attributes of their environment (e.g., stream hydrogeomorphology, predation, and competition levels).

Jamie's Ph.D. plans are collaborative with Paul and Dr. Eric Hallerman at Tech. They propose to use molecular genetic markers to ask a number of questions about darter populations, potentially including: What is the spatiotemporal extent of a population, and what factors regulate this extent? How do natural and unnatural barriers shape darter population dynamics? What is the evolutionary history and current population structure of Roanoke logperch? Answers to these sorts of questions may prove useful for fitting or validating population regulation models

(e.g., metapopulation models), and for setting protection priorities.

Jay Kilian reports that MDNR will complete the final year of the second round of the Maryland Biological Stream Survey (MBSS) in the summer of 2004. To date, the survey has collected quantitative chemical, physical, and biological data from over 3,000 non-tidal stream sites statewide. These data are currently being used in the development of conservation management plans for state-listed endangered aquatic fauna (fish, mussels, and amphibians). MBSS data are currently used by the Maryland Department of the Environment in the development of watershed biocriteria. EPA, MDNR, and Versar, Inc. are also exploring further refinement of the current Maryland Fish Index of Biotic Integrity with data collected since initial index development in 2000. Also, "Stream Waders", a volunteer monitoring program developed by MBSS staff, annually recruits and trains local volunteers in stream monitoring. In addition to improving stream stewardship ethics and local watershed management at the grassroots level, "Stream Waders" provides MDNR professionals with additional data on stream conditions across the state. MDNR is currently developing a Brook Trout Management Plan to provide information necessary for future management of this recreational and ecologically important species.

South Carolina DNR's Freshwater Fisheries Section initiated a statewide survey of stream fishes in 2003, the first concerted effort since the 1980's. Last year was a pilot study, with more effort anticipated in 2004 and the coming years. DNR biologist Jason Bettinger is soliciting information on fish species population status, distribution, and threats to their continued existence from scientists familiar with the state's freshwater fishes, including Fritz Rohde, Rudy Arndt, Wayne Starnes, Jeff Foltz, and others. The compiled information will be used to develop conservation management plans for imperiled species in the state. This spring the Section is hiring a biologist with expertise in mussel and crayfish taxonomy to assist in freshwater conservation efforts. Mark Scott is starting a study this year with collaborators at Clemson University to examine the ecological consequences of changing land use in the Reedy River and its tributaries, which drain the rapidly developing Greenville area. Joe Quattro is collaborating with Jean Leitner on an investigation of hybridization among black bass species in Upper Savannah River reservoirs and streams, where data suggest native *Micropterus coosae* redeye bass are in decline while introduced *M. punctulatus* spotted bass are expanding. Joe and Jean hope to learn the extent of hybridization and introgression, as well as assess the role of tributary streams as possible refuges for redeye from reservoirs where spotted bass have become predominant.

Steve Fraley sends news from the North Carolina Wildlife Resources Commission, Non-game Aquatic Research and Survey. The Commission's aquatic non-game program has undergone a number of changes in the past

couple of years. In early 2002, the state's Non-Game and Endangered Wildlife program was reorganized and divided along terrestrial and aquatic lines. The aquatic portion became the Non-Game Aquatic Research and Survey group within the Habitat Conservation Section of the Inland Fisheries Division. Director and out-going AFS national president, Fred Harris, has made integration of the non-game program into the traditionally game fish-oriented Division a high priority. The Division is working toward a more holistic, ecosystem management approach for managing aquatic systems in NC—and that can only be a good thing for all our little buddies!

There has been a complete turnover of staff since 2001. With the management reorganization, staffing structure within the state also changed from state-wide to region-based staff. In the Coastal Region (Roanoke and Neuse basins and northeastward), Angie Rodgers is the coordinator and Nolan Banish is the assistant biologist; in the Piedmont Region (Yadkin-PeeDee, Lumber, Cape Fear, and White Oak basins), Ryan Heise is the coordinator and Rob Nichols is the assistant biologist; and in the Mountain Region (Catawba and New basins and westward) Steve Fraley is the coordinator and Jeff Simmons is the assistant biologist. Scott Van Horn supervises the group.

Some highlights from the past year or so include cooperating with Bob Jenkins on on-going work with the as-yet undescribed "sicklefin" redhorse in the Hiwassee and Little Tennessee river systems. Last spring, we cooperated with Dr. Jenkins and TVA (Ed Scott & Dave Matthews) to collect pre-spawn males and females for fecundity and other reproductive study. We found a large concentration of sicklefins preparing to spawn on a shoal immediately downstream from the Emory Dam (Porters Bend) on the Little Tennessee River near Franklin, NC. This appears to be an important spawning area for this and other redhorse species. During this effort, some sicklefin eggs were fertilized and transported to CFI in Knoxville where they were reared for larval descriptions and early life history study. In mid-August, we attempted to locate sicklefin juveniles in the Valley River (Hiwassee). No sicklefins were found while seining at several localities. Very few sucker juveniles in general were collected, possibly a function of high flows experienced throughout the spring and summer in 2003. One age-1 sicklefin was observed while snorkeling near Andrews, NC (Valley RM 19). This fish was in a pool and actively feeding predominately among woody debris. A group of similar sized *M. duquesnei* was feeding predominantly among gravels nearby.

Species reintroductions to the recovering Pigeon River (French Broad) has been in progress in TN for the past few years. Efforts to reintroduce certain fish species into the North Carolina portion of the Pigeon began in 2003. This river was severely polluted for close to a century primarily from paper mill effluent. Recovery began in the mid-1990's when substantial improvements were made to the paper mill's processes and wastewater treatment. A cooperative group of stakeholders (including NCWRC,

USFWS, Blue Ridge Paper, NCMNS, USFS, UTK, NCDENR-DWQ) convened last March to determine a list of potential reintroduction target species. This March (2004) we're set to begin translocating four *Notropis* spp. (*rubricroceus*, *spectrunculus*, *photogenis*, and *telescopus*) to one site within the 25-mile reach between the Blue Ridge paper mill at Canton (formerly Champion) and Walters Reservoir.

FERC-fish related news from western NC: The NCWRC and other resource management and community entities are presently negotiating with Duke Energy to remove the Dillsboro Dam on the Tuckasegee River (Little TN), near Dillsboro, NC.

The NCWRC, with cooperation from the USFWS, USFS, and others performed multiple surveys to assess baseline fish, mussel, and crayfish populations in the Cheoah River in August, prior to changes related to hydro-relicensing. Flow in this river is bypassed from Santeeclah Dam to the confluence with the Little Tennessee River. Minimum flows and bedload augmentation were agreed upon as part of Tapoco Power Co. relicensing settlement.

– Wayne Starnes and Mark Scott

REGION II – Southeast

Jim Peterson, USGS BRD, Athens, GA is working with Bud and Mary Freeman, University of Georgia, and Elise Irwin, Auburn University on models of aquatic species distributions in some Georgia and Alabama rivers. They have completed models for the Upper Coosa, Tallapoosa, and Flint river systems. This work was conducted as part of the Aquatic GAP program. Also, two of Jim's students (Dale McPherson and John Ruiz) collected bluenose shiners (*Pteronotropis welaka*) last summer in a lower Flint River system stream. These are only the second and third specimens of this species collected in some time from Georgia. Bud Freeman along with Brett Albanese, GADNR will be conducting a status survey for this species in Georgia in the coming year.

Steve Walsh and Jim Williams, USGS (Gainesville), completed a survey of fishes and mussels in 17 Florida state parks containing significant spring resources, including several of the state's 33 first-magnitude springs (discharge > 100 cfs). This work was supported by the Florida Park Service, as part of a statewide "Florida Springs Initiative," which has had \$10 million earmarked since 1999 from the Florida Department of Environmental Protection for study, protection, and restoration of springs. Over 7,000 fish specimens of 79 species representing 52 genera and 31 families were observed or collected. As expected, cyprinids, centrarchids, poeciliids, and fundulids represented the greatest diversity and abundance. Greatest species richness was associated with large-magnitude springs with long spring runs or rivers supporting abundant macrophyte communities (e.g., Silver

Springs), and systems in close proximity to marine waters (e.g., Homosassa Springs) where euryhaline species commonly penetrate inland waters. No critically rare or threatened species were observed, although *Acipenser oxyrinchus desotoi* is known to occasionally utilize spring runs in the Suwannee River drainage. Florida springs have a low diversity and relative abundance of freshwater mussels in comparison to the approximately 60 species known statewide. A total of 18 species was found in spring habitats of 11 of the parks surveyed. In most cases, mussel abundance was low, especially nearest vent discharge areas, increased at downstream reaches, and was greatest in river habitats with less spring-water influence. Reasons for the relatively low diversity and abundance of mussels in Florida springs are unknown, but may related to a combination of physicochemical conditions (e.g., dissolved oxygen, temperature, and ionic composition), geological history, available habitats, and trophic factors. Steve is continuing monitoring of both fishes and benthic invertebrates in the St. Johns River drainage, in conjunction with physicochemical studies being done in collaboration with hydrologists from the USGS Altamonte Springs field office, through joint support from the St. Johns River Water Management District. This work is expected to extend over the next four years and is specifically intended to address issues related to establishing minimum flows and levels (MFLs) that are mandated by state legislation.

Steve and Bill Tate, also with USGS, are conducting surveys for *Enneacanthus chaetodon* and *Elassoma okefenokee* in Florida through support from the Florida Fish and Wildlife Conservation Commission. The FWC is also conducting surveys for other rare species throughout the state. So far, no recent collections of blackbanded sunfish have been made. As part of the statewide survey, Gray Bass (FWC, Milton) reported that two specimens of *Crystallaria asprella* were collected in early December 2003 from the Escambia River in Florida, near the Alabama border; these represent the first specimens of this species taken from the state since the early 1970's.

Steve is also continuing study of habitat utilization by fishes in the Apalachicola River floodplain. Efforts during 2003 concentrated on use of light traps to sample year-class 0 fish. Over 27,000 larval fishes were sampled from March through September, representing at least 45 species. *Notropis texanus* dominated samples and may be the most important forage species for larger piscivores. Of surprise was a great abundance of larval *Etheostoma fusiforme*, also possibly representing a significant prey base for benthic piscivores. A primary goal of this study is to search for correlations between hydrological conditions, flooded habitat, fish recruitment, and abundance in relation to the highly regulated conditions of the river and habitat alteration resulting from extensive sedimentation of the floodplain. As previously reported, specimens of *Etheostoma* sp. cf. *zonifer* were collected from sloughs near the confluence of the Apalachicola and Chipola rivers, representing the first records from Florida. Efforts

are being made to collect additional material for genetic analysis to confirm species identification or determine if a new taxon is represented.

Patti Lanford from GADNR reports that the Fisheries Section, Stream Survey Team sampled 88 sites during the 2003 field season in the Chattahoochee, Ocmulgee, Oconee, and Savannah river basins in Georgia. An additional 17 sites were sampled in the Coosa and Tennessee basins. They spent most of the season in the Piedmont working to fill some of their sampling gaps. In spite of an unusually wet field season, they were able to sample 105 of the 120 sites they had set as a season goal. This work is an ongoing project aimed at developing a statewide Index of Biotic Integrity (IBI) that can be used to assess the health of Wadeable streams in Georgia.

Jim Williams (USGS) along with Chris Skelton (Georgia College & State University), Gerry Dinkins (Dinkins Biological Consulting), and Beth Schilling (Oak Ridge National Lab) are conducting a survey of mussels in the Ogeechee River system in Georgia. The primary target is the Atlantic pigtoe (*Fusconaia masoni*) which was last seen in the system about five years ago. The species has not been located during the current survey. They have completed surveys at 35 sites and plan to visit 15 more this summer.

Chris Skelton and his student Mike Weis (mostly Mike) completed surveys at 37 sites in the Ohoopsee River system in summer and fall of 2003. They came up with a list of 55 species from the system. Included in the list were probable first records of Florida gar (*Lepisosteus playrhincus*) and least killifish (*Heterandria formosa*). Heavy rains last year prevented sampling of larger mainstem sites which they hope can be surveyed this summer.

– Chris Skelton

REGION III – North-Central

Reintroduction, augmentation, and other management activities

Fishes

Joyce Coombs (University of Tennessee graduate student) reports the status of the Pigeon River Recovery Project. Partners in this project include Tennessee Department of Environment and Conservation, Tennessee Valley Authority, Tennessee Wildlife Resources Agency, U.S. Geological Survey, North Carolina Wildlife Resources Commission, Blue Ridge Paper Products, Conservation Fisheries Inc., and University of Tennessee-Knoxville. Volunteers from Americorps, Isaak Walton League, and Pellissippi State also participated. At the end of 2003, the total numbers of fish re-introduced included: 1015 gilt darters (*Percina evides*), 766 blueside darters (*Etheostoma jessiae*), 270 stargazing minnows (*Phenacobius uranops*), and 381 mountain madtoms (*Noturus eleutherus*).

Due to a wet spring and stream flows at higher than average all year, collection events were minimal. The blue-breast darter (*E. camurum*) was not collected at all this year due to sustained high flows in the Nolichucky River, the only source for that species within the French Broad watershed. In 2003, three new species were re-introduced, including: 493 stripetail darters (*E. kennicotti*), 477 American brook lampreys (*Lampetra appendix*) and 239 mountain brook lampreys (*Ichthyomyzon greeleyi*).

Snorkel surveys of 18 habitat sites on the Pigeon River between Denton and Newport observed only one target species, the gilt darter. Snorkelers observed 155 gilt darters (59 tagged, 96 untagged) representing three age classes (89 adults, 15 juveniles, and 51 young of year) at seven sites including the re-introduction site; the young and juveniles confirm successful reproduction of at least two year classes. Upstream and downstream movements were noted, and categorized as follows: adults - 30% upstream, 10% downstream; juveniles - 13% upstream, 67% downstream; and all YOY moved downstream. Snorkel surveys will begin as soon as water temperatures allow, and re-introduction of all target species will continue in 2004.

The 2003 snorkel surveys also located three genera of river snails (*Io*, *Leptoxis*, *Pleurocera*) at five sites. Three of those sites were re-introduction locations and hundreds of *Leptoxis* and *Pleurocera* were observed, indicating successful recruitment. A new re-introduction site was established at Brown's Island (right channel) in 2003.

Brood stock, for the captive propagation of the tangerine darter (*P. aurantiaca*), are in place at Conservation Fisheries, Inc. If the propagation is successful, re-introduction of the tangerine darter may take place in both the Tennessee and North Carolina segments of the Pigeon River as early as 2005.

The table below summarizes Pigeon River re-introductions between 1996 and 2003.

Year	Organism	Genera/ Species	#Individuals
1996-2003	Snails	6	170-180k
2000-2003	Mussels	9	145
2001-2003	Darters	4 sp.	2608
2002-2003	Madtom	1 sp.	381
2002-2003	Minnow	1 sp.	270
2003	Lampreys	2 sp.	716

Ed Scott, Tennessee Valley Authority, reported on the status of the upper Tennessee River lake sturgeon restoration efforts that were initiated in 1998. Minimum flows and aeration of discharges began in the early 1990's at Douglas Dam on the French Broad River, have resulted in dramatic recovery of aquatic communities downstream. Because of those improvements, the lake sturgeon restoration project was initiated. Many agencies, universities, and

environmental groups are partnering in this project, which is a long-term effort based on eggs supplied by Wisconsin DNR, and reared by National Fish Hatcheries in Arkansas, Mississippi, and Georgia.

Through 2003, more than 21,000 fish have been stocked in the lower French Broad and Holston rivers below Douglas and Cherokee dams. Since the project began, 30 individuals have been caught by fishermen, and 10 additional individuals were collected during monitoring surveys. Many of the sturgeon were recaptured near the release sites, but individuals have been collected as far away as Chickamauga Reservoir (~200 stream miles from the release site).

Ed reports that stocking activities and efforts to monitor the success of this project will continue in 2004. The project is projected to continue for at least 20 years, with the ultimate goal of a self-sustaining population in the upper Tennessee River system, and perhaps a limited sport fishery.

Pat Rakes (Conservation Fisheries, Inc.) reported that Little River (Blount County, TN) duskytail darters are the object of a new effort to propagate individuals to expand that population further upstream in the system where suitable habitat is present. Young (135) propagated from stock in the lower end of the Little River population were stocked upstream, above Coulter Bridge, in November. Additional suitable habitat for future stockings appears to be present in and above Townsend in Great Smoky Mountains National Park, but will require additional evaluation before any stocking takes place.

The reach of the Tellico River officially designated by the U.S. Fish & Wildlife Service as Nonessential Experimental Population for spotfin chub, duskytail darter, and yellowfin and smoky madtoms received 4,000 captively propagated spotfin chubs in October 2002, and in April CFI released 226 tagged smoky madtoms, 154 yellowfin madtoms and 450 duskytail darters. Snorkel monitoring surveys resulted in observation of four adult spotfin in September 3, 2003. Hopefully, 2004 surveys will indicate successful spawning has taken place.

Token releases of only smoky and yellowfin madtoms were made in Abrams Creek in 2003. Good numbers of adults and young-of-the-year of both madtoms, and duskytail darters were observed during snorkel monitoring efforts. These three species are all successfully spawning in Abrams Creek.

Efforts continue to restore populations of *Fundulus julisia* to portions of their former range. About ten sites were stocked with a total of 2000 captively reared individuals in 2003. Partners in this effort include CFI, several private landowners, the Natural Resources Conservation Service, the U.S. Fish & Wildlife Service, (including the Cookeville office and the Dale Hollow, Wolf Creek, and Chattahoochee National Fish hatcheries), students and faculty at Tennessee Technological University, and the Tennessee Aquarium. The first release to a site in the Duck River system (Tennessee drainage) was made this

year at Ovoca Lake. This was one of the first known historic sites for the species. An additional wild population was discovered in the Barren Fork system, bringing the total number of known wild populations to three.

One new propagation effort is to spawn and rear warrior darters, *Etheostoma bellator*, as surrogates for the endangered vermilion darter, *E. chermocki*. CFI has successfully produced several hundred young darters, developing some innovative rearing and husbandry techniques in the process. Snubnose darters attach eggs individually to various substrates all over the aquaria. CFI personnel refused to participate in the resulting "Easter egg hunt" for these eggs. (Pat says the name for this egg-deposition strategy should incorporate this analogy!) Resulting larvae were found to be tiny, pelagic, and phototropic. Breeding tanks were eventually set up with overflows to larval rearing containers to automatically "capture" larvae as they swam up. The technique works extremely well, greatly reducing the labor and effort of handling eggs and larvae, and may prove applicable to many other species (credit for the idea must go to Tom Brandt et al. at the San Marcos National Fish Hatchery and Technology Center).

Mollusks

Jeff Garner (Alabama Game & Freshwater Fisheries), Steve Ahlstedt (U.S. Geological Survey), and Don Hubbs (Tennessee Wildlife Resources Agency) transplanted 80 individuals of three mussels and a snail into the Tennessee River downstream of Wilson Dam (Buck Island), near Muscle Shoals. These species, all federally listed, are *Epioblasma cf. capsaeformis*, *Lemiox rimosus*, *Dromus dromas*, and *Atheurina anthonyi*. The mussels were placed inside 10 ft. by 5 ft metal frames anchored to the bottom to facilitate future monitoring. The Tennessee River reintroduction site is within the historical range of all of these mussels, and was officially designated as a Nonessential Experimental Population for these mussels by the U.S. Fish & Wildlife Service. Spiny riversnails (*Io fluvialis*), cultured by Paul Johnson (Tennessee Aquarium Research Institute), were stocked in the TN River at Bridgeport, AL.

Steve Ahlstedt and Mark Fagg report that spiny riversnail reintroductions continued in the Holston and Pigeon Rivers. None were put in the French Broad River this year. Ahlstedt reported that spiny riversnails continue to survive in all three rivers but are difficult to find in the French Broad. He noted evidence of recent reproduction in the Holston River at Surgoinville, where he found three native mussel species (*Lampsilis fasciola* 7, *Villosa iris* 3, *V. vanuxamensis*). The success of the mussel reintroductions in the French Broad River at Seven Islands was evaluated. Ahlstedt noted that mussels at this site show excellent recovery, and evidence of some reproduction was noted. Partners in this project are Jim Layzer (USGS), Mark Fagg, and Ed Scott (TVA).

Ahlstedt also reported continued reintroductions of common snail and mussel species into the Pigeon River

from stock in the Nolichucky River. Common snails are reproducing and mussels are surviving. Dick Biggins (U.S. Fish & Wildlife Service, retired) and Mark Fagg are partners in this project.

Steve Bakaletz (National Park Service), Jess Jones, Rachael Mair, Nathan Johnson (Virginia Tech.) and Steve Ahlstedt (USGS) report stocking captively propagated mussels (*Epioblasma brevidens*, *E. capsaeformis*, *E. walkeri*, and *V. trabalis*) into the Big South Fork. This is the beginning of a project proposed by the National Park Service (NPS) to restore freshwater mussel biodiversity and ecological functions to the free-flowing reach of the Big South Fork within the National River and Recreation Area and further the recovery of federally endangered mussels. The NPS proposes to protect and conserve existing mussel populations, augment existing federally listed and non-listed mussel populations with juveniles propagated from adults collected within the Big South Fork, reintroduce federally listed and non-listed mussel species that were historically reported from the river using adults and propagated juveniles from individuals collected outside the river, and monitor the progress of the project. Currently, 26 species remain in the Big South Fork National River and Recreation Area, including six that are federally protected: *Alasmidonta atropurpurea*, *E. brevidens*, *V. trabalis*, *E. capsaeformis*, *E. walkeri*, and *Pegias fabula*. Partner agencies include Tennessee Wildlife Resources Agency, Tennessee Department of Environment and Conservation, Kentucky Department of Fish and Wildlife Resources, Kentucky Division of Water, Kentucky State Nature Preserves Commission, U.S. Fish and Wildlife Service (Asheville, NC and Cookeville, TN field offices), and the U.S. Geological Survey.

Status surveys and other interesting finds

Al Brown, Donny Lowery, and Kurt Lakin report interesting collections of species from the 2003 Vital Signs monitoring program at Tennessee Valley Authority. Crews also continue to track the expansion in range of several species. Atlantic needlefish have been collected on Wheeler reservoir (TRM 292.5). Inland silversides were collected on Nickajack reservoir and in 2002 were collected below Ft. Loudoun dam (TRM 600.0). Several Blueback herring were collected on Tellico reservoir (LTRM 1.0 & 15.0) and one was recorded at Chickamauga inflow (TRM 529.0).

Unfortunately, poor collecting conditions for much of 2003 affected much of the field season and resulted in no additional collections of slender chub, *Erimystax cahni*. The lone individual collected at Grissom Island on the Clinch River in October 2002 died in October 2003 without the opportunity to reproduce.

Additional surveys in the Big South Fork system again failed to observe any additional sites for *Etheostoma percunurum*. Results of genetics studies from tissues CFI collected from all duskytail populations still pending.

Pat Rakes and J. R. Shute report efforts in 2003 to find

the undescribed Chucky madtom (*Noturus* sp.) in Little Chucky Creek (Greene Co., TN) were unsuccessful. However, a recent effort, on 3 May 2004, resulted in two Chucky madtoms. These individuals were moved to CFI for propagation attempts. Additional collections to try to add a few more individuals to the captive population are planned. The two individuals were only the 13th and 14th ever collected from Little Chucky Creek!

CFI concluded snorkel surveys of fish communities in the Great Smoky Mountains National Park for the All Taxa Biodiversity Inventory effort. This effort will allow the National Park Service to fill in gaps in their GIS database and may influence decisions on the proposed North Shore Road project near Fontana Reservoir. Interesting finds included Tennessee dace, *Phoxinus tennesseensis*, a robust fantail darter population, *Etheostoma flabellare*, in the Hesse Creek system, a tributary to the Little River, and a lone sicklefin redhorse, *Moxostoma* sp., from Deep Creek.

Mike Pinder, Virginia Department of Game & Inland Fisheries, collected a yellowfin madtom May 6, 2004 in the Clinch River at Nash Ford (Russell Co., VA). This is a tremendous range extension for yellowfin madtoms in the Clinch River, as the closest record is from the Clinch River at the mouth of Copper Creek (Scott Co., VA, ~40 river miles downstream).

Lastly, Tom Near has taken over for Etnier at UT. He's apparently having a blast enjoying the collection, teaching, mentoring students, and writing prodigiously. Etnier has stayed on a quarter-time appointment to manage the fish collection.

—Peggy Shute

REGION IV - South-Central

Frank Parauka of the Panama City, Florida Field Office, U.S. Fish & Wildlife Service, along with Laura Kovatch conducted investigations on the availability of spawning habitat for gulf sturgeon, *Acipenser oxyrinchus desotoi*, in northwest Florida and southeast Alabama river systems, including the Escambia/Conecuh, Yellow, Pea, Choctawhatchee, Apalachicola, and Ochlockonee rivers. One hundred fifty two sites were identified in 93 km of river as having characteristics similar to documented spawning habitats. Sites ranged from 45 m to 7.2 km in length. Ninety percent of the potential habitat was in Alabama, with most of the river km in the Conecuh, Pea, and Choctawhatchee. The Choctawhatchee had the largest number of potential spawning sites, followed by the Pea and the Conecuh. A typical spawning site in Alabama had rocks, limestone, clay bluffs, rock and limestone walls and outcroppings, shoals and hard substrate, and cobble. Frank is continuing his study in the Escambia/Conecuh River that began in 2002 where he is collecting sturgeon for a database that will be used to cal-

culate the size of the population in the system. About 20% of the netted individuals are over 100 lbs. Sonic tagging of specimens from the Escambia over to the Ochlockonee also continues.

Daniel Drennen of the Jackson, Mississippi Field Office, U.S. Fish and Wildlife Service Office has been examining land use changes in the Turkey Creek watershed, Locust Fork drainage, Jefferson County, AL, using black and white aerial photographs. Turkey Creek is home to three species of imperiled darters, the vermilion darter, *Etheostoma chermocki*, the rush darter, *E. phytophyllum*, and an introduced population of the watercress darter, *E. nuchale*. Daniel examined photos of a portion of the watershed from 1956, 1977, and 1997. Overall obvious land changes as percent acreage change was discernible, but the footprint of urbanization was not visible at a scale that was anticipated. Qualitative differences between non- and sparsely-vegetated areas and vegetated areas were noted, but the overall net change was not as large as expected. It appears that these three imperiled darter species are impacted by site destruction rather than overall watershed disturbances based on the aerial photos. This emphasizes the need for best management practices in close proximity to the creek for the recovery of these species.

Pat Rakes and J.R. Shute at Conservation Fisheries Inc. report that annual surveys continue in the Conasauga River, and surveys within the Cherokee and Chattahoochee National Forests for *Cyprinella caerulea*, *Etheostoma brevirostrum*, *Percina* sp. cf. *macrocephala*, and *P. jenkinsi* indicate that these species appear to be doing well. Additional surveys were also initiated in the Etowah River and Conasauga River tributaries within the Chattahoochee National Forest. Efforts to propagate *P. jenkinsi* were unsuccessful—apparently the four specimens collected in August 2002 were all females! Two more individuals have been acquired for the 2004 effort; hopefully at least one is a male. Somewhat more success was achieved with *E. etowahae*, with the production of a small number of juveniles. Egg deposition sites were variable, with some found buried in sand both under and beside rocks, while others were found in small pebble interstices, mostly under cover objects. Most eggs were individually deposited, but some were found in adhesive clusters. The only possible pattern appeared to be related to a preference for small, mostly enclosed cavities under cover objects—substrate on the floor of the cavity seemed less important. Development of propagation protocols and establishment of an ark population for *E. chermocki* was put on hold due to questions about the species' status. Therefore, in order to be prepared to do so in the future and utilize funding, Pat and J.R. collected *E. bellator* to work with as surrogates from the most closely related population just north of Turkey Creek. These are currently being winter conditioned for spring spawning efforts. Three old *P. aurora* refused to spawn in 2003, possibly due to old age, sex composition, or too small of a group. Fortunately, in October Todd Slack collected eight young

fish to utilize for 2004. Finally, as noted last year, Susie Adams at the Southern Forest Research Station in Oxford, Mississippi has contracted CFI to propagate *E. stigmaeum*, *E. artesiae*, and *E. douglasi* from the Sipsey Fork for a growth study of otoliths (using oxytetracycline marking). Limited numbers of all three species were produced, some from original wild adults as well as from F2s. Perhaps the most significant development to come from this work was a circular flow-thru rearing chamber fashioned for the tiny pelagic larvae of *E. douglasi*. Pat and J.R. look forward to testing the set-up with all *Etheostoma* (*Nothonotus*) and *Percina* spp. larvae in 2004.

Scott Mettee of the Geological Survey of Alabama in Tuscaloosa reports that GSA biologists continued fish bioassessment studies in the Tennessee River drainage and Terrapin Creek, studies to track paddlefish, *Polyodon spathula*, and southeastern blue sucker, *Cycleptus meridionalis*, in the Alabama River, the Bobcat Cave study at Redstone Arsenal, mussel studies in the Coosa River and Bear Creek (Tennessee River drainage), the fish passage study at Claiborne and Millers Ferry Locks and Dams on the Alabama River, and a biological inventory of fish, mussel, snail, crayfish, and aquatic insect species inhabiting the Mobile Delta. GSA completed fish and mussel species accounts for Volumes 1 through 4 of the forthcoming Alabama Imperiled Species Report scheduled for release sometime in 2004. Additionally, two papers were published, one on mussels and one on Alabama shad, *Alosa alabamiae*, and skipjack herring, *A. chrysochloris*. A status report was published on the Cahaba shiner, *Notropis cahabae*, and coal and Tuscaloosa darters (*Percina brevicauda* and *Etheostoma douglasi*) in Locust Fork in the GSA publication series. A manuscript on the biology of a spawning population of the southeastern blue sucker in the Alabama River will be published soon. GSA has initiated new projects to investigate the status of imperiled fishes inhabiting the Elk River in north Alabama and several small coastal rivers in south Alabama.

Todd Slack from the Mississippi Museum of Natural Science reports the recent hiring of Mark Dugo to collaborate on a 2+ year project addressing movement of non-indigenous Nile tilapia in coastal waterways of Mississippi using telemetry. Mark completed his MS in August 2003 at The University of Southern Mississippi assessing fine-scale genetic structure of Gulf sturgeon, *Acipenser oxyrinchus desotoi*, within the Pascagoula drainage. Todd is continuing his collaboration with Mark Peterson (USM-Gulf Coast Research Laboratory) on research projects addressing the distribution, expansion and potential impact of Nile tilapia in aquatic systems of Mississippi. Research on Gulf sturgeon in the Pascagoula drainage is in the final stages of completion. This project began in 1997 and is based primarily on the collaborative efforts between Todd, Steve Ross (USM), his students (Ryan Heise, M. Dugo), and Brian Kreiser (USM). During the period from 1997 to January 2004, the Gulf sturgeon research team has processed a total of 289 individuals when all recaptures

are included. The total number of unique Gulf sturgeon captured, processed and tagged in the Pascagoula drainage since 1997 is 201. In addition, one spawning area has been documented on the Bouie River near Hattiesburg and based on telemetry patterns over successive field seasons, likely spawning sites have been identified in the upper Chickasawhay River. These sites represent isolated patches of potential spawning habitat totaling 20 kilometers of riverine habitat distributed along a 120-kilometer reach between Waynesboro and Enterprise. Beginning in Spring 2005, the Gulf sturgeon research efforts will be directed on the Pearl River in collaboration with biologists from Louisiana Department of Wildlife and Fisheries. Todd will initiate a survey of the upper Pascagoula drainage (i.e., Leaf and Chickasawhay rivers) for Pearl darters, *Percina aurora*, during Summer 2004 along with Brian Kreiser, Bryant Bowen and Paul Mickle (USM). The Pascagoula River proper was surveyed during 2000-2001 and resulted in the capture of 145 individuals from among 28 sites. The Ichthyology Collection at MMNS continues to grow. The collection is approaching 31,000 cataloged lots with approximately 66% of the total holdings computerized. Backlog collections are being cataloged, many collected by MDWFP personnel from the Tombigbee, Pascagoula, and Pearl drainages during the 1980's. Following the acquisition of the MSU Ichthyology Collection in 2001, MMNS has completely computerized the catalog with approximately 85% of the holdings geo-referenced. Todd anticipates incorporating these holdings into the main collection within the near future.

Mark Peterson at the Gulf Coast Research Lab in Ocean Springs, Mississippi, is still working on mapping water quality and habitat of the Pascagoula River ecosystem with Steve Ross, Melissa Partyka and Marisa Weber; a study of *Phragmites australis* with M. Partyka, and altered habitats with Bruce Comyns and M. Partyka. All three projects are funded by the NOAA, CIAP program. He is also involved in the production of a Mississippi-Alabama SeaGrant project entitled "Field Guide to Aquatic Habitats and common fauna of the Northern Gulf of Mexico from Chandeleur Islands, Louisiana to St. Joseph's Bay, Florida", which, in conjunction with Dauphin Island Sea Lab and Ken Heck, will be used for summer teaching programs. Mark is also working with Todd Slack on tilapia migration studies and has just started organizing and developing a site profile for the Grand Bay NERR site with Mark Woodrey. He continues to work with Chet Rakocinski and Bruce Comyns on otolith microchemistry of spotted seatrout, *Cynoscion nebulosus*, and red drum, *Sciaenops ocellatus*. Mark and Nancy Brown-Peterson continued their work in Mexico collaborating with colleagues at FES-Iztacala, UNAM in Mexico City on fishes of Alvarado lagoon near Veracruz, Mexico. Nancy and Mark received funding from Environmental defense, the Harte Research Institute and USM College of Science and Technology to organize, translate, edit and submit for peer-review senior theses from FES-Iztacala on research activi-

ties in Alvarado lagoon and the Tecolutla estuary. To date, six papers have been completed and accepted for publication in *Gulf and Caribbean Research*. Mark recently resumed his Editorship of this journal that he previously held from 1996-2001.

Bob Jenkins at Roanoke College, Virginia, requests any information on specimens of *Moxostoma* that may be preserved from the Ochlockonee River drainage. A 1983 report by the Georgia Department of Natural Resources, authored by Russell Ober and Lee Keefer, lists *Moxostoma* sp., grayfin redhorse, from one mainstem site. Unfortunately, the specimens were too big to preserve. This species has long been known only from the Apalachicola River drainage. Bob has not seen a *Moxostoma* from the Ochlockonee, but Russell told him that circumpeduncle scales were counted on the released fish and the spotted sucker, *Minytrema melanops*, was eliminated as a possibility with this count. Bob intended to change the common name of this undescribed species from grayfin to Apalachicola redhorse because some specimens have orangish lower fins. If the fish inhabits an additional drainage, it would be good to document this and rethink its name.

Jim Godwin of the Alabama Natural Heritage Program in Montgomery has begun a survey for mussels in the headwaters of the Paint Rock River along with Doug Shelton of the Alabama Malacological Research Center. Approximately 100 species of freshwater fish and 45 extant species of mussels are found in the Paint Rock. Four of the mussels are federally listed as endangered, the shiny pigtoe (*Fusconaia cor*), fine-rayed pigtoe (*Fusconaia cuneolus*), Alabama lampmussel (*Lampsilis virescens*), and pale lilliput (*Toxolasma cylindrellus*). The Alabama lampmussel and pale lilliput have been extirpated throughout their range except within the headwaters of the Paint Rock River. Three additional species are considered globally imperiled based on the Natural Heritage ranking system developed by The Nature Conservancy. These are the Tennessee pigtoe (*Fusconaia barnesiana*), slabside pearlymussel (*Lexingtonia dolabelloides*), and the purple lilliput (*Toxolasma lividus*). So far over 500 individuals of 23 species have been captured, measured and marked.

Rob Angus and Ken Marion at the University of Alabama at Birmingham, along with Jaideep Honavar, have been examining the status of fish communities in the rapidly developing upper Cahaba River watershed. Their objective was to identify the fish species that are most sensitive to siltation and whose change in abundance can serve as an indicator of the impact of sediment stress in a stream system. They assessed the habitat quality and then investigated the degree to which sediment-indicative habitat quality variables at the study sites were correlated with ichthyofaunal assemblages at those same sites. An index of biotic integrity was also calculated and correlated to sediment-indicative habitat parameters. Multivariate ordination techniques were used to investigate overall changes

in species composition at sites with different degrees of siltation. The index of biotic integrity did not correlate very strongly with sediment-indicative habitat quality variables. Other characteristics of the ichthyofaunal community, such as the percent relative abundance of crevice-spawning minnows, disturbance-sensitive darters, suckers, top carnivores, herbivores and omnivores did show associations with sediment-indicative variables. Multivariate ordination successfully separated silt-impacted from non-impacted sites.

Carol Johnston at Auburn University reports that graduate student Wendi Hartup is examining population levels of *Etheostoma boschungi*, the slackwater darter. Habitat loss due to agricultural practices and water use changes is the greatest threat to the continued existence of this species. This study assesses population levels at historic sites, calculates survival rates for each life stage (larvae, juvenile, and adult), and uses the program, Poptools, to construct a stage-based Leslie matrix and run a Monte Carlo simulation. Analyses of the model will assess which life stages are most sensitive to environmental changes and which life stage has the greatest effect on population growth rate, predict average extinction time periods, and estimate minimum viable population size. Results from this study will aid in the prioritization of populations of *E. boschungi* for management and may provide evidence for strengthened federal protection. Carol and another graduate student, Casey Knight, are examining the predation of pygmy sculpin (*Cottus paulus*) eggs by crayfish (*Cambarus latimanus*) and male sculpin, which exhibit filial cannibalistic behavior. Nesting tiles were placed in Coldwater Spring run. The egg clutches produced on these tiles were then placed inside enclosures within the run. The enclosures (with egg clutches) were used in one of four treatments ranging from the control (a lone clutch of eggs) to a clutch of eggs, a male sculpin and a crayfish. The findings of this experimental study support the contention that both parental male sculpin and crayfish are predators in this system.

Rick Mayden at Saint Louis University and his students are still involved in research on southeastern fishes. Nick Lang is looking at morphological and genetic characters within the *Etheostoma swaini* and *E. whipplei* complexes, Anna George is examining relationships among logperches, and post-doc Dave Neely continues his research on sculpins.

Michael Stewart of Troy State University, Alabama currently has a graduate student doing a project on life history of some rare mussels in the Choctawhatchee/Pea River drainage. In addition, he hopes to start a student on crayfish and environmental indicators in the same drainage. Michael is also continuing some mussel work on the Conecuh River this summer if water levels cooperate.

Some quick notes: Dave Etnier at the University of Tennessee reports that Ben Keck has completed his thesis on the fishes of the Hatchie River system. Bob Butler at the U.S. Fish and Wildlife Service in Asheville, North

Carolina, reports that the recovery plan for seven mussel species endemic to drainages between Econfinia Creek (St. Andrew Bay) and Suwannee River basins is finalized and can be accessed from the USFWS website.

Steve Powers left the University of Alabama upon completion of his doctorate and is now an Assistant Professor at Reinhardt College in Waleska, Georgia. He can be reached there at SLP@reinhardt.edu. A manuscript by Steve, Rick Mayden and Dave Etnier on the conservation genetics of the ashy darter, *Etheostoma cinereum*, identifies populations from tributaries to the Cumberland, Duck and Upper Tennessee rivers as three different genetically divergent, imperiled management units and has been accepted for publication in Copeia. Detailed examination of nuptial pigmentation and other morphological differences among these management units will continue this spring. In his dissertation, Steve identified six (yes 6) different allopatric, diagnosable species within the *Etheostoma simotermum* species complex. Ranges of each species are largely consistent with areas of endemism within the Cumberland and Tennessee rivers. One more field season is required to identify exact distributions of each species, but the descriptions should be submitted for publication this summer. Steve, along with Mel Warren at the Southern Forest Research Station in Oxford, Mississippi has identified genetic divergence between two disjunct populations of *Etheostoma raneyi* in the Yocona and Little Tallahatchie rivers. The two populations are restricted to small streams in the upper Coastal Plain hills of Mississippi and separated by extensive reaches of unsuitable habitat in the downstream portions of each river on the lower Coastal Plain. A similar pattern exists in the recently described *Etheostoma cervus* and *E. pyrrhogaster* from western Tennessee and Kentucky.

Jim Williams of the U.S. Geological Survey Center for Aquatic Resource Studies in Gainesville, Florida discovered the blackmouth shiner, *Notropis melanostomus*, in Bay Minette Creek, Mobile Bay drainage, in April 2003. Fourteen specimens were collected in a backwater area off of the main creek. This discovery fills in the gap between populations in the Pascagoula and Blackwater/Yellow River drainages. Jim and myself are examining morphological and genetic variation across these three drainages.

Lastly, I am pleased to report that Fishes of Alabama by Herb Boschung and Rick Mayden, with color illustrations by Joe Tomelleri, is expected to be available in May!! Included are 112 color plates illustrating about 350 fishes. The book is being published by the Smithsonian Press and will sell for the low price of \$55.00.

– Bernie Kuhajda

REGION VI – Southwest

Region VI, like a moss-draped bayou, can be languid and quiet, then flooded and pulsing with vitality. Last year there was an energetic and eclectic surge of reports demonstrating the rich potential for aquatic research in this region. Topics included: a hotspot for biodiversity, military activities and stream life, invasive and undesirable fishes, primitive and charismatic fishes, crawfish AND crayfish, the research value of carcasses recovered in the aftermath of rodeos, and the environmental value of puddles formed on the Mississippi River floodplain.

Ronnie Ulmer reports that The Nature Conservancy (TNC) is beginning its sixth year of study in the Bayou Bartholomew watershed with an aquatic inventory in 2004 of the freshwater mussels north of the Louisiana/Arkansas state line. Extant mussel inventories do not exist for these reaches. Previously, TNC helped form partnerships among a range of stakeholders in the watershed, received a USEPA watershed initiative grant for 2003, and made significant progress toward the study and conservation of the resources of Bayou Bartholomew. Fish populations in the entire watershed and the freshwater mussels south of the Arkansas state line were the focus of a study during 2000 in which 109 fish species and 31 species of freshwater mussels were documented. Priority areas for conservation were identified and interactions with landowners and other partners for habitat preservation and restoration were made. Data on the efficacy of some restoration measures are available. One study conducted by the Bayou Bartholomew Alliance noted post-restoration increases in fish species richness as high as 7 species south of a series of sediment reduction buffers that were installed in cooperation with NRCS.

Effects of military activities on aquatic communities conducted at Fort Polk, LA were described by Danny Hudson. A two year-study by Fort Polk and Ohio State University personnel evaluated effects of road crossings on dispersal of fish marked with elastomer paint tags. When compared with natural reaches, fords and bridges were found to have no detectable effects, but culverts significantly reduced upstream and downstream fish movements and were prone to damming by debris. A second study evaluated influence of habitat, drainage, time, and military training activity on fishes and invertebrates. Assemblages were structured principally by variation in habitat and drainage (especially stream gradient), and invertebrates by seasonal variation. There were no detectable impacts of military training. A third study, by Fort Polk and Ohio State University, assessed impacts of sedimentation on fishes and invertebrates by comparing Birds Creek, a stream deforested in 1989 and now maintained as a grassland, with Whiskey Chitto, a reference stream. Diversity was high at the deforested sites, and there were no differences between streams in diversity, turbidity, or total suspended solids suggesting no impact or recovery during the intervening 15 year period.

Around Fort Polk, in the Kisatchie National Forest, other studies of aquatic organisms are ongoing. Tim Bonner and Danny Hudson are studying fish distribution in headwater streams. Tim also just completed a study of stream fish distributions in Louisiana and east Texas and a study of the life history of the Sabine shiner (*Notropis sabinae*) funded by the National Fish and Wildlife Foundation. Lance Williams is measuring impacts of sedimentation on fish and macroinvertebrate communities, and David Byrd and Scott Raborn the effectiveness of artificial reefs. Recently completed are a study of the Cane River watershed hydrology by John Novosad and a CD on the "Crawfish of the Kisatchie National Forest" by Steve Shively and Jerry Walls.

The Nekton Research Laboratory (NRL) at the Pontchartrain Institute for Environmental Sciences has of late been particularly active in fish conservation research in southeastern Louisiana. Director Martin T. O'Connell in cooperation with Robert C. Cashner, Vice Chancellor for Research at the University of New Orleans, has organized a team of expert fish biologists and ecologists to address numerous fish and fishery issues in the valuable aquatic environments of coastal Louisiana. The NRL has just completed the most extensive fish survey of the Lake Pontchartrain Estuary ever conducted, with monthly samples being taken over a three year period (2000-2003). Led by senior biologist and boat captain Chris Schieble, the NRL confirmed that the federally threatened Gulf sturgeon (*Acipenser oxyrinchus*) was not extirpated from Lake Pontchartrain as was previously believed. Based on the success of the three year survey, the NRL was awarded funding to study trophic interactions in the estuary using stable isotope and fatty acid analyses. Jason P. Turner, an expert on sargassum food webs, is conducting this research on local estuarine communities to determine which habitats along a salinity gradient provide the most energy for resident, estuarine-dependent, and transient fish species. Another ongoing NRL project combines fish surveys with trophic analyses to compare the productivity of the Biloxi Marshes and the Chandeleur Islands. Begun in October 2003, this project will be the first comprehensive fish survey of the remote Chandeleur Islands since Tony Laska's work in the 1970s. Along with Schieble and Turner, boat crew members Kenny Blanke, Jeff Van Vranken, and Jeff Corbino have been sampling monthly in these estuarine and marine habitats while also conducting their own research. For example, Blanke is working on his M.Sc. thesis and has been awarded \$5000 by the J. Bennet Johnston Science Foundation to study possible relationships between habitat degradation and diet shifts in estuarine fish species over time.

Other important NRL student research includes Tom Lorenz's dissertation work on the invasive Rio Grande cichlid (*Cichlasoma cyanoguttatum*). This exotic freshwater fish has become established in the canals of New Orleans and is now moving into valuable estuarine habitats, threatening native species. Lorenz is focusing on

studying the role of inter-species aggression in determining the success of an aquatic invader. Senior biologist and database manager Meg Uzee O'Connell has been studying long term trends in fishery data from the Barataria Basin in coastal Louisiana and how land loss may affect different fish species. She is also working with Martin on using museum database records to assess the population status of the rare blackmouth shiner (*Notropis melanostomus*). This small minnow species is found only in southern Mississippi and western Florida. Preliminary results from O'Connell and O'Connell suggest that further survey work is necessary to better understand the true distribution and conservation status of this species.

Jeff Quinn, Arkansas Game and Fish Commission, reports several studies of paddlefish (*Polyodon spathula*) underway in the state. The Fisheries Division tagged paddlefish in the 10,600-acre Ozark Pool of the Arkansas River, which was closed to commercial fishing on January 31, 2002. During November 2002 to March 2003, 1,066 unique and 75 recaptured paddlefish were collected providing an estimate for the recruited population of 4,505-5,681. Jeff estimated that 21% of the paddlefish susceptible to gill nets were marked last year and that 50% of the paddlefish captured were greater than the 36-inch minimum length limit. A total of 559 paddlefish have been captured since November 2003, 16% of which had been marked last year. Growth of recaptured adult paddlefish averaged 2.5 cm. To obtain life history information, 100 paddlefish are being sacrificed in Lake Dardanelle, Ozark Pool, and Pool 13. These fish will provide estimates of age-frequency, fecundity, sex ratio, and spawning frequency needed for fishery models that assess sustainability of the paddlefish population using different minimum lengths. To determine spawning areas, survival, movements, and habitat use, a telemetry project has been contracted with Arkansas Tech University.

AGFC is also working with commercial fishermen. During February 2003, thirteen fishermen harvested a total of 1,558 paddlefish during the 10-day commercial fishing season. Of the fish harvested, 37% were gravid females, 41% were non-gravid females, and 20% were male. A 36-inch EFL minimum length limit was in effect during the season. Preliminary data suggests female paddlefish do not mature until they are 36-inches EFL, which is the minimum length limit for the Arkansas River. Weather and flow conditions were optimal for commercial fishermen during the start of the special season. During a special 5-day commercial fishing season (5-9 Feb 2004) on Ozark Pool, Fisheries Division determined percent of marked fish returned (exploitation). Harvested fish were measured and weighed, sex and spawning condition determined, and the dentary bone removed for aging.

Brian Wagner, also at AGFC, is working on several projects concerning non-game species. With funding from the National Fish and Wildlife Foundation, he is collaborating with Arkansas Tech University to quantify habitat characteristics for the yellowcheek darter (*Etheotoma*

moorei) at several scales. Their goal is to recommend stream restoration measures that will enhance habitat for this declining species. The yellowcheek darter is a candidate for federal listing and is the subject of a captive propagation study by USFWS and Conservation Fisheries Inc.. In collaboration with USFWS, Arkansas Natural Heritage Commission and the Nature Conservancy, Brian is also conducting visual surveys of the state's major populations of Ozark cavefish (*Amblyopsis rosae*) and two endangered cave crayfish species. Other crayfish-related activities include collection-building with Chris Taylor at Illinois Natural History Survey, development of a statewide database with Henry Robison, a distribution and status evaluation for *Procambarus ferrugineus* with Henry and with Keith Crandall, and crayfish-workshops for teachers. In his free time, Brian compiles fish distribution records from AGFC files for a draft geo-referenced database and for inclusion in the revised edition of "Fishes of Arkansas."

Dennis Riecke, Mississippi Department of Wildlife, Fisheries and Parks, notes increased public awareness of aquatic invasive species (e.g., snakeheads, Eurasian carps) and comments on the promising development of Aquatic Nuisance Species Panels for the southeastern United States. A Mississippi River Basin panel has recently been formed under the guidance of joint federal-state fisheries group called the Mississippi Interstate Cooperative Resource Association (MICRA). A Gulf of Mexico panel is being coordinated by the Gulf States Marine Fisheries Commission. Through education, outreach, risk assessment, prevention, control, management and rapid response these panels work to combat exotic species introductions and minimize their impacts.

Dennis also sends the following "behind the scenes" report on a fish rodeo: "Saltwater fishing rodeos can be huge affairs. For over 50 years the Mississippi Deep Sea Fishing Rodeo in Gulfport has been an annual tradition around July 4th. One of the popular attractions is the display of fish caught by anglers who compete for daily and overall prizes. Fish of each species are placed on blocks of ice and people stream past to gaze, comment and take pictures. I always see some fish I have never seen before. I marvel at the number of people that patiently line up for 14 hours and wait to view the fish. But few are aware of important work going on behind the scenes. Due to the abundance and variety of fish landed in a few days scientists and researchers have seized the opportunity to glean information from them. Fish are examined for parasites and hard structures are collected for age discrimination. This rodeo is the best place for me to obtain information on alligator gar, which once had a wide distribution in Mississippi. Now it seems to be restricted to the coastal areas and the Mississippi River floodplain. I have seen fish weighing from 8-120 pounds and up to 6 feet long. I've also collected tissue samples for genetic analysis, skins for taxidermy mounts and for those who make jewelry out of their large scales. This rodeo is a fine blend of fun, education, competition and science."

In the interests of education, Dennis also announces the availability of a PBS-quality, 28 minute video produced by the Warmwater Streams Committee of the American Fisheries Society: "Warmwater Streams: A Resource Worth Protecting." The video describes aquatic ecology, food webs, habitats, and how seasons affect aquatic life, often taking viewers underwater to observe fish and aquatic invertebrates in their natural settings. It also presents threats to warmwater streams imposed by the changing needs of our society. Although many streams continue to suffer from past and present abuses, much is already being done by federal, state, and local agencies to correct some of those problems. The video concludes on an optimistic note, saying that public concern and involvement can go a long way toward restoring warmwater streams to their fullest potential under the constraints of modern society. This educational video is intended for middle and high school classrooms, as well as the general public. VHS copies are available for \$10.00 each by contacting: Dennis Riecke, Warmwater Streams Tape, 1505 Eastover Dr., Jackson, MS, 39211.

Biologists from the U.S. Army Engineer Research and Development Center at Waterways Experiment Station (WES) evaluated several proposed civil works projects in 2003. Studies to evaluate stream restoration projects were performed in the Boeuf River and Bayou Macon, LA, and water supply projects for Bayou Meto and the southeast Arkansas delta. Studies of restoration benefits continue for the San Antonio River, TX, a system dominated in species, numbers, and biomass by exotic invasive fishes. One of the more conspicuous (and potentially destructive) groups, the sailfin catfishes (*Pterygoplichthys* spp.), were studied in the San Antonio River and in south Florida where the fishes are invading new areas, disrupting food chains, and eroding shorelines. Participation by WES in the multi-agency comprehensive study of the White River, AR-MO also continues with studies of fish communities in upland streams, lowland rivers, and wetlands. In collaboration with Henry Robison, these data will be compared with historical records, to evaluate temporal changes and current status of fishes in the most species-rich drainage of the western Mississippi Basin.

In addition to community-level studies, WES biologists are conducting several research projects with sturgeon populations. Surveys of pallid sturgeon (*Scaphirhynchus albus*) and shovelnose sturgeon (*S. platyrhynchus*) are ongoing throughout the middle and lower Mississippi Rivers. Taxonomic and demographic data are obtained for pallid sturgeon, and habitat and diet data obtained for both species. A growing database for evaluating field characters, character indices, growth rates, mortality, habitat and food preferences will also enable impacts and benefits of

civil works projects to be evaluated. Also under evaluation are the effects of sand- and gravel-mining on sturgeon. Field surveys are being conducted at dredge and reference sites to determine possible impacts of commercial and Corps mining activities on sturgeon. Laboratory studies are being conducted in swim tunnels to determine maximum swimming and station holding speeds of juvenile sturgeon. These will be interfaced with flow field models for dredge heads to assess entrainment risk under a range of dredge operations.

Members of the Louisiana and Mississippi Chapters of the North American Native Fishes Association (NANFA) were especially busy in 2003, volunteering their time and resources for several worthwhile education and research projects. In April, with biologists from WES, they staged "Fabulous Fishes," their second annual hands-on ichthyological workshop, at the Clinton Community Nature Center in Clinton, MS. More than 200 visitors (mostly under the age of 15) attended the event and learned sampling techniques, taxonomy, osteology, functional morphology, trophic ecology, behavior, and aquarium science. In June, NANFA members conducted an unusual study of aquatic snakes. Tyler Strange (Oak Grove High School, LA) and I recovered more than 150 snake carcasses from a "rodeo" in Lake Providence, LA. Along with Heather Smith (St. Andrews Episcopal School, MS), Dena Dickerson (WES), and Steven George (WES), we processed all specimens. Skulls and tissue samples were preserved for taxonomic and genetic study by Louisiana Department of Wildlife and Fisheries. Size, weight, gender, reproductive condition, and prey were recorded for our own study of life history. We will compare our data with Steven's data from an identical effort 10 years ago.

Throughout the summer, Tyler Strange and Heather Smith also worked on an ecological study of small floodplain pools at Tara Wildlife, near RiverMiles 445-460 of the Mississippi River. These pools provide important feeding grounds for shorebirds, including the federally endangered wood stork, and nurseries for numerous species of fishes, including those characteristic of small, transient wetlands. Heather and Tyler found that very shallow pools (to 25 cm) were low in fish diversity and not used as feeding grounds by the wood storks but that slightly deeper pools (to 50 cm) harbored diverse fish assemblages and were used intensively for feeding by the birds. Two of their noteworthy finds were pools used as rearing grounds by the invasive Eurasian silver carp (*Hypophthalmichthys molitrix*) and others used by the historically exploited, and now "vulnerable" alligator gar (*Atractosteus spatula*). As a result of their work with floodplain pools, Tyler and Heather were recognized by the Mississippi Wildlife Federation as Youth Conservationists of the Year.

- Jan Hoover

Southeastern Fishes Council Proceedings

INFORMATION FOR CONTRIBUTORS

The primary purpose of the *Proceedings* is to publish peer-reviewed research papers and critical reviews of activities; regional reports and notes; and other pertinent information pertaining to the biology and conservation of southeastern fishes. The *Proceedings* is also an outlet for range extensions, distributions, and status papers, covering ecology and conservation ichthyology. Life history studies, faunal surveys, management issues, behavior, genetics and taxonomy of southeastern fishes are appropriate topics for papers in the *Proceedings*. Review papers or information on imperiled waters or fishes are particularly appropriate.

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The entire manuscript including the Abstract (required for longer articles), Introduction, Methods, Results, Discussion, Acknowledgments, Literature Cited, Appendices, Tables, and Figure 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. Literature cited should be standardized and abbreviated, using the *World List of Aquatic Sciences And Fisheries Serial Titles* or guidelines in *CBE Manual for Authors, Editors, and Publishers 6th ed.* for journals not included in the *World List*.

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. When possible, tables and figures will be reduced to one column width (3.5 in), so lettering on figures should be of appropriate size. Color figures can be printed at the author's expense.

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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:

Frank Pezold, Editor
Southeastern Fishes Council Proceedings
Museum of Natural History
College of Arts and Sciences
207 Hanna Hall
The University of Louisiana at Monroe
Monroe, LA 71209-0504
Phone: (318) 342-1868; Fax: (318) 342-1755
email: pezold@ulm.edu

Southeastern Fishes Council Web Site:

<http://www.flmnh.ufl.edu/fish/organizations/sfc/SFCDefault.htm>

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