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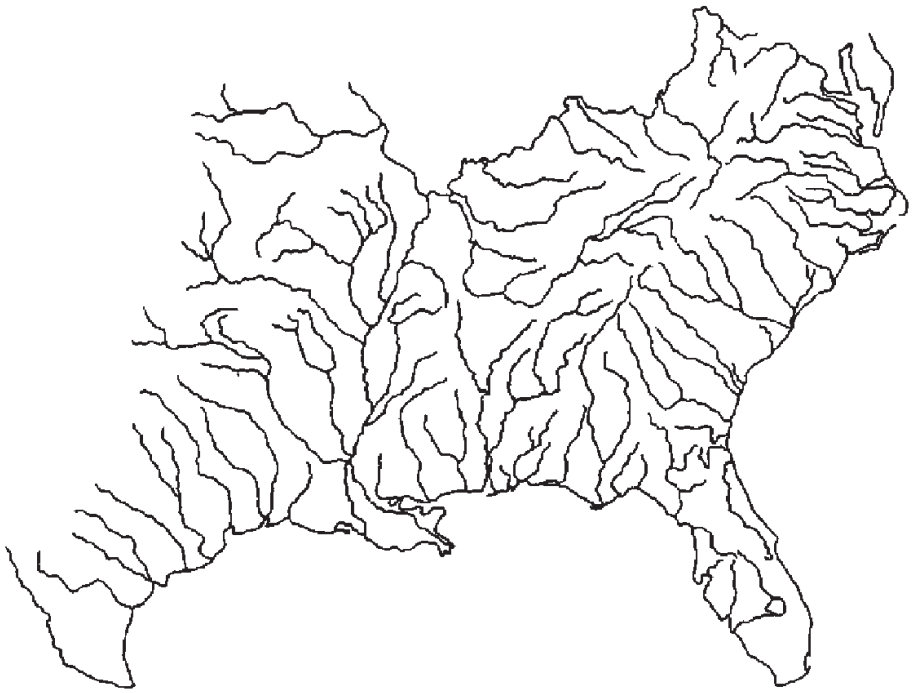

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Annual Dues

Please check your mailing label. Opposite your name on the mailing label is the last year for which we have a record of dues paid (or "9999" for lifetime members). If you have not yet paid 2009 dues (or other dues in arrears), please send a check payable to *Southeastern Fishes Council* to Anna George, Tennessee Aquarium, 1 Broad St, Chattanooga, TN 37402, phone (423) 785-4171. Dues are $30 per year. If you are uncertain regarding your status, email Anna George at alg@tnaqua.org

35th Annual Meeting, Southeastern Fishes Council

The SFC met in Guntersville, Alabama on Thursday and Friday, the 12th and 13th of November 2009. The meeting program and abstracts are posted on our website <www.sefishescouncil.org>.

Student Award Winners

Oral Presentations

1st Place: Brook Fluker, University of Alabama. Comparative phylogeography of *Etheostoma boschungi* and *E. tuscumbia*: assessing habitat preference and dispersal ability (with Bernard R. Kuhajda, and Phillip M. Harris)

2nd Place: Mollie Cashner, Tulane University. If you build it, who will come? Differences in spawning assemblage structure between *Nocomis micropogon* and *Semotilus atromaculatus*

3rd Place: Clint R. Johnson, University of Central Arkansas. Population ecology and habitat use of the invasive northern snakehead (*Channa argus*) near Brinkley, Arkansas (with Reid Adams, and Ginny Adams)

Poster Presentations

1st Place: Daniel J. Farrae, University of Georgia. Evidence of a source-sink population of shortnose sturgeon in the Altamaha and Ogeechee rivers, Georgia (with Douglas L. Peterson)

2nd Place: Robert A. Bahn, University of Georgia. Sturgeon bycatch in the Altamaha River shad fishery, Georgia (with Douglas L. Peterson, and Joel Fleming)

3rd Place: Audrey M. Richter, Morehead State University. Bioassessment of a recently restored headwater stream in Rowan County, Kentucky
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Post-impoundment Changes in the Cyprinid Fauna of the Lower Sabine River, Louisiana and Texas

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ABSTRACT

We compared minnow populations in the lower Sabine River from before and after the construction of the Toledo Bend Dam (TBD). Total cyprinid abundance and species richness decreased downstream of TBD while minnow populations remained fairly constant or increased upstream of Toledo Bend Reservoir. The red shiner (*Cyprinella lutrensis*), the dominant minnow species collected in the lower Sabine River in 1969-1970, was not collected in the 80 river km section of the Sabine River below TBD in 1979-1980 and 1982. It did occur in collections taken in the next 80 km downstream section of river in 1969-1970 and 1979-1980, but it also disappeared in this lower region by 1982 During the same period, the blacktail shiner (*C. venusta*) became the dominant cyprinid in both of these downstream regions. Two factors likely contributed to the changes in the cyprinid populations in this section of the lower Sabine River. Discharges from TBD lowered the water temperature of the lower Sabine River to below the optimum spawning temperature of most minnow species except *C. venusta*. Also, high energy discharges during hydroelectric generation disrupted marginal stream habitats that, prior to dam operation, provided important habitat for all Sabine River minnows.

INTRODUCTION

Dam construction has long been associated with subsequent declines in local populations of fishes (Helfman, 2007). Unfortunately, the full impact of dam construction on fish assemblages has been difficult to assess because pre-construction data are generally unavailable. The Sabine River originates northeast of Dallas, Texas and flows to the southeast toward Logansport, Louisiana, where it becomes the common boundary between Louisiana and Texas (Fig. 1). From Logansport, it takes a more southerly course for about 463 km and flows into Sabine Lake which empties into the Gulf of Mexico. Toledo Bend Dam (TBD) was constructed to create a water supply, a source of hydroelectric generation, and a recreational reservoir for the states of Louisiana and Texas. Dam construction started in April 1964 and the reservoir began filling in October 1966. When full reservoir capacity was achieved in 1968, Toledo Bend Reservoir inundated approximately 160 km of riverine habitat in the lower Sabine River, though over 371 river km upstream of the reservoir remained unobstructed.

Historically, the red shiner (*Cyprinella lutrensis*) and the blacktail shiner (*C. venusta*) were two of the most important bait fishes collected and sold from the Sabine River system . The bait fish industry of the lower Sabine River was important to both Louisiana and Texas. Approximately 40 million minnows were harvested annually in this section prior to the construction of TBD (USCOE, 1971). Our goals here were to document changes that occurred in the relative abundance of several minnow species (Cyprinidae), especially *C. lutrensis* and *C. venusta*, in the downstream section of the Sabine River after TBD was completed, and to offer possible explanations for the causes of these population changes.

MATERIALS AND METHODS

Twelve pre-impoundment fish samples were collected in 1963-1966 from the now inundated section of the Sabine River from Logansport to Toledo Bend (Fig. 1). Post-impoundment fish collections were taken from three different regions of the river. First, quarterly collections were made at seven sites between Burkeville and Bon Wier (downstream of TBD) in 1969-1970 and 1979-1980 (Fig. 1). In 1982, only one sample was collected at each of these sites. Second, 10 sites were each sampled once from Bon Wier to Deweyville in July 1969, July 1970, and July 1982. Finally, fishes were collected from four sites upstream of Toledo Bend Reservoir in September 1982 between Winona and Carthage (Fig. 1). Two of these sites and two new sites were also sampled in October 1982. Most fish collections were made with a nylon minnow seine (3.05 m x 1.83 m). All available habitats were sampled at each site during each effort. Fishes were sorted, identified, and catalogued into the Tulane Museum of Natural History.

Water temperature data were obtained from annual U.S. Geological Survey water reports for the State of Texas (USGS, 1972; 1973; 1974; 1975; 1976; 1977; 1978; 1979; 1980; 1981; 1983) to assess the effects of TBD discharges on min-

now spawning success and egg survival. We examined water temperature data taken during July and August from 1967 to 1982 at four sites: one upstream of Toledo Bend Reservoir (Tatum) and three downstream (Burkeville, Bon Weir, and Ruliff). For *C. lutrensis*, the most abundant cyprinid species in the lower Sabine River prior to impoundment, the lowest estimated temperature for hatching and larval survival is 29°C (Islam, 1972). We compared Sabine River water temperatures at these four sites with this reported minimum temperature.

RESULTS

Pre-impoundment collections - Logansport to Toledo Bend (1963 to 1966)

Twelve pre-impoundment fish collections from the main stem of the Sabine River (Logansport to Toledo Bend) produced 16 cyprinid species and 17,665 specimens (Table 1). The most numerous species was *C. lutrensis* which comprised 40% of all minnows collected. Other common cyprinid species collected were ghost shiners (*Notropis buchanani*) and bullhead minnows (*Pimephales vigilax*) comprising 19.7 % and 16.4% of all minnows collected, respectively. The remaining 23% of minnows collected included *C. venusta*, shoal chubs (*Macrhybopsis hyostoma*,), Sabine shiners (*Notropis sabinae*), pallid shiners (*Hybopsis amnis*), emerald shiners (*Notropis atherinoides*), Mississippi silvery minnows (*Hybognathus nuchalis*), mimic shiners (*Notropis volucellus*), and weed shiners (*Notropis texanus*).

Post-impoundment collections - Burkeville to Bon Wier (1969-1982)

Cyprinid species richness and relative abundance declined over time in the Burkeville to Bon Wier region with 15 species and 42,063 specimens collected in 1969-1970, 12 species and 9,602 specimens collected in 1979-1980, and 9 species and 3,220 specimens collected in 1982 (Table 1). In 1969-1970, *C. lutrensis* comprised 40% of all minnows collected, followed by *C. venusta* (29.1%), *P. vigilax* (16.9%), and *N. sabinae* (8.7%). Species comprising the remaining 5.1% of minnows included *H. nuchalis*, *M. hyostoma*, *N. atherinoides*, *H. amnis*, *N. buchanani*, *N. texanus*, and *N. volucellus*. Golden shiners (*Notemigonus crysoleucas*), ribbon shiners (*Notropis fumeus*), pugnose minnows *(Opsopoeodus emiliae*), and suckermouth minnows (*Phenacobius mirabilis*) were also collected in this region but in lower numbers. Only 39 specimens were collected in 1969-1970 and 38 specimens were collected in 1979-1980.

Five minnow species collected between Burkeville and Bon Wier in 1969-1970 (*C. lutrensis*, *N. buchanani*, *H. amnis*, *M. hyostoma*, and *N. atherinoides*) were not collected in 1979-1980 (Table 2). The relative abundances of *P. vigilax*, *N. sabinae*, and *H. nuchalis* declined over this period as well (Table 2). By contrast, the relative abundance of three species (*C. venusta*, *N. texanus*, and *N. volucellus*) increased between these two periods (Table 2). The largest change in relative abundance occurred in *C. venusta* whose abundance increased from 29.1% of all minnows collected in 1969-1970 to 83.3% in 1979-1980 (Table 2). Similarly, 145 *N. texanus* were collected in 1969-1970 versus 316 in 1979-1980 (Table 2).

In 1982, *C. lutrensis*, *N. atherinoides*, and *N. buchanani* remained absent from Burkeville to Bon Wier collections (Table 1). Three other species (*H. nuchalis*, *N. texanus*, *and P. vigilax*) continued to decline in abundance while *N. texanus* and *N. volucellus* increased slightly. Again, the dominant species in this river region was *C. venusta*, accounting for 83.4% of all minnows collected (Table 2).

Post-impoundment collections - Bon Wier to Deweyville (1969-1982)

Cyprinid species richness and relative abundance also declined in the Bon Wier to Deweyville region, but the process occurred over a longer time period. Fourteen species and 6,497 specimens were collected in this region in 1969, 15 species and 7,944 specimens were collected in 1970, and only 10 species and 3,615 specimens were collected in 1982 (Table 1). The slight increase in total species and specimens collected from 1969 to 1970 possibly occurred after minnows in the Burkeville to Bon Wier section moved downstream to escape the initial effects of cool water discharge from TBD. Consistent collection results from both of these downstream regions in 1982 likely resulted when the full effects of cool water discharge were realized throughout minnow populations that inhabited the lower 160 river km of the Sabine River.

Post-impoundment collections - Winona to Carthage (1982)

The magnitude of the faunal change brought about by the impounding of the lower Sabine River is also evident in a comparison of data collected upstream of Toledo Bend Reservoir (Winona to Carthage) in 1982 with data collected downstream of TBD during the same time period. Sixteen species and 65,184 specimens were collected upstream of Toledo Bend Reservoir in eight collections (Table 1). Fifty-four percent of all minnows collected were *C. lutrensis*, 31.6% were *P. vigilax*, 4.5% were *N. sabinae*, and 4.0% were *M. hyostoma*. Compared to post-impoundment downstream regions where *C. venusta* became dominant, *C. venusta* comprised only 2.5% of all minnows collected between Winona and Carthage. In contrast, only nine species and 3,220 minnows were taken in nine collections made between Burkeville and Bon Wier and 10 species and 3,615 minnows were taken in 10 collections made between Bon Wier and Deweyville.

Post-impoundment water temperatures: Tatum, Burkeville, Bon Weir, and Ruliff (1969 -1982)

Post-impoundment water temperatures collected upstream of Toledo Bend Reservoir (as measured at Tatum) in July and August usually exceeded the 29°C minimum temperature reported for successful *C. lutrensis*

hatching and larval survival (Islam, 1972) while post-impoundment temperatures collected below TBD at Burkeville, Bon Weir, and Ruliff were consistently lower than 29°C (Fig. 2).

DISCUSSION

The abundance and diversity of most cyprinid species inhabiting the lower Sabine River substantially declined following the construction of TBD. The most marked change is the apparent extirpation of *C. lutrensis* downstream of the impoundment. Prior to construction, *C. lutrensis* had been the most common minnow in this region. We recognize that without actual experimentation it is somewhat difficult to ascertain those intrinsic factors actually involved in changes in the relative abundance of minnow populations in the lower Sabine River. Our long-term data and observations, though, allow us to offer likely explanations for these changes. In the lower Sabine River, the artificial lowering of river temperatures downstream of the impoundment along with other factors such as increased turbidity and habitat alteration all likely contributed to the reduction of *C. lutrensis* reproduction and survival. While we have focused here on changes to the two dominant species (*C. lutrensis* and *C. venusta*), it is also apparent that the post-impoundment disruptions have reduced overall cyprinid diversity and abundance, including the extirpation of *N. atherinoides* and *N. buchanani* from the Burkeville to Bon Wier region. While these two species differ in some aspects from *C. lutrensis* in regard to habitat requirements (e.g., neither are crevice spawners), we suspect that the post-impoundment conditions in the region were not conducive for their survival due to other factors.

Water temperature is a major factor determining *C. lutrensis* habitat selection and it can also influence *C. lutrensis* meristics (Matthews, 1977; 1987). Under experimental conditions, the optimal temperature range for hatching *C. lutrensis* eggs was 29° to 31°C and the highest growth rate (3.3 mm/week) occurred at 29°C (Islam, 1972). Frequency histograms for *C. lutrensis* collected in Oklahoma and Texas suggested prolonged high reproductive conditions in populations from both areas, but seine mesh-size young were never collected until the middle of July (Farringer et al., 1979). Collections of small *C. lutrensis* throughout August and September suggested spawning occurred from about mid-June to the end of August and possibly into September (Farringer et al., 1979). During this study, average water temperature was 30°C in July and August with slightly lower temperatures in September (Farringer et al., 1979). In another Oklahoma study, 47.6% of adult *C. lutrensis* were collected in August when water temperatures ranged from 33° to 37°C (Matthews and Hill, 1979).

Water temperatures were consistently lower downstream of the impoundment after TBD began discharging (Fig. 2). In most cases, the July and August temperatures were lower than the 29° to 31°C reported for optimum spawning and egg survival of *C. lutrensis* (Islam, 1972). By comparison, July and August water temperatures at Tatum, upstream of Toledo Bend Reservoir, remained constant after impoundment and *C. lutrensis* remained the numerically dominant cyprinid in this region (Table 1). At Burkeville in 1969-1970, *C. lutrensis* represented 40% of all cyprinids but none were collected either in 1979-1980 or 1982. Similarly, at Ruliff where July and August temperature averages were slightly higher than Burkeville (Fig. 2), we suspect they were still too low to support *C. lutrensis* spawning. In 1970, 25.7% of all cyprinids collected at Ruliff, just downstream of the Bon Wier to Deweyville section, were *C. lutrensis,* but the species had disappeared in this area by 1982. The relative abundance of *C. venusta* increased substantially at both sites during the same period, from 29.1% in 1969-1970 to 83.4% in 1982 at Burkeville, and populations increased from 22.5% to 53.9% at Ruliff. We suspect that the broader habitat tolerance of *C. venusta* allowed for its rapid replacement of declining populations of *C. lutrensis*.

Although *C. lutrensis* is noted for its turbidity tolerance, especially where it has been introduced beyond its native range (Ross, 2000; Boschung and Mayden, 2004), we suspect that increased turbidity downstream of the impoundment may have also contributed to *C. lutrensis* population declines. In Oklahoma, adult *C. lutrensis* were typically collected in habitats where turbidity ranged from 4 to 27 JTU (~ NTU) in August (Matthews and Hill, 1979). By comparison, our turbidity measurements, taken from the Sabine River between Bon Wier and Deweyville during July 1969 ranged from 88 to 325 JTU. Measurements taken in the same region in July 1970 ranged from 35 to 50 JTU. These elevated turbidities may have impacted *C. lutrensis* spawning either by contributing to the instability of shallow substrates or by disrupting chemical cues used to attract conspecifics during spawning events (Asbury et al., 1981).

Other post-impoundment changes that possibly affected *C. lutrensis* populations include an input of excess woody debris, loss of low-energy marginal feeding habitats, and changes in water chemistry. Large quantities of partially burned limbs, bark, and small logs were flushed downriver when TBD began operating. Much of the potential reservoir area was never cleared of timber and many piles of uprooted trees were never burned before impoundment. This debris cluttered the formerly clean, white, sandbars downriver for many miles and altered shoreline habitat. In the Colorado River of central Texas, *C. lutrensis* feed primarily in shallow water along the shore (Harwood, 1972). These areas are biologically, physically, and chemically critical for successful reproduction of *C. lutrensis* in the Sabine River. The loss of optimum conditions for a prolonged period, more than the typical life span of the species, may have played a role in the extirpation of *C. lutrensis* in the lower Sabine River. Changes in water chemistry may have also affected down-

stream minnow survival. The lower zone of the reservoir stratified chemically and thermally, and dissolved oxygen was depleted each summer. This stratification allowed iron, manganese, and hydrogen sulfide concentrations to increase to nuisance levels. Stratification usually continued until the fall of the year (Shampine, 1971). We did not measure the three above mentioned parameters during our Sabine River fish surveys, so we are unable to comment on their affect, if any, on water quality below TBD.

Our long-term sampling and observations suggest that the main channel of the Sabine River was the obvious center of *C. lutrensis* populations in the upper and lower sections of the Sabine River prior to the completion of TBD. Tributary populations of *C. lutrensis* did not repopulate the main channel after impoundment. Though we have no evidence, we suspect that tributary populations were too small and were incapable of producing sufficient numbers of individuals to outcompete rapidly expanding *C. venusta* populations. This suspicion is supported in our collection results from two Sabine River tributaries. Fifty-three samples collected at five sites along Anacoco Bayou (Fig. 1), an eastern tributary to the Sabine River, from August 1969 through January 1980 produced ten times more *C. venusta* (22,514 specimens) than *C. lutrensis* (2,249 specimens). Eleven samples collected from Big Cow Creek, a western tributary to the Sabine River at km 76, from July 1970 through November 1973 contained eight times more *C. venusta* (1,875 specimens) than *C. lutrensis* (238 specimens). The collection of *C. lutrensis* x *C. venusta* hybrids was not unexpected since both species spawn at almost the same temperatures and in the same habitats in Sabine River tributaries. We collected 12 *C. lutrensis* x *C. venusta* hybrids in 53 samples collected in Anacoco Bayou and one hybrid in 11 samples collected in Cow Creek. We never observed any evidence of hybrid swarms in any tributaries or the main stem of the Sabine River

Two other examples of post-impoundment *C. lutrensis* extirpations exhibit similar characteristics to conditions found in the lower Sabine River. In 1970, the senior author and associates began a sampling program that would eventually document the extirpation of a previously recognized introduced population of *C. lutrensis* in the Grand Canyon area of the lower Colorado River. The first records of introduced *C. lutrensis* in the lower Colorado River occurred in 1953 (Hubbs, 1954) and five locality records were documented, presumably prior to 1970 (Minckley, 1973). Powell Reservoir, the impoundment created by Glen Canyon Dam, obtained full pool level in 1968 and thereafter began discharging cool water from the bottom of the reservoir. Water discharged from Mead Reservoir (located more than 360 km downstream of Glen Canyon Dam) during the summer months was about 10°C cooler than normal river water in the area. After impoundment, five *C. lutrensis* were collected at km 194.5 in the Colorado River on 16 August 16 1971 and a single specimen was collected at km 340 (Suttkus et al., 1976; Suttkus and Clemmer, 1979). No additional *C. lutrensis* were collected even though one or two collecting trips were completed in this 360 km-long section of river every year from 1971 through 1981. Other populations of *C. lutrensis* were collected in Mead Reservoir at the mouth of Spencer Creek (km 246) and elsewhere along the shores of the reservoir where summer water temperatures were not appreciably modified by upstream releases from Glen Canyon Dam (Suttkus et al., 1976; Suttkus and Clemmer, 1979).

The creation of Lake Texoma also led to *C. lutrensis* extirpations, particularly in those tributaries that fed into the lake. In this case, though, temperature change did not play a role. The elimination process likely began during severe droughts and continued when stream recolonization was inhibited by Lake Texoma, which fragmented the original river-creek system (Matthews and Matthews, 2007). In addition, extensive high-water flooding events modified the lower reaches of these tributaries. These modifications formed deep pools near the stream mouths which favored piscivorous species (e.g., centrarchids) and provided poor habitat for *C. lutrensis*. These population changes were not detected until decades after the impoundment was completed. These delayed observations suggest that biologists should be alert to long-term changes in direct tributaries following reservoir construction (Matthews and Mathews, 2007).

Our long-term data on cyprinid declines in the lower Sabine River provide more evidence of impoundment-related negative effects on local fish populations. When essential fish habitats are altered for periods longer than the typical life span of local fishes, population recovery becomes problematic. Prolonged disturbances increase the possibility of invasion by other species. These invaders may, in turn, become numerically dominant and preclude later recolonization by the original species. Our hope is that with proper management and restoration efforts, the cyprinid fauna of the lower Sabine River can be eventually restored to its pre-impoundment abundance and diversity.

ACKNOWLEDGMENTS

Most pre-impoundment samples from Toledo Bend to Logansport were collected by students taking summer classes at Tulane University and we thank them for their efforts. All of the data files for these samples, including trainee information, were destroyed by Hurricane Katrina. These field programs were part of a Training Program sponsored by the National Institute of Health, awarded to the senior author. We thank Glenn Clemmer and Jayson S. Suttkus for their participation in most summer programs. We extend our sincerest appreciation to the late Gerald E. Gunning for his participation in collecting post-impoundment samples below TBD. We are grateful to John H. Caruso, Robert C. Cashner, John V. Conner, and the late Bruce A. Thompson for their participation in many post-impoundment surveys. William M. Brenneman participated in the long 1982 float trip from Bon Wier to Deweyville, Texas. Tulane University Biology of Fishes classes assisted in collecting fish samples upstream of Toledo Bend Reservoir in September and October 1982.

We are most appreciative of Alwyn John's expertise in salvaging our Katrina damaged copy of the Toledo Bend Reservoir map. This manuscript could not have been completed in such detail and accuracy without the retrieval of catalogued collection data in the Tulane University Museum of Natural History. We thank Henry L. Bart, the Museum Director and Nelson Rios, the Collections Manager for honoring our requests.

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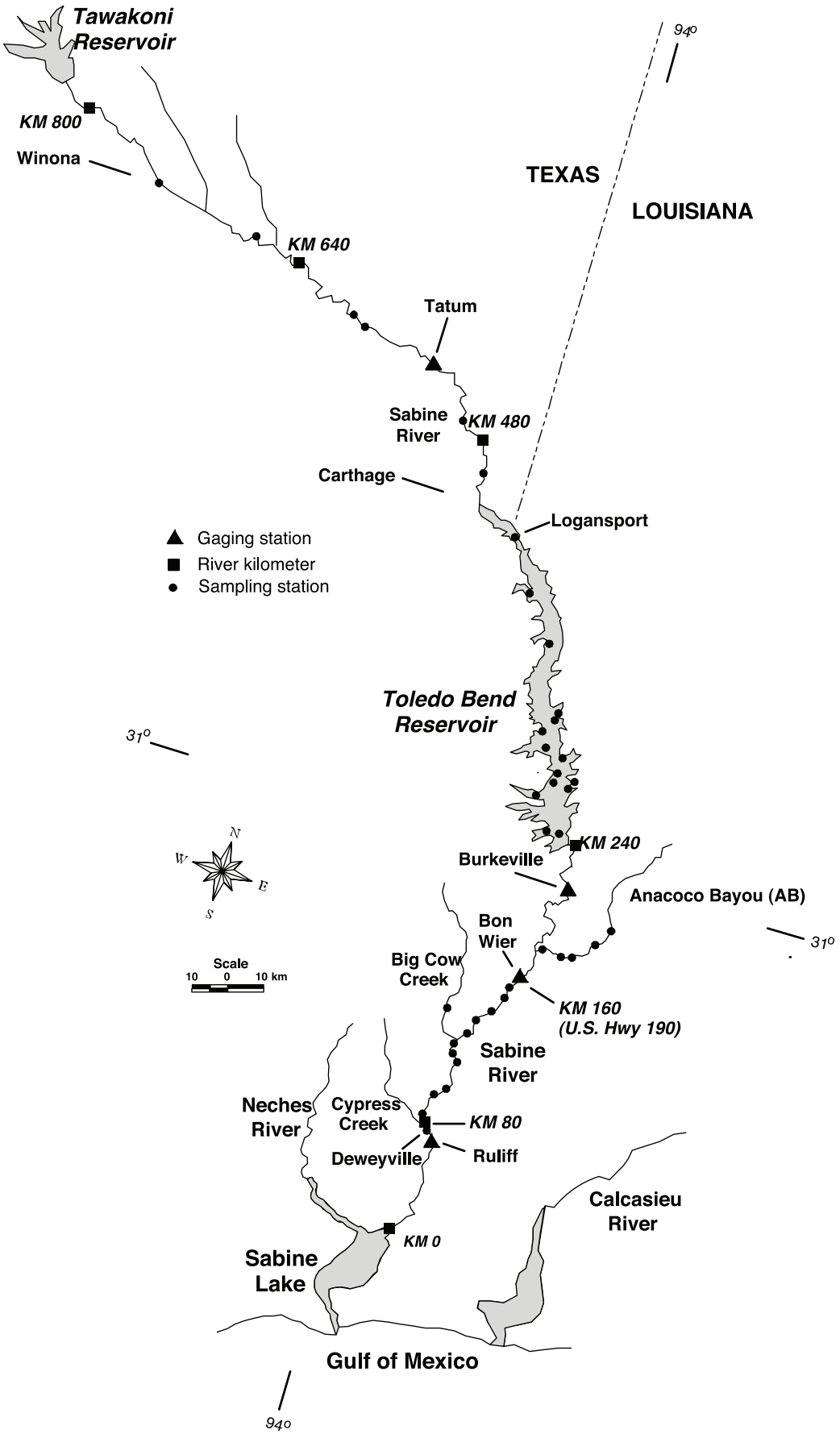

FIGURE 1. Map of the Sabine River in Louisiana and Texas showing sampling stations.

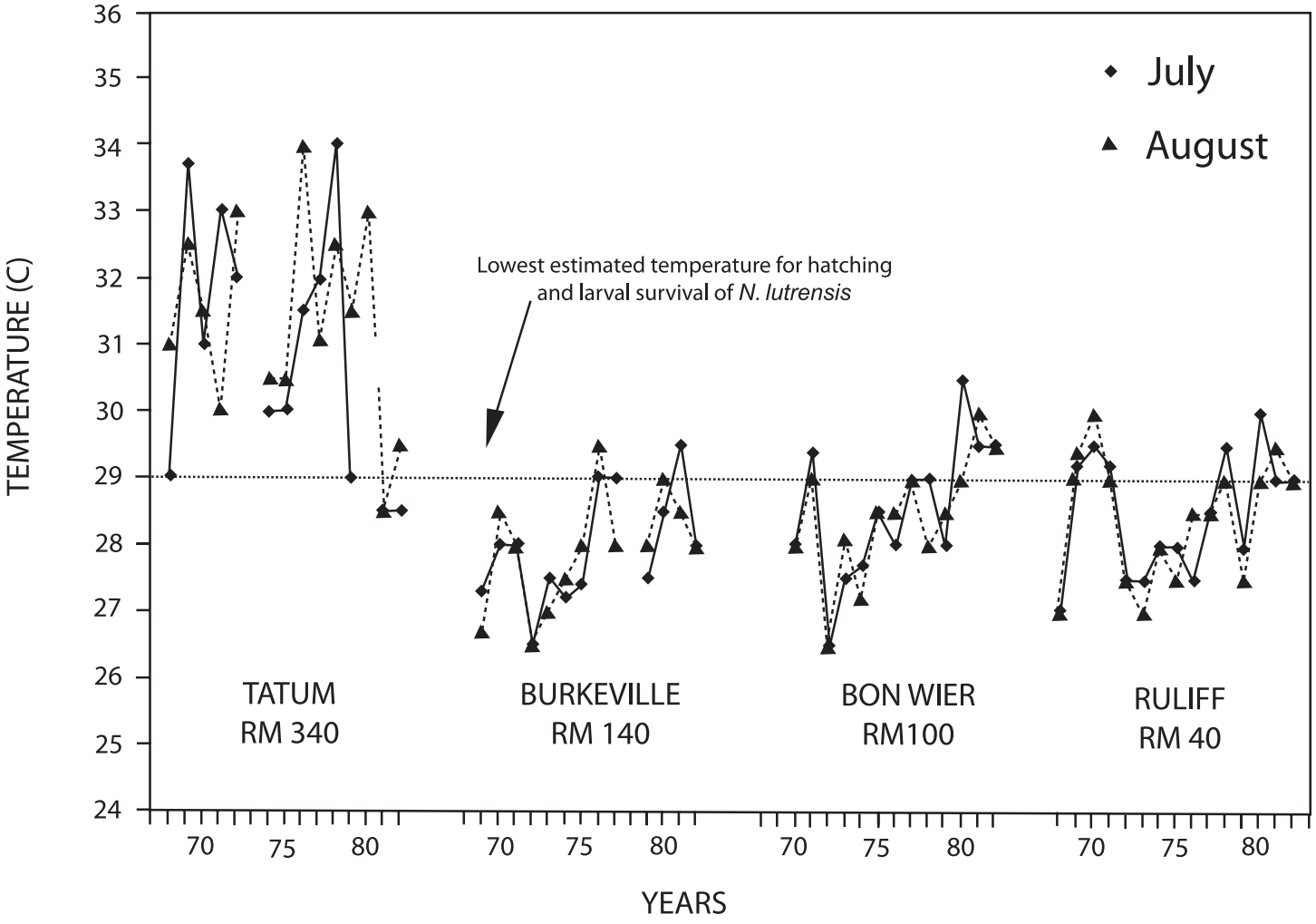

FIGURE 2. Average July and August water temperatures (°C) at four U.S. Geological Survey sampling stations (Tatum, Burkeville, Bon Weir, and Ruliff) on the Sabine River, Texas. Tatum is upstream of the Toledo Bend Reservoir while Burkeville, Bon Weir, and Ruliff are downstream of the impoundment. The horizontal line at 29°C represents the lowest estimated temperature for hatching and larval survival of *C. lutrensis*.

TABLE 1. Comparison of relative abundance of 11 minnow species collected from four regions of the Sabine River, Louisiana and Texas. Note that the 12 Logansport to Toledo Bend collections were taken prior to impoundment by the Toledo Bend Dam and that the eight Winona to Carthage collections were taken upstream of the impoundment.

River section (upstream to downstream)	RKm 240-400 Logansport to Toledo Bend	RKm 160-240 Burkeville to Bon Wier			RKm 80-160 Bon Wier to Deweyville			RKm 472-672 Winona to Carthage
Sample dates	1963-1966	1969-1970	1979-1980	July 1982	July 1969	July 1970	July 1982	Sept-Oct 1982
Total collections	12	28	28	7	10	10	10	8
Total specimens	18,969	42,889	10,910	3,582	7,264	8,944	4,139	68,620
Total species	51	50	53	31	45	44	30	46
Total minnows (%)	17,665 (93.1)	42,063 (98.1)	9,602 (88.0)	3,220 (89.9)	6,497 (89.4)	7,944 (88.8)	3,615 (87.3)	65,184 (95.0)
Total minnow species	16	15	12	9	14	15	10	16
Minnow species	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Cyprinella lutrensis	40.0	40.0	0.0	0.0	14.7	25.7	0.0	54.5
C. venusta	4.1	29.1	83.0	83.4	4.9	22.4	53.9	2.5
Hybognathus nuchalis	1.3	1.7	0.7	0.03	24.5	13.6	3.8	0.01
Hybopsis amnis	1.7	0.1	0.0	0.9	3.4	1.3	1.9	0.01
Macrhybopsis hyostoma	7.6	0.1	0.0	0.03	0.09	0.3	0.08	4.0
Notropis atherinoides	1.4	0.08	0.0	0.0	1.3	0.02	0.0	0.07
N. buchanani	19.7	1.0	0.0	0.0	0.1	0.3	0.0	1.1
N. sabinae	5.6	8.7	4.2	4.9	4.6	3.3	14.2	4.5
N. texanus	0.2	0.3	3.3	0.06	19.1	16.5	8.8	0.6
N. volucellus	1.3	1.8	2.9	5.6	13.4	5.7	7.8	0.55
Pimephales vigilax	16.4	16.9	5.5	4.9	13.2	9.0	8.0	31.6

TABLE 2. Relative abundance, percentage composition, and frequency of occurrence of 11 species of minnows (Cyprinidae) in four quarterly samples collected at seven stations on the Sabine River between Burkeville and Bon Wier, 1969-1970 and 1979-1980.

Species	1969-70	% of all minnows collected	Frequency of occurrence in 28 samples	1979-80	% of all minnows collected	Frequency of occurrence in 28 samples
Cyprinella lutrensis	16,829	40.1	28	0	0.0	0
Cyprinella venusta	12,231	29.1	28	7,968	83.3	28
Pimephales vigilax	7,105	16.9	28	532	5.6	23
Notropis sabinae	3,671	8.7	28	405	4.2	23
Notropis volucellus	766	1.8	23	278	2.9	21
Hybognathus nuchalis	715	1.7	24	65	0.6	11
Notropis buchanani	405	1.0	16	0	0.0	0
Notropis texanus	145	0.3	16	316	3.3	17
Hybopsis amnis	62	0.1	8	0	0.0	0
Macrhybopsis hyostoma	60	0.1	5	0	0.0	0
Notropis atherinoides	35	0.1	10	0	0.0	0
Total specimens	42,024			9,564		

The Desperate Dozen: Southeastern Freshwater Fishes on the Brink

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THE DESPERATE DOZEN: AN INTRODUCTION

Aquatic animals have experienced dramatic declines in recent decades (Abell et al., 2000). There are currently 582 species of animals on the Federal list of Endangered and Threatened species, of which 268 (46%) are found in freshwater habitats. Of the diverse assemblage of 675 fishes found in southeastern waters, more than a quarter are considered imperiled (Warren et al., 2000). While all of the Earth's ecosystems are threatened to some extent, freshwater habitats are recognized to be at severe risk because of their scarcity and the high demands placed on them by humans (Vitousek, 1997; Wood et al., 2000; Postel, 2002). The combined effects of agriculture, damming, dredging, construction, logging, overharvest, and pollution are destroying this critical resource for animals, plants, and even humanity itself (Master, 1990; Richter et al., 1997). This major conservation crisis calls for immediate action to conserve and protect the remaining populations and their habitats.

When resources are limited, one of the most important steps in conservation is prioritization (Master, 1991; Possingham et al., 2002). We sought to determine where immediate conservation actions were needed to prevent loss of native southeastern freshwater fish diversity. We decided to focus our efforts on the Desperate Dozen fishes, the 12 species that local and regional experts would identify as the most likely to become extinct in the Southeast. Our goal is to use this list to raise awareness of the plight of freshwater habitats in the Southeast, including rivers, creeks, wetlands, springs, and caves (Abell et al., 2000). By highlighting these 12 species, ranging from the spring pygmy sunfish (*Elassoma alabamae*) to the Alabama sturgeon (*Scaphirhynchus suttkusi*), we hope to encourage partnerships to address the needs of our freshwater animals and hopefully prevent them from slipping into extinction.

We created the initial list of the most imperiled southeastern fishes by using species listed as Endangered or Threatened by Warren et al. (2000), eliminating those species outside of the range of the Southeast as defined by the Southeastern Fishes Council (SFC) constitution. Species described since 2000 were added to the list, but undescribed species were not included in the ranking. Lists of imperilment created by the U.S. Fish and Wildlife Service (USFWS) or state wildlife agencies were not consulted in SFC's identification of the Desperate Dozen fishes at any stage of the process. The Southeastern Fishes Council Executive Committee (SFC ExCom) was asked to review and rank the initial list of 40 species. Criteria used for ranking, in order of importance, were distribution, number of populations, low abundance, and severity of threats. Species were not chosen to represent a broad geographic or taxonomic spectrum, nor based on the ease or potential success of their recovery.

Through this ranking system, the SFC ExCom developed a list of 14 potential Desperate Dozen species, with a brief synopsis on the status of each. This list was sent to four reviewers. Two responded with their ranking of the potential species and included three other species to consider. The SFC ExCom then ranked these 17 species, all listed as Endangered in the latest list of the conservation status of imperiled freshwater fishes of North America (Jelks et al., 2008). The 12 most highly ranked species from the SFC ExCom and external reviewers were selected as the Desperate Dozen. After the ranking based on level of imperilment, species were arranged in phylogenetic order so that all would receive equal attention. We contacted experts on each species to provide the following brief accounts on the Desperate Dozen, which include background, distribution, abundance, threats, and proposed conservation actions.

The Desperate Dozen:

Alabama sturgeon, *Scaphirhynchus suttkusi*
Slender chub, *Erimystax cahni*
Chucky madtom, *Noturus crypticus*
Alabama cavefish, *Speoplatyrhinus poulsoni*
Pygmy sculpin, *Cottus paulus*
Diamond darter, *Crystallaria cincotta*
Vermilion darter, *Etheostoma chermocki*
Relict darter, *Etheostoma chienense*
Bayou darter, *Etheostoma rubrum*
Pearl darter, *Percina aurora*
Conasauga logperch, *Percina jenkinsi*
Spring pygmy sunfish, *Elassoma alabamae*

The Desperate Dozen is represented by taxa that belong to seven families of fishes: a sturgeon (Acipenseridae), a minnow (Cyprinidae), a catfish (Ictaluridae), a cavefish (Amblyopsidae), a sculpin (Cottidae), six darters (Percidae), and a pygmy sunfish (Elassomatidae). Five species are restricted to Alabama, two in Mississippi, and one each in Kentucky, Tennessee, and West Virginia. Two species are found in two states: the slender chub (*E. cahni*) in Tennessee and Virginia and the Conasauga logperch (*P. jenkinsi*) in Tennessee and Georgia (Fig.1). Seven species have always been restricted to a small area, some to a single spring or cave, while four were historically wider ranging. Half of the Desperate Dozen occupy smaller bodies of water (e.g., springs, cave pools, creeks), while the other half live in medium and large rivers (Table 1). The main threat for all of these species is their relatively restricted ranges, where one acute pollution or habitat destruction event could cause extinction (Johnson, 1998; Purvis et al., 2000). Habitat alteration also impacts all species, from dams, channelization, and head-cutting in rivers and creeks to pumping of groundwater and the presence of impervious surfaces in recharge areas for caves and springs (Richter et al., 1996; Watters, 1999; Wenger et al., 2008). All of these habitat alterations potentially lead to population fragmentation (Dynesius and Nilsson, 1994; Richter et al., 1997). Water pollution, especially sedimentation, is also a pervasive problem for all Desperate Dozen species (Table 2). The recent severe drought in the southeastern U.S. coupled with burgeoning human population growth has placed additional stress on aquatic habitats (Manuel, 2008).

While each Desperate Dozen species has its own specific set of threats, many proposed conservation actions are similar. Those species occupying smaller habitats and ranges can greatly benefit from a watershed management plan that involves all public and private stakeholders in mitigating current conditions that contribute to habitat degradation and planning for wise future development (Leach et al., 2002; Bohn and Kershner, 2002). Watershed management plans require cooperation and coordination between municipal, state, federal, and non-government agencies, but can be relatively inexpensive, which is very important in times of economic shortfalls (Selin and Chevez, 1995; Heathcote, 1998). Other commonly recommended conservation actions for the Desperate Dozen include monitoring abundance, assessing water quality and quantity, surveying for additional populations, developing propagation programs, and examining the genetic diversity within and between populations (Table 3).

Only 8 of the Desperate Dozen are listed by the USFWS: 5 are Endangered and 3 are considered Threatened. Two are Candidate species for listing and 2 have no federal status (Table 4). Of the 8 listed species, only 4 have critical habitat determined and 6 have approved recovery plans. We encourage the use of all available recovery options under the Endangered Species Act to begin the process of habitat restoration and recovery for these species.

At every stage of this process, it was clear that many other fishes also deserved to be on a list of species in a desperate need for conservation action. While our call to action is targeted at only 12 species, the principles behind their recovery must be applied throughout Southeastern drainages. Without immediate, coordinated action, the Southeast stands to lose far more than just the Desperate Dozen.

ACKNOWLEDGMENTS

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Scaphirhynchus suttkusi – Alabama Sturgeon

Background: One of the rarest vertebrates globally, the Alabama sturgeon is the smallest of eight North American sturgeon species (maximum 30.7 in [78 cm] fork length). Its description in 1991 (Williams and Clemmer, 1991) was followed by years of controversy regarding its taxonomic status even though numerous morphological and genetic studies support its validity as a species (Mayden and Kuhajda, 1996; Campton et al., 2000; Simons et al., 2001; Ray et al., 2007). The Alabama sturgeon was federally listed as Endangered in 2000 (USFWS, 2000a) and critical habitat was designated in 2009 (USFWS, 2009). This species is state protected in Alabama (ALDWFF, 2007) and considered a species of Highest Conservation Concern (Kuhajda, 2004a).

Distribution: Historical collection records and reports indicate the range of the Alabama sturgeon encompassed 1600 km of large rivers, including the Black Warrior, Tombigbee, Alabama, Cahaba, Coosa, Tallapoosa, Mobile,

and Tensaw rivers (Burke and Ramsey, 1995). Currently it occupies only 524 km of its historical range in the lower Cahaba River and Alabama River in south Alabama (USFWS, 2009).

Abundance: No population estimates available; very rare. An estimated 19,000 Alabama sturgeon were commercially harvested in 1898 (Mayden and Kuhajda, 1996), indicating an abundant historic population. However, very little information on abundance existed between 1898 and the early 1980s, although collection data and anecdotal reports indicated a general decline in abundance (USFWS, 2005a). Sampling efforts in the mid-1980s yielded only six Alabama sturgeon (Burke and Ramsey, 1985) with an additional five specimens collected from 1997 to 1999 (Rider and Hartfield, 2007). Over the last nine years only two specimens have been collected, one captured and released in the lower Cahaba River in 2000 and the other captured, sonic tagged, and released below Claiborne Lock and Dam in 2007.

Threats: Extremely small population size increases vulnerability to extinction. Historic unrestricted commercial harvesting likely triggered the initial decline of the Alabama sturgeon (USFWS, 2005a). Thereafter, years of habitat alteration proved detrimental, with large dams and navigation locks fragmenting free-flowing riverine habitats into a series of impoundments. These structures block migratory routes to spawning grounds and disrupt natural flow patterns leading to unsuitable conditions for feeding and larval development. Extensive dredging in the Mobile Basin has reduced or eliminated stable substrates, shoal areas, snags, channel sinuosity, and heterogeneous flows (USFWS, 2000b).

Proposed Conservation Actions:
1. Continue tracking of sonic tagged individual to identify new sampling sites and provide information on current habitat requirements.
2. Continue sampling for viable adults to establish propagation program.
3. Pursue fish passage at the 3 U.S. Army Corps of Engineers (USACE) hydro and navigation projects on the Alabama River.
4. Develop a baseline water quality model for the Alabama River.
5. Protect and maintain current habitat conditions.

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***Erimystax cahni* – Slender Chub**

Background: The slender chub (maximum 3.7 in [94 mm] total length [TL]) was described in 1956 (Hubbs and Crowe, 1956). At that time it had not been collected in 17 years, but it was rediscovered in the Powell River in 1964 (Davis and Reno, 1966). The slender chub was listed as federally Threatened with critical habitat designated in 1977 (USFWS, 1977). A recovery plan has been developed (USFWS, 1983) and relationships within the genus have been determined (Harris, 1986; Simons, 2004). It is currently listed by Tennessee and Virginia as Threatened (TDEC, 2004; VDGIF, 1987). Previous conservation actions include a status review (Burkhead and Jenkins, 1982) and several status surveys (see below).

Distribution: Historically known from the Clinch, Powell, and Holston rivers in the upper Tennessee River drainage, northeastern Tennessee, and southwestern Virginia. In the past quarter century the slender chub has been known from fewer than 100 river km in the Powell and Clinch rivers in Tennessee and Virginia (Harris, 1986; Etnier and Starnes, 1993; Jenkins and Burkhead, 1994).

Abundance: No population estimates available; very rare. Through 1987, a total of only ~420 individuals had been collected as a result of ~90–100 collecting efforts in the Clinch and Powell rivers (Hubbs and Crowe, 1956; Davis and Reno, 1966; Burkhead and Jenkins, 1982; Jenkins and Burkhead, 1991; R. Mayden, pers. comm.). Eight specimens were captured in a single collection in 1987 in the Clinch River (R. Mayden pers. comm.), but since then only a single specimen has been collected (1996, D. Etnier pers. comm.) in the Clinch River. Despite intensive efforts during favorable conditions in both the Clinch and Powell rivers, including over 740 person-hours effort since 2000, no additional specimens have been found.

Threats: Reduced range increases vulnerability to extinction. Severe chronic and acute water pollution from factories, sewage, and coal mines, excessive sedimentation from agricultural runoff, and gravel removal threaten slender chub populations and habitat. The highly porous karst geology and relatively narrow floodplains elevate nutrients and pollutants leeching into the Clinch and Powell rivers (Etnier and Starnes, 1993; Jenkins and Burkhead, 1994).

Proposed Conservation Actions:
1. Continue to conduct surveys in order to determine the status of this species.
2. Determine the causes of decline, using a surrogate species if necessary, and minimize or eliminate threats utilizing legal mechanisms to protect the species and its habitat (i.e., land acquisition and conservation easements; controlling or restricting mining, pollution, and poor agricultural practice).
3. If individuals are collected, determine the best methods

for protecting and increasing the population numbers (e.g., captive propagation and reintroduction of adults or juveniles or both).

4. Address potential genetic concerns, such as possible hybridization.
5. Gather life history information, including specific invertebrate food items and critical food population levels necessary for the slender chub, which are currently unknown.

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Noturus crypticus – Chucky Madtom

Background: The distinctiveness of the Chucky madtom, a small catfish (maximum size 2.9 in [74 mm] TL), was noted in 1969 (Taylor, 1969), but the species was not described until 2005 when additional comparative material became available (Burr et al., 2005). This species is listed as Endangered by the state of Tennessee (TDEC, 2004). Federal listing of *N. crypticus* as the undescribed Chucky madtom was first discussed in 1994 (USFWS, 1994a) and was given official Candidate status 12 years later (USFWS, 2002). Original listing priority for *N. crypticus* was level 2 and has not changed through subsequent reviews (USWFS, 2004; 2005b; 2006; 2007a). The USFWS has funded multiple surveys and worked with the Middle Nolichucky Watershed Association on an action plan for Little Chucky Creek. Seven Partners for Fish and Wildlife projects have been completed in the Little Chucky Creek watershed with support from the Greene County Soil Conservation District, the Natural Resources Conservation Service, the Tennessee Valley Authority, and the Tennessee Wildlife Resources Agency. These projects have installed riparian fencing, stabilized banks, and created alternate water sources for livestock.

Distribution: Historically known from only two streams in the French Broad River system of the upper Tennessee River drainage in northeastern Tennessee. It is considered extirpated from Dunn Creek (Little Pigeon River system, Sevier Co., TN) where a single specimen was collected in 1940, and is known recently (1991–2004) from two sites separated by 3 river km in Little Chucky Creek (Nolichucky River system, Greene Co., TN). The species may also have been found in the middle Tennessee River drainage in Alabama (Piney Creek and Flint and Paint Rock rivers), but positive identification of specimens is not possible due to extreme fading of pigments (Burr et al., 2005).

Abundance: No population estimates are available, but *N. crypticus* is very rare and both temporally and spatially patchy within its known range. The largest collection, nine specimens from the two Little Chucky Creek sites over two days, was made in 1994 and, despite intensive field surveys by several independent groups, only three specimens have been captured since (1 in 2000 and 2 in 2004, for a total of 14 known specimens) (Burr and Eisenhour, 1994; Shute et al., 1997; Lang et al., 2001; 2005; Weber and Layzer, 2007).

Threats: Extremely small range increases its vulnerability to extinction. Sedimentation from poor agricultural practices, including erosion due to removal of riparian vegetation and livestock access to the streambed have visibly degraded habitat in Little Chucky Creek (USFWS, 2005b). It is also possible that chemical contamination from agricultural runoff has an adverse effect, including chemical noise interfering with the chemosensitivity of catfishes (Etnier and Jenkins, 1980).

Proposed Conservation Actions:

1. Within the Little Chucky Creek watershed, it is imperative that the successful Partners for Fish and Wildlife projects are monitored, supported, and extended to new areas. The focus of these agreements has been and should continue to be improvement of stream conditions via a watershed management plan.
2. A captive breeding program must be developed so it can be activated quickly upon the capture of additional specimens.
3. There should be a continuous and intensive survey effort throughout the French Broad River system that utilizes a wide variety of sampling methods throughout the year.

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Speoplatyrhinus poulsoni – Alabama Cavefish

Background: The rarest and most cave-adapted of only five species of North American cavefishes, the Alabama cavefish (maximum size 2.8 in [70 mm] TL) is white, lacks eyes and pelvic fins, and has a snout with a bill-like appearance (Kuhajda, 2004b). It was described in 1974 (Cooper and Kuehne, 1974), listed as federally Threatened with critical habitat in 1977 (USFWS, 1977), and reclassified as Endangered in 1988 (USFWS, 1988). A revised recovery plan was approved in 1990 (USFWS, 1990). The Alabama cavefish is state protected in Alabama (ALDWFF, 2007) and considered a species of Highest Conservation Concern (Kuhajda, 2004b). Previous conservation actions include status surveys in the 1980s, 1990s, and most recently in 2008-09, and the establishment of the Key Cave National Wildlife Refuge in the high recharge area of the Key Cave aquifer (Kuhajda and Mayden, 2001; Kuhajda, 2004b).

Distribution: Restricted to Key Cave in Lauderdale County in northwestern Alabama within the Tennessee River drainage (Kuhajda and Mayden, 2001).

Abundance: Extremely rare with a total population estimated to be less than 100 individuals. The maximum number observed during a single visit to the cave was 10 individuals (Kuhajda and Mayden, 2001).

Threats: Extremely small native range, subterranean specialization, and complete reliance on Key Cave aquifer increases vulnerability to extinction. The Key Cave aquifer and recharge area are threatened by urban and industrial growth which can lead to lowering of water table, diminished winter flows (cues to synchronize spawning), and acute and chronic water pollution (Kuhajda, 2004c). Disruption of the gray bat (*Myotis grisescens*) colony could interrupt critical nutrients entering the deep cave ecosystem (Kuhajda, 2004b; 2004c).

Proposed Conservation Actions:

1. Protect Key Cave aquifer by more precisely delineating the recharge area and by using a management plan that addresses urban and industrial growth and agricultural practices within the unprotected recharge area to prevent lowering of water table, diminished winter flows (cues to synchronize spawning), and acute and chronic water pollution. This includes consistent networking and collaboration between federal and state agencies, non-government organizations, local governments and businesses, and private landowners to formulate unique strategies to protect groundwater.
2. Establish regular status surveys for Alabama cavefish and gray bats and monitor water quality and quantity in Key Cave to detect any issues in a timely manner.
3. Gather additional population and life history information for the Alabama cavefish.
4. Unsurveyed caves in the vicinity of Key Cave that have pools should be examined for additional populations of Alabama cavefish.

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Cottus paulus – Pygmy Sculpin

Background: The smallest sculpin in North America (rarely greater than 1.5 in [38 mm] standard length [SL]), the pygmy sculpin was originally described as *Cottus pygmaeus* in 1968 (Williams, 1968) and renamed as *C. paulus* in 2000 (Williams, 2000). It was listed as federally Threatened in 1989 (USFWS, 1989a), is state protected in Alabama (ALDWFF, 2007), and considered a species of Highest Conservation Concern (Stiles and Warren, 2004). Previous conservation actions include implementation of a minimum daily flow of the spring and water quality monitoring within the spring recharge area. Studies on pygmy sculpin have included population monitoring, habitat use (Johnston, 2001), reproductive biology (Johnston, 2000) and competitive interactions with variable crayfish (*Cambarus latimanus*; Johnston 2003) and banded sculpin (*Cottus carolinae*).

Distribution: Restricted to Coldwater Spring and spring run in east-central Alabama in the Coosa River drainage.

Abundance: Approximately 25,000 individuals in the spring pool and 2,500 in the spring run.

Threats: Extremely small native range and complete dependence on Coldwater Spring aquifer increases vulnerability to extinction. Although it is protected in the spring with an agreement between USFWS and the Anniston Water Works and Sewer Board (which removes less than half of the 32 million gallons per day outflow), groundwater contamination is a concern from the nearby Anniston Army Depot where hazardous compounds are stored (USFWS, 1991). Banded sculpin, which are excluded from the spring pool by a weir, are a potential predation threat to pygmy sculpin in the spring pool. Predation or competition with this species, together with limited habitat and changes in water quality, may limit the population size of pygmy sculpin in the spring run and its distribution in Coldwater Creek.

Proposed Conservation Actions:

1. Continue to develop and implement methods for removal of contaminants from Dry Creek and the recharge area of the aquifer. Environmental Protection Agency, USFWS, and the U.S. Army are working

towards decreasing the threat of groundwater contamination.

2. Continue working with Anniston Water Works and Sewer Board to maintain minimum spring flows. Continue water quality monitoring (Coldwater Spring) and groundwater monitoring by other agencies (wells throughout spring recharge area and Dry Creek).
3. Establish a monitoring program for pygmy sculpin in the spring pool and run. This program should account for variation in numbers with habitat type.
4. Implement regular monitoring of Coldwater and Dry creeks for pygmy and banded sculpins.

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Crystallaria cincotta – Diamond Darter

Background: One of only two species of darters in the genus *Crystallaria*, the diamond darter (maximum size 3 in [77 mm] SL) was described recently (Welsh and Wood, 2008) and not yet been reviewed for federal listing, but is considered critically imperiled in West Virginia (WVDNR, 2007). Previous conservation actions include genetic analyses (Wood and Raley, 2000; Morrison et al., 2006), a distribution and habitat assessment (Osier, 2005), and a threat assessment (Strager, 2008).

Distribution: Historically occurred within the Ohio River basin in the Cumberland, Elk, Green, and Muskingum River drainages in Kentucky, Ohio, Tennessee, and West Virginia (Welsh and Wood, 2008; Welsh et al., 2009). Extirpated from Kentucky (Burr and Warren, 1986), Ohio (Trautman, 1957), and Tennessee (Etnier and Starnes, 1993); extant within the lower 36 km of the Elk River in west-central West Virginia (Cincotta and Hoeft, 1987; Welsh and Wood, 2008).

Abundance: No population estimates available; very rare. Despite concerted sampling efforts, only 16 individuals collected from Elk River in 28 years; 12 individuals collected during the period of 1980 to 2005 (Welsh and Wood, 2008) and 4 collected in 2008 (S. Welsh, unpublished data).

Threats: Reduced range increases vulnerability to extinction. Large dams, river channel and flow modifications, water quality degradation from urban and rural sources, excessive sedimentation, and the effects of habitat fragmentation are likely principal causes for its widespread extirpation. Its rarity in the Elk River may be attributed to degradation of benthic habitats by sedimentation (Grandmaison et al., 2003; Strager, 2008).

Proposed Conservation Actions:

1. Conduct additional sampling and monitoring of the Elk River population to assess occupancy rates and further define its range.
2. Sample additional streams within the Ohio River drainage where populations were previously present.
3. Initiate a captive breeding program if and when appropriate broodstock can be obtained. Maintain a captive population and draft a plan for a reintroduction program. Include studies of reproductive biology and early life history as additional components of the captive breeding program.

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Etheostoma chermocki – Vermilion Darter

Background: This brightly colored darter (maximum size 2.4 in [60 mm] SL) was described in 1992 (Boschung et al., 1992) and was listed as federally Endangered in 2001 (USFWS, 2001). It is state protected in Alabama (ALDWFF, 2007) and considered a species of Highest Conservation Concern (Blanchard and Drennen, 2004). Previous conservation actions include status surveys (Blanco et al., 1995; 1996; Blanco and Mayden, 1997; Stiles and Blanchard, 2003; Khudamrongsawat, 2007), examination of population genetics (Khudamrongsawat, 2007), a life history study (Khudamrongsawat et al., 2005), and propagation techniques using the Warrior darter (*Etheostoma bellator*) as a surrogate (Rakes and Shute, 2005a). In addition, a federal recovery plan has been developed for this species (USFWS, 2007b).

Distribution: Restricted to only 12 km of Turkey Creek and two of its tributaries in the Locust Fork system of the Black Warrior River drainage in north-central Alabama (Blanchard and Drennen, 2004).

Abundance: Small population estimated from 1,667 to 2,919 individuals in the late 1990s (Blanco, 2001). Variably common at scattered locations within its range, however several populations have shown significant decline since 1990s (Stiles and Blanchard, 2003; USFWS, 2007b).

Threats: Extremely small native range and fragmented populations within that range plus benthic specialization increases vulnerability to extinction. The species occu-

pies an area of increasing and often poorly regulated urban and industrial development which has lead to heavy sedimentation, eutrophication, streambed modifications, as well as flashy runoff and fluctuating flows (Blanchard and Drennen, 2004; USFWS, 2007b).

Proposed Conservation Actions:

1. Continue to work with public and private stakeholders on sustaining and improving the watershed management plan designed to encourage best management practices in construction, forestry, and agriculture. Efforts should be made to help reduce sedimentation, nonpoint source pollution, and stormwater runoff and also improve water quality while protecting and enhancing riparian zones. Current stakeholders, including Jefferson County, the city of Pinson, the Society to Advance Resources at Turkey Creek, Freshwater Land Trust, and the State of Alabama, have made significant gains in protecting the area within the Turkey Creek watershed**.**
2. Establish regular status surveys of existing populations and continue monitoring stream habitats, water quality, and flows.
3. Obtain additional life history and habitat data.
4. Develop and implement a habitat restoration plan.

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Etheostoma chienense – Relict Darter

Background: The relict darter only reaches a maximum size of 3 in [76 mm] SL. It was described in 1992 (Page et al., 1992) and listed as federally Endangered in 1993 (USFWS, 1993). It is listed in Kentucky as Endangered and is considered a species in need of conservation action (KSNPC, 2005; KDFWR, 2005). A draft recovery plan was issued in 1994 (USFWS, 1994b), but a final plan has not been completed. A 5-year review was recently completed (USFWS, 2008). Previous conservation actions include information on distribution and abundance, threats, and reproductive biology. For example, the use of artificial spawning substrates, such as ceramic tiles, has been found to enhance reproduction (Piller and Burr, 1999). Other conservation actions included increased efforts to work cooperatively with landowners to restore habitat and reduce impacts through better land use practices (e.g., Partners for Fish and Wildlife projects).

Distribution: Endemic to the Bayou du Chien drainage, a direct tributary of the Mississippi River, in extreme southwestern Kentucky. It is currently known from 16 sites in five streams in the upper half of Bayou du Chien drainage (Piller and Burr, 1998).

Abundance: Rare, population size estimated as 9,533–31,293 individuals occupying 47 linear km (29.3 mi.) of stream (Piller and Burr, 1998). Current population size and abundance estimates are unknown.

Threats: Extremely small native range and population fragmentation resulting from habitat deterioration increases vulnerability to extinction. Current regulatory mechanisms have been inadequate to prevent negative impacts to existing populations from channelization, riparian vegetation removal, siltation from poor land-use practices, drainage of riparian wetlands, and pollutants from municipal wastewater plants, resource extraction activities, and agricultural livestock operations. Low abundance levels observed make populations more vulnerable to extirpation from toxic chemical spills, habitat modification, siltation, and nonpoint-source pollution (Piller and Burr, 1998).

Proposed Conservation Actions:

1. Continue to protect, restore, and enhance habitat quality throughout the drainage through cooperative efforts by federal and state agencies and private stakeholders, especially in areas where reproduction has been documented (e.g., Jackson Creek).
2. Complete new survey of Bayou du Chien drainage to determine current status and distribution of the relict darter and associated fish species.
3. Evaluate genetic exchange between populations and genetic variation within populations to assess long-term viability of the species.
4. Determine habitat preferences and movements of larvae and juveniles.
5. Further explore the use of artificial spawning substrates (ceramic tiles, etc.) to enhance reproduction.

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Etheostoma rubrum – Bayou Darter

Background: The bayou darter is one of the smallest members of the subgenus *Nothonotus*, only reaching a maximum size of 2.2 in [57 mm] SL (Page, 1983; Ross, 2001). It was described in 1966 (Raney and Suttkus, 1966) and was listed as Threatened in 1975 (USFWS, 1975). It is designated by Mississippi as Endangered (MMNS, 2001). A revised recovery plan was approved in 1989 (USFWS, 1989b). Previous conservation actions include status surveys (Ross et al., 1992), population estimates (Ross et al., 2001), conservation genetics (Wood, 1996; Slack et al., *in press*) and studies focusing on basic life history (Knight and Ross, 1992; 1994; Ross and Wilkins, 1993; Slack et al., 2004).

Distribution: The bayou darter inhabits Bayou Pierre and lower sections of its major tributaries in southwestern Mississippi (Ross et al., 1992; 2001; Slack et al., 2004). The species tends to not occur in headwater reaches and is noticeably absent from Little Bayou Pierre despite the occurrence of suitable habitat (Ross et al., 1992).

Abundance: Greatest densities occur in the zone of active headcutting, primarily in the middle section of Bayou Pierre and the lower portion of Foster Creek, ranging from 3–10 individuals/m^2, but most sites with darters support <1 individual/m^2 (Ross et al., 2001).

Threats: Extremely small native range and population fragmentation resulting from headcutting increases vulnerability to extinction. Bayou Pierre is experiencing accelerated erosion in the form of headcutting as the system stabilizes from downstream channel modifications such as meander cutoffs, channelization, and in-stream and bankside gravel mining (Patrick et al., 1991a; b; Ross et al., 2001). The bayou darter has moved upstream following the zone of active erosion in response to development of upstream riffle habitat (Ross et al., 1992; Ross et al., 2001). From 1940 to 1994, the rate of knickpoint movement has varied from 48 to 750 m/year (Patrick et al., 1991b; Ross et al., 2001). Once the headcutting cycle reaches the headwaters, however, it is uncertain how much suitable habitat will remain. While headcutting results in the creation of upstream riffle habitat, it also promotes sedimentation of suitable downstream habitat. The bayou darter continues to persist downstream of the active headcut, but in low numbers.

Proposed Conservation Actions:

1. Reduction or cessation of activities that exacerbate headcut formation and knickpoint migration.
2. Continue promoting landowner cooperation by negotiating cooperative agreements with local stakeholders (board of supervisors, private landowners, timber companies, highway departments) to reduce erosion within the system by establishing conservation easements and streamside buffer zones and also implementing bank stabilization programs to restore previously damaged areas. Some examples of these efforts include establishing Partners for Fish and Wildlife agreements with landowners for small-scale bank stabilization projects, continued dialogue between USFWS and timber companies concerning the importance of watershed conservation, and providing recommendations to Mississippi Department of Transportation and National Park Service regarding bank stabilization projects in proximity to the Bayou Pierre watershed.
3. Restrict gravel mining in or near Bayou Pierre.

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Percina aurora – Pearl Darter

Background: The Pearl darter only reaches a maximum size of 2.4 in [60 mm] SL. It was described in 1994 (Suttkus et al., 1994) and listed as a Candidate for federal protection in 1999 (USFWS, 1999). It is designated by Mississippi as Endangered (MMNS, 2001). Previous conservation actions include status surveys (Bart and Piller, 1997; Bart et al., 2001; Ross et al., 2000; Slack et al., 2002; 2005), conservation genetics (Dugo et al., 2008), and studies focusing on captive propagation (Ross et al., 1998; Schofield et al., 1999; CFI, 2003; Schofield and Ross, 2003).

Distribution: The species is historically known only from the Pearl and Pascagoula River drainages in south-central and southeastern Mississippi and extreme eastern Louisiana. Pearl darters have not been taken in the Pearl River since 1973 and are considered extirpated from that system (Suttkus et al., 1994; Bart and Piller, 1997).

Abundance: The species is uncommon and rarely encountered in routine sampling. In targeted sampling it has been collected in abundances as high as 58 individuals per day in the Pearl River and 32 individuals per day in the Pascagoula River (Slack et al., 2005). No population estimates are available.

Threats: The species persists only in the Pascagoula River system and thus occupies less than 50% of its former range. The Pearl darter depends on mainstem portions of rivers, and its demise in the Pearl River was likely the result of completion of Ross Barnett Reservoir, which

caused geomorphic instability in the lower Pearl River, and low sill dams constructed to serve the West Pearl Navigation Waterway, which blocked migration to upstream spawning areas. This species is vulnerable to nonpoint-source pollution, urbanization, and changes in river geomorphology due to its localized distribution (Bart et al., 2001; Schofield and Ross, 2003). Increased urban and commercial development within the Pascagoula River watershed may result in increased runoff, sedimentation, and water withdrawal and discharge from the waterway.

Proposed Conservation Actions:

1. Investigate geomorphic changes in the Pearl and Pascagoula river systems and the relationship of these changes in the Pearl River to Ross Barnett Reservoir and flow regime changes in the West Pearl River. Explore conservation advantages of removing low sill dams associated with the defunct West Pearl Navigation Waterway.
2. Continue developing protocols for captive rearing including thermal tolerances and survivorship. The USFWS initiated a propagation program for this species in 2003 with Conservation Fisheries, Inc. (CFI), but the program has been met with limited success.
3. Develop a more integrated program demonstrating the importance of maintaining natural hydrologic regimes and adequate bankside vegetation in the Pearl and Pascagoula rivers. A partnership of the Pascagoula River Watershed Team, the USACE, the Pearl River Water Management District, and The Nature Conservancy could develop such a program.

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Percina jenkinsi – Conasauga Logperch

Background: A long, tiger-striped darter (maximum size 4.6 in [116 mm] SL), the Conasauga logperch was first captured in 1969 and described in 1985 (Thompson, 1985). It was listed as federally Endangered with critical habitat designated in 1985 (USFWS, 1985) and a recovery plan was completed in 1986 (USFWS, 1986). The Conasauga logperch is designated by Georgia and Tennessee as Endangered (TDEC, 2004; GADNR, 2006). Previous conservation efforts have largely focused on habitat restoration with cooperative landowners, including stream bank restoration and installing riparian buffers. Captive propagation was attempted by CFI in 2002, but initial efforts were unsuccessful (Rakes and Shute, 2005b). Ongoing efforts funded by USFWS, U.S. Forest Service, and U.S. Geological Survey include a study of conservation genetics (George et al., *in review*), surveys to estimate occupancy and detection (Freeman et al., 2006), and water quality monitoring in the Conasauga River (Freeman et al., 2006).

Distribution: Restricted to 55 river km of the mainstem Conasauga River (Coosa River system of the Mobile Basin) in northwestern Georgia and southeastern Tennessee (Thompson, 1985; George et al., *in review*).

Abundance: The best available estimate suggests a population size of 200 adults (George et al., *in review*). Over the past 20 years, numbers observed at historic localities have consistently declined and some localities are no longer being occupied by the species (Freeman et al., 2006).

Threats: Extremely small native range increases its vulnerability to extinction. Poor agricultural practices have led to sedimentation, nutrient enrichment, and pesticide runoff, resulting in a decline in the water quality (GADNR, 1998; Roghair et al., 2001). Conasauga logperch are particularly susceptible to siltation, which interferes with their feeding mode of flipping rocks during foraging (Jenkins and Burkhead, 1994). Recent flooding and drought events may have further jeopardized this species and increasing suburban development with competing demands for water pose future threats (Freeman et al., 1996).

Proposed Conservation Actions:

1. Riparian buffers should be installed to filter agricultural runoff and fencing erected to prevent livestock from entering the river.
2. Outreach programs on ways to minimize stressors to the Conasauga River should be increased for landowners, government officials, and local students.
3. Pilot captive propagation projects need to continue for ark populations or augmentation. Captive propagation must be done in conjunction with genetic analyses due to the small population size of the species.
4. Continue meetings with local government officials and other stakeholders to develop ordinances and guidelines to minimize the impact of future urbanization on the river.
5. The cause of the recent decline in aquatic vegetation, particularly river weed (*Podostemum*), must be determined and reversed.

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Elassoma alabamae – Spring Pygmy Sunfish

Background: The spring pygmy sunfish is one of the smallest fishes in the Southeast, with a maximum size of 1 inch (25 mm) SL. In 1938, the only known population (Cave Spring, Lauderdale Co., AL) was extirpated with the formation of Pickwick Reservoir. Another population discovered in 1941 at Pryor Spring (Limestone Co., AL) was extirpated by 1945 from aquatic herbicide treatment (Jandebeur, 1979). The species was thought extinct until its rediscovery in Beaverdam Creek (Limestone Co., AL) in 1973. It was proposed for federal listing in 1979, but the proposal was never finalized (J. Williams, pers. comm.). The spring pygmy sunfish was described in 1993 (Mayden, 1993). It is state protected in Alabama (ALDWFF, 2007) and considered a species of Highest Conservation Concern (Warren, 2004). A recent status review recommends this species be reconsidered for federal protection (Conway and Mayden, 2006).

Distribution: A single population occupies a five-mile stretch of Beaverdam Creek in north-central Alabama (Sandel, 2008). In the mid 1980s, populations were re-established in two spring pools at Pryor Branch (Mettee and Pullium, 1986), but suffers from groundwater withdrawal, herbicide application, and inbreeding, and may be re-extirpated.

Abundance: Rare and localized. May exceed 1 fish per cubic meter in optimal habitat of shallow vegetated areas of five spring pools, but low densities elsewhere in Beaverdam Creek (Sandel, 2008).

Threats: Extremely small native range and spring specialization increases vulnerability to extinction (Mayden, 1993). Chronic drought and increased irrigation has reduced spring flows and desiccated shoreline aquatic vegetation, eliminating critical habitat for this species. Of seven spring pools occupied by the spring pygmy sunfish, five are pumped for irrigation at rates of up to 16,000 gallons per minute (over four times the discharge rate during summer), and three were completely drained in 2007, resulting in the extirpation of two subpopulations and a 99% reduction in the third (Sandel, 2008). Rapid industrial and suburban growth threatens Beaverdam Creek with contamination, further groundwater withdraw, disruption of aquifer recharge via impervious surface runoff, and sedimentation (Warren, 2004). In light of these threats, it is imperative that USFWS list the spring pygmy sunfish as Endangered.

Proposed Conservation Actions:
In early 2008, a conservation summit was hosted by USFWS for the spring pygmy sunfish. The following conservation actions are derived, in part, from a list of priorities produced at that meeting.

1. Purchase property within the watershed and recharge area, especially within 150 feet of spring pools, wetlands, and spring runs (Warren, 2004).
2. Establish a water resource management plan for Beaverdam Creek, which regulates and schedules all municipal and agricultural withdrawals of surface and groundwater within the watershed and aquifer, and monitors groundwater levels and chemistry, with the ultimate goal of maintaining acceptable spring flow and minimum water levels in spring pools.
3. Determine the recharge area of the local aquifer.
4. Develop a regulation that limits the amount of impervious surface over the recharge zone, and identifies appropriate riparian buffers (91 m or 300 feet) surrounding Beaverdam Creek and all confluent spring pools.
5. Continue to develop captive husbandry protocol in collaboration with CFI, the Alabama Aquatic Biodiversity Center, or the Riverbanks Aquarium in Columbia, SC.

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TABLE 1. Distribution data and abundance for the Desperate Dozen.

Species	State (current)	State (historical)	Habitat	Narrow endemic	Once widely distributed	Abundance
Alabama sturgeon	AL	MS	Big river		Yes	2 individuals seen in last 9 yrs
Slender chub	TN, VA		River		Yes	1 individual seen in last 21 yrs
Chucky madtom	TN	AL?	Small creek		?	3 individuals seen in last 14 yrs
Alabama cavefish	AL		Cave	Yes		Fewer than 100 individuals
Pygmy sculpin	AL		Spring	Yes		27,500 individuals
Diamond darter	WV	KY, OH, TN	Big river		Yes	16 individuals seen in 28 yrs
Vermilion darter	AL		Small creek	Yes		1,667 to 2,919 individuals
Relict darter	KY		Small creek	Yes		9,533 to 31,293 individuals
Bayou darter	MS		River	Yes		Most sites < 1 individual per m^2
Pearl darter	MS	LA	Big River		Yes	No estimates
Conasauga logperch	TN, GA		River	Yes		200 individuals
Spring pygmy sunfish	AL		Spring	Yes		No estimates

TABLE 2. Threats to the Desperate Dozen.

Species	Threat 1	Threat 2	Threat 3
Alabama sturgeon	Habitat alteration - dams & dredging	Historical overharvest	
Slender chub	Reduced range	Water pollution - industrial & agricultural	
Chucky madtom	Small range	Water pollution - agricultural	
Alabama cavefish	Small range & specialization	Aquifer reduction & pollution	
Pygmy sculpin	Small range & specialization	Water pollution	Competition
Diamond darter	Reduced range	Habitat alteration - dams	Water pollution - sedimentation
Vermilion darter	Small range & fragmentation	Water pollution & flows - urban	
Relict darter	Small range & fragmentation	Habitat alteration - channelization	Water pollution
Bayou darter	Small range & fragmentation	Habitat alteration - head cutting	
Pearl darter	Habitat alteration - dams	Water pollution - urban & industry	
Conasauga logperch	Water pollution – agriculture and siltation	Small range	
Spring pygmy sunfish	Small range & specialization	Aquifer reduction	Water pollution

TABLE 3. Proposed conservation actions (PCA) for the Desperate Dozen.

Species	1st PCA	2nd PCA	3rd PCA	4th PCA	5th PCA
Alabama sturgeon	Tracking	Broodstock capture/propagation	Fish passage	Water quality	Protect habitat
Slender chub	Survey abundance	Cause of decline	Propagation	Genetics	Life history data
Chucky madtom	Watershed plan	Propagation	Survey		
Alabama cavefish	Watershed plan	Survey abundance/ monitor water quality	Life history data	Survey	
Pygmy sculpin	Decontaminate watershed	Monitor water quality	Survey abundance	Survey competitors	
Diamond darter	Survey abundance	Search additional populations	Propagation		
Vermilion darter	Watershed plan	Survey abundance/ monitor water quality	Life history data	Habitat restoration	
Relict darter	Watershed plan	Survey abundance	Genetics	Life history data	Spawning techniques
Bayou darter	Habitat restoration	Watershed plan	Restrict gravel mining		
Pearl darter	Habitat restoration	Propagation	Watershed plan		
Conasauga logperch	Habitat restoration	Outreach programs	Propagation/genetics	Restrict impacts	Address aquatic vegetation decline
Spring pygmy sunfish	Purchase property	Watershed plan	Determine recharge area	Limit impervious surfaces	Propagation

TABLE 4. Year of species description, current status of federal protection (Candidate, Threatened, or Endangered), status of critical habitat, recovery plan, and 5-year reviews, and imperiled status in conservation publications for the Desperate Dozen.

Species	Year Described	C	T	E	Critical Habitat	Recovery Plan	5-year Review	Warren et al., 2000	Jelks et al., 2008
Alabama sturgeon	1991			2000	2009	NO	NO	E	E
Slender chub	1956		1977		1977	1983	2008	E	E
Chucky madtom	2005	2002						T	E
Alabama cavefish	1974		1977	1988	1977	1990	NO	E	E
Pygmy sculpin	1968		1989		NO	1991	2008	E	E
Diamond darter	2008							T	E
Vermilion darter	1992			2001	NO	2007	2008	E	E
Relict darter	1992			1993	NO	1994 draft	2007	E	E
Bayou darter	1966		1975		NO	1990	2006	E	E
Pearl darter	1994	1999						E	E
Conasauga logperch	1985			1985	1985	1986	2005	E	E
Spring pygmy sunfish	1993							E	E

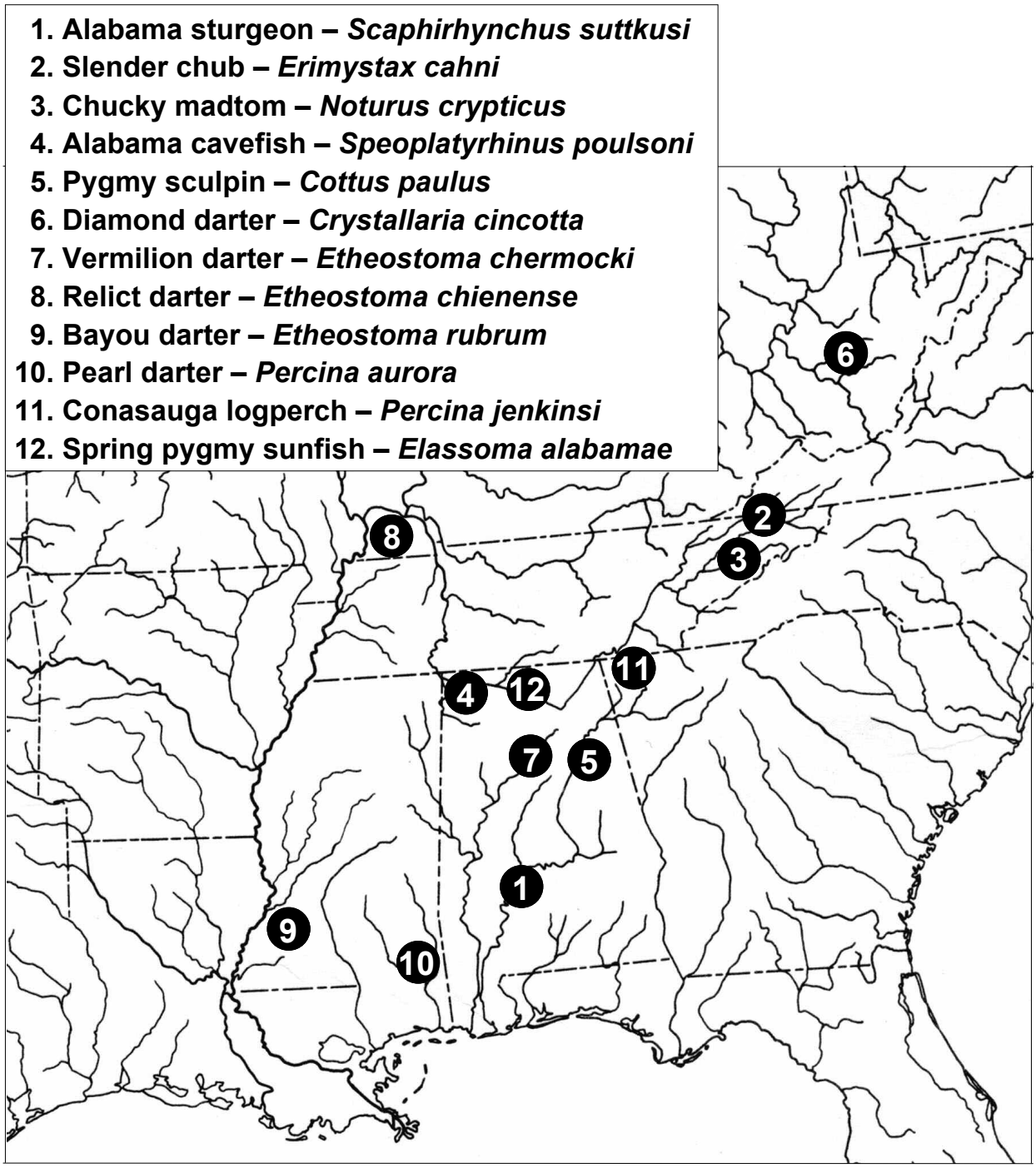
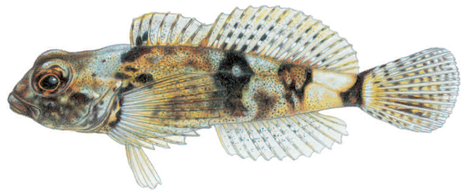


FIGURE 1. Distribution of the Desperate Dozen in the southeastern U.S.

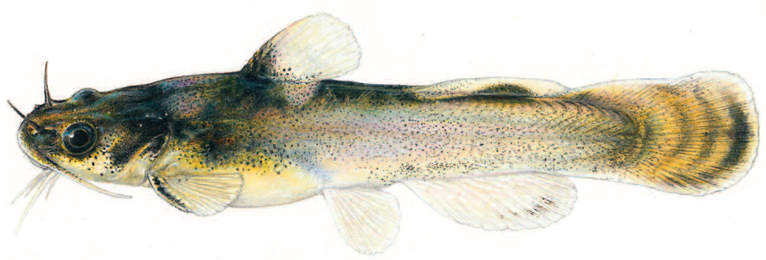
Alabama sturgeon, *Scaphirhynchus suttkusi*



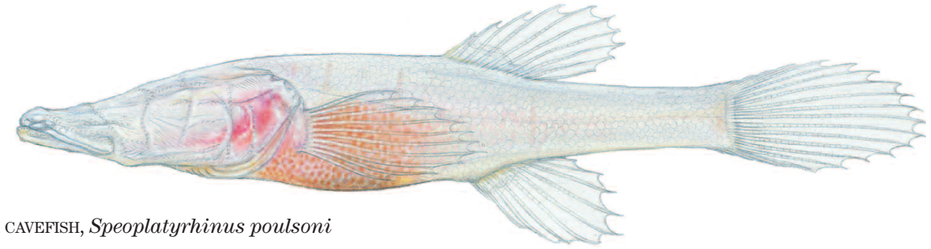
Pygmy sculpin, *Cottus paulus*

Vermilion darter, *Etheostoma chermocki*

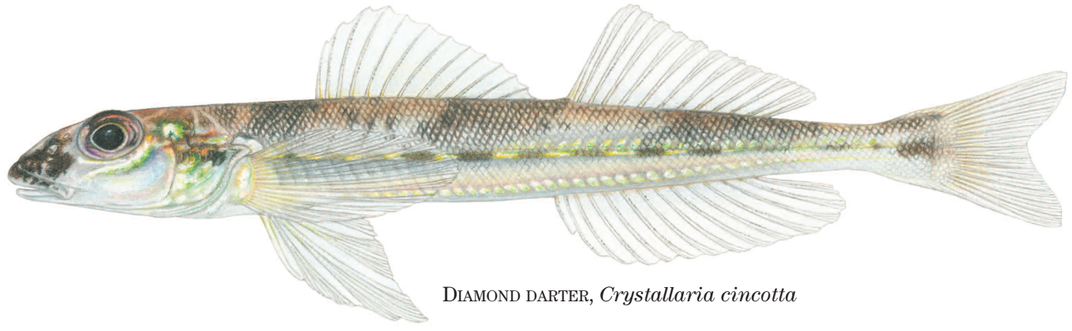
Spring pygmy sunfish, *Elassoma alabamae*



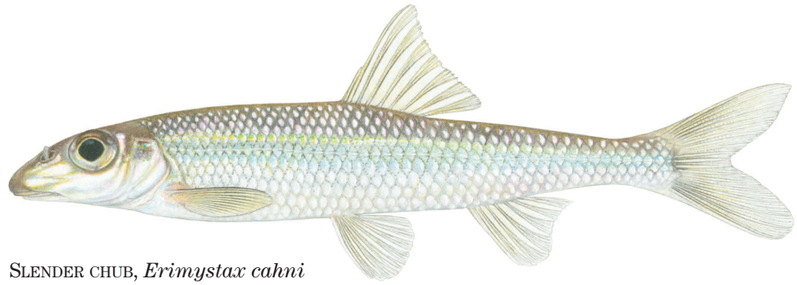
Chucky madtom, *Noturus crypticus*



Alabama cavefish, *Speoplatyrhinus poulsoni*



Diamond darter, *Crystallaria cincotta*



Slender chub, *Erimystax cahni*

Relict darter, *Etheostoma chienense*

Bayou darter, *Etheostoma rubrum*

Conasauga logperch, *Percina jenkinsi*

Pearl darter, *Percina aurora*

Prioritizing Areas of the Conasauga River Sub-basin in Georgia and Tennessee for Preservation and Restoration

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ABSTRACT

Land preservation and restoration are important tools for managing imperiled aquatic species, but they are often applied in the absence of a transparent scheme of geographic prioritization. To help guide preservation and restoration efforts in the Conasauga River Basin in Georgia and Tennessee, we used the "Zonation" algorithm to prioritize sub-watersheds. Zonation is a prioritization system that uses species occurrence to identify localities of highest biodiversity, greatest interconnectivity, and (optionally) lowest cost. We based the prioritization on known and predicted distributions of 10 imperiled fish species and 12 imperiled invertebrate species, with predicted distributions derived from maximum entropy niche modeling. In the resulting prioritization scheme, highly ranked areas included the Conasauga River mainstem, the Conasauga headwaters, and the Holly Creek tributary system. We propose that a prioritization such as this should be conducted prior to any major program of land preservation or restoration.

INTRODUCTION

Protected reserves are often regarded as the backbone of species-oriented conservation (Margules and Pressey, 2000). Although the reserve approach *per se* has not been widely applied in freshwater biodiversity management (Abell et al., 2007), governments have been buying and protecting land for the enhancement of game species for centuries, sometimes to the benefit of other fishes and invertebrates. In many locations, freshwater biodiversity also benefits inadvertently from the protection of mountainous, forested headwaters. To date, however, many such preservation efforts have been opportunistic and have not been guided by an overarching plan that considers the distributions and needs of imperiled species. In contrast to freshwater reserves, freshwater "restoration" measures have received extensive attention and are far more controversial (Simon et al., 2007). Here we define restoration to mean direct modification of stream channels with the goal of enhancing some aspect of stream function or structure. This has emerged as a billion dollar a year industry, but there continues to be considerable debate as to whether many restoration projects achieve ecological or social benefits, or whether they do so in a cost-effective manner (Bernhardt et al., 2005; Palmer et al., 2005). There have been numerous restoration projects conducted in the Southeast, including in the Upper Coosa Basin, but like preservation efforts their locations have rarely been selected through a transparent prioritization scheme (Sudduth et al., 2007). Rather, many sites have been selected on the basis of land availability, usually without consideration of a larger watershed plan (Sudduth et al., 2007). Benefits to imperiled aquatic species are usually considered only secondarily.

Because both land preservation and stream restoration are expensive tools, there is a general public interest in ensuring that they are employed in a way that maximizes the benefit-cost ratio and, in particular, that they are applied in the appropriate geographic locations (Sarkar et al., 2006). This requires a method for prioritizing or ranking localities. A key element of conservation prioritization is irreplaceability: the identification of locations that are essential for supporting the full biodiversity of the area (Margules and Pressey, 2000; Brooks et al., 2006; Sarkar et al., 2006). Numerous algorithms have been developed to determine optimal locations (Sarkar et al., 2006), but most of these methods can be divided into two broad categories: scoring procedures and complementarity-based algorithms (Abellan et al., 2005). Scoring procedures rank all potential locations on the basis of criteria such as species richness, vulnerability, and rarity, then select the highest ranking areas. Complementarity methods consider the additional benefit of each potential location when added to existing or potential protected areas. These algorithms outperformed scoring procedures in efficiently identifying a network of reserve sites for biodiversity (Abellan et al., 2005). One well-developed example of a complementarity algorithm is the "Zonation" method (Moilanen et al., 2005; Moilanen, 2007), which was created for terrestrial systems but has

been recently extended to cover freshwater applications (Moilanen et al., 2008).

The objective of this study was to use the Zonation algorithm to prioritize sub-watersheds (USGS HUC-12 level) of the Conasauga River sub-basin, part of the Upper Coosa system in North Georgia and Southeast Tennessee. Our goal was to rank sub-watersheds according to their importance in preserving the imperiled aquatic biodiversity of the river system, defined here as federally or state protected vertebrates and invertebrates (Tables 1 and 2). This will help to guide both preservation and restoration efforts to those sub-watersheds of the Conasauga where they may provide the greatest benefit.

STUDY AREA AND SPECIES

The Conasauga River is a tributary of the Coosa in the Mobile drainage, located in the Blue Ridge and Valley and Ridge physiographic provinces of Northwest Georgia and Southeast Tennessee. It is a highly diverse river system with approximately 77 extant native fish species, 15 introduced fish species, and six fish species presumed to be extirpated (Walters, 1997). Although most of its fish fauna is intact, only 19 of the 37 historically present mussel species are believed to persist (Novak et al., 2004). Those mussel species that remain may be threatened by high nutrient concentrations and toxic contaminants in sediments originating from agricultural activities (Sharpe and Nichols, 2007). Ten of the fish species (Table 1) and 14 of the mussel species (Table 2) are listed as threatened or endangered by the state of Georgia and/or by the U.S. Fish and Wildlife Service. These 24 species are the focus of this study.

METHODS

We used the software Zonation 2.0 (Moilanen, 2008) to prioritize sub-watersheds. Zonation is a prioritization system that uses species occurrence to identify localities of highest biodiversity, greatest interconnectivity, and (optionally) lowest cost. Zonation implements an algorithm that starts with the full landscape of interest and iteratively discards locations (cells) of lowest value in terms of species occurrence and connectivity (Moilanen et al., 2005; Moilanen, 2007). The result is a nested hierarchy of solutions that seek to maximize coverage of species habitat and connectivity for any given number of cells. Zonation 2.0 includes options specifically designed for freshwater conservation that allow for watershed-based analysis and upstream-downstream connectivity among watersheds (Moilanen et al., 2008). Below we describe the preparation of known and estimated species occurrence data (the latter we term species potential ranges) used in the analysis, followed by an explanation of the Zonation analysis itself.

We drew species occurrence data from a database maintained by the Georgia Museum of Natural History. We considered records between 1995 and 2007 which represent a 13-year time span centered on the year of most recent land cover data (2001). This was important because land cover data were used to estimate species potential ranges, as described in the next section, so we wanted the species data to be roughly contemporaneous with the land cover data. We excluded a small number of species records we considered dubious because they fell well outside the species' known ranges and preserved individuals were unavailable for verification. The full data set included 463 fish collection records and 523 mussel and crayfish collection records. Occurrence data for these collections can be viewed at the online supplement (Supplemental Figures S1-S6; http://ichthyology.usm.edu/sfc/proceedings/supplementary/Wenger_etal.pdf).

Because the species data were originally collected for different purposes, the intensity of sampling effort was not uniform across all sub-watersheds, nor was it consistent across taxa. Prioritization based solely on these recorded locations might produce a biased estimate, emphasizing those sub-watersheds with higher sampling densities and those species with better-defined ranges. In an effort to mitigate this bias, we developed species niche models and used them to predict the probability of species occurrences in sub-watersheds where the species had not been collected (i.e., the species "potential ranges"). For sub-watersheds where little or no sampling has been conducted (these differ for fishes and mussels; Supplemental Figures S1-S6), this prediction represents the probability that a species might actually occur there. For sub-watersheds where significant sampling has occurred, a prediction of presence suggests that factors other than those included in the model (see below) are important in determining species absence. These could include historical land use activities that caused extirpations.

We used maximum entropy modeling (Phillips et al., 2006a) to calculate potential ranges. With this approach, geographic coordinates of species occurrence data are overlain on a set of environmental raster data and maximum likelihood methods are used to identify the distribution closest to uniform (i.e., that of maximum entropy) which satisfies the constraints imposed by the environmental variables. The resulting model is then applied to the landscape. Maximum entropy is not a new technique, but it has recently become popular for species niche modeling because it can be used with presence-only data, it is now supported by a convenient software interface (MaxEnt; Phillips et al., 2006b) and its performance compares well to other niche modeling methods (Elith et al., 2006). Our data set did include absence data, but collections were made with differing methods and varying degrees of effort, resulting in variable detection probability. As a consequence, the reliability of absence records is difficult to estimate under conventional methods (such as generalized linear modeling) without extensive additional analysis or exclusion of significant portions of the data. In contrast, maximum entropy can make efficient use of this heterogenous data set.

We did not attempt to model species that were recorded only at a few (< 15) separate sites, because such sparse data sets provide little information to define distributions. The excluded species were *Noturus* sp. cf. *munitus* (Coosa madtom), *Etheostoma ditrema* (coldwater darter), *Percina lenticula* (freckled darter), *Cambarus cymatilis* (Conasauga blue burrower), *Elliptio arctata* (delicate spike), *Medionidus acutissimus* (Alabama moccasinshell), *M. parvulus* (Coosa moccasinshell), and *Strophitus subvexus* (southern creekmussel). For the remaining 14 species, we selected five environmental variables as potential predictors: sub-watershed drainage area, elevation, number of dams in the sub-watershed, total impervious area, and forest cover, all of which we had found to be useful predictors of fish occurrence in a previous analysis in the nearby Etowah sub-basin (Wenger et al., 2008). We hypothesized that these five variables explained a significant amount of the variation in species distribution patterns. Sub-watershed drainage area ("area") was calculated by creating an artificial drainage area map from USGS digital elevation models. Elevation was derived from USGS digital elevation models. We calculated dams per sub-watershed ("dams") by (1) identifying dams from reservoirs that appeared on USGS topographic quadrangles and aerial photos and (2) summing the number of dams in each USGS HUC-12 sub-watershed. Total impervious area (TIA) was derived from the 2001 National Land Cover Database Zone 54 Impervious Layer (USGS, 2003). In a previous study we found that the presences and absences of some fish species were well predicted by impervious cover within 1.5 km of the collection site (Wenger et al., 2008). Therefore, we transformed the TIA coverage by replacing the value for each pixel by the mean of a 1.5 km radius circle around it. Forest cover was derived from 2001 land cover data (Kramer, 2004) and transformed in the same manner as the TIA coverage. Each environmental variable was input as a raster with a resolution of 180 m. This low resolution helped to ensure that collection points aligned correctly with streams and rivers in the drainage area coverage.

The MaxEnt program allows various transformations of environmental variables, such as quadratic, product (interactions), and thresholds. We used the "auto features" setting which determined which transformations to allow based on the size of the data set for each species, using a set of empirically-derived rules (Phillips et al., 2006b). For species that occurred at 25 or more sites, we divided the data set randomly into a training set (90% of records) and a test set (the remaining 10%) for calculating model performance. For species with fewer than 25 collection sites, there was no test set and therefore only an estimate of within-sample model performance. Performance was estimated by the area under the curve (AUC) of the receiver-operator characteristic plot, a method not subject to bias due to species prevalence (Manel et al., 2001).

Zonation Analysis

We assigned each HUC-12 sub-watershed the value of 1 for each species recorded to be present within it, indicating 100% probability of presence. We considered a species' potential range to include those sub-watersheds where a species had not been collected, but where the species was predicted to be present with a probability of 10% or greater in each cell along at least one kilometer of stream based on maximum entropy modeling. All such sub-watersheds were assigned a value of 0.25 for the species in question. Essentially, this gives sub-watersheds within a species' potential range a weighting one fourth that of sub-watersheds with a species' actual range. All species were given equal priority.

Zonation allows for different cell removal rules which govern the prioritization algorithm. We used the "additive benefit function" rule, which emphasizes locations that benefit multiple species, in contrast to the "core area" rule, which seeks to find the best locations for each individual species. We also defined upstream-downstream connectivity among sub-watersheds, which allows for the possibility that failure to protect a sub-watershed can have negative impacts on downstream sub-watersheds. Therefore, if a watershed is prioritized highly due to the presence of target species, its tributary sub-watersheds will also receive some prioritization, regardless of the species they support. Finally, we included a cost layer which was allowed to influence the prioritization. The cost layer was based on land cover and imposed a cost of zero on forested cells, 1 on agricultural cells, and a value equivalent to percent impervious cover (i.e., 1-100) for cells with impervious cover of 1% or greater. These costs are in relative terms and do not have a simple translation to dollar values. The reasoning behind the cost layer is that forested land tends to be relatively inexpensive to acquire and preserve and generally requires little restoration. Agricultural land is somewhat more expensive and more likely to require restoration, whereas land that currently supports suburban and urban uses would be far more expensive to acquire and preserve and might require extensive restoration, depending on the degree of urbanization.

RESULTS

The maximum entropy models had good predictive performance, with AUC > 0.96 in all cases. However, this was largely due to the fact that these are aquatic species that only occur in the relatively small subset of landscape cells that fall within streams or rivers. Therefore, any model that includes sub-watershed drainage area has a high nominal predictive ability, since it can easily predict species absence in terrestrial cells. Accordingly, sub-watershed drainage area was by far the most important explanatory variable for each species (Table 3), contributing between 68.6% and 95.8% of the variance explained for each species (a mean of about 90% overall). The number of dams per sub-watershed was the next most important

predictor variable, followed by elevation, TIA, and forest cover, respectively (Table 3).

The Zonation analysis gave highest priority to the reaches of the mainstem (Fig. 1). The headwaters were also ranked highly, primarily due to their importance in protecting the downstream mainstem reaches. Mill Creek, flowing into the mainstem from Tennessee, received a moderately high priority (64) and downstream tributaries generally declined in priority in a downstream direction. Another high priority set of sub-watersheds was the Holly Creek system, whose sub-watersheds scored from 59-70 due mainly to a high number of listed mussel species. Tributaries in the Dalton area and tributaries to the lowest reaches of the mainstem ranked the lowest. Most of Coahulla tributary system also ranked low, but the Coahulla mainstem received a moderate priority because maximum entropy modeling showed it to be potential habitat for multiple fish and mussel species, even though it currently supports very few.

DISCUSSION

The prioritization algorithm gave the highest ranking to the Conasauga River mainstem and headwaters, which is reasonable because most of the imperiled species of the sub-basin can be found within these sub-watersheds. The Holly Creek system is a separate region of high diversity that emerged as a secondary priority. The Mill Creek sub-watershed of Tennessee and the Sumac Creek sub-watersheds are also ranked moderately high because they are upstream of species-rich sections of the mainstem. From a conservation ecology perspective, it makes sense to pursue a management strategy focused on two separate population areas: 1. the mainstem and headwaters, which provide habitat for most of the listed species and 2. Holly Creek, which provides habitat for about half of the invertebrate species as well as *Cyprinella caerulea* (blue shiner), *Etheostoma trisella* (trispot darter), and *Percina kusha* (bridled darter). Notably, the headwaters of both of these systems are already partially protected in National Forests and any future preservation efforts can build on this base.

Modeling suggested that the lower Coahulla Creek could be favorable habitat for several species, although only *P. lenticula* has been recorded there in recent years. It is possible that additional species once inhabited this small river but were extirpated by past land use activities and channel modifications. Historic agriculture has been implicated in the loss of other fish species in the Southeast (Harding et al., 1998; Maloney et al., 2008; Wenger et al., 2008), but the degree of impact in the Conasauga remains a matter of speculation. Alternatively, it is possible that we omitted important environmental variables that describe natural differences between the Coahulla system and other parts of the Conasauga sub-basin. In any case, the Coahulla is not ranked as a high priority, and the fact that few imperiled species are currently present mean that it is not a candidate for preservation, although future restoration activities should perhaps not be ruled out.

One question is the degree to which middle tributaries of the Conasauga should be targeted for preservation and restoration. Sugar Creek, Sumac Creek, and Georgia's Mill Creek (Murray County) rank only moderately high and yet are upstream of important habitat in the mainstem. We suggest that management efforts in these sub-watersheds be focused on identifying and mitigating any obvious stressors, rather than large-scale land preservation and restoration. It is perhaps most important that agricultural producers in this region use appropriate best management practices to minimize nutrient and pesticide transport downstream, which have been identified as two likely stressors contributing to declines in some mainstem mussel species (Sharpe and Nichols, 2007).

A limitation of our approach is the simplistic upstream-downstream loss response function we employed, which assumes that upstream watersheds are important for protecting downstream watersheds, but that the reverse does not hold true. The complex life histories of mussel species (Strayer et al., 2004) implies the need for connectivity for dispersal and *E. trisella* and *E. ditrema* are known to make short spawning migrations (Boschung and Mayden, 2004), which means that connectivity between downstream feeding habitat and upstream spawning habitat can be important. Quantifying the degree of dependence of upstream sub-watersheds on their downstream neighbors is not straightforward, however. In contrast, because likely stressors in the system are transported downstream (Sharpe and Nichols, 2007), we considered it essential that there be some dependence of downstream sub-watersheds on their upstream neighbors. However, this is a simple first approximation that should be revisited in the future with a more thorough, species-by-species consideration of the importance of connectivity.

Linke et al., (2007), building on others (Margules and Pressey, 2000; Sarkar et al., 2006), suggested that watershed conservation planning should consider three key attributes: irreplaceability, condition, and vulnerability. "Irreplaceability" is the probability that the sub-watershed is essential to meeting conservation goals. Our use of the Zonation algorithm was intended to rank the sub-watersheds of the Conasauga from irreplaceable (or most critical) to irrelevant to the purpose of conserving imperiled aquatic species. "Condition" considers whether the sub-watershed is degraded or of high quality. The most highly ranked sub-watersheds in our analysis are of generally good condition and are candidates for preservation, while lower ranked sub-watersheds tend to be degraded and may be candidates for restoration. However, condition can vary greatly within sub-watersheds and within highly ranked sub-watersheds there may be individual sites that are degraded and which would also be strong candidates for restoration. "Vulnerability" is the likelihood that the sub-watershed will be exposed to land use changes that

will degrade its condition. We did not incorporate this into our prioritization scheme, although we suggest that it be a consideration in site-level decision making. Among two otherwise equally valuable parcels, one that is subject to change in the near future may be more of a priority than one that is considered unlikely to change.

We suggest that a prioritization such as the one conducted here should be a mandatory step in any watershed supporting species of conservation interest prior to the initiation of any significant program of preservation or restoration. Such an exercise should also be repeated periodically as conditions change and new data are collected. With the free availability of user-friendly tools such as the MaxEnt and Zonation software, these analytical methods can be employed by any governmental agency or non-governmental organizations with a conservation focus. While prioritizations such as this are not without their limitations and caveats, we think that conservation efforts would benefit from their more general application.

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TABLE 1. Federally and state protected fish species of the Conasauga River sub-basin.

Genus species	Common Name	State status	Federal status
Cyprinella caerulea	blue shiner	E	T
Macrhybopsis sp. cf. *aestivalis*	Coosa chub	E	-
Noturus sp. cf. *munitus*	Coosa madtom	E	-
Etheostoma sp. cf. *brevirostrum*	holiday darter	E	-
Etheostoma ditrema	coldwater darter	E	-
Etheostoma trisella	trispot darter	E	-
Percina antesella	amber darter	E	E
Percina jenkinsi	Conasauga logperch	E	E
Percina kusha	bridled darter	E	-
Percina lenticula	freckled darter	E	-

TABLE 2. Federally and state protected invertebrate species of the Conasauga River sub-basin.

Genus species	Common Name	State status	Federal status
Cambarus cymatilis	Conasauga blue burrower	E	-
Elliptio arca	Alabama spike	E	-
Elliptio arctata	delicate spike	E	-
Hamiota altilis	finelined pocketbook	T	T
Medionidus acutissimus	Alabama moccasinshell	T	T
Medionidus parvulus	Coosa moccasinshell	E	E
Pleurobema decisum	southern clubshell	E	E
Pleurobema georgianum	southern pigtoe	E	E
Pleurobema hanleyianum	Georgia pigtoe	E	-
Ptychobranchus greenii	triangular kidneyshell	E	E
Strophitus connasaugensis	Alabama creekmussel	E	-
Strophitus subvexus	southern creekmussel	E	-

TABLE 3. Relative contribution of environmental predictor variables for each modeled species. "Records" indicates the number of unique sites with a positive species occurrence used in the analysis for each species. The numbers in the remaining columns indicate the percent contribution of that predictor variable to the predictive model for each species.

Species	Records	Area	Dams	Elevation	TIA	Forest
blue shiner	218	91.7	4.3	2.6	1.2	0.2
speckled chub	26	92.7	4.1	2.7	0.3	0.2
holiday darter	21	68.6	7.6	10.0	9.4	4.3
trispot darter	93	88.2	5.3	5.5	0	0.9
amber darter	31	94.2	5.2	0.6	0	0
Conasauga logperch	32	93.9	2.6	2.2	0.3	1.1
bridled darter	30	77.6	7.9	8.7	2.6	3.2
Alabama spike	16	95.5	0.5	0.9	3.0	0.1
finelined pocketbook	155	90.8	5.4	1.8	0.8	1.2
southern clubshell	49	98.3	0	0.6	1.1	0
southern pigtoe	34	92.1	3.1	0.7	3.9	0.1
Georgia pigtoe	15	95.8	1.9	1.0	1.1	0.3
triangular kidneyshell	27	94.6	0.9	1.6	2.9	0
Alabama creekmussel	55	89.8	7.9	1.1	0.7	0.6

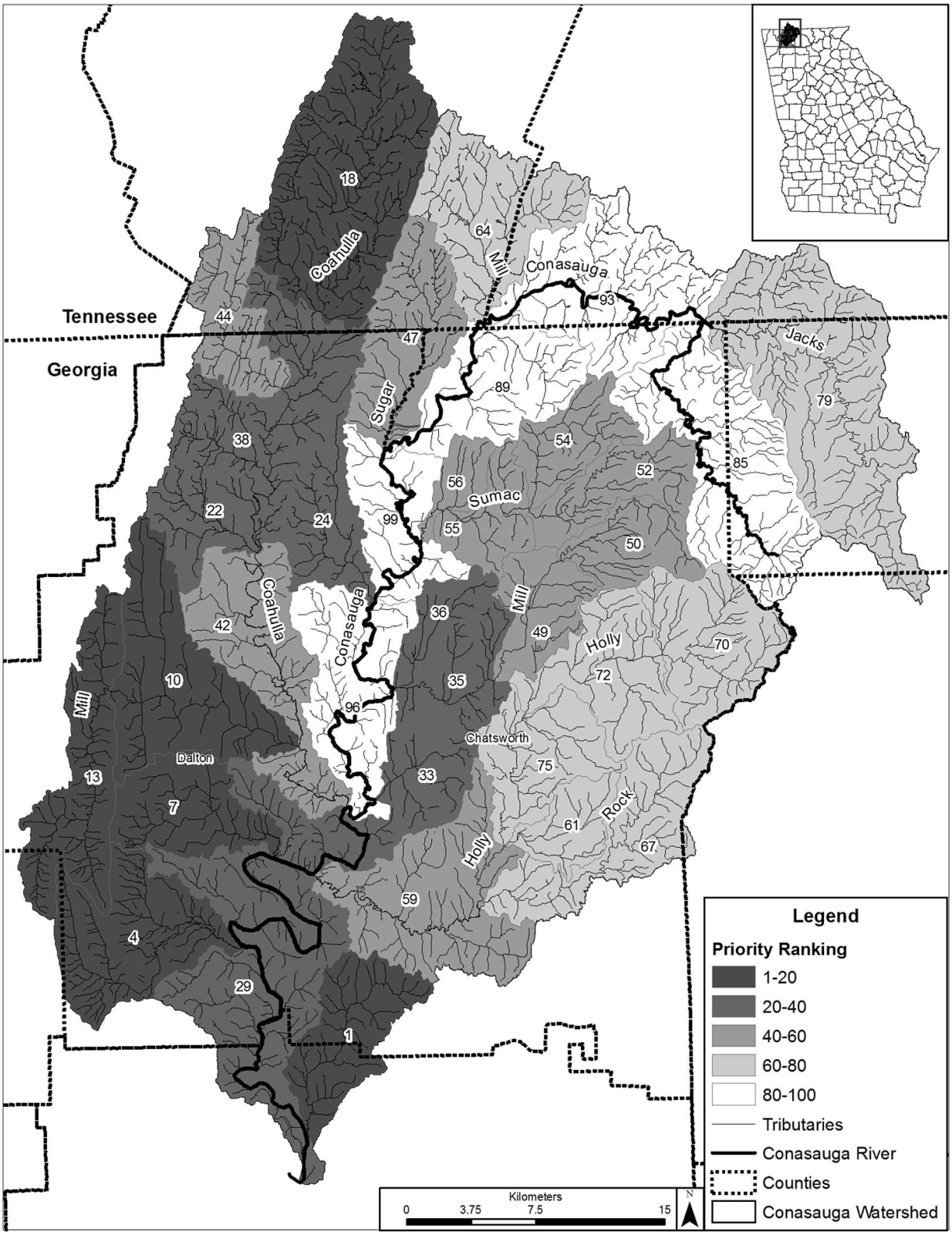

FIGURE 1. Prioritization of Conasauga HUC-12 sub-watersheds. Priority values on a scale of 1-100 are shown on the map for each sub-watershed.

STATE REPORTS

ALABAMA

The Alabama Division of Wildlife and Freshwater Fisheries (ADWFF), Aquatic Resources Program hired Andrew Henderson into the newly created Stream Fish Biologist position in January 2009. Andrew is responsible for implementation of the statewide stream sampling program and assisting District personnel with stream sampling. After nearly 2 years of tracking the sonic tagged Alabama sturgeon (*Scaphirhynchus suttkusi*) collected in April 2007, the tag battery died. However, the effort produced a wealth of information on movement and habitat, including additional areas to target for sampling. High spring flows precluded sampling this past spring, however, while electrofishing for Alabama shad below the Robert F. Henry Lock and Dam on 23 April 2009 an Alabama sturgeon was sighted but not captured. The USFWS was criticized for including the upper Alabama River in the critical habitat designation because it was argued Alabama sturgeon were extirpated from the upper reaches; this sighting confirms the USFWS was correct in its assessment. Since 2005, ADWFF has been assessing the status of the southern walleye (*Sander* sp. cf. *vitreus*) and attempting to develop a broodstock for recovery efforts in Alabama. We have sampled all historic sites. Of the 52 specimens collected, only 39 have been southern walleye, the remaining specimens have either been northern x southern hybrids, northern walleye, or saugeye. ADWFF has begun a 3-5 year project assessing the status of Alabama shad in Alabama. The Alabama River was the only river sampled in 2009. No Alabama shad were collected. Sampling will be concentrated in the Conecuh River in 2010. ADWFF recently completed a 2 year project examining the distribution of the saltmarsh topminnow (*Fundulus jenkinsi*) in the Mobile Delta. This data combined with sampling from Auburn University indicate saltmarsh topminnows are found in the mid Mobile Delta region and may be more numerous than once thought.

The Geological Survey of Alabama (GSA) is conducting a status survey for fish species of conservation concern in the Bear Creek system (Tennessee Drainage) in northwest Alabama. There are ten species of moderate, high, and highest conservation concern historically known to occur there. Thus far, the project has produced new records of six of these species, *N. miurus*, *E. zonistium*, *E.* sp. cf. *zonistium*, *P. evides*, *L. appendix*, and *N. micropteryx*. The trispot darter (*Etheostoma trisella*), was recently rediscovered in Alabama after an absence for more than 50 years from fish collections in the state. While conducting a biological assessment of selected sites in the Big Canoe Creek system, biologists with the GSA and USFWS collected three trispot darters in Little Canoe Creek near Springville, St. Clair County, on October 30, 2008. Over 5 months of sampling, 228 trispot darters were found at 13 out of 22 sites sampled. Two active breeding sites were discovered and sampling data suggest that *E. trisella* is likely more widespread in the Little Canoe Creek system. The GSA is working in cooperation with the USFWS, the Alabama Aquatic Biodiversity Center (AABC) of the ADCNR, and the Alabama Clean Water Partnership (ACWP) to create new opportunities for imperiled aquatic species recovery and restoration through a concept called Strategic Habitat Units (SHU). Designated SHUs currently encompass designated critical habitat for listed mussels species in Alabama and also include much of the critical habitat for listed fish species as well. The Alabama Cooperative IBI (Index of Biotic Integrity) Project between GSA, ADCNR, and the Alabama Department of Environmental Management (ADEM) is completing its third year of work calibrating the IBI to Alabama's unique physiography and biologically diverse fish communities. To date, a standardized fish community sampling protocol has been established, the state has been regionalized into five ichthyoregions, and IBI metrics and criteria have been established for the Ridge and Valley/Piedmont and Southern Plains ichthyoregions and are currently under construction for the Tennessee Valley.

Carol Johnston (Auburn University, Fish Biodiversity Lab) reports that they are documenting the distribution of red shiners in the Coosa system, paying particular attention to potential areas of overlap with blue shiners. They are also investigating predation potential and habitat overlap of banded and pygmy sculpins in Coldwater Spring (yes, they do eat them!). As part of a larger project documenting biodiversity of selected state lands, they have collected 52 fishes sampling in the Sipsey bottoms. Graduate students Patty Speares, Dan Holt and Nicole Kierl continue to work on various projects related to sound production and sensory reception in fishes. Dan is especially interested in how high levels of ambient noise (including noise pollution) affect fish reproductive behavior, using *Cyprinella venusta* as a model. Patty is examining the effect of acoustic signals produced by male darters (*Etheostoma crossopterum*) on hormone levels in conspecific males and females. Patty has also completed a project investigating the potential for barcheek darters (*Catonotus*) to use UV perception. Nicole Kierl has completed her work documenting sound production in pygmy sculpin, and is finishing up a study investigating male color and reproductive

success. Working with Dave Mann, they have initiated a pilot project on cavefish sound production using a remote recorder in an Alabama cave. On the systematic front, Carol is working with Alexis Janosik to describe species in the *Etheostoma rupestre* complex; a paper on the phylogeography of this complex is in the works. Carol continues to work with Winston Baker on documenting his findings on systematics of the *Micropterus coosae* complex.

Graduate students at the University of Alabama Ichthyological Collection are using sequence and microsatellite data to examine relationships and population genetics of *Elassoma* species including the imperiled *E. alabamae* (Mike Sandel), *Pteronotropis* species (Gray Hubbard), and darters associated with spring and spring seeps, including the imperiled species *Etheostoma boschungi*, *E. ditrema*, *E. nuchale*, *E. phytophilum*, and *E. tuscumbia* (Brook Fluker). While collecting tissues for *E. boschungi*, Brook rediscovered this species in Swan Creek (Tennessee River), including a new spawning site, after more than a decade of unsuccessful collecting efforts by others. Brook is working with Bernie Kuhajda monitoring the population of *E. nuchale* at Roebuck Springs (Black Warrior River) that was decimated after the city of Birmingham removed a dam that had created a large spring pool last September. More than half the population was wiped out due to dewatering and crayfish predation, and reproduction has been depressed, likely due to a reduced food supply. Bernie and Brook have also been surveying Key Cave (Tennessee River) for the endangered *Speoplatyrhinus poulsoni*, where numerous specimens of different size classes have been observed. During this survey a new population of cave shrimp was discovered, which is likely an undescribed species. Surveys of Shades Creek (Cahaba River) continue to find specimens of the endangered *Notropis cahabae* and threatened *Percina aurolineata*, which is surprising given that this stream drains the western Birmingham metropolitan area.

Pat Rakes and JR Shute (CFI) continue to work with captive propagation of several Alabama species of fishes, including spawning and establishing ark populations of rush darter and spring pygmy sunfish.

Chris Taylor (Illinois Natural History Survey) and Guenter Schuster (Eastern Kentucky University) are continuing with their efforts to study the crayfishes of Alabama. This work will lead to the publication of an atlas of Alabama crayfishes, including distribution maps of each species. As spin off projects, Taylor and Schuster have been tackling taxonomic problems (e.g., various species complexes such as *Cambarus miltus* and the subgenus *Orconectes* [*Trisellescens*]).

Jeff Powell and Eric Spadgenske (Alabama Field Office, USFWS) report that in coordination with ADCNR and the Alabama Power Company (APC), baseline mollusk surveys were conducted in the Alabama River. These efforts reported three new locations for tulotoma snail in the Alabama River. In coordination with the Geological Survey of Alabama (GSA), a map was published in June 2008 designating critical habitat units for freshwater mollusks in the Mobile Basin. In Birmingham, the USFWS continues to work with various parties on watercress darter issues resulting from last year's Roebuck Spring event. As a result of this event, a new water control structure has been installed that will establish and new and permanent pool elevation. The USFWS's Partners for Fish and Wildlife Program continue to work with landowners in Blount County to identify habitats for the rush darter in known and new locations. In June 2009, the USFWS published a final rule that designated critical habitat for the Alabama sturgeon (*Scaphirhynchus suttkusi*). The USFWS also published a proposed rule in July 2009 to list and designate critical habitat for the interrupted rocksnail, rough hornsnail, and Georgia pigtoe. The Service continues to work with the APC and Federal Energy Regulatory Commission (FERC) to make final provisions on the operations of the hydropower projects along the Coosa River. Results from this effort will lead to improved water quality conditions below several dams and a seasonally variable flow below Weiss Dam. Daniel Drennen (Jackson Field Office, USFWS) is writing the proposed critical habitat for the vermilion darter (*Etheostoma chermocki)*. The proposed listing of the Rush Darter (*Etheostoma phytophyllum*) as endangered is being reviewed at the Washington level.

Submitted by Carol Johnston
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ARKANSAS

Brian Wagner (AGFC) joined biologists from USFWS, Arkansas Natural Heritage Commission, and The Nature Conservancy to conduct Ozark cavefish monitoring at Cave Springs Cave (home to most of the observed individuals of this threatened species).

Arkansas Game and Fish Commission funded an eradication attempt on an established population of northern snakeheads from the Big Piney watershed in east central Arkansas. The effort was executed March 19- 27, 2009, involving a combined effort of approximately 90 people from AGFC, USFWS, Tennessee Wildlife Resources Agency, National Park Service, and the University of Central Arkansas (UCA). The effort included assessment crews following one-to-two days post-rotenone application to assure that an effective kill was achieved in all areas. Assessment crews picked up over 800 snakeheads from locations throughout the basin. The University of Central Arkansas (Ginny Adams, Reid Adams and Sally Entrekin)

involved over 30 students in the assessment and are currently researching life history and habitat associations of the northern snakehead and other target species collected during the rotenone and examining food web dynamics. Clint Johnson will conduct his MS thesis on the re-colonization of native fishes to the Big Piney system.

As part of the U.S. Geological Survey's National Water-Quality Assessment Program (NAWQA), periphyton, macroinvertebrate, and fish communities were sampled in 2006 at 30 sites in the Ozark Highlands of Arkansas, Missouri, and Oklahoma (a subset of these sites were sampled again in 2007). Two of these sites in northern Arkansas have been sampled every one to two years since 1993. The 2006 data from the 30 sites has been analyzed to evaluate usefulness of the three communities to describe the effect of elevated nutrient concentrations on aquatic biota of small Ozark streams. The 2007 data are being analyzed along with data from other parts of the country to compare seasonal variations in communities in response to nutrients. Additional information about NAWQA activities in the Ozark Highlands can be found at http://ar.water.usgs.gov/nawqa/ozark/index.html.

Bill Matthews, Edie Marsh-Matthews (University of Oklahoma) and Ginny Adams (University of Central Arkansas) conducted sampling in the Piney Creek drainage in summer 2008 as part of the long-term dataset began by Bill during his MS degree. A subset of the established long-term sites was sampled to examine effects of near record flooding on the system that had occurred in spring 2008.

ADEQ will be sampling approximately 30 sites the next few months for fish and macroinvertebrate community analysis. These sites are located in the Boston Mountains and Ozark Highlands. There are another 10 sites in the Saline River watershed.

Art Brown, University of Arkansas, Fayetteville, is conducting bioassessment work. They have 2 years of spring and fall fish electrofishing data from 10 sites in the upper Illinois River drainage.

The Ouachita National Forest (ONF) has an on-going research project with Dr. Tony Echelle (Oklahoma State University) to look at the genetics of leopard darters range wide in AR and OK. They have also provided him a number of logperch for his work on their genetics. ONF, along with Dr. Charles Gagen (Arkansas Tech University) and his graduate student, Jade Ryles, are in the second year of assessing fish passage at a number of crossings in the Long Creek drainage, a tributary of the Little Missouri River. Two of nine crossings have been replaced with box culverts designed for fish passage to assess whether the box culvert designs do allow passage or not as well as testing a prototype fish movement sensor. ONF is working with Dr. Joe Stoeckel (Arkansas Tech University) and a new graduate student to relocate a former population of stargazing darters in the Ouachita River above Lake Ouachita. They are also looking at the range and distribution of the Ouachita darter, an undescribed species formally thought to be longnose darters. ONF is also working with Ginny Adams, Reid Adams, and Sally Entrekin and graduate students Richard Walker and Evan Soper from UCA to assess the effect of wood addition to headwater streams in the Sylamore District on fish and crayfish assemblages.

A reproducing population of alligator gar was recently discovered on the Fourche LaFave River. Tommy Inebnit, Ed Kluender, Lindsey Lewis (USFWS), and Reid Adams (UCA) have collected data relating hydrology and temperature regimes to reproductive success and have made observations of spawning and early life stages. In addition to reproduction, we are studying movement and habitat use with radio telemetry techniques. Lindsey Lewis also developed a website for Alligator Gar conservation and status assessment: http://www.fws.gov/arkansas-es/A_Gar/ index.html

Chris Davidson with USFWS developed BMPs for a natural gas pipeline in Arkansas (http://www.fws.gov/arkansas-es/wn.htm). Sites on Gulf Mountain Wildlife Management Area will be monitored to examine the effectiveness of the BMPs starting fall 2009 by researchers from the University of Central Arkansas (Sally Entrekin, Ginny Adams, Reid Adams), the University of Arkansas (Michelle Evans-White) and The Nature Conservancy (Ethan Inlander and Daniel Miliken).

Baseline data were collected by the University of Central Arkansas (Ginny Adams and Sally Entrekin) on the Middle Fork Saline River to allow for assessment of restoration activities planned by The Nature Conservancy (Joy DeClerk) in late summer 2009.

Rich Grippo (Arkansas State University) is studying the effects of stream bank stabilization on benthic macroinvertebrate and fish assemblages in the South Fork of the Spring River, near Salem, AR.

Submitted by Ginny Adams (gadams@uca.edu)

FLORIDA

Debra Murie (University of Florida), D. C. Parkyn (UF), Leo G. Nico (United States Geological Survey), Jeff Herod (United States Fish and Wildlife Service), and Bill Loftus (USGS, ret.; Volunteer) just published on the age, growth and mortality of the Florida gar *Lepisosteus platyrhincus* in the Florida Everglades. Leo Nico, William Loftus, and James Reid (USGS) recently published two articles on Florida populations of invasive armored suckermouth catfishes. The most recent is one is entitled "Interactions between non-native armored suckermouth catfish (Loricariidae: *Pterygoplichthys*) and native Florida manatee (*Trichechus manatus latirostris*)

in artesian springs." Similarly, Leo Nico, Howard Jelks (USGS) and Travis Tuten (Florida Fish and Wildlife Conservation Commission) published a paper describing nest burrows of the invasive catfish, comparing their burrows to those of other burrowing animals; the paper also assesses the effects of catfish burrow colonies on shoreline erosion and stability. It is available at http://fl.biology.usgs.gov/ pdf/ansrp-v09-1(LR).pdf. Pam Schofield (USGS) and Leo Nico published on their laboratory study comparing the salinity tolerances of different populations of Asian swamp eels (Synbranchidae, genus *Monopterus*) established in peninsular Florida. Steve Walsh (USGS), Elissa N. Buttermore, Towns Burgess, and William E. Pine, III (UF) recently published a summary report of aspects of their studies on larval fishes in the Apalachicola River floodplain (http://pubs.usgs.gov/of/2009/1145/). In addition, Steve Walsh published results of a multi-year study of aquatic communities in selected springs of the St. Johns River drainage, emphasizing macroinvertebrates, with limited surveys of fishes (http://pubs.usgs.gov/sir/2009/5046/). Steve Walsh, Howard Jelks, and Noel Burkhead (USGS) recently published "The decline of North American freshwater fishes at: http://www.actionbioscience.org/biodiversity/walsh.html. The article, written for the public, is a general summary of the AFS list revision published in 2008 and contains relevant links to other sources of information on aquatic fauna in peril.

Osvaldo Sepulveda-Villet (University of Toledo), Alexander Ford (Cleveland State University), James D. Williams (Florida Museum of Natural History), and Carol Stepien (University of Toledo) recently published an article on population genetic diversity and phylogeography of the yellow perch *Perca flavescens*. The study sampled populations from the Great Lakes, Lake Winnipeg, the upper Mississippi basin, northeast and southeast Atlantic slope, and Gulf of Mexico, including Chattahoochee and Apalachicola rivers in Florida and Mobile River, Alabama.

Franklin (Buck) Snelson, Jr., (Florida Museum of Natural History), stated that his last official act as an ichthyologist is the description of the "Apalachicolan pygmy sunfish" *Elassoma* sp. cf. *okefenokee*, along with Trevor J. Krabbenhoft (University of Mexico), and Joseph M. Quattro (Rutgers University). The new pygmy sunfish patronym honors Carter Gilbert, University of Florida (ret). The species ranges from tributaries of the Choctawhatchee Bay to the Suwannee River, where both species occur, and *E. okefenokee* occurs northeast of the Suwannee and south in the Florida peninsula. Buck states his new aspiration is to become a rock star.

Bill Loftus has been working with Fairchild Tropical Botanical Garden in Miami, FL to remove African jewelfish *Hemichromis letourneuxi* from 11 lakes on their property, and to increase the diversity of the lakes by stocking native fishes.

Since 2004, the Florida Chapter of the Nature Conservancy (Conservancy) has coordinated local, state, and federal partner input and recommendations to the U.S. Army Corps of Engineers (ACOE) for providing fish passage at Jim Woodruff Lock and Dam on The Apalachicola River. After several years of study, the ACOE agreed to include operation of the existing lock at Jim Woodruff Lock and Dam in their interim fish spawning operations. The Nature Conservancy is working with the ACOE for similar fish passages in other Gulf drainages. In 2007, the Conservancy teamed with The E.O. Dun Foundation, the U.S. Fish and Wildlife Service (USFWS), and the Florida Fish and Wildlife Conservation Commission (FFWCC) for removal of a small dam and poorly designed road culverts and stream restoration of Kelley Branch, a globally rare steephead stream located in Bristol, FL. The Conservancy is completing a second year of assemblage monitoring in Kelly Branch to understand how the fish assemblage is responding to renovation efforts and the findings should be published in Fiscal Year 2010. The Conservancy is cooperating in a dam removal and stream restoration project of another steephead stream in Fred Gannon Rocky Bayou State Park in Florida. The Conservancy is currently completing an assessment of riparian corridors and road crossings in the Yellow River drainage in Alabama and Florida. The Conservancy has coordinated a similar, partner-led effort for the St. Mary's River in northeastern Florida.

Frank Parauka, USFWS Panama City Field Office, has been monitoring the Gulf sturgeon. The 2007 and 2008 annual population census suggests that the Choctawhatchee population is doing well; the annual census will be conducted in the Apalachicola River in 2009. Jerry Ziewitz completed the 5-year status review for Gulf sturgeon, which is currently out for peer-review. Karen Herrington and Sandy Pursifull are working on population biology and life history of imperiled mussels in the Apalachicola, Chattahoochee, Flint, Ochlocknee, and Suwannee rivers. Chris Metcalf is working with multiple partners on several stream restoration projects in the Ochlockonee River (and Spring Creek in Georgia). Chris Metcalf and Bill Tate are working with the Conservancy and FFWCC to assess threats and restoration needs in the Ochlockonee and Yellow rivers of Florida, Alabama, and Georgia. Bill Tate is working with Eglin Air Force Base and other partners to manage and conserve aquatic resources on military lands. This year, the FWS staff at Eglin has grown, with the addition of Channing St. Aubin and Jeff Van Vrancken. Chan's work is primarily aquatic macroinvertebrates but he will be assisting with stream restoration and fish projects. On Eglin AFB, seven stream restoration projects were completed in 2009, including the removal of four impoundments and the

elimination of three fish passage barriers associated with road crossing structures. Two large stream restorations are currently being designed or permitted and construction should begin in early 2010.

Bill and his staff will continue to work with Howard Jelks (USGS) and Frank Jordan (Loyola University, New Orleans) to assess Okaloosa darter response to restored stream habitat. Other ongoing Eglin projects include: assessing physiological effects of sprayfield effluent on stream fishes, population genetics for the Okaloosa darter, movement of Gulf sturgeon in nearshore coastal waters, development of GIS models that predict aquatic habitat condition from landuse characteristics, changes in stream channel geomorphology resulting from erosion control activities, faunal composition of Ephemeroptera, Plecoptera, and Trichoptera (EPT) fauna in steephead streams, stream restoration planning, design, and monitoring, as well as the ongoing recovery activities concerning the Okaloosa darter *Etheostoma okaloosae*.

Walt Courtenay (Florida Atlantic University, and USGS volunteer) was senior author of a paper entitled "Risks of Introductions of Marine Fishes: Reply to Briggs." He was joined in this effort by several others including Bill Smith-Vaniz (USGS volunteer). Walt was also involved with many other coauthors from Canada and Mexico in a publication entitled "Trinational Risk Assessment Guidelines for Aquatic Alien Invasive Species", published by the Commission for Environmental Cooperation, a unit of the North American Free Trade Agreement, in April 2009. He, and senior author Cindy Kolar (USGS, Reston, VA) and Leo Nico, have a book chapter (Managing Undesired or Invading Species) in press for the third edition of Inland Fisheries Management in North America, published by the American Fisheries Society.

Jim Williams (USGS, ret.), along with coauthors Art Bogan (North Carolina State Museum) and Jeff Garner (Alabama Division of Wildlife and Freshwater Fisheries), described a new species of freshwater mussel from the Gulf Drainages of Alabama, Florida, Louisiana and Mississippi. The new mussel *Anodonta hartfieldorum* is named in honor of Paul Hartfield (USFWS) and Libby Hartfield, Director of the Mississippi Museum of Natural Science, Jackson.

Submitted by Noel Burkhead
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GEORGIA

Gary Beisser and crew (GADNR) have continued work on the Lake Sturgeon reintroduction project, which has involved stocking juveniles throughout the Coosa system since 2002. Using side scan sonar, DNR recently began mapping the Coosa River to identify important habitat features for lake sturgeon. Tim Barrett and Elizabeth Colvin (GADNR) have been working on striped bass restoration in coastal Georgia. Since 2000, an average of 33,000 striped bass has been stocked annually into the Savannah and Altamaha rivers. Population samples indicate that striped bass numbers in both rivers have increased dramatically, especially in the Savannah River. Joe Rydell (GADNR) is managing Ocmulgee Public Fishing Area (PFA) for trophy largemouth bass (LMB). They have stocked only female LMB at low density (no males) and the lake has produced several 8 to 9 lb stout bass. Brian Estes (Jordan Jones and Goulding) and Kevin Thomas (Edwards-Pitman) have been working on rare fish surveys for transportation projects throughout Georgia. In an effort to improve reproductive success of the State Endangered robust redhorse, Jimmy Evans (GADNR) has been working on an Oconee River gravel augmentation project. To date a single site has been augmented with 370 tons of gravel and a total of 1,400 tons of gravel will be utilized at this and two other high priority sites. As part of a GADNR project, Steve Sammons (Auburn University) is presently conducting a comprehensive study of relations between shoal bass and sympatric congeneric black bass species on the Flint River, Georgia. Preliminary results include documentation of long migrations during spring flooding to find suitable spawning grounds and relatively high angler catch rates combined with high release rates.

Brett Albanese (GADNR) and crew have been working on a spring restoration project for the Coldwater darter (collaborative project with the Anna George and Dave Neely, Tennessee Aquarium, and the Conasauga River Alliance), a survey for the goldline darter in the Coosawattee system, and on species accounts for Georgia's state protected fishes. He hopes to help Bud Freeman and Carrie Straight put some finishing touches on the Fishes of Georgia Atlas this fall. As part of a GADNR project, Dave Neely is revising Georgia sculpin taxonomy, including a key to described and undescribed species of sculpin in the state.

Cecil Jennings and crew (USGS) have been working on a radio telemetry study of adult robust redhorse in the Oconee River, GA. To date, they have found evidence that of a new spawning site located upstream of the current only confirmed spawning site at Avant Mine; they also tracked a single individual from the Oconee River into the Ocmulgee River and back. Finally, this research team documented consistently high usage newly a formed oxbow on the Oconee River. Jim Peterson is not doing any fish work in Georgia right now, but he has an army of students working on endangered Georgia mussels.

Gary Grossman's research group (University of Georgia) is continuing to conduct long-term studies on fish assemblages in southern Appalachian streams as well as assess the relative importance of density-dependent and

density-independent factors on these populations. Peter Hazelton has finished studies of the impacts of turbidity and competition on yellowfin shiners and rosyside dace. Duncan Elkins is finishing up his dissertation on the effects of rainbow trout stocking on assemblage structure and microhabitat use on native fishes. Collaborative work includes an assessment of whether yellowfin shiners are native to the Tennessee drainage with John Wares at UGA.

Bud Freeman (UGA) has been focusing on *Micropterus* taxonomy and amber darter genetics (with Brady Porter). Carrie Straight is assessing spawning habitat and recruitment of robust redhorse in the Broad River system. Megan Hagler is coordinating Section 6 projects in the Etowah and Conasauga Rivers, including an assessment of factors that may be causing the apparent decline of Conasauga River mainstem fishes (e.g., the undescribed Coosa madtoms and Coosa chubs). Greg Anderson just completed his thesis research on reproductive biology of the Etowah darter, holiday darter, and bridled darter. Mary Freeman is working on models to predict the persistence of imperiled stream fishes in the Coosa system and on water availability for ecological needs in the Flint system. Doug Peterson has several ongoing sturgeon projects.

Chris Skelton's graduate student Meiko Camp is conducting a life history study of the striped crayfish, *Cambarus (D.) striatus* in a small seepage area near Milledgeville, Georgia. Meiko began capturing and tagging *C. striatus* with visual alphanumeric internal tags in April. en adult *Cambarus* spp. were tagged and held in the laboratory to assess tagging mortality and tag retention. To date, there has been no mortality (except for an escapee) and in two individuals that molted, the tags were retained and readable.

Bill Ensign, Thom McElroy and Scott Reese at Kennesaw State's Biology Department are exploring the life and times of *Campostoma oligolepis* in the middle and lower Etowah River basin. McElroy and Ensign have been collecting *C. oligolepis* from a number of watersheds to determine if dam building, road crossings and the other various impediments to fish movements have affected stoneroller population genetic structure. Reese is gearing up to look at thermal preferences in stonerollers from urban, suburban and rural watersheds in conjunction with age and growth work by Ensign.

A survey of the fishes of the Withlacoochee River is being conducted from January 2009 to June 2010 by Matt Cannister and David Bechler (Valdosta State University). To date, they have documented range extensions for Alabama shad and brown darter.

Conservation Fisheries saw above average numbers of Etowah, holiday, and bridled darters at the GA 52 and Hightower Church Rd Bridges in the Etowah River system. In the upper Conasauga, CFI saw far above average numbers of blue shiners and bridled darters and average holiday numbers, but did not observe Conasauga logperch in any portions of the upper Conasauga (US Forest Service lands).

Submitted by Brett Albanese
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KENTUCKY

Matt Thomas (Kentucky Department of Fish and Wildlife Resources, KDFWR) completed status surveys for two "species of concern" in Kentucky. *Etheostoma susanae* (Cumberland darter), an upper Cumberland basin endemic, was collected at 50% of known historic localities, with a current distribution contained within six minor tributaries of the Cumberland River immediately above Cumberland Falls. *Etheostoma sagitta spilotum* (arrow darter), an endemic of the upper Kentucky River drainage, was collected at 58% of known historic localities visited, with strongest populations persisting in streams within the Daniel Boone National Forest and Robinson Forest (UK).

Matt Thomas and Rebecca Blanton-Johansen (Austin Peay State University) are collaborating on a paper addressing the taxonomic status and population genetics of *Etheostoma sagitta*. Rex Strange (University of Southern Indiana) is analyzing genetic variation within *E. susanae*. Pat Rakes and J.R. Shute (Conservation Fisheries, Inc., CFI) have successfully developed captive spawning protocols for *E. s. spilotum* and *E. susanae*. In July 2009, 110 captive spawned *E. s. spilotum* were injected with visible implant elastomer tags and released into a small tributary of the Red Bird River (upper Kentucky basin) for careful follow-up monitoring. A similar release is being planned for *E. susanae* within its known historic range in the upper Cumberland drainage. Michael Floyd (U.S. Fish and Wildlife Service, USFWS) has prepared a draft proposed listing rule for *E. susanae* (to be listed as Endangered) and a candidate assessment for *E. s. spilotum* (soon to be elevated to species rank by Matt and Rebecca).

The KDFWR has initiated long-term projects, funded through SWG, to restore populations of *Acipenser fulvescens* (lake sturgeon) and *Atractoseus spatula* (alligator gar) through captive propagation and reintroduction into suitable habitat where they occurred historically in Kentucky. Between 2007 and 2009, 1,675 lake sturgeon have been released into the Cumberland River between Lake Cumberland and Cumberland Falls, and in lower Big South Fork. An initial release of 4,300 young-of-year alligator gar was accomplished at 11 localities in western Kentucky in July 2009.

Michael Compton (Texas Tech University) is conducting an analysis of environmental requirements for

Etheostoma cinereum (ashy darter) and *Percina squamata* (olive darter) in the Rockcastle River system. His primary objective is to document occurrences of those target species within the Rockcastle system and characterize stream reaches (where present) based on environmental variables to construct models for occupancy estimation.

Michael Floyd (U.S. Fish and Wildlife Service, USFWS) has completed draft 5-year reviews for *Phoxinus cumberlandensis* (blackside dace) and *Notropis albizonatus* (palezone shiner). Michael has also been actively involved with monitoring Mill Branch, an approximately 2,300-ft Priority I stream restoration for blackside dace in Knox County, southeastern KY. The National Park Service (NPS), USFWS, KDFWR, and others are working to restore another blackside dace population in Davis Branch at Cumberland Gap NHP through a beaver eradication/control program combined with stream restoration. Other habitat restoration and improvement projects in the upper Cumberland Basin are being funded through the USFWS Partners for Fish and Wildlife Program, aimed chiefly at blackside dace, palezone shiner, and Cumberland darter habitats.

Rob Hopkins and Brooks Burr (Southern Illinois University, Carbondale, SIUC) have digitized over 50,000 specimen based records for fishes in Kentucky, dating from the 1890s to the present. Rob just completed his Ph.D. dissertation investigating relationships between distributions of rare fishes and landscape composition at multiple spatial scales in the upper Green River basin. Bob Gerwig (SIUC) has completed the life history of *Moxostoma poecilurum* (blacktail redhorse) in Terrapin Creek, western KY. Bob's work began in March 2007 to document spawning activity and habitat use, and to estimate population size and demography.

David Eisenhour (Morehead State University) with graduate students Josh Schiering and Audrey Richter, completed a status survey and habitat assessment of *Percina macrocephala* (longhead darter) in Kinniconick Creek, northeastern KY. They found the species at 15 of 55 reaches sampled, with a total of 104 individuals over a 50 km stretch. Also noteworthy is that they were fairly easy to find snorkeling, but very difficult to capture by seine or electrofishing! David and Lynn, along with Audrey, have begun examining the life history of *Percina stictogaster* (frecklebelly darter). David, along with Brooks Burr and Matt Thomas, is still "plodding" along on the Kentucky Fish Book.

Sherry Harrel (Eastern Kentucky University) and graduate student, Stephanie Brandt, are nearing completion of an ichthyofaunal survey of Rock Creek, Big South Fork drainage. Stephanie's objectives are to evaluate changes in species composition and distribution relative to previous collection data and to address predation potential of stocked Rainbow Trout on rare native fishes throughout the system. A particularly noteworthy record encountered during her research is a single *Notropis albizonatus* in a 2008 collection from lower Rock Creek. Aside from the Paint Rock River, AL, this represents the first record outside of the Little South Fork Cumberland River in more than 60 years! Sherry and another graduate student, Garrett Stillings, have begun a distributional and habitat assessment of *Thoburnia atripinnis* (Blackfin Sucker) in the Barren River system.

Submitted by Matt Thomas (matt.thomas@ky.gov)

LOUISIANA

Marty O'Connell with the Nekton Research Laboratory (NRL) at the University of New Orleans (UNO) reports that another invasive fish has been found in southeastern Louisiana. In December 2008, specimens of a yet to be determined strain of *Oreochromis* were collected in the vicinity of Port Sulphur, which is located on the Mississippi River south and downstream of New Orleans. The Louisiana Department of Wildlife and Fisheries (LDWF) responded quickly and aggressively to wipe out this potential threat to native fishes. The area was closed off to all fishing and rotenone was applied by LDWF personnel to all infested water bodies. Melissa Kaintz of LDWF and Dr. Tom Lorenz (former NRL student) participated in these efforts and developed and on-site experiment to test effective rotenone concentrations for tilapia in brackish waters. Tom estimates that up to 95% of the fish biomass killed by the rotenone treatment consisted of tilapia. A post-treatment monitoring effort is being planned to assess the overall effectiveness of the response. Specimens of the Rio Grande cichlid (*Herichthys cyanoguttatus*) were collected with the tilapia around Port Sulphur. This invasive species has been studied by NRL personnel for over ten years and it continues to expand in southeastern Louisiana in both freshwater and estuarine habitats. Recent preliminary analyses conducted by Senior Biologist and Database Manager Meg Uzee O'Connell suggest that where *H. cyanoguttatus* have become established in New Orleans, they negatively impact native poeciliids. As part of her dissertation research, new Ph.D. student Celeste Espinedo will be studying behavioral interactions between *H. cyanoguttatus* and livebearers.

Other NRL projects include continuing research led by Senior Biologist Chris Schieble on the pupping activity of lemon sharks (*Negaprion brevirostris*) at the Chandeleur Islands, Louisiana's oldest and most remote barrier island chain. These essential reproductive habitats are being threatened by increasing storm activity and sea level rise. Chris is being assisted by graduate students Jonathan McKenzie (Ph.D.) who is tracking the lemon sharks using

satellite tags to determine their habitat use and Chris Davis (M.Sc.) who is examining lemon shark diet and prey availability. Graduate student Sunny Brogan (M.Sc.) and undergraduate student worker Jenny Wolff continue their work with restoring native red drum (*Sciaenops ocellatus*) to an urban fishery in New Orleans. Both students also participated in an LDWF project which is testing the possibility of using native largemouth bass (*Micropterus salmoides*) to control numbers of *H. cyanoguttatus* in New Orleans' City Park. Tagged *M. salmoides* were introduced to cichlid infested habitats this spring and Sunny and Jenny are assessing any changes in numbers of *H. cyanoguttatus*.

Dr. Brian Alford of LDWF has been studying changes in fish assemblages following a freshwater diversion of the Mississippi River to the Davis Pond area of southeastern Louisiana. Electrofishing, gill net, and seine samples were collected quarterly from 1998-2001 (pre-diversion period) and 2002-2008 (post-diversion period) by the LDWF. After accounting for natural physicochemical variation (e.g., salinity, water temperature, turbidity) among sample sites, seasons, and years, there was a significant change in fish assemblages following the diversion among all sampling gears (partial Canonical Correspondence Analysis, CANOCO® software). In the electrofishing samples, the freshwater diversion had a positive effect on numerical abundances (fish/hour) of Gulf killifish (*Fundulus grandis*), striped mullet (*Mugil cephalus*), and inland silverside (*Menidia beryllina*), whereas diversion negatively affected golden shiner (*Notemigonus crysoleucas*), white crappie (*Pomoxis annularis*) and southern flounder (*Paralichthys lethostigma*). From the gill net samples, the diversion positively affected abundances (kg/net-night) of freshwater drum (*Aplodinotus grunniens*) and negatively influenced black drum (*Pogonias cromis*), spotted seatrout (*Cynoscion nebulosus*), and Atlantic croaker (*Micropogonias undulatus*). Seine sampling revealed that the diversion positively influenced abundances (fish per haul) of banded drum (*Larimus fasciatus*), Spanish mackerel (*Scomberomorus maculatus*), rainwater killifish (*Lucania parva*), guaguanche (*Sphyraena guachancho*), and *M. beryllina*. Conversely, the freshwater diversion had a negative influence on Gulf menhaden (*Brevoortia patronus*), *S. ocellatus*), and *C. nebulosus* from seine samples.

Eric Shanks, the LDWF Inland Fisheries Supervisor for District 5, is testing the use of the antibiotic oxytetracycline (OTC) for mass marking of fingerlings to determine the recruitment success of individual stockings of largemouth bass (*Micropterus salmoides*). These studies will be conducted at the Fort Polk Joint Readiness Training Center, a 100,000 acre military installation located in Vernon Parish. Louisiana. Several impoundments ranging in size from 3 to 5 acres are located on the installation. The results of this study will provide LDWF with information on supplemental stocking success in small impoundments.

Bobby Reed with LDWF Inland Fisheries District 5 along with Jan Dean from the USFWS Natchitoches National Fish Hatchery are working with a team of fisheries biologists on a research project to better understand river sturgeon populations at the Old River Control Structure (ORCS) in Concordia Parish, Louisiana. This team includes personnel from LDWF, USFWS, Mississippi State University (MSU), and the Lower Basin Pallid Sturgeon workgroup. The channels around and below the structures are habitat for the largest concentrations of pallid sturgeon (*Scaphirhynchus albus*) found in the U.S. Captured fish are scanned for marks (PIT tags), photographed, morphometric measurements taken, and tissue and blood samples were taken for sex recognition and maturation, disease diagnosis, and species determination. All fish are being marked with PIT tags and released back to the river at ORCS. In 2008-2009 a total of 50 adult *S. albus* were implanted with sonic tags and released in the Atchafalaya River. Researchers at MSU are tracking the fish weekly to determine movements and habitat.

Billy Justus and James Wallace of the USGS Arkansas Water Science Center report that from 2005 to 2007, the USGS sampled fishes and invertebrate assemblages and monitored dissolved oxygen during critical summer conditions at 35 stream sites in southern Louisiana. The purpose of the study was to assess relations between fishes and invertebrate assemblages and dissolved oxygen, and to provide information that could be used to validate or refine existing aquatic life use categories and dissolved-oxygen criteria (5 milligrams per liter) for streams in southern Louisiana. Preliminary data indicate a biological threshold exists between 2 and 3 milligrams per liter of dissolved oxygen. This finding indicates that fishes and invertebrate assemblages in low-gradient streams have adaptations that enable them to withstand low dissolved-oxygen concentrations.

Todd Slack reports that the Fish Ecology Team at the US Army Engineer Research and Development Center (ERDC) is studying the effects of existing and proposed water diversion structures in south Louisiana. Surveys of sturgeon entrained during the 2008 opening of the Bonnet Carre spillway were used to develop protocols for estimating "take" of entrained pallid sturgeon. Impacts of these estimates on population viability will be modeled by ERDC and Nick Friendenberg, Applied Biomathematics. Field surveys, conducted by ERDC and by Dave Schultz and Clint Troxler, Nicholls State University, will be used to describe fish assemblages in the river and outflows and, eventually, assess risk of entrainment. Tissue samples collected from sturgeon will be sent to Rob Wood, St. Louis University, to provide genetic characteristics of pallid and shovelnose sturgeon at the southern limits of their geographic range. The Team is also investigating the feasibili-

ty of retrofitting an existing earthen dam in the Bayou Bodcau Wildlife Management Area with control gates to reduce downstream flooding. Field surveys within the project area will address impacts and benefits to fish habitat for the identified project alternatives. Lastly, the Team is participating in restoration efforts for the Spring Bayou Ecosystem Area located in central Louisiana.

Tim Bonner (TSU) is working in collaboration with Northwestern State University of Louisiana assessing changes in fish assemblage structure in Kistachie Bayou, a component of the state Natural and Scenic Rivers System.

Submitted by Marty O'Connel1 (moconnel@uno.edu)

MARYLAND

Biologists at the Maryland Biological Stream Survey (MD DNR) and Frostburg State University are working to establish the current status of blackbanded sunfish (*Enneacanthus chaetodon*) in the state. Blackbanded sunfish were found in three small ponds in Caroline County in 2006 and two additional ponds were located this summer (2009). Kilian et al. found that pH of the ponds where *E. chaetodon* was captured in 2006 was < 4.6 and non-native predators (e.g., largemouth bass, black crappie) were rare or absent. Surveys conducted during 2008 in collaboration with biologists from the Delaware Department of Natural Resources and Environmental Control found that blackbanded sunfish were extirpated from all historical localities in the Nanticoke River drainage of that state. The species was found at a single locality in the Delaware River drainage this summer. Tissue has been collected from specimens in the Nanticoke River drainage of Maryland and the Delaware River drainage of Delaware for genetic analysis (to be done in collaboration with South Carolina DNR).

The Maryland DNR Fisheries Service is funding a project to study brook trout (*Salvelinus fontinalis*) movements in the Savage River drainage of western Maryland. The Maryland DNR Fisheries Service has determined that brook trout currently occupy only 38% of their historic range in Maryland. Biologists at the University of Maryland Appalachian Laboratory are using PIT tags to examine movements. Tagging will begin in August 2009 with a goal of implanting 1,500-2,000 tags before December and an additional 2,000-2,500 tags in early 2010.

The Maryland DNR Natural Heritage Program and the U.S. Fish and Wildlife Service are funding a two-year study to determine the status of the federally-endangered Maryland darter (*Etheostoma sellare*). The species was last seen in 1987 and may be extinct, although there have previously been large periods of time during which the Maryland darter was not found. The species is known from only three streams in the lower Susquehanna River drainage in Maryland. Biologists from Frostburg State University, the Maryland Biological Stream Survey (Maryland DNR), and Marshall University (WV) are collaborating on this project, which will begin in September 2009. In addition to sampling the historic localities in Swan Creek, Deer Creek, and Gashey's Run, surveys will be conducted in the mainstem Susquehanna River in the vicinity of these streams using electric trawls and SCUBA (not at the same time/location, in case you wondered).

Submitted by Rich Raesly (rraesly@frostburg.edu)

MISSISSIPPI

Jake Schaefer, Brian Kreiser (The University of Southern Mississippi-Hattiesburg) and Dave Duvernell (Southern Illinois University Edwardsville) have been studying contact zones among species in the *Fundulus notatus* species complex. The team is interested in the implications of different contact zone structure on the ecology and evolution of the populations in these systems. The phylogeographic component of the project is being tackled by Brian Kreiser. Students at the University of Southern Mississippi are perusing a number of questions regarding the contact zone work. Charles Champagne (MS) is studying the diet and feeding morphology of the two species across the contact zone. Melissa Gutierrez (MS) is studying mate choice dynamics, asking if females prefer males based on body size or spot density. Melissa and Wilfredo Matamoros (PhD) have also undertaken a mark-recapture study to estimate movement dynamics, population size and habitat use of *F. olivaceus* in a local creek. Other students not working with the *Fundulus* include Scott Clark (feeding ecology of *Esox niger* and *Esox americanus*), Paul Mickle (ecology of *Alosa alabamae*), Wilfredo Matamoros (biogeography of Honduran fishes) and Bjorn Schmidt (project undefined).

Mel Warren reports on the fish, crayfish and mussel research activities in Mississippi by the staff at the USDA Forest Service Center for Bottomland Hardwoods Research, located in Oxford, Mississippi. The group (Susan Adams, Mickey Bland, Mason Bryant, Amy Commens, Gordon McWhirter, Andrew Rypel (post-doc, University of Mississippi), Ken Sterling (M.S. student at University of Mississippi), Wendell Haag, and Mel) has been working on a diverse array of projects which includes the following highlights: (1) Continued periodic sampling of fishes in flooded bottomland forests and other wetland habitats at high and low water periods, Delta National Forest, Little and Big Sunflower River system (Yazoo River basin) (Warren and Bryant). Last year was a Spotted Gar (*Lepisosteus oculatus*) and Shortnose Gar (*L. platostomus*) boom; this year was a Silver Carp

(*Hypopthalmichthys molitrix*) and Bighead Carp (*H. nobilis*) bonanza. (2) Initiated six research projects focused on the Yazoo Darter (*Etheostoma raneyi*) (Warren): collected tissues (non-destructively) for microsatellite assessment of population differentiation, particularly the effects of barriers on genetic structure (Warren with Ken Sterling, David Reed, and Bryce Noonan, University of Mississippi); surveyed non-historical sites for the darter; re-surveyed randomly selected historical sites to evaluate changes in abundance across the range of the species; initiated seasonal comparisons of microhabitat use; initiated a field study of effects of installed natural spawning substrates on darter density (Warren with Ken Sterling, David Reed, and Bryce Noonan, University of Mississippi); and initiated a mark-recapture pilot study of darter movement and the use of constructed woody bundles for establishing the darter in a non-occupied small tributary (within an occupied stream system). (3) Continued evaluation of spawning, recruitment, and population demographics of the Alabama Shad (*Alosa alabamae*), Pascagoula River system (Adams with Brian Kreiser and Jake Schaefer, University of Southern Mississippi). (4) Re-surveyed 10 randomly selected stream reaches (original surveys 1999-2004) in the Little Tallahatchie and Yocona rivers to help evaluate, in part, temporal changes in fish and habitat in streams of National Forests in Mississippi (Warren with Jake Schaefer, University Southern Mississippi). (5) Initiated genetics studies on *Fallicambarus gordoni* (Adams with Jim Lee, Nature Conservancy, and Jim Fetzner, Carnegie Museum of Natural History). (6) Continued genetic analyses on *Orconectes* (*Trisellescens*) spp. from multiple drainages in Mississippi (Adams, with Keith Crandall, Brigham Young University). (7) Continued diversity assessment of crayfishes of north-central Mississippi (Adams and Warren, with Chris Taylor, Illinois Natural History Survey). (8) Continued adding records and collections to the in-progress distributional atlas of crayfishes of Mississippi (Adams). In addition, the website "Crayfishes of Mississippi" is active at http://maps.fs.fed.us/crayfish/crayfish_general_info.jsp" http://maps.fs.fed.us/crayfish/crayfish_general_info.jsp. The website provides interactive distribution maps of Mississippi's crayfishes (with Chris Lukhaup's photographs) and allows searches by lists of species, county, or HUC code or mapping of distributions of species by county or HUC. (9) Completed 10-year study of mussel population demographics in Sipsey River, AL and Little Tallahatchie River, MS

Mark Peterson, The University of Southern Mississippi-Gulf Coast Research Laboratory reports a very busy year in his lab with most of his time being directed towards the following research projects: (1) Ecosystem-based management: assessing ecosystem services of oyster reefs using stable isotope signatures. The project is being conducted with Kevin Dillon and Rich Fulford. (2) Participation in the NGI prototype Integrated Ecosystem Assessment for the northern Gulf of Mexico. Rich Fulford and Steve Lohrenz are co-PIs on the project. (3) Habitat characteristics and aspects of the reproductive life history of the saltmarsh topminnow, *Fundulus jenkinsi*, in coastal Mississippi watersheds, with the production of a comparative diagnostic key for young stages of select members of the genus *Fundulus*, Todd Slack as a co-PI. (4) Gulf sturgeon, *Acipenser oxyrinchus desotoi*, in the Pascagoula drainage, Mississippi: post-Hurricane Katrina assessment of habitat and movement of the juvenile cohort. This project is being conducted with Todd Slack. (5) Ecosystem-based management - ecosystem models - years 1 - 3, with Rich Fulford as co-PI. (6) *Fundulus jenkinsi*, Saltmarsh Topminnow: Conservation Planning and Implementation. Development of this management plan is a collaborative effort including Dave Ruple, Rafael Calderon, Mark Woodrey and Gretchen Grammer.

Larry Pugh, Assistant Chief of Fisheries for the Mississippi Department of Wildlife, Fisheries and Parks, commented that the agency was supporting a number of fisheries related research projects. Don Jackson (MSU) is studying the recovery of river fisheries on the Pascagoula River following Hurricane Katrina. This work was prompted by reports of massive fish kills occurring on the lower reaches of the river after Hurricane Katrina made landfall. Eric Dibble (MSU) has been funded to develop management practices regarding chemical and biological aquatic plant control methods to restore habitat and facilitate fishery management goals in Mississippi Delta lakes. Lastly, Steve Miranda (MSU) and Glen Parson (UM) are determining habitat used for spawning by adult crappie in four large flood control reservoirs of northwest Mississippi. These data will be utilized to explore flexibility in the reservoir operational rule curves that would allow crappie-friendly adjustments to water levels.

The Fish Ecology Team (Jack Killgore, Jan Hoover, Steven George, Phil Kirk, Todd Slack, Bradley Lewis, Jay Collins, Bill Lancaster, Krista Boysen, Alan Katzenmeyer, Larry Southern and Kathie Eagles) at the US Army Engineer Research and Development Center (ERDC) continues its 20-year program of sampling the Mississippi delta and the mainstem Mississippi River. Delta work includes evaluations of the biotic integrity of streams and rivers and descriptions of the impacts and benefits of water control structures. River projects include assessments of dike-notching and dredging on fish assemblages, and ongoing population studies of pallid and shovelnose sturgeon. ERDC is also working with the Lower Mississippi River Conservation Committee to prioritize secondary channels for restoration. Surveys of Asian carp continue in Forest

Home Chute with new collaborative studies of plankton and carp diets by Cliff Ochs and Orathai Pongruktham, University of Mississippi. Completion of a new Brett swim tunnel and two smaller Blazka tunnels have provided swimming performance data on juvenile Asian carp and adult shovelnose sturgeon. Juvenile silver carp swimming performance studies were completed by student researcher Larry Southern, Hinds Community College, and by National Great Rivers Research and Education Center (NGRREC) summer intern Rachel Schmidt, Southern Illinois University. Swimming performance of juvenile bighead and grass carps are underway by student researcher Alan Katzenmeyer, Louisiana Tech University.

Submitted by Jan Hoover (hooverj@wes.army.mil) and Todd Slack (Todd.Slack@usace.army.mil)

MISSOURI

Alligator gar (*Atractosteus spatula*) were reintroduced into the Mingo Basin of southeastern Missouri in Mingo National Wildlife Refuge (NWR). In May 2007, 19 radio-tagged juvenile *A. spatula* were released into 1,214-ha Monopoly Marsh and were tracked by Southeast Missouri State University graduate student (and Open Rivers and Wetlands Field Station employee), Levi Solomon. An internal MDC missive was published detailing the study. To determine the possible effects of introduced *A. spatula* on the unique fish community, a survey was designed to document changes to species richness in the basin that could be attributed to introducing *A. spatula*. After three years of conducting surveys using this design in Mingo NWR, we have decided to stop sampling for the next three years, give the gar time to grow, and then measure the possible effects of the gar on species richness in Mingo NWR for the ensuing three years.

Open Rivers and Wetlands Field Station (ORWFS) staff was involved in a two-day meeting to determine the status of and to evaluate the need for listing stargazing darter (*Percina uranidea*). The impetus for the meeting was, in part, the result of many new locality records collected by staff using the Mini-Missouri Trawl, which was developed by ORWFS staff. The species has a wider distribution and seems more abundant in Arkansas than Missouri. Missouri's locality records have been greatly increased because of ORWFS trawling in the Black River. Prior to 2006, there were only eight records of *P. uranidea*; we have since added 21 records. Many of these records resulted from the experimental work of Joe Ridings (ORWFS), who has developed a new trawl named the "brail trawl." The brail trawl is a modification of the Mini-Missouri Trawl whereby mussel brail hooks are towed immediately in front of the opening of the trawl. The hooks flip over small rocks and debris forcing fish into the water column and are intercepted by the trawl. Riding's data shows significant increases in catch of madtoms (*Noturus*), sculpins (*Cottus*), and darters (*Etheostoma* and *Percina*) over the Mini-Missouri Trawl without a significant increase in snagging. An underwater video is available as well showing how the brail trawl scours the bottom releasing fish that were hiding under cover.

The Missouri Trawl was also the primary reason Dave Knuth (Missouri Department of Conservation-West Plains) decided to survey the Gasconade River for crystal darters (*Crystallaria asprella*). In 8 days of sampling, he captured 13 *C. asprella* from 7 locations in two counties. Prior to these collections, *C. asprella* had not been collected from the Gasconade River since 1990. Enticed by these results, focus shifted to the Meramec River. Jeff Ray from the University of Northern Alabama used the Mini-Missouri Trawl with help from Knuth and ORWFS staff to survey parts of the Meramec River this summer. At this writing, 6 *C. asprella* were captured from different locations in the river; more surveys are being planned.

A new darter species was described by John Switzer and Rob Wood (St. Louis University): *Etheostoma erythrozonum* (Meramec saddled darter). It is the first known fish species endemic to the Meramec Basin. It differs morphologically and genetically from its sister species *E. tetrazonum* from the Gasconade, Osage, and Moreau River basins.

Other highlights involving the ORWFS include: (1) Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System. We concluded our 17th straight year of monitoring the fish community in a 50-mile stretch of the Middle Mississippi River at Cape Girardeau, Missouri. This summer, our LTRMP crew reports higher than usual catches of the rare Ohio shrimp (*Macrobrachium ohione*), a species we have closely monitored since we rediscovered it in 1991. In August 2009, Tom Jones from Marshall University captured a single specimen of *M. ohione* from the Ohio River just below Smithland Dam; an important new find. (2) Fish community monitoring continues for several side channel restoration projects in the Middle Mississippi River: Schenimann Chute, Establishment Island, and Buffalo Chute. Schenimann Chute and Buffalo Chute are still in the pre-construction monitoring phase, but Establishment Island (which is actually an evaluation of the effects of river training structures on fish communities of a river bend) is now in the post-construction monitoring phase. (3) The Middle Mississippi River pallid sturgeon demographics project, a cooperative effort between Southern Illinois University-Carbondale and the ORWFS continued in 2009, but emphasis is moving away from adult and sub-adult demographics and vital statistics to better understanding larval and juvenile dynamics. (4) ORWFS staff hosted a group of scientists representing the Yangtze

River where we exchanged information about our respective programs on the Yangzte and Mississippi Rivers. Plans are underway to further the exchange with ORWFS staff going back to China to demonstrate the Missouri Trawl and develop holistic restoration projects.

The Missouri Department of Conservation (MDC) has suspended the Resource Assessment and Monitoring (RAM) program while it evaluates the efficacy of the sampling design. Concern about Missouri's ability to track rare and endangered species and communities, and manage for them, has led to a movement led by Bob Hrabik to create a Missouri Biological Survey and establish an accredited systematics research collections for aquatic material in Missouri. The idea was first proposed to the Conservation Division of the Missouri Academy of Sciences (MAS) in 2007. MAS has endorsed the concepts and is planning a survey to determine the extent and status of such collections in the state. In the meantime, the Resource Science Division of the Missouri Department of Conservation conceptually approved the idea as well as the state's heritologists, a group representing several state organizations and agencies concerned with tracking rare and endangered species and communities.

Submitted by Bob Hrabik
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NORTH CAROLINA

Fritz Rohde (Habitat Conservation Division, National Marine Fisheries Service) retired from the North Carolina Division of Marine Fisheries in October 2008 but immediately un-retired and accepted a position in the Habitat Conservation Division of the National Marine Fisheries Service in Beaufort, North Carolina. He will be working primarily on fish passage issues at hydroelectric dams on the Roanoke and Pee Dee rivers as well as instream flow issues in other rivers in the state. Since the Freshwater Fishes of South Carolina (by Fred C. Rohde, Rudolf G. Arndt, Jeffrey W. Foltz, and Joseph M. Quattro, http://www.sc.edu/uscpress) will appear in April 2009, Fritz plans on returning to his study of the undescribed broadtail madtom, *Noturus* sp. cf. *leptacanthus*.

Wayne Starnes (NC Museum of Natural Sciences) reports that additional strides have been made toward the databasing of fish holdings with nearly 50,000 lots now completely processed at the North Carolina Museum of Natural Sciences (NCSM). This has involved considerable sleuthing of locale information and data upgrades, including complete hierarchal drainage data for freshwater collections, and virtually all collections are georeferenced to facilitate mapping. These data are available on the museum's new collections website (http://collections.naturalsciences.org/). Within the past year, NCSM has assembled a fully operational molecular lab, an interim facility to serve until such time as the museum's new Nature Research Center is completed (projected 2011) in which a well equipped lab, fully on display to the public and designed to educate visitors on the hows and whys of biodiversity research, will be installed. The interim lab is managed by Morgan Raley (morgan.raley@ncmail.net), who is collaborating with Wayne and Arthur Bogan on a number of fish and mollusk studies. Wayne has collaborated with Bryn Tracy and Bob Jenkins on a historic analysis of the Pee Dee-Yadkin River fish fauna in North Carolina with emphasis on invasions of a host of nonnative species and, in particular, a case study on the invasion dynamics of two catostomid species, the striped jumprock and northern hogsucker. Wayne and Morgan have a number of ongoing joint studies employing molecular and morphological techniques, including a joint study with Mollie Cashner on *Hydrophlox* species in the Santee River basin. Other ongoing studies include investigations of southern populations of johnny/tessellated darters on the Atlantic Slope, surveys for bridle shiner, *Notropis bifrenatus*, southern *Notropis procne*, and some enigmatic landlocked populations of river herrings which exhibit ambiguous characteristics between Blueback Herring and Alewife and fully mature at but four inches total length!

The Robust Redhorse Conservation Committee (RRCC) continues its joint efforts to study the rediscovered Pee Dee River population of this extremely rare and charismatic species in North and South Carolina, in the reach beginning below Blewett Falls Dam near Rockingham, NC. Participants include the NCWRC, Progress Energy, SC Department of Natural Resources, NC State University, NCSM, South Carolina Aquarium, and others. Work in 2008 consisted of nine days of boat electrofishing of shoal areas during the late April-early May spawning season in an attempt to capture further specimens for transmitter implantation. A masters student from the NCSU Cooperative Fisheries Unit, Michael Fisk, is currently devoting sustained effort to tracking these large and mobile fish (currently 19 individuals) in the Pee Dee throughout the year, similar to the prior efforts of Tim Grabowski of Clemson University in the Savannah River. For the first time in several years, the RRCC also conducted a fall survey of many miles of the river in the SC portion in an attempt to capture more individuals for tracking. Only a single individual was captured, though high flows thwarted effective electrofishing efforts in the reach that was thought to be most promising. In a related development, though the new licensing agreement for operation of Blewett Falls by Progress Energy has not quite been formalized, that corporation has agreed to go ahead and informally instigate minimum flow requirements to assure ade-

quate watering of spawning shoal areas during the spawning season.

Tom Kwak (USGS NC Cooperative Fish and Wildlife Research Unit at NC State University) advises seven grad students involved with five research initiatives on important nongame fishes in the southeast U.S. Steve Midway (MS student) combined field and laboratory research to investigate habitat use of the Carolina madtom, as well as efficacy of an artificial cover unit. Scott Favrot (MS student) assessed spatial and temporal bounds of spawning migration, quantified seasonal movement patterns, identified microhabitat suitability, and characterized behavior of a population of Sicklefin Redhorse in the Hiwassee River Basin.

Michael Fisk (MS Student) is studying the Robust Redhorse population in the Pee Dee River, North Carolina and South Carolina to examine movement and habitat use between two years of varying regulated flow regimes downstream of Blewett Falls Dam. Dan Weaver (MS student) is conducting research in the North Toe River, North Carolina, to quantify changes in fish density, distribution, and habitat use of nongame fishes as affected by the presence of stocked trout. Tom and his research group are also conducting research in Puerto Rico on stream fish sampling dynamics and protocols, island-wide fish surveys, influential factors on fish distribution and abundance, amphidromous fish ecology, and fish contaminant loads and pathways.

Patrick Rakes (CFI) reports that they assisted Steve Fraley and T. Russ with spotfin chub, (*Cyprinella monacha*) monitoring in the Little Tennessee River below Lake Emory. They also collected sicklefin redhorse (*Moxostoma* sp. cf. *macrolepidotum*) from the Little Tennessee River for eggs and milt in April and attempted to fertilize more than 25,000 eggs. However, viability was low, resulting in ~1,200 larvae. From this, ~680 young juveniles were produced with 230 released in the Tuckasegee River near Cullowhee, NC in September, 450 juveniles transferred to the Eastern Band of the Cherokee Indians in Cherokee to grow out for 2009 release into the Oconaluftee River. Staff also propagated more than 500 wounded darters (*Etheostoma vulneratum*) from captive spawning of Little Tennessee River stock. Of these, ~330 were stocked in the Cheoah River (below Lake Santeetlah) for the first releases of fish to inaugurate the FERC relicensing-mandated restoration efforts of the fish community there. The remainder will be stocked out in early spring 2009. Lastly, they propagated and transferred ~1,000 spotfin chub to the NCWRC's Marion Fish Hatchery to grow out for the first reintroductions of this species to the Cheoah River planned for 2009.

Steve Fraley and T. R. Russ (NCWRC Aquatic Wildlife Diversity Program) report that during 2007 and 2008, NCWRC Aquatic Wildlife Diversity staff sampled fish communities at selected sites throughout the Catawba, French Broad, and New river systems in western North Carolina. In general, results were mixed with a few notable declines in some species. They failed to detect 13 species in the French Broad, seven of which were already presumed to be extirpated; however mooneye (*Hiodon tergisus*) and mountain madtom (*Noturus eleutherus*) were collected for the first time since 1977 and 1888, respectively. Fish densities were notably low in the lower South Fork New and mainstem New rivers, but species richness was generally as expected.

Chris Wood and Rob Nichols (NCWRC Aquatic Wildlife Diversity Program) report that during 2008, 22 sites were surveyed in the upper Dan River and its largest tributaries, the Mayo and Smith Rivers (Roanoke River Basin). Survey results show that most sites which previously harbored state and federally listed species still maintained detectable populations of those species. However, rustyside sucker were not collected at any site and it is believed that this species may now be extirpated from the state. Bigeye jumprock were not detected at several of its historical occurrence locations and preliminary data suggests this species may be declining. Orangefin madtom were absent from its most downstream historical occurrence locations. Its distribution in the Dan River appears to be constricting to the upper reaches of the Dan River in North Carolina and Virginia. A highlight of the project was the discovery of two previously unknown populations of the Federally Endangered Roanoke logperch (*Percina rex*), in the Mayo and Smith Rivers. The first North Carolina population discovered in the summer of 2008 was below a hydroelectric dam on the Mayo River. A second population was verified in the Smith River when 10 Roanoke Logperch were captured, ranging in size from 63-159 mm. Further research and surveys are planned for 2009 to investigate population structure of these two populations (e.g., abundance and age classes).

Mike LaVoie (Eastern Band of the Cherokee Indians) reports that he and his staff are completing brook trout distribution and genetic inventories in all tribal streams, as well as conducting habitat assessments (in-stream, riparian, and barriers to non-native trout) to identify and prioritize potential restoration projects. They are also initiating a fish weir project on the upper Oconaluftee River to begin monitoring white sucker (*Catostomus commersonii*) and redhorse (*Moxostoma* spp.). Staff will be looking at assemblage composition, relative abundance, migratory patterns, spawning ecology, etc.

Dave Mathews (TVA) reports that during 2008, Tennessee Valley Authority's Aquatic Monitoring and Management group conducted Index of Biotic Integrity surveys on 18 streams and five tailwaters in the Tennessee River portion of western North Carolina.

Bryn H. Tracy (NC Division of Water Quality) reports that between March and June 2008, the stream fish community assessment program sampled 71 basinwide sites in the New River, Watauga River, and in the Sand Hills and Coastal Plain region of the Cape Fear River basins. The complete data, ratings, analyses, and reports for these river basins will be available in spring 2009 at http://www.esb.enr.state.nc.us/BAU.html and http://www.esb.enr.state.nc.us/bar.html).

Carol Johnston and Andrew Henderson (Auburn University MS Student) have completed their work with larval and juvenile habitat use by the Cape Fear Shiner in the Rocky River system of the Cape Fear River drainage. They are now finishing an analysis of population viability of this federally endangered species.

Joyce Coombs (UTK Wildlife and Fisheries) reports on Pigeon River restoration efforts in the Pigeon River: in the North Carolina portion of the drainage, more significant numbers of fish were translocated in 2008 and 2009—gilt darters (214), mirror shiners (601), silver shiners (908), telescope shiners (678), and Tennessee shiners (856); monitoring activities saw a significant decrease (nearly half) in the total densities of fish observed in 2008 relative to 2007, with no gilt darters or mirror shiners observed.

Submitted by Bryn Tracy (bryn.tracy@ncmail.net)

OKLAHOMA

D. B. Fenner, K. Collins, B. Bristow, R. Standage, and R. Bastarache are conducting annual surveys to monitor the status of the federally-threatened leopard darter in southeastern Oklahoma and southwestern Arkansas. Information from the monitoring effort, which began in 1998, has been used to evaluate the species' status as threatened and guide recovery actions for the species. Since 1998, survey results suggest that leopard darter population trends are stable to declining.

A. D. Martinez, D. B. Fenner, and V. M. Tabor are conducting surveys to update the status of the Arkansas darter in Oklahoma. The updated information is needed to support a reevaluation of the species as a federal candidate for listing under the Endangered Species Act. The surveys have confirmed the species' continued existence at many historically-inhabited localities in the state. However, human uses of water, physical stream modifications, water quality degradation, and other factors appear to pose continuing and new threats to the species.

A. A. Echelle, W. L. Fisher, and R. A. Van Den Bussche are investigating levels of genetic divergence between populations of various species (Rocky Shiner, Redspot Chub, Logperch, and Least Darter) in the Ozark/Ouachita region and populations in Blue River, southcentral Oklahoma. The purpose is to help evaluate the evolutionary distinctiveness of the Blue River ichthyofauna in response to conservation concerns generated by potential over-mining of the Arbuckle-Simpson aquifer in southcentral Oklahoma.

A. A. Echelle, W. L. Fisher, and R. A. Van Den Bussche are studying geographic variation in genetic structure of the Leopard Darter, a federally threatened species endemic to the Ouachita Mountains of southeastern Oklahoma and southwestern Arkansas. The purpose is to provide baseline data on levels and pattern of genetic diversity as a benchmark for future management of the species.

Submitted by David Martinez (David_Martinez@fws.gov)

PENNSYLVANIA

Recent sponsored projects by the Wild Resources Conservation Fund (WRCP) and State Wildlife Grants (SWG) Programs have been assessments by Penn State University in the Pennsylvania section of the Ohio River which revealed range extensions of several benthic species and the development of an electrified benthic trawl and inventories of large-bodied and benthic fishes along over 90 miles of the Allegheny River by researchers at California University of Pennsylvania.

The recent establishment of the Three Rivers Ecological Center in Pittsburgh has led to the development of clearinghouse for information on the Three Rivers (Allegheny, Ohio, and Monongahela) as well as the formation of a Rivers Advisory Board. Of particular concern in the region is the effect that sand and gravel dredging are having on the availability of fish habitat within the Allegheny and Ohio Rivers.

In the Ohio River Basin, the Pennsylvania Department of Environmental Protection (PA DEP), in partnership with the U.S. Environmental Protection Agency (EPA), is conducting a two-year (2008 and 2009) intensive, multi-parameter sampling program on two major tributaries of the Ohio River: the Allegheny and the Monongahela rivers. The purpose of the project is to evaluate the biological conditions of the Monongahela River from river mile 0 in Pittsburgh south to river mile 91 and the Allegheny River from river mile 0 in Pittsburgh north to river mile 75 via probabilistic sampling. During 2008, fish, fish habitat, macroinvertebrates, mussels, water chemistry, plankton and sediment samples were collected at 31 sites on the Monongahela River and 34 sites on the Allegheny River. Fifteen sites were chosen randomly and sampling will be repeated at those sites during summer 2009.

Researchers at California University of Pennsylvania (Drs. Argent and Kimmel) have completed sampling of 40 named tributaries to the Monongahela River

as well as its Pennsylvania mainstem. Systematic sampling every 0.8 miles with gill nets and every mile with benthic trawls yielded over 6,000 individuals and over 50 species.

American Rivers is currently working with the USGS Water Resources Division, DEP, California University of Pennsylvania, US Dept. of Agriculture, and PFBC to develop a plan for removal of two dams along Dunkard Creek, a major Monongahela River tributary. If funding is secured, pre-dam removal assessments will begin in September 2009 with both fish and macroinvertebrate samples. The dam would be removed in early 2010 with follow up assessments during fall.

Reports of glass shrimp (*Palaemonetes kadiakensis*) from the Monongahela River several years ago have been further substantiated by recent sightings by a local angler at Prickett's Fort State Park in Fairmont, WV. This account represents the farthest known southern extent for this aquatic species within the Monongahela River Basin. Additionally, video submitted by an angler near Suttersville, PA appears to show a large (500+ fish) aggregation of paddlefish (*Polyodon spathula*) in mid-April in the Youghiogheny River.

Submitted by David Argent (Argent@cup.edu)

SOUTH CAROLINA

Jeff Foltz's (Clemson University) graduate student Steph Irwin has finished a two year study which examined the population density, time of spawning, fecundity and GSI of turquoise darters which belong to a population that the Foltz lab established in Six Mile Creek within the Clemson Experimental Forest. This species of fish was extirpated from Six Mile Creek in the period 1850-1930.

Bert Ely's group at University of South Carolina demonstrated that the annual effective number of breeders is less than 50 for the Santee Cooper system striped bass population. In 1992, two pairs of fish contributed 25% of a poor year class and in 1993, 13 pairs of fish contributed nearly one third of a very good year class.

The South Carolina Stream Assessment is in its third year of a five year rotation to sample the state's wadeable streams. The sites are randomly generated and sampled using standardized backpack electrofishing methods by the SC DNR stream team, headed by Kevin Kubach. Habitat, water quality, and geomorphology are measured at each site, and Clemson University researchers are collaborating with DNR to collect macroinvertebrates and toxicological data as well. The focus of 2009 sampling is in the Catawba-Wateree and Pee Dee basins. Two dams are scheduled for removal from Twelve Mile Creek, a large tributary to Lake Hartwell in the upper Savannah River drainage of South Carolina. Mark Scott with SC DNR is directing a study in collaboration with Clemson University to examine the effects of dam removal on fishes, macroinvertebrates, and physicochemical conditions in the creek. The study is planned for at least five years post-removal.

SC DNR's diadromous fish section (Bill Post) is also completing its first of year experimental stocking of American Shad in the Edisto River, evaluating the use of genetic tags, and genetic characterization of the population. Mark Collins has also recently started a new project on the Santee River in cooperation with NC State (Joe Hightower)/USGS. The focus is on shortnose sturgeon habitat use, abundance, and movements using sidescan sonar, Didson sonar, and traditional gillnet collections. SC DNR's estuarine finfish section (Tanya Darden) is in its third year of an experimental population restoration study of striped bass within the Ashley River system. SC DNR's freshwater fish section (Scott Lamprecht) has completed its 5th year of a population restoration study of robust redhorse in the Santee River system; they continue to study striped bass recruitment and juvenile growth/abundance in the Santee System; and are beginning a dietary overlap study among white perch, striped bass and American shad in this system.

Submitted by Tanya Darden (DardenT@dnr.sc.gov)

TENNESSEE

Mark Cantrell, USFWS Asheville, NC, reports that the madtom condos deployed in Little Chucky Creek have not been successful yet. USFWS intern, Ida Evertjam, assembled the madtom pots from common flowerpot bases and custom-made nest chambers produced by a local potter. A team from CFI, TVA, and USFWS deployed these devices as artificial cover and survey traps in Little Chucky Creek in mid-April 2009, concentrating on the Bible Bridge vicinity to above the last capture locations at RM 5.9. Return checks of the 80 pots caught zero madtoms. Crayfish occupancy rates have been high. The team has also done some additional seining at historic localities and a couple of other good spots without capturing any madtoms.

Mark and Ed Scott braved incredibly cold weather and snow during early February 2009 on Fort Loudon, Watts Barr and Tellico reservoirs in search of stocked lake sturgeon. Because of commercial fishing closures in the upper Tennessee due to fish consumption advisories, the small but elite team deployed multiple trotlines to monitor lake sturgeon numbers. The team noted that chucklehead catfish numbers are booming. Also noteworthy was their catch of hellbenders at upper Tellico Reservoir in the Little Tennessee River near Chilhowee. Lake sturgeon restoration efforts continue in the Upper Tennessee system, with partners including TWRA, USFWS, TTU/Tennessee Cooperative

Fisheries Research Unit, and TVA. Phil Bettoli's lab (TTU) deployed seven sonic receivers in the upper Tennessee system, and 37 tagged fish were released in two groups. TWRA and TN Aquarium have also begun lake sturgeon releases into the Cumberland River in Nashville.

Jim Herrig, Cherokee National Forest has compiled data on the spawning runs of suckers in Citico Creek in Monroe County. Smallmouth buffalo (and a mix of other sucker species) stage at the mouth of Citico Creek in Tellico Reservoir towards the end of March and into early April. The largest run that lasts roughly five days is dominated by smallmouth buffalo, with black buffalo and redhorse also present. After these fish leave a much smaller run follows made up primarily of silver redhorse, with black buffalo and river carpsuckers also present. Jim estimates that at least 50,000 fish continue to participate in this run but a statistical estimate is needed. Public interest in the buffalo run continues to increase each year, and Jim gets many questions that he is unable to answer. Opportunities for research on this ecological phenomenon are broad and he welcomes anyone with interest to contact him.

Nick Lang (Field Museum), reports that in August of 2008, he discovered an *Etheostoma spectabile* species group member in the western Highland Rim portion of the Cumberland River drainage (Sams Creek SSE of Ashland City). Although the range of the undescribed "Mamequit Darter" is geographically closer to the site (upstream through Marrowbone Creek, Cheatham Co.), analysis of mitochondrial DNA indicates that the population is most closely related to a group member further upstream in the Cumberland River drainage (*Etheostoma lawrencei* and the "Ihiyo Darter"), the previously furthest downstream record for which was Goose Creek, Trousdale County. Molecular and morphological studies are ongoing in collaboration with Jeff Ray (UNA). Work also continues on his study of genetic variation in *Etheostoma luteovinctum*. Despite the fact that many previously sampled sites were found to be dry during multiple visits last year, he was able to greatly increase his sample size.

Anna George (TN Aquarium) is working with Shea Tuberty, Carol Babyak (Appalachian State University) and Donna Lisenby (Watauga Riverkeeper) to monitor the impact of the coal ash spill in Watts Bar Reservoir. The TN Aquarium is still propagating and reintroducing Barrens topminnows with CFI and USFWS. Anna George and Dave Neely are also working on a population genetics study of Tennessee dace. They are also working with CFI on propagation and genetics study of Conasauga logperch; 3 have been collected in Tennessee so far this year.

Joyce Coombs (UTK Wildlife and Fisheries) reports on Pigeon River restoration efforts in the Pigeon River: in the Tennessee portion of the drainage, numbers translocated in 2008 and 2009 were greatly reduced due to first low, then high water conditions, with the exception of bluebreast darters (166) and mountain madtoms (430); monitoring found total fish densities in 2008 were similar to 2007, with a significant decrease in insectivore species (darters in particular) and a significant increase (more than double) in omnivores. The re-introduced gilt darter numbers dropped from 19 individuals observed at Tannery Island in 2007 to one individual in 2008.

Carol Johnston (Auburn University), reports that she continues to monitor selected streams on the Cherokee National Forest (Tellico, Hiwassee and Ocoee drainages) as part of a long-term dataset looking at fish population trends for the Forest Service (with Jim Herrig).

During 2009, Pat Rakes reports that CFI has been propagating, stocking, and monitoring of smoky and yellowfin madtoms, Citico (formerly duskytail) darters, and spotfin chubs in Tellico River, concurrent with monitoring source populations in Citico Creek. In June, a robust local population of Powell River yellowfin madtoms was discovered above Mulberry Creek, Hancock County during an unbelievably quick collection of nests to rear. Efforts to collect marbled (formerly duskytail) darters in Little River were a wash-out this year, due to constant high waters and captive adults failed to breed in captivity. Similarly, boulder darters and spotfin chubs were stocked to Shoal Creek, but high waters precluded monitoring all spring. Species successfully spawned and/or reared include ashy darter, five slackwater darter populations (all of TN's), >5000 sicklefin redhorse, blotchside logperch, wounded darters (LTNR pop), Roanoke logperch, spotted darters (WV pop), spring pygmy sunfish, rush darter, banded (and Holston sp.) sculpin (for mussel hosts), Kentucky arrow darter, and Cumberland darter. Diamond darters and upper Allegheny R (PA) gilt darters had not spawned by end of July. Number of species spawned and reared to date: 55. For more information, visit: http://www.conservationfisheries.org

Rick Bivens (TWRA) reports that their biologists collected *Phoxinus tennesseensis* in Back Creek on the Cherokee National Forest, Greene Co. in 2008. USFS biologists also collected them at the same location in 2009. This makes only the second known locality for *P. tennesseensis* in the Nolichucky River watershed in Greene Co. The other location is an unnamed tributary to Gregg Creek, discovered by TWRA in 2006.

Finally, former students and fellow faculty and ichthyologists assembled November 25, 2008 at the University of Tennessee in Knoxville to witness the long overdue naming and dedication of the "David A. Etnier Ichthyological Collection" (DAEIC). In addition to the accolades for his efforts and contributions to the scientific knowledge of the fishes and aquatic insects of the southeast, fond recollections of past field "experiences" and "Etnierisms" were

shared over appropriate beverages [i.e., "The sleeping dog fears not the chicken", "You never really know an animal until you've eaten it", "Either way is best", "Big or small, keep them all"]. A campaign to create an endowment to support and maintain the collection has been initiated. Dr. Gary McCracken, Ecology and Evolutionary Biology (EEB) Department Head, reports that contributions can be made by contacting Randy Atkins within the College of Arts and Sciences Development Department at (865) 974-2131 or matkin11@utk.edu.

The DAEIC represents 40 years of work by Dr. David Etnier. In total species it ranks in the top 25 (or maybe top 20) among North American fish collections. It is the best darter collection in North America based on number of species, number of specimens, and number of lots and specimens of rare species. It is a predominantly eastern US collection, with excellent coverage of freshwater fishes of North America east of the Rocky Mountains. Other strengths include marine fishes of the Gulf of Mexico, North Atlantic, and the Bering Sea. The collection is well known and well used by UT staff and students as well as colleagues from other institutions. Nearly every paper dealing with the systematics of freshwater fishes of the southeastern US since the early 1970s has utilized specimens from the collection. Since its inception in 1966, we have loaned 2,250 lots of fishes, and have processed 847 loans. It contains roughly 424,002 specimens representing 206 families. There are 2900 paratypes representing about 100 species. Drs. Etnier and Hulsey curate the collection. Jennifer Joice is the collection manager. Jennifer reports that 30,000 of the 35,000 lots have been entered into a relational database using Filemaker Pro and are searchable (as of July 31, 2009). A web site for the collection is planned for the future.

Submitted by Pat Rakes (xenisma@gmail.com) and Jeff Simmons (jwsimmons0@tva.gov)

TEXAS

Tim Bonner (Texas State University) is working on a series of studies in the lower Brazos River examining the reproductive ecology of *Notropis shumardi* (silverband shiner), *N. buchanani* (ghost shiner), and *Macrhybopsis hyostoma* (shoal chub), quantification of larval fish drift densities, and macroinvertebrate and fish assemblage structures and habitat associations within lower Brazos River tributaries. He is also working on life history and habitat associations of *N. atrocaudalis* (the blackspot shiner) in the Neches River basin. Tim and Catherine Phillips (USFWS) are working on a survey evaluating the needs for fish and aquatic organism passage across the state of Texas. This project hopes to identify critical areas of focus for future research and habitat restoration.

Texas Parks and Wildlife Department (TPWD) researchers are examining seasonal movement and habitat use by alligator gar and striped bass in the Trinity River. The TPWD River Studies Program (project leader: Roy Kleinsasser) and the Texas Commission on Environmental Quality (TCEQ) are completing their second year of sampling rivers and streams across the state of Texas as part of the National River and Stream Assessment Survey. The TWPD River Studies Program (project leader: Kevin Mayes) is also working with TCEQ, Texas Water Development Board, and the respective river authorities on instream flow studies for the Brazos, Sabine, and San Antonio rivers in an effort to determine the instream flow requirements necessary for supporting an ecologically sound environment.

Submitted by Catherine Phillips (Catherine_Phillips@fws.gov)

VIRGINIA

Steve Powers completed his first year as Bob Jenkins' successor at Roanoke College and began work on updating the RC fish collection. The ultimate goal of this work is a fully georeferenced, computerized, and web-searchable database available to researchers. Work has also begun on assessing genetic diversity of Tennessee/Duck/Cumberland endemics with contrasting population sizes. Systematic study of the *Etheostoma cinereum* (ashy darter) complex continues with some complication due to their welcome rediscovery in the Elk River, TN. Life-history research on *Percina nevisense* (chainback darter) is set to begin pending a student to assist with the research.

Werner Weiland at the University of Mary Washington reports on surveys of American shad (*Alosa sapidissima*) on the Rappahannock River, and their response to the breaching of a dam at Fredericksburg in 2004 and its complete removal in 2005. VDGIF has been stocking shad fry in the upper Rappahannock in hopes of re-establishing a spawning population. In April 2008 VDGIF collected eight adults at Kelly's Ford (~28 miles upstream of former dam). One of these was a wild six year old male presumably spawned below the dam in 2002. In spring 2009 DGIF collected one blueback herring (*Alosa aestivalis*) at Kelly's Ford. It appears that herring will migrate above the falls on the Rappahannock. There has been no stocking of herring by DGIF.

Mike Pinder at the Virginia Department of Game and Inland Fisheries (VDGIF) reports that VDGIF has made a concerted effort towards the recovery of the federally threatened yellowfin madtom (*Noturus flavipinnis*). Over the last 3 years, VDGIF and the USFWS have funded Conservation Fisheries, Inc. (CFI) to propagate the species to reintroduce in the upper reaches of Copper Creek, VA. In 2008, they were able to document their first recaptures from this effort. This year CFI is examining the potential

for yellowfin madtom reintroduction into the upper North Fork Holston River (NFHR). Populations reintroduced into the NFHR would be designated as experimental/nonessential. VDGIF secured funding for Virginia Tech researchers to investigate distribution, habitat use, population/age structure, and genetic distinctiveness/effective population size of the variegate darter (*Etheostoma variatum*). The study will continue through 2012. VDGIF in partnership with the Tennessee Valley Authority has begun an Index of Biotic Integrity study of the fish community in Big Moccasin Creek, Scott and Russell counties, VA. To date, 35 species including *Noturus flavus* and *Percina burtoni* have been collected from 5 sites. Additional sites will be surveyed through the summer. These efforts will help to provide a picture of water quality and species presence in this under-surveyed water body. New contracted projects for 2010 will be a Roanoke logperch (*Percina rex*) mitochondrial DNA study, a survey for bridle shiner (*Notropis bifrenatus*), and life history of the Clinch dace (*Phoxinus* sp. cf. *saylori*).

Submitted by Steve Powers (fishdoc.powers@gmail.com)

WEST VIRGINIA

Barb Douglas (Senior Endangered Species Biologist, U.S. Fish and Wildlife Service, Elkins, WV) reports that a status assessment for the diamond darter was completed in May 2009 and has been submitted to the Washington Office for review. The summary and conclusions of that review will be published in the Federal Register as part of the annual Candidate Notice of Review and the public comment will be invited. The full status assessment will also be posted online. If the USFWS determines after public comment and review that the species qualifies for listing under the Endangered Species Act, and the species is determined to be a high priority for listing, then the species will proceed through the formal process.

A study on the spotted darter (*Etheostoma maculatum*) from the Elk River, WV, is a component of graduate research by Crystal Ruble (Hatchery manager, CFI). Captive propagation of this species was successful, and Crystal is also conducting similar research with the diamond darter. Recently completed theses or dissertations at WVU included population status of brook trout (J.W. Clingerman), evaluation of highway construction on benthic macroinvertebrates (L.B. Hedrick), predictive modeling of freshwater mussels (A.R. Mynsberge), and habitat selection and predation risk in larval lampreys (D.M. Smith).

The proceedings of a 2008 crayfish symposium (southern Division AFS, Wheeling, WV) will be published in a special issue of the Southeastern Naturalist. The proceedings include 17 papers, with four relevant to West Virginia.

Submitted by Stuart Welsh (swelsh@wvu.edu)

Business Meeting
34th Annual Meeting (2008)
Southeastern Fishes Council
Chattanooga Marriott and Convention Center
Chattanooga, Tennessee

The 2008 business meeting of the Southeastern Fishes Council was called to order by Chair Bernie Kuhajda at 4:10 p.m. This was the second stand-alone meeting of the Southeastern Fishes Council. Sixty-six people attended the business meeting.

Secretary's Report
Rebecca Blanton announced that the minutes from the 2007 business meeting were approved unanimously. Thirty-two members voted by email. The approved 2007 minutes are posted on the Southeastern Fishes Council website.

Treasurer's Report
Anna George summarized the society's financial standings, noting an increase in membership and a healthy bank account with over $11,000 carried over from 2007, and $35,000 in the society's account prior to payment of the various meeting costs. After, the meeting, Treasurer George provided a detailed report of the society's financial standing, including deductions associated with the 2008 meetings to the Executive Committee.

Treasurer George thanked the World Wildlife Fund for their continued support of SFC. She also proposed a raise in membership dues for 2009 to cover the cost of maintaining a Paypal account for the society and general inflation. The proposed changes were as follows: (1) student membership would be raised from $10 to $15; (2) Regular membership would be raised from $20 to $30; and a new family membership option, which would include only one copy of the Proceedings per household, would be added at a cost of $40. Lifetime membership cost would stay at $400. Gerry Dinkins moved that the proposed changes be accepted; his motion was seconded by Hank Bart. The motion was opened for discussion by Chair Kuhajda.

David Etnier proposed keeping student membership at the current cost and raising regular membership by an additional $5. Chair Kuhajda noted that even with the proposed increase for students, membership was still very affordable and well below most society costs. Treasurer George called for a vote for the original proposed changes. The motion was passed unanimously.
Treasurer George informed the membership that registration rates for the 2009 Annual Meeting to be held at Guntersville State Park in Alabama would be approximately the same as the 2008 meeting rates.

Committee Reports

Nominating Committee *– Gerry Dinkins*
Chair of the Nominating Committee, Gerry Dinkins, asked if there were a required number of people for this committee. Chair Kuhajda reported that the SFC Constitution stated two additional people should assist the Chair of each committee. Gerry agreed to find two additional members to serve on the nominating committee.

Bernie Kuhajda suggested adding a list of past chairs to the SFC website and asked about nominating a Council Historian to put together and maintain a list of past Chairs. Gerry Dinkins suggested adding a list of all current and past SFC officers. Bruce Bauer and Hank Bart pointed out that older lists do exist including one in the Proceedings, but that the list needed to be updated.

Program Committee *– Jim Williams, Chair and Anna George*
Jim Williams announced that in an effort to keep SFC meetings as centrally located and accessible for the membership as possible, the plan for future meeting locations was to have the meeting held in Chattanooga, TN every third year, and at different locations in the southeast for other years. He also announced that the 2009 SFC meeting would be held at Guntersville State Park in northern Alabama on the 12th and 13th of November, 2009. He described the park's features noting that the park has recently renovated facilities, several accommodation choices ranging in cost from $10/night for camping to $125/night for chalets, meals provided at an on-sight dining hall and several nearby dining options in Guntersville, free internet, and conference rooms that can accommodate 200 people. All information on the meeting site and upcoming meeting rates will be posted on the SFC website.

Jim Williams opened the floor for discussion. Brett Albanese asked if the meeting would be two entire days. Jim responded yes. Pat Rakes suggested that the symposium theme for the 2009 meeting continue along past meeting lines. He proposed the theme be the 'Not-so-desperate Dozen' to include talks highlighting successful recovery stories of southeastern fish species. A habitat recovery theme was also suggested. Jim agreed to consider these suggestions and asked that others submit ideas to him via email for the 2009 meeting symposium.

Jim asked for volunteers for local hosts for the 2009 meeting in Alabama and asked for members to consider taking on the role of Program Committee Chair, noting that his last year as Chair will be 2009.

Constitution Committee – nothing to report

Resolution Committee – nothing to report

Proceedings Committee *– Editor, Marty O'Connell; Associate Editor, Chris Skelton*
Editor O'Connell announced that the 50th issue of the Proceedings had been sent out to the membership. He also announced that the current regional editors want to be replaced and called for volunteers to serve as regional editors for the Proceedings and asked that anyone interested contact him via email. He also pointed out that his term as Editor expires in 2009 and asked for volunteers to take on this position at the end of his term. He also encouraged the membership to submit manuscripts for review and publication in the Proceedings.

Discussion: Jim Williams proposed replacing regional reports with state reports to more clearly define a reporter's region of coverage. Chair Kuhajda supported this proposal, noting the increase in state agency participation in the society that could thus result in improved reports if conducted at the state level rather than region level. Peggy Shute added that state reports were a good idea given the state Fish and Wildlife's potential role. Pat Rakes added to this idea that state reports could be submitted to state agencies for use on their websites. Jim Williams noted that this could also lead to funding opportunities for the society.

David Etnier suggested having multiple reporters for each state. Chair Kuhajda agreed that in some cases having multiple reporters could be beneficial.

Chris Skelton, Bruce Bauer, and Chair Kuhajda discussed the goals of regional/state reports. They noted that these reports provided an outlet to share ongoing research activities of the membership and to raise awareness and promote actions regarding fish conservation issues.

Gerry Dinkins asked if this change would require a change to the Constitution. Bernie Kuhajda stated that yes this would require a change to the constitution, and that such changes required a quorum of the membership to vote. Anna George noted that there was not a quorum at the business meeting, but that a vote could be held electronically. Chair Kuhajda and Jim Williams volunteered to write up the proposed Constitutional change from regional reports to state reports and present to the membership for vote via email.

Brett Albanese asked if the regional reports would continue to be published as part of the Proceedings or alternatively posted on the website. Chair Kuhajda and Jim Williams noted that publishing the reports online only would save money.

Chris Skelton said he was investigating having the Proceedings picked up by BioOne, which is free for nonprofit organizations. He also pointed out that all back issues of the Proceedings are available on the SFC website to current SFC members.

Awards Committee *– Noel Burkhead*
Noel Burkhead announced the winners of the 2007 student paper and poster competitions and noted that the winners, their presentation titles, and awards received were posted on the SFC website. He also announced winners of the 2008 Special Awards including the Most Fecund Lab Award which went to the Department of Fisheries at Auburn University for having the most student presentations from a single institution, and a special award to Anna George and Jim Williams to acknowledge their services and hard work to make the SFC stand-alone meetings such a huge success. Gratitude for their service was further emphasized by Chair Kuhajda and applause from the membership. Noel also announced that the winner of the Most Vagile Student Award had cancelled just before the meeting and the winner of that award would be reassigned at a later date.

Treasurer George encouraged student participation in the competitions noting the monetary award for the winners and that there were only nine competitors for the presentation award and only five for the poster award at the 2008 meeting.

Membership Committee *– Hank Bart, Chair, and Rebecca Blanton*
Rebecca Blanton provided a summary of the overall membership for the society for 2007 and 2008 and presented the following to those attending the business meeting:

2008: 192 total members (institutional and individual) including:
- 4 life members (2% of membership)
- 129 regular members (67%)
- 59 student members (31%)

Note: Overall membership has more than doubled since 2007; Student membership increased by more than 5 times that of 2007.
2007: Total of 79 members (institutional and individual) including:
- 4 life members (5% of membership)
- 64 regular members (81%)
- 11 student members (14%)

She also pointed out that membership renewal was now available online through the SFC website.

Tech Advisory Committee *–*
Chair Kuhajda and Jake Schaefer discussed the proposal to move the SFC website from the Florida Museum of Natural History to another hosting institution due to the growing needs of the society to have more direct access to the website, the need for a hosting institution that can support a Paypal account, and one that provides greater server space for adding high resolution images. Noel Burkhead and Chair Kuhajda acknowledged the generosity of the Florida Museum staff and suggested that the Society draft a letter to FLMNH personnel expressing the society's gratitude for their services.

Jake Schaefer announced that he had secured a domain name – sefishescouncil.org– for the website in the event the site was moved from the current hosting institution. He also presented two possible alternative options for moving the website: (1) using the server at University of Southern Mississippi or (2) using a hosting service.

Brett asked what advantages a hosting service would offer. Jake responded that they guarantee that the website is always up, but that they are expensive, whereas, USM is offering free non-restricted server space and to support our Paypal services. Jim Williams asked if the USM server was regularly backed-up. Jake responded that yes there was a backup server to guarantee no data loss, but that the website could be down in the event of power outages. Gerry Dinkins asked what other societies use (hosting site or institution servers). Hank Bart responded that the American Society of Ichthyologists and Herpetologists use the Tulane University Museum of Natural History Server and Jake Schaefer pointed out that the Desert Fishes Council use a server at the University of Texas, which can support credit card payments to DFC.

Treasurer George stated that the previous problems with using Paypal on the FLMNH site had been resolved, but that a link to an offsite location was required. She also added that a hard drive could be purchased to backup the SFC website materials if needed. Brett Albanese asked if during the period of transition from current host to new host, if the website would be unavailable. Jake Schaefer indicated that there should be no downtime and that we should be able to establish a mirror page and a redirect page from the FLMNH site.
Chair Kuhajda recommended further consideration of options for establishing a new hosting site with continued discussion between Jake Schaefer, the Tech Advisory Committee, and the Executive Committee to reach a conclusion on what would best meet the needs of the society.

Old Business

1. **Electronic Only Proceedings** – Mel Warren asked if a decision had been made regarding a former proposal to have the Proceedings published electronically and eliminate paper copies. He argued for this change, noting that SFC was conservation oriented and eliminating paper copies would promote this agenda.

   Discussion: Jim Williams asked how much the society would save by eliminating paper copies. Treasurer George responded that it cost $2,000 for layout and printing costs and that electronic only would save $1250. She suggested providing members with the option to choose electronic or paper versions of the Proceedings. Chair-elect Gerry Dinkins pointed out that adding the state (regional) reports would increase the size and thus cost of publishing the Proceedings. As a solution, he suggested publishing state reports online only. Brook Fluker noted that if this was done, the information in the reports could not be cited. Chair Kuhajda argued that the website could be cited instead. Treasurer George agreed to add an option on membership renewal forms to choose either a paper or electronic version of the Proceedings. Brett Albanese moved that society go to an electronic only format for publishing the Proceedings. Noel Burkhead seconded the motion. David Etnier pointed out that hard copies would still be needed for libraries. Chair Kuhajda recommended shelving the motion with further consideration and also to allow Chris Skelton time to further investigate our options through BioOne. Brett agreed to shelve the motion.

2. **Formal Partnership with SARP (requested in 2007)** – Chair Kuhajda reminded the membership that in 2007 SARP had requested a formal partnership with SFC, but there was much dissent from the membership. He asked that we return to their proposal for reconsideration. He noted that SARP has imperiled aquatic species workgroups and they would like to have SFC members as part of these groups.

   Discussion: Noel Burkhead pointed out that SARP is focused on applied restoration and not research oriented. Participation of SFC members could offer a research based contingent to help improve their restoration efforts. Chair Kuhajda agreed that having an SFC member(s) serve on these committees would be a plus. He also clarified that SFC would not become an official affiliate of SARP, but would participate in workgroups and restoration committees. Steve Rider noted that SARP is an organization that is trying to find its way at the moment and is in need of funding for restoration projects. He agreed that having an SFC member working with SARP would help guide their efforts in a positive way. Chair Kuhajda reiterated that SARP wants our input and involvement and that it would be stupid to not offer a research based voice in their applied recovery efforts, not to mention that having an SFC representative on their committees would help promote the goals of SFC.

   Chair Kuhajda requested a motion to have a member be the official SFC representative of SARP. Noel Burkhead moved; Jim Williams seconded the motion. The motion was approved unanimously.

3. **White Paper or Resolution to Guide Water Supply Development During Droughts** – Chair Kuhajda noted previous discussion to have SFC draft a white paper or resolution regarding water supply development during drought conditions and noted that this effort never got off the ground.

   Discussion: Mary Freeman said that the water problem was not going away and that this is still a major problem in Georgia. She emphasized the need for scientific input in guiding water usage and storage solution in the states suffering from drought conditions, noting that major water usage plans are being made with little input from fish researchers. Given the severity of the problem Mary further argued that a Resolution only would fall short and not be a sufficient course of action.

   Chair Kuhajda noted that a White Paper is a large, difficult job. Jim Williams suggested selecting a chair and committee to put together a White Paper draft. Mary Freeman suggested a national publication in Fisheries instead of a White Paper. Gerry Dinkins noted that the Duck River Association was trying to develop ways to meet water needs in upcoming years and that they are considering reservoir construction and other disturbing ideas to deal with drought and water shortage issues. Jim Williams suggested a Chair be nominated to lead and form a committee to put together a publication or white paper to draw attention to these issues. Brett Albanese noted that we should consider our audience in deciding which route to take.

   Chair Kuhajda called for volunteers to serve as Chair of a White Paper/publication committee. Mary Freeman volunteered to head the committee and start emails to form a committee and determine the best route for addressing the water usage issues discussed.

4. **Surface Mining Resolution** – Chair Kuhajda noted that the comments and resolution opposing the reduction of buffer zones around streams for surface mining were unsuccessful.

5. **Opposition to federal agency self-regulation regarding T&E species** – Jim Williams discussed the opposition to the proposal to allow federal agencies to monitor themselves with regards to protecting threatened and endangered species rather than having to go through the Fish and Wildlife Service. Jim noted that 300,000 letters discussing proposed changes to the ESA were received by the USFWS, but the current Administration was attempting to push changes through quickly, without full consideration of written and voiced opposition. However, the new administration, under President Obama would have the opportunity to review the letters and proposed changes to the ESA.

New Business

Chair Kuhajda suggested taking the Desperate Dozen concept of the 2008 meeting to the state and regional levels in an official capacity. Mel Warren suggested going to states for funding. Chair Kuhajda noted that the Desperate Dozen accounts would be published in the SFC Proceedings.

The meeting was adjourned at 5:27 p.m.

Respectfully submitted,
Secretary Rebecca Blanton Johansen

2008 Treasurer's Report for the Southeastern Fishes Council Prepared by Anna George

Starting Balance 1 January 2008	**$17,254.84**
EXPENSES	
2008 Annual Meeting	
Convention Center—room and food	$6072.00
Reception food	$1630.00
Aquarium rental	$1372.00
T-Shirts	$1886.65
Supplies	$452.80
Tomelleri illustrations	$1951.00
Miscellaneous Costs	$720.99
Awards	$600.00
Paypal Fees	$310.17
Layout of Proceedings	$1527.00
Postage and Envelopes	$435.70
TOTAL EXPENSES	**$16,958.31**
INCOME	
Memberships	
85 regular at $20	$1700.00
39 students at $10	$390.00
2008 Meeting Registration	$7515.00
2008 T-Shirt Sales	$1930.00
2008 Miscellaneous Sales	$365.00
Grants	
2008 World Wildlife Fund	$5000.00
Additional Contributions	$190.00
TOTAL INCOME	**$17,090.00**
ENDING BALANCE	**$17,386.53**

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.

Manuscripts can be submitted electronically via email (send to: moconnel@uno.edu) or mailed as hard copies to the address below. Mailed hard copies should be submitted in triplicate. A good guide for manuscript preparation is the Sixth 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 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 edition* 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.

Manuscripts will be subject to editing and will be reviewed by at least two anonymous persons knowledgeable in the subject matter. The edited manuscript and page proofs 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 can be ordered at the time of printing, and will be supplied to the author at the cost of printing.

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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