

Abstracts: Oral Contributions

1.

A CONSISTENT METHOD FOR RAPIDLY ASSESSING THE CONSERVATION STATUS AND SURVEY NEEDS FOR LARGE NUMBERS OF AQUATIC SPECIES

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Information on the range and conservation status of large numbers of aquatic species is needed for state wildlife action plans, assessments of species petitioned for listing under the U.S. Endangered Species Act, and other reviews carried out by groups such as NatureServe and the American Fisheries Society. A major challenge for these assessments is the lack of comparable data across taxa, which is often limited to presence-absence data or in some cases presence-only data with limited knowledge of areas that have been surveyed. We developed a method to assess the current range and survey needs of aquatic species using a combination of presence-only and presence-absence data. Our method uses a simple GIS algorithm to identify the most recent occurrence record for USGS Hydrologic Unit Code (HUC) 10 digit watersheds and then classifies all watersheds into 5-year intervals. Occurrence records as well as locations of recent surveys where the target species was not detected are then overlaid to produce a conservation status map. This map serves as the key resource for targeting areas in need of additional sampling and can be updated periodically to incorporate new survey results. Maps can also be used as a foundation for assessing conservation status by providing comparable metrics across taxa, such as the number of occupied watersheds (index of range size), proportion of potential watersheds currently occupied (index of range stability) and watershed land cover (index of threat). We are currently applying our method to all imperiled Georgia freshwater fishes. While more detailed monitoring and assessments may be required for some species, our method has the potential to provide useful and consistent information for large numbers of aquatic species.

2.

MULTI-SCALE HABITATS AND STRESSORS INFLUENCING LAKE PONTCHARTRAIN BASIN STREAM FISH ASSEMBLAGES

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This study assessed hierarchical relationships among reach, subwatershed and watershed characteristics that structure fish assemblages the Lake Pontchartrain Basin, Louisiana and Mississippi. Reach-scale habitat (i.e., instream and riparian) had the strongest association with the assemblage, after removing potential

interactions among spatial structure and environmental variation from subwatershed and watershed data (Partial redundancy analysis; 13.5% variation explained). Channel width, depth, aquatic vegetation, human debris, rapid habitat assessment (RHA) score, and large woody debris volume were the most important variables at the reach scale. At the subwatershed (pRDA; 9.2%) and watershed scales (pRDA; 12.8%), geomorphic characteristics were important, including elevation, gradient, watershed area, wetland cover and stream density. Stressors included road, dam and oil/gas well densities. Cumulative fit statistics from the pRDA plots revealed that 23 species were influenced primarily by reach-scale habitats, including two rare species (*Fundulus euryzonus* and *Pteronotropis signipinnis*). One species was influenced most by subwatershed characteristics, while six species showed greater variation in abundance with watershed-scale factors, including the rare *Percina suttkusi*. Species exhibiting greater variation with a particular spatial scale tended to have similar life history characteristics. For example, the species associated with watershed factors had life spans less than four years, egg diameters less than 2 mm, spawning periods greater than three months, and were foraging generalists (i.e., more r-selected). Conversely, species associated primarily with in-stream/riparian attributes had life spans longer than four years, egg diameters larger than 2 mm, spawning periods less than three months, and were foraging specialists (i.e., more k-selected).

3.

CONSERVATION GENETICS AND POPULATION STATUS OF THE FLAME CHUB, *HEMITREMA FLAMMEA*

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The southeastern United States has a rich geologic history that contributed to the evolution of an extremely diverse aquatic fauna throughout the region. Biodiversity offers the opportunity to uncover phylogenetic relationships within and among species groups to better understand evolutionary and geologic history. The Flame Chub, *Hemitremia flammea*, is a brightly colored minnow species native to the Cumberland, Tennessee, and Coosa river drainages in Kentucky, Tennessee, Georgia, and Alabama. This monotypic species has been described as a spring endemic and was believed to be experiencing long-term population isolation across its range. In this study, the cytochrome-b gene region was analyzed for 230 individuals from 29 populations across the three drainages, including two new populations. Results from maximum parsimony and Bayesian analyses recovered very shallow divergence between the 31 haplotypes. AMOVA analyses indicated that most genetic variation was distributed within and between populations, not between drainages. Based on these results as well as field observations, this species may not be restricted to spring habitats as was originally presumed. *H. flammea* can move within river systems and likely even between drainages similar to *Fundulus julisia*

and the *Catostomus commersoni* darters. Preliminary screening of microsatellite primers identified four primers that work for this species: Lco5, seat406, seat409, seat412. Further analyses using microsatellite techniques and further field sampling using geospatial modeling would refine these results. Species like *H. flammea* are indicators of the health and persistence of groundwater resources that are under increasing pressure due to a growing human population.

4.

EVALUATION OF SAMPLING STRATEGIES FOR MONITORING THE SICKLEFIN REDHORSE *MOXOSTOMA SPP.* IN GEORGIA

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The sicklefin redhorse (SFR) *Moxostoma spp.* is a rare, candidate species of sucker (Catostomidae) found in moderate-sized streams of western North Carolina and north Georgia that migrates upstream to Brasstown Creek in Towns County, Georgia in late spring. To establish consistent monitoring of this fish in Georgia, we evaluated four sampling strategies (streamside visual surveys, upstream and downstream underwater observation, and seining) at six 100-m representative sites from April to June 2013. Streamside surveys were conducted using binoculars; underwater observation occurred with two snorkelers moving systematically upstream and then floating downstream; seining was implemented by pulling a seine net quickly downstream. Additionally, an approximately 8-km section of Brasstown Creek was canoed to observe SFR abundance and occupancy. All captured redhorses (including *M. anisurum*, *M. carinatum*, *M. duquesnii*, and *M. erythrurum*) and additional data on occupied habitats were recorded. Throughout the study, 37 SFR were captured with the majority (59%) observed through visual surveys. SFR capture in seines ranged in total length from 43 to 55 cm and consisted of only males. The first and last SFR capture occurred on 24 April and 23 May 2013, respectively. Regardless of method, predicted capture probabilities are low (<20%), but streamside visual surveys were most likely (~15%) to detect SFR. Although sample size is small, SFR presence and abundance was most significantly correlated to small boulder ($r = 0.68$; $P = 0.04$) and cobble ($r = -0.83$; $P = 0.04$) substrates. We also report a potential upstream record for this fish. Further research will occur in spring 2014 at additional sites along Brasstown Creek and will include the use of block nets to prevent SFR migration during sampling.

5.
THE DISTRIBUTION OF TOPMINNOWS (FUNDULIDAE) IN SOUTH AND SOUTHEAST
GEORGIA

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Two major species complexes in the family Fundulidae are found in South and Southeast Georgia. This study is examining the distribution of the members of each complex from the Aucilla River in the western portion of the study area to the east side of the Okefenokee Swamp. Initial work has focused in morphometric characters, with subsequent genetic analysis underway. The *Fundulus lineolatus* complex includes both eastern and western forms with only one population of the western form found in the study area. Members of the *F. chrysotus* complex include *F. cingulatus* and *F. rubrifrons*, as well as the more abundant *F. chrysotus*. *Fundulus cingulatus* is found in the southeastern portion of the study area in the Alapaha River basin and the Okefenokee Swamp, and *F. rubrifrons* consists of a single population from the Alapaha River Basin in southern Lanier County. *Fundulus chrysotus*, while the most abundant species in the complex, is restricted primarily to the Withlacoochee River Basin. Current analyses are in progress for microsatellite expression.

6.
OCCUPANCY AND POPULATION ESTIMATES OF THE KENTUCKY ARROW DARTER
(*ETHEOSTOMA SPILOTUM*) IN CLEMONS FORK, BREATHITT COUNTY, KENTUCKY

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The Kentucky arrow darter (*Etheostoma spilotum*) is endemic to the upper Kentucky River system and is currently a candidate for federal listing under the Endangered Species Act. The species has declined across its range and now occurs in only 38 streams. An initial step in improving its conservation status is a better understanding of its densities and associated sampling efficiencies. Thus, quantifiable methods were used to establish detection probabilities and estimate population size in a historically robust Kentucky arrow darter stream, Clemons Fork. Population estimates were derived by obtaining densities within 10m² quadrats among randomly chosen reaches, and extrapolating those to a watershed scale. Utilizing the program PRESENCE, we calculated detection probabilities (p) and proportion of occupied sites (psi). Habitat covariates were used as predictors of presence/absence of Kentucky arrow darters. Results indicated that substrate size and flow regime influence probabilities of Kentucky arrow darter presence. Site occupancy was higher downstream when compared to upstream of a waterfall

located midway in the watershed. There were no occurrences of Kentucky arrow darters in John Carpenter Fork or Millseat Branch, a tributary with historical records. Using imperfect detection and having an estimation of population size can give insight to sampling efficiencies and propagation of Kentucky arrow darters to ensure stability of this imperiled species.

7.

ESTABLISHMENT AND SPREAD OF A NONINDIGENOUS CYPRINID IN BEAR CREEK SYSTEM AND EFFECTS ON THE NATIVE FISH ASSEMBLAGE

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The impacts of nonindigenous fish species on native fish assemblages have been poorly studied relative to the effects of exotic species introductions. Changes in native fish assemblage structure caused by invasive species are especially concerning in the Southeast United States, which harbors the highest fish diversity in the country. Recent studies document an increasing rate of aquatic faunal homogenization, in part due to species introductions. Bear Creek in north Alabama and northeast Mississippi is a highly diverse tributary of the Tennessee River Drainage, with approximately 106 species. Weed shiner (*Notropis texanus*) was detected in the Bear Creek system in 2007, and is thought to have moved into the drainage from the Mobile Basin via the Tennessee-Tombigbee Waterway. The species has since been collected in over 40 collections at 21 sites in the Bear Creek system. We document the invasion path and establishment of Weed Shiner in the Bear Creek system, and correlated fish assemblage change at selected study sites.

8.

INVESTIGATION OF MOVEMENT PATTERNS OF LAKE STURGEON IN THE UPPER TENNESSEE RIVER

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We established an array of acoustic monitoring receivers in the upper Tennessee River and large tributaries to study the movement patterns of resident lake sturgeon (*Acipenser fulvescens*) reintroduction program. In August 2013 we deployed, mapped, and range tested acoustic monitoring receivers at select locations around known concentrations of lake sturgeon, at locks/dams, and along

tributary streams in eastern Tennessee. In November 2013, we surgically implanted resident lake sturgeon ($n=36$) of wild, hatchery origin with acoustic coded tags that send acoustic pings at 69 kHz. Acoustic coded tags have a battery life expectancy of 5-6 years. Acoustic monitoring receivers will be checked and data offloaded regularly in order to map the gross movement patterns of lake sturgeon. Additional data will be gathered with a mobile acoustic receiver from a roving boat. We are eager to identify the daily, seasonal, and annual movement patterns of individual sturgeons in the upper Tennessee River. Because the earliest stocked fish are approaching reproductive age/size classes, we anticipate upstream spawning behaviors and associated movements during the course of our study. The lake sturgeon reintroduction program is an interagency cooperative project initiated in 2000, with releases of juveniles and fingerlings from wild broodstock. Since that time, over 120,000 fish have been stocked. Recent monitoring, captures, and angler reports indicate these sturgeon are surviving, growing, and dispersing throughout the accessible mainstem Tennessee River and large tributaries.

9.

EFFECTS OF HABITAT COMPLEXITY AND PREDATION THREAT ON THE
MOVEMENT PATTERNS OF THE BLACKSPOTTED TOPMINNOW, *FUNDULUS*
OLIVACEUS

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The movement of animals throughout a landscape is an important mechanism regulating a host of ecological and evolutionary processes operating at different spatial and temporal scales. Identifying potential ecological drivers that promote movement behavior may lend valuable insight into many of these processes (e.g. assemblage composition, metapopulation dynamics, etc.), which are strongly influenced by the movement of individuals within and between populations. Although movement patterns of stream fishes have been well documented, the ecological factors influencing such patterns are to a much lesser extent understood. It has been well established that a stabilizing relationship often exists between increasing levels of habitat complexity and predator-prey interactions. Using passive integrated transponder (PIT) technology, we assessed the movement patterns of the blackspotted topminnow (*Fundulus olivaceus*) in a mesocosm setting, across a gradient of habitat complexity (complexes of woody structure) in the presence or absence of a free-swimming predator (*Micropterus salmoides*). The presence of structure was found to mediate movement rates in the presence of a predator; however, when absent, predators significantly reduced movement rates. Individuals increased usage of shallower habitat in the presence of the predator, consistent with observed responses linked to predators in other systems. Furthermore, both males and females exhibited an inverse response to the activity levels of the predator, significantly decreasing per capita movement rates with

increasing predator movement. Our results indicate that predators can function to suppress movement; however this effect may be mitigated by increased levels of habitat heterogeneity.

10.

FISH ASSEMBLAGE DIFFERENCES OF BLACKWATER AND CLEARWATER STREAMS OF COASTAL ALABAMA

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In the southeastern US, blackwater and clearwater streams can occur in the same basin, yet relatively little comparative work has been conducted on their hydrological, chemical, and biological conditions. We quantified fish assemblages and physicochemical parameters of blackwater and clearwater streams in Baldwin County, SW Alabama. Study streams were characterized by a gradient of shifting sand and woody substrates, with clearwater streams typically being more transparent and less acidic than blackwater streams. We electrofished 8-13 streams per season (spring, summer, fall) for 7 seasons spanning 2008 to 2013; blocknetted reaches were at least 30x wetted width and were fished with 3 passes. We captured 5,140 fish representing 31 species from 14 families, with Centrarchidae and Cyprinidae contributing 30.4% and 25.2% of the catch, respectively. An NMS ordination (Bray-Curtis distance) indicated a strong separation between blackwater and clearwater streams fish assemblages. Indicator species analysis revealed that 2 species were associated with blackwater streams (*Esox americanus* and *Erimyzon succeta*) whereas 10 species were associated with clearwater streams (*Lepomis cyanellus*, *Lepomis macrochirus*, *Lepomis megalotis*, *Micropterus salmoides*, *Gambusia holbrooki*, *Percina nigrofasciata*, *Etheostoma swaini*, *Noturus leptacanthus*, *Icthyomyzon gagei*, and *Notropis texanus*). Mixed-effects models from fall 2008, spring and summer 2009, and spring 2010 showed stream type was marginally correlated with discharge; clearwater streams had slightly higher discharge than blackwater streams. Mean instream woody debris per reach was correlated with stream type, with clearwater streams having less woody debris than blackwater streams. These relatively closely spaced blackwater and clearwater streams share a regional species pool, yet differences in assemblage between the 2 stream types indicate that, within a basin, environmental filters may operate to produce stronger contrasts in fish assemblage structure at the individual stream scale than previously thought.

11.

HOW LONG, IS TOO LONG? A CASE STUDY BETWEEN THE FEDERALLY THREATENED BLACKSIDE DACE (*CHROSOMUS CUMBERLANDENSIS*) AND BEAVERS (*CASTOR CANADENSIS*) IN DAVIS BRANCH, CUMBERLAND GAP NATIONAL HISTORICAL PARK, BELL COUNTY, KENTUCKY

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Davis Branch in Cumberland Gap National Historical Park (CUGA) was considered important for the recovery of the Federally threatened *Chrosomus cumberlandensis* (Blackside Dace, BSD). Monitoring of the Davis Branch population began in 1990. *Castor canadensis* (North American Beaver) colonization was reported in 1994, and a series of dams have persisted in the upper section of the stream. The pervasive effects of Beavers on BSD populations were unknown. Our goals were: 1) characterize the fish assemblage structure and relative abundance of BSD within the assemblage, 2) determine the direct and indirect effects of beaver dams on the fish community, and BSD population, 3) monitor the age structure of the BSD population, and 4) recommend management actions to CUGA. Fishes were collected from eight stations annually from 1990-2010, except for 2003-2005. Stations were delineated as downstream and upstream based on Beaver presence, and within three periods, prior (1990-1993), post (1994-2002), and recent (2006-2010). Fish assemblage structure indicated distinct downstream and upstream assemblages prior to beaver colonization, with the relative abundance of BSD approximately 6% and 18%, respectively. The fish assemblage and relative abundance of BSD shifted over time, with the relative abundance of *Lepomis gulosus* (Warmouth), *Lepomis auritus* (Redbreast Sunfish), and *Chrosomus erythrogaster* (Southern Redbelly Dace, SRBD) increasing, and BSD decreasing; only 25 individuals were encountered from 2006-2010. Comparison of BSD age classes between the 3 periods indicated the 0+ age class decreased over time and 1+ and 2+ age classes increased initially but eventually declined within both the downstream and upstream sections. It is speculated that the continued presence of beaver dams increased stream temperatures downstream and upstream, altered the flow regime, and changed the available habitat, thus creating conditions more suitable for centrarchid species and SRBD, which probably preyed upon and out-competed BSD, respectively.

12.

SIZE, ABUNDANCE, AND SPATIAL DISTRIBUTION OF AMERICAN EELS (*ANGUILLA ROSTRATA*) IN THE MIDDLE OUACHITA RIVER BASIN, ARKANSAS

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The American eel is a facultative catadromous fish that can undergo an extensive upstream migration into inland riverine habitat. Recently, American eels have experienced declines from historical population sizes in parts of their range. Multiple causes for the decline have been hypothesized, including barriers to migration. A majority of previous and ongoing research focuses on Atlantic river systems, while limited data exist for rivers discharging into the Gulf of Mexico. In particular, few data exist for the Ouachita River Basin. Our objective was to describe demographics of American eels in the Ouachita, Caddo, Saline, and Little Missouri rivers that comprise the middle Ouachita Basin located in south central Arkansas. From June 2011 through June 2013, twenty main channel sites and four sites directly downstream of dams in tailwaters were sampled in the Ouachita Basin by standardized boat or backpack electrofishing. Mean total length was 395 mm (236 - 763 mm). Mean CPUE was 27 eels/hour with a range of 0 to 78 eels/hour. Differences in total length and CPUE were observed between main channel and tailwater sites. Eels collected in tailwaters were significantly smaller than eels collected from main channel sites and greatest CPUE was observed in tailwaters. Potentially, small eels collected directly below dams were attempting upstream migration but were impeded by barriers. These observations suggest opportunities to facilitate eel passage should be explored.

13.

PROGRESS IN PROTECTING SOUTHEAST FRESHWATER SPECIES UNDER THE ENDANGERED SPECIES ACT

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The southeastern United States is a global biodiversity hotspot for freshwater species, hosting a wealth of endemic species of fishes, crayfishes, and mollusks that are vulnerable to extinction. The region's rich fauna is threatened by numerous factors including habitat loss and degradation, invasive species, global climate change, and the inadequacy of existing regulatory mechanisms to safeguard species from threats that contribute to water quality degradation in the region. In 2010 the Center for Biological Diversity submitted a citizen's petition to the U.S. Fish and Wildlife Service seeking Endangered Species Act protection for 404 aquatic, riparian

and wetland species from 12 southeastern states. Of the petitioned species, 393 are under consideration for federal protection. Only 11 species received negative 90-day findings, two of which were negative because the species are presumed extinct. The petition has catalyzed research and funding for previously understudied imperiled species. Under a settlement agreement reached with the Service in 2011, 757 imperiled species across the country are on an accelerated timeline for consideration for ESA protection. Under the agreement, the Center can expedite protection decisions for ten species per year and is seeking input from scientists on species prioritization. Numerous southeastern freshwater species have recently gained federal protection or are slated for decisions by 2018 due to the settlement. The next step in the Center's campaign to abate the southeast freshwater extinction crisis is to launch a campaign to increase recovery funding for listed species.

14.

AN OVERVIEW OF EDNA PROJECTS BEING CONDUCTED BY THE USFWS CONSERVATION GENETICS LABORATORY

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The USFWS Conservation Genetics Laboratory (CGL), has developed and tested a standard protocol for eDNA detection of aquatic invasive species (AIS) on two National Wildlife Refuges (Loxahatchee and Savannah). Focal AIS species for Loxahatchee National Wildlife Refuge include the African jewelfish (*Hemichromis letourneuxi*) and the bullseye snakehead (*Channa marulius*). For Savannah, target species include the Mayan cichlid (*Cichlasoma uruphthalmum*), the swamp eel (*Monopterus albus*) and the lion fish (*Pterois volitans*). For these species, we developed genetic markers (primers and probes) for eDNA detection through qPCR. We also tested these primers in field samples from Loxahatchee and are currently monitoring three sites at the Savannah NWR for presence and absence of swamp eels, lion fish and Mayan cichlids using the newly developed primers. In addition, we have conducted experiments to estimate the lower limit of detection for each species i.e., the minimum amount of DNA that we can detect from water samples and the total number of qPCR amplification cycles required to make such detection and tested the effect of time, abiotic factors, PCR inhibitors and fish density on detection probability and persistence of eDNA using aquarium tanks as mesocosm. Additional advances include the comparison of values of detection probability obtained from tank experiments with new values obtained in experimental ponds using the African jewelfish as model species. Results from pond experiments will be also useful to determine the most effective and efficient sampling strategy for predicting the occurrence of *H. letourneuxi* in lentic systems.

15.

A STRATEGY FOR DEVELOPMENT OF LARGE-SCALE FLOW MANAGEMENT
ALTERNATIVES BELOW DAMS: A CASE STUDY IN THE APALACHICOLA-
CHATTAHOOCHEE-FLINT RIVER BASIN

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Large dams have a profound effect on riverine ecology and biota with effects that often extend hundreds of kilometers. Given the spatial scale at which dams affect habitat, wildlife-conservation-oriented changes in dam operation represent one of the greatest opportunities to conserve large expanses of riverine habitat. Over 560 km of the Apalachicola and Chattahoochee rivers are flow regulated by the US Army Corps of Engineers (Corps) and private dams. Numerous species persist in these rivers, including federally listed mussels and sturgeon. The Corps is developing a revised Water Control Manual for the basin. As part of coordination with the Corps, the US Fish and Wildlife Service spearheaded an iterative modeling effort to develop and evaluate over 80 potential basin-wide flow management scenarios. Flow-ecology metrics that were used to evaluate scenarios in the Chattahoochee River included shoal bass recruitment and reservoir fisheries reproductive habitat availability. Floodplain fish spawning and rearing, mussel habitat hydrology, Gulf sturgeon spawning habitat availability, and salinities near oyster beds and juvenile sturgeon habitat were used to assess effects to Apalachicola River and Bay. Results suggest that improvements to all of these metrics can be accomplished through changes in water releases without compromising reservoir elevations- an important socioeconomic consideration for the Corps. Because dam licenses and manuals remain unchanged for decades, it is critical that managers and scientists are fully prepared for predictable opportunities to inform dam management. Factors that contributed to project success included: 1) development of flow-ecology relationships well in advance of the manual update; 2) formation of an interdisciplinary team that developed management options; and 3) a highly flexible modeling tool for quickly examining multiple alternatives. We speculate that this proactive strategy may be highly informative and useful if applied in rivers with predictable opportunities to inform flow management.

16.

THE MORE THINGS CHANGE, THE MORE YOU STAY THE SAME: HABITAT
SELECTION IN THREE CO-OCCURRING DARTERS

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When studying species interactions, it is important to know how co-occurring species partition their environment in order to reduce competition. While this partitioning of environment happens on many levels (e.g., diet, timing of spawning), determining the habitats occupied by a species can provide a clear picture of how competition may be reduced among species. Throughout the Meramec River drainage of Missouri, the habitat preference of three species of darters (*Etheostoma flabellare*, *E. blennioides*, and *E. erythrozonum*) was determined over two summers by measuring various habitat variables (substrate, depth of water column, and flow) at 6 sites throughout the drainage. A clear picture emerges showing how these three species are able to co-occur without much competition over habitat, and where these species fall on the continuum of habitat specialist to habitat generalist.

17.

INVESTIGATING INTERFERENCE OF WHITE BASS REPRODUCTION BY YELLOW
BASS AND HYBRID STRIPED BASS IN BARREN RIVER LAKE, KENTUCKY

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White bass *Morone chrysops* are native to the Barren River in south central Kentucky. Over the last thirty years, the population of white bass in Barren River Lake has been in decline. During that same time, two congeners of white bass have been introduced to the lake. Hybrid striped bass *Morone chrysops* — *Morone saxatilis*, were introduced in 1985, and yellow bass *Morone mississippiensis* were first discovered in 2000. Due to the similar life histories and spawning strategies of all three *Morone* species, we hypothesized that the two introduced species are interfering with reproduction of the native white bass. In the springs of 2012 and 2013 we sampled fish from within a four-mile stretch of Barren River upstream of the lake. We collected 144 white bass, 111 yellow bass and 29 hybrid striped bass. Arrival at spawning sites was staggered with yellow bass arriving after white bass but leading to a period of co-occurrence. Compared to published data, the white bass on the spawning sites appeared healthy: fecundity (75,200 to 937,000 eggs per female), gonadosomatic indices (10.7% and 23.7% in sequential years), relative weight (94 average), and length at age (above 50th percentile). Of the yellow bass stomachs examined, 21.6% contained fish eggs or larval fish. Based on arrival times

and evidence of egg predation, it is likely that yellow bass are directly impacting white bass spawning success. Information from this study may elucidate causes for declining white bass populations and aid in the management of white bass in Barren River Lake.

18.

EXAMINING NATURAL GAS DEVELOPMENT AND FISH COMMUNITIES OF THE
FAYETTEVILLE SHALE, ARKANSAS

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Recent developments in hydraulic fracturing have allowed for the production of natural gas more efficiently and economically than conventional methods. The long-term effects of unconventional gas well development on aquatic communities are relatively unknown. The Fayetteville Shale has experienced exponential growth in gas well development with 2 wells in 2001 to 5,707 wells in 2013. In spring 2012 and 2013, we sampled 12 sites throughout the eastern Fayetteville Shale. Fishes were sampled quantitatively using backpack electrofishing and three-pass depletion at multiple riffle-pool units per site. We examined percent sensitive taxa, percent darters, percent Green Sunfish *Lepomis cyanellus*, and species richness in relation to increasing gas well density. Pairwise correlations from both spring 2012 and 2013 show persisting relationships for all variables, except species richness. Proportional abundance of sensitive taxa ranged from 19.5 to 63.0% (2012) and 16.6 to 78.2% (2013) and was negatively correlated with gas well density in both years (2012: $r = -0.81$; 2013: $r = -0.75$). Proportional abundance of darters ranged from 6.1 to 63.0% (2012) and from 0.0 to 78.2% (2013) and was negatively correlated to gas well density (2012: $r = -0.84$; 2013: $r = -0.70$). Proportional abundance of *L. cyanellus* ranged from 1.31 to 23.6% (2012) and 0.0 to 47.4% (2013) and was positively correlated with gas well density (2012: $r = 0.61$; 2013: $r = 0.77$). We used partial correlations to examine the strength of the relations to gas well density when % pasture, the only significant land use variable, was held constant. With the exception of species richness, which had a higher partial correlation with % pasture, all other variables showed the strongest relationship with gas well density in each year. In spring 2013 we also collected fine deposited sediment samples across a gradient of gas well densities and these data will also be presented.

19.

CLIMATE CHANGE AND DISTURBANCE MEDIATED STREAM FISH ASSEMBLAGES IN
THE SOUTHEAST

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The effects of climate change will likely involve increased variability in precipitation and flow. Previous research has shown that biodiversity in some southern Appalachian streams is positively correlated with flow variability and that this variability overwhelms the effects of interspecific interactions. I test the hypothesis that assemblage organization in Coweeta Creek fishes is a function of both flow variability and strong density dependence within populations of assemblage members. I then explore how these relationships will be affected by climate change.

20.

EVALUATING POPULATION TRENDS OF SMALL FISHES THAT OCCUR IN BIG
RIVERS

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Natural History

We conducted annual seine surveys of small-bodied shoal-dependent fish species at 10 shoals on the upper Etowah River in most years from 1997-2012 with the goal of monitoring populations through time with minimal harm to imperiled species. The upper Etowah River (free-flowing above Allatoona Reservoir in north central Georgia) harbors several fish species of conservation concern, including the federally protected amber darter (*Percina antesella*) and the Georgia protected Coosa madtom (*Noturus sp. cf. N. munitus*), and several non-imperiled species. To assess evidence of a trend in the abundance of target species while accounting for incomplete capture of individuals, we used N-mixture models implemented in WinBUGS. We estimated capture probability as a function of water temperature and discharge on the survey date, and abundance as a function of stream flow variability (e.g., the frequency of spates of high flow during summer). There was support for a trend over time in some target species (e.g., a decline in the abundance of amber darter), but credible intervals were relatively large. We used these data to evaluate how useful count data from seine surveys in a large river may be for monitoring rare animals, and explore the amount of effort that would be required to achieve greater precision in estimates that will address questions of interest to managers (e.g., is the species declining in abundance?).

21.

REPRODUCTIVE SCHEDULE OF THE NORTH AMERICAN CYPRINID *NOTROPIS*
PHOTOGENIS IN THE FLINT RIVER OF NORTHERN ALABAMA

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The primary focus of this study was to determine the reproductive schedule of the Ohio River Basin native cyprinid, *Notropis photogenis* (Silver Shiner) and contribute information to the taxonomic library of fish species currently being catalogued and evaluated in the Flint River. Historically this species has been rarely reported in northern Alabama but is now known to have an established population in the Flint River at the southern limit of its range, east of Huntsville, Alabama. Reproductive timing was determined by examining female gonadosomatic index (GSI) values calculated from collections spanning 24 months. Data suggest that *N. photogenis* found in the Flint River of northern Alabama, spawn February through April with a peak mean GSI in March. Initial elevation of mean female GSI to 5% was observed in November. By February mean GSI was observed at 8%, with a peak GSI at 22% in March. A sharp decline to a mean 3% GSI showed reproductive competency ending in May, thus indicating an end to the spawning season. The same general GSI trending was observed in males as well. Cyprinid spawning is temperature dependent and starts with an elevation in water temperature. Water temperature during the peak GSI month of March was found to be 13 °C, with GSI increases for both males and females beginning in November when water temperature averages 12 °C. The ability of *N. photogenis* to reproduce at lower temperatures and therefore earlier in the season than other Flint River cyprinids, yields a reproductive niche for the species in the Flint. In relationship to spawning times of other cyprinids studied from the Flint, data suggests that *N. photogenis* is one of the first, possibly the first, in the synchrony of spawning for Flint River cyprinid populations. Further data are currently being evaluated for egg development and niche use.

22.

EFFECTS OF LOW-HEAD DAMS ON NORTH CAROLINA ATLANTIC SLOPE FISH
COMMUNITY STRUCTURE

Jordan Holcomb and Michael Gangloff

Appalachian State University

Dams restrict organism movements, impound streams, reduce downstream sediment movement, and alter other stream physicochemical characteristics. Low-head dams (<7m height) are ubiquitous in the piedmont of North Carolina and may impact ecological communities and function across broad geographic scales. In 2010-2011 we sampled fish at 25 dams (9 breached, 7 relict, 9 intact) in the Tar,

Neuse and Roanoke basins. Study reaches were located upstream of the impoundment, immediately downstream (mill reach) of and >500m downstream from the dam (n=75 reaches) and sampled via backpack electro-shocking. General Linear Model (GLM) revealed fish CPUE, taxa richness, % intolerant fish taxa and abundance, and select intolerant taxa and eel abundance were significantly higher in the mill reach of intact dams and upstream of breached dams compared to other reaches. There were no between-reach differences at relict sites. Nonmetric Multi-Dimensional Scaling and Indicator Species Analysis revealed streams in the Tar and Roanoke with intact dams and all relict dams contained natural, lotic habitats and communities while Neuse streams with intact dams and all breached dams contained disturbed habitats and communities.

23.

**MICROHABITAT PARTITIONING AND THE EVOLUTION OF JAW PROTRUSION
ANGLE AMONG LITTLE RIVER MINNOWS**

Phillip R. Hollingsworth*

University of Tennessee

Microhabitat segregation along a vertical habitat axis could facilitate species co-occurrence in communities of eastern North American cyprinids. However, it remains unclear if this ecological mechanism operates in the most diverse eastern cyprinid communities and what morphological traits are associated with this type of habitat specialization. In this study, I performed snorkel surveys in order to quantify vertical microhabitat use among 15 species of cyprinids from the Little River, Blount Co., TN. I show that these fish partition the water column into vertically stratified foraging zones. I also quantified jaw protrusion angle from the same species and found that this ecomorphological trait is evolutionarily correlated with vertical habitat preference. These results suggest that ecological and morphological evolution along a vertical habitat axis has strongly influenced the generation of the impressive diversity of eastern NA cyprinid fishes.

24.

**SOUNDSCAPES OF CYPRINELLA VENUSTA: DESCRIBING THE NATURAL AND
UNNATURAL IN SMALL FRESHWATER STREAMS**

Daniel Holt and Carol E. Johnston

Auburn University

The ability to communicate effectively is a critical aspect for any sexually reproducing organism, and requires not only the ability to produce and detect signals, but also an environment which supports the detection of those signals.

Although acoustic signals are a common mode of communication for both marine and freshwater fishes, and have been described for a large number of species in both environments, little attention has been paid to the potential effect of anthropogenic noise in small, freshwater systems. Elevated noise levels can be a potential barrier to acoustic communication by decreasing signal-to-noise ratios or masking signals altogether. One potential noise source that is relatively common to small streams is a bridge crossing. Despite their occurrence in virtually every drainage, no literature currently exists describing the propagation of such noise in streams, or the impact it may have on fish populations. The aim of this study is to characterize the noise, and propagation of noise produced by trucks and trains passing over small streams in eastern Alabama. We also investigate the relationship between vocalizations of the Blacktail shiner (*Cyprinella venusta*), the natural ambient soundscape of its environment, and the impact bridge crossings may have on the ability of *C. venusta* to communicate in these systems.

25.

DIFFERENCES IN OXYGEN CONSUMPTION AND CRITICAL OXYGEN LEVELS OF FIVE STREAM FISHES

Nathan Hartline*, Dennis R. DeVries, Russell Wright

Auburn University

Many freshwater mussels require specific host fish species to complete the parasitic portion of their complex life cycle. Despite this we know little about the abiotic requirements of many host fishes, in part because most are non-game species that have received far less research attention. We used respirometry to quantify the influence of two abiotic factors as potential stressors on host fishes: temperature and dissolved oxygen. We determined routine metabolic rates and the critical oxygen level (DO_{crit}) of 5 fish species, one from the Tennessee River Basin (*Cottus carolinae*) and 4 from the Mobile River Basin (*Percina nigrofasciata*, *P. palmaris*, *Etheostoma jordani*, and *Cyprinella venusta*). Combining intermittent flow with static respirometry allowed us to measure oxygen consumption as a function of dissolved oxygen concentration, as well as the DO_{crit} , at three different temperatures (20°, 24°, and 28° C for *E. jordani*, and *C. venusta*, 20°, 22°, and 24° C for *C. carolinae*, *P. nigrofasciata*, and *P. palmaris*). Linear and segmented regression analysis was used to determine if the oxygen curves had a DO_{crit} . Oxygen consumption patterns varied among species, some showing typical oxyregulating patterns while others were atypical oxyregulating/oxyconforming. Respiration increased with temperature for all species except *C. carolinae*, which showed a declining trend. DO_{crit} did not change significantly with temperature among species, but generally remained constant or increased slightly with temperature. However, *C. carolinae* was again an exception, with the DO_{crit} showing a decline as temperature increased. Results from this research will allow us to derive the functional relationships of respiration with body size, temperature, and dissolved oxygen for these species. These functions are

critical to the determination of water quality standards (i.e. in the tailrace of hydropower facilities).

26.

DEVELOPMENT OF A PRIMER COCKTAIL FOR DETECTION OF FRESHWATER MUSSELS USING ENVIRONMENTAL DNA AND NEXT GENERATION SEQUENCING TECHNOLOGY

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Eastern Kentucky University

Environmental DNA, which can be used for species detection from water samples, is likely highly degraded and thus small DNA regions are generally amplified (<150bp). However, designing species-specific primers may be difficult or impossible when target species co-occur in a community of closely related species where known sequence divergences might be too small to design species-specific primers. This poses a challenge for the utilization of eDNA as a detection tool for freshwater mussels as many assemblages contain closely related taxa. Next generation sequencing (NGS) allows for the amplification and sequencing of mixed samples, thus eliminating the need for species-specific primers. While several universal primers have been published, these primers also amplify many non-mussel taxa, thus reducing sequence signal from the target group. The purpose of this research is to develop molecular markers for freshwater mussels that will 1.) be utilized with NGS as a means of distinguishing closely related taxa and examining entire communities at once and 2.) selectively amplify mussels over other taxa while cover taxonomically informative regions for identification. We used published COI sequences and employed a Sliding Window Analysis to identify short, taxonomically informative regions for species of mussels and identify conserved flanking regions. No single region was informative at the species level for all taxa so we developed a primer cocktail to maximize coverage of taxonomically informative regions for each mussel tribe. Primers were tested on tissue samples representing major unionid mussel clades to confirm amplification. Finally, as a test run, water samples were taken from a mussel propagation facility and were sequenced using NGS. Results from the NGS will be presented.

27.

Using eDNA for detection of rare fishes: spatial effects

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Environmental DNA (eDNA) in aquatic systems is material left in the water by species that can be detected with genetic markers. These species-specific markers can be used for detection of aquatic organisms, even when traditional sampling fails to detect them. This technique is particularly useful for the detection of rare species, especially when their presence is temporally or spatially variable. The effects of species density, water velocity and persistence of the DNA signature are all aspects of the technique that have yet to be determined. Our work with Slackwater Darter indicates that eDNA was much better at detection for this species than traditional sampling. However, spatial position within the stream effected positive detection.

28.

COMPARISON OF RARITY PATTERNS IN TWO CRAYFISHES ON THE CUMBERLAND PLATEAU

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Tennessee Technological University

Recently, a petition to list *Cambarus pristinus* and *Cambarus obeyensis* was filed with the U. S. Fish and Wildlife Service. Both are considered imperiled due to their limited distribution and are the focus of conservation objectives by the Tennessee Wildlife Resources Agency (TWRA) and the Cumberland Habitat Conservation Plan (CHCP). The objective of this study was to assess the rarity of these species. Two forms of *C. pristinus* are recognized, and our study focused on the Upper Caney Fork form. For each species, a stratified random sampling design was used to select 20 first-through-fourth-order streams across four watersheds (Bee Creek (BC), Upper Caney Fork (UCF), East Fork Obey River (EFOR) and West Fork Obey River). At each site, a 100-m reach was systematically sampled to quantify target species. Mark-recapture experiments were conducted to test the efficiency of collection methods and predict abundance based on initial capture rates. *Cambarus obeyensis* was documented at 4 of 80 sites with a mean estimated density of 362 individuals per 100 m. *Cambarus obeyensis* was only observed in the Hurricane Creek sub-watershed of EFOR and occupied all stream orders. *Cambarus pristinus* was documented at 13 of 80 sites with a mean estimated density of 52 individuals per 100 m. *Cambarus pristinus* was observed in UCF and BC but was absent from first order streams. The two species represent different forms of rarity. Both have a limited distribution but *C. pristinus* has lower abundance and has a higher level of habitat specificity. Conservation actions by the TWRA and the CHCP should reflect these observed differences in

distribution, abundance, and habitat specificity. Regular monitoring and specific threat analysis should be conducted for both species to inform future management decisions.

29.

CONSERVATION STATUS OF THE BARRENS TOPMINNOW *FUNDULUS JULISIA*, AN IMPERILED SPRING ENDEMIC

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Tennessee Aquarium Conservation Institute

The Barrens Topminnow, *Fundulus julisia*, ranks among the most imperiled fishes of the southeastern United States and is currently known to exist only on the Eastern Highland Rim in central Tennessee. Endemic to springs and spring-influenced streams the species experienced a rapid decline during the 1980s. In the 1990s, a partnership was formed to guide the recovery of *F. julisia*. While this partnership has been largely successful in establishing a captive propagation and reintroduction program, annual fluctuations in habitat conditions and the presence of the invasive Western Mosquitofish, *Gambusia affinis*, creates concern about the long-term persistence of *F. julisia*. As *F. julisia* have recently been petitioned for listing under the Endangered Species Act, current knowledge about population size and status and threats to the species and their habitat are critical. All known wild (unstocked) and reintroduced populations and several historical sites for *F. julisia* were surveyed in late February to mid-March 2013. Three of the four wild populations had individuals present, all with high abundance and evidence of recruitment. No *F. julisia* were collected in one wild population, but water levels were high. Twelve reintroduced populations had *F. julisia* present, with abundance ranging from 1 to 150, but very few sites had small individuals indicative of recruitment. No *F. julisia* were present at ten reintroduced sites. *Fundulus julisia* were not present in three historical sites sampled, but additional sites need to be surveyed. Surveys will continue through 2015.

30.

Using environmental DNA (eDNA) for surveillance and monitoring in aquatic ecosystems

Andy Mahon

Central Michigan University

Effective management of rare species, including endangered native species and recently introduced nonindigenous species, requires the detection of populations at low density. Non-invasive molecular genetic tools for detection, surveillance, and

monitoring of organisms are increasingly being employed by researchers and management groups to determine species presence. These approaches are particularly useful in aquatic systems where molecular techniques can reveal the presence of rare species that are difficult to capture using traditional fisheries techniques (nets, electroshocking, etc.). In this presentation, I will discuss the multiple platforms and techniques for eDNA sample analyses that are currently being used, including traditional PCR, more quantitative approaches, and next generation sequencing methods. Along with methods and innovations in eDNA science, quality assurance and control guidelines for those employing these sensitive techniques will also be discussed. Application of these molecular protocols and quality assurance guidelines demonstrates that data generated using these tools provides management agencies with reliable, actionable information to help protect our aquatic ecosystems.

31.

STREAM COMMUNITY PATTERNS DURING AND AFTER DROUGHT CONDITIONS IN THE CHIPOLA RIVER (APALACHIOLA RIVER), FLORIDA, AND SPRING CREEK (FLINT RIVER), GEORGIA

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USGS Southeast Ecological Science Center

We are assessing environmental flows in headwater tributaries of the Apalachicola-Chattahoochee-Flint river basin. Our study objective is to evaluate persistence, recruitment, and colonization of fish and mussel species in relation to abiotic parameters (discharge, stream type, and habitat variables). We sampled at thirteen fixed sites over three seasons in the Chipola River and Spring Creek drainages. Four sites intermittently become dewatered due to any combination of surface-water diversions, ground-water withdrawals, and drought. For all sites, 46 fish species representing 28 genera of 15 families were collected. Quantitative mussel sampling yielded 17 species of 12 genera, including three federally endangered species. Not unexpectedly, raw counts of fish and mussels, species richness, and Shannon-Weiner index of diversity grouped by site permanence (perennial versus intermittent) indicated that perennial sites exhibited greater diversity and abundance (Kruskal-Wallis ANOVA; $p < 0.01$). Occupancy models fitted to fish and mussel data revealed interesting patterns. A model that allowed colonization to vary seasonally resulted in occupancy and colonization probabilities of large-bodied fishes that increased significantly from 2012 (a drought year) to Spring 2013 (a wet year), suggesting a change following drought conditions. However, the fish sampling design (two samples per site for three seasons) had low analytical power with occupancy models. Our mussel sampling design was altered in 2013 to include timed searches with previously employed suction sampling in quadrats. For mussel data, a model that allowed detection to vary by season and method suggested that

timed searches significantly enhanced detection (Kruskal-Wallis ANOVA; $p < 0.01$). The suction sampler improved our ability to detect smaller mussels (shell length 20 mm), suggesting that a multi-method sampling design is a suitable approach for estimating occupancy and recruitment in mussel populations.

32.

DEVELOPING A LONG-TERM MONITORING PROTOCOL FOR THE PYGMY SCULPIN
(*COTTUS PAULUS*)

Christopher Matechik* and Carol E. Johnston

Auburn University

Long-term monitoring protocols require adequate levels of precision in order to detect temporal changes in abundance or density of a species. However, the ability to detect changes can be reduced by sampling variation. We used underwater visual observation, and evaluated two sources of sampling variation, habitat patch type and observer effects, to aid the development of a long term monitoring protocol for the pygmy sculpin (*Cottus paulus*). The Pygmy Sculpin is endemic to Coldwater Spring and its associated run, near Calhoun County, AL. Rising concentrations of trichloroethylene (TCE) threaten the Pygmy Sculpin, thus there is a great need for a monitoring protocol. Our data indicate that pygmy sculpin utilize habitat patches disproportionately, which causes an increase in sampling variation if habitat patch type is not accounted for in the sampling scheme. A comparison between a simple random sampling scheme and a sampling scheme stratified by habitat type showed that the stratified sampling scheme had less variation for an equivalent amount of sampling effort. Coefficients of variation were used to determine the optimal sample sizes for the strata. After developing a protocol, we compared multiple observers to determine if observer experience levels affected Pygmy Sculpin counts.

33.

FILLING THE GAP: HABITAT FACTORS INFLUENCING THE DISTRIBUTION OF
MADTOMS IN A POORLY DESCRIBED TENNESSEE COASTAL PLAIN STREAM, THE
RUTHERFORD FORK, OBION RIVER TN

Kristen Pilcher* and Rebecca Blanton Johansen

Austin Peay State University

The Rutherford Fork (Obion River) is a poorly studied Coastal Plain stream in northwest Tennessee. Alteration of streams and the surrounding landscape in this region have resulted in channelization of streams, removal of riparian zones, and creation of drainage ditches. While studies throughout the southeastern United States have addressed declines of freshwater diversity caused by such disturbances,

Coastal Plain lotic systems have been largely overlooked. Channelization alters the natural accumulation of woody debris in streams and leads to loss of species diversity, which is particularly important for benthic species, such as madtoms (*Noturus spp.*), that generally rely on woody debris for cover and spawning. However, specific microhabitat requirements including size and type of woody debris used as cover have not been documented for most madtom species. Understanding these microhabitat requirements is crucial given that madtoms are one of the most imperiled groups of fishes in the Southeast, largely due to habitat loss. We examined the fish community of the Rutherford Fork to document species diversity, but more specifically, to measure microhabitat variation and cover choice for three madtom species (*N. hildebrandi*, *N. miurus*, and *N. phaeus*). Efforts to link specific habitat parameters to occurrence and abundance of these focal taxa provided insight into factors influencing their distribution in Rutherford Fork. Presence and abundance of individual madtom species varied across sites and among microhabitat cover types, but all species were significantly associated with cover versus non-cover patches. Several habitat variables (e.g., velocity, depth, and % leaf pack) were linked to the presence of *N. hildebrandi* and *N. phaeus*. Conclusions for *N. miurus* were limited due to small sample size. Understanding these requirements will help shape the conservation of madtoms in these increasingly impacted coastal plain habitats.

34.

FISH KILL IN THE PEARL RIVER: THE GOOD, THE BAD, AND THE UGLY

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The Pearl River is a moderately diverse Gulf Coastal Plain system in eastern Louisiana and southern Mississippi that harbors over 100 species of freshwater fishes. The ichthyofauna of the Pearl River has been surveyed on a quarterly basis for more than half of a century (1956-present). In August 2011, the release of “black liquor”, an industrial by-product of the paper making process, caused a reduction of dissolved oxygen in the river that resulted in a total local extirpation of fish and freshwater mussels in a 40 mile stretch of the river’s main channel downstream of the discharge site. We surveyed the fish community, both upstream and downstream of the discharge site, from August 2011 through December 2012 and noted a significant shift in fish community structure in the impacted section. Although the effects of the event are seen as a shift in fish community structure, and a loss of species richness directly following the event, the fish community displayed a rapid increase in richness within only a few months of the perturbation. In addition, the present situation of the fish community mimics the impacts observed after other natural events (i.e. drought and hurricanes) that have previously occurred in the basin. However, this spill represents a more localized disturbance and the impacted stretch of river has returned to pre-spill richness levels in a timely

manner. These results suggest that connectivity with upstream unimpacted reaches may have aided in fish community rebound in the impacted section.

35.

LIFE-HISTORY ASPECTS OF *THOBNURNIA RHOTHOECA* (TORRENT SUCKER) AND
MOXOSTOMA CERVINUM (BLACK JUMPROCK) IN SOUTHWESTERN VIRGINIA

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Roanoke College

Life-history aspects of *Thoburnia rhothoeca* (Torrent Sucker) and *Moxostoma cervinum* (Black Jumprock) were identified using specimens from the Roanoke College Ichthyological Collection and from recent collections which were examined to illuminate their age, growth, food habits, and reproductive cycle. For the Torrent Sucker, the largest specimen examined was a female 37 months, 165.1 mm standard length, and 73.73 g total weight. Spawning occurs in the spring, specifically February to May, with a mean of 782.6 mature oocytes up to 2.02 mm diameter in gravid females. Sexual maturity is reached by 1-2 years of age, with a maximum lifespan of between 3 and 4 years of age. Chironomidae and detritus composed the bulk of the diet. Mass, number, and variety of food items peaked in spring and early summer. For Black Jumprock, the largest specimen examined was a female 161.27 mm SL and 42 months of age. Spawning occurs from April through May, with a mean of 2549.45 oocytes (SD = 2229.6) up to 1.5 mm diameter in gravid females. Sexual maturity appears to occur by 1-2 years of age in males and 2-3 years of age in females. Chironomidae composed the bulk of the diet, but detritus, Trichoptera, Ephemeroptera, and Acari were important food items in multiple months. Weight and variety of food items increased with size of specimens examined.

36.

WHERE DID YOU COME FROM, WHERE DID YOU GO? A LOOK AT *RHINCHTHYS*
ATRATULUS IN THE BLACK WARRIOR BASIN

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Auburn University

The riffle daces, *Rhinichthys* (Cypriniformes: Cyprinidae), are small fishes that are restricted to cool, flowing, near headwater streams and springs. Members of the genus are trans-North American in their distribution and currently the center of taxonomic and phylogenetic studies. In Alabama, the Blacknose Dace, *Rhinichthys atratulus*, has historically been found in almost all major tributaries of the Tennessee River basin, the Upper and Middle Coosa River tributaries, and three localities in the headwaters of the Black Warrior River basin. Until recently, the

populations within the Black Warrior were considered extirpated. Recent surveys failed to detect their presence at the historical locality within the Locust Fork. However, a survey of Borden Creek in the Sipsey Fork within Bankhead National Forest revealed that these fishes are still present in the Black Warrior River basin. A single specimen was collected and was the first documented collection of Blacknose Dace in that area in 40 years. Phylogenetic relationships of the Borden Creek Blacknose Dace were investigated using mitochondrial ND2 genes. These were compared to those from the Coosa, Tennessee, Duck, and Cumberland to determine phylogenetic relationships. The specimen from Borden Creek was sister to individuals from the Tennessee River populations, sharing a haplotype with several individuals. This suggests that stream capture in the area likely accounts for the presence of this fish, however biogeographic patterns are difficult to discern when compared with other patterns observed in the region.

37.

FISH ASSEMBLAGE STRUCTURE IN LENTIC VEGETATED MICROHABITATS IN SOUTHERN GEORGIA

John S. Salter and David L. Bechler

Valdosta State University

Aquatic vegetation provides multiple resources such as shelter, food, and breeding habitats for a variety of fish species, and fishes that occupy habitats with similar ecological characteristics are often described as fish guilds. However, not all vegetation offers the same set of resources. Therefore, this study, conducted in South and Southeast Georgia, examined fish assemblages at 18 vegetated lentic sites to determine guild structure and physicochemical and biological variables that might influence guild structure. Total area, percent vegetated surface area coverage, water volume, and major plant species as well as other physicochemical data were recorded for each locality. Comparative analyses were conducted using, one-way ANOVA, Freidman test, Principal Component Analysis (PCA) and regression analyses. Thirty-two fish species were collected across all sites, and significant differences in fish assemblages existed between sites. No defining factors related to assemblage structure were identified. PCA identified *Gambusia holbrooki*, *Leptolucania ommata*, *Elassoma okefenokee*, and *Lepomis macrochirus* as principal species defining fish assemblage structure. From these results, three putative fish subguilds within the 18 aquatic vegetation sites were identified.

38.

NEW HYPOTHESES REGARDING THE EVOLUTION OF AQUATIC BIODIVERSITY IN
THE GULF-ATLANTIC COASTAL PLAIN

Michael Sandel

The University of Alabama at Birmingham

The Gulf-Atlantic Coastal Plain (GACP) of the southeastern United States ranks among the most biologically diverse freshwater ecoregions outside the tropics, but mechanisms responsible for the generation and maintenance of this diversity are poorly understood. The first geologists to study the GACP were quick to implicate historical sea level change as a driver of landscape structure and watershed organization. Decades later, biogeographers derived vicariance hypotheses from early geological accounts, most of which have since been revised or rejected. Additionally, recent geological literature provides evidence for novel mechanisms of watershed evolution in the GACP, including processes that may be independent of historical sea-level change. Here I summarize a large library of geophysical literature and reevaluate vicariance hypotheses relevant to freshwater fauna. I focus on a region bounded by the Pearl River and Apalachicola River watersheds (hereafter Bailey's Zone), which is characterized by comparable patterns of mitochondrial population genetic structure among freshwater lineages, indicative of complex intraspecific genealogies. I revisit published hypotheses poised to explain replicated biogeographic patterns among GACP fauna; 1) the east-west coastal plain suture zone, 2) the Gulf/Atlantic Slope divide; 3) insular vicariance on the Florida Peninsula; and 4) post-glacial range expansion. Genetic and biogeographic data are shown to contradict published hypotheses related to patterns 1 & 2, and to refine hypotheses related to patterns 3 & 4. When considered in a continuous temporal context, concordant patterns revealed by this study improve our understanding of regional geophysical processes affecting intraspecific genealogies, and redefine knowledge gaps pertinent to the generation of freshwater biodiversity in the GACP.

39.

POPULATION GENOMICS OF TWO ECOLOGICALLY DISPARATE *FUNDULUS* HYBRID
ZONES

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An earlier survey of ten replicate topminnow (*Fundulus olivaceus* and *F. notatus*) hybrid zones revealed that the species were typically distributed in an upstream-downstream manner with contact zones localized at confluences featuring abrupt shifts from tributary to river habitat. The rate of hybridization among drainages ranged from no hybrids in two drainages to near random mating in others. The best

predictor of hybridization rate was the homogeneity of habitat through tributary-river confluences (ratio of river to tributary size). Phenotype differences between the species reflect predicted selection differences along stream gradients. Downstream populations (lower food availability and greater predator pressure) generally showed larger investment in reproduction (higher gonadal somatic index), smaller body size and lower somatic condition compared to upstream populations. In two drainages, the species typical up and downstream positions were reversed. Phenotypic differences between the species in the two reversed drainages were consistent with convergence of life history traits in the respective habitats. We sampled the middle of two ecologically disparate hybrid zones (one typical and one reversed) and used genotyping-by-sequencing to generate a genome wide SNP dataset. We ask whether there is a greater rate of hybridization or directional introgression in converging populations from reversed hybrid zone.

40.

THE INFLUENCE OF MIGRATION PATH CHARACTERISTICS ON THE POPULATION STRUCTURE OF *FUNDULUS OLIVACEUS* AND *SEMOTILUS ATROMACULATUS* IN FOUR DRAINAGES OF MISSISSIPPI

Bjorn Schmidt*¹ Jacob F. Schaefer¹ Brian R. Kreiser¹

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One of the major goals of landscape genetics is to examine the influence of various environmental features on gene flow and population structure of organisms. River drainages provide an ideal system for examining these patterns because of their dendritic, hierarchical, linear arrangement, which limits movement and migration for purely aquatic organisms such as fish. The goal of this project was to examine the effects that connecting riverine habitats had on gene flow for populations of fish that resided in small tributaries and headwaters. Populations of *Fundulus olivaceus* and *Semotilus atromaculatus* were sampled in creeks of the Pascagoula River, Pearl River, Big Black River, and Bayou Pierre drainages of Mississippi. Fin clips were collected from six populations consisting of at least 15 individuals for each drainage. Population structure was assessed using eight microsatellite loci for *F. olivaceus* and seven microsatellite loci for *S. atromaculatus*. Genetic distance values were mapped to connecting stream segments using an algorithm in the Stream Tree program (Kalinowski et al., 2008). Correlations were then performed on these values and various characteristics of the connecting stream segments. These characteristics were length, maximum cumulative drainage area, average cumulative drainage area, the number of confluences, and the number of significant confluences (size ratio greater than 0.6). Results varied with species and drainage, but generally, population structure patterns of *S. atromaculatus* were more influenced by the characteristics of the connecting habitat than those of *F. olivaceus*. Future directions include adding data for two more fish species and two more drainages in Arkansas (Little Red River and Black River).

41.

COUNTRY STREAM VS. CITY STREAM: A COMPARISON OF STREAM RESTORATION SUCCESS.

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Restoration of degraded stream habitat has been a major part of the recovery process for imperiled Okaloosa darters. Herein we describe responses of Okaloosa darters to restoration of three stream reaches with different management histories: Mill Creek emptied into a series of man-made impoundments on an urban golf course; Anderson Branch emptied into a large recreational impoundment in a forested watershed; and Tom's Creek emptied into a beaver impoundment in a forested watershed. Okaloosa darters were absent from these impoundments prior to restoration, but were abundant in nearby free flowing stream reaches. Restoration involved removing the impoundment (Tom's Creek) or diverting flow through a newly constructed channel (Mill Creek and Anderson Branch). We monitored Okaloosa darter abundance, fish assemblage structure, and habitat characteristics within each restored stream reach and in upstream or downstream reference reaches. Aquatic macrophytes colonized restored stream reaches within the first year and rapidly formed lush and dense beds. Fish assemblages shifted from primarily Centrarchids and Poeciliids to Percids and Cyprinids. In Mill Creek, YOY Okaloosa darters recruited into restoration reaches within three months of construction. In contrast, adult Okaloosa darters from upstream and downstream recruited into restored reaches during the first year. Darter numbers in the restored portions of Mill Creek neared those in the reference reaches in year 4. Darters have colonized nearly all of the restoration area in Anderson Branch and Tom's Creek, but densities remain below those in reference reaches. Much of the difference in macrophyte colonization is likely attributable to landuse within the watershed-heavy fertilizer input in Mill Creek from the golf course. Comparisons among projects like these inform the adaptive process during future stream restoration work on Eglin AFB and other coastal plain systems and aid in effective recovery of imperiled species.

42.

MICROHABITAT PARTITIONING OF AN ASSEMBLAGE OF DARTER SPECIES WITHIN TWO TRIBUTARIES OF THE TENNESSEE RIVER IN ALABAMA

Brian Thompson and Bruce Stallsmith

The University of Alabama in Huntsville

Habitat partitioning among syntopic darter species (Percidae: Etheostomatini) was

examined in the Flint River and Estill Fork of the Paint Rock River in northeast Alabama from September 2010 through September 2011. Substrate composition, depth, and water velocity were important variables by which species segregated. Niche overlap values also indicated a high degree of habitat partitioning among species at both study sites, though a substantial amount of overlap was seen between *Etheostoma simoterum* and *E. caeruleum* at the Estill Fork site. Segregation among species was present throughout the year, but the significance of differences in habitat preferences did vary seasonally, especially during the post-spawn period when habitat heterogeneity was reduced. Intra-specific variation in habitat utilization was present among some species, with males generally preferring higher flow and coarser substrates than females. Habitat segregation was a well-structured mechanism allowing the coexistence of ecologically similar species.

43.

SUCCESSFUL MANAGEMENT AND MORPHOLOGICAL CHANGE WITH AN INVASIVE SPECIES OF TILAPIA

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Invasive tilapia (*Oreochromis spp.*) were discovered in dense numbers in a seven-mile canal in Port Sulphur in 2009. This canal, and connecting waterways, were treated with rotenone and subsequent introductions of native predatory fish, including largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), warmouth (*L. gulosus*), green sunfish (*L. cyanellus*), and alligator gar (*Atractosteus spatula*). In the following years the canals were sampled by seine, cast netting, and electrofishing. Although hundreds of each species of stocked fishes were captured from late 2009 until early 2011, approximately twenty tilapia were captured during this time. Following collection of a mouth-brooding female tilapia in April 2011, there have been no tilapia found through September 2013, despite extensive seasonal electrofishing in the canals and nearby waterways. Numbers of introduced centrarchids have remained consistently high, with bluegill gradually becoming the dominant species. Invasive tilapia that were captured after the rotenone/predator introduction treatments were analyzed morphometrically and were found to have a significantly different shape (Discriminant Function Analysis, $p < 0.05$) and body condition (MANOVA, $p < 0.001$) when compared to pre-management tilapia. It is possible that this change to a deeper body shape is an indication of the successful impact of stocked predators in this system.

44.

THE UPLAND DUSKY SHINER, *NOTROPIS CUMMINGSAE COLLIS* HUBBS AND RANEY 1951, A MISTAKEN COLLECTION LOCALITY, A SUBSPECIES EXTIRPATED FROM ITS TYPE LOCALITY, OR SOMETHING ELSE?

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The Dusky Shiner, *Notropis cummingsae* Myers 1925 was partitioned by Hubbs and Raney in 1951 into two subspecies, the Lowland Dusky Shiner (*Notropis cummingsae cummingsae*) and the Upland Dusky Shiner (*N. cummingsae collis*). The distribution of the Lowland Dusky Shiner lies east and south of the Fall Zone from North Carolina to Alabama, whereas that of the Upland Dusky Shiner is restricted to two disjunct populations in the upper and lower Piedmont of the Santee River drainage; a zone of intergradation separates the two subspecies. For the upland subspecies, the type locality is Roses Creek, a Foothills stream where the population in the 1940s was separated by six major hydroelectric reservoirs and more than 175 river miles from the next closest population near the North Carolina-South Carolina state line. Currently, the two subspecies and five races designated by Hubbs and Raney are not in general usage by ichthyologists. The Upland Dusky Shiner has not been collected from its type locality since the six original type specimens were collected in 1946. This begs the questions: Did the specimens actually come from Roses Creek and what might have happened to this subspecies since then? The history of the discovery of the Upland Dusky Shiner, the sleuthing of its type locality, its subsequent fate, and its true identity are baffling stories unto themselves. We will try to make sense of it all.

45.

HABITAT SELECTION AND PARTITIONING BY THREE SUCCESSFUL TENNESSEE DARTER SPECIES

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Three widely dispersed darter species in Tennessee are the snubnose darter (*Etheostoma simotermum*), the redline darter (*Nothonotus rufilineatum*), and the rainbow darter (*E. caeruleum*). Snorkel surveys for these species were conducted in two adjacent tributaries of the Clinch River, Coal Creek (3 sites) in Anderson County, TN, and Cove Creek (2 sites) in Campbell County, TN, to assess how they were selecting and partitioning their habitat. Habitat was quantified by substrate measurements in 0.25-m² plots surrounding observed darters (n=330). It was hypothesized that the fish would be selecting habitat nonrandomly, and that the

species observed would be partitioning the available habitat by associating with different types of substrate. An ANOVA indicated that there were significant differences between the habitat occupied by the darters and random unoccupied habitat (n=159), suggesting nonrandom habitat selection ($P < 0.001$). There was also significant difference in available habitat among the 5 sites ($P = 0.04$). Correspondence analysis suggested that habitat selection by the darters was driven by site, and at most sites the species associated with discrete substrate classes separate from each other. These results indicated that these species are capable of thriving in a wide variety of available substrate profiles, and that they partition the habitat available to them. This adaptability is likely involved in the widespread success of these species across the Tennessee River system.

46.

DISPERSAL ABILITY OF THE FRECKLEBELLY DARTER (*PERCINA STICTOGASTER*)

Brooke Washburn*, Carol-Rose Gingras, David J. Eisenhour

Morehead State University

The Frecklebelly Darter, *Percina stictogaster* (Burr and Page), is restricted to high-quality streams in the Kentucky River and Green River drainages. This species has narrowly documented basic life history information, including dispersal ability. Among the 12 darter species found in our study site in the Red River, Menifee and Powell counties, Kentucky, *P. stictogaster* is the most pelagic. Using a reach-specific tagging system we compared its movements with three benthic and two semi-pelagic darters. We tagged a total of 936 individuals of six darter species using subcutaneous injections of visible implant fluorescent elastomer (VIE) from May 2012-May 2013. Fishes were tagged from four reaches of the Red River, spanning a total of 440 m. These reaches plus an additional four reaches (two upstream and two downstream), spanning a total of 1470 m, were surveyed by snorkeling or seining to detect previously tagged fishes. The VIE tags are brightly colored and easily visible underwater. Over six sampling sessions spanning June 2012-September 2013 a total of 54 darters have been recaptured, including 17 *P. stictogaster*. Our recapture data indicated three things. First, our studied darters seemed to move little, as only 7 of 54 darters were recaptured in a different site than tagged. Second, most movements (6 of 7) were upstream, perhaps compensating for downstream drift during early life history. Third, the pelagic and semipelagic *Percina* darter species moved more than the benthic *Etheostoma* species. The greater dispersal tendencies of *Percina* darters may make them more vulnerable to in-stream barriers, such as poorly-designed road crossings, than benthic darters.

47.

COMPARATIVE PHYSIOLOGY OF ENDEMIC AND INJURIOUS FISH SPECIES
COHABITING CHOCCOLOCCO CREEK SPRING TRIBUTARIES

Lindsay M. White and Mark E. Meade

Jacksonville State University

The Choccolocco creek watershed in Northeast Alabama is home to numerous endemic fishes. At least 70 fish species can be observed, many unique to the stream tributaries and springs within the watershed. In recent years, the Asiatic weatherfish, *Misgurnus anguillicaudatus*, has been observed inhabiting springs in the Choccolocco watershed. Some consider the weatherfish injurious and are concerned the species may compete with sensitive endemic species cohabiting the springs such as the coldwater darter, *Etheostoma ditrema*, and the banded pygmy sunfish, *Elassoma zonatum*. In this study we compared the effects of increasing temperature on the physiology of weatherfish and several endemic stream and spring species. Intermittent-flow respirometry was used to determine oxygen consumption rates (MO_2) in fishes at 15, 20, and 25 C. Temperatures were chosen to reflect normal temperature variations experienced in Choccolocco creek watershed (5-30 C range annually), although spring temperatures in the watershed are less variable and typically are around 15-17 C annually. Once collected from the field, fishes were acclimatized to the lab (up to two weeks maximally) to their experimental temperatures. Oxygen consumption rates for at least five fishes were used to determine mean metabolic rates at the various temperatures. Oxygen consumption rates for weatherfish, did not significantly increase from 20 to 25 C (mean 125 and 168 mg O_2 /kg*hr, respectively). Oxygen consumption rates were also not significantly higher in coldwater darters at 20 and 25 C. (1142 and 1273 mg O_2 /kg*hr, respectively). Oxygen consumption rates were, however, significantly higher in the coldwater darter than the weatherfish at 20 and 25 C. High oxygen consumption rates in spring species as well as highly variable consumption rates both suggest elevated temperatures were stressful to the animals. This data suggests that weatherfish can tolerate a wider range of temperatures than observed in its preferred habitat in springs.

48.

CAN MORPHOLOGY ACCURATELY PREDICT THE SUCCESSFULNESS OF
INTRODUCED SPECIES?

Paul Wieczorek II* and Jonathan W. Armbruster

Auburn University

There are many methods utilized to predict whether an introduced species will successfully integrate into a new environment. Morphology appears to be

overlooked when predicting said successfulness. Using the introduced and native cyprinids of the Mobile Basin (60 species in all), we applied traditional geometric morphometrics methodology to determine where in shape space the introduced species occupied. All of the introduced species occupied either different areas of shape space from the native species or occupied areas along the fringe of the native species' shape space. This is a novel way to attempt to predict niche overlap and thus competition between native and introduced species. While there are some limitations to this method (cannot predict predation by introduced species on native species nor does it incorporate abiotic environmental factors), when combined with other methods, we believe this could play a valuable part in understanding the effects of introduced species within an ecosystem.

49.

ASSESSMENT OF GENETIC DIVERSITY WITHIN AND AMONG POPULATIONS OF YELLOWFIN MADTOM (*NOTURUS FLAVIPINNIS*)

Ashantye' Williams and Gregory Moyer

US Fish and Wildlife Service, Georgia

One rare madtom species characterized as endemic and imperiled in the southeastern United States is the yellowfin madtom (*Noturus flavipinnis*). The species, which is presumed extirpated from the Holston River, is currently found in the Powell, Clinch (including Copper Creek), and Little Tennessee (Abrams and Citico Creeks). The goal of this study was to provide an estimate of genetic diversity within and among the five extant populations of yellowfin madtom. Tissue samples were obtained from 130 individuals and genetic diversity and population structure were assessed using 13 microsatellite loci. All populations exhibited low levels of genetic diversity (average number of alleles ranged from 1.15-3.6; observed heterozygosity ranged from 0.029-0.296). The greatest level of genetic variation was observed in the Powell River and the lowest was in Citico and Abrams creeks. Bayesian population assignment identified significant population structure and three distinct populations (Powell, Clinch+Copper, Citico+Abrams). We will discuss these findings in relation to future reintroduction efforts in the Holston River.

50.

SPECIES-HABITAT ASSOCIATIONS OF A RARE TENNESSEE STREAM FISH AT FOUR SPATIAL SCALES

Brianna Zuber* and Hayden T. Mattingly

Tennessee Technological University

Identifying factors that influence habitat use is fundamental to developing conservation strategies for rare species. Knowledge of habitat relationships at multiple scales can also be useful for conservation efforts for rare stream fishes. The Barrens Plateau region of middle Tennessee harbors a number of unique and rare aquatic species, including the Barrens darter (*Etheostoma forbesi*). During June-October of 2009, we sampled 44 100-m reaches in 29 streams for Barrens darters. We studied the darter's distributional patterns at four spatial scales (microhabitat, reach, local, and network) to determine habitat variables significantly associated with Barrens darter presence or absence. GIS was used to examine the spatial distribution of the Barrens darter in relation to historic (1976) and current (2006) land cover at the local and network scales. At the reach scale, Barrens darter distribution was associated with five variables: link magnitude, stream gradient, dissolved oxygen, pH, and an index of bank erosion. Darters were more likely to be present in reaches with link magnitudes < 5, stream gradients between 0.3 and 0.8 % slope, and dissolved oxygen concentrations < 7.5 mg/l. With the exception of one site, Barrens darters were more likely to be found in reaches with pH < 8 and low levels of bank erosion. Although six microhabitat variables were measured, our analyses did not reveal any important darter-habitat associations at this scale. At the local and network scales, the historic local, current local, and current network models suggested that Barrens darters are more likely to occupy areas that have experienced less change in land cover from 1976 to 2006 than other surveyed sites. Reach-scale, historic, and current land cover variables are potentially important in explaining the current distribution of the Barrens darter.

Abstracts: Posters

1.

STATUS OF THE SOUTHERN CAVEFISH (*TYPHLICHTHYS SUBTERRANEUS*) IN ALABAMA AND TENNESSEE

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Caves in Alabama and Tennessee were surveyed for the Southern Cavefish (*Typhlichthys subterraneus*). Caves were sampled visually either from the shore of cave streams or snorkeling in large pools, and specimens were collected via dip net when possible. *Typhlichthys* was uncommon in most caves surveyed, but were spotted in most historical localities. Few, if any, populations surveyed appeared to be self-sustaining communities, and it is likely that *Typhlichthys* live in inaccessible underground systems with most accessible caves acting as sinks. An extralimital population in the Coosa River Drainage (Sells Cave) was collected; however, no samples could be obtained from an apparent Black Warrior River basin population. All localities had species significantly different from the type locality, and caves in Madison County, Alabama, have two species co-occurring.

2.

DIET OF INVASIVE RIO GRANDE CICHLIDS (*HERICHTHYS CYANOGLUTTATUS*) IN LOUISIANA: HABITAT EFFECTS AND IMPLICATIONS FOR NATIVE SPECIES

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Rio Grande cichlids (*Herichthys cyanoguttatus*) are non-native fish introduced into the Greater New Orleans Metropolitan Area (GNOMA) over 20 years ago. They have spread widely and their presence has been shown to impact native fishes. This species occurs in a variety of habitats, including cypress swamps, bayous, and concrete canals which indicates a potential concern for future spread. We examined the diet of *H. cyanoguttatus* to determine: 1. the breadth of their diet in these habitats; 2. potential diet overlap with native species; and 3. the possibility of *H. cyanoguttatus* predation on native species. We collected over 200 *H. cyanoguttatus* from GNOMA and surrounding areas. Half of these fish were from concrete canals and half were from sites with relatively natural substrates and vegetation. We also placed Hester-Dendy invertebrate traps at certain sites to determine prey availability. Cichlids collected from concrete canals exhibited a narrow diet consisting mostly of algae. Cichlids from more natural habitats exhibited more varied diets, which included prey such as crayfish, fish scales, fish eggs, various

arthropods, and mollusks. When *H. cyanoguttatus* diet was compared with available invertebrate prey items (as measured by Hester-Dendy sampling), it appears that cichlids are preferentially feeding on mollusks and crustaceans. These data indicate that the diet of *H. cyanoguttatus* is variable and that this species consumes native organisms such as crayfish and other fishes. We also found that the diet of some co-occurring native fishes overlaps with that of *H. cyanoguttatus* suggesting that they may be impacted by this invasive species.

3.

A SYSTEMATIC EVALUATION OF *ORCONECTES CF. BARRENENSIS* FROM THE RED RIVER SYSTEM (CUMBERLAND RIVER) OF TENNESSEE AND KENTUCKY

Erin Bloom, Rebecca Blanton Johansen, John Johansen, Mollie Cashner

Austin Peay State University

Orconectes barrenensis is endemic to the Green River system of KY and TN. The closely related species, *Orconectes mirus*, is restricted to Tennessee River tributaries in TN and AL. Neither species has been reported from the Red River (Cumberland R.); however, there have been multiple reports of a crayfish from the Red River that is morphologically similar to *O. barrenensis* and *O. mirus*, and has been referred to as *O. cf. barrenensis*. Recently, the authors also discovered populations of this taxon in Sycamore Creek and Obey River (Cumberland R.). The taxonomic status and phylogenetic relationships of *O. cf. barrenensis* have not been evaluated; thus, the objectives of this work were to resolve the phylogenetic relationships of *O. cf. barrenensis* and use a combination of molecular and morphological data to assess its taxonomic status. Tissues and specimens representing all known localities of *O. cf. barrenensis*, and a subset of those for *O. barrenensis* and *O. mirus* were collected or borrowed from institutions. Previously published primers were used to amplify and sequence the cytochrome oxidase subunit I (COI) gene. Additional COI sequences of other *Orconectes* and outgroup taxa were obtained from GenBank. Gene trees were reconstructed using Maximum Parsimony and Bayesian inference methods. Current results support the morphology-based assumption of a close relationship among *O. cf. barrenensis*, *O. barrenensis* and *O. mirus*, which were recovered as a well supported clade. Within this clade, *O. cf. barrenensis* was monophyletic and 5%-7% divergent from *O. barrenensis* and *O. mirus*. Relationships among the *O. cf. barrenensis* clade and these other taxa were unresolved. Assessment of morphological characters and relationships inferred from nuclear genes are underway to better elucidate sister relationships and evaluate the taxonomic status of *O. cf. barrenensis*.

4.

CAPTIVE PROPAGATION OF PYGMY SCULPIN, *COTTUS PAULUS*, IN SUPPORT OF
FUTURE CONSERVATION ACTIVITIES

Michael Buntin and Paul Johnson

Alabama Department of Conservation and Natural Resources

Pygmy Sculpin (*Cottus paulus*), endemic to Coldwater Spring system in Calhoun County, Alabama, are considered threatened by the US Fish and Wildlife Service (FWS). The recharge area Coldwater Spring is being subjected to slowly increasing concentrations of trichloroethylene (TCE) from a historical source. In other fishes, exposure to TCE has elicited sublethal behavioral responses in concentrations as low as 5-10 ppb and direct mortality at higher concentrations. In response to this threat, the FWS recommended propagation and captive husbandry techniques be developed for *C. paulus*. Captive progeny from the program could be used to define specific TCE concentration thresholds for *C. paulus* and maintain a permanent captive population should the need arise. In 2011, captive spawning efforts at the Alabama Aquatic Biodiversity Center (AABC) were unsuccessful due to failure of adult males to fertilize eggs, egg clutch predation, and fungal infestation of egg clutches. However, adult fishes survived over 19 months in captivity. Changes in tank design and husbandry protocols in 2012 focused on hatching and rearing juveniles from egg clutches recovered on artificial spawning tiles placed in Coldwater Spring. Hatching trials in 2012 produced over 100 juveniles, with the largest individual reaching 34 mm in 10 months. Protocols were again modified in 2013 and focused on preventing fungal infection of the egg clutches with regular 1000 ppm formalin treatments and 2% NaCl. These efforts have improved hatching success and 120 juvenile *C. paulus* were hatched at the AABC in 2013. Current work is focused on improving juvenile growth and survivorship by augmenting the diet (live *Artemia nauplii*, chopped frozen bloodworms and *Mysis*) with prepared dry foods. All fish from 2013 will be grown to maturity for eventual captive spawning trials.

5.

DIET OF *FUNDULUS NOTATUS* AND *FUNDULUS OLIVACEUS* IN SYNTOPIC AND
ALLOTOPIC POPULATIONS

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¹The University of Southern Mississippi ²Southern Illinois University Edwardsville

The *Fundulus notatus* species complex consists of three described species: *F. notatus*, *F. olivaceus* and *F. euryzonus*. Both *F. notatus* and *F. olivaceus* have broad overlapping ranges with many populations being found in and out of contact zones. Contact zones are generally found in mid reaches with *F. olivaceus* dominating

headwaters and *F. notatus* larger rivers downstream. Both species share similar ecological niches so the mechanism allowing for stable coexistence in contact zones is unknown. The purpose of this study was to examine variability in diet of *F. notatus* and *F. olivaceus* in syntopic and allotopic populations across three drainages. Both *Fundulus* were sampled in Pascagoula River, Pearl River and Neches River contact zones. Diet of *Fundulus* consists predominantly of terrestrial invertebrates (Coleoptera and *Solenopsis invicta*), littoral and benthic aquatic invertebrates (Gerridae, Diptera and Trichoptera) and filamentous algae. Although the *Fundulus* have similar diets, there were diet differences among drainages as well as between syntopic populations and allotopic populations.

6.

KNOWN UNKNOWN: DOES CULVERT PASSABILITY RELATE TO LANDSCAPE CHARACTERISTICS?

Evan Collins¹ Duncan Elkins¹ Nathan Nibbelink¹ Will Duncan²

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Engineered structures including dams and roads provide an invaluable benefit to society. However, these structures also have a negative impact on the landscape and ecosystems where they are situated. Like dams, road crossings have the potential to fragment stream habitat and obstruct fish movement. However, because these structures are less prominent than dams on the landscape, they are often inadequately surveyed or overlooked during studies on hydrologic connectivity, so their number and effects on habitat connectivity are uncertain. A recent study of the Great Lakes watershed found 38 times more road crossings than dams, drastically increasing the number of potential barriers to fish. Given the tremendous uncertainty surrounding culvert abundance and passability, region-wide surveys are clearly desirable. Field surveys, however, are often cost prohibitive. In lieu of large scale, region wide surveys, we used a geographic information system (GIS) and logistic regression approaches to help determine if environmental variables influenced culvert passability. Surveys were conducted on various streams in the Chipola River System in Alabama and Florida during July, 2013. We used logistic regression to model passability of culverts with environmental variables. We hypothesized impassable barriers would correlate with factors such as topographic variation, flow, and adjacent land use practices. This information, coupled with imperiled species range data, could be useful to managers for identifying regions with an increased risk of habitat fragmentation from road crossings and targeting those areas for focused surveys and remediation.

7.

IS HABITAT PREFERENCE A DRIVER OF GENETIC ISOLATION AT DIFFERENT SPATIAL SCALES IN PERCID FISHES?

Kerstin L. Edberg and Robert M. Wood

Saint Louis University

A cornerstone of the life history paradigm surrounding North American darters is the widely held, yet scarcely tested, assumption that these fishes have a high degree of fidelity to their preferred habitats and do not move great distances from those sites. Reduced levels of gene flow have been documented for many darters at large spatial scales, but very few studies have attempted to determine the fine-scale population dynamics of darter species and what role habitat preferences play in the observed patterns of genetic diversity and population subdivision. The purpose of this study is to determine whether the range of habitats inhabited by three co-occurring species of Missouri darters, *Etheostoma flabellare*, *E. blennioides*, and *E. erythrozonum*, is correlated with the amount of gene flow and genetic diversity found within these species. Results from nine microsatellite loci will be explored in the context of the overall paradigm of habitat preference within darters at large.

8.

GENETIC STRUCTURE AND DISPERSAL POTENTIAL OF *PTERONOTROPIS EURYZONUS* (SUTTKUS, 1955)

Erika Krahl, Malorie Hayes, David C. Werneke, Jonathan W. Armbruster

Auburn University

The Broadstripe Shiner, *Pteronotropis euryzonus* (Suttkus, 1955), is a freshwater fish endemic to tributaries of the middle Chattahoochee River of Alabama and Georgia. Populations of *P. euryzonus* are fragmented between tributaries within the range, and have not been detected in main channel of the Chattahoochee River itself, which appears to limit dispersal potential and gene flow. The mitochondrial gene, cytochrome b, was used to explore the genetic structure of *P. euryzonus* within and among tributaries of the Chattahoochee River. We examined the genetic data to determine the amount of gene flow and infer the potential for *P. euryzonus* to disperse within its native range.

9.

THE INVASIVE ASIATIC WEATHERFISH, *MISGURNUS ANGUILLICAUDATUS*, IN
NORTHEAST ALABAMA.

Mark Meade¹ Lindsay White¹ Megan Cordle¹ Chester Figiel² Greg Scull²

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The Asiatic weatherfish, *Misgurnus anguillicaudatus* (Cantor, 1842), is a potentially invasive species that has been reported in US watersheds since the 1960s. Several reasons for the occurrence of this fish in the US include aquarium trade, use for food by Asian immigrants, and use as a baitfish. Weatherfish are considered a hardy species and have been observed to survive in conditions of low oxygen, drought, and starvation. In recent years the species has been observed in numerous watersheds in the Southeast. Weatherfish were first reported in Alabama in 2009 at Poorhouse branch near Goray Spring (Talladega AL). Poorhouse branch, a relatively small stream, is a tributary of the Coosa River and is located near Choccolocco creek, one of the more biodiverse subwatersheds of the Coosa River. We reported a population of weatherfish in 2012 at Blue Eye spring near Blue Eye creek (Lincoln AL), another small Coosa River tributary. Goray and Blue Eye springs are located only a few miles from one another. In the winter of 2013, we began extensive surveys looking for weatherfish in and around the Lincoln/Talladega AL areas and focusing primarily on springs. To date, we have surveyed Kelly, Flynn, Plumb, Everetts, and Dills springs. Habitat, mainly the presences of Eurasian milfoil, occurs at several of the sites, however, weatherfish were not found. Due to the elusive nature of the weatherfish, future surveys will focus on the use of e-DNA to detect the species.

10.

FLUCTUATING ASYMETRY AS A MEASURE OF ENVIRONMENTAL STRESS CAUSED
BY THE 2010 DEEPWATER HORIZON OIL SPILL.

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Fluctuating asymmetry (FA) is often used as an indicator of environmental stress on a population. Stress encountered during development can result in asymmetries in bilateral traits. We quantify fluctuating asymmetry in *Menidia beryllina* as an indicator of possible environmental stress linked to the DeepWater Horizon oil spill in the Gulf of Mexico. *Menidia beryllina* were used because they are a numerically dominant species found in high wave action coastal estuaries, an area heavily affected by the oil spill. We collected *M. beryllina* monthly (beginning in May 2011) at sites where we also had specimens cataloged from pre oil spill samples. We measured FA in three bilateral traits: eye diameter, pectoral fin length, and pelvic fin length. Data were analyzed using a two way mixed model ANOVA with side (left and

right) as the fixed factor, individual and repeated measurements as factors. This model allows for measurement of FA while controlling for measurement error. We then tested the hypothesis that the levels of FA will be greater in *M. beryllina* from post oil spill samples than pre oil spill samples. What we found was that there was a detectable level of FA from environmental stress caused by the 2010 DeepWater Horizon oil spill.

11.

CHANGES IN NATIVE FISH ASSEMBLAGES IN THE PRESENCE OF INCREASED DENSITIES OF INVASIVE RIO GRANDE CICHLIDS (*HERICHTHYS CYANOGUTTATUS*): IS A NON-NATIVE INVADER FACILITATING A NATIVE INVADER?

Martin T. O'Connell, Ann M. U. O'Connell, Patrick W. Smith

University of New Orleans

The invasive Rio Grande Cichlid (*Herichthys cyanoguttatus*) has been expanding its non-native range in southeastern Louisiana over the past two decades. Before 2000, it was not present in Bayou St. John (BSJ) and the lagoons of City Park (CP), New Orleans. Since then, has spread into the freshwater and estuarine habitats of BSJ and CP, becoming one of the most common fish species. To assess whether native fish assemblages changed in response to different densities of (high, medium, and low), we analyzed long-term (2006-2012) monthly assemblage data from three sites in BSJ (North, Middle, South) and three sites in CP (North, Middle, South). Assemblages were tested for significant differences in species composition among different densities over time using Analysis of Similarity (ANOSIM). If significant differences were detected, we used the SIMPER routine to determine which species contributed most to assemblage differences. Significant assemblage differences (ANOSIM, all $p < 0.05$) were detected at four sites: BSJ North, BSJ Middle, CP Middle, and CP South. At BSJ North, CP Middle, and CP South assemblages associated with high densities were significantly different than those associated with medium and low densities. In four of six comparisons, the main driver of assemblage change was an increase in Inland Silversides at high densities. To a lesser extent increases in Rainwater Killifish, and Sailfin Molly were also associated with high densities of *H. cyanoguttatus* at these three sites. At BSJ Middle, a decline in Bluegill at high/medium densities was the driver of assemblage change. It is interesting to note how increases in (a native invader elsewhere) are consistently associated with high densities of, a non-native invader.

12.

EFFECTS OF SALINITY ON GROWTH AND BEHAVIOR OF INVASIVE RIO GRANDE CICHLIDS (*HERICHTHYS CYANOGLUTTATUS*) IN LOUISIANA

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The spread of non-native Rio Grande cichlids (*Herichthys cyanoguttatus*) in the Greater New Orleans Metropolitan Area (GNOMA) has included the brackish habitats of Lake Pontchartrain and the La Branche Wetlands. To determine the potential spread of this species in brackish habitats, we studied the effects of three different salinity levels on the biology of *H. cyanoguttatus*. The highest salinity tolerated, before cessation of feeding & eventual death, was 30.0 psu. No cichlids survived to the acclimation point of full seawater (35.0 psu). Body mass increased significantly less with this higher salinity treatment. Interestingly, aggression levels were higher with brackish versus freshwater conditions. After a period of six months, the difference in growth between fresh and brackish conditions became significant, indicating a potential detriment to juvenile fish living in brackish conditions for long periods of time. The significance of this study is that most higher-salinity habitats in Louisiana, even those approaching sea water, can be tolerated by this species.

13.

REINTRODUCTION OF NATIVE MUSSELS INTO THE PIGEON RIVER, TENNESSEE

Chloe Ridings and Michael L. McKinney

University of Tennessee

For more than 10 years, there have been several attempts to reintroduce several species of native mussels into the Pigeon River in Tennessee. This effort has been motivated by significant improvements in water quality and the hope that this would promote population growth of reintroduced mussels. However, until recently there has been relatively little monitoring of these relocated populations to see if they have been successful. We report the results of several monitoring efforts to find and identify relocated individuals. Unfortunately, to date, we have found only a small proportion of the many hundreds of individuals released. While some or much of this may result from sampling error, some lines of evidence may indicate a lack of success: significant numbers of dead individuals and, most importantly, indications of poor growth rates and lack of reproduction. A potential reason for any lack of success could be the relative lack of food in the Pigeon relative to the source rivers. Large dams (as present on the Pigeon above the reintroduced populations) have been known to reduce available food supplies to mussels. A next step is to measure

growth rates in transplanted juveniles kept in silos and to examine glycogen content in tissue samples.

14.

UPDATING THE CONSERVATION STATUS OF THE IRONCOLOR SHINER, *NOTROPIS CHALYBAEUS*, IN THE STATE OF MISSISSIPPI

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The conservation status of the ironcolor shiner, *Notropis chalybaeus*, in the State of Mississippi has been in question following a targeted survey conducted 1995 to 1996 that did not detect presence of the species at any historic or otherwise similar localities. Although never frequently encountered in Mississippi, relatively large collections taken from the Jourdan River are vouchered from the 1950's and periodic occurrences are documented from the Wolf, Biloxi, Pearl, and Escatawpa rivers until the early 1980's. No occurrences of *N. chalybaeus* in State of Mississippi waters have been vouchered since, barring the incidental capture of three individuals from the Escatawpa River in 1996. We present findings from our ongoing *N. chalybaeus* status survey including a new vouchered record from the Escatawpa River taken 10 July 2013.

15.

TO BE OR NOT TO BE: IS *NOTURUS FASCIATUS* RARE OR LOCALLY ABUNDANT?

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Madtoms (*Noturus* spp.) are one of the most imperiled groups of fishes in the southeastern US. Despite their nocturnal behavior, collections to describe population parameters and the conservation status of species have largely relied on daytime collection methods. *Noturus fasciatus* is a state threatened species, restricted to 33 known historical localities of the Duck and Tennessee River systems, TN and was recently included on a petition to the US Fish and Wildlife Service for federal listing consideration. The most recent status survey (1996) found individuals at only 12 historical localities and noted an average of 2.1 individuals/collection versus historical records averaging 9.3 individuals/collection. The objectives of this study were to evaluate the current status of *N. fasciatus* and specifically compare detection, abundance, and density observed during day versus night collections. For 24 historical localities, 75 m closed reaches were sampled during the day using a standard two-pass, mark-recapture approach and a standard number of kick-sets, determined based on the wetted stream width. The number,

size, and species of madtom collected and the average depth and flow of the area sampled were recorded. A subset of these sites (5) was also sampled at night using the same methods. *Noturus fasciatus*, was present at 20 localities and was most frequently associated with shallow, moderately flowing glides and riffles in both day and night samples. The average number of individuals/collection across all localities was 9.8 and the average number of individuals collected at night (27.6) was significantly greater ($p = 0.04$) than the number collected during the day (15.6). Although preliminary, populations of *N. fasciatus* appear stable. Results also demonstrate that daytime-only collections of nocturnal species, especially rare species, may underestimate population variables and lead to erroneous conclusions regarding conservation status.

16.

IDENTIFICATION OF FISH HOSTS OF PARASITIC GLOCHIDIAL LARVAE OF FRESHWATER MUSSELS (MOLLUSCA: UNIONIDAE) FROM THE DUCK RIVER, TENNESSEE

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The host-parasite relationship of fishes and parasitic unionid mussel larva (glochidia) has not been described for many mussel species. Given that fishes play a vital role in the dispersal and development of these mussels, documenting the species involved in the host-parasite relationship is crucial for effective conservation of the highly imperiled North American unionid mussel fauna. The objectives of this study were to identify fishes in the Duck River, Tennessee that are hosts for glochidia and use DNA sequencing of glochidia to identify the species or genus of mussel infecting a given fish species. Fishes were collected from several reaches of the Duck River and the gills, body, and fins were inspected for the presence of glochidia using head mounted magnifiers. Fishes with glochidia were preserved in 95% ethanol and the presence of glochidia was confirmed with further inspection under a dissecting microscope in the lab. Fishes with confirmed infestations were identified to species using previously published keys. Glochidia were dissected from gills for DNA extraction and amplification of two mtDNA genes, COI and ND1. Resulting gene sequences were compared to those for known mussel species published on GenBank. A total of 14 fish species from 4 families, and 7 genera were confirmed as hosts for unionid mussels, including two previously unknown hosts, *Etheostoma planasaxatile* and *E. obama*. DNA sequencing of glochidia is ongoing, but has resulted in successful amplification and sequencing of glochidia from seven individuals and two species of fishes (*E. obama* and *E. blennioides*), resulting in identification of glochidia representing two genera of mussels (*Obovaria* and *Limiox*). Although more data are needed, including more comparative mussel sequences from the Duck River, the results provide novel information on the host-parasite relationships, which is essential to successful

conservation of one of America's most threatened groups of animals.

17.

TEMPERATURE PREFERENCE IN THE *FUNDULUS NOTATUS* SPECIES COMPLEX

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Temperature is one of the most pervasive and influential abiotic factors affecting the life histories of fish, regulating a host of physiological processes and influencing behavioral thermoregulation. As temperature varies over time and space, individuals must respond to the thermal heterogeneity in the local environment. Certain temperatures are often selected amongst an array of other available temperatures, resulting in a range of preferred temperatures. *Fundulus notatus*, the blackstripe topminnow, and *Fundulus olivaceus*, the blackspotted topminnow, are widely distributed species that often co-occur throughout an extensive part of their distributions. Furthermore, when sympatric, they often inhabit vastly different habitats along the river continuum, with *F. olivaceus* occurring in the headwaters characterized by cooler waters, while *F. notatus* occur in larger river habitats that are generally warmer. Due to their broad geographical ranges, populations of the two species inhabit a wide range of thermal regimes, thus having to locally adapt to their surrounding thermal environments. We examined whether latitude reflects intra- and interspecific differences in thermal preference across a gradient of temperatures. Both species were collected at three latitudes (southern Mississippi 31°N, northern Alabama 34.5°N, and central Missouri/southern Illinois 38.5°N). Thermal preference was assessed using a series of experimental streams featuring a temperature gradient ranging from 23-32°C. Understanding the role of temperature within and among species, and how it shapes differential patterns of thermal preference, may allow us to gain further knowledge into the nature of variation of thermal adaptation.

18.

GENETIC STRUCTURE AND GEOMETRIC MORPHOMETRICS OF *NOTROPIS LONGIROSTRIS*

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Notropis longirostris, the longnose shiner, is currently recognized as a single species with a southeastern US range extending from the Mississippi drainage in the west to the Apalachicola drainage in the east with records of collections extending to isolated pockets of the upper Etowah and Flint rivers in Georgia. Many studies have

shown that despite morphological similarities, significant genetic divergence is present in a variety of southeastern freshwater fishes. We suspect that the wide distribution range of *N. longirostris* makes this a prime candidate to investigate the possibility of cryptic diversity. Using the CO I gene to identify potential distinct lineages and geometric morphometrics to help elucidate previously unrecognized shape distinctions across the drainages, we found that there is indeed genetic structure among the Mississippi/west of the Mobile Basin, Mobile/east, and the Flint/Etowah Rivers, despite the lack of any morphometric differentiations.

19.

NEW METHODS FOR CAPTIVE PROPAGATION OF THE GREENSIDE DARTER,
ETHEOSTOMA BLENNIOIDES

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The objective of this effort was to develop protocols to captively propagate the greenside darter, *Etheostoma blennioides*. Propagation attempts began in 2011 and concluded in 2013. In 2011 the adults were collected too late in the season to be successfully spawned. In 2012 egg predation by the adults was observed to be highly problematic for this species; additionally, there was a lack of preferred spawning habitat. Efforts in 2012 resulted in only 26 propagated greensides. In 2013, building upon observations that greenside darters spawn on riverweed-covered rocks, the authors created synthetic spawning mats using latch-hook craft technique. The density of breeders was reduced from 10 per 100-gallon tank in 2012 to 3 (one male and two females) per 50-gallon tank in 2013 in order to reduce egg predation and increase each breeder's access to food. The 2013 propagation resulted in 625 captive-bred greensides.

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