Southeastern Fishes Council 45th Annual Meeting
Holiday Inn at World's Fair Park, Knoxville, TN
November 13-16, 2019

Wednesday, Nov 13th

12:00-8:00 pm	Registration (Holiday Inn)
12:00-4:00 pm	*R* workshop (Holiday Inn)
6:00-8:00 pm	Welcome Reception (McCLung Museum, UT campus)

Thursday, Nov 14th

7:00-8:30 am	Breakfast available in hotel or on your own
8:00 am	Registration
8:30-10:00 am	Welcome and Presentation Session
10:00 am	Morning break
10:15-11:45 am	Presentation Session
Noon	Lunch on your own
1:30-2:30 pm	Presentation Session
2:30 pm	Afternoon break
2:45-3:50 pm	Presentation Session
4:00-5:00 pm	*Hidden Rivers* film showing
5:00-6:00	SFC Business Meeting
6:00-8:00 pm	Dinner and Poster Session
8:00-10:00 pm	Live Auction Fundraiser

Friday, Nov 15th

7:00-8:30 am	Breakfast available in hotel or on your own
8:30-10:00 am	Presentation Session
10:00 am	Morning break
10:15-12:00 pm	Presentation Session
12:00 pm	Awards Ceremony

Saturday, Nov 16th

7:00-8:30 am	Breakfast available in hotel or on your own
9:00 am-2:00 pm	Field Trip with CFI to Little River

Southeastern Fishes Council 2019 Annual Meeting

TECHNICAL PROGRAM (presenter in bold)

Thursday: early morning: Jonathan Armbruster (moderator)

8:30. **Brian Alford, Local host**

Introductory remarks

8:45. **Clay W. Tamburri,** Richard C. Harrington, and Thomas J. Near
Student Presentation (UG)

A systematic study of the Fantail Darter, *Etheostoma flabellare*

9:00. **Kyler B. Hecke** and J. Brian Alford
Student Presentation (G)

Ecological niche-modeling of the Sickle Darter (*Percina williamsi*)

9:15. **George Gavrielides**, Ginny Adams, Reid Adams, and Matthew H. Connolly
Student Presentation (G)

Potential effects of land cover change on fish assemblages in the Eleven Point River Basin

9:30. Aaron Krolow and **Kyle Piller**

Assessing the diversity of fish communities at or around artificial reefs along the Louisiana coast through the use of environmental DNA (eDNA)

9:45. **Megan Ryba** and Kyle R. Piller
Student Presentation (G)

Environmental DNA as a tool to survey the fish communities of artificial reefs in Lake Pontchartrain

10:00. **Morning break**

Thursday: late morning Cyndi Williams (moderator)

10:15. **Topher Hockaday** and Aaron Geheber
Student Presentation (UG)

Quantifying morphology of *Cyprinella lutrensis* x *venusta* hybrids in a Missouri reservoir

10:30. **Daniel Akin** and Aaron Geheber
Student Presentation (G)

Morphological divergence of a stream fish in altered flow: teasing apart the influences of natural selection and plastic response on body shape

10:45. **Laurel Nave-Powers** and Kyle R. Piller
Student Presentation (G)

Testing global niche convergence in Cyprinoidei: a geometric morphometric approach

11:00. **Loren Stearman**, Joshua Hubbell, and Jake Schaefer
Student Presentation (G)

Coevolution of geomorphology and fish assemblage structure in Bayou Pierre, Mississippi

11:15. **Dan MacGuigan** and Thomas Near
Student Presentation (UG)

Phylogeography of the *Etheostoma nigrum* species complex

11:30. **Josh Hubbell** and Jake Schaefer
Student Presentation (G)

Confluences and land use as agents of change: temporal habitat variability modifies rates of dispersal

11:45. **Lunch on your own**

Thursday: early afternoon: Jamie Roberts (moderator)

1:30. **Austin P. Hannah**[1] and Mollie F. Cashner [1]
Student Presentation (G)

Evaluating the effects of elevated water conductivity on *Chrosomus erythrogaster* at different life history stages

1:45. **Erin Schwarzbach** and Mollie F. Cashner
Student Presentation (G)

The dose makes the poison: behavioral response of the Southern Redbelly Dace (*Chrosomus erythrogaster*) to chondroitin

2:00. **Kenny D. Jones II**, Michael W. Sandel, and Bernie R. Kujahda
Student Presentation (G)

Conservation genomics of the Coal Darter (*Percina brevicauda*)

2:15. **Blake Mitchell**, Jennifer Main, Ginny Adams, and Reid Adams
Student Presentation (UG)

Variation in habitat use and body condition of *Etheostoma caeruleum* and *Etheostoma fragi* in the Strawberry River, Arkansas

2:30. **Afternoon break**

Thursday: late afternoon: Brittany McCall (moderator)

2:45. **Daemin Kim**, Bruce Bauer and Thomas Near
Student Presentation (G)

Species delimitation and phylogeography of the Longear Sunfish, *Lepomis megalotis* (Centrarchidae)

3:00. **Ava Ghezelayagh** and Thomas J. Near
Student Presentation (G)

Diversification rate patterns across major North American freshwater fish lineages

3:15. **Nicky M. Faucheux**, Leandro E. Miranda, Jason M. Taylor, and Jerry L. Farris
Student Presentation (G)

Defying expectations: tributary fish assemblages are similar above and below impoundments

Lightning talks:

3:30. **Brian K. Wagner**, Kathleen Quebedeaux, and Christopher A. Taylor

Hubbs' Crayfish (*Cambarus hubbsi*): a confusing Ozark endemic

3:35. **Caleb A. Aldridge**

Stream site selection using conditioned Latin hypercube sampling

3:40. **Matthew D. Wagner**

Status update on the Frecklebelly Madtom in the Mobile Basin in Mississippi

3:45. **Sarah Sweat**

Using machine learning to create a suitability model for the Laurel Dace, *Chrosomus saylori*

3:50. **Langston Haden**, Matthew D. Wagner, Sara Barrett, Jake Schaefer, David Schumann, and Michael Colvin

Assessing the utility of benthic trawls for collecting *Percina aurora* in the Pascagoula River

3:55. Hilary K. Canada, M. Taylor Perkins, Anna L. George, Bernard R. Kuhajda, and **Brook L. Fluker**

Population genetic assessment of the endangered Cumberland Darter (*Etheostoma susanae*)

4:00. ***Hidden Rivers*** **film showing, Jeremy Monroe, Freshwater Illustrated**

5:00. **Southeastern Fishes Council Business Meeting**

6:00. **Dinner and Poster Session**

8:00. **Live auction fundraiser: Jim Williams, auctioneer**

Friday: early morning: Hayden Mattingly (moderator)

8:30. **Calvin Rezac**, Ginny Adams, Reid Adams, and Matthew H. Connolly
Student Presentation (G)

A 40 year outlook on the impacts of land use and fluvial geomorphology on fish assemblages in the Spring River, Arkansas

8:45. **River A. Watson**, Brook L. Fluker, and Bernard R. Kuhajda
Student Presentation (UG)

Taxonomic evaluation of the Goldstripe Darter, *Etheostoma parvipinne*, using species delimitation methods with molecular and morphological data

9:00. **Sara Barrett**, Jake Schaefer, and Scott Clark
Student Presentation (G)

Alternative stable state driving changes in fish assemblage within the Pascagoula River

9:15. **Colby D. Denison**, Mark C. Scott, and Brandon K. Peoples
Student Presentation (G)

Incorporating network connectivity into stream classification frameworks

9:30. **Kyle J. Brumm**, Brandon K. Peoples, Robert F. Baldwin, and R. Daniel Hanks
Student Presentation (G)

Addressing the potential of a scale-linked conservation planning framework for freshwaters

9:45. **Jacob Westhoff**, Douglas Novinger, and Jamey Decoske

Lessons from monitoring Missouri's rare fishes using occupancy estimation

10:00. **Morning break**

Friday: late morning Brandon Chance (moderator)

10:15. **Richard Harrington**, Jeffrey W Simmons, Hayden Mattingly, and Thomas Near

Family feud on the Caney Fork: Collection records and population genetic analyses of Barrens Darter, *Etheostoma forbesi*, and Fringed Darter, *E. crossopterum*, reveal displacement and gene flow between two closely related species

10:30. **J. Brian Alford**, Grant Fisher, and John Schwartz

Does physical habitat restoration in urban streams of the Ridge and Valley ecoregion improve biotic integrity?

10:45. **Kayla Fast**, Parker Nenstiel, Anakela Popp, Pat O'Neil, Brett Albanese, and Michael Sandel

eDNA surveillance and genomic characterization of the threatened Trispot Darter (*Etheostoma trisella*)

11:00. **William Ensign**, William Commins, and Katie Owens

The effects of culvert removal on fish movement in Raccoon Creek, Paulding County, Georgia

11:15. **Luke M. Bower**[1] and Kirk Winemiller[2]

Fish assemblage convergence along stream environmental gradients: an intercontinental approach

11:30. **M. Worth Pugh**, Gary Pandolfi, Thomas Franklin, and Michael M. Gangloff

Influences of in-stream habitat and upstream land-use on site occupancy of an endemic darter species

11:45. **Aaron D. Geheber**, Daniel A. Marschalek, and Daniel M. Wolcott

Aquatic assemblage structure dynamics following construction of a CAFO: When you confine bovine to dine do fishes decline?

12:00. **Awards Ceremony**

Thursday evening Poster Session

1. **Nastasia T. Disotell**, Zachary L. Wolf, Mollie F. Cashner, and Rebecca E. Blanton
   Student Poster (G)

   Are neighbors pillaging nests: detecting allopaternal care in the imperiled Egg-mimic Darter (Percidae: *Etheostoma pseudovulatum*)

2. **Jacob F. Brumley** and Rebecca E. Blanton
   Student Poster (G)

   Genetic diversity of a highly imperiled, habitat specialist, *Etheostoma marmorpinnum*, from Little River, TN

3. **Jennifer Caudle** and Kit Wheeler
   Student Poster (G)

   Temporal changes in freshwater fish communities: implications for management and conservation

4. **Rachel Moore** and Brandon K. Peoples

Quantifying macroinvertebrate diversity in nests constructed by Bluehead Chubs

5. **Mack White** and Kit Wheeler
   Student Poster (G)
   Abundance estimates of spawning catostomids in a small, oligotrophic stream using aerial imagery

6. **Grace Davenport**, Ginny Adams and Reid Adams
   Student Poster (G)

   Examination of the current status and distribution of *Etheostoma collettei* in the Ouachita River Basin

7. **Aaron Coons**, Amanda Rosenberger, and Jacob Westhoff
   Student Poster (G)

   Distribution and habitat associations of Longnose Darters (*Percina nasuta*) in Missouri

8. **Daniel Morrill**, Ginny Adams, and Reid Adams
   Student Poster (G)

   Historical fish assemblages of the Current River in the 1940s and the 1990s

9. **Laurel Hansen** and Mollie Cashner
   Student Poster (UG)

   Microsatellite loci information of the Yellowfin Shiner (*Notropis lutipinnis*) in the Rock Creek population of the Savannah River system

10. **Mariah Slaughter** and Philip Lienesch
    Student Poster (UG)

    An investigation on the cover preference of the Mountain Madtom (*Noturus eleutherus*)

11. **Jon D. Eisenhour**, Matthew Fossett, and David J. Eisenhour
    Student Poster (UG)

    Searching for life on the edge: microhabitat and movement of the Bigeye Shiner, *Notropis boops*

12. **Jewel Streeter** and James H. Roberts
    Student Poster (UG)

    Preliminary assessment of larval fish habitat use in the Ogeechee River

13. Chance Garrett, Ginny Adams, and Reid Adams
    Student Poster (G)

    Fish assemblage dynamics in an extremely intermittent Ozark stream

14. **Brittany L. McCall** and Brook L. Fluker
    Student Poster (G)

    Applications of hydrologic-climatic, genetically informed species distribution modelling for headwater conservation

15. **Courtney A. Weyand** and Jonathan W. Armbruster
    ***Student Poster (G)**

    Daced and confused: a phylogenetic assessment of the genus, *Rhinichthys*

16. **J. Robbie Carl**, Thomas C. McElroy, Mario Bretfeld, Heather Sutton, and Matthew J. Troia
    ****Student Poster (G)***

    High-resolution mapping of fish conservation priorities within the Mobile River basin

17. **Hilary K. Canada**, Ronald L. Johnson, and Brook L. Fluker
    ****Student Poster (G)***

    Conservation genetic assessment of the endangered Yellowcheek Darter, *Nothonotus moorei*

18. **Alexsis M. Mross** and Brook L. Fluker
    ****Student Poster (G)***

    Assessing species boundaries among clades of the Least Darter, *Etheostoma microperca*, using multilocus species delimitation methods and morphological data

19. **Anna M. Pieri**, John L. Harris, Brook L. Fluker, Jennifer L. Bouldin, and Jeffery A. Steevens
    ****Student Poster (G)***

    Evaluation of elevated nitrogen on freshwater mussel (Bivalvia: Unionidae) recruitment and population trends in the Buffalo National River

20. **Andrew Coomes**
    ****Student Poster (G)***

    Developmental plasticity in the salinity tolerance of *Gambusia affinis* and *Gambusia holbrooki*

21. **Joseph Miller**, Ginny Adams, and Reid Adams
    ****Student Poster (G)***

    Status, distribution and detectability of the Colorless Shiner (*Notropis perpallidus*) in Arkansas

22. **Tyler B. Brown**, Lindsey A. Martin, and Brook L. Fluker
    ****Student Poster (G)***

    Effects of black-spot disease on the body condition of Bleeding Shiners, *Luxilus zonatus*

23. **Anna Eastis**, Michael Sandel, Zachary Culumber, and Carla Gutierre
    ****Student Poster (G)***

    Phylogenomics and stable isotope analysis of the invasive Green Swordtail (*Xiphophorus hellerii*)

24. **Danielle Talbot**, Ginny Adams, and Reid Adams

Student Poster (G)

Status and ecology of two minnows endemic to the Ozarks of Arkansas and Missouri

25. **Logan Bodiford**, Jon Blalock, Emily Judson, and Brandon K. Peoples
Student Poster (UG)

Comparing scales and otoliths to age endemic Bartram's Bass

26. Paul E. Bugas, Jr., Corbin D, Hilling, Val Kells, Michael J. Pinder, Derek A. Wheaton, and **Donald J. Orth**

Field Guide to the Freshwater Fishes of Virginia

27. Andrew Turko, Colby Nolan, Graham Scott, Sigal Balshine, and **Trevor Pitcher**

Thermal tolerance depends on age, condition and season in Redside Dace (*Clinostomus elongatus*)

28. Dakota R. Spruill and **Steven L. Powers**

Microhabitat comparison of *Percina roanoka* (Roanoke Darter) and *P. nevisense* (Chainback Darter) in the Roanoke River

29. **Matthew R. Thomas** and Stephanie L. Brandt

Status survey of the Goldstripe Darter, *Etheostoma parvipinne*, in Kentucky

30. **Ashantye S. Williams** and Nathan V. Whelan

Assessment of hatchery contribution and genetic diversity of American Shad (*Alosa sapidissima*) in the Edisto River, SC

31. **Bruce Stallsmith** and Tiffany Bell

Do two sympatric *Ulocentra* darter species differ in any life history parameters?

32. Sierra Kincaid, **Thomas Martin**, Michael LaVoie, Karen Kandl, Rachel Hoch, and Luke Etchison CANCELLED

Restoration of Wavy-rayed Lampmussel (*Lampsilis fasciola*), Spike (*Eurynia dilatata*), and Rainbow Mussel (*Villosa iris*) to their native range in the Oconaluftee River basin of Cherokee, North Carolina

33. **John Larrimore** and Michael Sandel

Metabarcoding freshwater fish species of the Mobile River Basin

34. **Brian J. Zimmerman**, S. Mažeika, P. Sullivan, John Navarro, and Jeromy Applegate

Conservation and restoration of Ohio wetland and glacial-lake fishes

35. **Daniel J. Farrae**, Brandon Peoples, Mark Scott, Kevin Kubach, and Tanya L. Darden

Genetic identification of pure and hybrid Bartram's Bass in the tributaries of the Savannah Basin

36. Mel Warren, Brooks Burr, Tony Echelle, **Bernie Kuhajda**, and Steve Ross

Coming Soon: Volume 2 of Freshwater Fishes of North America

37. **Valerie J. Jones** and Hayden T. Mattingly

    Summer habitat use patterns of the endangered Bluemask Darter (*Etheostoma akatulo*) at two spatial scales in the Collins River, Tennessee

38. **Hayden T. Mattingly**, Valerie J. Jones, and W. Keith Gibbs

    Interbasin comparison of stream habitat to inform reintroduction strategies for the endangered Bluemask Darter (*Etheostoma akatulo*)

39. **Alex Rakestraw**, Michael Sandel, and Kenny Jones

    Genomic composition of Walleye (*Sander vitreus*) populations within the Mobile River Basin

40. **Isaac Bentley** and Sherry L. Harrell

    Movement of stream fishes across potential migration barriers in East Fork Indian Creek, Menifee County, Kentucky

Southeastern Fishes Council 45th Annual Meeting Holiday Inn at World's Fair Park, Knoxville, TN November 13-16, 2019

PRESENTATION ABSTRACTS

Caleb A. Aldridge[1]

Stream site selection using conditioned Latin hypercube sampling

[1]Mississippi State University, Department of Wildlife, Fisheries and Aquaculture

Daniel Akin[1] and Aaron Geheber[2]

Morphological divergence of a stream fish in altered flow: teasing apart the influences of natural selection and plastic response on body shape

Drastic effects of dams such as extirpation and obstruction of migration are well-studied, but we currently lack understanding of the effects of dams on resilient stream species that persist and inhabit reservoirs after a damming event. *Cyprinella lutrensis* is historically a stream dwelling minnow species (Family Cyprinidae) native to the Osage River watershed in mid-Missouri. The construction of Truman Dam (completed in 1979) has resulted in relatively high abundances of *C. lutrensis* within the reservoir and its surrounding tributaries. The widespread distribution of this species across the reservoir and connected streams provides an optimal study system for testing the effects of habitat alteration via stream impoundment on fish populations. Specifically, we were interested in the effects of flow alteration on *C. lutrensis* body shape. We hypothesized that populations in systems with no flow (i.e., reservoirs) would have reduced body shape streamlining. This was predicted due to the known importance of fish body form as it relates to locomotion in differing environment types. Here, we assumed that body streamlining would be beneficial for swimming in flowing environments. Analyses of morphology comparing *C. lutrensis* samples taken from Truman reservoir to samples taken from surrounding streams in the Osage River watershed showed significant differences in body shape between reservoir and stream populations, which indicated greater streamlining in stream populations. One possible mechanism of change (flow induced phenotypic plasticity) was tested in the lab using stream flow mesocosm units. This experiment also yielded significant results in support of the original hypothesis, and displays rapid phenotypic change dictated by environmental factors. Methods used, result implications, and future directions of study will be discussed.

[1]Auburn University, Department of Biological Sciences; [2] University of Central Missouri, Department of Biological Sciences

J. Brian Alford[1], Grant Fisher[1], and John Schwartz[2]

Does physical habitat restoration in urban streams of the Ridge and Valley ecoregion improve biotic integrity?

The business of stream restoration is a billion dollar industry today. Funds are used to correct anthropogenic damage to hydrologic and geomorphic functionality and to allow natural processes to return. Unfortunately, ecological improvement from stream restoration projects, particularly in urban watersheds, have had mixed results. The purpose of this study was to 1) determine if stream habitat restoration has had an effect on the biotic integrity of fish and benthic macroinvertebrate assemblages in urban streams within the Ridge and Valley Physiographic Province of east Tennessee and 2) evaluate the effect of stream restoration on the

biotic lift in functional traits expressed by fish and benthic macroinvertebrate assemblages. Twelve sites were selected, whereby three were considered physically restored for at least seven years, three were impaired reaches from varied levels of urbanization, and three streams were considered ecoregion reference streams to serve as a baseline for healthy benthic integrity. Invertebrates were collected bimonthly during 2018-2019 along with water quality and habitat quality data, and fishes were sampled semi-annually. To assess ecosystem health, index of biotic integrity (IBI) metrics and scores were calculated for each sample for fish and benthic macroinvertebrates, respectively, following Tennessee Valley Authority (TVA) and Tennessee Department of Environment and Conservation (TDEC) protocols. Results indicated that restored stream reaches showed improvement over impaired stream reaches, but did not score as high as ecoregion reference streams. Restored streams scored higher on particular biodiversity IBI metrics and for nest-spawning fish traits, in addition to improved habitat quality scores. More research is still needed to properly understand restoration effects of urban stream ecosystems at larger spatiotemporal scales.

[1] University of Tennessee, Department of Forestry, Wildlife, and Fisheries; [2] University of Tennessee, Department of Civil and Environmental Engineering

Sara Barrett[1], Jake Schaefer[1], and Scott Clark[2]

Alternative stable state driving changes in fish assemblage within the Pascagoula River

Stable states are thought to represent alternative assemblages of species that may exist in stable equilibrium over time. Such states are defined as discrete temporal or spatial patterns in abundance of resident species. Theory predicts that shifting from one stable state to another may be facilitated by perturbations that may be either natural, anthropogenic or a combination of both. The Pascagoula River in southeastern Mississippi is the largest remaining un-impounded river system in the contiguous United States and could potentially be in an alternative stable state. Examination of long-term fish assemblage data show that the mainstem Pascagoula River, and its two major tributaries (mainstem Leaf and Chickasawhay Rivers) have been dominated by five abundant taxa that comprise 71% of individuals sampled. Within the last eight years, a change in the mainstem Pascagoula River (but not mainstem Leaf and Chickasawhay) was seen to an alternate assemblage where three different taxa dominate (67% of assemblage). Thus, a shift in stable states seems to have occurred in one portion of the drainage but not the other. To further explore this process, a null model will be constructed to determine whether changes in dominate resident species was a result of stochastic processes or whether it was driven by a disturbance.

[1] The University of Southern Mississippi, School of Biological, Environmental, and Earth Sciences; [2] U.S. Fish and Wildlife Service

Isaac Bentley[1] and Sherry L. Harrell

Movement of stream fishes across potential migration barriers in East Fork Indian Creek, Menifee County, Kentucky

In 2015–16, the U.S. Forest Service and Kentucky Department of Fish & Wildlife Resources (KDFWR) restored two sections of East Fork Indian Creek (EFIC) in the Red River Gorge. Man-made barriers were removed, and channelized stream sections were reshaped to increase habitat availability for fishes and macroinvertebrates. Eight crossvanes were installed in the stream to minimize bank erosion and provide habitat stability throughout the restored sections. However, four of the crossvanes have been deemed impassible by KDFWR, posing as potential upstream migratory barriers. Using both PIT tags and VIE markings, we are monitoring the

movement of all captured fishes in the two restored sections of EFIC for one year to determine whether fish can move over these potential barriers. Movement data will be linked with seasonally-variable abiotic factors such as stream depth, wetted width, and flow rate to quantify their impact on fish movement. It is predicted that we will see decreased or absent upstream movement in smaller-bodied pelagic and benthic fishes in comparison to larger-bodied pelagic fishes. If upstream movement is observed at any of the sites, it is predicted that this will be a direct result of varying water levels across seasons. The results of this study may inform KDFWR on whether to continue use of crossvane installation as a form of restoration.

[1] Eastern Kentucky University

Logan Bodiford[1], Jon Blalock[1], Emily Judson[1], and Brandon K. Peoples[1]

Comparing scales and otoliths to age endemic Bartram's Bass

Bartram's Bass *Micropterus* sp. cf. *cataractae* is an undescribed fluvial black bass endemic to the Savannah River Basin of South Carolina and Georgia, USA. This species is threatened by habitat alteration and hybridization with nonnative congeners. Very little is known about the life history of Bartram's Bass. Age-and-growth information can help scientists more effectively manage this species, but lethal ageing techniques (e.g. otoliths) are not ideal for a species already in decline. We compared saggital otoliths and dorsolateral scales for estimating ages and back-calculated length-at-age for Bartram's Bass. In summer 2017/2018, we collected 622 individuals from 53 sites in the Savannah River basin. For each individual, we measured total length (mm) and weight (g), then extracted otoliths and scales. A subsample of 112 individuals from 35 sites was used to compare otoliths and scales for age estimation. Obvious other *Micropterus* species and hybrids (based on morphology) were excluded from the study; genetic identifications are pending. Ages were estimated by two observers, and confirmed by a third observer in cases of discrepancy. Estimated ages reached up to 10 years. Age determination based on scales were generally lower than that otoliths, and were 85.4% congruent with otoliths; and age discrepancies were generally small (one year). Back-calculated lengths-at-age based on scales were generally higher and more variable than otolith-based estimates, but differences were only statistically significant for age-1 individuals. Scales can be used as a non-lethal method of aging Bartram's Bass, but may underestimate age, over-estimate length-at-age, and be more variable. A long-term tagging study is necessary to corroborate these results.

[1] Clemson University, Department of Forestry and Environmental Conservation

Luke M. Bower[1] and Kirk Winemiller[2]

Fish assemblage convergence along stream environmental gradients: an intercontinental approach

Species that pass through similar environmental filters, regardless of geographic proximity or evolutionary history, are expected to share many traits, resulting in similar assemblage trait distributions. Convergence of assemblage trait distributions among different biotic regions would indicate that consistent ecological processes produce repeated patterns of adaptive evolution. This study analyzes trait–environment relationships across multiple stream fish assemblages representing evolutionarily divergent faunas. We hypothesized that trait–environment patterns converge across regional faunas in response to a common set of environmental filters acting on functional traits. One hundred and ninety-seven species and forty streams were sampled from five regions: Belize, Benin, Brazil, Cambodia and USA. By examining trait–environment plots, multiple congruent trait–environment patterns were found across all regions, indicative of a consistent set of environmental filters acting on local

community assembly. The consistency of these patterns strongly suggests that water velocity and habitat structural complexity function as universal environmental filters, producing similar assemblage trait distributions in streams across all regions. Bivariate relationships were not universal, and only one of the associations between a single functional trait and single environmental variable was statistically significant across all five regions. Strong phylogenetic signal was found in traits and habitat use, which implies that niche conservatism also influenced assemblage trait distributions. Overall, results support the idea that habitat templates structure trait distributions of stream fish assemblages and do so in a consistent manner.

[1] Clemson University, Department of Forestry and Environmental Conservation; [2] Texas A&M University

Tyler B. Brown[1], Lindsey A. Martin[1], and Brook L. Fluker[1]

Effects of black-spot disease on the body condition of Bleeding Shiners, *Luxilus zonatus*

Black-spot disease is common in freshwater fishes and results from encystment of digenetic trematodes into the fins and flesh of the fish. The fish serves as an intermediate host in the life cycle of the trematode, and deposits melanin around the cyst as an immune response, producing the black spots for which the disease is named. Several studies have documented the occurrence of black-spot disease on game fishes, but little is known about how the trematode infestations affect the health or body condition of small stream fishes. The objective of this study was to evaluate the prevalence of black-spot infection in the Bleeding Shiner (*Luxilus zonatus*) throughout Myatt Creek, a tributary to the Spring River in northeastern Arkansas, and compare it with body condition. Specimens collected in the 1970s were obtained from the Arkansas State University Museum of Zoology (ASUMZ) and examined for abundance and location of black-spot infection. Infection rates were compared to the coefficient of condition ($K = W \times 10^5/L^3$), where W = mass in grams and L = standard length in millimeters. Preliminary results revealed an infection rate of approx. 86.5%, with a mean of 22 encystments per individual. Coefficient of condition ranged from 0.57–2.16, and there was a general trend of increasing number of encystments with increasing body condition. Future work will incorporate individuals collected in the 1970s from additional sites on Myatt Creek to evaluate black-spot infection rates along the upstream to downstream gradient.

[1] Arkansas State University, Department of Biological Sciences,

Jacob F. Brumley[1] and Rebecca E. Blanton[1]

Genetic diversity of a highly imperiled, habitat specialist, *Etheostoma marmorpinnum*, from Little River, TN

The federally endangered Marbled Darter, *Etheostoma marmorpinnum*, is endemic to the Little River in eastern Tennessee. Anthropogenic land use in the upper Tennessee Valley has contributed to degradation and fragmentation of *E. marmorpinnum* habitat. These changes have resulted in a decrease in population abundance and occurrence of the species, reducing its range from one that historically included the South Fork Holston River to a 20 rkm stretch of the lower Little River. *E. marmorpinnum* is patchily distributed across this reach of the Little River, utilizing a specific habitat of low-flowing pools with clean gravel and cobble substrate, bracketed by Fort Loudoun Dam downstream and Perry's Mill Dam upstream. Our objectives were to estimate genetic diversity at site and species levels to provide a baseline for conservation actions and for future genetic monitoring. Fifty-six individuals were captured and clipped while snorkeling at 3 known localities that spanned the range of the species. A subset of 8 out of 20

variable microsatellite loci were used to collect genotypic data for all individuals, and a standard suit of population genetic analyses were performed. Presented are the preliminary results of the genetic diversity and structure of *E. marmorpinnum* in the Little River. Continuing efforts include collections of genotypic data for the remaining 12 loci to provide more robust estimates of genetic diversity and effective population size and also to test expectations of isolation-by-distance and downstream increases in genetic diversity common to obligate riverine fishes.

[1]Austin Peay State University, Department of Biology and Center of Excellence for Field Biology

Kyle J. Brumm, Brandon K. Peoples[1], Robert F. Baldwin[1], and R. Daniel Hanks[1]

Addressing the potential of a scale-linked conservation planning framework for freshwaters

Systematic conservation planning methodologies must be adapted to suit the challenges of freshwater ecosystems. Considerable progress has been made in recent years, but the utility of multi-scale planning efforts has received little valuation. Here, we assessed the efficiency of Marxan, a conservation planning tool, in addressing functional and taxonomic diversity targets in a scale-linked approach. In the summer of 2019, we sampled 48 sites within the Congaree Biosphere Reserve of South Carolina, USA. Species distribution models were developed using random forest models at HUC12 and local catchment spatial scales. Ecological risk surfaces were derived from model parameters and were incorporated into the analyses as proxies of ecological cost. We evaluated the degree of complementarity between functional and taxonomic diversity surfaces and compared solutions from single- and multi-scale Marxan scenarios. Our results are expected to highlight the scale-dependent nature of ecological stressors and provide a framework for better addressing the hierarchical nature of riverscapes when defining priority networks. Future efforts will integrate fish, macroinvertebrate, and salamander diversity layers in a multi-taxon, scale-linked effort.

[1] Clemson University, Department of Forestry and Environmental Conservation

Paul E. Bugas[1], Jr., Corbin D, Hilling[2], Val Kells [3], Michael J. Pinder[1], Derek A. Wheaton[4], and **Donald J. Orth**[2]

Field Guide to the Freshwater Fishes of Virginia

A Field Guide to the Freshwater Fishes of Virginia is needed to fulfill a longstanding need in nature education. Central and Southern Appalachians are unrivaled in the U.S. for aquatic species diversity, which makes this regional field guide extremely important. Most authoritative information is contained in extensive references or online databases that are less useful for the beginning naturalist interested in sampling local waters. Furthermore, biologists worldwide are clamoring for more natural history skills to prepare young biologists for future challenges. We created the field guide in a 5.5x8-inch layout format, and Johns Hopkins University Press published the field guide. The book teaches the beginner how to identify the families and reliably identify Virginia fish species with field characteristics. The taxonomy of family and common names follows recent authoritative references. The field guide includes introductory chapters on fishes, river drainages, and freshwater habitats of Virginia, how to use the field guide, how to observe fish in the wild and captivity, and essential messages of fish conservation. Distribution maps are based on recent distributional databases. Color illustrations of 179 fishes provide easy identification. In addition, 26 black and white illustrations provide most reliable diagnostic characteristics (e.g., snout shape, pigment patterns, mouth morphology) for field

identifications. Co-authors will be present to sign copies of the field guide.

[1] Virginia Department of Game and Inland Fisheries; [2] Department of Fish and Wildlife Conservation, Virginia Polytechnic Institute and State University; [3] Val Kells Illustration; [4] Conservation Fisheries, Inc.

Hilary K. Canada[1], M. Taylor Perkins[2], Anna L. George[2], Bernard R. Kuhajda[2], and **Brook L. Fluker**[1]

Population genetic assessment of the endangered Cumberland Darter (*Etheostoma susanae*)

[1]Department of Biological Sciences, Arkansas State University, [2]Tennessee Aquarium Conservation Institute

J. Robbie Carl[1], Thomas C. McElroy[1], Mario Bretfeld[1], Heather Sutton[1], Matthew J. Troia[2]

High-resolution mapping of fish conservation priorities within the Mobile River basin

Identifying potential conservation areas is increasingly important as freshwater fishes and associated aquatic organisms are under increasing peril. Human population growth and subsequent landscape alteration is degrading water quality and changing the physical characteristics of streams, potentially threatening aquatic species. Our goal was to assess the capacity for protected areas to maintain diverse stream fish communities within the Mobile River Basin by overlaying projections of fish species distributions and footprints of protected areas. We developed environmental niche models (ENMs) using the Maximum Entropy (MaxEnt) algorithm to map the distributions of 180 species over 67,420 reaches using open-source species occurrence records from the IchthyMaps dataset and stream-reach environmental predictors from the StreamCat dataset. To date, ENMs have been fit for 180 species, with generally high model accuracy (mean AUC = 0.88range 0.65 to 0.99). The most important predictor variables were watershed area (WsAreaSqKm), capacity for soilerosion (KffactWs), baseflow index (BFIWs), and elevation watershed (ElevWs). Additional geospatial analysis will be used to evaluate how well protected areas overlap with diverse and unique reaches. Finally, potential future protected areas for conservation planning and land acquisition will be identified.

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Jennifer Caudle[1] and Kit Wheeler[1]

Temporal changes in freshwater fish communities: implications for management and conservation

Studies of temporal changes in stream fish community health are important tools used by freshwater resource managers. Indices of Biotic Integrity (IBIs) provide a snapshot of the current status or quality of streams, and can be examined over time. Fish are considered good indicators for use in IBIs due to their relative ease of collecting and identification. The general public better accepts the use of fish for indices when management changes affect interactions with aquatic resources. Changes in stream health via fish community structure can be monitored and referenced to land use changes, effectively providing biological responses to changes in

management plans. Community changes also provide information regarding shifts in community structure, such as invasive species moving into an area not previously inhabited or population declines of rare species. Therefore, temporal change evaluations have strong applications to management plans and conservation practices. Our project will focus on freshwater fish community changes over time on Arnold Air Force Base (AAFB), Manchester, TN. We will examine the distribution of mosquitofish (*Gambusia affinis*, an invasive species of concern, in streams and springs, which are being considered as possible introduction sites for threatened Barrens topminnow (*Fundulus julisia*), a native species negatively impacted by mosquitofish. Sampling will be conducted during winter2020 for spring sites, with stream sampling having been conducted in summer 2019. The resulting information from my project will give useful information for effective management and conservation of aquatic resources at AAFB.

[1]Tennessee Tech University

Andrew Coomes[1]

Developmental plasticity in the salinity tolerance of *Gambusia affinis* and *Gambusia holbrooki*

Developmental plasticity refers to changes during development as a result of environmental contributions. Salinity is a varying environmental condition in freshwater and estuarine habitats that can mediate developmental plasticity in Gambusia *sp*., which can increase their tolerances as an invasive species. For my study, estuarine and freshwater populations of *Gambusia affinis* and *Gambusia holbrooki* will be collected from three distinct populations. *Gambusia affinis* were collected from Texas and Mississippi while *Gambusia holbrooki* were collected from Florida. All populations were brought back to the laboratory where pregnant females were acclimated to three different salinities (0‰, 15‰, 25‰) until they give birth. The offspring will be raised in the salinity they were born in until they reach maturity at which point they were acclimated back to 0% salinity in order to look specifically at developmental plasticity. After the acclimation period, the offspring were directly transferred to experimental trial tanks at 20%, 25%, and 30% salinity for 24-hours. After the 24-hour trial, percent mortality was calculated and used in a linear regression to determine LD50. Based on prior studies, I predict that estuarine populations of these two species will have a greater salinity tolerance (higher LD50) than freshwater populations and that for all populations, the offspring reared at the higher salinities will have greater tolerance than offspring reared at lower salinities.

[1]The University of Southern Mississippi, Department of Biological Sciences

Aaron Coons[1], Amanda Rosenberger[1], and Jacob Westhoff [2]

Distribution and habitat associations of Longnose Darters (*Percina nasuta*) in Missouri

Snorkel surveys during summer 2019 refined the known distribution of the state endangered Longnose Darter (*Percina nasuta*) in Missouri. From May - August, 120 individuals were observed, including young-of-year. Preliminary habitat analysis is being conducted to explore relationships between Longnose Darter occurrence and habitat characteristics at multiple scales.

[1]Tennessee Tech University - USGS Cooperative Fishery Research Unit, [2] Missouri Department of Conservation

Grace Davenport[1], Ginny Adams[1] and Reid Adams[1]

Examination of the current status and distribution of *Etheostoma collettei* in the Ouachita River Basin

Research on the distribution of fishes tends to focus on the species identified as vulnerable, with fewer community level data available to assess changes in status for species considered more widespread. Long-term data allows us to detect a species decline prior to reaching critical status. *Etheostoma collettei* is considered a stable species throughout its range in Arkansas and Louisiana. However, recent collections in the Ouachita River Basin in Arkansas indicated a range contraction in *E. collettei* compared to historical data at the same sites. Contemporary data (collected during 2016 and 2017) revealed *E. collettei* were detected at 15 fewer sites compared to historical collections (during the 1970s and 1980s) using similar collection methods. The objectives of our research were to better understand habitat use and distribution of *E. collettei* as well as assess potential correlates related to reduced detection. We explored macrohabitat use and correlations between land cover/land use and instream habitat at sites where *E. collettei* was detected historically but absent in recent collections. A total of 541 individuals were collected from 24 sites during 2016 and 2017. 44% of these individuals were collected from riffle habitat, 33% from run, and 23% from pool. Sites where *E. collettei* were not detected tended to be in smaller catchments with high pasture land use. Additional analyses on habitat correlates will be discussed.

[1] University of Central Arkansas, Department of Biology

Nastasia T. Disotell[1], Zachary L. Wolf[1], Mollie F. Cashner[1], and Rebecca E. Blanton[1]

Are neighbors pillaging nests: detecting allopaternal care in the imperiled Egg-mimic Darter (Percidae: *Etheostoma pseudovulatum*)

Alloparental care has been documented in several clades of animals, including fishes. Despite the increased energy cost of caring for more offspring, raising non-descendent young has potential benefits, including attraction of mates or reduced egg predation by dilution effects. The Egg-mimic Darter, *Etheostoma pseudovulatum*, is an imperiled darter species restricted to only five tributaries of the Duck River, TN. Male Egg-mimic Darters and those of other species of clade *Goneaperca* construct nests under rocks and guard eggs until hatched. Two species from this clade, *E. virgatum* and *E. olmstedi*, exhibit allopaternal care; whether this is a common strategy to all members of the clade is not known. Furthermore, the potential benefits of kin-selection and how nest density or male size influences such behaviors have not been tested. We used microsatellite loci to genotype eggs and guarding males from nests, collected in 2015 and 2019, totaling samples from 38 nests. Other non-guarding males and females from both collection events were also genotyped to identify the following: (1) if allopaternal care occurs in this species, (2) if kin-selection is one benefit of allopaternal care, (3) if male size correlates to the proportion of non-descendant eggs in a nest, and (4) if distance between nests influences allopaternal care frequency. To date, we have identified 18 microsatellite loci that are variable in *E. pseudovulatum*. Data presented are preliminary results from 4 of these 18 loci from our 2019 samples for which egg parentage was estimated using colony (v2.0) to address our objectives.

[1] Austin Peay State University Department of Biology and Center of Excellence for Field Biology

Colby D. Denison[1], Mark C. Scott[2], and Brandon K. Peoples[1]

Incorporating network connectivity into stream classification frameworks

River classification frameworks are important tools for conserving aquatic resources; they simplify

landscape complexity and inform management objectives across river networks in the absence of complete data. Despite their utility, most classification frameworks have not incorporated network relationships. In this study, we take a novel approach to stream classification by developing and comparing three classification frameworks for South Carolina rivers and streams using a biologically-informed approach. The first will classify streams according to local geomorphic and climatic characteristics largely following the precedent set by previous stream classifications. The second will classify streams according solely to network connectivity parameters, while the third will consider both local and network parameters. Each classification will be trained and validated using stream fish community data from the South Carolina Department of Natural Resources Stream Assessment (SCSA) and Small River Assessment (SRA) datasets, containing over 500 sites and 101 fish species. Through the development and comparison of these frameworks we expect to highlight the importance of incorporating network relationships into stream classifications and to provide an adaptive tool for the management of riverine ecosystems.

[1] Clemson University, Department of Forestry and Environmental Conservation; [2] Freshwater Fisheries Research Division, South Carolina Department of Natural Resources

Anna Eastis[1], Michael Sandel[1], Zachary Culumber[2], and Carla Gutierre [3]

Phylogenomics and stable isotope analysis of the invasive Green Swordtail (*Xiphophorus hellerii*)

Invasive aquatic species are an ongoing issue in North America due to their environmental and economic impacts like threatening biodiversity, ecosystem health, and displacing native fishes. Invasive species are ranked second behind habitat loss as factors responsible for loss of biodiversity across the globe. The Green Swordtail (*Xiphophorus hellerii*) is a tropical ornamental fish native to Veracruz, Mexico stretching downward into Guatemala. They are found in ponds, rivers, and swift-flowing streams and have been introduced on every continent besides Antarctica. We have sequenced individuals from populations in Florida, Hawaii, Wyoming and Mexico with Cytochrome Oxidase I (COI) mitochondrial DNA (mtDNA) and DArT-seq methods to provide insight into the genetic variation, ancestry, and allele frequency divergence of invasive populations. We have addressed the question of how the Green Swordtail is displacing native fish populations by performing stable isotope analysis of ^{13}C and ^{15}N isotopes by investigating the trophic interactions between the Green Swordtail and native stream fishes. We also present molecular phylogenetic data for the Green Swordtail throughout much of its global distribution. Overall, these results will help improve the understanding of this aquatic invasive species by how it interacts with its community and by examining phylogenetic relationships of native and invasive populations.

[1] The University of West Alabama, Department of Biological and Environmental Sciences, [2] University of Alabama in Huntsville, Department of Biological Sciences, [3] Instituto de Ecologia

Jon D. Eisenhour[1], Matthew Fossett[1], David J. Eisenhour[1]

Searching for life on the edge: microhabitat and movement of the Bigeye Shiner, *Notropis boops*

The Bigeye Shiner (*Notropis boops*) is a sensitive minnow species that occupies clear, rocky streams of the Midwest and Appalachian highlands. Unfortunately, little data on this fish that has been published, which is needed to make conservation management decisions. We studied the microhabitat preferences and movement patters of the Bigeye Shiner during the summers of 2017 and 2018 in Triplett Creek using Visible Implant Elastomer (VIE) tags. A total of 120 Bigeye Shiners were tagged at eight sites in April and June; we subsequently sampled for tagged minnows

four times. Only seven Bigeye Shiners were recaptured, six of which were recaptured in a different site. Upstream and downstream movements were about equal; the average movement was 52 meters upstream. This pelagic species appears to be much more mobile than published movements of benthic darter species suggesting a relatively high vulnerability to instream barriers. However, average movement distance was about 210 meters per fish recaptured. Principal component analysis of microhabitats indicates Bigeye Shiners occupy calm or slow-moving water immediately adjacent to faster current, over heterogeneous substrates of sand and gravel, often with *Justicia* or woody cover. We suspect this location allows them to capture drifting terrestrial insects while reducing swimming costs.

[1] Morehead State University

William Ensign[1], William Commins[1,2], and Katie Owens[3]

The effects of culvert removal on fish movement in Raccoon Creek, Paulding County, Georgia

Habitat fragmentation associated with barriers to fish movement is a pervasive threat to fishes in flowing waters. Road culverts associated with points where roadways cross streams and rivers are ubiquitous elements of the human landscape and given their wide distribution can have significant impacts on stream connectivity. The purpose of this study is to document the effects of removing a culvert that potentially limited movements of fishes in Raccoon Creek, Paulding County, Georgia. During the summer before and the summer following culvert removal individuals from six species of fish were tagged with passive integrated transponder tags (PIT tags) in stream reaches above and below the culvert. To detect movements by PIT-tagged fishes, a single instream antenna was placed downstream of the culvert and a series of three instream antennas were placed at approximately equal distances upstream of the culvert. Data obtained from the antenna arrays were used in a multi-state model to estimate the likelihood of fish moving from one location to another over the course of the study. During the sampling period prior to culvert removal, fish were 14 times less likely to move upstream across the impeded reach of stream than across an unimpeded reach of similar length. Similarly, they were 7 times less likely to move downstream across the impeded reach than across an unimpeded reach of similar length. Analysis of the post-removal data is still in progress, but initial results indicate that both upstream and downstream movement across the reach from which the culvert was removed is similar to movements in the upstream control reach.

[1] Kennesaw State University, Department of Ecology, Evolution, and Organismal Biology, [2] Cobb County Water System, [3] The Nature Conservancy

Daniel J. Farrae[1], Brandon Peoples[2], Mark Scott[1], Kevin Kubach[1], and Tanya L. Darden[1]

Genetic identification of pure and hybrid Bartram's Bass in the tributaries of the Savannah Basin

Bartram's Bass (*Micropterus sp. cf. M. cataractae*) is endemic to the Savannah Basin in western South Carolina and eastern Georgia. It is one of three priority species included in National Fish and Wildlife Foundations' (NFWF) Native Black Bass Initiative (NBBI) and has been listed as a species of highest concern in South Carolina Department of Natural Resources' (SCDNR) Comprehensive Wildlife Action plan, due primarily to effects of habitat degradation and hybridization with the introduced Alabama Bass *M. henshalli*. Previous research has documented that Bartram's Bass populations are diminishing due to introgression with Alabama Bass in Savannah River impoundments, but the extent of this process in tributary streams is unknown. Samples were collected in 2017 and 2018 from adult individuals and eggs and larvae from nests

throughout Savannah River tributaries in South Carolina and Georgia. We used a standard suite of microsatellite markers to identify black bass as 'pure' or hybrids by comparing the unknown field-collected samples to a reference set of known 'pure' species of several black bass that potentially co-exist in the Savannah Basin. Genetic results indicated that approximately three quarters of the fish collected were predominantly Bartram's Bass and nearly 90% of these could be considered 'pure' Bartram's Bass. Future work will integrate the results of individual fish ancestry (species identification and pure or hybrid) with location and local conditions to identify possible refugia for Bartram's bass and the range and frequency of hybridization events.

[1] South Carolina Department of Natural Resources, [2] Clemson University

Kayla Fast[1], Parker Nenstiel[2], Anakela Popp[3], Pat O'Neil[2], Brett Albanese[3], and Michael Sandel[1]

eDNA surveillance and genomic characterization of the threatened Trispot Darter (*Etheostoma trisella*)

The Trispot Darter (*Etheostoma trisella*) is a small freshwater fish found in the Coosa River watershed in the southeastern United States. In 2018, the trispot darter was listed as a threatened species under the Endangered Species Act (ESA). In an effort to describe population genetic diversity in this newly reclassified species, we have inferred evolutionary relationships and gene flow among extant populations using Diversity Arrays Technology (DArTseq). Population genomic analyses for this species include populations from Alabama, Tennessee, and Georgia. In addition to assessing population genomic variation, we are monitoring the current distribution of the trispot darter at historical and novel sites in cooperation with the Georgia Department of Natural Resources (GADNR) and the Geological Survey of Alabama (GSA). We have implemented an alternative to traditional fish sampling methods in the form of environmental DNA (eDNA). This type of genetic material is DNA extracted from environmental samples (i.e., water) instead of an individual, biological specimen. We extracted eDNA from filtered water samples and detected the presence of trispot darters using loop-mediated isothermal amplification (LAMP). LAMP detects small quantities of DNA rapidly by amplifying multimeric DNA at a single temperature in real time. Approximately 10,374 single nucleotide polymorphisms (SNPs) were recovered after DArTSeq data were filtered. These SNP data support three genetic populations: one including fish from Ballplay Creek, a second of Little Canoe Creek populations, and a third which includes the Mill Creek, Coosawattee, and Coahulla Creek populations. We have confirmed the presence of the trispot darter at Little Canoe Creek where it has historically been found. Trispot darter DNA was also detected at additional, possibly novel sites. Confirmation of trispot darter presence at historical sites and detection at new localities will provide a platform for conservation efforts and investigation of evolutionary histories.

[1] University of West Alabama, [2] Geological Survey of Alabama, [3] Georgia Department of Natural Resources

Nicky M. Faucheux[1], Leandro E. Miranda[1], Jason M. Taylor[3], Jerry L. Farris[4]

Defying expectations: tributary fish assemblages are similar above and below impoundments

Impoundments can drastically change the physical and biological characteristics of fluvial systems. Changes in the physical characteristics, such as reductions in flow, increased sediment deposition, and increased surface area often influence the system's biological components including plant, macroinvertebrate, and fish assemblages. In addition to direct effects on impounded waterbodies, impoundments can also have wide-ranging effects at the watershed scale, particularly

on upstream tributary streams. For example, changes in stream fish assemblages have been attributed to colonization by lacustrine species, as well as the prevention of recolonization by fluvial species due to discontinuities in stream networks created by reservoirs. The purpose of this study was to assess the magnitude of these effects. We analyzed historical data from 24 streams distributed across five sub-basins in the bluff hills region of the Yazoo Basin. All four major tributary rivers in this region are impounded by large (11,240 - 26,143 hectares) reservoirs for flood control. We compared fish assemblages in streams located upstream and downstream of the four reservoirs using PERMANOVA and contrary to expectations, found no significant differences between the upstream and downstream assemblages. We explore several possible explanations for this discrepancy.

[1] Mississippi State University, Mississippi Cooperative Fish and Wildlife Research Unit, U.S. Geological Survey, [2] U.S. Department of Agriculture, Agricultural Research Service, National Sedimentation Laboratory, Water Quality and Ecology Research Unit, [4] Department of Biological Sciences, Arkansas State University

Chance Garrett[1], Ginny Adams[1], and Reid Adams [1]

Fish assemblage dynamics in an extremely intermittent Ozark stream

Intermittent streams and fishes that inhabit them have been largely overlooked in scientific literature, and there is a paucity of data on fish utilization of intermittent streams in the Ozarks. Recent literature has suggested intermittent streams are more important than previously thought, and ecology of fishes living in them should be further investigated. Rockhouse Creek drains approximately 49 km^2 of primarily forested public lands and is most connected in winter but is only fully connected following rain events. Community samples were collected at 8 sites distributed from the confluence with the Kings River to 3.5 km upstream. In addition to the highly intermittent stream template, there are two low water crossings (LWC) that are barriers to fish passage. The first LWC is located ~ 0.4 km upstream of the confluence and is the most limiting to fish movement. Downstream of the first LWC, 16 species were collected while upstream only 6 species were collected. A second intermittent stream with similar patterns of connectedness (Keels Creek) was identified as a reference stream and community samples at three sites along 2.5 km yielded 22 species indicating diversity of intermittent streams without barriers can be quite high, even during periods of low water. Future sampling will be conducted seasonally and at various water levels to evaluate how fish assemblages in the two intermittent streams are changing temporally. Additionally, The Nature Conservancy is beginning a project in cooperation with Southeast Aquatic Resource Partnership and Arkansas Stream Heritage Partnership to reroute Rockhouse Creek around the first LWC. This will allow for potential recolonization of Rockhouse Creek, and we will monitor the recolonization process.

[1] University of Central Arkansas, Department of Biology

George Gavrielides[1], Ginny Adams[1], Reid Adams[1], and Matthew H. Connolly[2]

Potential effects of land cover change on fish assemblages in the Eleven Point River Basin

The Eleven Point River is a spring-fed, karst-dominated stream flowing through the Salem Plateau of the Ozarks ecoregion in southeast Missouri and northeast Arkansas. Limited research has been conducted on the Arkansas stretch of the river despite growing concerns about the existing and projected expansion of the poultry industry in the watershed. Land cover within the watershed is approximately 69% forest, 30% agriculture, and 1% development. Increased poultry production in the lower watershed may result in increased deforestation, water withdrawal and effluent which

may negatively affect fish assemblages. Overall land cover change may also alter channel morphology and water chemistry of the stream. Johnson and Beadles (1977) collected 90 species of fish from 1976-1977 prior to the land cover change. In order to examine changes in fish assemblage, we replicated Johnson and Beadles' sampling method using similar seine dimensions and scope of habitat selection (riffles, runs, pools). NMDS of their historical fish collections will be compared with National Wall-to-Wall Anthropogenic Land Use Trends (NWALT) from 1974-2012 to examine changes in contemporary assemblages. Persistence and stability were calculated on fish collections at contemporary tributary sites. Geomorphology data will be collected at each site to further our examination of physical change in the stream. Water table fluctuation and in-stream habitat alterations due to land use are expected to be the main causes of assemblage changes since the Johnson and Beadles study. However, analyses of future collections will determine how the land cover disturbances within the watershed have affected fish biota.

[1] The University of Central Arkansas, Department of Biology; [2] The University of Central Arkansas, Department of Geography

Aaron D. Geheber[1], Daniel A. Marschalek[1], and Daniel M. Wolcott[1]

Aquatic assemblage structure dynamics following construction of a CAFO: When you confine bovine to dine do fishes decline?

Concentrated Animal Feeding Operations (CAFOs) may result in increased animal waste inputs into nearby freshwater systems, altering physical and chemical properties of the ecosystem. When these alterations occur, aquatic communities may be impacted as a consequence. In Johnson County Missouri, a CAFO housing nearly 1,000 cattle lies within the upper reaches of the Crawford Creek watershed. A recent request (i.e., through permitting) by this CAFO to increase cattle holdings has led to concerns from nearby landowners. To examine the potential impacts of the operation on the adjacent aquatic system, we quantified fish and invertebrate assemblage structure within the Crawford Creek watershed. Data were collected from 10 stream sites on a near-monthly basis during spring and summer (May–September) starting in 2018. Our study design included sites located in East Crawford Creek (potential CAFO impacts) and West Crawford Creek (control). This setup provided us with the ability to quantify potential CAFO impacts using comparative approaches. Our results suggest general assemblage similarities between East and West Crawford Creeks; however, some seasonal and stream gradient related differences were observed. Additionally, we observed trophic congruence among fish and invertebrate assemblages in the system. By establishing these baseline measures within the system, we are well positioned to conduct informative future monitoring.

[1] University of Central Missouri, School of Natural Sciences

Ava Ghezelayagh[1] and Thomas J. Near[1]

Diversification rate patterns across major North American freshwater fish lineages

The diversity of freshwater fishes in eastern North America, unrivaled among temperate regions of the world, has been attributed to the continent's geographic and climatic stability. Despite this relative stability compared to other continents, North America has undergone significant paleo-geologic and -climatic changes, with effects on the diversification dynamics of its inhabitants. This study explores the tempo of diversification across six lineages that dominate North American freshwater systems: Cyprinidae (minnows and chubs), Catostomidae (suckers), Ictaluridae (common catfishes), Fundulidae (topminnows and killifishes), Etheomastinae (darters), and Centrarchidae (sunfishes and black basses). Using the R package TESS and phylogenies based on Sanger Sequencing data, we have identified major shifts in the diversification rates of these

lineages. Our results suggest that in addition to Pleistocene glaciation, temperature changes in the Miocene and Pliocene may have impacted rates of lineage diversification in North American fishes.

[1] Yale University, Department of Ecology and Evolutionary Biology

Austin P. Hannah[1] and Mollie F. Cashner [1]

Evaluating the effects of elevated water conductivity on *Chrosomus erythrogaster* at different life history stages

The Blackside Dace (*Chrosomus cumberlandensis;* BSD) is a federally threatened cyprinid that has been extirpated from 31 streams in Tennessee and Kentucky since it was first described in 1978. Anthropogenic factors, particularly elevated water conductivity caused by surface mining activity, pose the greatest present threat to the species. Although there is strong evidence linking elevated conductivity levels and low BSD occurrence, the exact mechanistic relationship between the two are poorly understood. The goal of our research was to determine whether elevated water conductivity alone affects hatch rate of eggs obtained from a closely related species with ecological overlap, Southern Redbelly Dace (*Chrosomus cumberlandensis:* SRBD*),* in laboratory conditions as well as investigate sub-lethal effects of elevated water conductivity on adult SRBD. We hypothesize that conductivity affects reproduction of BSD and has sub-lethal effects which contribute to reduced survival and reduced fitness in wild populations. Using water parameters provided by the Kentucky Division of Water as well as samples obtained from EPA records, we reconstituted water chemically analogous to streams within BSD historic range along a gradient reflecting differing levels of mining related impairment. We found a significant relationship between egg hatch rate and water conductivity level (p-value = .00083, n = 87) with hatch rate decreasing as conductivity levels increased (71 uS/cm to 1523 uS/cm). Our results provide the first evidence demonstrating the role of elevated water conductivity analogous to surface mining on the development and survival of fish embryos.

[1] Austin Peay State University

Laurel Hansen[1] and Mollie Cashner[1]

Microsatellite loci information of the Yellowfin Shiner (*Notropis lutipinnis)* in the Rock Creek population of the Savannah River system

The Yellowfin Shiner (*Notropis lutipinnis*) is a widespread species, ranging from the Edisto river system in South Carolina to the Chattahoochee river system in Georgia and Alabama. Although their range crosses multiple disjunct river systems, and there have been multiple documented range expansions, few studies have explicitly addressed population structure within and among these river systems. A set of seventeen polymorphic microsatellite loci were identified for the Yellowfin Shiner and an initial assessment of allelic diversity was 2 to 12 alleles. To further investigate the utility of these markers, we assessed Hardy-Weinberg equilibrium (HWE), allelic richness and diversity for a population of 22 Yellowfin Shiners from Rock Creek in the Savannah River System. These markers will be useful in documenting population structure within river systems, aiding in identifying origin populations for those undergoing range expansion, and can be used in parentage studies for this aggregate nest associating minnow.

[1]Austin Peay State University

Richard Harrington[1], Jeffrey W Simmons[2], Hayden Mattingly[3], Thomas Near[1]

Family feud on the Caney Fork: collection records and population genetic analyses of Barrens Darter, *Etheostoma forbesi,* and Fringed Darter, *E. crossopterum*, reveal displacement and gene flow between two closely related species

The Barrens Darter, *Etheostoma forbesi*, is one of the most geographically restricted freshwater fish species in North America, with a distribution limited to headwater portions of nine streams in the western part of the upper Caney Fork River, a tributary of the Cumberland River in Tennessee. This limited geographic distribution makes *E. forbesi* especially vulnerable to potential threats posed by nonpoint-source pollution, habitat alteration, and the risk of ecological competition and introgressive hybridization with the closely related Fringed Darter, *E. crosspoterum*. Museum collection records and targeted surveys conducted since its description suggest that *E. forbesi's* present-day range does not include several streams it previously inhabited– some as recently as 15 years ago. We set out to reanalyse the distribution of both *E. forbesi* and *E. crossopterum* in the upper Caney Fork River, and assess phylogeographic patterns among populations using both mitochondrial DNA and genomic ddRADseq sequence data. We report a newly discovered population of *E. forbesi* from the upper Collins River, and strong evidence that *E. crossopterum* has displaced *E. forbesi* in at least two streams in the Barren Fork River system. We also present population genetic analyses that indicate gene flow between *E. forbesi* and *E. crossopterum*. Our results suggest that sympatry between the two species is a potential threat to the persistence of *E. forbesi*, where mechanisms such as ecological competition and hybridization may contribute to its displacement.

[1] Yale University, Department of Ecology and Evolutionary Biology, [2] Tennessee Valley Authority, [3] Tennessee Tech University, School of Environmental Studies

Kyler B. Hecke[1] and J. Brian Alford[1]

Ecological niche-modeling of the Sickle Darter (*Percina williamsi*)

The Sickle Darter *Percina williamsi* is a species of fish endemic to the upper Tennessee River basin in eastern Tennessee and southwestern Virginia. Because of its narrow range and presumed decline in occupied sites over the last half century, it has been listed as threatened by the states of Tennessee and Virginia and is being petitioned for federal listing under the Endanger Species Act. The species' current distribution has not been assessed throughout its historic range. Microhabitat utilization, historic occurrence, and diet are known, but a new study was warranted to determine its current distribution, occupancy status, and ecological niche. During 2016, electrofishing with seining and snorkel sampling occurred for the Sickle Darter at historically occupied sites and previously un-sampled sites within its range. A total of 144 Sickle Darters were observed at 17 different sites. Niche-modeling was used to estimate the probability of stream segment occupation by the Sickle Darter across its range in the upper Tennessee River basin. These data will be useful for determining future federal listing status, informing monitoring activities and conservation decisions for this species.

[1] University of Tennessee Institute of Agriculture, Department of Forestry, Wildlife and Fisheries

Topher Hockaday[1] and Aaron Geheber[1]

Quantifying morphology of *Cyprinella lutrensis* x *venusta* hybrids in a Missouri reservoir

Non-native *Cyprinella venusta* (Blacktail shiner) are known to occur in Truman reservoir (West

Missouri), and in 2017 hybridization between *C. venusta* and native *C. lutrensis* (Red shiner) was documented. Our study objective was to quantify hybrid morphology in relation to the two parent species. Geometric morphometric data, based on fourteen homologous landmarks, were collected from both hybrid and parent individuals. Principal Component Analysis was then used to describe and visualize body shape variability among individuals, and ANOVA was employed to test for body shape differences among hybrid and parent species. In addition, meristic relationships among individuals were examined based on four different counts including: lateral line scale number, anal fin ray number, below lateral line scale rows, and circumferential scale rows. Geometric morphometric data showed that hybrid individuals were intermediary between *C. lutrensis* and *C. venusta* in morphospace, and this was mainly driven by an intermediate body depth in hybrids. Meristic comparisons showed a greater similarity between hybrid and *C. venusta* individuals. These results compliment findings of previous genetic research conducted on *C. lutrensis* and *C. venusta* hybrids which lacked full morphological comparisons. The possibility of hybrid persistence and the implications of these hybrid individuals in Truman reservoir will be discussed.

[1] University of Central Missouri

Josh Hubbell[1] and Jake Schaefer[1]

Confluences and land use as agents of change: temporal habitat variability modifies rates of dispersal

Movement facilitates colonization, gene flow, and a species opportunity for local adaptation. Habitat fragmentation limits species movement by disrupting the connectivity and structure of habitat patches. Confluences are origins of habitat construction, diversifying channel morphology. Consequently, confluences generate abrupt geomorphological transitions in streams. Disturbance influences confluences' role as agents of habitat heterogeneity. In this study, our objective was to examine how habitat variability, as an effect of upstream land use or confluence size, influenced movement using mark-recapture methods. A functional group of stream fishes, water column specialists (e.g., Cyprinidae), was used to assess the influence of these factors on movement rates through time. Specifically, we asked: 1- Does confluence size or land use influence movement across a confluence? 2- Does confluence size or land use influence movement within and among stream reaches? 3- Is the effect of confluence size or land use on movement modified by an interaction with habitat? Selected streams for this study were paired based on their confluence ratios and the dominant land use type occurring within these sites' watersheds. For each land-use pairing, a site with a large confluence ratio was paired with a site with a small confluence ratio. Reach lengths were standardized so that both tributaries and the downstream reach were 100 m. We made three passes within each riffle or pool using a seine and backpack electrofishing unit. Four cyprinid species (*Lythrurus roseipinnis*, *Cyprinella venusta*, *Notropis baileyi*, *Pteronotropis signipinnis*) were marked. Movement within and among reaches was best modeled ($wi = 0.24$) as a function of wetted width (t-value: 3.35, $p = 0.002$). Furthermore, a strong, negative interaction (t-value: -3.93, $p = 0.0003$) between urban land use and wetted width suggests movement rates are higher in urban systems.

[1] The University of Southern Mississippi, Department of Biological Sciences

Kenny D. Jones II[1], Michael W. Sandel[1], and Bernie R. Kujahda[2]

Conservation genomics of the Coal Darter (*Percina brevicauda*)

The Coal Darter (*Percina brevicauda*) is an imperiled freshwater fish that is currently under review for federal protection and is known from only three watersheds of the upper eastern part of the Mobile River Basin in Alabama. In 2015, the Alabama Department of Conservation and

Natural Resources deemed Coal Darters as a species of high conservation concern, but no data has been presented concerning their population genetics until our recent surveys. This study used Single Nucleotide Polymorphisms (SNP's) and mitochondrial DNA (mtDNA) sequence data to assess population genomic structure and diversity within the Coal Darter. Analysis of mtDNA indicates that Coal Darter populations retain ancestral polymorphisms and independent haplotypes, but the Hatchet Creek population exhibits significant divergence from the other two populations. Our SNP analyses reveal that all populations of Coal Darter are geographically and genetically isolated. Furthermore, the Hatchet Creek population of Coal Darter has significantly lower genetic variability than the Cahaba River and Locust Fork populations and is approximate to genetic diversity estimates for the federally threatened Pearl Darter (*Percina aurora*). We provide evidence that each population of Coal Darter should be recognized as separate Management Units, and recommend that the Hatchet Creek watershed be designated as critical habitat to strengthen the population viability of Coal Darters in Hatchet Creek.

[1] The University of West Alabama, Department of Biological and Environmental Sciences; [2] Tennessee Aquarium Conservation Institute

Valerie J. Jones[1] and Hayden T. Mattingly[2]

Summer habitat use patterns of the endangered Bluemask Darter (*Etheostoma akatulo*) at two spatial scales in the Collins River, Tennessee

Knowledge of ecological requirements at different spatial scales during different seasons of the year is widely known to facilitate species conservation and recovery efforts. We studied summer habitat use of the bluemask darter (*Etheostoma akatulo*) at two spatial scales in the Collins River of central Tennessee, which harbors the most abundant known population of this federally protected stream fish. Sampling took place at the 300-cm^2 microhabitat and 160-m^2 plot scales by snorkeling during July, August, and September 2018. Habitat variables were quantified at microhabitats used and available to the darter, and at plots where the darter was detected and not detected by snorkelers. We found that bluemask darters used microhabitats with significantly ($p < 0.05$) lower column velocities, more intermediate pH, smaller substrate mean particle sizes, and lower levels of silt compared to available microhabitats in our study plots. Furthermore, bluemask darters occupied plots with more intermediate substrate roughness and smaller substrate particle sizes compared to unoccupied plots in the river. Our findings complement previous studies of springtime reproductive habitat to provide a more complete ecological knowledge base for this endangered stream fish.

[1] Tennessee Tech University, Department of Biology; [2] Tennessee Tech University, School of Environmental Studies

Daemin Kim[1], Bruce Bauer[2], and Thomas Near[1]

Species delimitation and phylogeography of the Longear Sunfish, *Lepomis megalotis* (Centrarchidae)

Lepomis megalotis, the Longear Sunfish, is a freshwater fish that inhabits various habitats across North America east of the Rocky Mountains. Species delineation within *Lepomis megalotis sensu lato* and its sister species *L. marginatus* has been controversial for almost a century. Phylogenetic analyses derived from nuclear genomic (ddRAD-seq) data reveal that 1) *L. peltastes* makes *L. megalotis* paraphyletic, 2) there are six highly distinct lineages within *L. megalotis s.l.* and 3) these distinct lineages have geographic ranges that are consistent with several species in other groups of fishes (e.g., Cyprinidae and Percidae). Based on the multiple lines of evidence derived from molecular and morphological data, we warrant propose the recognition of species that represent

the distinct lineages identified within *L. megalotis s.l.*.

[1] Yale University, Department of Ecology and Evolutionary Biology; [2] University of Tennessee, Etnier Ichthyological Collection

Sierra Kincaid[1], **Thomas Martin**[1], Michael LaVoie[2], Karen Kandl[1], Rachel Hoch[3], and Luke Etchison[3]

Restoration of Wavy-rayed Lampmussel (*Lampsilis fasciola*), Spike (*Eurynia dilatata*), and Rainbow Mussel (*Villosa iris*) to their native range in the Oconaluftee River basin of Cherokee, North Carolina

The Wavy-rayed Lampmussel (*Lampsilis fasciola*) and Spike (*Eurynia dilatata*) are listed as Species of Special Concern and Rainbow Mussel (*Villosa iris*) are listed as Threatened in North Carolina. Once common, anthropogenic factors such as agricultural pollution, siltation, and impoundments have led to their sharp decline. A previous feasibility study confirmed that *L. fasciola* and *V. iris* could survive and grow in enclosures in the Oconaluftee River within the Qualla Boundary. This study pursued the next step in the efforts to restore natural populations of these organisms by introducing individuals of *L. fasciola, V. iris*, as well as *E. dilatata* back into the Oconaluftee. The individuals of all three species were marked and stocked at four study sites chosen based on adequate substrate types for mussel survival. Sampling took place over the course of one growing season (May to November 2019) to record survival and growth. Additionally, measurements of the remaining silo populations from the previous feasibility study were continued, as well as monitoring of an additional three new silos at each site, to allow comparison of growth in free-living mussels and those in the enclosures. We concluded that the free-living mussels could survive, and that they showed significantly greater growth. There was not a significant difference in growth or survivorship among sites.

[1] Western Carolina University, [2] Eastern Band of Cherokee Indians, [3] North Carolina Wildlife Resources Commission

Aaron Krolow[1] and **Kyle Piller** [1]

Assessing the diversity of fish communities at or around artificial reefs along the Louisiana coast through the use of environmental DNA (eDNA)

Globally, estuarine and marine fisheries have declined over the past century and a variety of approacheshave been employed to improve fisheries including the development of protected areas, catchregulations, stocking, and habitat augmentation. The focus of this study is the reintroduction of habitatalong the Louisiana coast as a result of intense fishing pressure necessitating the growth of fishpopulations via the deployment of artificial reefs. Unfortunately, assessing the success of these reefs hasbeen problematic due to the high turbidity of the region and the difficulty of using traditional samplinggears at reef sites. Therefore, the goal of this study was to utilize environmental DNA (eDNA) techniquesin a metabarcoding approach to monitor fish diversity at nine artificial reefs of varying ages and materialsalong the Louisiana coast. To accomplish this, water samples were taken from nine reefs & control sitesand were filtered, DNA was extracted, and PCR amplified (12S mtDNA) using a previously publishedprotocol. PCR amplicons were Illumina sequenced and the recovered data was submitted to the MiFishpipeline. Recovered sequences were used to calculate species richness, diversity, and evenness indicesto make comparisons between reefs & paired control sites, ages, location, and materials. The resultsindicate significant differences between seasons, reefs versus control sites, reef materials, reef ages, andlocation. This suggests that this technique is a viable method that can be used to monitor ray-finned fishspecies on artificial reefs; while also showing that the application of artificial reefs

requires detailedinformation in order to successfully augment habitat for long term fisheries improvement.

[1] Southeastern Louisiana University, Department of Biological Sciences

John Larrimore[1] and Michael Sandel[1]

Metabarcoding freshwater fish species of the Mobile River Basin

Alabama is home to a high number of freshwater fish species, many of which are endangered. It is vital to gather as much information as possible about these species in order to properly establish methods for conservation and monitor their status. Traditional methods to survey fish species rely on manually collecting individuals from a local environment and using the information that has been obtained to extrapolate the biomass and relative abundance of fishes in that local environment. Instead of spending countless hours and funds to traditionally sample, aquatic ecologists can now utilize a tool called environmental DNA (eDNA) to detect species in their habitats without having to collect physical specimens. Through the use of environmental DNA (eDNA), genetic material can be obtained from sources such as the sediment or water. The sample contains genetic material from various species, which can be identified through the use of a database of sequences to match to the DNA within the sample. By extracting the eDNA, we will be able to efficiently survey locations without interfering with the habitat. In addition to being able to determine the presence or absence of a particular species through the use of eDNA, metabarcoding can be used to determine the presence or absence for multiple species and their relative composition within the area. However, metabarcoding requires the use of a metabarcoding database containing a chosen sequence for each species that would need to be detected. My project will focus on creating a metabarcoding database for the freshwater fish species of the Mobile River Basin. The databases for this project will be made with a focus on the mitochondrial genome, specifically the Cytochrome Oxidase I (COI) and the 12S rRNA regions.

[1] University of West Alabama

Dan MacGuigan[1] and Thomas Near[1]

Phylogeography of the *Etheostoma nigrum* species complex

The prevalence of geographic isolation as a speciation mechanism is exemplified by darters, a clade of ~250 freshwater fishes. Nearly all darter sister species pairs are separated in different river drainages, precluding the possibility of gene flow. One exception is *Etheostoma nigrum* and *E. olmstedi*, a widespread sister species pair with three separate areas of range overlap. These species have a complicated taxonomic history, fluctuating between one and four recognized species and between two and twelve recognized subspecies. To understand the evolutionary history of *E. nigrum* and *E. olmstedi*, we used double digest restriction site associated (ddRAD) sequencing to collect thousands of genomic markers for ~500 individuals from across the ranges of *E. olmstedi* and *E. nigrum*. Our analyses supported the recognition of two contested species, *E. perlongum* and *E. susanae*, while also concluding that *E. olmstedi* consists of two distinct species. We uncovered two previously unrecognized peripheral and ancient evolutionary lineages within *E. nigrum*. Finally, our results revealed a complex history of secondary in New York and Virginia. Our study highlights the utility of genomic data for addressing complex taxonomic situations while simultaneously providing a window into the speciation process.

[1] Yale University, Department of Ecology and Evolutionary Biology

Hayden T. Mattingly[1], Valerie J. Jones[2], and W. Keith Gibbs[2]

Interbasin comparison of stream habitat to inform reintroduction strategies for the endangered Bluemask Darter (*Etheostoma akatulo*)

Reintroduction of a species into formerly occupied habitat within its native range is an important conservation and recovery strategy. Successful reintroduction efforts are facilitated by contemporary knowledge of habitat conditions in both currently and formerly occupied portions of the range. The bluemask darter (*Etheostoma akatulo*) is a federally protected stream fish endemic to the upper Caney Fork River and several of its tributaries. Recent recovery activities have been devoted to reintroducing the darter into the Calfkiller River, a Caney Fork tributary with historical occupancy records from the 1960s. We quantified stream habitat variables in 160-m^2 plots within the Calfkiller River and compared those data to plots in the Collins River, where the most abundant bluemask darter population currently resides. The Calfkiller River plots had significantly ($p < 0.05$) cooler bottom and surface water temperatures, faster mean column velocities, higher dissolved oxygen and conductivity readings, lower levels of silt, narrower channel widths, and lower underwater visibilities compared to plots in the Collins River. Based on these differences, the plots showed moderate separation between rivers along one of two axes in a principal components analysis. Our results can be used in conjunction with other studies to guide bluemask darter management decisions based on best available scientific information.

[1] Tennessee Tech University, School of Environmental Studies and [2] Tennessee Tech University, Department of Biology

Brittany L. McCall[1] and Brook L. Fluker[2]

Applications of hydrologic-climatic, genetically informed species distribution modelling for headwater conservation

Ecological niche modeling, also termed spatial distribution modeling (SDM), has become a useful method for estimating contemporary and future geographic distributional patterns of species. However, the application of SDM for aquatic systems, particularly headwater environments, has been less explored. Anticipated changes in climatic patterns, including changes in temperature, rainfall, and runoff, necessitate further understanding of how species distributional patterns will be affected, and how to incorporate such changes into conservation management planning. The objective of this study is to examine the potential hydrologic-climatic impacts on distributional patterns of southern U.S. regional freshwater fishes, specifically madtom catfishes. Distributional shifts will be assessed under a series of hydrologic-climatic scenarios to better understand and determine hydrologic-climatic and genetic drivers of spatial distribution patterns. Models will be developed for four species of madtoms; Mountain Madtom, Tadpole Madtom, Speckled Madtom, and Brindled Madtom, and will explore the impacts of three emission scenarios for expectations averaged over 2041 – 2070. The preliminary results will demonstrate the model calibration and validation for the Mountain and Tadpole madtoms. Future work includes validated hydrologic-climatic models for the remaining species, as well as a comparison of genetic driven models.

[1] Environmental Sciences Program, Arkansas State University; [2] Department of Biological Sciences, Arkansas State University

Joseph Miller[1], Ginny Adams[1], and Reid Adams[1]

Status, distribution and detectability of the Colorless Shiner (*Notropis perpallidus)* in Arkansas

The Colorless Shiner (*Notropis perpallidus*) is a rare, diminutive minnow found exclusively in the Red and Ouachita river drainages of southeastern Oklahoma and southern Arkansas, and is currently under review by the U.S. Fish and Wildlife Service for listing. The last survey for the Colorless Shiner was completed in 1999-2001 by Robison (2006), and he reported a significant decline in distribution and abundance. Our objective is to provide a comprehensive survey of historical *N. perpallidus* sites in Arkansas and assess the species' current status, distribution, and detectability. Sampling is conducted by exhaustively seining contiguous pool and run habitat at each site (15-30 seine hauls per site). Each seine haul is treated as an individual survey, such that each haul has a unique set of corresponding data (species captured, number of individuals, and 24 habitat covariates), and is considered a spatial replicate. Using seine haul and habitat covariate data from 50 sites (38 historic *N. perpallidus* sites; 12 new sites) we can estimate site occupancy while accounting for imperfect detection. Preliminary results from 6 sites, a total of 140 seine hauls, and capture data for 1,813 individual fish has provided insight into detectability of 32 species; however, *N. perpallidus* has yet to be detected. Research is ongoing, but recent data and preliminary sampling for this project suggests a continuing decline of *N. perpallidus* in Arkansas. Preliminary results for detectability of species of differing relative abundances will be presented.

[1] University of Central Arkansas, Department of Biology

Blake Mitchell[1], Jennifer Main[1], Ginny Adams[1], and Reid Adams[1]

Variation in habitat use and body condition of *Etheostoma caeruleum* and *Etheostoma fragi* in the Strawberry River, Arkansas

The Strawberry River is occupied by 19 fishes listed as Species of Greatest Conservation Need, including the endemic *Etheostoma fragi*. We explored potential differences in habitat use and body morphometrics between E. fragi and the more widespread *E. caeruleum* to better understand interactions between these two species. Totals of 453 *E. fragi* and 571 E. caeruleum were collected during 2017 and 2018 across 30 sites. Compared to historical data (1970-1980s), *E. fragi* was found at three additional sites and in higher abundance overall. Mean relative abundance *E. fragi* to *E. caeruleum* was significantly higher in pools (0.67 +0.08) compared to riffles (0.28 +0.06) and runs (0.20 +0.1) ($P < 0.001$). At 40% of sites where *E. fragi* was detected, they were found at 2X or greater abundance in pools compared to riffles, while *E. caeruleum* showed the opposite pattern. Both species showed similar condition (ANCOVA, $p>0.05$) within a species across habitat types (riffle, run, pool). Based on our data, future monitoring should include pool and run habitat to increase detection probability of *E. fragi*. Our data suggest *E. fragi* is stable or expanding within the system and interactions with *E. caeruleum* are probably influenced by habitat segregation.

[1] University of Central Arkansas, Department of Biology

Daniel Morrill[1], Ginny Adams[1], Reid Adams[1]

Historical fish assemblages of the Current River in the 1940s and the 1990s

Historical survey data are important in order to identify long term trends in fish assemblages. Survey data from the Current River drainage is available through the Missouri Department of Conservation from as early as 1930. We compared 1940s and 1990s data from the

Current River drainage in Missouri to assess temporal trends in fish community assemblage. Survey data are available for eleven sites for both the 1940s and the 1990s. Preliminary analyses show that at these sites in the 1940s, 3,059 fishes were collected representing 49 different species compared to 6,217 fishes collected representing 54 different species in the 1990s. To date we have also collected contemporary survey data at 3 of these sites. At these 3 sites in the 1940s 337 fishes were collected representing 29 different species; in the 1990s 818 fishes were collected representing 37 different species; compared to contemporary data where 1364 fishes were collected representing 39 different species. Between these sites it is clear that sampling was more intense in the 1990s and in 2019 in terms of fishes caught and species represented; however, though sampling in 2019 was more intense than the 1990s, the number of species represented are similar.

[1] University of Central Arkansas, Department of Biology

Rachel Moore[1] and Brandon K. Peoples[1]

Quantifying macroinvertebrate diversity in nests constructed by Bluehead Chubs

Bluehead Chub are a minnow species that construct nests for spawning by carrying stones in their mouths, constructing large gravel mounds. These nests can provide a unique gravel microhabitat in the streambed, which can be vital for macroinvertebrate community diversity. During spawning season, the male chub attends to the nest daily; after spawning season the nests are unattended, which allows macroinvertebrate communities to colonize. Macroinvertebrate sampling was conducted at several streams, from chub nests and paired samples (same microhabitat as the nest). Nests and paired locations were sampled over a period of several weeks to compare diversity and abundance both spatially and temporally. Preliminary results suggest both abundance and diversity of aquatic insects in both samples are very similar.

[1] Clemson University, Department of Forestry and Environmental Conservation

Alexsis M. Mross[1] and Brook L. Fluker[1]

Assessing species boundaries among clades of the Least Darter, *Etheostoma microperca*, using multilocus species delimitation methods and morphological data

The Least Darter occurs in tributaries to the Hudson Bay, Great Lakes, and upper Mississippi River drainages, with additional disjunct southern populations in the Ozarks and the Blue River drainage, Oklahoma. Previous morphological and molecular studies revealed that southern populations of the Least Darter are differentiated from northern populations, yet the taxonomic status of the southern populations remains undetermined. This project examines morphological variation of southern populations in relation to northern populations with the goal of elucidating the taxonomic status of distinct Least Darter populations in Arkansas, Missouri, and Oklahoma. In combination with morphological data, DNA sequence data from multiple single-copy nuclear genes and one mitochondrial gene will be used with species delimitation and species tree methods to evaluate hypotheses of species distinctiveness among populations of the Least Darter. When compared to previously published relationships based on the nuclear S7 locus, our preliminary phylogenetic analyses using multiple nuclear loci are providing higher resolution and support for the distinctiveness of populations in the Illinois River Drainage in Arkansas. Additional samples will be included into this phylogenetic framework, in addition to analysis of morphological characters, to provide a robust taxonomic evaluation of southern Least Darter populations.

[1]Arkansas State University, Department of Biological Sciences

Laurel Nave-Powers[1] and Kyle R. Piller[1]

Testing global niche convergence in Cyprinoidei: a geometric morphometric approach

Niches of animals can be inferred from the shape of their bodies. By quantifying body shape, the niches of individual species can be compared and niche-packing patterns of communities can be examined. Cyprinoidei (Cypriniformes) is a suborder of freshwater fishes that are widely distributed and ecologically variable. By comparing body shape data for communities of cyprinoid fishes across their range, we can investigate patterns of niche use and assess whether the same general patterns of niche packing are recovered throughout their distribution. We hypothesize that the same general niche patterns will be recovered across the globe regardless of species richness (niche conservatism), however, the disparity of niches (spread in morphospace) will vary based on species richness. This hypothesis will be tested by comparing body shapes of representative stream-dwelling cyprinoids across the globe. At present, we have gathered body shape data from cyprinoid fish communities and analyzed the data using standard geometric morphometric data analyses. We have found there to be clear, replicated patterns of body shape and niche position across the globe regardless of the number of co-occurring species and the degree of disparity among and within groups is reduced as species diversity increases.

[1]Southeastern Louisiana University, Department of Biological Sciences

Anna M. Pieri[1], John L. Harris[1], Brook L. Fluker[1], Jennifer L. Bouldin[1], and Jeffery A. Steevens [2]

Evaluation of elevated nitrogen on freshwater mussel (Bivalvia: Unionidae) recruitment and population trends in the Buffalo National River

The Buffalo National River (BNR) is a 246 km (153 mi) free-flowing river, which was established as the first national river in 1972. Flowing through the Boston Mountains, Springfield, and Salem Plateaus, only 11 % of the watershed is owned by the National Park Service. In 2012, the Arkansas Department of Environmental Quality approved the general permit of a 6,500-head swine concentrated animal feeding operation (CAFO) less than 10 km from the confluence of Big Creek and Buffalo River. Currently, several regions of the river are 303d listed as impaired and threatened waters, which has elevated the concern for nutrient contamination such as nitrogen compounds during low flow conditions. Eighteen of the 26 freshwater mussel species currently in the BNR are of conservation concern. Many declining mussel populations are characterized by a loss of recruitment indicated by the absence of juveniles. Although laboratory assays demonstrate that juvenile mussels are sensitive to un-ionized ammonia and nitrates, in situ experiments bridge the gap between statistical biological endpoints measured in the laboratory and real-world effects due to exposure. The goals of this study are: (1) measure the effect of nitrogen on the recruitment of juvenile mussels using a common species (*Lampsilis reeveiana)*; (2) compare the toxicity of field-collected water samples to three standard aquatic bioassay organisms; (3) evaluate population trends of native mussels from Ponca to the confluence of the White River. These findings will support the Buffalo National River's long-term watershed management and the conservation of its resident mussel populations. Thus far, preliminary qualitative surveys have revisited 13 historical sites along a gradient of nutrient impacted areas and identified 16 species along with relics of the threatened Rabbitsfoot. Future quantitative surveys will document changes in mussel assemblages and improve estimates of species abundance and diversity.

[1] Arkansas State University, Department of Biological Sciences; [2] U.S. Geological Survey, Columbia Environmental Research Center

M. Worth Pugh[1,2], Gary Pandolfi[1,3], Thomas Franklin [1,4], Michael M. Gangloff [1]

Influences of in-stream habitat and upstream land-use on site occupancy of an endemic darter species

Freshwater communities are threatened by the conversion of forested landscapes for urban and agricultural purposes. Such changes in watersheds disrupt stream nutrient and geomorphological processes leading to poor water-quality, increased sedimentation and decreased substrate heterogeneity. Concomitantly, stream fauna are negatively impacted by rapid changes in habitat leading to species loss and decreases in ecosystem productivity. Populations of endemic species are often at greater risk of fragmentation and extirpation from stream habitat alteration due to their often constrained distributions. Here we tested the utility of upstream land-use and in-stream habitat to predict site occupancy of the Kanawha Darter (*Etheostoma kanawhae*), a relatively understudied fish species endemic to the New River Drainage in North Carolina and Virginia, USA. Generalized linear models revealed that in-stream habitat composition and upstream forest cover are reliable predictors of *E. kanawhae* site occupancy. Specifically, we found probability of occupancy increased in stream reaches with reduced stream width, velocity and bedrock substrate while also containing more woody debris. We also found that total catchment forest cover shared a positive relationship with occupancy of *E. kanawhae*. Taken together, our data demonstrate that *E. kanawhae* presence is a robust indicator of the stability of stream habitat and that it is less likely to occur in main-stem tributaries. Moreover, as the watersheds of *E. kanawhae* continue to urbanize, wildlife managers and private stakeholders should advocate for the preservation of forest at the catchment scale to ensure the longevity of this charismatic species.

[1]Appalachian State University, Department of Biology; [2] The University of Alabama, Department of Biological Sciences; [3]United States Fish and Wildlife Service; [4] United States Department of Agriculture, Forest Service

Alex Rakestraw[1], Michael Sandel[1], Kenny Jones[1]

Genomic composition of Walleye (*Sander vitreus*) populations within the Mobile River Basin

Sander vitreus, commonly referred to as the walleye, is a North American game fish native to eastern waterways that drain into the Atlantic. This broad range covers the various climate and habitat types stretching north-to-south across the contiguous United States, which has given rise to rich genomic diversity amongst the species. Of this genomic diversity, the Mobile River Basin has previously been found to have one of the most unique genomes, which is also supported by our evidence. Our objective was to investigate the genetic variation amongst the various walleye populations, specifically within the Mobile River Basin, and determine if there were any significant differences in the genetic composition of those populations. We extracted DNA from 188 samples caught in areas extending from Lake Eerie to the Mobile Basin, which were then sequenced using dartR to create a library of nuclear single nucleotide polymorphisms (SNPs). Vetting the library yielded 6,503 high quality SNPs to provide insight pertaining to the genomic composition of the populations. Results indicate populations of genetically distinct southern strains isolated to the Mobile River basin, as well as some loss of southern strain genetic diversity by the stocking of northern strains in southern watersheds.

[1] University of West Alabama, Department of Biological and Environmental Sciences

Calvin Rezac[1], Ginny Adams[1], Reid Adams[1], Matthew H. Connolly[1]

A 40 year outlook on the impacts of land use and fluvial geomorphology on fish assemblages in the Spring River, Arkansas

The Spring River, located in the Ozark Highlands of northern Arkansas, is a spring fed system supported by the 7th largest spring in the United States (Mammoth Spring). The consistent flow makes the Spring River one of the most dependable and important recreational rivers in Arkansas. The river also features a high diversity of aquatic life, including 127 documented fish species making it one of the most diverse in North America. Since the early 20th century clearing of the Ozark forests has stressed the region's water resources. Legacy effects of deforestation combined with increasing residential and agricultural development since the 1970's may be factors leading to channel instability and streambed gravel aggradations. These factors along with a lack of data concerning Species of Greatest Conservation Need and baseline stream habitat parameters, prompted a need for further study within the basin. We collected fish to compare historical fish surveys (1978-1980) to contemporary fish assemblages (2018-2019). We also performed geomorphic stream surveys and analyzed land-use change using ArcGIS. In 2018-2019 we collected 22,298 individuals representing 70 species across 30 sites. Nonmetric multidimensional scaling (NMDS) was used to compare assemblage composition between time periods. Stability and persistence were calculated, and 23 of the 28 site assemblages were considered to be highly persistent (>0.6). Preliminary findings suggest species composition of the historical surveys remain similar to current surveys. Future fish and geomorphic surveys will help to improve understanding of the entire drainage.

[1] The University of Central Arkansas, Department of Biology

Megan Ryba[1] and Kyle R. Piller[1]

Environmental DNA as a tool to survey the fish communities of artificial reefs in Lake Pontchartrain

Environmental DNA (eDNA) is a relatively new approach that is used to monitor imperiled and invasive species, as well as monitor habitats that are difficult to sample by conventional approaches. The presence of eDNA is controlled by abiotic factors including, but not limited to, UV, temperature, and pH. Lake Pontchartrain is a large estuarine system in southeast Louisiana that has been subjected to substantial anthropogenic modifications over the last half century. Shell dredging has eliminated much of the hard substrate, resulting in a paucity of firm substrates for fishes. As a result, artificial reefs have been deployed to augment habitat. Currently there are 15 artificial reefs in Lake Pontchartrain comprised of concrete reef balls and crushed limestone/concrete rubble. Due to the high level of turbidity, monitoring the success of the reefs has been problematic. Therefore, the goal of this study was to utilize eDNA metabarcoding to seasonally examine the fish communities of six artificial reefs and their paired controls. The surveyed reefs consisted of three concrete reef ball reefs and three concrete/limestone rubble reefs that ranged in deployment age from 2001 to 2016. Abiotic data was collected along with every sample and detected seasonal differences in salinity, temperature, and dissolved oxygen. The movement of different species of fish in and out of the lake, some possibly due to these seasonal abiotic changes, was captured during this study. Results also indicate significant differences in fish community profiles among controls and artificial reefs and differences in reef age.

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Erin Schwarzbach[1] and Mollie F. Cashner [1]

The dose makes the poison: behavioral response of the Southern Redbelly Dace (*Chrosomus erythrogaster*) to chondroitin

Social organisms are known to use chemical alarm cues, which warn conspecifics of the presence of predators. A well-known case of this is seen in ostariophysan fishes in the form of "Schreckstoff". Historically, an extract made from skin has been used to test fish for their fright response, however it is difficult to determine concentrations and ensure consistency among trials and across species. Recently, biochemical fractionation has revealed that chondroitin is a major component of zebrafish skin extract, and it has been hypothesized that all ostariophysans will react to chondroitin in a similar fashion to skin extract. The objective of this study was to determine if chondroitin is an effective alarm substance for the Southern Redbelly Dace (*Chrosomus erthrogaster*). To better understand the role of chondroitin for this species, I designed a lab experiment in which fish were exposed to either a skin extract or chondroitin stimulus. A 0.07g chondroitin stimulus was used as it is a standard in previous studies. 0.07g of chondroitin is more than the amount of chondroitin in a skin extract sample for this species. The behavior of the fish were compared before and after they were treated with the randomly assigned stimulus. The fish in tanks treated with skin extract had an increase in speed as expected, however, there was no significant behavioral change seen in fish exposed to chondroitin. These results do not support the hypothesis that chondroitin is an effective alarm substance.

[1] Austin Peay State University

Mariah Slaughter[1] and Philip Lienesch[1]

An investigation on the cover preference of the Mountain Madtom (*Noturus eleutherus*)

Madtom catfish, members of the genus *Noturus*, are common in the waters of the Southeastern US. A previous study observed that madtoms in the Green River, Kentucky, preferred to shelter within old mussel shells compared to the rock cervices. A laboratory study on the Carolina Madtom (*Noturus furiosus*), found that they did not utilize mussel shells and preferred rocks as shelter. We conducted a similar laboratory study to determine which microhabitats the Mountain Madtoms (*Noturus eleutherus*) prefer. Shelter preference was determined by offering the madtoms shelter options (rocks or mussel shells) in 10-gallon aquaria. After the animal had acclimated to the tank for 24 hours the tank was inspected, and the animal's shelter choice recorded. Based on results from preliminary trials the Mountain Madtoms selected to use the mussel shells over the rocks. Freshwater mussels are one of the most endangered taxa and are currently declining throughout their range. If madtoms rely on mussel shells for shelter, the loss of freshwater mussels may cause a decrease in madtom populations within Kentucky waterways, negatively impacting the overall ecosystem.

[1] Western Kentucky University, Department of Biology and Center for Biodiversity Studies

Dakota R. Spruill[1] and **Steven L. Powers**[1]

Microhabitat comparison of *Percina roanoka* (Roanoke Darter) and *P. nevisense* (Chainback Darter) in the Roanoke River

Snorkel observations of *Percina roanoka* and *P. nevisense* in the Roanoke River during summer months were followed by measuring current velocity, water depth, and substrate diameter at points of occupation. A total of 89 observations of *P. roanoka* and 81 observations of *P. nevisense* were

compared using two-sample T-tests. *Percina roanoka* inhabited faster, shallower water than *P. nevisense* with the former found in a mean flow of 0.318 m/s and depth of 31.53 cm and the latter in a mean flow of 0.17 m/s and depth of 55.6 cm. Mean diameter of substrate at points of occupation did not differ significantly between the two species with *P. roanoka* over substrate 10.14 cm diameter, and *P. nevisense* over substrate of 9.7 cm diameter. Differences in habitat among age classes were not detected for either species. These findings suggest habitat partitioning along current velocity and depth help maintain the diverse darter assemblage in the Roanoke River.

[1] Roanoke College

Bruce Stallsmith[1] and Tiffany Bell[1]

Do two sympatric *Ulocentra* darter species differ in any life history parameters?

Monthly collections of *Etheostoma duryi* and *E. simoterum* were made between September, 2014, and August, 2015, at a site on the Flint River in Madison County, Alabama. This site has roughly equal populations of the two species which is atypical. Our primary interest was whether there is any significant difference in the reproductive strategies of the two species in terms of timing and reproductive effort as measured by Gonadosomatic Index (GSI) and oocyte number. Other parameters defining a species' niche were also measured including average standard length (SL) each month of both sexes, female to male ratio, and the lipids fraction of somatic mass. GSI data show that both species have a spawning season from March to May. Monthly GSI averages were virtually identical for females of both species, while *E. simoterum* males had higher values than *E. duryi* males. For almost every month for both sexes *E. duryi* was found to have greater SL than *E. simoterum*, especially during the spawning season. A strong female skew was found for both species, especially in the spawning season. Total fish collected were 158 females and 112 males of *E. duryi*, 445 females and 203 males of *E. simoterum.* Monthly averages of somatic lipids fraction showed wider swings among females of both species from lows during the spawning season to highs in late summer. Sex skew found in both species remains to be adequately explained. Given an assumption of a 50/50 ratio female/male at birth, we suggest male/male competition causes elevated male mortality before and during the spawning season. To our knowledge such differential male mortality has not been reported for any darter species.

[1] University of Alabama in Huntsville

Loren Stearman[1], Joshua Hubbell[1], and Jake Schaefer[1]

Coevolution of geomorphology and fish assemblage structure in Bayou Pierre, Mississippi

Anthropogenic changes to landscapes and river channels alter the rates of sedimentary processes. Emergent broad scale effects of basin evolution on aquatic fauna at large spatial scales are well documented. Elucidating direct linkages from basin-scale processes to local-scale habitat formation and persistence, and subsequent fish assemblage evolution, has proved more complicated. The Bayou Pierre is a system in southwest Mississippi that is currently experiencing evolution in the form of an erosional wave. Early research indicated basin-scale processes related negatively to riffle dwelling fish density. As part of a status update for the endemic Bayou Darter, we repeated historical collections at 43 sites in the Bayou Pierre. We quantified basin-scale processes on a decadal scale using digital elevation maps and aerial imagery. Significant differences existed in local scale geomorphic measurements derived from field-collected habitat data among basin scale process classes (MRPP a = 0.08, P = 0.002). More advanced stages were typified by wider, shallower channels with bedrock and coarser substrate with increased velocity; however, considerable variation and overlap existed among classes. Preliminary analyses indicated

fish assemblage structure related strongly to stream size and poorly to local habitat. Comparing historical to current collections we observed changes in the rank abundances of riffle dwelling fishes, notably Least Madtom, Brighteye Darter, Bayou Darter, and Saddleback Darter. We explore hypotheses explaining linkages across process scales and the predictions these hypotheses have for fish assemblage responses.

[1] The University of Southern Mississippi, Department of Biological Sciences

Jewel Streeter[1] and James H. Roberts[2]

Preliminary assessment of larval fish habitat use in the Ogeechee River

The habitat ecology of larval stream fishes is poorly known relative to adults, yet larval habitats might be particularly vulnerable to anthropogenic influences. We characterized relative abundance of larval fishes in river-margin versus main-channel habitat at a site on the Ogeechee River, a Coastal Plain stream with a diverse fish community. Our primary goals were to discern which groups of fishes use which types of larval habitats and how this use changes over time. We made weekly collections in June and July 2019, using paired light-trap and drift-net sampling gears to sample margin and channel habitats, respectively. We captured and identified a total of 338 individuals (yolksac larvae, larvae, and small juveniles), representing seven families. Overall, the proportional distribution of families differed significantly between the two gears ($P < 0.0001$) and between all pairs of sampling dates (all $P < 0.003$). Cyprinids and centrarchids dominated catch in both gear types, but showed no consistent trends over space or time. In contrast, ictalurids, which were captured only in drift nets, increased in relative abundance over time, while atherinids, which we captured only in light traps, decreased over time. Catch rates of both gear types were influenced by stream discharge, but in opposite directions. Our preliminary results suggest that fish families utilize larval habitats differentially and that larval sampling may be an effective way to document reproductive success and timing.

[1] Ogeechee Technical College, Department of Fish and Wildlife Management; [2] Georgia Southern University, Department of Biological Sciences

Danielle Talbot[1], Ginny Adams[1], and Reid Adams[1]

Status and ecology of two minnows endemic to the Ozarks of Arkansas and Missouri

The purpose of this study was to examine status, habitat use, and natural history of *Erimystax harryi* (Ozark Chub) and *Notropis ozarcanus* (Ozark Shiner). Both species are endemic to the Ozarks of southern Missouri and northern Arkansas and have experienced range declines. Few ecological data are available for these two Species of Greatest Conservation Need. They reportedly tend to be associated with flow near riffles and/or in pools with some current in Ozark upland streams. Specimens for this study were collected during fish assemblage seining surveys from 2016-2019; 381 *Erimystax harryi* (76-riffles, 57-runs, 104-pools, and 144-unknown habitat) and 402 *Notropis ozarcanus* (6-riffles, 150-runs, 227-pools, and 19-unknown habitat) individuals were collected. Our data suggest *N. ozarcanus* used runs and pools to a greater extent compared to riffles. Interestingly, *E. harryi* appeared to use macrohabitats relatively equally. In terms of parasites, specimens of *E. harryi* examined had considerably more black spot parasites while *N. ozarcanus* specimens tended to have more anchor worms. Ecological data collected during this study may help shed light on the decline and conservation of these two Ozark endemics.

[1] The University of Central Arkansas

Clay W. Tamburri[1], Richard C. Harrington[1], and Thomas J. Near[1]

A systematic study of the Fantail Darter, *Etheostoma flabellare*

The Fantail Darter and Carolina Darter, *Etheostoma flabellare* and *E. brevispinum*, are two widespread species of freshwater fishes in eastern North America. *Etheostoma flabellare* is distributed throughout the Mississippi River Basin and some areas of the Atlantic Slope, whereas *E. brevispinum* is restricted to upper portions of the Savannah, Santee, and Yadkin River systems. The taxonomic status of *E. flabellare* across its distribution, including populations in Atlantic draining rivers remains uncertain, due to the large geographic range size and documented patterns of morphological variation. Previous studies using morphology and molecular data both suggest there are multiple species masquerading as *E. flabellare*. The purpose of this study is to investigate the phylogeny of *E. flabellare* and *E. brevispinum* using DNA sequences sampled from the mtDNA *cytb* gene. As in previous studies, fantail darters (*E. flabellare*, *E. brevispinum*, *E. kennicotti*, and the *E. percnurum* complex) are not resolved as a clade and *E. flabellare* is deeply paraphyletic. Populations of *E. flabellare* sampled from the upper Tennessee River and New River systems are paraphyletic relative to a well-supported clade containing all populations of *E. brevispinum* and *E. flabellare* sampled from the Savannah, Santee, Yadkin, and the Tellico River (Little Tennessee system) systems. Most other populations sampled from the Mississippi River system resolve as a well-supported clade. However, populations of *E. flabellare* from the White River system (Missouri and Arkansas) are the sister lineage of populations sampled from the Roanoke River system (Virginia and North Carolina) and this clade is nested in a more inclusive lineage that includes populations sampled from the James, Potomac, and Susquehanna River systems. The taxon sampling presented in the *cytb* gene tree will serve as the basis for future phylogenomic investigations examining the monophyly of fantail darters and provide a tool to delimit species currently recognized as *E. flabellare*.

[1] Department of Ecology & Evolutionary Biology and Peabody Museum of Natural History, Yale University

Matthew R. Thomas[1] and Stephanie L. Brandt[1]

Status survey of the Goldstripe Darter, *Etheostoma parvipinne*, in Kentucky

The Goldstripe Darter is a fish species of greatest conservation need (SGCN) with a limited distribution in western Kentucky. Fish community sampling at 69 sites in Graves and Calloway counties during 2014-2016 detected Goldstripe Darter presence at 5 sites in the lower Tennessee River drainage (Blood River and Cypress Creek systems) and 14 sites in the North Fork Obion River drainage (Terrapin Creek, Powell Creek, and Blackamore Creek systems). We found the species at all but two previously documented locations and 11 new sites. It is most densely distributed and abundant in the Terrapin Creek system, but sparsely distributed elsewhere. Distribution and abundance data were also collected for ten additional fish SGCN in the Blood River, Terrapin Creek, Powell Creek, and Blackamore Creek drainages. The Dollar Sunfish was collected for the first time in the Blood River drainage and new steam occurrences were documented for the Bluntface shiner, Brown Madtom, Central Mudminnow, Cypress Darter, and Gulf Darter. Streams in western Kentucky that support Goldstripe Darter populations contain wooded wetland areas and individuals were captured at locations having canopy cover. Blood River Bottoms (Kentucky Lake) Wildlife Management Area, Blood River Seeps and Terrapin Creek State Nature Preserves contain the largest amounts of contiguous suitable habitat for the species. Our survey results indicate that the Goldstripe Darter steadily persists in western Kentucky, especially in the Terrapin Creek drainage. However, it remains vulnerable to habitat loss and modification from development, as described in other parts of its range. Conservation efforts for the Goldstripe Darter should include protection and maintenance of forested riparian zones adjacent to first-order or headwater streams.

[1] Kentucky Department of Fish and Wildlife Resources

Andrew Turko[1,2], Colby Nolan[1], Graham Scott[2], Sigal Balshine[2], and **Trevor Pitcher**[1]

Thermal tolerance depends on age, condition and season in Redside Dace (*Clinostomus elongatus)*

Urbanization increases water temperatures in streams and rivers, via decreased canopy cover and warming of stormwater runoff, and is hypothesized to be responsible for the declines of many endangered fishes. However, little is known about seasonal variation in thermal tolerance for many species at risk, nor do we understand the physiological factors that promote increased tolerance. Redside dace (*Clinostomus elongatus*) is listed as endangered in Canada but some healthy populations persist in the USA. Using fish from a robust Ohio population, we measured acute thermal tolerance (CTmax) in summer, autumn, and winter. In summer (when stream temperature was ~22°C) CTmax was significantly higher in juveniles than adults, but in winter (when stream temperature was ~2°C) CTmax was higher in adults. Body condition was positively correlated with CTmax at each time point, but CTmax was not related to reproductive investment or energy stores. Temperatures in Canadian redside dace habitat approach summer CTmax values when pavement-warmed stormwater is discharged directly to streams, so restoration strategies that mitigate these temperature spikes should be emphasized. We also suggest that overall body condition of redside dace may provide an indication of the capacity of these fish to tolerate acute thermal stress.

[1] University of Windsor, Great Lakes Institute for Environmental Research; [2]McMaster University

Brian K. Wagner[1], Kathleen Quebedeaux[2], and Christopher A. Taylor[2]

Hubbs' Crayfish (*Cambarus hubbsi*): a confusing Ozark endemic

Cambarus hubbsi (Creaser 1931) was described from Little Creek, a tributary of the St. Francis River. This crayfish is endemic to the Ozarks, where it is found across southeastern Missouri and northeastern Arkansas in the White, Black, and St. Francis river basins. It is fairly common in Ozark streams of the St. Francis River basin (22 documented collections totaling 162 individuals) and the Black River basin (90 documented collections totaling 901 individuals). In the remainder of the White River basin further west, it is much less common (23 documented collections totaling 67 individuals). Coloration and habitat use differences between the two areas also are curious, and warrant future attention. We will be collecting specimens from across their range to examine morphometric characters, coloration of live specimens, and molecular analyses of mitochondrial DNA from the 16S and COI gene regions. Analyses of combined DNA and morphological characters will be conducted to determine levels and patterns of variation within and across populations and for phylogeny reconstruction.

[1]Arkansas Game & Fish Commission, [2]University of Illinois

Matthew D. Wagner[1]

Status Update on Frecklebelly Madtom in the Mobile Basin in Mississippi

The Frecklebelly Madtom, *Noturus munitus* (Suttkus and Taylor 1965), is found in the Pearl and Mobile River drainages and is currently petitioned for federal listing with a listing decision deadline of 2020. Recent surveys targeting *N. munitus* in the Pearl River drainage in Mississippi and Louisiana showed the species status is stable; however, no recent surveys have targeted the species in the Tombigbee River system in Mississippi. In order to provide the Fish and Wildlife Service with up to date data for the species status assessment we surveyed 46 localities throughout the East Fork Tombigbee River, Buttahatchie River, Luxapallila Creek, and Bull Mountain Creek.

We completed our surveys by backpack electrofishing into a 10' seine with chain for a minimum of 60 minutes per locality. Survey results indicated the species status is stable in the tributaries to the Tombigbee River, except for Bull Mountain Creek upstream of the reservoir. Additionally, the lack of available habitat in the historic mainstem Tombigbee River due to the construction of the Tennessee-Tombigbee Waterway has greatly reduced the range of *N. munitus* in the system and potentially fragmented the remaining populations from each other.

[1] Mississippi Museum of Natural Science

Mel Warren[1], Brooks Burr[2], Tony Echelle[3], **Bernie Kuhajda**[4], and Steve Ross[5]

Coming Soon: Volume 2 of *Freshwater Fishes of North America*

North America has the greatest diversity of temperate freshwater fishes in the World, with over 1,200 native species. While this has been the most thoroughly studies group of fishes on Earth in last half of the twentieth century, major scientific advances have been made in this century across systematics, genetics, physiology, behavior, ecology, and conservation. Increased knowledge has been accompanied by increased specialization, resulting in the science on the North American fish fauna being scattered across the literature. This three-volume series of Freshwater Fishes of North America (published by Johns Hopkins University Press) is the first ever fully-illustrated work synthesizing the diversity, natural history, ecology, and biology of 52 families of North American freshwater fishes (including several marine families with species occurring in fresh water). The coverage includes all of Canada, the continental United States, and Mexico (south to about the Isthmus of Tehuantepec). Chapter authors are synthesizing existing information on freshwater fishes in North America on standard topics for each family. Freshwater Fishes of North America also covers non-taxonomic topics including evolution and ecology of fish assemblages, mating behavior, foreign fishes, fishes as models for scientific studies, and conservation overviews. Volume 2 is scheduled for publication in the spring of 2020 and will cover 21 families (Characidae to Poeciliidae), with contributions from 38 different authors. The volume includes families of major interest to those concerned about Southeastern fishes, including Ictaluridae, Amblyopsidae, Aphredoderidae, Atherinopsidae, and Fundulidae.

[1] USDA Forest Service, Stream Ecology Lab; [2] Southern Illinois Universiy at Carbondale, Department of Zoology; [3] Oklahoma State University, Department of Integrative Biology; [4] Tennessee Aquarium Conservation Institute; [5] University of New Mexico, Museum of Southwestern Biology

River A. Watson[1], Brook L. Fluker[1], and Bernard R. Kuhajda[2]

Taxonomic evaluation of the Goldstripe Darter, *Etheostoma parvipinne*, using species delimitation methods with molecular and morphological data

The Goldstripe Darter, *Etheostoma parvipinne*, inhabits shallow spring-fed streams in the Gulf Coastal Plain from the Colorado River drainage in Texas to the Altamaha River drainage in Georgia. A previous morphological study identified slight differences in far western populations of *E. parvipinne*, but few differences were found among populations separated by major river drainages, a pattern often seen in darter species. The objective of this study was to evaluate molecular variation and phylogeographic patterns in *E. parvipinne* across its range using a combination of mitochondrial (mt) and nuclear (n) DNA sequence data. Results from phylogeographic analysis of one mtDNA and one nDNA marker for all sampled individuals revealed a deep phylogenetic rift for *E. parvipinne* populations east and west of the Mississippi River, with support for two distinct clades. Preliminary phylogenetic analysis of four nuclear loci provide further support for the distinctiveness of eastern and western populations of *E. parvipinne*.

DNA sequence data from four nuclear loci for all sampled individuals, in addition to meristic and morphometric analyses, will be used with species delimitation methods to further elucidate the taxonomic distinctiveness of eastern and western clades.

[1] Department of Biological Sciences, Arkansas State University; [2] Tennessee Aquarium Conservation Institute

Jacob Westhoff [1], Douglas Novinger[1], Jamey Decoske[1]

Lessons from monitoring Missouri's rare fishes using occupancy estimation

Monitoring sensitive populations of rare fish is an essential but often de-emphasized aspect of management. These populations of fish are often difficult to monitor due to inherent rarity resulting in a high degree of annual variation. Monitoring approaches based on abundance metrics can be uninformative because of this variation. Occupancy estimation provides a relatively stable metric to model and can provide valuable information on trends in distribution. We outline an overarching occupancy-based monitoring approach for three federally listed fishes in Missouri (Niangua Darter *Etheostoma nianguae*, Neosho Madtom *Noturus placidus*, and Topeka Shiner *Notropis topeka*) and discuss results from the nearly 10 years of data collected to date. We cover advantages and disadvantages of the occupancy estimation approach, some of the challenges associated with covariates in modeling, and briefly discuss actual results for each species.

[1] Missouri Department of Conservation

Courtney A. Weyand[1] and Jonathan W. Armbruster[1]

Daced and confused: a phylogenetic assessment of the genus, *Rhinichthys*

Commonly known as riffle daces, *Rhinichthys* is a genus of freshwater fishes with the broadest ranges of any North American fish group. Given this broad distribution, the taxonomic history of this group is complex with numerous species names in synonymy. To better elucidate evolutionary relationships within the genus, a comprehensive phylogeographic analysis is essential in order to examine the genetic variation throughout its range and better understand the distinctiveness of the populations (i.e. subspecies) and define their current taxonomic boundaries to better assess conservation concerns. Currently, nine species are recognized with eight extant and several species recognized as species complexes. Six species (one extinct) have a limited distribution west of the Continental Divide. Two species are found east of the Continental Divide in the Atlantic, Great Lakes, Hudson Bay, Mississippi River, and upper Mobile Bay drainages. One species, *R. cataractae*, has a wide range from the Atlantic to Pacific coasts in the northern US and Canada (including Mackenzie, Churchhill, and Koksoak-Canapiscau river drainages and Hudson Bay tributaries) and down the Rocky Mountains to Mexico and the Appalachians to Georgia. Given the complexities within the group, to better understand their current taxonomic status, we accessed phylogenetic relationships in a Bayesian framework using previously accession sequences of the mtDNA (cytb) and nDNA (S7) genes obtained from GenBank as a first pass at the relationships within the genus prior to embarking on a phylogenomic analysis.

[1] Auburn University, Department of Biological Sciences

Mack White[1] and Kit Wheeler[1]

Abundance estimates of spawning catostomids in a small, oligotrophic stream using aerial imagery

Abundance estimates of species providing ecologically-important services are imperative to advance understanding of the extent to which they are contributing to their respective ecosystems. We used aerial imagery, a cost-efficient, non-invasive approach, to obtain abundance estimates of large-bodied catostomids in Citico Creek, a tributary to the Little Tennessee River in Monroe County, Tennessee. Using an unmanned aerial vehicle (UAV), we obtained a series of images at predetermined intervals across an 80m reach containing spawning fishes. We then used DroneDeploy, software used for managing and interpreting UAV data, to create a singular map of the reach by stitching together multiple UAV images. We counted all detected individuals (n_d = 4,829) within the reach using ArcMap and then used quadrat sampling to estimate the total number of individuals (n_q= 5,167 ± 528 ind) within the reach from randomized quadrats (1m^2). Despite the sheer density of individuals (d = 3.02 ind/m^2) within available stream habitat, quadrat sampling (n_q) 95% confidence intervals encompassed total counts of detected individuals (n_d). Although financial and logistical constraints may exist, the use of aerial imagery to estimate abundance of aquatic organisms may be a viable option.

[1] Tennessee Technological University, Department of Biology

Ashantye S. Williams[1] and Nathan V. Whelan[1]

Assessment of hatchery contribution and genetic diversity of American Shad (*Alosa sapidissima*) in the Edisto River, SC

In an effort to rebuild American shad populations in the Edisto River, Bears Bluff National Fish Hatchery began a propagation program for population augmentation. A critical component of a successful propagation program is that wild and hatchery produced organisms maintain similar genetic profiles. In keeping with the guidelines of responsible hatchery enhancement programs, we used 10 microsatellite loci to evaluate genetic diversity of American Shad in the Edisto River, compare genetic metrics between brood fish and out-migrating juveniles, and perform parentage analysis to evaluate the contribution of hatchery-produced fish to the natural population. The genetic diversity of Edisto River American Shad was relatively high, as measured by degree of polymorphism (N_a = 10-27 alleles/locus and A_r = 10-27.90) and heterozygosity (H_{Obs} = 0.74-0.92). Using microsatellite loci as molecular tags to match brood fish with their offspring, we determined that current hatchery contribution of American Shad in the Edisto River is approximately 10%. Overall, these results indicate that American Shad in the Edisto River are genetically diverse, agreeing with prior studies on American Shad in the Edisto River. Our detection of hatchery-produced fish during fall out-migration provides continued optimism for stocking as a viable management option for American Shad in the Edisto River.

[1] US Fish and Wildlife Service, Southeast Conservation Genetics Lab

Brian J. Zimmerman[1] S. Mažeika P. Sullivan[1] John Navarro[2] Jeromy Applegate [3]

Conservation and restoration of Ohio wetland and glacial-lake fishes

Fishes associated with wetland and glacial lake habitats are highly imperiled in Ohio. Here, we present the initial stages of a plan to restore these fishes through a combination of captive propagation, research, and reintroduction activities. In four years of propagation efforts (2016-2019), we successfully propagated 1,735 Blacknose Shiners *Notropis heterolepis*, 143 Blackchin Shiners *Notropis heterodon*, 1017 Lake Chubsuckers *Erimyzon sucetta*, 210 Least Darters *Etheostoma microperca*, 1286 Iowa Darters *Etheostoma exile*, and 547 Western Banded *Killifish Fundulus diaphanous menona* at rearing facilities of the Schiermeier Olentangy River Wetland Research Park at The Ohio State University. Subsequently, propagated fish were released into protected constructed wetlands (2016-2018) and two natural beaver ponds (2019). We

have observed natural reproduction in several of the constructed wetlands. These propagation and reintroduction efforts are complemented by research that will help identify the environmental conditions that affect success of reintroductions and the establishment of stable populations, as well as evaluate the influences of native wetland fish reintroductions to resident aquatic communities and food webs.

[1] The Ohio State University, School of Environment and Natural Resources (SENR); [2] Ohio Division of Wildlife; [3] U.S. Fish and Wildlife Service