2016 Meeting

March 15 – 16

Montgomery Bell State Park

Burns, TN

2016 TNAFS Meeting Schedule

March 15

1:00 – 2:45 Session 1

2:45 – 3:00 Break

3:00 – 3:30 Poster Session

3:30 – 4:00 Session 2

4:45 – Business Meeting

7:00 Banquet, Silent Auction, Awards

March 16

9:30 – 10:30 Session 3

10:30 – 10:45 Break

10:45 – 11:30 Session 4

2016 TNAFS Session Schedule – March 15		
1:00		Welcome & General Information – Kathlina Alford
1:15	1	*A Landscape Divided: Assessing Fish-Habitat Relationships in West Tennessee Streams – Juju Wellemeyer
1:30	2	*Does newly introduced riparian row cropping impact aquatic ecosystems in the Nolichucky River watershed? – Hayley Gotwald
1:45	3	*Diet of and Prey Availability for Reintroduced Juvenile Lake Sturgeon (*Acipenser fulvescens*) in the Upper Tennessee River Basin – Todd Amacker
2:00	4	*Production and Performance of Propagated Southern Appalachian Brook Trout – Thomas Johnson
2:15	5	*Bigheaded Carp in the lower reaches of the Tennessee River and Cumberland River – Josey Ridgeway
2:30	6	*Assessment of Blue Catfish and Channel Catfish populations and standard sampling methods in Tennessee River reservoirs – Cole Harty
2:45		Break
Poster Session 3:00 - 3:30		Trophic Ecology of Banded Sculpin (*Cottus carolinae*) Across a Stream Size Gradient in Tennessee – Will Curtis
		Testing Predator Control of Banded Sculpin (*Cottus carolinae*) Distribution in The Blackburn Fork Watershed, Tennessee – Kelsey Stephenson
		Forty Years of Fish Community Change in the Blackburn Fork Watershed, Tennessee – Zachariah Tankersly
3:30	7	*Restoration suitability index for Southern Appalachian Brook Trout (*Salvelinus fontinalis*) in the Cherokee National Forest – Caylor Romines
3:45	8	*Loiterers, Leavers, and Leptokurtosis: Measuring and Predicting Short-Term Movement of Banded Sculpin (*Cottus carolinae*) – Amy Gebhard
4:00		Closing Remarks
4:45		Business Meeting
7:00		Banquet, Silent Auction and Awards

2016 TNAFS Session Schedule – March 16		
9:30		Good Morning Welcome and Announcements – Kathlina Alford
9:45	11	Status of the endangered tuxedo darter, *Etheostoma lemniscatum*, within reaches of the Big South Fork Cumberland River affected by return to normal operations of Wolf Creek Dam following an extended drawdown period, with discussion of the current status of fish, mussel, and crayfish fauna – Jeffery Simmons
10:00		
10:15	12	High Definition Stream and Fish Surveys: Integrating Fish Habitat, Channel Geomorphology, Water Quality, Water Quantity, and Infrastructure Surveys – James Parham
10:30		Break
10:45	13	A GIS Tool for Prioritizing Dams for Removal within the Tennessee and Cumberland River – Emily Granstaff
11:00	14	Management of muskellunge (*Esox masquinongy*) in Cumberland Plateau streams – William Collier
11:15	15	Intersex Condition of Fishes Inhabiting the Upper Tennessee River System – Brian Alford
11:30		Closing Remarks

Oral Presentations

J. Brian Alford, jalfor12@utk.edu, 865-974-8752

Intersex Condition of Fishes Inhabiting the Upper Tennessee River System

Alford, J.B. [1], C. Warren [2], P. Hurst [1], J. Fisher [2], and D. Miller [1,2]

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We investigated the prevalence and severity of intersex condition in male Largemouth Bass (*Micropterus salmoides*), Smallmouth Bass (*M. dolomieu*), Greenside Darter (*Etheostoma blennioides*), and Banded Darter (*E. zonale*) in tributaries of the Upper Tennessee River. During March 2015, we found 6% occurrence of intersex (oocytes present in testes) in male Largemouth Bass (N = 28, Tennessee and Nolichucky rivers) and Smallmouth Bass (N=2, Nolichucky River) combined at 2 of 5 sites sampled. In May-June 2015, we found no evidence of intersex in male darters sampled in shallow riffles of the Nolichucky River at sites heavily-impacted (HI) and least-impacted (LI) by agriculture and urban land use and point-sources of pollution. Occurrence of intersex in male Smallmouth Bass (N=75) was high in the Little Pigeon, Pigeon, and Nolichucky Rivers. Fish collected from LI sites had similar prevalence (88%) as those from HI sites (85%). However, severity of intersex was mild (mean severity score = 2, ranges 0-4) and did not differ between site classifications. Mean hepatosomatic index (HSI) for males and females was low and did not differ between site classifications (HI = 0.83, LI = 0.80). We attempted to discern a baseline level of intersex in fishes by sampling in sites thought to be little impacted by endocrine-disrupting compounds (EDC) from agriculture and point-source effluents from wastewater treatment plants. However, it may be that freshwater sites cannot avoid pollution from EDC (e.g., via atmospheric deposition or low-level, chronic runoff), that the baseline level of intersex in Smallmouth Bass is just high, or that other confounding factors need to be discovered. We found parasites in intersex Smallmouth Bass testes in both LI and HI sites in 2015. We will be investigating a new hypothesis during summer 2016, that parasite-induced intersex is occurring, even in low impact areas.

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Diet of and Prey Availability for Reintroduced Juvenile Lake Sturgeon (*Acipenser fulvescens*) in the Upper Tennessee River Basin

Amacker, T.A.[1] and J.B. Alford[1]

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After fifteen years of reintroducing juvenile Lake Sturgeon (*Acipenser fulvescens*) in the Upper Tennessee River Basin, fisheries biologists are researching basic ecological traits of subsistent organisms. We set out to seasonally assess whether Lake Sturgeon forage opportunistically or selectively in Ft. Loudoun Reservoir. After anesthetizing individual juvenile Lake Sturgeon caught on trot lines in a 13 km reach of the reservoir, we used colonic flush and gastric lavage techniques to describe diets quantitatively. We also used two methods to assess available prey items in the study area by 1) taking systematic benthic grabs along several transects across the width of the reservoir and 2) opportunistically deploying rock cages filled with various types of hard substrate to assess potential prey that colonize hard surfaces. After identifying macroinvertebrates to their lowest taxonomic level, the foraging modes of Lake Sturgeon were determined by comparing the relative abundances of invertebrate taxa in the gut contents of each sturgeon specimen to the relative abundances of the same invertebrate taxa collected from the resource base. Indices that quantify resource overlap or segregation were used to determine how selective Lake Sturgeon in Ft. Loudoun Reservoir were with respect to diet.

William R. Collier, Will.Collier@tn.gov, 931-242-4256

Management of muskellunge (*Esox masquinongy*) in Cumberland Plateau streams

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Muskellunge *Esox masquinongy* are native to Tennessee and historically occupied the upper Cumberland River and upper Tennessee River systems. The creation of reservoirs and declining water quality due to poor land use practices limited their abundance and distribution; by the early 1950s their distribution on the Cumberland Plateau was limited to only 11 streams. During that time the Tennessee Wildlife Resources Agency (TWRA) established a captive brood stock of the southern subspecies (*E. m. ohioensis*) and began a stock enhancement program. Conservation measures via harvest restrictions began in 1949 with daily limits, minimum length limits, closed seasons, and closed counties. Despite these conservation efforts, native populations declined to the point where the species was state-listed as "Endangered" in 1975. In 2013, TWRA ended the stocking program in the Collins River, a Cumberland River tributary, due to evidence of natural reproduction and the following year raised the minimum length limit from 914 mm to 1270 mm to promote a self-sustaining population. TWRA began tagging Collins River muskellunge with passive integrated transponders (PIT tags) during annual electrofishing surveys in 2011. As of 2015, 144 muskellunge have been captured, of which 112 were PIT tagged. Mean catch per unit effort (CPUE) was 3.1 fish per hour (SE = 0.9). Median year-to-year movement of tagged individuals was low (320 m), and mean growth of fish over 875 mm was 21 mm per year (SE = 3). Because sampling muskellunge using standardized boat electrofishing has proved challenging, a visual survey using "stand on top" kayaks was employed in 2015 to provide a more precise measurement of relative abundance, and preliminary results are encouraging.

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Loiterers, Leavers, and Leptokurtosis: Measuring and Predicting Short-Term Movement of Banded Sculpin (*Cottus carolinae*)

Gebhard, A.E[1]., W.G. Wells[2], T.C. Johnson[1], R.T.R. Paine[2], L.A. Hix[1], H.N. Ferrell[1], A.N. Engle[1], and J.S. Perkin[1]

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Movement of fishes through space and time is critical for population regulation and community structuring, but the dispersal of many benthic stream fishes remains largely unstudied. We used passive integrated transponders to track the short-term dispersal of 51 Banded Sculpin (*Cottus carolinae*) throughout a 600 m reach in Little Creek, Tennessee during April and May of 2015. Our short-term study was conducted to assess the efficacy of recently developed dispersal models, evaluate temporal variability in movement, and determine if individuals switched between stationary and mobile movement behaviors. Observed movement distances did not differ from modeled leptokurtic dispersal kernels, estimated using *fishmove* package in R Statistical Environment, for 12 of 13 recapture occasions. Leptokurtic dispersal kernel parameters included the mobile component (σ_{mob}) and shared stationary component (p) which were temporally dynamic and differed from static median values reported for congeneric fishes, while the more abundant stationary component (σ_{stat}) showed agreement with the congeneric median. The one recapture occasion during which model predictions were not validated was associated with a large flow pulse that stimulated increased movement at the population scale. At the individual scale, 28 of 51 fish switched between stationary and mobile dispersal behavior and the frequency distribution of switches was leptokurtic. Collectively, our findings reveal an emergent property characterized by consistent upstream movement of sculpin despite fluctuations in population-scale responses to flow and individual-scale switches in movement behavior. This apparent paradox represents the march of the sculpin in which a diffusive, upstream spread of fish is constant despite multi-scale variability in movement behaviors.

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Does newly introduced riparian row cropping impact aquatic ecosystems in the Nolichucky River watershed?

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There has been increasing concern about the impacts of polluted runoff from row crops in the Nolichucky River watershed and other Southern Appalachian rivers on aquatic communities. High amounts of pesticides and fertilizers are used during the growing season to increase yields. Runoff and throughflow transfer the toxins from these chemicals to the nearest waterbody and negatively impact its aquatic community. The objective is to connect the impact of row crop agriculture on aquatic ecosystems in the Nolichucky watershed. We assumed that the row crop fields can be used as a proxy for the amount of applied fertilizers and pesticides. We further hypothesized that the trend in the area of row crops within a riparian area will negatively correlate with biodiversity in aquatic communities. Land cover from publicly available aerial photos was digitized using ArcMap v. 10.3. Measurements for riparian buffer width and aerial extent of four land use types were produced: row crop, pasture, forest, and impervious surfaces. The identified land cover types were related to aquatic macroinvertebrate and fish assemblage population metrics. This study will aide stakeholders in implementing best management practices as well as providing new methods to evaluate the health of the Nolichucky River and other Southern Appalachian rivers with similar environmental conditions.

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A GIS Tool for Prioritizing Dams for Removal within the Tennessee and Cumberland River

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Dam removal as a means of improving aquatic habitat conditions and expanding habitat availability to species is becoming more widespread in the Southeast. Selecting high priority dam removal projects is a complex process that often involves many ecologically significant components. The Tennessee-Cumberland Barrier Prioritization Tool provides fisheries managers a valuable analytical means of selecting dam removal projects that provide the most ecological benefit in the Tennessee and Cumberland River basins. The framework uses an objectives hierarchy with five criteria and thirty-eight indicators that can be used to rank dams for removal. Weights can be assigned to criteria and indicators using the Multi-Attribute Utility Theory or the Analytic Hierarchy Process. A spatial database of dams and natural barriers was compiled, and existing spatial data was used to assess the ecological conditions of each dam. The results of a Principle Components Analysis are presented to support the selection of indicators for each prioritization scenario. The tool has proven its ability to successfully select priority projects through the large number of top 20 dams in the Tennessee Dam Removal Prioritization Scenario that align with the priorities of project managers in the region. The compilation of data and the flexibility of the decision support tool allows managers to efficiently and strategically find new dam removal projects for the limited restoration dollars available.

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Assessment of Blue Catfish and Channel Catfish populations and standard sampling methods in Tennessee River reservoirs

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Catfish are important components of sport and commercial fisheries in several Tennessee reservoirs. In 2014, catfish were the third most pursued recreational species in the state behind black bass and crappie. Sport fishing effort directed at catfish accounted for approximately 16% of all fishing pressure in Chickamauga Lake in 2014, when more than 40,000 Blue Catfish *Ictalurus furcatus* and Channel Catfish *I. punctatus* were harvested. Catfish in Tennessee have received scant attention because catfish were not classified as a sport fish until 2007. The lack of knowledge regarding catfish populations in Tennessee reservoirs and how to effectively sample them presents many research opportunities. A primary focus of this research is to develop unbiased and standardized catfish sampling protocols using tandem hoop nets, low-frequency electrofishing, trotlines, or a combination of these three approaches. In a pilot study during the summer of 2014, tandem hoop nets were deployed in Kentucky Lake (24 series), Chickamauga Lake (16 series), and Fort Loudoun Lake (16 series) and over 450 Channel Catfish were collected. Sampling effort was nearly tripled (160 series) in 2015 and more than 3,600 Channel Catfish were collected across several seasons. Additionally, length, weight, and age data has been collected from over 400 Blue Catfish. Population characteristics are being compared within and among study reservoirs. Future goals are to model the response of catfish populations to different management scenarios and to assess the potential for growth and recruitment overfishing in Tennessee reservoirs.

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Production and Performance of Propagated Southern Appalachian Brook Trout

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Substantial declines (~75%) in distribution of native southern Appalachian Brook Trout *Salvelinus fontinalis* populations have led to several restoration projects in Tennessee since the 1980s. The restoration paradigm of translocation has been questioned recently due to non-random mating among groups of translocated individuals. Propagation was evaluated as an alternative restoration method in this study. Objectives were to: 1) summarize propagation techniques used at three hatcheries, 2) compare fingerling production among hatcheries, and 3) determine survival and growth of stocked fingerlings. Wild broodstock from two source populations were spawned in October 2013 and 2014. Eyed eggs were divided into three equal groups and reared through the fingerling stage at three distinct facilities, each with a unique thermal regime and water source type. Prior to stocking, fingerlings were marked using visible implant elastomer and microtags. Post-stocking performance of hatchery-reared fingerlings was assessed through subsequent sampling of stocked streams. Total egg production exceeded 22,000, and overall survival to the eyed stage was greater than 60% each year. Survival to fingerling stage was lowest at the spring water hatchery (2.9%; Erwin Trout Hatchery) and highest at the municipal water hatchery (43.3%; Tennessee Aquarium Conservation Institute), although survival was similar at the surface water hatchery (40.3%; Tellico Trout Hatchery). Limited fingerling production at the Erwin facility excluded this group from experimental stockings. In 2014 and 2015, 400 marked fingerlings (200 Aquarium and 200 Tellico) were stocked throughout a 400 m reach within each of the two source streams. Post-stocking surveys found persistence of hatchery-reared fingerlings beyond 500 days. Annual survival was estimated using cohort catch curves and was greater than 30% in both streams. Additionally, growth was comparable to published length-at-age data for wild southern Appalachian Brook Trout. These findings indicate that propagation is a viable restoration technique.

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High Definition Stream and Fish Surveys: Integrating Fish Habitat, Channel Geomorphology, Water Quality, Water Quantity, and Infrastructure Surveys.

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Traditionally, stream fish habitat, channel geomorphology, water quality, water quantity, infrastructure survey methods use different survey methods and are based on detailed descriptions of short (several 100m) stream segments which are intended to characterize the stream as a whole. As a result, we end up with multiple survey methods collecting inconsistent information spread haphazardly throughout a stream system. Integrating the results of the different survey approaches is difficult and defining problems and solutions are imprecise at best. High Definition Stream Survey (HDSS) is a stream survey system that integrates GPS, video, depth, and other sensors to allow many miles of stream to be surveyed in a single day with data collected approximately every meter. By using this multi-attribute data collection technique, we move from broad extrapolations about the condition of the study area based on short survey sites to continuous high-resolution maps of the stream and stream channel. High Definition Fish Survey (HDFS) provides a method to rapidly survey fish and fish habitat use over long distances in clear water streams and rivers. The HDFS uses geo-referenced, high-definition underwater video to replace snorkelers doing visual surveys. The big advantages of the HDSS and HDFS approaches over traditional surveys include faster data collection, reviewable survey footage, less disturbance to the fish, a wider range of sampling conditions, lower cost, and broad applicability to a wide range of stream management issues. An overview of the process of field data collection, data management, classification, mapping, and analysis will be shown from a number of recent studies. These projects address issues associated with instream flow documentation, understanding mitigation needs, and assessing habitat distribution for fish species. These case studies show the range of data collected and its utility in GIS mapping, fish habitat identification, and overall stream health applications.

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Bigheaded Carp in the lower reaches of the Tennessee River and Cumberland River

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The invasive Bighead Carp *Hypophthalmichthys nobilis* and Silver Carp *H. molitrix* (collectively referred to as Bigheaded Carp) were introduced to the U.S. in the 1970s to control algae blooms and improve water quality in aquaculture ponds and wastewater systems with little regard for potential impacts on native fishes. Both species escaped and their range in the Mississippi River system continues to expand. These two invasive species have the ability to disrupt aquatic food webs and fisheries when they become established and there is much concern regarding the biotic integrity of Tennessee waters as Bigheaded Carp numbers grow. In the lower reaches of the Tennessee River and Cumberland River systems, Bigheaded Carp were systematically sampled seasonally in 2015 and the winter of 2016 using multiple gears. Nearly 11,000 m of experimental gill nets fished overnight captured 289 adult Silver Carp and 5 Bighead Carp. Hoop nets (n = 96) with 3-day soak times captured only 2 Silver Carp and 2 Bighead Carp. Twenty-six hours of boat mounted electrofishing collected 121 adult and 200 young-of-year (YOY) Silver Carp. Cast nets (n = 600 throws) captured 15 YOY Silver Carp. Adult Silver Carp in Lake Barkley and Kentucky Lake are similarly robust, and more robust than Silver Carp below Barkley Dam, suggesting that food resources and habitat are ideal in those reservoirs. Some YOY Silver Carp were collected 180 and 110 river kilometers upstream of Kentucky Lake and Lake Barkley, respectively, and are presumed to be the first evidence of natural reproduction in these reservoirs or their tributaries. Continued research will describe age and growth, recruitment mechanisms, and the leading edge of Bigheaded Carp in the Tennessee and Cumberland rivers.

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Restoration suitability index for Southern Appalachian Brook Trout (*Salvelinus fontinalis*) in the Cherokee National Forest

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Over the course of the last century, Brook Trout (*Salvelinus fontinalis*) have been reduced in high elevation streams throughout the Southern Appalachian Mountains. These fish are being affected by many anthropogenic factors, including warming temperature in the downstream portion of watersheds and acid deposition in the headwaters of the streams. These impacts will restrict the distribution of Brook Trout across the longitudinal gradient of the stream. Overall, the Southern Appalachians contain some 18,000 km of coldwater streams with the potential for supporting salmonid populations. Wild trout inhabit about 9,660 km of these streams and native Brook Trout are found in approximately 2,580 km. In order to develop a restoration suitability index, thirty trout streams were randomly selected across the north zone of the Cherokee National Forest. Each of these streams will be evaluated by estimating Brook Trout abundance, examining instream habitat characteristics and riparian forest structure. Habitat characteristics will be modeled against Brook Trout abundance to determine the variables that are most significant to a Brook Trout restoration suitability index. If validated, then models of restoration suitability will provide state and federal agencies in the Southern Appalachians a valuable guide towards selecting locations for Brook Trout restoration projects. This model will also work as a guide to determine the particular instream and forest habitat characteristics that should be improved to successfully restore Brook Trout within stream reaches.

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Status of the endangered tuxedo darter, *Etheostoma lemniscatum*, within reaches of the Big South Fork Cumberland River affected by return to normal operations of Wolf Creek Dam following an extended drawdown period, with discussion of the current status of fish, mussel, and crayfish fauna.

Jeffrey W. Simmons
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Lake Cumberland, impounded by Wolf Creek Dam, is the largest storage reservoir operated by the U.S. Army Corps of Engineers (USACE) east of the Mississippi River. The Big South Fork is the largest tributary to Lake Cumberland. At full pool, Lake Cumberland affects the lower 44 river miles of the Big South Fork. Wolf Creek Dam has had a history of chronic seepage problems related to erosion of clay-filled cavities in the limestone base beneath the dam, and during January 2007, the USACE made the decision to immediately lower Lake Cumberland to ease stress on the dam to prevent possible dam failure. From January 2007 until spring 2014, lower reservoir elevations created free flowing conditions throughout a 10 mile reach of the Big South Fork that had been previously inundated. Prior to raising reservoir elevations to normal operating levels, the U.S. Fish and Wildlife Service (USFWS) requested that the USACE conduct a survey for rare aquatic species that may have colonized this reach during reservoir drawdown. During 2013, the USACE contracted with the Tennessee Valley Authority (TVA) to conduct these surveys, which resulted in the observation of the endangered tuxedo darter, *Etheostoma lemniscatum*, at eight shoals within this reach. Following this discovery, the USACE entered into formal consultation with the USFWS to determine the impact of this finding on return to normal operation of Wolf Creek Dam. The USFWS issued a Biological Opinion on March 24, 2014, allowing the USACE to resume normal operation with agreement of compliance with several "Terms and Conditions", including development and implementation of a monitoring plan to determine the effects of higher reservoir levels on tuxedo darters and their habitats for at least five years (USACE again contracted the TVA to conduct this annual monitoring). Data on tuxedo darter abundance, age class structure, and micro-habitat use were recorded during 2014 and 2015. Additional fish community monitoring has documented 62 species of fish within this reach. Freshwater mussel sampling from 2013 to 2015 has documented 14 species, including one federally endangered species, Cumberlandian combshell, *Epioblasma brevidens*. We also documented a rapid invasion of the non-native crayfish, *Orconectes rusticus*, which creates significant conservation concerns for native crayfishes and benthic nest building fishes such as the tuxedo darter. Compared to historical conditions, water quality conditions during the time of these surveys were greatly improved. A decrease in active mines and improvements in water quality from acid mine drainage remediation have greatly improved water quality conditions, which is evident by the presence of an extremely diverse fish community and recovering mussel fauna.

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A Landscape Divided: Assessing Fish-Habitat Relationships in West Tennessee Streams

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Landscape-scale ecological assessments aid in conservation and management of aquatic biota and can direct mitigation decisions aimed at preserving organism diversity. The western-most Grand Division of Tennessee occurs between the Mississippi and Tennessee rivers and represents a landscape divided by low-gradient steams to the west and high-gradient streams to the east. Across this gradient of stream habitat types, the distribution and abundance of stream fishes are governed by watershed-scale alterations to terrestrial landscapes such as urbanization, agriculture, and vast networks of impervious road surfaces. However, the mechanisms by which these watershed alterations regulate fish communities differ for high-gradient versus low-gradient streams, and measurements of the biological integrity of fish communities must be adapted to fit stream habitats occurring across the divided West Tennessee landscape. The goal of this study is to use existing Tennessee Wildlife Resources Agency (TWRA) data to establish indices of biological and ecological integrity for streams and fish communities across West Tennessee. Objectives include: (1) assessing fish-habitat relationships at the assemblage scale across the region using canonical correspondence analysis (CCA), (2) determining responses by fish communities to watershed alterations in the Mississippi Basin versus the Tennessee Basin using geospatial data for each watershed in which fish communities were sampled, and (3) developing measures of fish community biological integrity specific to each watershed alteration. The CCA highlighted fish-habitat associations unique to high-gradient streams (e.g., riffles, coarse substrates) and low-gradient streams (e.g., pools, fine substrates). Geospatial data revealed strong gradients in watershed alterations ranging from streams draining mostly forested watersheds in the east to streams draining mostly agricultural watersheds in the west. Although fish species identities turnover across the landscape, preliminary results suggest unifying ecological traits such as spawning guilds are a useful approach for pinpointing potential areas for concentrated conservation efforts that could benefit imperiled endemic aquatic species.

Poster Presentations

Will Curtis, wjcurtis42@students.tntech.edu, 931-372-6242

Trophic Ecology of Banded Sculpin (*Cottus carolinae*) Across a Stream Size Gradient in Tennessee

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Biotic and abiotic processes operate across space and time to regulate prey consumption by fishes. For stream fishes, biotic dietary constraints might include gape limitations or variability in energetic demands related to survival, growth, and reproduction. Abiotic dietary constraints might include temporal variability in streamflow or spatial variability in stream size. Banded Sculpin (*Cottus carolinae*) is a widely distributed benthic fish that inhabits first- through eighth-order streams with variable hydrologic regimes. The goal of this study was to assess "landscape-scale" trophic ecology of Banded Sculpin in the Roaring River Basin in north-central Tennessee. Objectives included: (1) assessing the relationship between fish size (total length, mm) and diet breadth measured using Levin's Niche Breadth formula; (2) quantifying change in diet niche breadth as flows declined from spring to summer; and (3) testing for changes in diet niche breadth across second- to fifth-order streams. We collected 196 Banded Sculpin from four sampling sites distributed across the Roaring River Basin in northcentral Tennessee. Stomach contents were identified to the lowest practical taxonomic levels and diet niche breadth was calculated for each individual. We found larger fish had broader diet niches, niche breadth was constrained as flows declined, and niche breadth was greatest in smaller streams. Our study represents the most comprehensive analysis of Banded Sculpin diet to date and suggests that stream environmental templates regulate diet niches across aquatic landscapes. Specifically, headwater streams promote broader diet niche breadth, but these streams are sensitive to periods of low flow during which diet niche breadth is constrained. In larger streams flow is more stable, but diet niche breadth is consistently narrower. Enlarged mouths is a potential adaptive response by Banded Sculpin to combat spatiotemporal variation in prey availability across aquatic landscapes as larger mouths allow for consumption of a greater diversity of prey items.

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Testing Predator Control of Banded Sculpin (*Cottus carolinae*) Distribution in The Blackburn Fork Watershed, Tennessee

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The distribution and abundance of stream fishes are determined by abiotic processes that regulate habitat templates as well as biotic processes that regulate species interactions. Banded Sculpin (*Cottus carolinae*) occurs across stream sizes ranging from small headwaters to large upland rivers in the southeastern United States. Across this stream size gradient, smaller individuals typically dominate populations in smaller streams and larger individuals typically dominate populations in larger streams. One proposed mechanism for the gradient pattern is size-selective predation of smaller Banded Sculpin by Rock Bass (*Ambloplites rupestris*) in larger streams. In this study, we used replicated experimental mesocosms (n = 3) to test if Rock Bass preferentially consumed small sculpin relative to large sculpin. Ten small (45-65 mm total length, TL) and ten large (85-140 mm TL) Banded Sculpin were introduced to mesocosms containing three adult Rock Bass (190-220 mm TL) and survival of each sculpin size group was measured daily over a 7-day period. Length-frequency distributions prior-to and following consumption by Rock Bass were compared to test the hypothesis that smaller sculpin were disproportionally consumed relative to larger sculpin. Across replicates, smaller sculpin were consumed at a faster rate than larger sculpin, and post-consumption length-frequency distributions illustrated loss of the smaller size group. These observations support size-selective predation of sculpin by Rock Bass in an experimental setting. We then compared size distributions for sculpin measured at three field sites distributed across a stream order gradient including second-order (Rock Bass absent), third-order (Rock Bass present), and forth-order (Rock Bass present) streams. Data from field collections illustrated reduced numbers of small Banded Sculpin at sites containing Rock Bass. Collectively, field observations and laboratory experiments suggest size-selective predation is one biotic mechanism regulating the distribution and abundance of Banded Sculpin.

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Forty Years of Fish Community Change in the Blackburn Fork Watershed, Tennessee

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Stream fish communities vary across spatial and temporal scales within riverine landscapes. From a spatial perspective, fine-scale habitat patches including small tributaries are nested within broad-scale habitats such as upland river mainstems. This hierarchical pattern creates an emergent property in which small tributary fish communities represent nested subsets of broader assemblages occurring in a watershed. Through time, fish communities exhibit dynamic swings in species occurrences and abundances as abiotic and biotic structuring mechanisms govern local communities. Framing spatial processes within short-term temporal contexts of seasons or years is common practice in fish ecology because assessment of spatial processes over broader temporal scales is operationally challenging. We used fish community samples from 10 sites in the Blackburn Fork Watershed in Northcentral Tennessee to assess temporal change in community structure between 1976 and 2015 and across a stream size gradient ranging from first- to fourth-orders. Results indicate species richness increases with increasing stream size, and the number of species encountered in 2015 was similar to 1976 for all stream orders except first-order streams, which exhibited declines in richness between 1976 and 2015. Fish diversity measured using Brillouin's Diversity metric indicated reduced diversity across stream orders, notably first- and second-order streams. Fish evenness measured as Pielou's Evenness metric illustrated transformation in which sites that were historically (1976) most even became least even during contemporary (2015) sampling. Our work illustrates long-term change among Blackburn Fork fish communities over a 40-year period and suggests headwater (first-and second-order) streams are most sensitive to temporal change even over broad time scales. This conclusion presents an apparent scale-dependent paradox: although broad-scale fish species occurrence have not changed in the watershed, fine-scale measurement of community structure suggest transformations have occurred.