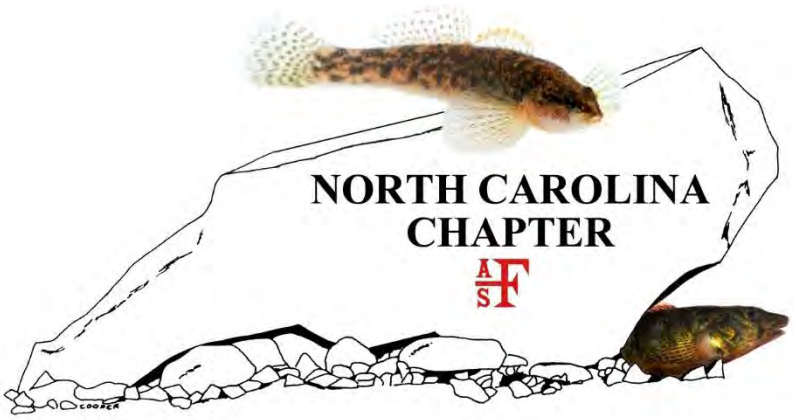

2018 Meeting

The North Carolina Chapter of the American Fisheries Society

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The North Carolina Freshwater Mollusk Workgroup

Monday, February 19th – Thursday, February 22nd, 2018

Morganton Community House
120 North King St.
Morganton, NC 28655

We would like to thank our sponsors of the 29th annual meeting of the North Carolina Chapter of the American Fisheries Society

2018 NCAFS Annual Meeting Workshop

Climate Change, Climate Models, and Best Practices for Using Them for Impact Assessments and Adaption Planning

Dr. Ryan Boyles, Acting Director, Department of the Interior, US Geological Survey, Southeast Climate Science Center, North Carolina State University, Raleigh, NC, 919-513-2816, rpboyles@ncsu.edu

Dr. Ryan Boyles is a physical scientist with the USGS Southeast Climate Science Center. As a former State Climatologist and extension faculty at North Carolina State University, he has spent his entire career working to help other disciplines better use climate data and climate science. In this workshop, he'll cover some of the basics of what drives climate changes and how climate models work. He'll also review some best practices on how to actually use the science and models for natural resource management. Workshop participants will interact with Ryan and each other to better understand when and how climate science can be used to better understand habitat and species dynamics and make climate-smart adaptation.

Is Contaminant Removal by Native Freshwater Mussels an Ecosystem Service?

Jennifer M. Archambault*[1], W. Gregory Cope[1], Teresa J. Newton[2], and Heidi L. Dunn[3]
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Mussels ingest contaminants as they filter water for nutritional gain. Because native freshwater mussels (Unionidae) comprise a large proportion of benthic biomass, and each individual filters several liters of water per day, there is potential for mussel populations to sequester large masses of contaminants. We quantified the ecological function of contaminant removal by native freshwater mussels and assessed the magnitude of their ecosystem services related to reducing contaminants for ecosystem and human well-being. The main objectives of the research were to use population estimates to calculate the total mass of contaminants sequestered by mussels and to understand the relative value of contaminant removal by native mussels (e.g., water treatment), and the cost of other important ecosystem services lost (e.g., nutrient cycling) from impacts on mussel populations (e.g., population decline). To address these questions, the three dominant species from each of two pools in the Upper Mississippi River were collected (*Amblema plicata, Fusconaia flava,* and *Lampsilis cardium* from Pool 5 and *A. plicata, Obliquaria reflexa,* and *Quadrula quadrula* from Pool 18), and soft tissues were analyzed for a suite of contaminants. An analysis of the average total metal tissue concentrations (for 22 metals) in the mussels collected, scaled up to the overall population estimates of 190 million and 212 million mussels in Pools 5 and 18 respectively, suggests that the native mussel fauna from just these two pools in the Upper Mississippi River contained a total of 18.2 tons of metals. Our research begins to elucidate the scale of contaminant sequestration by native mussels in a large river system, provide information to the public and stakeholders about the value of healthy mussel populations to water quality, and highlight that the beneficial reach of pollution prevention extends from our ecosystems to our faucets.

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NOTES

Monitoring the Effects of *Hydrilla* Removal on the Fish Community of a Piedmont River in North Carolina

Jessica R. Baumann*[1] and Tyler R. Black[2]
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Hydrilla, a federally and state listed noxious weed, can negatively impact aquatic communities by altering available habitat. *Hydrilla* was first observed in the main stem portion of the Eno River, located in the upper Neuse River drainage of North Carolina, in 2005. To control the growing infestation, an herbicidal drip was installed to release Fluridone into the river on a yearly basis beginning in 2015 and it has successfully reduced *Hydrilla* densities to negligible amounts. The Eno River supports a plethora of fish species including the Roanoke Bass, a state listed species of concern. The objective of this project was to evaluate possible responses of fish communities related to the removal of *Hydrilla* that could indicate environmental changes. A Before and After, and Control and Impact (BACI) design was used to compare fish densities from five locations, two sites located upstream of the herbicidal drip system (control) and three located within the treatment zone. This study was initiated three years prior to the start of the herbicidal treatment and concluded after the first two years of treatment. Sites were comprised of riffle/run/pool complex habitats and fish were collected using barge electrofishing. Fish were pooled and evaluated based on North Carolina's Index of Biotic Integrity (NCIBI) parameters that account for overall abundance, trophic levels, habitat preference, tolerance levels, and recruitment potential. Based on these parameters, BACI analysis determined that there was no significant ($\alpha = 0.05$) effect of *Hydrilla* removal detected within any fish community densities (fish/m^2). BACI analysis also determined that there was no significant effect detected in fish condition at various trophic levels. This study was not able to detect acute changes in fish communities due to *Hydrilla* removal in a lentic system, however, future studies should focus on possible chronic effects that were not captured during this study.

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NOTES:

Potential Effects of the Invasive Asian Clam on Methane Cycle Processes in an Urban Stream

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Methanogenesis occurs in stream sediments where anoxic microsites have been formed by decomposition. Methanogenesis, subsequent methane oxidation and flux from the sediment are subject to local biogeochemical conditions in the stream. The invasive Asian clam, *Corbicula fluminea*, has been shown to affect stream biogeochemistry and may have a density dependent effect on methane cycle processes via bioturbation and respiration. *Corbicula*'s effect on methane cycle processes was examined using sediment and clams collected from North Buffalo Creek, Greensboro, NC. The response of methanogenesis rate, potential methane oxidation rate and net methane flux to *Corbicula* density was tested using laboratory microcosms. No significant response of methanogenesis was observed in microcosms. However, potential methane oxidation decreased and net methane flux increased with increasing *Corbicula* density. This suggests that as *Corbicula* populations become denser, they have potential to increase methane flux from stream sediments by reducing methane oxidation. To test the response of sediment pore water [CH_4] to *Corbicula* density, cage enclosures containing assigned *Corbicula* densities were installed in 3 blocks along a 40m stream reach. This experiment revealed that *Corbicula*'s effect on pore water [CH_4] differed between upstream and downstream blocks of the study reach, indicating *Corbicula's* effect on methane cycle process varies over the reach scale.

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NOTES:

29th Annual Meeting of the North Carolina Chapter of the American Fisheries Society
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Evaluation of Freshwater Mussel Sensitivity to Algaecides for Potential Control of Giant Lyngbya

Sean B. Buczek*[1], W. Gregory Cope[1], Meredith Shehdan[1], West M. Bishop[2], Robert J. Richardson[3], James A. Rice[1], JoAnn M. Burkholder[1], Thomas J. Kwak[4], Justin Nawrocki[5], and Tom Warmuth[6]
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Harmful algal blooms are becoming an ever increasing global threat to human health, the environment, and the economy. Giant Lyngbya, *Lyngbya wollei,* is a filamentous cyanobacterium that is capable of producing blooms and toxins that can adversely affect water quality and aquatic life. The range distribution of Lyngbya is rapidly expanding, including several water bodies in North Carolina. Little is known about the potential effects of Lyngbya on already imperiled native freshwater mussel fauna or candidate algaecides that may be used for its control. We evaluated the sensitivity of subadult plain pocketbook (*Lampsilis cardium*) mussels to six candidate algaecides (Algimycin® PWF, Captain® XTR, Cutrine®-Ultra, GreenClean® Liquid 5.0, Hydrothol® 191, Reward®) for control of Lyngbya in a series of standard acute (96 h) toxicity tests. The 96-h median lethal concentration (LC50) for each algaecide tested was less than the current recommended treatment concentrations needed for control of Lyngbya, with the exception of Reward®. Three additional 96-h toxicity tests with combinations of the algaecides (Algimycin® PWF/AMP activator, Captain® XTR/ Reward®, Hydrothol® 191/ GreenClean® Liquid 5.0) currently recommended for Lyngbya control showed no evidence of additive or synergistic toxicity to mussels. Lastly, we conducted concurrent toxicity tests with two water types (standard laboratory softwater and water from Lake Gaston) in the presence of Lyngbya to assess algaecide efficacy and potential differences in mussel sensitivity under more realistic treatment conditions. Results indicated that Lake Gaston water had little effect on algaecide toxicity to mussels. Overall, our results suggest that freshwater mussels are sensitive to all of the algaecides tested, except for Reward®, at the concentrations recommended for control of Lyngbya. Assessment of other eradication options in systems where Lyngbya and mussels co-occur, and development of other strategies to minimize the spread of Lyngbya to new waterbodies, should be important management priorities.

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NOTES:

29th Annual Meeting of the North Carolina Chapter of the American Fisheries Society
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Status, Habitat, and Genetics of the Endemic Carolina Madtom

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The Carolina Madtom, *Noturus furiosus*, is a small nongame catfish endemic to the Tar and Neuse river basins of North Carolina. Systematic surveying of Carolina Madtom populations first began in 1962, and subsequent surveys in 1989 and 2007 have shown declining occurrence and abundance in the Neuse River basin, with stable populations in the Tar basin. The 2007 survey showed a 92% occurrence decrease throughout historically inhabited sites in the Neuse River basin. In 2016, we sampled 20, 150-m reaches in snorkel surveys of sites previously sampled in 2007. In 2017, we surveyed three to four, 30-m sites within 16, 4-km reaches for a total of 55 surveys. In total, we collected 59 Carolina Madtoms during snorkel surveys in the Tar River basin, whereas no fish were collected from the Neuse River basin. Analysis with the occupancy software PRESENCE estimated Carolina Madtom occupancy probability at 0.34, and detection probability was 0.81. Generalized Linear Modeling of microhabitat covariates showed that mean column velocity ($p = 0.03$) was positively related to detection of Carolina Madtoms. Artificial habitat units were constructed and deployed for 14-day periods at 8 sites in the Tar and Neuse basins, and 26 Carolina Madtoms were collected in them in the Tar River basin, but none in the Neuse River basin, indicating the potential of artificial habitat units as an efficient sampling device. Additionally, fin clips were taken from collected specimens, and combined with archived tissue samples from 2007 surveys, analysis of genetic differentiation among Tar and Neuse river basin populations is ongoing. Findings from surveys and genetic analyses will be applied to inform future species protective listing decisions and potential population augmentation in the Neuse River basin.

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NOTES:

Mapping Ocean Resources Using High-Resolution Aerial Imagery

David J. Coughlan[1]* and Julia R. Willmott[2]
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High altitude, aerial, digital, high-resolution imagery has been used for nearly a decade to provide survey data for off-shore wind farms in Europe. Advantages and disadvantages of this method compared to boat-based surveys and low altitude, aerial visual surveys are discussed. Currently, two of the world's largest aerial digital survey efforts are underway; one in New York off Long Island and the second off the coast of the Carolinas. One year's worth of ultra-high resolution imagery from New York is revealing a unique and detailed view of natural and anthropogenic activity over four seasons. Example data range from the flight heights of northern gannets to the timing and locations of fish shoals, large whales, turtle congregations, and commercial fishing vessels. Additional insights are presented on how aerial digital imagery can be used both offshore and onshore.

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NOTES:

Movement of Acoustic Tagged Largemouth Bass between Lake Mattamuskeet and Surrounding Canals in Relation to Changes in Lake Level

Kevin J. Dockendorf

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Largemouth Bass (*Micropterus salmoides*) are popular sportfish found at Lake Mattamuskeet, a large (16,187 ha), shallow (mean depth < 1.0 m), coastal lake surrounded by a system of canals at Mattamuskeet National Wildlife Refuge in Hyde County, North Carolina. Lower lake levels annually occur due to environmental (evaporation in summer) or anthropogenic (pumping for refuge impoundments, and draining through canal water control structures) conditions may reduce available shoreline habitat for Largemouth Bass, whereas connecting canals are relatively deeper due to maintenance dredging and may provide alternative habitat when habitat in lake is reduced. The study objective is to define the temporal and spatial scale of Largemouth Bass movement with acoustic telemetry. Specifically, this study will test the hypothesis that Largemouth Bass movements into deeper, canal habitats are triggered by decreasing water levels in the main lake and dewatering of shoreline habitats. Between March and May 2017, a total of 31 VEMCO VR2W receivers were strategically placed in proximity to the canal connections to the lake. During May-June 2017, a total of 42 Largemouth Bass were collected, anesthetized, surgically implanted with VEMCO V9 acoustic transmitters (or tags), and released at seven locations; five in the lake and two in the canals. Receivers were checked monthly from June to December to download available data, service as necessary, and then redeployed. Receiver downloads between 15 May and 12 December revealed more than 145,000 detections of at least 29 acoustic-tagged Largemouth Bass at 30 of the acoustic receivers in the array. This survey will continue through February 2019 (extent of transmitter battery life) or until all acoustic-tagged Largemouth Bass are defined as dead. This study will provide valuable information regarding optimal water levels for Largemouth Bass in main lake habitats, while providing insights into environmental characteristics that elicit movement between available habitats.

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NOTES:

Assessing Angler Use and Demographics at Three Sandhills Region Lakes in North Carolina using Trail Cameras

Lawrence G. Dorsey

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The North Carolina Wildlife Resources Commission's (NCWRC) Sandhills Game Lands encompass a 25,500 ha area in the Sandhills Region of North Carolina. These public lands are used for hunting, fishing, horseback riding, and other recreational uses as well as military training. There are approximately 22 impoundments on these lands ranging from 1 – 27 ha and collectively they represent most of the impoundments owned and managed for fishing by the NCWRC. Many of these impoundments were constructed before 1950 but little or no effort has been made to assess the use of these areas by anglers and other recreational users. For this study, we selected three lakes that represented different levels of amenities and access for anglers in this area: Indian Camp Lake, Crappie Lake, and Kinney Cameron Lake. In order to assess use, we deployed one trail camera at each impoundment from October 2015 through September 2016. Cameras recorded images every 15 minutes from 7 am until 6pm daily. In total, 45,464 images were enumerated using Timelapse software. Preliminary results indicate that Indian Camp Lake is the most heavily used by anglers while Crappie Lake is the least used. Our results indicate that bank anglers are the most predominant type of anglers at all three sites and that most anglers at all three sites are adult males. While collection of these data using trail cameras is very cost effective, there are also factors which limit their ability to completely replace in person surveys. These factors will be discussed and examples of how these factors limited survey collection in this study will also be reported.

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NOTES:

Spotfin Chub Habitat Association in the Little Tennessee River

Luke Etchison*[1], William T. Russ[2], and Steve J. Fraley[3]
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In August 2016, we completed a ten-year study that assessed the population status of the federally and state threatened Spotfin Chub, *Erimonax monachus*, in the Little Tennessee River. Ten sites comprised of 4 to 8 transects, each, were surveyed within the 23-mile (37-km) occupied reach between Fontana Lake and Franklin Dam. Adult and juvenile abundances varied from year to year at sites and transects, so comprehensive habitat surveys were conducted in summer and fall 2017 to explore habitat factors influencing this variation. We collected habitat data for substrate composition, depth, and flow at 442 points in 3 sites and 16 transects and compared adult and juvenile habitat associations between sites and transects. Adult Spotfin Chub abundances were higher in transects with high proportions of coarse substrates (gravel, cobble, bedrock) and low flow variability in the water column. Sub-adult Spotfin Chub abundances were highest in transects with bedrock as dominant substrate and sand as a sub-dominate substrate. Results from this study provide a better understanding of Spotfin Chub habitat requirements and distribution of adults and juveniles in the Little Tennessee River. This study also serves as a model for evaluating range-wide habitat suitability and population status for Spotfin Chub.

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NOTES:

Angler Tendencies and Population Characteristics of a New Hybrid Striped Bass Fishery In Lake Norman, NC

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In 2013, the North Carolina Wildlife Resources Commission terminated a long-term stocking program for Striped Bass in Lake Norman and replaced it with Hybrid Striped Bass. Seasonal behavior and anecdotal fishing reports have led to concerns of overharvest. To determine angler harvest and release rates, a high reward tag return study was initiated. Starting in December 2015 Hybrid Striped Bass were implanted with high reward anchor tags monthly. As of January 2018, a total of 1,033 tags have been deployed. Of these, 408 tags have been recaptured by anglers and returned for a 40% recapture rate. Recaptures from boat anglers comprised 54% of total recaptures while bank anglers recaptured 46%. Harvest and release rates for boat anglers were 58% and 42%, while bank anglers harvested 93% and released 7%. Angler recaptures and subsequent harvest peaked in the winter when Hybrid Striped Bass were concentrated in warm water effluent and again in the spring when fish were concentrated in the river during spawning runs. To date, Hybrid Striped Bass over 600 mm have been collected and mean relative weight (Wr = 85.2) has been higher than the previous Striped Bass fishery. The Hybrid Striped Bass fishery in Lake Norman appears to be popular among anglers but may be vulnerable to overharvest, especially during winter and spring. Additional analyses including monthly and annual mortality rates will assist in determining if current regulations are adequate.

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NOTES:

Evaluation of Recreational Hand-Crank Electrofishing on Flathead Catfish in Four Southeastern North Carolina Rivers

J. Michael Fisk II*[1] and Clint W. Morgeson[2]
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In response to declines in native fish species, recreational hand-crank electrofishing was established in four counties in southeastern North Carolina by the NC General Assembly in the 1980s and early 2000s to help control the expansion of non-native catfish in the Black, Cape Fear, Lumber, and Waccamaw rivers. These reaches of river are the only waterbodies in the United States where this gear can be legally used. Although this unique gear type has been allowed dating back to 1985 in the Cape Fear River, little is known of its impacts on the catfish community. These four rivers were sampled using low frequency boat electrofishing in ten 1-rkm sites in two reaches (HCE reach; hand-crank electrofishing allowed and the NON-HCE reach; hand-crank electrofishing not allowed) for a total of 20 sites in each river in 2015 and 2016. Population characteristics were compared and considered significant at ($\alpha = 0.05$). Differences in size and age distribution, as well as growth and mortality rates indicate recreational hand-crank electrofishing does impact Flathead Catfish population structure. However, these impacts to control the population are minimal at current harvest levels. This information will aid in understanding the efficacy of utilizing non-traditional gears to control established non-native catfish and help guide future management practices.

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NOTES:

Population genetics of the Carolina Heelsplitter (*Lasmigona decorata*) a critically-endangered freshwater mussel

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Freshwater mussel biodiversity has declined substantially in many southern Atlantic Slope streams during the last four decades and several species are now critically endangered. The Carolina Heelsplitter, *Lasmigona decorate,* is a federally endangered freshwater mussel that historically occurred in the Catawba, Pee Dee, Saluda and Savannah basins in Georgia, North Carolina and South Carolina. Currently, Carolina Heelsplitter persists as small, isolated populations, primarily within the Charlotte and Carolina Slate Belt physiographic provinces. In order to assess range-wide genetic diversity among Carolina Heelsplitter populations, we obtained non-lethal DNA samples from wild animals and individuals held in hatchery facilities and sequenced a portion of the mitochondrial COI gene. To date, we have examined COI sequences from 40 Carolina Heelsplitters including 25 from the Pee Dee and 15 from the Catawba drainages. At the COI locus genetic variation in this species appears to be minimal (i.e., <0.2% pairwise divergence) both within populations and among river basins. Future work will include examination of data from populations from the Saluda and Savannah drainages as well as sequencing other mitochondrial loci and screening microsatellites to assess whether there is any evidence of finer-scale genetic structuring among populations. Assessments of the degree of genetic differentiation among remaining Carolina Heelsplitter populations may provide data important to future management of this species as well as insights into the evolution and biogeography of an endangered and highly endemic freshwater mussel.

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NOTES:

Effects of Beavers on North Carolina Stream Fish Communities: A Preliminary Assessment

Samuel F. Fritz*, Rebecca Purkee, Susannah Minor, Chrissy Veridam,
Alison Linden, and Michael M. Gangloff
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For millennia Beavers, *Castor canadensis,* have had complex effects on North America's stream ecosystems and fish communities. Although numerous studies have examined beaver-fish interactions in western North America, few have focused on southeastern streams. We used field surveys and a meta-analysis to examine responses of fish communities to beavers in North Carolina streams. In spring 2017, we surveyed fishes in one stream with active beavers and three with inactive dams in the Blue Ridge Mountains. At each dam, we sampled the pond and free-flowing reaches up- and downstream from the pond. Fishes were identified, measured and released. We computed Simpson's D' and used a 1-way ANOVA to compare D' among sites. Diversity in the stream with an active dam was significantly lower compared to two streams with inactive dams ($p=0.032$ and 0.007). Fish diversity in the 3rd inactive-dam stream was similar to the active-dam stream, however habitats in this stream were impacted by riparian-zone cattle grazing. In the meta-analysis we examined data from 104 fish surveys obtained from (primarily) Piedmont and Coastal Plain streams in the NCPAWS database. Stream reaches were assigned to three categories; 1) reaches with dams present, 2) reaches with only indirect signs of beaver activity (i.e., gnawed branches) or 3) control reaches, which showed no evidence of beaver activity. We found that fish diversity in stream reaches with active dams was significantly lower compared to streams where surveys noted only indirect ($p<0.01$) or no evidence of beavers ($p=0.01$). These data suggest that fish community diversity may be reduced by active beaver dams. However, in-stream habitat and riparian landuse are likely important to understanding how communities respond to the return of an important ecological engineer. Future research will focus on understanding the effect of dam abandonment on beaver influenced systems, and the impact of riparian zone disturbance.

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NOTES:

Estimating Stock Structure of Cobia (*Rachycentron canadum*) Using Acoustic Telemetry

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In 2015, recreational landings of Cobia, *Rachycentron canadum,* exceeded estimates of the Annual Catch Limit (ACL) along the southeastern United States (SEUS). The subsequent closure of the federal cobia fishery prompted questions about Cobia stock structure and stock boundaries. To address current uncertainties, we will collect and telemetry-tag 120 Cobia (60, inshore and 60 offshore) over the course of two seasons in North Carolina and Virginia. Our study will utilize detections from tagged Cobia throughout the SEUS in order to assess stock structure and boundaries. Our findings will be important for future SEUS cobia stock assessment and management.

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NOTES

Phylogeography of the Freshwater Mussel Genus *Elliptio*: Preliminary Trends and Future Directions

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Despite increased awareness of and concern over the plight of many freshwater mussel species the number of genera and species that have been the subject of genetic studies is surprisingly small. This is especially true for *Elliptio*, which according to recent taxonomic lists is the most-species rich freshwater mussel genus in North America. The most recent list included several recent updates that moved *Elliptio* into other genera but still listed 30 species. Beginning in 2016 we began an effort to assemble a comprehensive genetic dataset for this genus with the goal of understanding which of the currently-recognized Elliptio taxa represent valid species. To date we have data from 24 nominal species collected from rivers in 10 states. The picture of species boundaries that is emerging in this group is complex but several consistent patterns are evident. First, we regularly observe a fairly pronounced rate of divergence between lanceolate taxa (e.g., *E. fisheriana, E*. *producta*) and taxa belonging to core group of Elliptios (e.g., *E*. *complanata, E*. *crassidens*, *E. icterina*). However, genetic analyses of specimens collected from sites believed to have high Elliptio species richness consistently reveal high levels of gene flow between taxa, suggesting that Elliptio may comprise many fewer taxa than was initially believed based on morphological diagnoses. Fieldwork in 2018 will be focused on obtaining material from remaining *Elliptio* taxa with an emphasis on material from type localities. Expected benefits of this research include an improved understanding of species boundaries within *Elliptio* and more scientifically defensible management units both within and among taxa in this species-rich and ecologically important mussel genus.

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NOTES:

Lake Waccamaw Rare Species Monitoring and Exotic Vegetation Management: A Progress Report on Positive Partnerships

Brena K. Jones

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Lake Waccamaw is a 9,000-acre natural Carolina bay lake in Columbus County, NC, home to a suite of rare fishes, mussels, and aquatic snails, including the federally threatened Waccamaw Silverside (*Menidia extensa*). Focused surveys to monitor population trends were initiated by the NC Wildlife Resources Commission in 2009, in partnership with NC State Parks. Catch rates of three SGCN (Species of Greatest Conservation Need) fishes remain variable but populations persist with consistent evidence of successful reproduction and recruitment. Mussels remain at a relatively stable mean overall density, which was 28 individuals/m^2 in 2017 (range 23-33/m^2). Densities of snail species continue to decline in visual surveys, although two endemic micro-snails, collected in substrate samples, tripled in combined mean density.

In 2012, *Hydrilla* (*Hydrilla verticillata*), an invasive exotic weed, was discovered in the lake, posing a significant threat to habitats with potential to colonize the majority of this clear, shallow water body by 2017. Representatives from resource agencies, universities, private sector groups, and citizen stakeholders formed the Lake Waccamaw Technical Advisory Committee (TAC), which developed and implemented a management plan that included treatment with the herbicide fluridone. Recent vegetative and tuber surveys suggest a successful and significant reduction of *Hydrilla* from the 600+ acres originally infested. The TAC is exploring adaptive management options, along with the challenges posed by another noxious introduction discovered in 2013, the cyanobacterium Black Mat Algae, *Lyngbya wollei*.

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NOTES:

Identifying Ecological Impacts of Common Carp to Inform Biomass Removal and Restoration Efforts in Lake Mattamuskeet

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Common carp, *Cyprinus carpio*, (hereafter carp) are one of the most widely introduced and ecologically disruptive freshwater fish species. High abundance of carp may increase turbidity, alter nutrient dynamics, and re-suspend sediment into the water column through the direct consumption and uprooting of aquatic vegetation while foraging. These deleterious effects are most pronounced in shallow lake ecosystems typically dominated by submerged aquatic vegetation. One such lake, Lake Mattamuskeet, has recently undergone a dramatic reduction in aquatic vegetation and water clarity and is now listed as a degraded system. Using aquatic vegetation as a proxy for overall lake health, my research addresses (1) the potential contribution of carp to this recent loss of aquatic vegetation, and (2) the feasibility of long-term carp exclusion as a restoration tool. To experimentally test for changes in chemical, physical, and biological parameters following carp removal, I will utilize a series of carp exclusion pens (exclosures) at various sites in Lake Mattamuskeet. To assess the influence of carp exclusion on the reestablishment and restoration potential of submerged aquatic vegetation, native aquatic plants will be obtained from a local nursery and transplanted into each exclosure following carp removal. Exclosures will be monitored monthly to record parameter changes and plant survival. These exclosures will not only serve as long-term sites for water quality monitoring, but, if we are successful at propagating vegetation in the absence of carp, may act like small nursery areas to support vegetation establishment and growth. Overall, this study provides an adaptive framework for the assessment, monitoring, and management of invasive carp populations, a step that is necessary to restoring the ecological integrity of Lake Mattamuskeet.

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NOTES:

Two Years of Assessing Trout Distribution: Where We Have Been and Plan to Go

Kenneth J. Lingerfelt*[1], Joseph A. Coleman[1], Dylan. P. Owensby[1], and Jacob M. Rash[1]
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North Carolina Wildlife Resources Commission, 654 Fish Hatchery Road, Marion, NC

North Carolina's trout populations provide significant biological and socioeconomic resources to the State. Considerable effort has been given by the North Carolina Wildlife Resources Commission (NCWRC) to document self-sustaining Brook Trout, *Salvelinus fontinalis*, Brown Trout, *Salmo trutta*, and Rainbow Trout, *Oncorhynchus mykiss,* populations, and as the State's only native salmonid, Brook Trout are a species of importance for the NCWRC. Since 2016, a two-person crew has focused on documenting the presence of wild trout populations, collecting Brook Trout genetic material, and assisting with other trout-management activities. Crew activities during this period were directed within NCWRC District 8 (2016) and District 7 (2017). As a result, the NCWRC has 9,366 collection records within its trout distribution database (663 were added in 2016–2017). Furthermore, over the last two-year period 125 Brook Trout populations were documented, with 3,593 Brook Trout fin clips obtained for genetic analysis. Of the observed Brook Trout populations, five were unidentified previously and nine had earlier collection efforts that failed to obtain Brook Trout. Future efforts will continue to build upon existing data, with a spatial focus of NCWRC District 9 (to date, approximately 200 field sites have been identified).

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NOTES:

Evidence of Freshwater Salinization Syndrome in Blue Ridge Mountain Streams and Implications for Aquatic Biodiversity

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Recent dramatic and widespread increases in dissolved ion concentrations in eastern US streams appear linked to urbanization and increased use of salts associated with agriculture and road maintenance. Streams in the Southern Appalachian Mountains should be buffered from these impacts because population density is low and agricultural activity limited. We examined temporal trends in water chemistry at seven sites in the New and Watauga drainages in northwestern North Carolina over a 46-year (1971-2017) period. We controlled for seasonal effects by separating data by month prior to analyses. We then used Pearson correlations to examine associations between dissolved oxygen (DO), pH, specific conductance (SC), water temperature and year within each month. Water temperature was unchanged while DO concentrations increased during winter months. However, SC and pH both increased significantly across all months and sites. SC increased significantly for all months at 4 of 7 sites. At the other 3 sites SC increased in 11, 9 and 6 months and scatter plots showed that the rate of SC change has increased during the past 20 years. Trends in pH largely mirrored SC changes although the strength of associations was generally lower. Significant pH increases occurring primarily during winter months. These trends suggest that southern Appalachian streams may be more susceptible to the effects of freshwater salinization than previously predicted. Changes to SC and pH may already be impacting sensitive biota in the New and Watauga drainages. Freshwater mussels in both drainages have undergone heretofore unexplained declines in the last 10 years. Increased awareness of Freshwater Salinization Syndrome is needed to reduce impacts to stream water quality and sensitive biota in western North Carolina streams as human populations continue to grow. Current strategies for managing wastewater and roadway safety may need to be re-examined as eventually these trends may impact drinking water quality.

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NOTES:

The New Norm: Species Status Assessments for All ESA Decisions

Sarah E. McRae

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The Species Status Assessment (SSA) framework was developed to inform decisions under the U.S. Endangered Species Act (ESA) by compiling the best available scientific information to document a species' historical, current, and future viability and extinction risk. The SSA process has three sequential stages: 1) documentation of the species' life history and ecological relationships to provide the foundation for the assessment, 2) description and hypothesized causes of the species' current condition, and 3) forecasts of the species' future condition in response to scenarios of possible change. The future condition in an SSA describes the species' ability to sustain populations in the wild over time under different plausible future scenarios that account for key uncertainties.

In 2016-2017, the Raleigh Field Office (RFO) applied the SSA framework to inform ESA listing decisions for four petitioned species (Yellow Lance, Atlantic Pigtoe, Carolina Madtom, and Neuse River Waterdog), and in 2018-2019, the RFO plans to apply the framework to several aquatic species; to inform listing decisions for two petitioned species (Magnificent Ramshorn and Carolina Pygmy Sunfish), to inform 5-Year Reviews for two species (Waccamaw Silverside and Tar River Spinymussel), and to inform Recovery of two species (Cape Fear Shiner and Roanoke Logperch). To evaluate the current and future viability of each species, we assess a range of conditions by applying the conservation biology principles of resiliency, representation, and redundancy, collectively referred to as the 3Rs. Brief updates will be provided for each species.

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NOTES:

Impacts of Invasive Ictalurids on Native Fish Communities in Southeast North Carolina Rivers

Clint W. Morgeson*[1] and J. Michael Fisk, II[2]
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Fish community ecology can be an informative tool for documenting ecosystem responses to environmental stressors (e.g. nonnative fish introductions, altered hydrology). Changes in fish assemblages over time and space may help managers understand how dynamic communities respond to these influences. Here we measure fish communities in four Southeastern North Carolina rivers: The Black, Cape Fear, Lumber, and Waccamaw Rivers. Nonnative catfish (i.e. Flathead Catfish, *Pylodictis olivaris* and Blue Catfish, *Ictalurus furcatus*) introductions have had measurable impacts on native fish communities in these systems. Each of these rivers have zones open to recreational hand-crank electrofishing (HCE) for catfish species. We sampled each river during 2015-2016 using pulsed-DC electrofishing at fixed sites; both low- and high-frequency electrofishing was used to sample fish species completely. Nonmetric multidimensional scaling (NMDS) was used to model relationships among fish assemblages in the rivers; permutational multivariate analysis of variance (PERMANOVA) was used to compare assemblages among rivers and strata. Nonnative catfish abundance was then fitted onto ordinations to illustrate their effects on community assemblages. NMDS ordinations distinguished differences between the mainstem Cape Fear River and the other rivers. River, HCE zones, and catfish abundance had significant ($p < 0.05$) effects on fish community structure. Understanding influences invasive species have on aquatic communities are important to help managers make informed decisions regarding their management.

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NOTES

Influence of River Discharge on Diurnal Movement of Smallmouth Bass: A Time Series of Fish Movements

Seth A. Mycko*[1], Yoichiro Kanno[2], and Jason M. Bettinger[3]
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Dams and altered flow regimes have many impacts on riverine fisheries. In addition to the ecological Impacts of altered flow, unpredictable changes in flow can influence fish populations in more obscure ways (e.g. behavior). Fisheries management practices are often influenced by water regulation and hydropower generation. Recurrent changes in river flow influence behavior of fish inhabiting the flow-regulated portions of rivers, and such individual behavior may ultimately have population-level effects (e.g. fish abundance and body condition). We evaluated the effects of river discharge variation on diurnal fish movement every 30 minutes within 1-km downstream of the Ninety-Nine Islands Hydroelectric Dam (Blacksburg, SC, USA) during daylight hours to establish linkage between hydro-power generation and fish behavior. Generalized additive mixed models (GAMMs) showed that movement distances slightly increased with river discharge associated with hydro-power generation in winter, but not in summer. The physiological impacts of this altered behavior were not known, but if rapid and major changes in flow magnitude act as a stressor to individual bass, then population-level effects could follow and impact fisheries resources within the study area.

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NOTES

The Other Brookie: Surveys for the Brook Floater Mussel (*Alasmidonta varicosa*) in the Cape Fear and Lower Yadkin-Pee Dee Basins

Anakela Popp* and Brena Jones
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The Brook Floater (*Alasmidonta varicosa*) is a State Endangered freshwater mussel species in North Carolina and has been petitioned for federal listing. Its range includes the Catawba, Cape Fear, and Yadkin-Pee Dee river basins. To provide updated distribution information for the status review, targeted surveys in the Cape Fear and lower Pee-Dee systems were initiated in 2017. Qualitative searches were conducted at 55 unique sampling locations in 38 waterbodies, where thirty Brook Floater were collected from nine streams. Density was low, with catch per unit effort ranging from 0.25 to 0.66 individuals per person-hour. Surveys will continue in 2018 to increase geographic coverage, as necessary to better understand the current population status of the Brook Floater in these drainages.

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NOTES:

Impacts of Nonnative and Invasive Fish Pathogens to North Carolina's Trout Resources and Its Managers

Jacob M. Rash*[1], Carlos F. Ruiz[2], and Stephen A. Bullard[2]
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Three parasitic species that affect salmonid populations were discovered recently in North Carolina: the parasitic copepods (aka "gill lice") *Salmincola edwardsii* (infections in Brook Trout *Salvelinus fontinalis*; 2014) and *Salmincola californiensis* (infections in Rainbow Trout *Oncorhynchus mykiss*; 2015) as well as the causative agent of whirling disease, *Myxobolus cerebralis* (infections in Rainbow Trout, Brown Trout *Salmo trutta*, and Brook Trout; 2015 and 2016). None of these pathogens previously had been diagnosed taxonomically from North Carolina or from the southeastern United States, but all can exert deleterious population-level effects on salmonids elsewhere in North America and abroad. As such, these pathogens fall within a geographic area where potential biological threats to coldwater resources (including the State's only native salmonid: Brook Trout) are indeterminate. Such knowledge gaps make it difficult to achieve informed decisions on behalf of resource managers. To address this issue, personnel of the North Carolina Wildlife Resources Commission, in collaboration with Auburn University's Southeastern Cooperative Fish Parasite and Disease Laboratory, have obtained and disseminated pathogen-specific information in a step-wise fashion to (1) inform management decisions within the state, (2) disseminate scientific research data to adjacent resource managers likewise concerned with these salmonid pathogens, (3) hasten inter- and intrastate biosecurity measures, and (4) engage in public outreach that targets anglers and other citizens. Although much remains to be investigated, progress has been made as a result of focused studies on disease diagnostics, parasite identification, pathological effects, pathogen temporal and spatial distribution, parasite life cycles, and parasite-host relationships. Research efforts will continue to expand in order to inform management decisions and improve knowledge on the health of North Carolina's salmonids.

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NOTES:

Movement by Adult American Shad (*Alosa sapidissima*) in Western Albemarle Sound, North Carolina and Associated River Basins

Fritz Rohde*[1] and Holly White[2]
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Populations of American Shad, *Alosa sapidissima*, in Albemarle Sound and Roanoke River are considered to be stable, but low. As part of the FERC re-licensing of Roanoke Rapids hydroelectric facility, estimates of the number of spawning adult shad in the Roanoke River have been made over seven years. Numbers are considered to be too low (6,000 to 29,000) to permit upstream trap and transport. What is unknown is which river basins in Albemarle Sound the shad prefer to ascend –primarily the Chowan or Roanoke rivers. Shad movements, survivability, and potential spawning information were gathered by receivers placed within the Chowan and Roanoke rivers. Telemetry data will better inform resource agencies on the impacts of current spring water releases from Roanoke Rapids Dam on spawning. We question whether these releases are sufficient to attract American Shad to the spawning grounds or if the shad prefer alternative spawning grounds, such as the Chowan River. Seven adult shad received acoustic transmitters in the spring of 2013, 53 in 2014, 56 in 2016, and 75 in 2017. Thirty-five of the 116 shad that were detected after being tagged made spawning runs. The Chowan River basin appears to be the most utilized in Albemarle Sound for spawning (89% of the shad in 2014 and 95% in 2017). Movement patterns of individual fish will be discussed.

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NOTES

Variation in Appalachian Elktoe Detectability in the South Toe River

Chantelle Rondel*[1], Jason Mays[2], and Michael M. Gangloff[1]
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Understanding how changes in behaviors or habitat conditions influence the detection probability of focal species is an important component of effective monitoring strategies. However, there have been surprisingly few attempts to understand how seasonality affects the detectability of freshwater mussels. The Appalachian Elktoe, *Alasmidonta raveneliana,* is an endangered freshwater mussel endemic to the upper Tennessee River system. Beginning in 2016 we began standardized mussel and habitat monitoring to assess changes in detectability and abundance of *A*. *raveneliana* in response to an ongoing highway expansion project crossing the South Toe River and several tributaries. We used timed searches, plotted the position of each individual mussel using a Trimble sub-meter GPS unit and measured microhabitat conditions at each mussel as well as at regular locations within the reach. Appalachian Elktoe abundance and CPUE decreased from 2015-2016 at 3 of 6 sites despite increased search effort, possibly in response to lower-than-average flows during summer 2016 (2015 surveys were conducted during June and July whereas 2016 surveys were conducted in fall). Spring 2017 *A*. *raveneliana* abundance and CPUE were considerably higher compared to fall 2016 and then both decreased again in fall 2017. Surprisingly, visualizing the location of individual animals indicated that each survey detected considerable numbers of new mussels. It is possible that this is attributable to spatio-temporal variability in fine particle abundance within study reaches. Pebble counts found that the concentration of fine particles in 2016 were highest at 4 of 6 sites including the site where mussel detectability was most variable. Taken together these results suggest that estimates of Appalachian Elktoe abundance may be subject to and affected by substantial variability in year-to-year and seasonal detectability. Future work will attempt to disentangle effects of microhabitat use, behavior and life history (e.g., age, gender) traits on Appalachian Elktoe detectability.

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NOTES:

Assessing Aquatic Faunal Response to Dam Removal: Milburnie Dam Removal Species Monitoring Overview

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Dam removals have become an increasing popular compensatory mitigation option to offset unavoidable impacts to regulated aquatic resources in the Southeast. The interagency North Carolina Dam Removal Task Force (DRTF) was formed to prioritize dam removal and develop guidelines on how to demonstrate chemical and biological improvement and provided a mechanism for determining mitigation credits. The monitoring guidelines, which include various success criteria that determine the amount and type of mitigation credits potentially awarded, have evolved over the years as projects have been implemented. The Performance Standards fall into three main restoration categories: 1) "appropriate aquatic community" criteria, 2) "Rare, Endangered and Threatened (RTE) Species and 3) water quality improvements. Additional site-specific mitigation credits can also be awarded from other benefits, such as restoration of anadromous species passage, demonstrated downstream benefits and human benefits such as independent research, or increased recreational value. The Milburnie Dam on the Neuse River near Raleigh North Carolina was removed in the fall of 2017 to establish the Milburnie Dam Mitigation Bank. The removal is expected to restore 32,590 linear feet of river to lotic conditions. Project specific Performance Standards have been established By DRTF for the bank. A seven-year monitoring protocol will begin in 2018 to determine if the removal project's restoration goals are achieved. Mitigation credits will then be released (in part) based on documented ecological improvements within the Neuse River. The details of the monitoring plan and implementation schedule will be presented.

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NOTES

Science Communication as a Strand in the Aquatic Ecosystem

William Seaman

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This presentation offers a rationale, encouragement and suggestions for professionals in the fishery and aquatic sciences to include interaction with non-technical audiences in their communications, even when it might be outside of our primary job descriptions. To do this it addresses the question, Whether as individual employees of a fishery/aquatic science-focused organization, or as members of the American Fisheries Society and its North Carolina Chapter, shouldn't we have a voice in explaining science to the variety of lay-level audiences that "do not know what they do not know?" Science, in general, and as a source of reliable information enjoys a relatively high level of trust and confidence among the general public, according to various Pew Research surveys. Pew also finds that over a third of American adults enjoy keeping up with science "a lot." Meanwhile, rates of science literacy are sometimes characterized as being quite low, and invoked as a detriment to wise decision and policy making. A tangible example of politics tampering with science-based ecosystem management centers on the threatened Delta Smelt, *Hypomesus transpacificus*, which was criticized as the reason that water was diverted from California farmers, causing a drought for them. The American Fisheries Society is seeking to build its science communications efforts both to build awareness and understanding of fish and habitat issues and to correct erroneous information. Brownell et al. observe, "Communication of science to the general public is increasingly recognized as a responsibility of scientists." Kuehne and Olden address this in part by recommending the preparation of "lay summaries" to disseminate technical findings. They cite research that documents that scientists "who engage in public communication enjoy an enhanced reputation among peers, and rate contacts with media as generally positive and beneficial to their careers." The author writes a science column for a local newspaper.

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NOTES:

Upcoming Removal of Hoosier Dam on the Rocky River in Chatham County

Vann F. Stancil*[1], Brena K. Jones[2], and Anakela Popp[2]
*Presenting

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Hoosier Dam impounds Reeves Lake on the Rocky River 5.5 miles (9 km) upstream of the Deep River confluence in Chatham County. The 25-foot (7.6 m) high hydroelectric dam was constructed in 1922 and currently separates two sections of designated Critical Habitat for the federally endangered Cape Fear Shiner, *Notropis mekistocholas*. This dam is slated for removal in 2018 with funds from a National Fish and Wildlife Federation grant. NCWRC surveys found a robust community of freshwater mussels downstream of Hoosier Dam, including multiple state listed species. The discovery of a population of state endangered Savannah Lilliput, *Toxolasma pullus* represents the first known record from the Rocky River since 1972. Beginning in the summer of 2017, the lake level was slowly lowered using existing turbine control gates and exposed slopes were seeded for stability. Savannah Lilliputs were relocated from the impoundment and the tailrace and a subset were PIT-tagged for monitoring of survival. Removing Hoosier Dam will return the impounded river to a riverine environment, reconnect aquatic communities, and restore connectivity of Critical Habitat for Cape Fear Shiner.

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NOTES:

Monitoring Changes to Interstitial Sediments in the South Toe River Using Freeze Cores

Michael Thompson*[1], Jason Mays[2], and Michael M. Gangloff[1]
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Sedimentation is widely-cited as having impacts to freshwater biodiversity but quantifying sediment composition at a scale that is meaningful to interstitial invertebrates like freshwater mussels can be challenging, especially in streams with coarse substrates. The South Toe River is a headwater of the Tennessee River in western North Carolina that supports one of only a few extant populations of endangered Appalachian Elktoe mussels. As part of a larger project to assess the impacts of a highway expansion project on this stream and its mussel populations we are monitoring surface and interstitial sediment composition using freeze-core sampling. Mussel populations, instream habitat including substrate composition and interstitial sediments were quantified at six sites in the South Toe River during spring and summer sampling. Freeze cores were collected by pounding galvanized iron tubes into the streambed and filling them with crushed dry ice. Tubes were left in place for 20 minutes before being extracted from the substrate. Sediments remaining on each tube were removed, dried, sieved and weighed. We computed the proportion of each sediment size fraction retained on sieves. Overall, the concentration of interstitial fines increased from spring to summer 2017 but the increase was only significant at two sites just downstream of the highway project. Analysis of Variance indicated that interstitial sediment composition differed significantly among sites. The highest concentrations of interstitial fines were measured downstream of Little Crabtree Creek. This site also exhibited a dramatic increase in interstitial fines (4.02% to 11.04%) between March and June 2017. Comparisons at other sites found that the concentration of fines was relatively similar between seasons at most other sites. These data suggest that freeze cores are a viable method for sampling interstitial substrates in montane streams and may provide insights into habitat changes that are not evident from studies of surface conditions.

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NOTES:

Improving Growth and Survival of *In-Vitro* Propagated Mussels and *In-Vitro* Propagation of the Dwarf Wedgemussel

Michael J. Walter* and Jay Levine
*Presenting

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Propagation of freshwater mussels for augmentation and restoration of imperiled species has been done in North Carolina for some time and is an effective tool for conservation. Traditional propagation of freshwater mussels requires a captive population of host fish and the facilities needed to support them. In-vitro propagation simplifies the propagation process by transforming glochidia in a medium bath containing basal media, blood serum and antibiotics/antimycotics instead of on the gill of host fish. While transformation rates of in-vitro propagated mussels are much greater than those propagated traditionally, long term growth and survival falls short. Our work seeks to improve this process through cataloging bacteria present in both newly transformed traditionally propagated individuals and those transformed under sterile in-vitro conditions, altering the grow out environments and feeding regimes of juveniles and through the use of host-specific blood serum (versus a variety of traditionally used mammalian sera). In addition to trials run with various species, we will attempt in-vitro propagation of the Federally Endangered Dwarf Wedgemussel, *Alasmidonta heterodon*. Through trials of different incubation temperatures and serum components, we hope to establish a protocol for the in-vitro propagation of this species.

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Lake Bathymetry Mapping using a Raspberry Pi and Open-Source Software

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Natural resource managers encounter many situations where understanding lake bathymetry is helpful. However, many approaches to collecting and visualizing these data are encumbered by proprietary file formats which only work with expensive and functionally-limited, closed-source software. Our goal was to develop simple and inexpensive techniques to collect and analyze bathymetry data. We used a small (200-acre) local lake to develop data collection techniques, create a bathymetry map, calculate total volume, and test whether we could discern fine-scale benthic features. We surveyed the lake in a jon boat while a Raspberry Pi single-board computer captured NMEA sentences from a traditional 2-D fish finder sonar unit. NMEA sentences are generated at the rate of one-per-second and contain information on location, location uncertainty, and depth. In addition, the lake was circumnavigated in a kayak with a handheld GPS unit to record its perimeter. Two-and-a-half man days of effort generated over 35,000 observations of depth and location. The GNU/Linux command line and the R programming language manipulated and organized the data and QGIS generated the depth raster and contour lines, and calculated the lake volume. The map we created successfully displays fine-resolution features of the lake bottom including the original stream channels and a breached earthen berm at base of the dam.

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NOTES

Impacts of Urbanization on Freshwater Fishes in the Upper Neuse Watershed

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Urbanization degrades ecosystems through a cascade of physical, biogeochemical, and biological modifications. While previous research has identified the drivers and associated responses of terrestrial species impacted by urban land development, these studies have been neglected in aquatic systems. Current projections predict a 139% increase in urban land cover by 2060, suggesting an urgency to understand how anthropogenic disturbances affect aquatic ecosystems and the mechanisms that drive those disturbances. We documented the responses of fish communities and populations in 10 streams across an urban-forest environmental gradient within the Upper Neuse Watershed in North Carolina, which is expected to experience the greatest rate of urban land development in the U.S. in the coming decades. We sampled a 50-meter reach at each stream site, and designated streams as “urban” or “forested” by using 2011 National Land Cover Data to calculate the percent land cover within each delineated stream catchment. Urban sites had a lower mean species richness compared to forested sites (7 ± 4 and 12 ± 2 fishes per stream, respectively). We documented a community shift from ecologically sensitive fish species in forested streams to ecologically tolerant species in urban streams. Specifically, forested streams had high abundance of Cyprinids, such as Bluehead Chubs, *Nocomis leptocephalus*, whereas urban streams were characterized by high abundances of Centrarchids, such as Green Sunfish, *Lepomis cyanellus*. There was an overall trend of decreasing population densities of fish with increasing urban land cover. Our results demonstrate the impacts of urbanization on freshwater fishes and form the foundation for additional projects. Our future research will link these measured responses to specific watershed characteristics, which will be the first study to identify watershed-level traits driving ecosystem responses to disturbance.

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