NORTH CAROLINA CHAPTER
AFS

34th Annual Meeting of the North Carolina Chapter
of the American Fisheries Society
&
The North Carolina Freshwater Mollusk Workgroup

Tuesday, February 21st - Thursday, February 23rd, 2023

Millennium Hotel
2800 Campus Walk Avenue
Durham, NC 27705

We would like to thank the sponsors of the 34th annual meeting of the North Carolina Chapter of the American Fisheries Society

Carolina Madtom - $1,500

Robust Redhorse - $1,000

Muskellunge - $500

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2023 Meeting of the North Carolina Chapter of the American Fisheries Society and the North Carolina Freshwater Mollusk Workgroup

Tuesday, February 21st – Thursday, February 23, 2023

Millennium Hotel
2800 Campus Walk Avenue
Durham, NC 27705

Program at a Glance	
Tuesday, February 21	
0930 - 1730	North Carolina Mollusk Workgroup Meeting
1815 - 2145	NC AFS and North Carolina Mollusk Workgroup Evening Social Hi-Wire Brewing, 800 Taylor Street, Durham (transportation provided)
Wednesday February 22	
0730 - 1800	Registration
0800 - 1130	NC AFS Workshop: "Media Relations and Content Creation"
1130 - 1230	Lunch – on your own
1230 - 1245	Opening Remarks
1245 - 1446	Contributed Papers
1446 - 1500	Afternoon Break I
1500 - 1654	Contributed Papers
1654 - 1715	Afternoon Break II
1715 - 1830	Business Meeting
1900 - 2030	Poster Session
1830 - 2300	Social, Dinner, and NCSU's Student Fisheries Society Raffle
Thursday February 23	
0730 - 0800	Rise and Shine - Bagels with Bryn, optional breakfast seminar
0800 - 1035	Contributed Papers
1035 - 1055	Morning Break
1055 - 1302	Contributed Papers
1302 - 1312	Stretch Break
1312 - 1330	Best Student and Professional Presentations Awards (W. Don Baker and Richard L. Noble awards)
1330	Closing Comments and Adjournment

Tuesday, February 21, 2023

TIME	
0930 - 1730	North Carolina Mollusk Workgroup Meeting
1815 - 2145	**NC AFS and North Carolina Mollusk Workgroup Evening Social** Hi-Wire Brewing, 800 Taylor Street, Durham (transportation to and from hotel provided)

Wednesday, February 22, 2023

TIME	
0730 - 1800	Registration
0800 - 1130	**NC AFS Workshop**
	Media Relations and Content Creation Madeline David, NCWRC
1130 - 1230	**Lunch** – on your own
1230 - 1245	Opening Remarks – Andrea Leslie, NC AFS President, and Kelsey Roberts, NC AFS President-Elect
1245 - 1332	**Session 1: Seeing the Forest for the Trees – New Species of Fish and Crayfish** **Moderator: Tom Fox**
1245 - 1305	**A Progress Report on the Scientific Description of Cyprinella sp. "Thinlip" Chub – A Known Taxon That Has Remained Undescribed for More Than 50 Years** Bryn H. Tracy*, Fred C. (Fritz) Rohde, Michael Perkins, Madelyn G. McCutcheon, and Heather K. Evans
1305 - 1325	**Bringing Back the Natives: Reintroduction of Three Sucker Species in the Upper French Broad River** Luke Etchison*, Dylan Owensby, and Chantelle Rondel
1325 - 1332	**Status of Crayfish Research in the Foothills Region of North Carolina** T.R. Russ* and Michael Perkins
1332 - 1406	**Session 2: Educational Snorkeling, Mola Mania, and Photographing It All** **Moderator: April Boggs**
1332 - 1352	**The Blue Ridge Snorkel Trail: Inspiring Stream Stewardship and Appreciation in Western North Carolina** Andrea J. Leslie* and Luke Etchison
1352 - 1359	**The Acquisition of a Sharptail Mola, *Masturus lanceolatus*, by the North Carolina Museum of Natural Sciences** Gabriela M. Hogue* and Lily C. Hughes
1359 - 1406	**Updates from the NCFishes.com Team** Jesse L. Bissette, Luke Etchison, Gabriela M. Hogue, Fred C. (Fritz) Rohde, Scott A. Smith, and Bryn H. Tracy*

1406 - 1446	**Session 3: Statistical Modeling** **Moderator: Loretta Lutackas**
1406 - 1426	**Integrating Information from Semi-Structured Interviews into Management Strategy Evaluation: A Case Study for Southeast United States Marine Fisheries** Matthew Damiano, Bethany Wager*, Alex Rocco, Kyle W. Shertzer, Grant D. Murray, and Jie Cao
1426 - 1446	**Using Support Vector Machines to Identify Spatiotemporal Drivers from Fishery-Independent Survey Data** Matt Damiano, Taliana Tudryn*, Noah Dunmire, and Jie Cao
1446 - 1500	**Afternoon Break I** **Sponsored by: Dewberry**
1500 - 1627	**Session 4: Stream Restoration, Habitat Fragmentation, and Fish Passage** **Moderator: Dylan Owensby**
1500 - 1520	**Stream Habitat Restoration Projects Focused on Connectivity** Greg Jennings
1520 - 1540	**Assessing Biota and Environmental Characteristics Above and Below a Low-head Dam** Trevor L. Alexander
1540 - 1547	**The Effect of Anthropogenic and Natural Stream Barriers on Sandhills Chub Population Genetic Structure** Riley W. Phelps*, Derek Crane, Tanya Darden, Charles Bryan, Brena Jones, Mark Scott, and Katharine DeVilbiss
1547 - 1607	**Wait for it…Wait for it! -- Detecting Changes in the Mussel Community after Aquatic Habitat Restoration** Michael Fisk*, Michael Walter, Sierra Benfield, and Andrew Glen
1607 - 1627	**Evaluating the Use of eDNA to Monitor American Shad and Atlantic Sturgeon Passage on the Cape Fear River** Heather K. Evans*, Aaron J. Bunch, and Kyle Rachels

1627 - 1654	**Session 5: Mussels – Toxicity & Health – Part 1** **Moderator: Jessica Bauman**
1627 - 1647	**Microbiome Analysis of the Endangered Tar River Spinymussel, *Parvaspina steinstansana*, from the Tar River and Neuse River Basins** Madelyn G. McCutcheon*, Rachael Hoch, Heather K. Evans
1647- 1654	**Evaluating Freshwater Mussel Biomarkers of Health and Immunocompetence** Madison E. Polera*, W. Gregory Cope, Erin McKenney, Catherine E. LePrevost, Jeffrey A. Yoder, Tal Ben-Horin, Chris B. Eads, Heather Evans, Rachael Hoch, J. Michael Fisk II, and Michael J. Walter
1654 - 1715	**Afternoon Break II** **Sponsored by: Jennings Environmental**
1715 - 1830	Business Meeting
1900 - 2030	**Poster Session**
	Assessment of Fish and In-Stream Habitat Responses to the Removal of Payne Branch Dam on the Middle Fork New River (Watauga County, North Carolina) Nick Campany*, M. Worth Pugh, Gary Pandolfi, Jason Selong, and Michael Gangloff
	Evaluating Associations Between Riverine Habitat and Spread of a Non-native Minnow Species in the Little Tennessee River System Jennifer Dunn*, Garrett McCarson, Keith Gibbs, and Bill McLarney
	Estimating Mortality of the North Carolina Blue Crab in Support of improving its Stock Assessment and Management Alex Rocco* and Jie Cao
1830 - 2300	**Social, Dinner and NCSU's Student Fisheries Society Raffle** **Sponsored by: Three Oaks, Duke Energy, and RK&K**

Thursday, February 23, 2023

TIME	
0730	Registration
0730 - 0800	**Rise and Shine – Bagels with Bryn** ***Optional*** **breakfast seminar presented by the North Carolina Freshwater Fishes Council** **The North Carolina Freshwater Fishes Council - An Update on Status Listings** Bryn H. Tracy*, Luke Etchison, Michael Fisk, Ryan J. Heise, Gabriela M. Hogue, and Fred C. (Fritz) Rohde
0800 - 0928	**Session 6: Imperiled Mussels, Crayfish, and Fish** **Moderator: Keith Gibbs**
0800 - 0820	**Age and Growth of the Federally Endangered Dwarf Wedgemussel, *Alasmidonta heterodon,* in the Tar River Basin** Michael Walter* and Andrew Glen
0820 - 0827	**Establishing a Standardized Single-Nucleotide Polymorphism (SNP) Panel for Genetic Parentage-Based Tagging (PBT)of the Tar River Spinymussel, *Parvaspina steinstansana,* and Yellow Lance, *Elliptio lanceolata*** Edie Nissen*, Heather Evans, and W. Gregory Cope
0827 - 0847	**The Distribution of Two Imperiled Native Crayfish, *Procambarus braswelli* and *P. pearsei*, and the Invasive Red Swamp Crayfish, *P. clarkii,* in Southeastern North Carolina** Robert E. Adams*, Sidney J. Busch, Elijah J. Thompson, Robert P. Creed, and Michael M. Gangloff
0847 - 0907	**Rare and Endangered Species Habitat Modeling in the Upper Little Tennessee River Basin** James Miles
0907 - 0914	**A Monitoring Update for the Carolina Pygmy Sunfish** Brena Jones
0914 - 0921	**Distribution of American Brook Lamprey, *Lethenteron appendix,* in North Carolina** Fred C. Rohde*, Bryn H. Tracy, and Michael Fisk
0921 - 0928	**Movement Characteristics of Endemic Sandhills Chub *Semotilus lumbee* in the Sandhills Ecoregion of North and South Carolina** Zachary A. Ramsey*, Derek Crane, Brena Jones, Katharine DeVilbiss, Mark Scott, Tanya Darden, and Charles Bryan

0928 – 1035	**Session 7: Mussels – Toxicity & Health – Part 2** **Moderator: Mike Walter**
0928 - 0948	**Chronic Effects of Sea Salt on Organ Tissues of Sub-Adult Freshwater Mussels in Reconstituted and Natural Waters** Joseph K. McIver II*, W. Gregory Cope, Nathan J. Hostetter, Ryan Boyles, Thomas J. Kwak, Tal Ben-Horin, Frank Weber, Jace Nelson, and Brian Watson
0948 - 1008	**Assessing the Acute Toxicity of Manganese to Freshwater Mussels** Clayton Lynch*, W. Gregory Cope, and Monte McGregor
1008 - 1015	**Composition and Effects of Multiple Serum Types on Freshwater Mussel Development During *In Vitro* Propagation.** Loretta M. Lutackas*, Chris B. Eads, and W. Gregory Cope
1015 - 1035	**New and Old Technologies for Point-Source Identification: A Look in the Toolbox** Sean Buczek*, Craig Hoover, and Eric Morris
1035 - 1055	**Morning Break** **Sponsored by: Transystems**
1055 - 1302	**Session 8: Re-introductions, Recovery, and Conservation of Our Native Species** **Moderator: Lily Hughes**
1055 - 1115	**An Introduction to the Yates Mill Aquatic Conservation Center** Chris B. Eads*, Loretta M. Lutackas, and W. Gregory Cope
1115 - 1135	**Assessing Previous Freshwater Mussel Stocking Sites in the Little Tennessee and French Broad River Basins to Make Informed Stocking Decisions in the Future** Chantelle Rondel*, Dylan Owensby, and Luke Etchison
1135 - 1155	**Draft Recovery Plan for the Federally Threatened Yellow Lance** Jennifer M. Archambault
1155 - 1202	**2022 Trent River Catfish Survey** Todd D. VanMiddlesworth* and Nicholas A. Shaver
1202 - 1222	**Fish Species Classification Using Random Forests** Laura M. Lee
1222 - 1242	**Fyke Nets and PIT Tags to Monitor Sicklefin Redhorse: Lessons Learned and Future Directions** Dylan Owensby*, Luke Etchison, Chantelle Rondel, and Jason Mays
1242 - 1302	**An Overview of Selected Brook Trout Conservation Efforts in North Carolina** Jacob M. Rash*, Douglas A. Besler, Amanda M. Bushon, David W. Goodfred, Kinnon B. Hodges, Thomas C. Johnson, A. Powell Wheeler, and Chris J. Wood
1302 - 1312	**Stretch Break**
1312 - 1330	Best Student and Professional Presentations Awards (W. Don Baker and Richard L. Noble awards)
1330	Closing Comments and Adjournment, Kelsey Roberts - 2023 NC AFS President

2022-2023 NC AFS Officers and Committees

OFFICERS

President: Andrea Leslie
President Elect: Kelsey Roberts

Secretary/Treasurer: Casey Joubert
Past President: Ryan Heise

COMMITTEES

Awards
Co-Chairs: Ryan J. Heise and Corey Oakley

Communications
Chair: Kyle Rachels
Members: Webmaster - Brena Jones; Facebook Administrator - Kevin Dockendorf; Newsletter Review Members - Brena Jones, Morgan Raley, and Bryn Tracy

Education and Outreach
Chair: Seth Mycko
Members: April Boggs, Nick Shaver, and Mike Walter

Finance
Chair: Casey Joubert
Members: Lawrence Dorsey and Joe Hightower

Nominations
Chair: Ryan Heise

Mentoring Committee
Chair: Kevin Dockendorf
Members: Jessica Bauman, Casey Joubert, Neil Medlin, TD VanMiddlesworth, Ben Ricks, and Kelsey Roberts

2023 Annual Meeting
Chair: Kelsey Roberts
Members: Casey Joubert and Bryn Tracy

NC AFS Workshop

"Media Relations and Content Creation"

Madeline David

North Carolina Wildlife Resources Commission, Raleigh, NC

This workshop will cover all of the essential do's and don'ts of creating high quality video and photo content of aquatic resources work. Attendees will learn how to create content with the phones and cameras that most field biologists have access to, with hands-on demonstrations of the best settings and accessories to use. Attendees will then learn best practices for handling media inquiries and broadcasting content to the public.

The Distribution of Two Imperiled Native Crayfish, *Procambarus braswelli* and *P. pearsei*, and the Invasive Red Swamp Crayfish, *P. clarkii,* in Southeastern North Carolina

Robert E. Adams*, Sidney J. Busch, Elijah J. Thompson, Robert P. Creed, and Michael M. Gangloff

*Presenting

Appalachian State University, Biology Department, Boone, NC

The crayfish *Procambarus pearsei* and P. *braswelli* are currently considered species of concern in North Carolina. Both species are endemic to the lower Cape Fear, Pee Dee, and Waccamaw River systems in North Carolina and South Carolina. These drainages have been extensively colonized by the invasive *Procambarus clarkii* raising concerns that this invader may displace smaller and more niche-limited native crayfish species. Indeed, prior to our surveys, *P. pearsei* had not been reported in North Carolina since October 2015. Our goal is to examine whether the distribution and abundance of *P. pearsei* and P. *braswelli* are being affected by *P. clarkii* invasions. To date, we have conducted surveys at 34 historical sites and 42 additional sites across the ranges of *P. pearsei* and *P. braswelli*. We detected *P. braswelli* at 7 of 17 historically occupied sites and *P. pearsei* at 2 of 17 historically-occupied sites. Future surveys will involve sampling year-round to assess the degree to which the distributions of these species have changed over time and determine how seasonality affects the detectability of native and invasive crayfishes. We will also obtain detailed demographic and reproductive-status information to assess whether life history traits may explain some of the potential for competition between native and invasive species. These data will help guide management of both native and invasive crayfishes and hopefully highlight the potential impacts of *P. clarkii* and other invasive crayfishes in this region's unique but vulnerable freshwater ecosystems.

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Keywords: Crayfish, *Procambarus braswelli, P. pearsei*, *P. clarkii*, Red Swamp Crayfish, distributions

Assessing Biota and Environmental Characteristics Above and Below a Low-head Dam

Trevor L. Alexander

Department of Biology, College of Arts and Sciences, Western Carolina University

Dams are a form of anthropogenic alteration to aquatic ecosystems that can affect natural conditions and influence aquatic fauna assemblages. The size and type of a dam can have different effects on the aquatic environment, such as altered flow rate, water temperatures, sediment transport, and can serve as barriers that limit fish migration or distribution of fishes, macroinvertebrates, and aquatic plant species. The focal point of this study is a low head dam, located on the Tuckasegee River in Jackson County, North Carolina. Fish and macroinvertebrates were sampled at multiple sites above and below the dam to compare species assemblages. Macroinvertebrates were sampled with a kick net in shallow riffles and a D-frame net for timed multihabitat sampling. Backpack electrofishers were used to sample fish in available wadeable habitats. We used multivariate statistical analyses to determine similarity of fish and macroinvertebrate assemblages among sites. Our results indicate the dam has minimal effect on aquatic habitat and macroinvertebrate assemblages. We found greater fish diversity below the impoundment. However, several species were only found above or below the dam. Restored connectivity to this system may improve fish diversity above the dam. Removing the dam may cause a temporary decrease in sensitive macroinvertebrates since the dam is withholding sediment. Substrate composition may change temporarily below the dam until the finer substrate is transported downstream. Overall, this study provides baseline data over several years that can be referenced if the dam is removed.

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Keywords: Macroinvertebrates, electrofishing, low-head dam, habitat reconnectivity, Tuckasegee River

Draft Recovery Plan for the Federally Threatened Yellow Lance

Jennifer M. Archambault, Ph.D.

U.S. Fish & Wildlife Service, Eastern North Carolina Ecological Services Field Office, Raleigh, NC

In November 2022, the US Fish and Wildlife Service (USFWS) released a draft recovery plan for the Yellow Lance, *Elliptio lanceolata*, a freshwater mussel listed as threatened under the Endangered Species Act. The USFWS announced the plan with a 30-day public comment period; however, input relevant to the species is welcome at any time. The Recovery Plan describes criteria for determining when the Yellow Lance should be considered for removal from the List of Endangered and Threatened Wildlife (50 CFR 17.11). It also describes specific actions that will be necessary to meet those criteria, and estimates the time and costs for implementing recovery actions. This presentation will include discussion of the three recovery criteria for the Yellow Lance, based on achieving population resiliency and appropriate redundancy within and among populations, species representation, and addressing threats; the rationale for each recovery criterion; recovery actions needed to support the species' recovery (e.g., surveys and monitoring, habitat protection, and captive propagation); and examples of activities that comprise several of the actions. The USFWS is also developing a Recovery Implementation Strategy and is seeking input from conservation partners about specific activities needed for the recovery of the Yellow Lance. The plan estimates that recovery of the Yellow Lance will take about 50 years at a cost of $98.8 million. The USFWS anticipates releasing a final Recovery Plan and a Recovery Implementation Strategy by September 2023.

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Keywords: Yellow Lance, *Elliptio lanceolata*, Recovery Plan, threatened species

Updates from the NCFishes.com Team

Jesse L. Bissette[1], Luke Etchison[2], Gabriela M. Hogue[3], Fred C. (Fritz) Rohde[4], Scott A. Smith[5], and Bryn H. Tracy[6]*

*Presenting

[1]Hubert, NC
[2]North Carolina Wildlife Resources Commission, Aquatic Wildlife Diversity Program, Waynesville, NC
[3]North Carolina Museum of Natural Sciences, Raleigh, NC
[4]Wilmington, NC
[5]Beaufort, NC
[6]Apex, NC

NCFishes.com is an independent, volunteer-driven project developed with the goal of collecting, photographing, and aiding in the identification of freshwater and marine fishes occurring within and off of the coast of North Carolina. Over the past two years we have traveled far and wide in our quest to obtain the highest quality images for our website and for an upcoming book: "*The Freshwater Fishes of North Carolina - A Guide to Their Identification and Distribution*" (in press). This talk will take you on a whirl-wind tour of our adventures in 2021-2022 including field trips to more than 65 sites from the Mountains to the Coast, the creation of thought-provoking blogs, and our public outreach efforts.

Type: Lightning
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Keywords: NCFishes.com website, fish photography, fish identification, outreach

New and Old Technologies for Point-Source Identification: A Look in the Toolbox

Sean Buczek*, Craig Hoover, and Eric Morris

*Presenting

North Carolina Department of Environmental Quality, Division of Water Resources, Raleigh, NC

In response to observed declines in native freshwater mussel populations and elevated in-stream ammonia values in the Rocky River (Chatham County, North Carolina), North Carolina Division of Water Resources (DWR) staff conducted a field investigation to assist in point-source identification employing multiple overlapping technologies. The Rocky River is located in the eastern central Piedmont region of North Carolina and has a drainage area of approximately 243 square miles that supports a diverse community of aquatic fauna including the Cape Fear Shiner, a federally listed endangered species. Beginning in August 2020, and continuing through September 2021, DWR staff conducted physical and chemical monitoring of the lower Rocky River and Loves Creek at nine sites strategically located throughout the drainage from US 64 to the confluence with the Deep River near Moncure. In our multiple approach design, analytical samples for total residue, suspended residue, ammonia, total Kjeldahl nitrogen, nitrate/nitrite, total phosphorus, chloride, turbidity, 5-day biochemical oxygen demand and chlorophyll α were collected during monthly site visits. Additionally, two multi-parameter hydrosondes with self-logging capabilities were deployed within the study area to monitor temperature, pH, dissolved oxygen, ammonia and conductivity. Furthermore, in addition to the chemical and physical data collection efforts described, DWR staff also deployed and monitored six mussel cages, each containing eight adult Eastern Elliptio, *Elliptio complanata*, as a bioindicator of water quality. Analytical results highlight the variability of this system in fluctuating flows but generally most parameters follow a spatial trend with few exceptions, most notably ammonia concentration, which ranged from 0.2 mg/L (PQL) to 6.5 mg/L with mean concentrations increasing markedly during the last two sampling events (0.21 [SD ± 0.42] mg/L and 1.27 [SD ± 2.47] mg/L). During this same period overall mussel survival declined 8%, however, recorded mortality was restricted to a single cage deployed below the confluence of Loves Creek in the Rocky River. Collectively, data generated across all employed methods helped to inform regulators and stakeholders of water quality issues and experience gathered through this study will help improve future intensive water quality monitoring efforts.

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Keywords: Water quality, point source pollution identification, Eastern Elliptio, *Elliptio complanata*

Assessment of Fish and In-Stream Habitat Responses to the Removal of Payne Branch Dam on the Middle Fork New River (Watauga County, North Carolina)

Nick Campany*, M. Worth Pugh, Gary Pandolfi, Jason Selong, and Michael Gangloff

*Presenting

Department of Biology, Appalachian State University

New River Light and Power's Payne Branch Dam on the Middle Fork of the New River was deconstructed in Summer 2020 nearly 50 y after it was decommissioned. The Middle Fork New River historically supported populations of > 20 fish taxa, including several species endemic to the New River drainage. Fish surveys in 2014 revealed that 15 species occurred in the Middle Fork upstream from the dam including small, localized populations of two endemics, Kanawha Minnow, *Phenacobius teretulus*, and Toungetied Minnow, *Exoglossum laurae*. This study evaluated the recovery of fish populations in response to the removal of this barrier. In 2021 and 2022, we sampled fishes using a backpack electrofishing unit and measured habitat parameters (channel width, depth, flow and substrate composition) to assess recolonization at 6 historically- sampled sites with 3 located upstream and 3 downstream from the former dam site. Channel depth and width decreased in the impoundment post-removal and velocity and substrate coarseness increased substantially. Habitat conditions in the tailrace and at our upstream reference sites remained largely unchanged. However, increases in fine sediment (primarily sand) and decreased depth was observed in sites further downstream in the Middle Fork. Post removal community sampling in the former impoundment revealed that fish communities are composed of species associated with high-gradient habitats prior to removal. However, communities at upstream reference sites appear largely unchanged following dam removal. New River endemics have not been detected upstream of the former dam since 2014. Surveys in Spring 2023 will examine whether migration associated with spawning runs affects community structure in the upper Middle Fork and assess whether trans-locations may be needed to promote recovery of upstream communities.

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Keywords: Dam removal, New River, fish, translocation, electrofishing

Integrating Information from Semi-Structured Interviews into Management Strategy Evaluation: A Case Study for Southeast United States Marine Fisheries

Matthew Damiano[1], Bethany Wager[1]*, Alex Rocco[1], Kyle W. Shertzer[2], Grant D. Murray[3], and Jie Cao[1]

*Presenting

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Management strategy evaluation (MSE) has become a more common tool for engaging stakeholders in fisheries management, and stakeholder participation in MSE is increasingly recognized as a vital component of the process. The participation of stakeholders, specifically fishers, in MSE is of particular importance because they often possess intimate knowledge of the socio-ecological management system that MSE seeks to model. When the resources to conduct a "full" MSE with direct fisher involvement are unavailable, MSEs are sometimes conducted by desk-based analysts with no fisher engagement. We propose an intermediate framework in which information collected from semi-structured interviews is used to inform a "desk-based" MSE. We demonstrate that semi-structured interviews with commercial and recreational fishers can elicit some of the same kinds of information that fishers provide during direct participation in MSE. We conducted 30 semi-structured interviews with commercial and recreational fishers from the Southeast United States participating in either Atlantic Cobia, *Rachycentron canadum,* or Black Sea Bass, *Centropristis striata,* fisheries. We collected primarily qualitative and some quantitative information about preferred conceptual objectives and management measures, and how their fishing behavior has changed in response to past management action. Commercial fishers generally preferred conceptual objectives and management measures that align with traditional MSY-based fisheries management, while recreational fishers' responses were substantially more heterogeneous, indicating a more diverse range of desired objectives and preferred management measures. We synthesized this information to develop a suite of management procedures that employ a range of fishing mortality-based constant-catch harvest control rules and size-based management measures for simulation testing against preferred objectives by sector. We demonstrate that integrating information from semi-structured interviews with MSE in this way offers a cost-effective alternative intermediate approach to fisher participation in MSE when direct participation is not possible.

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Keywords: Marine resource management, fishers' knowledge, management strategy evaluation, experiential knowledge, ecosystem approach management

Using Support Vector Machines to Identify Spatiotemporal Drivers from Fishery-Independent Survey Data

Matt Damiano[1], Taliana Tudryn[2]*, Noah Dunmire[2], and Jie Cao[1]

*Presenting

[1]Center for Marine Sciences & Technology, Department of Applied Ecology, North Carolina State University, Morehead City, NC
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Rising ocean temperatures driven by the anthropogenic effects of climate change has led to large-scale redistribution of marine fishes toward poles and deeper water to align with thermally optimal habitat. The development of tools that will improve understanding of changes in fish distribution over space and time is essential to adapt and respond to these shifts. Support vector machines (SVMs) are a family of supervised machine learning algorithms that are not based on characteristics of statistical distributions and therefore avoid the issue of autocorrelated observations likely to be present in ecological observations. The purpose of this study was to determine the general utility of SVMs in spatiotemporal modeling of marine fish distributions using Southeast Black Sea Bass, *Centropristis striata*, as a case study. We trained SVMs on fishery-independent video survey data of Southeast reef fishes during 2011-2021 to predict the presence and absence of Black Sea Bass over space and time. Additionally, we used the SVMs to identify data attributes driving the broad-scale pattern, and parameterized Vector Autoregressive Spatiotemporal (VAST) models for a comparison. SVM models were able to predict Black Sea Bass presence and absence over space and time with approximately 75% accuracy. SVMs identified latitude, longitude, date, depth, salinity, turbidity, and several species associations as the major drivers of the changes in distribution. SVM and VAST models had consistent results: Black Sea Bass distribution has been heavily truncated toward nearshore (< 30 m) environments with large reductions in the southern extent of their range. Furthermore, both models were generally consistent with the most recent standardizations of Southeast Black Sea Bass catch rates. We demonstrate that SVMs are a viable machine learning-based approach to modeling changes in marine fish distribution and a valuable supplementary tool for spatiotemporal models.

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Keywords: Black Sea Bass, Support Vector Machines, spatiotemporal models

Evaluating Associations Between Riverine Habitat and Spread of a Non-native Minnow Species in the Little Tennessee River System

Jennifer Dunn[1]*, Garrett McCarson[1], Keith Gibbs[1], and Bill McLarney[2]

*Presenting
[1]Western Carolina University, Department of Geosciences and Natural Resources, Cullowhee, NC
[2]Mainspring Conservation Trust, Franklin, NC

The Yellowfin Shiner, *Notropis lutipinnis*, is a small leuciscid fish considered to be native to Atlantic Slope watersheds primarily in Georgia and South Carolina. However, their native range extends into North Carolina in the headwaters of the Savannah River basin. Yellowfin Shiners were first documented in the Little Tennessee River (LTR) in Macon County, North Carolina in 1988. Continued sampling of the upper LTR watershed in North Carolina and Georgia over the last 34 years has shown a pattern of dispersal typical of an invasive species. Yellowfin Shiners have now been found in tributary streams more than 30 river kilometers downstream of the lowermost occurrence documented in 1990. Native minnow species, especially Tennessee Shiner, *N. leuciodus*, have been outcompeted, hybridized with, and displaced by yellow shiners in many of these tributaries. The effects are most evident in tributaries in which instream habitat has been visibly degraded due to surrounding land use. Landscape alteration can often change fish assemblages by inhibiting intolerant species while supporting tolerant and invasive species. Currently, Yellowfin Shiner expansion has appeared to have stalled and established populations are most prevalent in the more disturbed watersheds of the upper LTR. Protected riparian areas in the lower reaches may be preventing further spread. However, continued habitat degradation coupled with climate change could promote expansion of this non-native species in the LTR basin and negatively affect this aquatic biodiversity hotspot. Field and laboratory experiments could elucidate the mechanisms allowing yellowfin shiner proliferation outside of their native range.

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Student or Professional? Student
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Keywords: Invasive species, habitat degradation, species competition

An Introduction to the Yates Mill Aquatic Conservation Center

Chris B. Eads*, Loretta M. Lutackas, and W. Gregory Cope

*Presenting

North Carolina State University, Department of Applied Ecology, Raleigh, NC

The Interstate 540 loop around the Raleigh, North Carolina metropolitan area has been developed over multiple decades, and now, construction of the final and southernmost portion of that loop has begun. This part of I-540 crosses Swift Creek (Neuse), which is home to three federally listed freshwater mussels (the Dwarf Wedgemussel, Yellow Lance, and Atlantic Pigtoe), the endangered Carolina Madtom and the threatened Neuse River Waterdog. A lawsuit brought by multiple interest groups over this infrastructure project and its potential impacts led to a settlement that generated funds to establish a conservation aquaculture and research facility at North Carolina State University. Named the Yates Mill Aquatic Conservation Center, its primary mission is to support conservation of the listed species found in Swift Creek through propagation, research, education, and public outreach. In partnership with the North Carolina Department of Transportation, U.S. Fish & Wildlife Service, North Carolina Wildlife Resources Commission, and Wake County, North Carolina State University is renovating their existing research wing at Historic Yates Mill County Park. In total, the facility will consist of approximately 4000 ft^2 of both indoor and outdoor research and production space. An additional 800 ft^2 pump house was erected on site capable of delivering approximately 500 GPM of flow from the pond filtered down to 25 microns and also similarly filtering and UV sterilizing the outflow from the facility. Besides the primary wet lab, an additional classroom, office, and laboratory for *in vitro* mussel propagation will allow for a variety of production, research and educational opportunities. Current funding will support three permanent staff and additional seasonal help for an initial ten years. While our primary focus will be on the three listed mussel species found in Swift Creek, as well as the endangered Magnificent Ramshorn snail, we believe the facility will attract additional funding, students, collaborative research, and conservation projects for other imperiled aquatic species in North Carolina.

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Bringing Back the Natives: Reintroduction of Three Sucker Species in the Upper French Broad River

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The French Broad River is one of the oldest rivers in the world. From its headwaters in North Carolina to where it joins the Holston River to create the Tennessee River in East Tennessee, the French Broad River is home to an exceptionally high amount of aquatic biodiversity. The recent publication, An Annotated Atlas of Freshwater Fishes of North Carolina (Tracy et al. 2020), documented ~76 indigenous fish species from historical and recent collection data from the North Carolina sections of the French Broad River Basin. However, anthropogenic alteration over the last few centuries in the French Broad River and its tributaries have led to extirpations and population declines for many of its known and unknown historical species. Since Congress passed the Clean Water Act in 1972, the water quality of the French Broad River has drastically improved, but barriers to expansion (e.g. dams) limit the potential recovery of many historical fish species without stocking or translocation. Starting in June 2022, Black Buffalo, *Ictiobus niger,* Smallmouth Buffalo, *I. bubalus,* and Smallmouth Redhorse, *Moxostoma breviceps*, were reintroduced into the upper French Broad River. A combination of long-term monitoring sites and PIT antenna arrays will help track this reintroduction into the future.

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Evaluating the Use of eDNA to Monitor American Shad and Atlantic Sturgeon Passage on the Cape Fear River

Heather K. Evans[1]*, Aaron J. Bunch[2], and Kyle Rachels[3]

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Previously developed environmental DNA (eDNA) assays for American Shad, *Alosa sapidissima,* and Atlantic Sturgeon, *Acipenser oxyrhynchus*, were evaluated for use in monitoring passage of these two species above the lock and dam systems on the Cape Fear River. Of particular interest was the question of whether flood pulses released by the U.S. Army Corps of Engineers would create opportunities for these fish to access upstream spawning grounds in the spring. Weekly water samples were taken from March through May and analyzed for the presence of American Shad and Atlantic sturgeon DNA. Results for were compared with electrofishing and telemetry data taken during the same weeks. Our results show that American Shad were able to access habitat upstream of Lock and Dam 3 prior to flood pulses, likely due to natural flood pulses early in the spawning season. We also show that Atlantic Sturgeon were found downstream of Lock and Dam 1 during the spawning season, and we provide evidence that Atlantic Sturgeon were able to access spawning ground above Lock and Dam 1 after a pulse was released. No sturgeon were detected above Lock and Dam 2. Further investigation is needed to evaluate the use of eDNA as a quantitative measure of abundance and to assess passage efficacy in relation to flood pulse timing, magnitude, duration, and frequency.

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Wait for it … Wait for it!

Detecting Changes in the Mussel Community after Aquatic Habitat Restoration

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Dams can greatly alter lotic habitats by reducing flow, altering water quality, and inhibiting migration. As a result of the construction of the Roanoke Rapids Dam and new river channel on the Roanoke River in 1955, the original river channel was largely dewatered except for periodic dam releases and flooding events. Sporadic mussel surveys after construction documented some mussels within this reach but numbers were greatly reduced because of the lack of available, suitable habitat. As part of the hydropower relicensing agreement in 2005, Dominion Power began releasing water back into the original river channel (bypass reach) and were charged with conducting mussel surveys every seven years beginning in 2007. Since then, three mussel surveys have been conducted by the North Carolina Wildlife Resources Commission from 2007 up to 2021. In July 2021, eight surveyors spent 62.5 person hours over two days snorkeling for mussels through the bypass reach (~1 km). Over 2,000 mussels representing 10 species were documented. This was a significant increase in mussel abundance compared to past surveys documenting <100 mussels in 2007, and <200 mussels in 2014. Three species, the Northern Lance, *Elliptio fisheriana*, Eastern Elliptio, *E. complanata*, and Eastern Lampmussel, *Lampsilis radiata*, represent 97% of all mussels documented in 2021. Live Roanoke Slabshell, *E. roanokensis* and Triangle Floater, *Alasmidonta undulata* were documented in 2021 whereas in previous surveys only shells had been collected. Other notable species documented were the Alewife Floater, *Utterbackiana implicata*, Tidewater Mucket, *Leptodea ochracea*, and Eastern Pondmussel, *Ligumia nasuta*—all listed as state threatened in North Carolina. The increase in abundance shows that mussel restoration can take several decades before significant changes are documented and that extended timeframes should be considered when evaluating restoration efforts.

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The Acquisition of a Sharptail Mola, *Masturus lanceolatus*, by the North Carolina Museum of Natural Sciences

Gabriela M. Hogue* and Lily C. Hughes

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North Carolina Museum of Natural Sciences, Raleigh, NC

On November 30, 2022, a Sharptail Mola, *Masturus lanceolatus,* washed up on the shore of North Topsail Beach, Pender County. An avid fisherman and worker at Seaview Pier realized that this beautiful creature was a rare find and began contacting State agencies. This was how the journey for the members of the Ichthyology Unit of the North Carolina Museum of Natural Sciences, and many others, began in acquiring this wonderful addition for the museum. This presentation will detail the steps taken to bring the specimen to Raleigh and preserve it for future research and education.

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Stream Habitat Restoration Projects Focused on Connectivity

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Connectivity is a fundamental requirement for optimal stream function. Barriers to aquatic organism passage (AOP) are often associated with impoundments, road crossings, and utility crossings. Ecological impacts of these anthropogenic structures include habitat loss in the stream channel and floodplain, excessive erosion and sedimentation due to hydraulic adjustments, and changes to the natural fluvial sediment transport regime. Remediation measures may include complete structure removal and restoration of the natural ecosystem or a combination of ecological engineering practices to improve stream conditions while maintaining infrastructure functions. This presentation reviews several case studies that successfully implemented habitat enhancement techniques to address AOP barriers. Some projects include replacement of undersized and perched culverts with natural bottom crossing structures, while others removed unnecessary dams and culverts entirely. Most of the projects include natural stream bed structures consisting of rocks and logs to transition bed slope from upstream to downstream while facilitating aquatic organism passage. These step structures are critical elements of AOP projects that may be designed as step-pools, cascades, or riffles depending on site conditions and organism requirements. Specific design parameters include step height, flow depth, velocity, shear stress, and hydraulic convergence/divergence length. Successful stream restoration design teams include engineers, geomorphologists, and ecologists to ensure that all objectives are optimized. Lessons learned from AOP enhancement projects should be integrated into watershed planning to restore stream functions and to avoid future impacts of development infrastructure.

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A Monitoring Update for the Carolina Pygmy Sunfish

Brena Jones

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North Carolina Wildlife Resources Commission conducts ongoing annual monitoring for the rare Carolina Pygmy Sunfish, *Elassoma boehlkei*, a species endemic to small portions of the Coastal Plain of the Carolinas. Five years of monitoring have been completed, beginning in 2017. The species has successfully been detected at 38-75% of sites sampled, with average catch rates ranging from 2 to 13 individuals per person-hour. Despite the impacts of several major hurricanes during this period, the species appears to be persisting and successfully reproducing within the North Carolina portion of its range.

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Fish Species Classification Using Random Forests

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Random forests is a powerful statistical classifier that is well established in other disciplines and is gaining traction in the field of ecology. Random forests are widely used in a variety of applications, including species classification, because they can handle large datasets, work well with a mix of continuous and categorical features, and are resistant to overfitting. Additionally, random forests make no assumptions about the data. This presentation will demonstrate the use of random forest modeling for species classification. Species classification is the process of grouping organisms into categories based on their shared characteristics (physical, behavioral, ecological, and/or genetic). Species classification helps us understand and protect the natural world. I will discuss the advantages of using random forests for species classification, as well as the limitations and considerations to keep in mind when using this approach.

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The Blue Ridge Snorkel Trail: Inspiring Stream Stewardship and Appreciation in Western North Carolina

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The Blue Ridge Snorkel Trail (BRST) is an innovative education project that will link together a set of publicly accessible river sites where people can safely snorkel to experience the underwater world of streams and rivers of western North Carolina (NC). Phase I of the snorkel trail involves establishing a set of 10 pilot sites, in 10 different counties. Each site will have an educational sign, which provides safety information and a description of notable species at the site. Additional information on the fishes that can be found at each site and additional BRST locations will be provided on the NCFishes.com website. The BRST is a cooperative project among the North Carolina Wildlife Resources Commission, MountainTrue, Mainspring Conservation Trust, and the NC Fishes team. The trail is set to break ground in Spring 2023; if successful, it may be expanded to additional locations across the Blue Ridge, both in North Carolina and in other adjoining states.

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Composition and Effects of Multiple Serum Types on Freshwater Mussel Development During *In Vitro* Propagation.

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Captive propagation of freshwater mussels (order Unionida) is a tool used in conservation to augment populations that are declining in the wild. Through *in vitro* techniques that mimic the unique parasitic life phase possessed by this globally endangered animal group, we are able to propagate many species without the use of live host fish (*in vivo* propagation), thereby reducing costs, time, and potential impact on fish populations. Using modified cell culture techniques, larval mussels (called glochidia) are placed in a combination of cell culture media, mammalian serum (a readily available protein source), and antimicrobials until the metamorphosis to the juvenile life stage is complete. Suboptimal *in vitro* conditions, however, can negatively impact transformation rate, juvenile development, and consequently, juvenile performance post-transformation. We have observed differences in juvenile activity levels and foot and organ development based on different media serum types. In this study, we will characterize the amino acid and lipid composition of three common sera (equine, fetal bovine, and rabbit) used for *in vitro* propagation of freshwater mussels and use various combinations of them to propagate two North Carolina native mussel species: *Elliptio lanceolata* and *Venustaconcha constricta*. Pre-transformation development will be documented and categorized; metabolomics will be used to understand the biological processes occurring and those associated with the growth observed at a given time point. To further examine juvenile performance, survival and growth will be measured for one month. This study will fill an existing knowledge gap for larval development and its association with serum composition. It will aid in identifying critical components for suitable serum selection for these species and link visual developmental markers indicative of a successful transformation with metabolomic data. In the future, these data can be compared to host fish blood composition for further insight into integral elements required for early growth.

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Assessing the Acute Toxicity of Manganese to Freshwater Mussels

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North American freshwater mussels of the family Unionidae are experiencing high imperilment status due to multiple human mediated changes. Adverse impacts from unknown origins have caused mussel die-offs, population declines, and decreased mussel growth and survival. Investigations have uncovered an unexplained relationship between high Manganese (Mn) concentrations and these events. To understand the effects of Mn on mussel survivability, we conducted a series of acute toxicity tests on the early life stages of multiple species from the family Unionidae. Acute tests were run on the glochidia of 9 species and on the juveniles of 5 species. Glochidia and juveniles of each species were exposed to seven concentrations of Mn from 5 to 160mg/L following ASTM protocols. Glochidia underwent a 48-hour acute toxicity test, where viability was assessed at hour 24 and 48. Juveniles underwent a 96-hour acute toxicity test, where viability was assessed at hour 48 and 96. We calculated the median lethal concentration (LC50) for each of the acute toxicity tests. The LC50 for the glochidia stage at 24 h using $MnCl_2$ ranged from 16.8 mg/L to 115.6 mg/L. The LC50 for the glochidia stage at 24 h using $MnSO_4$ ranged from 18.1 mg/L to 125.2 mg/L. *Epioblasma triquetra* was the most sensitive to both forms of Mn. At the 96h time point, the juvenile LC50s ranged from 22.8 mg/L to 160 mg/L after $MnCl_2$ exposure and 18.9 mg/L to 143.7 mg/L after $MnSO_4$ exposure. *Utterbackia imbecillis* was most sensitive to $MnCl_2$ and *Lampsilis cardium* was most sensitive to $MnSO_4$. Acute exposure to dissolved Mn in two common forms can negatively impact freshwater mussel viability, especially at the glochidia stage. This research can be used to establish freshwater mussel conservation plans and identify stream areas at risk to mussels.

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Microbiome Analysis of the Endangered Tar River Spinymussel, *Parvaspina steinstansana*, from the Tar River and Neuse River Basins

Madelyn G. McCutcheon[1]; Rachael Hoch[2]; Heather K. Evans[1]

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The Tar River Spinymussel, *Parvaspina steinstansana,* is a freshwater mussel that inhabits fast-flowing, well-oxygenated waters along the Neuse River and Tar River Basins in North Carolina. This Unionid is considered endangered at both the state and federal levels due to several different factors such as the loss of larval host species, human impact (sediment disturbance and water pollution), and dam construction - both natural and man-made. Additionally, mass mortality events are of concern, as they have historically occurred ambiguously within this taxon. Recent studies on similar events, however, have revealed a probable connection between the presence of certain bacterial or viral taxa and populations experiencing mass mortality. The goal for this study is to analyze the microbiome of healthy and unhealthy hatchery populations of the Tar River Spinymussel and to classify the microbiota of each population to pinpoint any biomarkers or precursors for declining health. A total of 93 mussel samples (collected between May of 2009 and February of 2021) were swabbed for DNA extraction - 9 wild-born-unhealthy, 24 wild-born-healthy, 30 propagated-unhealthy, and 30 propagated-healthy. The 16S region was amplified, and subsequent libraries were sequenced on an Illumina MiSeq instrument. Data analyses and differential abundance testing was conducted using Qiime2. Initial analyses have identified differentially abundant bacterial taxa between the healthy and unhealthy populations. Of the identified taxa, several phyla, such as Planctomycetota, were more abundant in the healthy populations than in the unhealthy, which could indicate that the presence of certain bacteria may be necessary to maintain a healthy population. Future studies can examine the correlative versus causal relationships between the presence of these taxa and Tar River Spinymussel health to confirm potential biomarkers for future population monitoring and habitat maintenance.

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Chronic Effects of Sea Salt on Organ Tissues of Sub-Adult Freshwater Mussels in Reconstituted and Natural Waters

Joseph K. McIver II[1]*, W. Gregory Cope[1], Nathan J. Hostetter[2], Ryan Boyles[3], Thomas J. Kwak[2,a], Tal Ben-Horin[4], Frank Weber[5], Jace Nelson[6], and Brian Watson[7]

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Freshwater mussels can be negatively impacted by water salinization associated with climate-induced sea level rise. The impact of sea salt on freshwater mussel organs is poorly understood. After exposure to a toxicant (sea salt), histopathological evaluations can be used to examine damage incurred by organ tissues. Therefore, we conducted 28-day chronic toxicity tests on 2 species of sub-adult freshwater mussels that inhabit Atlantic Slope drainages (non-salinity adapted *Atlanticoncha ochracea,* salinity adapted *Atlanticoncha ochracea,* and *Utterbackiana implicata*). Mussels were exposed to the toxicant, Instant Ocean® Sea Salt (IOSS) and sampled for ion chemistry and histopathological analyses at day 0 (baseline), 7, 14, and 28. IOSS exposure concentrations were 1, 2, 4, and 6 parts per thousand (ppt) for the *U. implicata* test and 1, 2, and 4 ppt for both *A. ochracea* tests. Most freshwater mussel toxicity tests are conducted in standard reconstituted water. Conducting toxicity tests with standard reconstituted water is valuable for comparative purposes but is not as environmentally relevant as using natural waters. Therefore, *U. implicata* was tested in reconstituted water; non-salinity adapted *A. ochracea* and salinity adapted *A. ochracea* were tested in reciprocal natural waters to those of their broodstock collection. *U. implicata* exposed to 4 and 6 ppt treatments exhibited extensive mortality by day 4. *A. ochracea* did not exhibit mortality during either test. Notable damage to digestive diverticula was found in *U. implicata*. Mean sodium concentrations in mussel body tissues were significantly greater in some 2, 4, and 6 ppt treatments compared to mean baseline concentrations. Non-salinity adapted *A. ochracea* exhibited greater variance in tissue ion concentrations than their salinity adapted counterparts. This information can be used to enhance freshwater mussel conservation strategies in regions that are, or will be impacted by freshwater salinization associated with climate-induced sea level rise.

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Rare and Endangered Species Habitat Modeling in the Upper Little Tennessee River Basin

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The southeastern United States is known for rich levels of aquatic diversity, especially within its fish and mussel species. Decreases in diversity have been associated with the degradation and fragmentation of aquatic habitats essential to these diverse communities of aquatic organisms. Quantification and characterization of habitat use of imperiled fish and mussels are vital to fully understanding these species, with the hopes of preserving and possibly reintroducing them into their historic range where suitable habitat possibly still exists. Throughout this study, we identified, assessed, and compiled habitat availability in sites across the Little Tennessee River Basin upstream of Fontana Reservoir. We used geospatial and multivariate statistical analyses to develop habitat models for species of greatest conservation need to identify potential reintroduction sites. These models have been developed for several fish species such as Stonecat, *Noturus flavus*, Spotfin Chub, *Cyprinella monacha* (= *Erimonax monachus*), and the undescribed Sicklefin Redhorse, *Moxostoma* sp. Mussels of interest include the Tennessee Clubshell, *Pleurobema oviforme*, Appalachian Elktoe, *Alasmidonta raveneliana*, and Slippershell, *A. viridis*. Analysis of Similarity resulted in significant differences between mainstem sites above and below impoundments and tributary sites. The SIMPER function identified sand, silt, and woody debris percentages as being influential to differences among sites. These characteristics could prove to be limiting habitat factors for translocating some species. This information can be used by management organizations to further support the conservation needs of these species.

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Establishing a Standardized Single-Nucleotide Polymorphism (SNP) Panel for Genetic Parentage-Based Tagging (PBT)of the Tar River Spinymussel, *Parvaspina steinstansana*, and Yellow Lance, *Elliptio lanceolata*

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Freshwater mussels are among the most imperiled groups of organisms around the world, and North America harbors more than 300 species. Because of the important role these animals play in nutrient cycling and other ecosystem services, they can have a substantial impact on the health of aquatic habitats. Due to pollution, habitat loss, and declining water quality, around 75% of our 300 species are threatened, endangered, of special concern, or are already extinct. Two imperiled species distributed in central North Carolina are the federally endangered Tar River Spinymussel, *Parvaspina steinstansana*, and the state endangered Yellow Lance, *Elliptio lanceolata*. The objective of this study is to create a standardized single-nucleotide polymorphism (SNP) panel for these two species to be used in monitoring the success of hatchery stockings through genetic parentage-based tagging (PBT). DNA samples have been collected from Tar River Spinymussel and Yellow Lance broodstock. Positive controls for each species have been obtained, as well as any negative controls (wild-born not used as broodstock) that could be found. A selection of several hundred SNPs will be pulled from thousands of previously identified SNPs to create a panel that will allow for high throughput, yet accurate detection of hatchery-bred individuals. Ultimately, the panel will be used to monitor genetic diversity and population structure with ongoing restoration efforts. This study will contribute knowledge and resources for future reintroductions and augmentations of these imperiled mussel species, as well as provide insight on the benefits of using genetic tools in conservation.

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Fyke Nets and PIT Tags to Monitor Sicklefin Redhorse: Lessons Learned and Future Directions

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The Sicklefin Redhorse, *Moxostoma* sp., is a sucker species endemic to the Little Tennessee and Hiwassee River Basins in western North Carolina and northeastern Georgia. The fish was listed as a Candidate For Listing with the U.S. Fish & Wildlife Service in 2005, but a Candidate Conservation Agreement was created in 2015 to actively promote conservation actions of the species with the hope of avoiding an official listing under the Endangered Species Act. A variety of methods have been used to manage this species, including sampling gear such as fyke nets and passive integrated transponder (PIT) technology. Fyke nets function similarly to fish weirs; they consist of two mesh wings that funnel fish upstream into a metal-framed, mesh trap that can be easily checked without harming fish. PIT tags are often used as a tool for mark-recapture studies but can also illustrate migration patterns through the use of stationary antennas. These methods have been implemented in the Hiwassee and Little Tennessee river basins with mixed success. PIT tags have been effective at providing population estimates and home range information, but stationary PIT tag antennae were unsuccessful in the Valley River. Fyke nets were initially successful in capturing Sicklefin Redhorse and other Catostomidae species during their spring spawning runs in the Valley River (mean width: 24 m, mean flow: 256 cfs), but mostly unsuccessful in the Oconaluftee River (mean width: 44 m, mean flow: 524 cfs). During the 2021 and 2022 seasons, capture rates in fyke nets began to decline dramatically. Large holes, presumably from otters, were routinely found during net checks and fish were likely able to escape without detection. We plan to continue mark-recapture efforts and will experiment with fyke netting and other methods in small tributaries of the Hiwassee Basin in hopes of detecting new spawning runs for the Sicklefin Redhorse.

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The Effect of Anthropogenic and Natural Stream Barriers on Sandhills Chub Population Genetic Structure

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The Sandhills Chub, *Semotilus lumbee,* is a small, headwater stream fish endemic to the Sandhills ecoregion of North Carolina and South Carolina. Habitat loss, fragmentation, and land use changes threaten Sandhills Chub populations and South Carolina and North Carolina have listed Sandhills Chub as a Species of Greatest Conservation Need. Additionally, habitat fragmentation connectivity potentially leads to a reduction in gene flow. Stream barriers disrupting connectivity occur naturally and anthropogenically in the Sandhills. Beaver dams are a common natural stream barrier and small impoundments are a common anthropogenic barrier occurring in the Sandhills. Natural stream barriers' effects on small stream fishes are not well known, but anthropogenic barriers can impact dispersal and gene flow. The objectives of this study are to quantify the role of anthropogenic stream barriers and beaver dams on the genetic population structure, and genetic health of Sandhills Chub. Sampling of Sandhills Chubs began in May 2022 and will continue through October 2024, with samples being collected throughout the species distribution. Sandhills Chubs will be collected above and below natural and anthropogenic barriers and in unfragmented streams. Genetic population structure, genetic diversity, effective population size, gene flow, and inbreeding rates will then be examined as a function of number and barrier type. Thus far genetic samples have been collected from 231 Sandhills Chubs across six HUC12 units in the Great Pee Dee and Cape Fear watersheds. This study will provide useful insight into the role anthropogenic and natural barriers have in structuring Sandhills Chub population genetics.

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Keywords: Sandhills Chub, *Semotilus lumbee,* population genetics, anthropogenic barriers, conservation, habitat fragmentation

Evaluating Freshwater Mussel Biomarkers of Health and Immunocompetence

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Freshwater mussels (Order Unionida) are among the most imperiled faunal groups facing, enigmatic die-offs and widespread population declines. Historically, these declines have occurred following conspicuous impacts of habitat destruction, pollution, invasive species, and stream impoundments. Contemporary mussel die-offs often lack such discriminant explanations, and diagnoses are often limited to post-hoc mass mortality evaluations. Sublethal metrics and markers serve to proactively identify infection, stress responses, and deviation from physiological homeostasis. We intend to identify, evaluate, and validate a suite of biomarkers reflective of immunocompetence and immunopathology by integrating immunology, microbiology, histopathology, and metabolomics. Samples of wild and hatchery mussels will be used to establish biomarker baseline reference ranges and describe variation across spatial and taxonomic scales. Experimental trials will be used to quantify the response of immune defense parameters in circulating hemolymph such as total and differential hemocyte counts, hemocyte morphology, and hemocyte function in the face of environmental stressors and infectious disease. The correlation between microbiome diversity metrics and mussel immune status will be evaluated in hemolymph and mucosal surfaces. Finally, metabolomics will be used to explore disease mechanisms and identify candidate hemolymph metabolite biomarkers. These assays will combat challenges of conducting health assessments on threatened and endangered species in streamside surveys by evaluating potential surrogate species and cross-validating mobile, accessible, noninvasive, and high throughput methods. We anticipate that these standardized practices of surveying for early warning signs of compromised health or susceptibility will better inform management, propagation, and conservation decisions.

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Movement Characteristics of Endemic Sandhills Chub *Semotilus lumbee* in the Sandhills Ecoregion of North and South Carolina

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The Sandhills Chub, S*emotilus lumbee,* is a Leuciscid endemic to headwater streams in the Sandhills ecoregion of North and South Carolina, and restricted to the Cape Fear, Lumber, Lynches, Pee Dee, and Wateree River basins. They can be found in cool, clear streams with abundant cover and fine gravel and sandy substrates. Due to their limited range, the Sandhills Chub is considered a species of special concern and is vulnerable to population losses and decline from habitat modification and development within the region. Little is known about the behavior and ecology of Sandhills Chub. Therefore, the objective of this study is to quantify Sandhills Chub movement via mark-recapture methods using passive integrated transponder (PIT) tags. Specifically, this study will measure movement of fish at the individual level, as well as investigate if factors such as water temperature, water flow, and size are related to movement. We will also be investigating if Sandhills Chub exhibit seasonal movement patterns. Two study streams (Gum Branch Creek on U.S Army base, Fort Bragg, and an unnamed tributary of Aberdeen Creek in Pinebluff, NC) were selected based on historical catch records and data from a pilot study completed in summer 2022. Within each stream, the study is taking place in 900-m reaches that are divided into 25-meter sections. From October 8 through October 14, 2022, 85 Sandhills Chub were captured via backpack electrofishing and tagged. Sampling will continue in North Carolina through October 2023, to record recaptures and tag new fish. The study will be replicated in two South Carolina streams from October 2023 through October 2024. Results from this study will provide information about the ecology of Sandhills Chub and be used to help guide management of the species.

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An Overview of Selected Brook Trout Conservation Efforts in North Carolina

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As North Carolina's only native salmonid, Brook Trout, *Salvelinus fontinalis*, is a fish of considerable ecological and cultural significance in the state, but anthropogenic alterations to the landscape and introductions of nonnative salmonids have fragmented and reduced its native range. As a result, the North Carolina Wildlife Resources Commission (NCWRC) has enacted numerous efforts to help conserve this species. Comprehensive documentation of self-sustaining populations began in 1978, and to this date, previously unidentified populations are located annually. Of the over 700 populations identified, many were examined by historical allozyme (480 collections) and contemporary microsatellite (541 collections) analyses to generate a suite of genetic information. These data guided 17 population restoration projects during the last 15 years, while also informing habitat enhancement activities by the NCWRC and its partners. In 1989, long-term monitoring of self-sustaining trout populations began, and today, the NCWRC is collaborating with regional partners to characterize the spatial and temporal variability of Brook Trout population dynamics in the Southeastern United States. In addition, the NCWRC has worked since 2015 to evaluate fish health *via* screenings for the newly discovered, nonnative-invasive pathogens *Myxobolus cerebralis* (the causative agent of salmonid whirling disease) and gill lice (*Salmincola edwardsi and S. californiensis*). Although many efforts are longstanding, the NCWRC will continue to supplement existing baseline data and explore innovative approaches (e.g., Brook Trout phylogenomics) to increase understanding of the species). Ultimately, these endeavors will continue to improve the efficacy of conservation actions for Brook Trout in North Carolina and throughout its native range.

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Estimating Mortality of the North Carolina Blue Crab in Support of improving its Stock Assessment and Management

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The North Carolina Blue Crab, *Callinectes sapidus,* stock is the most valuable fishery in the state. Despite this, North Carolina Division of Marine Fisheries' recent Blue Crab stock assessments still partially rely on life history estimates, such as growth, from the Florida and Chesapeake Bay stocks, and other estimates, such as mortality, are outdated. In order to update these life history estimates, we are conducting mark-recapture study using injectable coded wire tags. In the summer of 2022, we regularly deployed traps and tagged the Blue Crabs we captured. Recaptures were sacrificed and brought back to the lab for identification. Once back in the lab, the tag was removed from the individual and identified using the code imprinted on it. This allows for identification of the specific tagged individual. So far, we have captured and tagged 192 individuals and had 4 recaptures, with a tag return rate of 2%. For the 2023 sampling season, we plan to improve our capture rate using active sampling methods such as beam-trawl sampling in conjunction with trapping. Moving forward, we plan to build a model that accounts for uncertainty in the mark-recapture process and accurately captures estimates of growth and mortality in North Carolina blue crabs.

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Distribution of American Brook Lamprey, *Lethenteron appendix,* in North Carolina

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The American Brook Lamprey, *Lethenteron appendix,* was first discovered in August 1977 in the French Broad River at the mouth of Spring Creek in Hot Springs (Madison County) in western North Carolina by Tennessee Valley Authority biologists, and until recently, this imperiled species has only been found in Spring Creek. In March 2021 we received a report from Todd Pusser of a sighting by Rufus Johnson, an amateur fossil-hunter and landowner in Halifax County (Roanoke River basin) of spawning small lampreys in "his" stream. Our initial assumption was they were Least Brook Lamprey, *Lampetra aepyptera,* because it is the only brook lamprey known to be found in eastern North Carolina, along with the much larger parasitic Sea Lamprey, *Petromyzon marinus*. One of us held out hope that it might be American Brook Lamprey because it has been documented in the nearby Meherrin River drainage in Virginia. The pandemic slowed us down for a year, but we visited the area on March 02, 2022. We quickly found adult lampreys in a tiny tributary of a larger unnamed tributary of Quankey Creek and immediately determined that they were indeed American Brook Lamprey. More individuals were observed in the larger unnamed tributary, and later that afternoon, additional adults were also found in nearby Little Quankey Creek. Thus, this represents the second location of the species in North Carolina, approximately 370 air miles east of the Spring Creek site. Surveys for American Brook Lamprey within the Roanoke River basin will continue in order to document the specie's current distribution in North Carolina.

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Assessing Previous Freshwater Mussel Stocking Sites in the Little Tennessee and French Broad River Basins to Make Informed Stocking Decisions in the Future

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Freshwater mussels are among the most imperiled taxa in the world. With wild freshwater mussel abundance and distribution decreasing, plans for species recovery often include augmentation and reintroduction. Augmentations and reintroductions are implemented by propagation and translocation methods. Since 2007, biologists with the North Carolina Wildlife Resources Commission have augmented or reintroduced eight freshwater mussel species in the Little Tennessee and French Broad River basins. When the Marion Conservation Aquaculture Center began large-scale propagation in 2012, the potential for recovery of freshwater mussel species across the state became more attainable. To date, the Little Tennessee and French Broad river basins have had >100,000 hatchery propagated and >3,000 translocated mussels stocked at 59 sites. However, growth and survival of all species has varied by year, site, and species. Variation in stocking success is likely driven by species specific habitat requirements within and between sites and needs to be better understood. Criteria for species specific habitat suitability needs to be determined to optimize growth and survival of stocked individuals. As propagation and translocation of freshwater mussels continues, it is important to understand what constitutes a suitable stocking site for these species to improve recovery of these imperiled species.

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Status of Crayfish Research in the Foothills Region of North Carolina

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Since 2015 Aquatic Wildlife Diversity biologists, in partnership with the North Carolina Museum of Natural Science (NCSM), have sought to better understand the crayfish distribution and diversity in the Foothills Region of North Carolina. Surveys were conducted in the Broad, Catawba, Upper Yadkin, and Dan River basins in various size streams; the general focus was to have a minimum one survey per 12 Digit Hydrological Unit. Crayfish capture techniques were variable but primarily focused on disturbing the stream bed via rock flipping, electrofishing, and kicking woody debris downstream into seines or dipnets. If possible, specimens were identified and released in the field or preserved in 95% denatured ethanol and later identified in the lab. To date 511 surveys have been completed, and 5,268 individuals have been identified. Collaborators at NCSM used standard Sanger sequencing of the COI barcoding region to confirm putative field IDs and identify unknown or unique lineages. Crayfish population genetics and morphometric analysis revealed at minimum, 13 undescribed crayfish in the region. One crayfish has been described (*Cambarus franklini*), 2 crayfish descriptions are in review, and 10 more await authorship. Several undescribed species are highly endemic and typically only occur in four or fewer 12-digit HUCs, while others span several counties and multiple river basins, some into South Carolina and Virginia.

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The North Carolina Freshwater Fishes Council - An Update on Status Listings

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The Freshwater Fishes Council operates under the auspices of the North Carolina Wildlife Resources' Nongame Wildlife Advisory Committee. Since 1988 our charge has been: "*to review the scientific evidence and to evaluate the status of wildlife species that are candidates for inclusion on a protected animal list*" (North Carolina General Statutes, Chapter 113, Article 25). Our current five member Council has conducted business between 2019 and the present day. Since that time, we have evaluated five species that warranted changes in their state status listing from Not Listed to Threatened. This presentation describes the process on how these recommendations were reached and what species the Council may address in the future.

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A Progress Report on the Scientific Description of *Cyprinella* sp. "Thinlip" Chub – A Known Taxon That Has Remained Undescribed for More Than 50 Years

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Cyprinella sp. "Thinlip" Chub, is an undescribed species endemic to the Sand Hills and upper Coastal Plain streams in North Carolina and South Carolina. It has been recognized as an undescribed species since the early 1970s (Jenkins 1972; Menhinick et al. 1974; Jenkins and Lachner 1980) known as *Hybopsis* n. sp., *H.* sp. *cf. zanema*, *Cyprinella* n. sp., and C. sp. *cf. zanema*). Unofficially, it has gone by the name: "Thinlip" Chub. It is thought to be closely related to the other "barbeled" *Cyprinella* species such as Thicklip Chub, *Cyprinella labrosa* (Cope, 1870), and Santee Chub, *Cyprinella zanema* (Jordan and Brayton, 1878). At one time, it had tentatively been considered a subspecies of the Santee Chub based upon minor morphological differences (Jenkins and Lachner 1980), but recent DNA analyses using mitochondrial (ND2 and cytochrome b genes) and nuclear (recombinant activation gene 1 (Rag1)) genes supported the supposition that "Thinlip" Chub is sister to Santee Chub and is an evolutionary distinct lineage from Santee Chub, which are both sister to Thicklip Chub (Anderson et al. 1999; Rohde et al. 2009; Schönhuth and Mayden 2010).

In late early 2019 we decided that a formal species description was imperative and long overdue given that no undescribed species can be afforded additional protection (i.e., uplisting to Threatened or Endangered if so warranted) under NCWRC guidelines than its currently held imperilment status -- in this case Special Concern. Additionally, recent survey efforts suggest populations may be in decline following several catastrophic flood events. With a small grant from NC AFS in 2022 to cover gene sequencing, we have embarked on producing a species description using a multitude of metrics including geographical distribution, meristic and morphometric data, and genetics. In our presentation, we will be reviewing what we have accomplished during the first year of our project.

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2022 Trent River Catfish Survey

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Historically, the Neuse River contained native catfish species such as Brown Bullhead, *Ameiurus nebulosus*, White Catfish, *Ameiurus catus*, and Yellow Bullhead, *Ameiurus natalis*. Non-native catfish species such as Channel Catfish, *Ictalurus punctatus,* are now considered naturalized. Invasive catfish species such as Blue Catfish, *I. furcatus,* became established after stocking in the 1960's and Flathead Catfish, *Pylodictis olivaris,* became established in the 1990's. Since then, invasive catfish have expanded in distribution throughout the Neuse River and are thriving. As a result, native catfish abundance has decreased due to predation on and competition with native catfish species. The Trent River is a tributary of the lower Neuse River and, until 2022, a catfish-specific survey had not been conducted. A total of 31 Flathead Catfish, 11 Blue Catfish, and 3 Channel Catfish were collected from 21 sample sites in 2022. No native catfish species were collected during this survey. Some challenges during this survey included low water conditions in the upper Trent River and elevated salinity in the lower Trent River which reduced the effectiveness of our electrofishing. Future surveys will need to adapt to these challenges, continue monitoring catfish populations, and document changes in population characteristics overtime to inform the objectives of the 2019 NCWC Catfish Management Plan.

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Age and Growth of the Federally Endangered Dwarf Wedgemussel, *Alasmidonta heterodon,* in the Tar River Basin

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Freshwater mussels are among the most imperiled taxa in North America. As wild populations continue to decline, opportunities for investigations of basic life history traits become increasingly rare. This is especially true for federally listed mussel species such as the Dwarf Wedgemussel, *Alasmidonta heterodon*. Historically, the Dwarf Wedgemussel occurred from the Petitcodiac River basin in New Brunswick, Canada to the Neuse River basin in North Carolina. However, habitat and water quality degradation due to anthropogenic influences have led to remnant populations existing mainly in two river systems in the Atlantic Slope drainages; the Delaware River basin in New York and the Tar River basin in North Carolina. This study utilized found shell material from 2 populations in the Tar River basin to study basic age and growth characteristics of the Dwarf Wedgemussel. Due to the small sample size available for thin section aging, Bayesian inference was used to incorporate previously reported growth data for the species resulting in realistic growth parameters for the species ($L\infty$ = 52.07, 90% CI [49.73, 54.37]; K = 0.32, 90% CI [0.25, 0.39]; t0 = -0.60, 90% CI [-1.31, -0.03]). These results offer insight into the life history of this endangered species and can be used to better inform management decisions and future research with the species.

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