35th Annual Meeting of the North Carolina Chapter
of the American Fisheries Society
&
The North Carolina Freshwater Mollusk Workgroup

Tuesday, February 27th - Thursday, February 29th, 2024

Clarion Pointe Inn
2807 US Highway 74 East
Sylva, NC 28779

We would like to thank the sponsors of the 35th Annual Meeting of the North Carolina Chapter of the American Fisheries Society

Carolina Madtom - $1,500

Robust Redhorse - $1,000

Muskellunge - $500

Striped Bass - $300

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2024 Meeting of the North Carolina Chapter of the American Fisheries Society and the North Carolina Freshwater Mollusk Workgroup

Tuesday, February 27th – Thursday, February 29th, 2024

Clarion Pointe Inn
2807 US Highway 74 East
Sylva, NC 28779

Registration

- Tuesday, Day 1: 12-4 PM in the Clarion Pointe Lobby
- Wednesday, Day 2: 7:30 AM – 12 PM in the Clarion Pointe Lobby
- If you have any questions about registration, please contact Casey Joubert (Casey.Joubert@ncwildlife.org)

Innovation Station Social (6:30-10 PM, Tuesday, 2/27/2024)

Transportation

- Innovation Station, 40 Depot Street, Dillsboro
- Western Carolina University students will be transporting NC AFS attendees in 10 passenger university vans to Innovation Station in Dillsboro starting at 6:00 PM. Meet outside in front of Clarion Pointe for transportation.
- The last trip from Innovation Station to Clarion Pointe will leave Innovation Station at 10:00 PM.

Drinks

- Our Treasurer/Secretary Casey Joubert will be handing out drink tokens at the social for free drinks.

Food

- There will be appetizers/snacks provided at the social and dinner is on your own.
- Innovation Station has several nearby food options that are walkable including but not limited to the following:
    - Food Truck (TBD)
    - The Rivers and Rails Tavern, 2 Dills St, Dillsboro, https://rnrtavern.com/
    - Quirky Birds Treehouse & Bistro, 148 Front St, Dillsboro, https://www.facebook.com/QuirkyBirdsTreehouse
    - Kostas Express, 489 Haywood Rd, Dillsboro, https://www.kostasexpress.com/

Program at a Glance	
Tuesday, February 27	
1200–1600	Registration
0900–1200	NC AFS Workshop: Getting Hired: How to Set Yourself Up for a Productive Career in Fisheries and Aquatics
1200–1400	Lunch (on your own)
1400-1415	Day No. 1, Opening Remarks
1416-1446	Plenary Session
1447-1526	Session 1, Contributed Presentations by Students, Part 1
1543-1603	Afternoon Break
1604-1708	Session 2, Contributed Presentations by Students, Part 2
1709-1748	Session 3, What's Been Going on in North Carolina's Mountain Streams? - Part 1
1748-1753	Day 1, Closing Remarks
1830-2200	NC AFS and North Carolina Mollusk Workgroup Evening Social at: Innovation Station Innovation Brewing, 40 Depot Street, Dillsboro (transportation provided)
Wednesday February 28	
0730-1200	Registration
0800-0805	Day No. 2, Opening Remarks
0805-0914	Session 4: A Loop Trail - AKA Circling Back to What's Been Going on in North Carolina's Mountain Streams? - Part 2
0915-1001	Session 5: Crossing the Divide: What's Been Going on in North Carolina's Piedmont Streams and Reservoirs? – Part
1002-1022	Morning Break
1023-1116	Session 6: Crossing the Divide: What's Been Going on in North Carolina's Piedmont Streams and Reservoirs? – Part 2
1117-1219	Session 7: East of the Fall Zone: What's Been Going on in North Carolina's Coastal Plain Streams?
1220-1225	Lunch Remarks
1225-1330	Box Lunch Provided
1331-1425	Session 8: Resembling the Mass Influx of Citizens from All Over to North Carolina: A Mélange of Presentations, Part 1
1426-1445	Afternoon Break I
1446-1604	Session 9: Resembling the Mass Influx of Citizens from All Over to North Carolina: A Mélange of Presentations, Part 2

Program at a Glance (continued)	
Wednesday February 28	
1605-1615	Poster Session Titles and Introductions
1615-1625	Afternoon Stretch Break
1625-1740	Business Meeting
1740-1755	Day No. 2, Closing Remarks
1830 - 2100	Poster Session
1830 - 2230	Social; Banquet; Best Student and Professional Presentations Awards (W. Don Baker and Richard L. Noble Awards); Jerry R. Finke and Fred A. Harris Service Awards; and universities' student fisheries raffle
Thursday February 29	
0830 – 0900	Coffee Meet and Greet
0900 - 1100	North Carolina Mollusk Workgroup Meeting Presentations
1100 – 1115	Break
1115 – 1300	Open Discussion

Tuesday, February 27, 2024

TIME	
1200-1600	Registration
	NC AFS Workshop
0900-1200	"Getting Hired: How to Set Yourself Up for a Productive Career in Fisheries and Aquatics" Instructors: Patrick Ciccotto, Heather Evans, Danci Guiot, Gabriela M. Hogue, Eryn Malloy, Seth Mycko, Chantelle Rondel, and Randy Walsh
1200–1400	Lunch (on your own)
1400-1415	Day No. 1, Opening Remarks Kelsey Roberts, NC AFS President, and Luke Etchison, NC AFS President-Elect
	Plenary Session
1416-1446	"Jack of All Trades, Master of None . . . : Contributions of Tribal Management" Dr. Caleb Hickman, Supervisory Fisheries & Wildlife Biologist, Eastern Band of Cherokee Indians, https://cherokeenaturalresources.com/programs/fish-wildlife
1447-1526	Session 1: Contributed Presentations by Students, Part 1 Moderator: Kevin Dockendorf, NCWRC
1448-1503	Distribution and Habitat Associations of *Procambarus pearsei* and *P. braswelli* and Range Overlap with invasive Red Swamp Crayfish, *P. clarkii,* in Southeastern North Carolina Robert Adams*, Sidney Busch, Elijah Thompson, Robert Creed, and Michael Gangloff
1504-1519	Habitat Correlates of Southern Appalachian Brook Trout, *Salvelinus fontinalis,* Populations in South Carolina Joseph M. Barnes*, Keith Gibbs, and Thomas Martin
1520-1526	Distributions and Habitat Use of Eurasian Water Starwort, *Callitriche stagnalis,* in Watauga County Brent Kinser*, Vivienne Taylor, and Hunter Probert
1527-1542	Environmental Flow Effects on Fish Passage in a Fragmented Coastal River: A Bayesian Multistate Modeling Approach Aaron J. Bunch*, Julie E. DeMeester, Henry J. Hershey, Josh K. Raabe, Margaret H. Gaither, Fred S. Scharf, Joseph A. Mathews, Kyle T. Rachels, Dennis R. DeVries, Russell A. Wright, David L. Smith, Ashley E. Hatchell, and Troy M. Farmer

TIME	
1543-1603	**Break** **Sponsored by: RK&K**
1604-1708	**Session 2: Contributed Presentations by Students, Part 2** **Moderator: Andrea Leslie, NCWRC**
1605-1620	**Hemolymph Preservation Optimization and Portable Cell Counting Validation: Tools for Rapid Evaluation of Freshwater Mussel Immune Status** Madison E. Polera*, W. Gregory Cope, Chris B. Eads, Loretta Lutackas, Dorian Hayes, and Jaclyn P. Zelko
1621-1636	**Surveys for and Molecular Identification of River Cruiser, *Macromia margarita*, Nymphs in the Southern Appalachians** Nolan Taylor*, Michael Gangloff, Jonathan Wells, and Jason Mays
1637-1652	**Turbidity as an Indicator for *E. coli* in the Swannanoa River** Harlow Higgins*, Mark Brenner, Liesl Erb, and Jeffrey Holmes
1653-1708	**Evaluating Associations Between Riverine Habitat, Biotic Assemblages, and Spread of a Non-native Minnow Species in the Little Tennessee River System** Garrett McCarson*, Jennifer Dunn, Keith Gibbs, and Bill McLarney
1709-1748	**Session 3: What's Been Going on in North Carolina's Mountain Streams? - Part 1** **Moderator: Andrea Leslie, NCWRC**
1710-1725	**Prioritizing Watersheds in the Upper Little Tennessee River to Guide Restoration Initiatives** W. Keith Gibbs
1726-1732	**Reintroduction of the Tangerine Darter in the Upper French Broad Watershed, NC** Chantelle Rondel*, Luke Etchison, and Dylan Owensby
1733-1748	**Floodplain Restoration along the French Broad River to Support Vital Habitats** Greg Jennings
1748-1753	**Day No. 1, Closing Remarks** Kelsey Roberts, NC AFS President, and Luke Etchison, NC AFS President-Elect
1830-2200	**NC AFS and North Carolina Mollusk Workgroup Evening Social** **Sponsored by: Three Oaks Engineering**
	Innovation Station Brewing, 40 Depot Street, Dillsboro (transportation provided)

Wednesday, February 28, 2024

TIME	
0730-1200	Registration
0800-0805	Day No. 2, Opening Remarks Kelsey Roberts, NC AFS President, and Luke Etchison, NC AFS President-Elect
0805-0914	Session 4: A Loop Trail - AKA Circling Back to What's Been Going on in North Carolina's Mountain Streams? - Part 2 Moderator: Thomas (TR) R. Russ, NCWRC
0806-0821	Dam Removal Initiative in Western North Carolina Andrea J. Leslie*, Chris Goudreau, Vann Stancil, and Chris Wood
0822-0837	Changes to Water Chemistry and Implications for Sensitive Aquatic Biota in Southern Blue Ridge Streams Hannah C. Woodburn* and Michael M. Gangloff
0838-0844	The Challenges and Opportunities of Brook Trout Conservation in Muskrat Branch Maggie E. Coffey*, Raymond M. Starmack, Jason K. Farmer, A. Powell Wheeler, Amanda M. Bushon, and Jacob M. Rash
0845-0900	Evaluation of North Carolina Trout Anglers' Opinions, Participation, and Socioeconomic Impact Kathryn Jewell, Cristina Watkins, Jacob Rash*, and Doug Besler
0901-0907	Associations of Stream-Adjacent Forest Fire with Juvenile Wild Steelhead Trout, *Oncorhynchus mykiss,* Survivorship in Southern Oregon Emma Latendresse
0908-0914	Watershed Stewardship in a Small Mountain Community: Stakeholder Involvement is Key to Education, Planning, and Resource Restoration and Management William Seaman* and Jacob Rash
0915-1001	Session 5: Crossing the Divide: What's Been Going on in North Carolina's Piedmont Streams and Reservoirs? – Part 1 Moderator: Corey Dunn, NCSU
0916-0931	Untangling Angler Opinions: North Carolina Reservoir Striped Bass Fisheries Casey G. Joubert*, Kelsey J. Roberts, Kathryn L. Jewell, and Cristina E. Watkins

TIME	
0932-0938	Experimental Stocking and Evaluation of F1 Hybrid Largemouth Bass in Three Piedmont Reservoirs Kelsey J. Roberts
0939-0954	Spawning Phenology and Springtime Migrations of Acoustic Tagged White Bass within the Flat and Eno Rivers above Falls Lake, NC. Seth A. Mycko
0955-1001	Blending Restoration And Education: A New Urban Stream Partnership Brena K. Jones
1002-1022	Morning Break Sponsored by: RK&K
1023-1116	Session 6: Still Crossing the Divide: What's Been Going on in North Carolina's Piedmont Streams and Reservoirs? – Part 2 Moderator: Kelsey Roberts, NCWRC
1024-1030	Population Genetic Assessment of the State Endangered Orangefin Madtom, *Noturus gilberti* Thomas (TR) R. Russ*, Michael A. Perkins, and Heather K. Evans
1031-1037	An Update on Newly Discovered Crayfish in the Yadkin River Basin Michael A. Perkins*, Bronwyn W. Williams, and Thomas (TR) R. Russ
1038-1053	A Direct Comparison of eDNA and Electrofishing Survey Methods for Management Purposes Heather K. Evans*, Thomas (TR) R. Russ, and Michael Perkins
1054-1100	Tournament Data Offers Insights on Lake Norman Black Bass Populations Casey G. Joubert
1101-1116	Initial Freshwater Mussel Translocation/Captive Propagation Efforts on the Deep River (Cape Fear River Basin), for the High Falls Dam Removal Project, Moore County, North Carolina Tim Savidge*, Tom Dickinson, and Trevor Hall

TIME	
1117-1226	**Session 7: East of the Fall Zone: What's Been Going on in North Carolina's Coastal Plain Streams?** **Moderator: Scott Smith, NCDMF**
1118-1133	**American Eel Ninja Warrior: Climbing Obstacles to Reach New Waters** Justin C. Dycus
1134-1149	**A Case Study in Reintroducing the Critically Imperiled Magnificent Ramshorn Snail** Emilia Omerberg*, Brena K. Jones, and Rachael Hoch
1150-1156	**Genetic Analysis for the Species Designation of *Cyprinella* sp. "Thinlip" Chub** Kara B. Carlson*, Michael A. Perkins, Bryn H. Tracy, Fred C. (Fritz) Rohde, Brena K. Jones, Madelyn McCutcheon, and Heather K. Evans
1157-1212	**Lumber River Creel Survey** Kyle T. Rachels*, April Boggs Pope, Cheyene C. Mata, and Kevin J. Dockendorf
1213-1219	**Agonistic Interactions Between Invasive Red Swamp Crayfish and two Regionally Endemic Crayfish Taxa in Eastern North Carolina** Sidney J. Busch*, Robert Adams, Elijah J. Thompson, Robert P. Creed, and Michael M. Gangloff
1220-1226	**Data Wanted for Flier – Elusive Aquatic Acrobats with Lightning Quick Bites** Kevin J. Dockendorf*, Tim Bonvechio, and Marty Hamel
1227-1232	**Lunch Remarks** Kelsey Roberts, NC AFS President, and Luke Etchison, NC AFS President-Elect
13232-1330	**Box Lunch Provided** **Sponsored by: Duke Energy**
1331-1425	**Session 8: Resembling the Mass Influx of Citizens from All Over to North Carolina: A Mélange of Presentations, Part 1** **Moderator: Madison Polera, NCSU**
1331-1346	**Natural Resource and Emergency Response** Dave Czayka
1347-1402	**Update on Selected Duke Energy Studies in 2022, 2023, and 2024** Richard W. Smith

TIME	
1403-1409	**Effects of Handling Frequency on Juvenile Mussel Production** Kelsey Pistner* and Sierra Benfield
1410-1425	**Casting a Wider Net: Optimizing Sampling to Monitor Imperiled Fishes in Southeastern Rivers** Corey G. Dunn* and Craig P. Paukert
1426-1445	**Afternoon Break** **Sponsored by: The Nature Conservancy (TNC)**
1446-1604	**Session 9: Resembling the Mass Influx of Citizens from All Over to North Carolina: A Mélange of Presentations, Part 2** **Moderator: Casey Joubert, NCWRC**
1447-1502	**Environmental DNA Applications for Invasive Species** Kara B. Carlson*, Andi Barker, and Heather K. Evans
1503-1518	**A New Conservation Tool - Reintroductions of Roanoke Logperch and Magnificent Ramshorn Using the Programmatic SHA/CCAA for 21 Aquatic Species in NC** Rachael Hoch*, Thomas (TR) R. Russ, Michael A. Perkins, Brena K. Jones, and Emilia Omerberg
1519-1525	**Patience, Perspiration, and Persistence Do Pay Off! The Creation of: A Guide to North Carolina's Freshwater Fishes** Bryn H. Tracy*, Fred C. (Fritz) Rohde, Scott A. Smith, Jesse L. Bissette, and Gabriela M. Hogue
1526-1541	**A Taxonomic Revision of the Pirate Perches (*Aphredoderus*)** Tyler A. Muller* and Andrew M. Simons
1542-1548	**Incorporating an Orphaned Collection: From a Basement to Global Accessibility** Gabriela M. Hogue* and Casey Bielefeld
1549-1604	**Diversity Of Stone Suckers in North Carolina with the First Report of One Species Parasitizing Full-bodied Fishes with Fleshy, Sucking Lips** Bryn H. Tracy*, Fred C. (Fritz) Rohde, Michael Fisk, Brena K. Jones, and Luke Etchison

TIME	
1605-1615	**Poster Session: Titles and Introductions** **Moderator: Bryn Tracy, retired**
	Conservation and Management Challenges and Opportunities for Diadromous Fish in Licensing of Hydropower Projects Melanie Harris, Nicholas Anderson*, Alex McOwen, and Bjorn Lake
	Phylogeography and Genetic Tracing of the Warpaint Shiner, *Coccotis coccogenis* Henry M. Gates
	Assessing Climate Change Effects on Fish Diversity and Distribution in the Swannanoa River Watershed Gillian Gavenus
	Assessing the Effect of Beaver Dam Analogues on Fish Abundance and Species Composition in an Unnamed Tributary to Canoe Creek, Caldwell County, NC Emily Gillikin*, Spencer Simino, Clarice Perry, Grant Buckner, and Michael Gangloff
	Barcoding Reveals Cryptic Diversity within the *Cambarus dubius* Species Complex Quentin LaChance*, Jon Wells, and Michael Gangloff
	Demonstration of Ecological Uplift in ILF Projects Charles Lawson
	Developing Genetic Parentage-Based Tagging (PBT) Tools for Imperiled Freshwater Mussel Conservation Edie Nissen*, Greg Cope, and Heather K. Evans
	Uncharted Waters: High-Resolution Stream Networks Reveal Hidden Habitats for Petitioned Headwater Crayfishes Devin M. Raburn*, Hafez Ahmad, Patrick F. Allison Jr., Susan B. Adams, Zanethia C. Barnett, Ryan C. Garrick, Kenneth A. Sterling, Sara Cathey, Michael E. Colvin, and Corey G. Dunn
	Changes to Fish Assemblages and Land Use Change Across 30 Years in the Upper French Broad River Basin Claire Roberson*, Vee Carter*, and David Gillette
	Determining Minimum Habitat Availability for Muskellunge in North Carolina Delaney Whitson* and Keith Gibbs
1615-1625	**Stretch Break**

TIME	
1625-1740	Business Meeting
1740-1755	Day No. 2, Closing Comments Luke Etchison - 2024 NC AFS President
1830 - 2230	Social, Banquet, Awards, Raffle, and Posters Sponsored by: Transystems
	Social; Banquet; Best Student and Professional Presentations Awards (W. Don Baker and Richard L. Noble Awards); Service Awards (Jerry R. Finke and Fred A. Harris Awards); and Universities' Student Fisheries Raffle
1830 - 2030	Poster Session

Thursday, February 29, 2023

TIME	
0830-900	Coffee Meet and Greet
0900-1100	North Carolina Mollusk Workgroup Presentations
1100-1115	Break Sponsored by: Dewberry
1115-1300	Open Discussion

2023-2024 NC AFS Officers and Committees

OFFICERS

President: Kelsey Roberts
President Elect: Luke Etchison

Secretary/Treasurer: Casey Joubert
Past President: Andrea Leslie

COMMITTEES

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

Communications
Chair and Newsletter Editor: Kyle Rachels
Webmaster: Brena Jones
Facebook Administrator: Kevin Dockendorf
Newsletter Review Members: Brena Jones and Bryn Tracy

Education and Outreach
Chair: Seth Mycko
Members: Anne Burroughs and Mike Walter

Finance
Chair: Casey Joubert
Members: Lawrence Dorsey

Nominations
Chair: Andrea Leslie

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

2024 Annual Meeting
Chair: Luke Etchison
Members: Keith Gibbs, Brena Jones, Seth Mycko, Chantelle Rondel, and Bryn Tracy

North Carolina Chapter of the American Fisheries Society
Continuing Education Workshop

Getting Hired: How to Set Yourself Up for a Productive Career in Fisheries and Aquatics

The 2024 NC AFS workshop will serve students and young professionals. Attendees will learn about the job opportunities and various work groups within North Carolina. We will go over the details of what various sectors are looking for in young hires and how to target your curriculum vitae or resume for different agencies/organizations. Several fisheries professionals will be on hand to answer questions and give advice to students. Successful attendees will gain the information needed to successfully apply for jobs with any North Carolina's fisheries/aquatic organizations, public or private. The format will include presentations from current professionals in both public and private sectors, panel Q&A discussions, and opportunities for one-on-one help

Instructors

- Patrick Ciccotto, Warren Wilson University, Swannanoa, NC
- Heather K. Evans, NCWRC, Geneticist, Raleigh, NC
- Danci Guiot, NCWRC, Division of Inland Fisheries, Mountain Region, District 7
- Gabriela M. Hogue, North Carolina Museum of Natural Sciences, Ichthyology Collection, Collections Manager, Raleigh, NC
- Eryn Malloy, Duke Energy Research & Nuisance Aquatic Weed Compliance, Charlotte, NC
- Seth A. Mycko, NCWRC, Division of Inland Fisheries, Piedmont Region, District 5
- Chantelle Rondel, NCWRC, Aquatic Wildlife Diversity Program, Waynesville, NC
- Randy Walsh, The Nature Conservancy, Asheville, NC

Distribution and Habitat Associations of *Procambarus pearsei* and *P. braswelli* and Range Overlap with Invasive Red Swamp Crayfish, *P. clarkii,* in Southeastern North Carolina

Robert Adams*, Sidney Busch, Elijah Thompson, Robert Creed, and Michael Gangloff

*Presenting

Appalachian State University, Department of Biology, Boone, NC

Crayfish are important components of freshwater ecosystems and North America supports a diverse fauna of >400 described species. Although native crayfishes are found in a range of freshwater and troglobitic habitats, many populations are facing increasing pressure from multiple stressors including the spread of invasive crayfish. The Red Swamp Crayfish, *Procambarus clarkii,* is an aggressive invader and can rapidly colonize a range of ecosystem types. The species has colonized large swaths of the eastern Carolinas in the last 20 years including the Lumber, Waccamaw, and Cape Fear drainages. These drainages are home to two native *Procambarus* species of concern in North Carolina; the Sandhills Crayfish, *P. pearsei*, and the Waccamaw Crayfish, *P. braswelli*. These species have limited ranges and recent surveys indicated that their ranges have declined concurrent with the spread of *P. clarkii* in these watersheds. Of the 120 independent sites we have now surveyed, we have confirmed that 10 out of 46 historically occupied sites still have populations of *P. pearsei* and 10 out of 30 historically occupied sites still have *P. braswelli*. We have also documented 9 sites where either *P. braswelli* or *P. pearsei* co-occur with *P. clarkii*. Moreover, we have detected *P. clarkii* at 42 of the 120 sampled sites (occupancy = 0.35) and in a range of different habitat types including larger rivers, temporary streams, bays, and roadside ditches primarily at sites in the Waccamaw drainage. We are currently characterizing the biotic and abiotic habitat variables associated with the occurrence of both native species and *P. clarkii*. This will allow for a better understanding of the habitat requirements for the crayfish species of interest in our study, and to better characterize sites most likely to be colonized by *P. clarkii*.

Type: Full
Student or a Professional? Student
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Conservation and Management Challenges and Opportunities for Diadromous Fish in Licensing of Hydropower Projects

Melanie Harris, Nicholas Anderson*, Alex McOwen, and Bjorn Lake

*Presenting

NOAA's National Marine Fisheries Service, Office of Habitat Conservation, Silver Springs, MD

The U.S. National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) uses our authorities to protect, restore, and enhance diadromous fish and their habitats to support resilient ecosystems and provide diverse and abundant populations of diadromous fish. Our actions support sustainable commercial, recreational, and tribal fisheries, and aid in the recovery of threatened and endangered species. We seek to accomplish these goals by providing effective passage and increased access to spawning and rearing habitat using an ecosystem based approach, and working with tribes, federal, state and local governments, and stakeholders. Specific to hydropower, NOAA Fisheries engages in the licensing process for non-federal Federal Energy Regulatory Commission (FERC) regulated dams for fish passage and habitat improvements. With a term of 30-50 years, licensings are once-in-a-lifetime opportunities to restore access to upstream and downstream habitat, and improve in-stream flows and water quality.

Hydropower licensing can include federal, state, and local resource managers, tribes, licensees, landowners, environmental organizations, fishing groups, agricultural organizations, and ratepayers, with different interests and objectives. Addressing these varied interests and objectives in the license conditions provides challenges and opportunities. Using a collaborative approach that fosters participation leads to more robust licenses with mutually agreeable conditions. Limited or incomplete data for fish movements and migrations, habitat conditions, and engineering aspects of fish passage facilities, as well as uncertainty regarding the impacts of climate change is a challenge. These data are essential in science-based conservation and management. To address data gaps, we request studies be conducted during the licensing process. Adaptive management measures are another approach which allow licensees to implement conservation measures and make modifications based on recommendations from NOAA Fisheries and others as information becomes available. Using these approaches we have enhanced in-stream habitat and improved access to thousands of river miles for diadromous fish.

Type: Poster
Student or Professional? Professional
Contact: Nicholas Anderson
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Phone: 952-334-6774

Habitat Correlates of Southern Appalachian Brook Trout, *Salvelinus fontinalis,* Populations in South Carolina

Joseph M. Barnes*, Keith Gibbs, and Thomas Martin

*Presenting

Western Carolina University, Department of Geosciences & Natural Resources, Cullowhee, NC

The Brook Trout, *Salvelinus fontinalis,* is the only native salmonid species found in the Appalachian Mountains. Populations of Brook Trout inhabit <80% of their historic range due to habitat loss, invasive species, and climate change. The purpose of this study was to determine if populations of genetically distinct Southern Appalachian Brook Trout (SABT) in the South Saluda River watershed are abundant enough to be used as a source population for translocations or propagation to restore populations to the North Saluda River watershed. We also sought to determine correlations of habitat characteristics between streams with SABT present compared to streams where SABT are absent. We conducted single-pass electrofishing surveys to calculate catch per unit effort (CPUE) for stream reaches above and below potential waterfall barriers. We also analyzed instream habitat characteristics in 100m reaches at 31 sites in 5 streams. We quantified habitat types, substrate size and percentages, availability of cover and large woody debris, and percent canopy cover. South Saluda River and Laurel Creek have SABT populations whereas populations in North Saluda River and Bryce Creek were historically extirpated. Additionally, the SABT population in Slicking Creek was extirpated after an intense wildfire in 2016. Laurel Creek had the highest CPUE (2.06 fish/min.) and South Saluda River had a lower CPUE (0.63 fish/min.). We did not detect significant differences in habitat characteristics among sites with or without SABT. However, canopy cover was significantly reduced in recently extirpated sites in Slicking Creek compared to sites with extant populations. Accordingly, Laurel Creek would be most suitable as a source population with appropriate management to maintain genetic integrity. We also recommend not attempting to reestablish a population in Slicking Creek until the canopy has recovered. Analyzing SABT habitat characteristics further bridges the information gap between northern and southern strains of brook trout.

Type: Full
Student or Professional: Student
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Phone: 919-724-0102

Environmental Flow Effects on Fish Passage in a Fragmented Coastal River: A Bayesian Multistate Modeling Approach

Aaron J. Bunch*[1], Julie E. DeMeester[2], Henry J. Hershey[3], Josh K. Raabe[4], Margaret H. Gaither[1], Fred S. Scharf[5], Joseph A. Mathews[5], Kyle T. Rachels[6], Dennis R. DeVries[3], Russell A. Wright[3], David L. Smith[7], Ashley E. Hatchell[8], and Troy M. Farmer[1]

*Presenting

[1]Clemson University, Department of Forestry & Environmental Conservation, Clemson, SC

[2]The Nature Conservancy, Durham, NC

[3]Auburn University, School of Fisheries, Aquaculture, & Aquatic Sciences, Auburn University, AL

[4]University of Wisconsin – Stevens Point, College of Natural Resources, Stevens Point, WI

[5]University of North Carolina – Wilmington, Department of Biology & Marine Biology, Wilmington, NC

[6]NCWRC, Raleigh, NC

[7]United States Army Corps of Engineers, Engineer Research & Development Center, Vicksburg, MS

[8]United States Army Corps of Engineers, Wilmington District, Wilmington, NC

Flow regimes and connectedness to natal spawning grounds have shaped life-history traits of anadromous fishes over evolutionary time scales. Habitat fragmentation from damming alters anadromous fish movements to natal spawning grounds. Our goal was to manipulate spring flows on a highly modified and fragmented Atlantic slope river (Cape Fear River, North Carolina) to mimic natural flood events that were high enough to submerge lock and dam structures that were not operable for "conservation locking". Acoustic tags were implanted into American Shad, *Alosa sapidissima*, Striped Bass, *Morone saxatilis,* during spring migrations in 2013-2015, and 2022-2023, and Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus*, in 2022 and 2023. An acoustic array of VR2W receivers was in place within the full extent of the study area. To evaluate year- and species-specific movements, we utilized a multistate Cormack–Jolly–Seber (CJS) model within a Bayesian framework to estimate probabilities of apparent survival, detection, and transition (passage over dams, movement to upper spawning grounds, or fallback). Five model states were defined based on locations upstream, downstream, and between four lowhead dams. Flow was incorporated as an environmental covariate. We found the highest passage probabilities for American Shad, followed by Striped Bass, and no passage by Atlantic Sturgeon. Environmental flow pulses triggered fish to pass over lowhead dams. Environmental flow pulses which effectively submerged lowhead dams improved passage during periods when lock chambers were not operable for conservation locking.

Type: Full
Student or a Professional? Student
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Agonistic Interactions Between Invasive Red Swamp Crayfish and two Regionally Endemic Crayfish Taxa in Eastern North Carolina

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

*Presenting

Appalachian State University, Department of Biology, 527 Rivers Street, Boone, NC

The Red Swamp Crayfish, *Procambarus clarkii*, is one of the most widely distributed and problematic introduced freshwater species. In eastern North Carolina, *P. clarkii* has increased in abundance across the ranges of two imperiled crayfishes; the Waccamaw Crayfish, *P. braswelli* - state endangered. and the Sandhills Crayfish, *P. pearsei* - state threatened. We examined agonistic interactions between *P. clarkii* and native species using behavioral experiments in a controlled laboratory setting. Our objective was to determine whether P. clarkii could be causing the decline of native crayfish populations through interference competition. Crayfish were collected from 14 sites within the Lumber River Basin, North Carolina for use in trials. Individuals were matched based on total carapace length and paired into the following groups: 1) *P. clarkii* vs. *P. pearsei*, 2) *P. clarkii* vs. *P. braswelli*, and 3) *P. clarkii* vs. *P. clarkii*. Interestingly, native crayfish *P. pearsei* were behaviorally dominant over *P. clarkii* and won most of the encounters in their group. Procambarus clarkii approached *P. braswelli* more frequently but there were no differences in fight wins between *P. clarkii* and *P. braswelli*. These results suggest that agonistic interactions among similarly sized *P. clarkii* and native crayfishes may not be likely mechanisms for species replacement in these systems. However, the longer-term effects of interactions between *P. clarkii* and regionally endemic crayfishes including consumptive competition and trophic impacts remain poorly understood. Ongoing research will examine the importance of these factors using a combination of field and laboratory experiments.

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Environmental DNA Applications for Invasive Species

Kara B. Carlson*, Andi Barker, and Heather K. Evans

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In September of 2023, three reports of potential new invasive species (Apple Snail, Zebra Mussel, and Silver Carp) were received by the North Carolina Wildlife Resources Commission. These species pose a significant risk to infrastructure and ecosystems, therefore rapid response was imperative to verify sightings, educate the public, mitigate spread, and remove animals from the environment where possible. Environmental DNA (eDNA) has become a widely utilized tool in wildlife studies, and the application of eDNA methodologies has proven powerful in detecting and monitoring the spread of invasive species. Despite its benefit and increasing usage, eDNA is not a one-size-fits-all approach and may not be the most suitable choice in certain systems or situations. Evaluating and understanding the limitations of eDNA monitoring, as with any other survey methodology, is important for study outcome and downstream management decisions. For North Carolina's three potential invasive species cases, the pros and cons of utilizing eDNA techniques for each system and species were weighed before deciding on the best plan of action for verification. This talk overviews the rationale behind whether to utilize eDNA methods, how these methods were applied, and the outcome of each case.

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Genetic Analysis for the Species Designation of *Cyprinella* sp. "Thinlip" Chub

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Endemic to the Sand Hills and Coastal Plain of North and South Carolina, *Cyprinella* sp. "Thinlip" Chub has gone formally undescribed for over 50 years. Across its range, "Thinlip" Chub numbers are declining and official designation as a species is needed for protection and potential listing. Our research has used a combination of morphometric and genetic analyses to describe "Thinlip" Chub as a distinct species. Two nuclear genes, Homeobox 13 and Recombination Activating Gene 1 (Rag1), and two mitochondrial genes Cytochrome b (cytb) and Cytochrome Oxidase I (COI) were sequenced to build phylogenies to assess the relationship of "Thinlip" Chub to other *Cyprinella* species. We find that fine scale phylogenetic resolution differs between nuclear and mitochondrial genes given the varying rates of evolution and selective pressures between the genes. However, all four phylogenies show that "Thinlip" Chub, especially those from the Black River and Cape Fear River systems, are distinct from both Thicklip Chub, *C. labrosa*, and Santee Chub, *C. zanema*. Separation of the three species into distinct clades was better resolved in mitochondrial gene trees, which further reinforces the divergence of "Thinlip" from *C. labrosa* and *C. zanema* within a larger, eastern *Cyprinella* clade. These results combined with morphometric data associated with this study suggest that "Thinlip" Chub is distinct and should be described as a unique species. Further, given the divergence between the Cape Fear and Pee Dee River basins, "Thinlip" Chub should be considered two evolutionarily significant units: the Black and Cape Fear River systems and the Pee Dee and Lumber River systems.

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The Challenges and Opportunities of Brook Trout Conservation in Muskrat Branch

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Self-sustaining Brook Trout, *Salvelinus fontinalis,* are uncommon in the Hiwassee River basin. There are only 15 known populations in the North Carolina portion of the basin, and genetic analysis suggests only two of these populations are native. One of the native populations, Muskrat Branch, is situated within the Nantahala National Forest and is managed in partnership between the NCWRC and the U.S. Forest Service. Muskrat Branch intersects the Appalachian Trail near its source in the headwaters and is bisected by U.S. Highway 64 approximately three stream kilometers upstream from its confluence with Shooting Creek; this road crossing represented an artificial barrier to upstream fish passage. Historically, allopatric Brook Trout occupied at least 1.4 kilometers of stream above the barrier, with self-sustaining Rainbow Trout, *Oncorhynchus mykiss,* present only downstream. However, following an infrastructure failure in 2017, Rainbow Trout became established above the barrier. Since the first observation of Rainbow Trout in 2018, electrofishing samples in 2021 revealed dwindling Brook Trout densities, and additional samples in 2023 observed no Brook Trout. Thus, Brook Trout were feared to have been lost from the stream. However, based on knowledge gathered from public engagement in September 2023, an electrofishing sample near the Appalachian Trail located allopatric Brook Trout in an unnamed tributary to Muskrat Branch at approximately 1,300 meters in elevation. These individuals were isolated above high-gradient natural features that provided protection from Rainbow Trout encroachment. Fin clips were obtained from a subsample of 40 individuals for ongoing genetic analysis. These results will dictate future direction for this stream and inform efforts throughout the entire Hiwassee River basin. This case emphasizes the importance of long-term monitoring, exhaustive spatial sampling efforts (e.g., longitudinal distribution mapping), and repeated temporal sampling to evaluate extirpation of native Brook Trout populations.

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Natural Resource and Emergency Response

Dave Czayka

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Natural resources are important to both the natural and economic worlds. Natural Resource Management considers the economic impacts, social science, physical science, pollution control and study of the resource itself. This presentation will include a discussion of natural resource management in the context of and un-planned projects (emergency response). The focus of the presentation includes agency coordination, listed species and strategies to successfully complete these projects while satisfying stakeholders and meeting regulatory expectations. These projects can have the same agency participation/coordination as planned projects. However, a different coordination process is often involved which follows the National Incident Management System (NIMS). NIMS is a comprehensive, national approach to incident management that is applicable at all jurisdictional levels across functional disciplines. It is intended to apply to all incidents, hazards, and impacts, regardless of size, location or complexity. The severity and size of an incident will determine the complexity of agency involvement.

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Data Wanted for Flier – Elusive Aquatic Acrobats with Lightning Quick Bites

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Flier, *Centrachus macropterus,* are found in swamps, sloughs, and slow flowing creeks of lowland areas. Our objective is to collect representative Flier data (total length and total weight) across the species range. These data will be compiled and analyzed to develop a standard weight equation and proportional stock densities (PSD) for this species. Our initial data request generated about 7,500 individuals across most of the range. For North Carolina we have about 400 individuals from six river basins so far. Thanks to those who contributed from routine collections, hook-and-line sampling, and referencing previous studies where Flier were collected with individual total lengths and total weights in the field. We'd love to add more to this dataset before we begin analysis this summer or fall, so we welcome any total length and total weight measured prior to any preservation method to be sent our way.

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Casting a Wider Net: Optimizing Sampling to Monitor Imperiled Fishes in Southeastern Rivers

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Southeastern rivers support hundreds of fishes, but few river sampling protocols are designed to detect many of these often small, benthic, and rare species. Hence, southeastern rivers are both vast sources of fish habitat and figurative knowledge gaps for biologists charged with managing sensitive species. Our goal is to overview a sampling protocol designed for monitoring fish assemblages within non-wadeable rivers of a physiographically and biologically diverse southeastern state (Missouri). Over three years, we completed 36 surveys at nine sites using a design featuring six gears: boat electrofishing, benthic trawling, seining, and mini-fyke, hoop, and stationary trammel nets. We caught 89,185 individual fish, 140 species, and 16 species within Missouri's State Wildlife Action Plan (SWAP), including "rediscovering" populations of multiple species that were presumably extirpated. We developed an analytical approach that reduced total sampling effort while optimizing the survey design to match sampling objectives of fisheries management biologists, including detecting high percentages of SWAP-priority species. Managers chose two protocols featuring four gears (electrofishing, seining, trawling, mini-fyke nets) that on average detected 80% (less-intensive protocol) and 95% (more-intensive protocol) of total species at sites, including 73% and 93% of SWAP species, respectively. By comparison, similar effort with an intensive electrofishing-only protocol (1–2 km of electrofishing) on average detected 64% of total species and only 30% of SWAP species at sites. Altogether, we demonstrate diversifying sampling gears detects a wider breadth of fishes at sites, and leads to large and disproportional increases in detections of SWAP species. Thus, optimal sampling with multiple gears could better inform riverscape conservation by more accurately monitoring the distributions of species and diversity within southeastern rivers.

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American Eel Ninja Warrior: Climbing Obstacles to Reach New Waters

Justin C. Dycus

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American Eel, *Anguilla rostrata*, is a catadromous species that spawns in the Atlantic Ocean. Young American Eels drift with ocean currents until they reach estuaries where they navigate upstream into freshwater systems, grow into adults, and then repeat the life cycle. Dams and other impediments restrict upstream access for migrating eels. Blewett Falls Hydroelectric Development, located at river kilometer 188 on the Pee Dee River, is the first impediment blocking access to upstream migrating American Eels. Constructed in the early 1900s, the Blewett Falls Development has restricted upstream access for more than 100 years. During relicensing of the facility, Duke Energy worked cooperatively with state and federal agencies to address passage of diadromous fish at the facility and put together date sensitive fish passage plans to be completed during the term of the new Federal Energy Regulatory Commission (FERC) License. Article 401 of the FERC License required Duke Energy to prepare an American Eel Upstream Movement Study Plan. Following FERC's approval of the plan on April 29, 2016, Duke Energy completed a three-year monitoring study which used wooden eel ladders at multiple locations along the spillway to document American Eel abundance and movement patterns to allow for the effective placement of a permanent passage facility best suited to encounter upstream migrating eels. Based on results from the three-year movement study, the permanent passage facility was constructed in the existing fish ladder and finalized November of 2022. Trial operations of the permanent facility occurred during spring and fall of 2023, and the facility now provides access to upstream riverine habitat that had been restricted for over a century.

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A Direct Comparison of eDNA and Electrofishing Survey Methods for Management Purposes

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The use of environmental DNA (eDNA) for species detection is rapidly increasing. However, little research has been done examining the efficacy of eDNA surveys for use in management compared to traditional methods such as electrofishing. We utilized a previously developed eDNA survey for federally endangered Roanoke Logperch, *Percina rex*, to directly compare eDNA and backpack electrofishing surveys at 23 sites (8 presumed positive, 8 presumed negative, and 7 exploratory). Detection rates, person hours, and total cost were evaluated for each method. Electrofishing detected Roanoke Logperch at one site while eDNA detected Roanoke Logperch at nine sites. Additionally, eDNA survey methodology required approximately 55% fewer person hours and reduced cost by 30%, even when molecular troubleshooting was included in the calculations. With optimized protocols, eDNA surveys are expected to reduce both man hours and total cost by 55% over traditional electrofishing while simultaneously increasing detection rates. While eDNA cannot currently address questions of age class structure, population estimates, or health, these rapid and cost-effective surveys can provide information that will help management agencies streamline and prioritize future intensive electrofishing surveys.

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Phylogeography and Genetic Tracing of the Warpaint Shiner, *Coccotis coccogenis*

Henry M. Gates

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Warpaint Shiners, Coccotis coccogenis, are small, regionally endemic minnows living in the southern Appalachian streams and rivers. This species ranges from southwestern Virginia through western North Carolina down through Georgia, as far west as northeastern Alabama. This species that prefers gravel riffles and pools in small to medium sized streams with clear, fast flow. They rely on flow to feed, reproduce, and disperse, making impoundments significant barriers to their dispersal. Their diet varies based on life stage and season, with a shift from mayfly nymphs to emerging and terrestrial invertebrates during the summer. To study the Warpaint Shiner, I used tissue samples from its native and putative naturalized range. The focus will be on river basins in the Atlantic Drainage, particularly in North Carolina. Tissues will be collected from fishes previously stored in various collections, ensuring the use of fresh DNA preserved in 96% ethanol. For DNA analysis, tissue clippings were taken from preserved and live specimens. DNA samples will be extracted using the QIAgen DNeasey kit system, and PCR run samples were sent to the genetics lab for sequencing. The samples were analyzed using Genious software to determine the structure of haplotype groups, which are specific gene groupings inherited from parent fish. The complexity of haplotype group makeup will help to identify native and non-native populations. Based on the results so far, the Warpaint Shiner genetic variation appears to diverge into two initial branch groupings, with one group consisting of primarily interior river basin individuals. The larger branch is more inconclusive, with individuals from various river basin groups all occupying different node families. This could be due to multiple source populations causing an increased pace in genetic variability. This deserves more research, to ensure that the genetic variations of this species are properly analyzed.

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Assessing Climate Change Effects on Fish Diversity and Distribution in the Swannanoa River Watershed

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Climate change impacts are one of the top threats to freshwater ecosystem health and biodiversity. An increase in freshwater temperatures can have detrimental impacts on overall stream health. The relationship between fish distribution and water temperature can accurately predict the future impacts of climate change on fish distribution. This study focuses on the water temperature and fish distribution of seven tributaries in the Swannanoa River watershed in Western North Carolina. It is hypothesized there will be a significant relationship between fish distribution and water temperature averages and daily variation. Data loggers were placed in these sites from mid-May 2022 until mid-June 2022 documenting water temperature every two hours. In August and September 2022, fish samples were collected and identified using an electrofisher. Using Microsoft Excel, the correlation coefficient between the average maximum temperature of the sites compared to the abundance of each fish species was calculated. The fish species with a significant relationship to average maximum water temperature and daily variation were graphed. Data from this study could be beneficial to compare to future studies in western North Carolina streams.

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Prioritizing Watersheds in the Upper Little Tennessee River to Guide Restoration Initiatives

W. Keith Gibbs

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We developed a watershed prioritization index for the mountains of western North Carolina, specifically the Upper Little Tennessee River Basin, to direct future conservation efforts in the region. We extracted land cover and use percentages and landscape features at multiple spatial scales to categorize attributes and rank subwatersheds from least to most susceptible to degradation. Instream and riparian habitat were evaluated, and sedimentation was quantified in a subset of subwatersheds to verify and validate geospatially derived prioritization rankings. Historical fish and macroinvertebrate assemblage data were compiled and georeferenced to identify gaps in knowledge and target supplemental sampling efforts. Fish and macroinvertebrate assemblages were sampled following standardized protocols for comparison to historical records. The basin is mostly forested (~86%); however, development (~10%) and agriculture (~2%) are concentrated along the riparian corridor of major streams and rivers (e.g., Little Tennessee (LTR) and Tuckasegee (TKR) rivers). The concentration of altered land use is due to gentler terrain and more productive soils in the floodplain and has resulted in substantial habitat degradation, especially in the upper portions of the upper LTR. Both the LTR and TKR have run-of-river dams bisecting them into upper and lower reaches. The lower LTR has a protected riparian corridor and biodiversity remains high. Hydropower reservoirs in the upper TKR watershed have altered hydrology and water quality, yet habitat quality remains high throughout the system. The upper reaches of both systems have depressed biotic integrity due to morphologic and hydrologic alteration. However, opportunities exist to restore ecological functionality and integrity within the basin with targeted rehabilitation, especially in riparian zones. Our findings will be shared with partners to assist prioritization of future monitoring and restoration efforts.

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Assessing the Effect of Beaver Dam Analogues on Fish Abundance and Species Composition in an Unnamed Tributary to Canoe Creek, Caldwell County, NC

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Across many regions of North America, beaver dams have been used to help restore stream habitats. Beaver dams help mitigate sedimentation, mitigate high flows, increase floodplain connectivity, enhance habitat complexity, and improve conditions for riparian and wetland vegetation. In areas where introducing beavers is undesirable or impractical, beaver dam analogs (BDAs) can be used to mimic the natural benefits of beaver dams. BDAs are crafted from semi-porous wooden posts interwoven with vegetation and sediment. We examined the effect of BDAs on fish abundance and diversity within a sediment-impacted, unnamed first-order tributary to Canoe Creek (Catawba Drainage). Pre-installation surveys used backpack electrofishing in late February 2023 to sample fish communities in the project stream and an adjacent reference stream. Six BDAs were constructed using materials obtained on site and deployed by Catawba Riverkeeper staff in March. Follow-up fish surveys were conducted in April and October 2023. Pre-installation (February) fish communities were comprised of six species (Central Stoneroller, Greenhead Shiner, Rosyside Dace, Creek Chub, Fantail Darter, and Tessellated Darter). Surveys immediately following construction of BDAs found decreased fish abundance and failed to detect Fantail Darters and Greenhead Shiners. Six months later, surveys reported that fish abundance increased but that species richness was largely unchanged. Crayfish abundance decreased after the BDAs were installed and did not change between April and October. Stream channel morphology exhibited dramatic changes with much of the reach becoming less incised as BDAs entrained mobile substrates, but the availability of deeper habitats also decreased which may explain reduced fish and crayfish abundance following BDA construction. Surveys are planned for Spring 2024 to examine how communities and habitat conditions will respond following fall and winter high water events.

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Turbidity as an Indicator for *E. coli* in the Swannanoa River

Harlow Higgins*, Mark Brenner, Liesl Erb, and Jeffrey Holmes

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Escherichia coli, a bacteria found in the gut of endotherms, can pose a health concern in water ecosystems and indicate fecal contamination. Measuring *E. coli* can take up to 24 hours, however, scientists have found that other indicators of *E. coli* may present a faster, reliable prediction of *E. coli* levels. This study focused on the relationship between turbidity and *E. coli* in the Swannanoa River, in Buncombe County, North Carolina to understand if it is well-founded as a predictor for *E. coli*. We gathered samples from the Swannanoa River over roughly a year and conducted a regression analysis. We discovered a strong relationship between the two factors, supporting the use of turbidity as a quick predictor of *E. coli* in freshwater ecosystems. Our results demonstrate the potential for widespread public access to *E. coli* predictions in local freshwater ecosystems. We anticipate that policies will be enacted using turbidity to predict unsafe rivers and streams due to high *E. coli* levels and could be used as a tool for providing almost instantaneous information on water quality to the public for recreation, such as fishing.

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A New Conservation Tool: Reintroductions of Roanoke Logperch and Magnificent Ramshorn Using the Programmatic SHA/CCAA for 21 Aquatic Species in NC

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Incorporating an Orphaned Collection: From a Basement to Global Accessibility

Gabriela M. Hogue* and Casey Bielefeld

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In September of 2022, the Ichthyology Unit of the North Carolina Museum of Natural Sciences (NCSM) undertook the task of rescuing Dr. Edward F. Menhinick's collection of fishes. This invaluable collection not only formed the basis for his 1991 book "The Freshwater Fishes of North Carolina" but also contained specimens from locations across the United States and abroad. The inclusion of these specimens has enriched the NCSM Collection by adding irreplaceable temporal and geographic historical data. This presentation will outline the meticulous steps taken to fully incorporate these specimens and accompanying field notes into the NCSM holdings, effectively taking them from a basement to global accessibility.

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Floodplain Restoration along the French Broad River to Support Vital Habitats

Greg Jennings

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Floodplain restoration has the potential to provide many ecological and societal benefits including habitat and water quality enhancements, recreational opportunities, and flood mitigation. Conserving Carolina is currently working with the NC Wildlife Resources Commission (NCWRC), U.S. Fish & Wildlife Service, and several funding organizations to acquire and restore floodplain properties along the upper French Broad River. The Mouth of Mud Creek project was implemented in 2020 on a 100-acre former farm where three backwater sloughs were created for fish habitat enhancement. Additional work included river berm removal to increase overbank flooding, wetland restoration for water quality and habitat, and native plant establishment. NCWRC monitoring work is documenting the benefits of this project in relation to fish use for spawning, nursery, and high flow refuge. A similar project was completed in 2023 on a 70-acre former golf course at the Pleasant Grove property near Etowah. In addition to the backwater slough, river berm removal, and wetland restoration, a reach of Little Willow Creek was restored at its confluence with the river. Two projects are planned for construction in 2024 at Kings Bridge, a former sod farm, and a private property near Etowah that was formerly used for corn production. Several other floodplain properties are slated for restoration in Henderson and Transylvania Counties with grant funding secured for six projects. Successful floodplain restoration requires a team of biologists, engineers, geologists, and land conservation professionals working together to optimize restoration efforts and resource management, including long-term stewardship and monitoring. Lessons learned from existing projects should be integrated into plans for future projects in this and other watersheds to increase flood resilience and ecosystem functions.

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Evaluation of North Carolina Trout Anglers' Opinions, Participation, and Socioeconomic Impact

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Trout fishing is an important recreational activity in North Carolina. Thus, it is important for the NCWRC (NCWRC) to understand trout angler opinions of management within its Public Mountain Trout Waters program (PMTW). To achieve this, the NCWRC conducted a social science project in 2023 to assess public perceptions on management of trout and expenditures on trout fishing in PMTW. An emailed survey was sent to a random sample of 22,650 resident and 2,500 non-resident license holders that held fishing privileges at any point during 2022. In 2022, approximately 369,968 anglers fished for trout in PMTW and provided an overall economic impact to North Carolina's economy of $1.38 billion. Most survey respondents reported that their participation in trout fishing has not changed over time, and in addition to places where fish would be caught, they indicated that locations on public land and secluded locations were important when deciding where to go fish. Stocked-trout resources were popular among respondents, with Hatchery Supported Trout Waters and Delayed Harvest Trout Waters as the waters fished most. As found in previous surveys, trout anglers were satisfied with PMTW, with 76% of respondents being somewhat or extremely satisfied with their trout fishing experience. Lack of trout and overcrowding were the most common reasons for angler dissatisfaction. In addition, this project continued to highlight the challenges associated with the loss of angling access and the importance of retaining and increasing access into the future. This, like previous trout angler research, provided the NCWRC with critical socioeconomic information to help guide its PMTW.

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Blending Restoration And Education: A New Urban Stream Partnership

Brena K. Jones

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New Hope Creek is a uniquely situated stream which runs through the city of Durham, NC. For nearly 100 years, the creek has had a rare good fortune in the form of broad areas of riparian forest protection, managed by Duke Forest. As a result, large reaches of New Hope Creek still support rare freshwater mussels which have long since been lost from other developed landscapes. The NCWRC's Aquatic Wildlife Diversity Program is partnering with Duke Forest to help guide two barrier removal projects currently planned for 2024 and to provide technical expertise in aquatic species conservation and restoration. Due to the Forest's affiliation and proximity with Duke University, as well as a strong relationship with the local community in a large population center, this partnership is also resulting in ongoing opportunities for broader outreach along with hands-on field experiences for students and constituents.

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Tournament Data Offers Insights on Lake Norman Black Bass Populations

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In March 2023, Major League Fishing (MLF) held the REDCREST tournament at Lake Norman. This tournament, which was the Championship event for the top 40 anglers in the Bass Pro Tour, included five days of intense fishing, the MLF Outdoor Sports Expo, and over $724,000 awarded in prize money. For this tournament a "scorable" black bass was any fish over 1 lb. 7 oz. (652 g). Anglers who captured fish they believed to be scorable brought the fish into the boat, weighed them, and immediately released them. Weights were recorded for each angler using a tablet and weights of the top five heaviest bass were used to rank anglers. Over five days of fishing, a total of 1,105 scorable fish were captured (Largemouth Bass n = 209; Alabama Bass n = 896). Following the tournament, this data was shared by MLF with NC Wildlife Resources Commission biologists. A few weeks after the REDCREST tournament the Commission conducted an electrofishing survey of black bass in Lake Norman. When compared to Commission fish weighing more than 652 g (Largemouth Bass n = 33; Alabama Bass n = 10), tournament Largemouth and Alabama bass were larger on average. Sample sizes were not similar however, and this should be considered when evaluating differences in sizes of fish. The largest Largemouth and Alabama Bass (by weight) collected during this tournament were also larger than those collected in our survey. This indicates that while our survey is lake-wide and repeatable, it may be missing some of the largest fish in the population. Tournament data is a valuable source of additional data and helps us to understand the overall population present in the lake. In addition to data gathered, tournaments like REDCREST allow biologists and anglers to interact and share knowledge and ideas.

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Untangling Angler Opinions: North Carolina Reservoir Striped Bass Fisheries

Casey G. Joubert*, Kelsey J. Roberts, Kathryn L. Jewell, and Cristina E. Watkins

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Since 1957 the NCWRC has been stocking Striped Bass into lakes and reservoirs to allow for an additional, otherwise unavailable angler opportunity. While biological surveys have been completed to determine the success of these fisheries, little is known about anglers' opinions of the stocking program and their fishing habits. To determine how many Striped Bass and hybrid Striped Bass anglers are utilizing the resource, their fishing habits, levels of satisfaction, and stocking perceptions, a questionnaire was developed. Survey distribution followed a modified Dillman method utilizing both emailed and mailed distribution to 24,918 randomly selected anglers. Respondents were split into two groups, those that did fish for Striped Bass or hybrid Striped Bass in lakes or reservoirs, and those that did not. Results suggest Striped Bass and hybrid Striped Bass anglers are primarily fishing from a motorized boat, have been fishing for Striped Bass and their hybrids for over 30 years, and would support implementing a no culling rule. This presentation will discuss results on Striped Bass or hybrid Striped Bass anglers' fishing habits, stocking perceptions, and expenditures. The agency is currently writing a management plan for Striped Bass and hybrid Striped Bass and these results will also be tied into this larger project. The management plan, and knowledge gained through this survey, will inform future Striped Bass and hybrid Striped Bass fishery management in reservoirs in North Carolina.

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Distributions and Habitat Use of Eurasian Water Starwort, *Callitriche stagnalis,* in Watauga County

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Callitriche stagnalis is an Old World freshwater invasive aquatic species with significant populations on the northeastern and northwestern coasts. However, this species has never been documented in North Carolina, yet suspect populations have been identified. Surveys were conducted in the spring of 2022 to locate and identify populations of *C. stagnali*s and collect records of these populations. Plant samples collected were DNA barcoded using the matK segment of the chloroplast gene with the 390F, 1520R, and 1326R primers used for Polymerase Chain Reaction (PCR). The resulting sequences were conclusively members of *Callitriche*, and trees constructed in Geneious showed the plants sampled were most likely European in origin. A marginal wing of ~0.1mm on fruit collected from individuals at Kennedy Fields confirms the presence of at least one population of *C. stagnalis* in western North Carolina. A site suitability model was developed showing that many of the streams in the mountains of western North Carolina had high suitability for *C. stagnalis,* thus being at risk of invasion. This preliminary survey confirms the presence of *C. stagnalis* in western North Carolina; further sampling and surveying would need to be conducted to discover the true extent of invasion. Further, impacts on aquatic communities harboring *C. stagnalis* are unknown and understudied.

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Barcoding Reveals Cryptic Diversity within the *Cambarus dubius* Species Complex

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Cryptic and undescribed species likely comprise a significant proportion of global invertebrate diversity. Recent research reveals that the Upland Burrowing Crayfish, *Cambarus dubius*, a widespread and phenotypically plastic species found throughout east-central North America, is a species complex. Several new species have been identified from within this complex based on genetic and morphological data including *Cambarus adustus*, Dusky Mudbug, northeastern Kentucky; *C. pauleyi*, Meadow River Mudbug, south-central West Virginia; and *C. loughmani*, Blue Teays Mudbug, Teays River Valley, West Virginia. The goal of our research was to determine whether putative *C. dubius* in the southern Appalachian mountains are genetically divergent from topotypic *C. dubius* and recently described sister taxa. To date, we have examined mtDNA COI sequences from 23 '*C. dubius*' from the New, Catawba and Nolichucky drainages. Sequences were compared to Genbank sequence (n = 12) from *C. loughmani*, *C. pauleyi, C. adustus* & topotypic (orange) *C. dubius*. All sampled individuals from North Carolina exhibited substantial levels of genetic divergence when compared with taxa in the northern Appalachians, including topotypic *C. dubius*. Phylogenetic analyses indicate that at least two undescribed species are present within North Carolina *C. dubius* populations and that *C. dubius* SS may not occur in the state. One cryptic taxon appears restricted to the Lower New River whereas the other taxon appears to straddle the eastern Continental Divide and is present in the Upper New, Tennessee, and Catawba river drainages. Future surveys will target populations in other Tennessee River headwaters as well as in the Atlantic Slope drainages with headwaters on the Blue Ridge to better define species boundaries. Additionally we are examining morphological differences in order to determine whether phenetic traits, including coloration, can be used to differentiate these cryptic crayfish taxa.

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Associations of Stream-Adjacent Forest Fire with Juvenile Wild Steelhead Trout, *Oncorhynchus mykiss*, Survivorship in Southern Oregon

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Steamboat Creek is the most significant spawning ground for wild summer Steelhead Trout (Rainbow Trout), *Oncorhynchus mykiss*, in the North Umpqua River basin in southwestern Oregon. In 2021 forest fires, known as the Rough Patch Complex, burned a significant portion of the Steamboat Creek basin. This study is based on a four-year data set of juvenile Steelhead Trout in the 0 Age class from 2019-2022. We estimated the population of Steelhead Trout Age 0s from snorkel surveys using the Hankin-Reeves visual estimation method. We then compared the density of 0 Age class Steelhead Trout before and after the 2021 fires. We did this comparison in a creek where fires burned both banks and on creeks that were almost untouched by fire. Besides the Rough Patch Complex fires, 2021 was a dangerous year for salmonids with both high-water temperatures and meager numbers of returning adult Steelhead Trout. This study attempts to use stream gauge, water temperature, counts of returning spawning Steelhead Trout, and streamside forest fire presence to make associations between the estimated mean density of juvenile Steelhead Trout and stream-adjacent forest fires. We statistically compared juvenile Steelhead Trout survivorship in the years before and after the fire. To do this we compared three creeks, one of which was severely burned and the others ranging from virtually unburnt to minimally burned controls. We found significant differences in the numbers of Steelhead Trout Age 0s in the severely burned creek before and after the fire that we did not find in the unburnt or minimally burned creeks. We then discussed the effects of fire on the stream conditions most impactful for salmonids.

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Demonstration of Ecological Uplift in ILF Projects

Charles Lawson

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In-lieu Fee (ILF) mitigation was born out of the Clean Water Act mandating that impacts to streams and wetlands be offset by restoration and perpetual conservation of similar habitats within the same watershed. Seniard Creek, an In-lieu fee project in the North Mills River Watershed, was constructed in 2020. 5,264 feet of stream, one (1) acre of wetland, and a 12-acre conservation easement were created/conserved and 2,000 acres of watershed reconnected. Among other aspects of the stream restoration, a hanging culvert 8' culvert was corrected during the restoration. To confirm continuity of the downstream and upstream reaches, single pass electro-fisheries surveys were conducted pre-restoration and annually post restoration to track the fisheries assemblage over time. Five species were identified within the study reach pre-construction, one (1) upstream and five (5) downstream. The cumulative MY3 species totals; six (6) species upstream and eight (8) species downstream. Cumulative rates of change in individual abundance were two (2) individual fishes per year and fifteen (15) fishes per year, in the upstream and downstream reaches respectively.

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Dam Removal Initiative in Western North Carolina

Andrea J. Leslie*[1], Chris Goudreau[2], Vann Stancil[3], and Chris Wood[1]

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In 2021, the North Carolina (NC) legislature appropriated $7.2 million to the NC Wildlife Resources Commission (NCWRC) to remove dams in western NC. Eight dams have been prioritized for removal using the Southeast Aquatic Resources Partnership barrier prioritization tool, staff input on ecological restoration priorities, feasibility, and project readiness. NCWRC has partnered with MountainTrue and American Rivers to carry out various steps in the dam removal process - from feasibility analysis to design to full removal. Three dams should be removed in 2024, with additional dams removed in the future. Dam removal projects are complex and challenging, and a broad partnership of agencies, tribal nations, and non-government organizations is essential in fundraising, permitting, project monitoring, and gaining landowner and community support.

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

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

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The Yellowfin Shiner, *Hydrophlox lutipinnis*, is a small leuciscid fish native to the Atlantic Slope watersheds of Georgia and South Carolina. However, their native range extends into North Carolina within the headwaters of the Savannah River basin. In 1998, Yellowfin Shiners were documented for the first time in the Little Tennessee River (LTR) in Macon County, North Carolina. Continuous sampling of the LTR Watershed over the past thirty-four years reveals a pattern of dispersal typical of invasive species. Yellowfin Shiners have been discovered in tributary streams more than thirty river kilometers downstream from their southernmost documented occurrence in 1990. In these tributary streams, native minnow species, particularly the Tennessee Shiner, *Paranotropis leuciodus*, are increasingly outcompeted, hybridized with, and displaced by the Yellowfin Shiner. The impacts of this invasion are more pronounced in tributaries where the instream habitat has visible degradation from surrounding land-use changes. Changes in biotic assemblages and habitat degradation linked to land-use practices have been observed in conjunction with the expansion of Yellowfin Shiners. The expansion of the Yellowfin Shiner seems to have stalled, with the more established populations occurring in the highly disturbed areas of the upper LTR. Protected riparian zones in the lower reaches may be inhibiting their further spread. However, ongoing habitat degradation and the impacts of climate change could promote the expansion of this non-native species throughout the LTR basin, adversely affecting this hotspot of aquatic biodiversity. Further field and laboratory experiments could elucidate the mechanisms allowing Yellowfin Shiner proliferation outside their native range.

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A Taxonomic Revision of the Pirate Perches (Aphredoderus)

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Aphredoderus were long considered to be a single species, consisting of an Eastern and Western subspecies native to the Atlantic slope and Mississippi River Valley/Great Lakes. Further taxonomic classification was confounded by widespread variation in *Aphredoderus* in the Southern Atlantic and Eastern Gulf slope, due to implied intergradation between the subspecies. Our objective is to determine the extent of intergradation in *Aphredoderus* both morphologically and genomically. We sampled Aphredoderus throughout their geographic range, and applied specimen-level morphologic analysis, we then constructed a phylogeny and tested for admixture. Our results support five morphologically and genetically distinct species of *Aphredoderus*, four of which are widely sympatric in the Southeastern United States. We conclude that sympatry and lowland distributions complicate systematic studies of freshwater fishes and stress the importance of specimen-level rather than drainage-level analyses for ambiguous taxa.

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Spawning Phenology and Springtime Migrations of Acoustic Tagged White Bass within the Flat and Eno Rivers above Falls Lake, NC.

Seth A. Mycko

NCWRC, Division of Inland Fisheries, Mebane, NC

Between February 2020 and June 2022, NCWRC biologists and staff captured White Bass, *Morone chrysops,* from rivers and tributaries flowing into the upper reaches of Falls of the Neuse Reservoir (Durham, NC). 80 of the largest individuals were implanted with acoustic transmitters (2020 n=50; 2021 n=30). Tag life was a maximum of 512 days. 50 tags were programmed with battery saving dormant periods which extended the lifespans. Approximately 45% of tags remained at large for more than a 365-day period. 35% of individuals were detected across two consecutive Springtime spawning seasons. Across all years, spawning area detections were dependent upon riverine discharge and peaked around the third week of March. Average time of arrival at each riverine array was consistent with river miles and gradient indicating that fish with longer migrations start earlier and stay longer. Flood pulses seem to be a strong indicator of White Bass movements to the upstream most locations during the Spring. Three potential spawning areas were identified within each river. White Bass were most frequently encountered at these locations during flood pulses after which most fish receded downstream when discharges subside. Both rivers contain large barriers to upstream movements. However, the Eno River retains approximately 10-km more free-flowing river channel than the Flat River. Riverine discharge appears to be the strongest predictor of upward spawning migrations in both rivers with discharge being a more reliable indicator of movement in the longer, more gradient, river. Overall, these data confirm the anecdotal evidence provided by many anglers who have a "only go when it flows" mentality for targeting White Bass within North Carolina's spawning rivers. Riffle-run habitats within the areas identified as spawning zones should be maintained for continued White Bass spawning success.

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Developing Genetic Parentage-Based Tagging (PBT) Tools for Imperiled Freshwater Mussel Conservation

Edie Nissen*[1], Greg Cope[1], and Heather K. Evans[2]

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Freshwater mollusks are among the most diverse groups of organisms around the world, and the Southeast United States harbors more than 300 species. Because of the important role these animals play in nutrient cycling and other ecosystem services, they can have a significant impact on the health of freshwater systems. Due to pollution, habitat loss, and declining water quality, around 75% of those 300 species are imperiled. Two imperiled species distributed in Central North Carolina are the federally and state endangered Tar River Spinymussel, *Parvaspina steinstansana*, and the federally and state threatened 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 brood mussels. Positive controls for each species have also been obtained, as well as any negative controls (wild-born not used as brood) that could be found. Currently, testing is underway on a selection of several hundred SNPs that have been selected from thousands of previously identified SNPs to create a panel that will allow for high throughput, yet accurate detection of hatchery-bred individuals. The panel may also be used to monitor genetic diversity and population structure with ongoing stocking efforts. This study will contribute knowledge and resources for future reintroductions and augmentations of these imperiled species, as well as provide insight on the benefits of using genetic tools in conservation.

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A Case Study in Reintroducing the Critically Imperiled Magnificent Ramshorn Snail

Emilia Omerberg*[1], Brena K. Jones[1], and Rachel Hoch[2]

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The Magnificent Ramshorn, *Planorbella magnifica*, is a large freshwater snail endemic to the lower Cape Fear River basin in North Carolina. The species was federally listed as Endangered in 2023 and believed extirpated from the wild since 2004. What began as a private landowner's personal commitment to save the snail in the mid-1990s has turned into a multi-partner effort to recover this unique species, spanning decades. The Magnificent Ramshorn provides a case study in persistence and cooperative efforts in the recovery of imperiled species. After over 20 years in captivity, which included many years of refining husbandry techniques, and searching for and preparing suitable habitat for reintroduction, the first individuals were released back into the wild in October 2023, where they immediately began reproducing. Creative propagation techniques, shared cooperative research data, and multiple funding sources aiding this animal's progress towards recovery has been critical to the advancement of the project. The snail is an example of a positive, hopeful conservation story using grant funding from the National Fish and Wildlife Foundation and an innovative regulatory tool in the form of a programmatic Safe Harbor Agreement.

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An Update on Newly Discovered Crayfish in the Yadkin River Basin

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North Carolina waters are home to about 50 species of crayfish. The upper Yadkin River basin is the most biodiverse, with at least 16 species. Using an integrative taxonomic approach, we described the Stony Fork Crayfish and Falls Crayfish in 2023 as part of an ongoing statewide collaboration between the NCWRC and the North Carolina Museum of Natural Sciences. Both species are endemic to the Yadkin River basin in North Carolina and found in only a few streams draining the eastern Blue Ridge escarpment. Furthermore, both species are more closely related to a species complex from interior basins on the western side of the escarpment. We hypothesize that the narrow endemism seen in these newly described species is the result of allopatry driven by a combination of stream capture and Passive Margin Escarpment Evolution (PMEE) events. A third crayfish species, putatively found only in the Roaring River watershed, was likely isolated by similar geologic phenomena and is the focus of ongoing research.

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Effects of Handling Frequency on Juvenile Mussel Production

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The Marion Conservation Aquaculture Center (MCAC) works towards the conservation of aquatic species through captive propagation. Freshwater mussels constitute the majority of this facility's efforts. The time and resources that go into producing these animals are extensive, and many of the species propagated are known to be sensitive to handling. This study was conducted to determine if reducing the staff handling of animals results in better growth and survivorship. Additionally, the results of this study will inform how staff distribute workload between multiple production lots. Sediment changes are conducted weekly for all juvenile mussels at the MCAC, which takes considerable time and may be stressful for the animals as they are removed from the system for cleaning and assessment. An experimental system was set up exactly like the standard tank systems used in our facility to test "hands-off" rearing of juvenile mussels. All systems were maintained at the same feed concentration, sediment type, and filtration. Approximately 500 juveniles of each propagated lot of mussels were placed in individual tanks in March as they were collected from host fish systems. These lots included propagated *Parvaspina steinstansana*, *Alasmidonta raveneliana*, *Alasmidonta varicosa*, and *Villosa vaughniana*. For the duration of four months, all normal maintenance was completed on this system with the exception of the weekly sediment changes. At time of evaluation in July, 3,893 individuals survived across all mussel lots in systems receiving standard protocol sediment changes, with an average size of 3.2mm. In the experimental system, only 10 total juveniles were produced across all lots, with an average size of 2.5 mm. These results suggest that our weekly handling may not cause mortality. Further studies are needed to determine if the ideal frequency for sediment changes may be somewhere between the two tested treatments.

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Hemolymph Preservation Optimization and Portable Cell Counting Validation: Tools for Rapid Evaluation of Freshwater Mussel Immune Status

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Contemporary freshwater mussel population declines often lack discriminant explanations, and diagnoses are commonly either post-hoc, subjective, expensive, or lethal. Sublethal metrics and biomarkers that identify early warning signs of infection, stress responses, and deviations from physiological homeostasis or resilience to environmental pressures are needed. Hemolymph, the circulatory fluid in mussels that is analogous to blood, can be withdrawn nonlethally and contains hemocytes, the backbone of the mussel immune system. Immune modulators can be differentiated by quantifying multiple endpoints based on hemocyte form and function, but spontaneous hemocyte aggregation, cell instability, travel times from sampling sites, and lack of access to costly instrumentation limits valuable immune status assessments. Widespread capacity to understand immune responses to disease, toxicants, and other stressors relies on effective hemolymph handling and preservation techniques. In this study, we have optimized methods to measure total hemocyte count, concentration, and longevity across five anti-aggregants (Alsever's Solution, K2EDTA and sodium citrate Microtainers, Isoton II, and Leibovitz's L-15) over time using a Beckman Coulter Multisizer 4e and a Millipore Scepter; a portable, rapid, relatively inexpensive cell counter. Compact cell counters might be an advantageous alternative to benchtop instruments for instantaneous evaluation when long-term holding in anti-aggregants is needed to best support hemocyte stability. Our preliminary results indicate K2EDTA Microtainers held on ice for at least three hours could be a viable option for hemolymph preservation and that the handheld Scepter is qualitatively comparable to the benchtop Multisizer. Further investigations will incorporate preservation technique impacts to cell physiology, implement these approaches to calculate reference ranges across populations, and identify how anticipated stressors such as infection and starvation alter the immune response. This research is intended to provide recommendations for approachable, standardized strategies to quantify freshwater mussel health across propagation facilities and in stable or declining ecosystems.

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Uncharted Waters: High-Resolution Stream Networks Reveal Hidden Habitats for Petitioned Headwater Crayfishes

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Burrowing crayfishes are among the most data- and knowledge-deficient crayfishes, partly because much of their life cycles occur underground. Burrowing could enable these species to inhabit temporarily wetted habitats such as roadside ditches and small streams. However, these habitats are rarely depicted in maps or sampled within standardized monitoring programs. Thus, these systems could be sources of crayfish habitat that are often overlooked in conservation assessments. Our goal was to compare the relative occupancy of rivulet crayfishes (*Hobbseus* spp.) among roadside ditches, and mapped, and unmapped streams. Our emphasis was *H. orconectoides*, a species petitioned for listing under the Endangered Species Act and historically known from only twelve sites in eastern Mississippi. Within the five 12-digit Hydrologic Units where *H. orconectoides* potentially occurs, we used Geographic Information Systems and 1-m^2 LiDAR elevation data to construct a high-resolution stream network depicting unmapped streams with watershed areas >300 m^2. We identified mapped stream sites (1–2 orders) within the National Hydrography Dataset along with discretized 50-m roadside-ditch sites. From February–May 2023, we used two-person dip-netting within a removal occupancy design to randomly sample crayfish at 91 unmapped streams, 29 mapped streams, and 64 roadside ditches. We detected *Hobbseus* crayfishes at 64 sites, demonstrating members of this genus are far more prevalent than historically reported. Observed site counts of *Hobbseus* crayfishes ranged from 1–913 individuals, with peak counts in unmapped streams. *Hobbseus* crayfishes were more common in unmapped streams (40 sites, naïve occupancy = 44%) and mapped streams (14 sites, naïve occupancy = 48%) than roadside ditches (10 sites, naïve occupancy = 16%). Although *Hobbseus* crayfishes have restricted ranges, there is an additional 1409 km of unmapped streams than mapped streams (363 km) and 554 km of roadsides within the five HUC12s.

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Lumber River Creel Survey

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A stratified non-uniform probability access-access creek survey was conducted along the Lumber River from January 2–December 30, 2022. Three hundred eighty-two creel sessions were conducted, resulting in interviews of 751 anglers in 399 angling parties. Overall, an estimated 39,556 (SE = 3,377) anglers expended 95,663 (12,606) hours of effort fishing the Lumber River in 2022. Anglers caught an estimated 51,020 (7,652) fish and harvested 26,425 (6,395) fish. Anglers spent an estimated USD $774,727 ($35,649) on direct fishing-related expenditures and indicated a willingness to spend $1,558,277 ($51,164) for a trip of equal or greater satisfaction. Over 76% of anglers fished from the shoreline without use of a boat and most anglers (49%) were non-specified generalists targeting "anything that bites". The angling demographic was largely comprised of local anglers as 63% were residents of Robeson County. The counties adjoining the Lumber River are home to the Lumbee Tribe of North Carolina - one of the largest Indigenous tribes in the United States - and 47% of anglers self-identified as Native American. Most anglers expressed satisfaction with the fishery and desired to "keep everything as is" (43%), though a large contingent (27%) also indicated a need to reduce trash at access sites along the river. The Lumber River fishery exhibits characteristics that are unique in North Carolina and conservation efforts should focus on collaborative management and community outreach.

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Changes to Fish Assemblages and Land Use Change Across 30 Years in the Upper French Broad River Basin

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Freshwater ecosystems around the world are threatened due to anthropogenic impacts. Included in this is the area of Western North Carolina because of increasing urbanization, impacting an area of incredibly high freshwater biodiversity. This study compared data from four streams in the Upper French Broad River Basin during 2023, 2012 and 1996. The objective was to analyze the changes in fish assemblages over 30 years in the area and compare to land use changes from the National Landcover Database. Students sampled fish populations and water quality parameters, such as conductivity and temperature, at Cane Creek, Hominy Creek, Newfound Creek, and the Swannanoa River, and compared the results from each sampling year. There was an overall decrease in species richness from 1996 to 2023 in relation to an increase in the percent of developed land cover. Almost every site also had a decrease in endemic fish species, and an increase in cosmopolitan species. Included in endemic species is the Redline Darter, *Nothonotus rufilineatus*, which had strong population decreases at almost all sites. These results suggest that an increase in urbanization across the Upper French Broad River Basin has negatively impacted the freshwater biodiversity, favoring biotic homogenization.

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Experimental Stocking and Evaluation of F1 Hybrid Largemouth Bass in Three Piedmont Reservoirs

Kelsey J. Roberts

NCWRC, Inland Fisheries Division, Mebane, NC

The NCWRC began stocking F1 hybrid Largemouth Bass in Lake Norman in 2021 and in Lake Gaston and Jordan Lake in 2023. Stocking will continue at all three reservoirs at a minimum rate of 10 fish/ha over the next 4–5 years. F1 hybrids are a 50-50 cross between a pure Florida Largemouth Bass, *Micropterus salmoides*, and a pure Northern Largemouth Bass, *Micropterus nigricans*. F1 hybrid Largemouth Bass are popular among anglers due to their potential fast growth and thus, these experimental stockings aim to augment Largemouth Bass populations by increasing the quantity of trophy Largemouth Bass in reservoirs. The Commission will closely evaluate F1 hybrid fingerling persistence, growth, and contribution to the Largemouth Bass population by collecting genetic and population data from electrofishing surveys and tournament weigh-ins. Program success will be evaluated until at least 2030 and compared across the three reservoirs with different levels of primary productivity to determine future management strategies.

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Reintroduction of the Tangerine Darter in the Upper French Broad Watershed, NC

Chantelle Rondel*, Luke Etchison, and Dylan Owensby

*Presenting

NCWRC, Aquatic Wildlife Diversity Program, Waynesville, NC

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 2021, Tangerine Darters, *Percina aurantiaca*, have been reintroduced into the upper French Broad, Mills, and Swannanoa Rivers. Visual surveys and VIE (Visible Implant Elastomer) tags will help track reintroduction success.

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Population Genetic Assessment of the State Endangered Orangefin Madtom, *Noturus gilberti*

Thomas (TR) R. Russ*[1], Michael A. Perkins[1], and Heather K. Evans[2]

*Presenting

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The state endangered Orangefin Madtom (OFMT) is a small catfish native to the upper Roanoke River Basin in Virginia and North Carolina with a disjunct distribution in the Dan River subbasin in both states, suggesting it was historically more widespread. To recover this species in NC, we sought to understand the genetic makeup of the entire population. Our objectives were to update the status and distribution throughout the Dan subbasin, assess overall genetic health, and determine the health and diversity of seemingly isolated populations. From 2015-2020 NCWRC and partners completed 124 fish surveys in the Dan subbasin, in Stokes and Rockingham counties. No OFMT were observed outside of the known range; the NC population is relegated to approximately 22km in the upper Dan River, upstream and downstream of Jessup Mill Dam. In 2021, NCWRC and Virginia DWR Biologists re-surveyed all known populations of the catfish. Tissue samples were collected from eighty-four individuals at nine sites in the Roanoke River Basin and one site in the Upper James River Basin. A total of 4,506 neutral single nucleotide polymorphisms (SNPs) were selected to conduct analyses. Fst values indicate the Dan population upstream and downstream of Jessup Mill have high connectivity and belong to the same population. Low Fst values were generated for South Fork Roanoke River and the Craig Creek populations in the James River basin, providing evidence that OFMT were introduced to the James River from the Roanoke population. STRUCTURE Bayesian analysis suggests OFMT populations are fragmented. The Roanoke, Craig, and Pigg rivers form one distinct population, and the Dan, Smith, and Mayo rivers constituting an additional three isolated populations. Genetic diversity is lower in the Dan, Smith, and Mayo when compared to the Roanoke population. Future OFMT conservation efforts via reintroductions or augmentations should strive to maintain and maximize genetic diversity in these four populations.

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Initial Freshwater Mussel Translocation/Captive Propagation Efforts on the Deep River (Cape Fear River Basin), for the High Falls Dam Removal Project, Moore County, North Carolina

Tim Savidge*, Tom Dickinson, and Trevor Hall

*Presenting

Three Oaks Engineering, 324 Blackwell Street, Suite 1200, Durham, NC

The High Falls Dam is an approximately 800-foot (ft) wide, run-of-river dam located on the Deep River in Moore County that is being removed for ecological restoration and recreational purposes. The Deep River is known to support several high-conservation priority aquatic species. These include two federally protected species, the Endangered Cape Fear Shiner, *Miniellus mekistocholas* and the Threatened Atlantic Pigtoe, *Fusconaia masoni*. Additionally, several state-listed freshwater mussel species are known to occur in this general portion of the Deep River, most notably the state endangered Brook Floater, *Alasmidonta varicosa*, Yellow Lampmussel, *Lampsilis cariosa*, and Savannah Lilliput, *Toxolasma pullus*, as well as the state threatened Triangle Floater, *Alasmidonta undulata*, and Creeper, *Strophitus undulatus*. While dam removal has been demonstrated to improve overall ecological function in the long term by restoring lotic habitats, short term adverse effects to some aquatic organisms, such as freshwater mussels, may occur shortly after removal, as sediment that is built up behind the dam is released downstream and the channel adjusts to the "new" flow regime. To help offset some of these potential adverse effects to mussel resources, Unique Places to Save (UP2S) and RES Environmental Operating Company, LLC (RES) and partners collaborated to incorporate a freshwater mussel salvage/translocation component into the project. Three Oaks Engineering (Three Oaks) was retained by RES to develop and implement a freshwater salvage and translocation effort involving targeted conservation priority species. Project partners identified an approximately 2,000 feet "salvage" area downstream of the dam Salvaged mussels were either translocated to two approved relocation sites on the Deep River, or they were taken into captivity for propagation and other research efforts. The river ranges from 800 to 1,000 feet wide in this section and mussels occur in high densities and thus, the salvage effort was very labor intensive. To meet this demand, Three Oaks procured volunteers, from multiple agencies, universities, and private individuals to participate in the efforts. A total of 35 people participated during three separate dates in September 2023. The general mussel abundances and distribution within the salvage reach were determined, and well over 18,000 individual mussels comprising eight species were found, with a total of 1,259 individuals comprising seven conservation priority species translocated to either the propagation facility, or the two natural translocation sites.

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Watershed Stewardship in a Small Mountain Community: Stakeholder Involvement is Key to Education, Planning, and Resource Restoration and Management

William Seaman*[1] and Jacob Rash[2]

*Presenting

[1]University of Florida, Fisheries and Aquatic Sciences, Montreat, NC

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The mountain headwaters stream Flat Creek, Buncombe County, North Carolina rises and flows only a short distance through the small town of Montreat, yet it exerts an inordinately large influence on the social dynamics and lifestyle of residents and more numerous seasonal visitors of all ages. In return, a diversity of stakeholders have emphasized Flat Creek in conservation, restoration, research, education and management, as presented here for six tangible and successful efforts, with five in just the last five years. Flat Creek waters are of sufficient quality to harbor Eastern Hellbenders and trout. In 2020 citizen scientists quantified eight baseline physical-chemical attributes. Homeowners organized a bio-control treatment program for invasive woolly adelgid insects attacking Eastern Hemlock trees, with one success being preservation of hemlocks along the creek. Third, an educational TRACK Trail of the national Kids-in-Parks program has been designated for a nearly mile-long stretch adjacent to Flat Creek. These efforts all had extramural funding and were under the auspices of the Montreat Landcare Committee (Landcare). In addition, the Town of Montreat just completed a Stormwater Inventory and Management Plan. Concurrently, Flat Creek is a focal point within the Town of Montreat's 2023 comprehensive plan, which included Landcare organization of a meeting where Montreat residents listed and mapped positive and negative issues and concerns such as runoff, erosion, water quality and aesthetics for Flat Creek, which were addressed in five plan objectives. Finally, a work in progress that has drawn broad community hands-on support is the new Flat Creek All-Access Trail being developed as a Landcare project. This all-persons trail will create a universally accessible one-tenth-of-a-mile path to the water. For a town with a population of about 800, the ecosystem services of Flat Creek are valued by many, and this model of stakeholder-driven engagement with watershed education, science and management may be useful to other communities and aquatic systems.

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Update on Selected Duke Energy Studies in 2022, 2023, and 2024

Richard W. Smith

Duke Energy, Water Resources Unit, New Hill, NC

Rick Smith's talk will cover:

- A brief description of why and what work is done for the Walter's Hydroelectric Plant's FERC (Federal Energy Regulatory Commission) License No. 432 will be given. This talk will cover certain aspects of the required work done in 2022. Haywood County, NC.
- Cyanotoxin Study in Waterville Lake, Haywood County, NC.
- Closure of Pactiv Mill in Canton, Haywood County, NC.
- Update on Lake Julian - What happens when the warm water goes away?, Buncombe County, NC.
- Disappearance of *Lyngbya/Microseira* from Harris Lake, Wake-Chatham counties, NC.
- Update on the fishery of Hyco Lake, Person-Caswell counties, NC.

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Surveys for and Molecular Identification of River Cruiser, *Macromia margarita*, Nymphs in the Southern Appalachians

Nolan Taylor*[1], Michael Gangloff[1], Jonathan Wells[1], and Jason Mays[2]

*Presenting

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The Mountain River-cruiser, *Macromia margarita* Westfall 1947, is a large dragonfly that occurs in and alongside moderate to large, upland streams in the southeastern US. This species has a relatively wide distribution that extends from the Piedmont of Virginia and North Carolina southwest through the Blue Ridge Mountains in upstate South Carolina and northern Georgia and west to the Ridge and Valley in Tennessee and northern Alabama. Mountain River-cruisers were recently petitioned for listing under the Endangered Species Act. Assessing the status of wide-ranging aquatic insects is challenging because adults are needed to positively identify many taxa and in the case of larger dragonflies, detectability is affected both by the aerial period as well as by difficulties inherent with capturing specimens. We used molecular bar-coding to verify larval *Macromia* identifications based on newly available species-level keys for this group. We have examined *Macromia* larvae from the Southeast obtained from our sampling efforts, North Carolina Department of Environmental Quality, and other collectors. The collection includes >200 late instar individuals identified to the species by morphology and/or genetics. DNA analyses confirmed that the morphological keys in Tennessen (2019) successfully diagnosed late-instar *M. margarita* and revealed the presence of several previously-unknown populations. During 2024 we will be using our existing dataset for *M. margarita* to create spatial distribution models with the goal of identifying likely streams to sample. These data will help the US F&WS and other agencies to better understand the range and conservation status of this cryptic and difficult to detect dragonfly and provide a model for similarly difficult to detect species.

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Diversity Of Stone Suckers in North Carolina with the First Report of One Species Parasitizing Full-bodied Fishes with Fleshy, Sucking Lips

Bryn H. Tracy*[1], Fred C. (Fritz) Rohde[2], Michael Fisk[3], Brena K. Jones[4], and Luke Etchison[5]

*Presenting

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[2]Wilmington, NC

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There are five species of Stone Suckers, more properly referred to as lampreys, Family Petromyzontidae, calling North Carolina home. Lampreys are very ancient and primitive fishes, but have successfully existed as a group for more than 300 million years. The first part of our presentation will discuss: 1) who and what are lampreys; 2) the species inhabiting North Carolina's fresh and marine waters and their distributions; 3) morphological characteristics that aid in their identification; and 4) their imperilment status and threats to their future existence.

The second part of our talk will present observations that we witnessed this past spring on the Pee Dee River in Anson-Richmond counties, North Carolina. In late April–early May 2023 several full-bodied fishes with fleshy, sucking lips, more appropriately called Robust Redhorse, *Moxostoma robustum* (Family Catostomidae), were collected from the Pee Dee River exhibiting open sores. We suspected that the wounds might have been caused by Sea Lampreys, *Petromyzon marinus*, even though none of the fish had a lamprey actively attached to the host. Our circumstantial evidence was confirmed by expert photo review: indeed the wounds had been caused by lampreys. Our observations are the first documented occurrences of the lamprey parasitizing Robust Redhorse anywhere throughout the suckers' range in the Carolinas and Georgia.

Our presentation will conclude with briefly discussing what research has been and is being conducted on lampreys in North Carolina.

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Patience, Perspiration, and Persistence Do Pay Off! The Creation of: *A Guide to North Carolina's Freshwater Fishes*

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

*Presenting

[1]Apex, NC

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A Guide to North Carolina's Freshwater Fishes is the first book since 1991 covering North Carolina's 258 described and undescribed freshwater fish species. The concept of an updated book was spawned in 2012, gestating very slowly until ~ 2021–2023 with expected hatching and swim-up in March 2024. During this process there were many trials and tribulations that had to be overcome, such as Covid; continuous distributional, identification keys, taxonomic, and etymological updates; contractual obstacles and obligations with the publisher; layout and cover designs; and our quest to obtain better and better images of our diverse fauna.

This book will serve as a companion to "An Annotated Atlas of the Freshwater Fishes of North Carolina" and the website: NCFishes.com. It will measure 6 X 9 inches Total Length and will tip the scales at approximately 470 pages. It will provide the reader with:

- Updated taxonomy and detailed identification keys for all 258 described and undescribed species;
- Full-color images for every species for clear identification;
- Updated distributional maps;
- a glossary with color images describing the morphological characters that are used in the identification keys;
- Bar charts from the most diverse families showing the total number of species, number of indigenous species, and the number of nonindigenous species for each of the 21 river basins;
- Information on North Carolina's 40 freshwater fish families and an ichthyological history of North Carolina; and
- An appendix that explains the meanings behind the scientific names.

The University of North Carolina Press is currently accepting pre-orders with a 30% discount. They are available at: https://uncpress.org/book/9781469678115/a-guide-to-north-carolinas-freshwater-fishes/ or by telephone: 1-800-848-6224. Discount code: **01UNCP30**. Don't go into the field or laboratory without one!

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Determining Minimum Habitat Availability for Muskellunge in North Carolina

Delaney Whitson* and Keith Gibbs

*Presenting

Western Carolina University, Department of Geosciences & Natural Resources, Cullowhee, NC

The Muskellunge, *Esox masquinongy*, is a species native to the western portion of North Carolina, including the French Broad and Little Tennessee rivers. As southern Muskellunge fisheries become more popular, anglers and management agencies are working to maximize habitat and establish self-sustaining populations throughout their native range. The purpose of this project is to identify and compare habitat in areas where Muskellunge population augmentation is occurring to an area with no current restocking effort to better understand minimum habitat requirements for the species. Two sections of the French Broad and Little Tennessee River in western North Carolina were analyzed for factors that could determine Muskellunge occupancy. Data collected includes gradient, depth, substrate, and presence of large woody debris. Sites were chosen using fish data previously collected by the North Carolina Wildlife Resources Commission. This work is ongoing, and we hope to identify any limiting factors that make the river uninhabitable for Muskellunge to focus future restoration efforts on those limiting factors.

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Changes to Water Chemistry and Implications for Sensitive Aquatic Biota in Southern Blue Ridge Streams

Hannah C. Woodburn*[1,2] and Michael M. Gangloff[2]

*Presenting

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My thesis project aimed to assess which broad-scale changes in water chemistry may correlate with the recent enigmatic declines of aquatic species in the region. I examined long-term (~60 years) water quality and land use (18 years) to assess how HUC10 watersheds have changed over time. Spearman correlations suggest most water chemistry parameters examined increased in value over the last 5 decades (dissolved oxygen concentration, total dissolved solids, pH, and specific conductivity). The most consistent trend was increased pH across most watersheds over the last 5 decades. Mixed effects models were used to identify the parameter that best explains the variation driving water chemistry measurements. 'Year' was the best predictor for all water chemistry parameters, and pH declined in watersheds with increasing impervious surfaces. I also used occupancy modeling to understand how species have shifted across multiple decades (1900-2010). The species included in the analysis represent a diverse assemblage of the most vulnerable aquatic organisms to changes in water quality (fish, mollusks, amphibians, and arthropods). My results demonstrated consistent declines in occupancy for 9 of 11 species, and 63% of watersheds experienced a loss of 1 or more study species. Freshwater fish were the only taxa group that had statistically significant losses over time. My study is one of the first to show widespread changes in streams that are generally considered to be at low risk of being impacted by anthropogenic and climatic disturbance. My study highlights the dynamic interplay between environmental factors, urbanization, and aquatic ecosystems over time. It also emphasizes the need to effectively protect and manage surface waters. Native and endemic species are vulnerable to changes in water chemistry, and the persistence of biological diversity in headwater stream networks is critical to ensure the resilience of the Southern Blue Ridge region in the face of emerging water challenges.

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