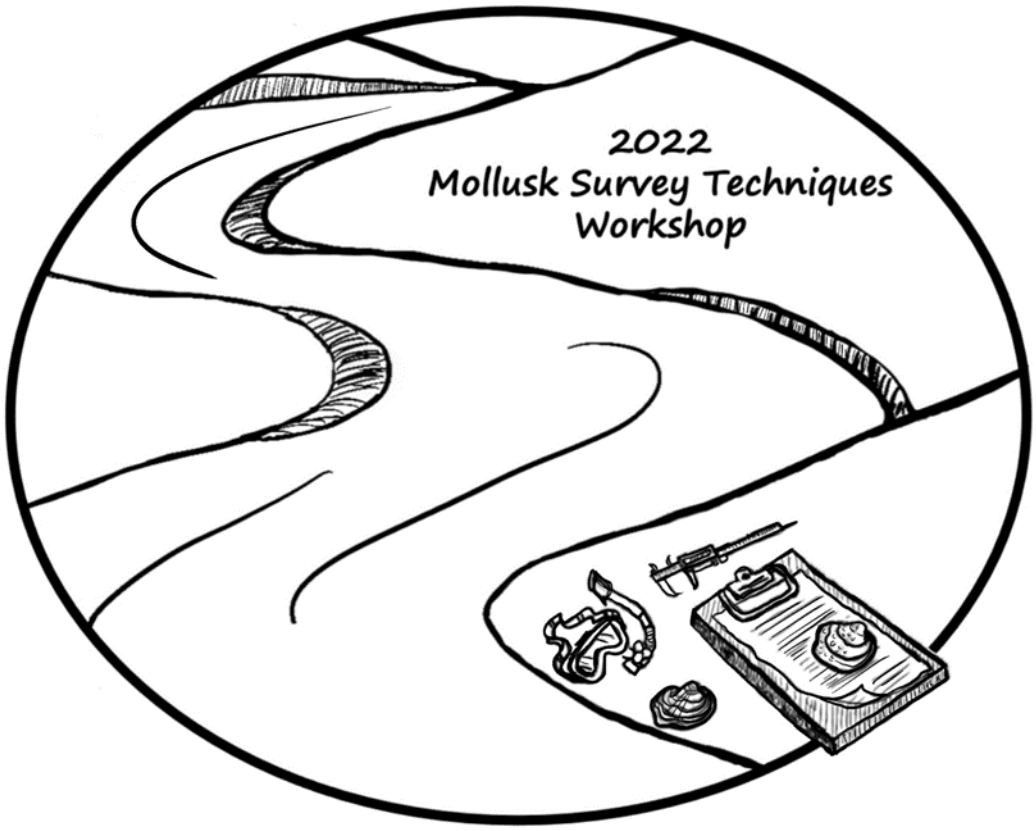
12th Biennial Workshop



Hosted by:

Freshwater Mollusk Conservation Society

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The Freshwater Mollusk Conservation Society (FMCS) is dedicated to the conservation and advocacy of freshwater mollusks for public education and the conservation science of freshwater mollusks, North America's most imperiled fauna. We would like to make a special thank you for generous donations of the following sponsors.

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Schedule Overview

Monday		
12pm-10pm	Registration Begins	Restaurant
2pm	Board Meeting	Conference Room C
6-10pm	Evening Mixer *Open Bar and Appetizers*	Restaurant

Tuesday		
7-8am	Breakfast (Registration) *Hot Breakfast Buffet*	Restaurant
8-9am	Welcome and Plenary Talk	Conference Hall
9-9:30am	Transition to Sessions	
9:30-4:30pm	Sessions, Presentations *Box Lunch*	Various Locations *Restaurant*
4:30-6pm	Evening Transition	
6-7pm	Dinner *Buffet Style Meal and Open Bar*	Restaurant
7-10pm	Poster Session *Open Bar*	Restaurant and adjoining Visitor Center

Wednesday		
7-9am	Breakfast *Hot Breakfast Buffet*	Restaurant
9-4pm	Sessions, Presentations *Box Lunch*	Various Locations *Restaurant*
4-6pm	Evening Transition	
6-10pm	Dinner *Buffet Style Meal and Open Bar*	Restaurant

Thursday		
7-9am	Breakfast *Hot Breakfast Buffet*	Restaurant
9-10am	Duck River Presentation	Conference Hall
10-3pm	Duck River Field Sampling	Field Site

Contents

Plenary Speaker

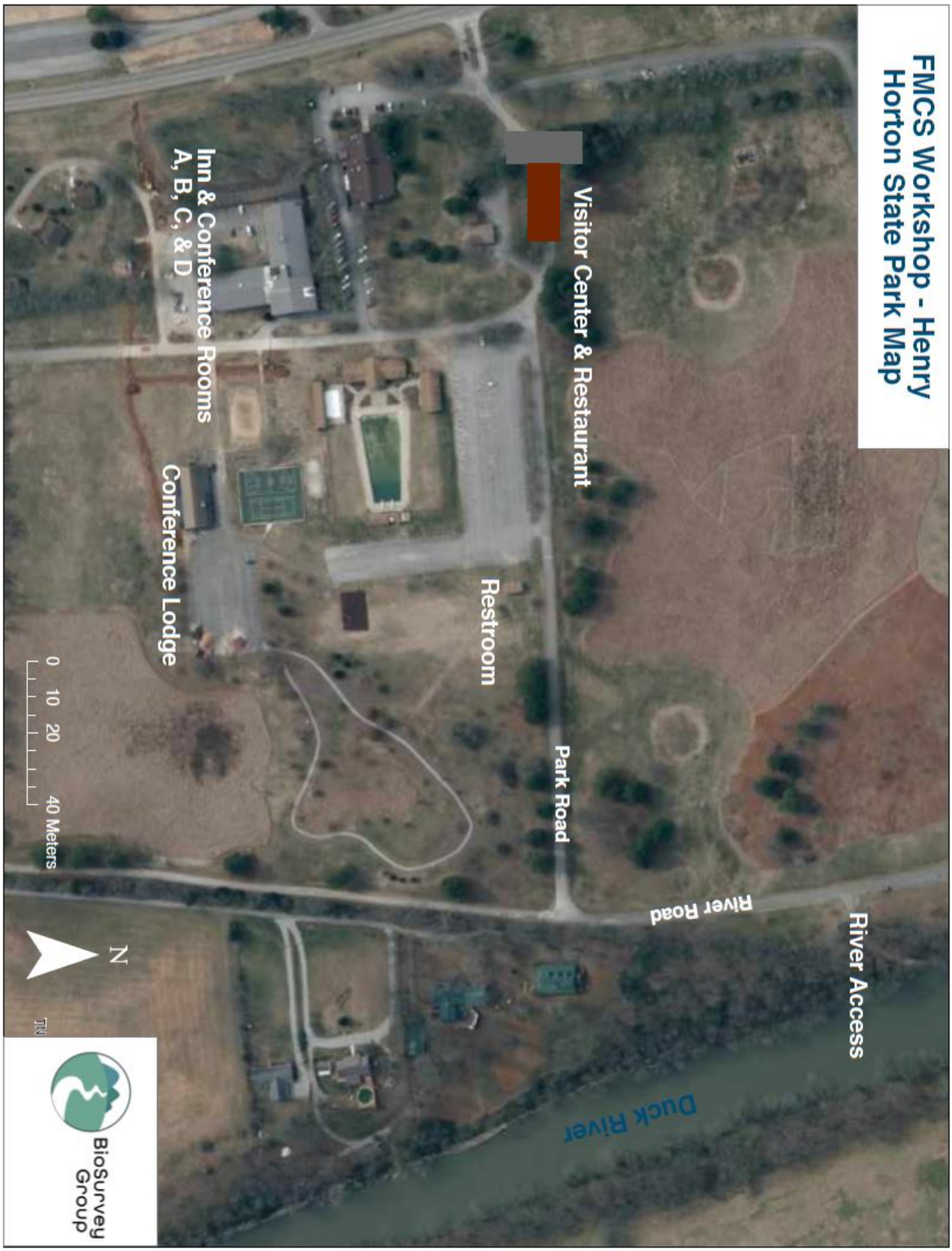
Dave Smith graduated from Colorado State (MS in Fish and Wildlife Biology) and University of Georgia (MS in Statistics and PhD in Forest Resources). Currently, he is a biological statistician at the USGS Leetown Science Center where he focuses on applied quantitative ecology in support of natural resource management and environmental decision making.

A CONCEPTUAL SURVEY DESIGN FRAMEWORK: PUTTING 'WHY' BEFORE 'HOW'

Dave Smith U.S. Geological Survey, Eastern Ecological Science Center, Kearneysville, WV

Abstract: Effective conservation of freshwater mussels relies on high-quality, management-relevant scientific data and evidence. Techniques for data collection and analysis to support freshwater mussel conservation have expanded with the advancement of methods and techniques, such as occupancy modeling, PIT tagging, eDNA sampling, species distribution modeling. Freshwater mussel conservationists now have many options in their survey-design toolbox. But survey design often jumps to 'how' to collect and analyze the data regardless of the data's value to meeting conservation objectives, i.e., 'why' collect the data. So, guidance is needed so that survey design starts with the information most relevant to conservation and then identifies the techniques that are best at providing that information. In this talk, I briefly review the conservation questions that motivate surveys and the core techniques used for freshwater mussel surveys. I hope to stimulate discussion on the current standardization of the core techniques based on the motivating questions and conservation objectives.

Workshop Map



Local Information

Henry Horton State Park was constructed in the 1960s on the estate of the former governor of Tennessee, Henry Horton. The park is located on the shores of the historic Duck River, one of the most diverse ecosystems in the world. Remnants of a mill and bridge operated and used by the family of Horton's spouse for over a century may be seen today on the Wilhoite Mill Trail. Check out the park map at the link below and save a version on your phone for quick reference.
https://tnstateparks.com/assets/pdf/additional-content/park-maps/HenryHorton_sm.jpg

Henry Horton is home to over 70 species of birds, check out this link provided by the park and hop on one of the nearby hiking trails when time allows.
https://tnstateparks.com/assets/pdf/additional-content/henry-horton_birding-flyer.pdf

With over 10 miles of hiking, Henry Horton State Park is a wonderful place to get outside and into nature. From deep and cool sinkholes to dry and hot cedar glades, from riverbank ecology to areas with deep cultural history, the trials here are unique, diverse and rewarding around every bend. Find more information about the trails at Henry Horton at the link below and use the park map to navigate. https://tnstateparks.com/parks/activity-detail/henry-horton-hiking

Paddling, Shooting, Disc Golf, Biking and much more, Henry Horton has activities for everyone. Check out the available activities at this link: https://tnstateparks.com/parks/activities/henry-horton

Driving Directions

Nashville Airport to Henry Horton is a one-hour drive.

Take I-65 S to US-431 S in Williamson County. Take exit 30 from I-840 W

26 min (28.5 mi)

3. Merge onto I-40 W

2.5 mi

4. Use the left 3 lanes to take exit 213A for I-440 W toward Memphis

1.3 mi

5. Continue onto I-440 W

2.1 mi

6. Use the right 2 lanes to merge onto I-65 S toward Huntsville

21.0 mi

7. Use the right 2 lanes to take the exit toward I-840 W

0.5 mi

8. Keep right at the fork to continue on Exit 59 B, follow signs for I-840 W/Memphis/Dickson and merge onto I-840 W

1.0 mi

9. Take exit 30 to merge onto US-431 S toward Lewisburg

0.3 mi

Follow US-431 S and State Hwy 99 E to US-31 ALT S in Marshall County

27 min (22.2 mi)

10. Merge onto US-431 S

14.0 mi

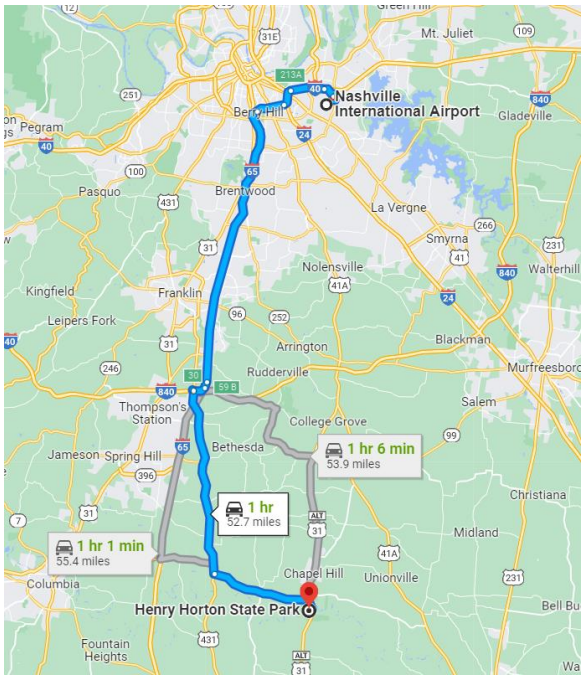
11. Turn left onto State Hwy 99 E

7.4 mi

12. Turn right onto US-31 ALT S

0.8 mi

Henry Horton State Park
4209 Nashville Hwy, Chapel Hill, TN 37034



Henry Horton to Field Trip Sampling Location is 11-minute drive.

Henry Horton State Park
4209 Nashville Hwy, Chapel Hill, TN 37034

Head north on US-31 ALT N toward N Park Rd

0.7 mi

Turn left onto State Hwy 99 W

3.7 mi

Turn left onto TN-272 S

2.5 mi

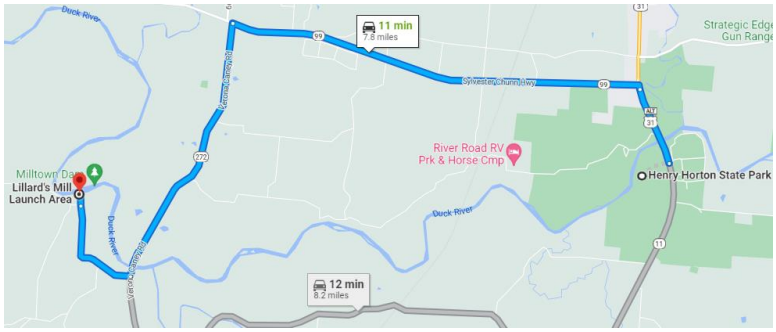
Turn right onto Milltown Rd

0.9 mi

Continue straight

463 ft

Lillard's Mill Launch Area
Lewisburg, TN 37091



Advanced Topics Schedule and Abstracts

Tuesday		
Conference Hall		
Time	**Speaker**	**Topic/Title**
9:30	Dave Smith	Symposium Intro: Day 1
9:45	Teresa Newton and Heidi Dunn	Regional Community Assessment Tool for Native Freshwater Mussels
10:15	Wendell Haag et al.	A Broadly Applicable, Objective Mussel Assemblage Health Index (MAHI)
10:45	Break	
11:00	Dave Berg et al.	Using Conservation Genomics to Assess Resiliency, Redundancy, and Representation in species status assessments
11:30	Amanda Rosenberger et al.	Making Your Survey Effort Count for the USFWS Species Status Assessment Process
12:00	Lunch	Restaurant for Box Lunch Pickup
1:00	Caitlin Carey and Jess Jones	The long game: The importance of LTM for freshwater mussel population assessments
1:30	Peter Hazelton et al.	Designing a multi-state mussel survey protocol: lessons from the Brook Floater Working Group
2:00	Break	
2:15	Emilie Blevins et al.	Efforts Toward Development of a Standardized Visual Survey Protocol for Western North American Freshwater Mussels
2:45	Katie Brockrath	Environmental DNA Applications and Best Practices
3:30	Protocol discussion I	Standardized assessment guidelines and techniques
4:30	End of the day	

Wednesday		
Conference Hall		
Time	**Speaker**	**Topic/Title**
9:00	Dave Smith	Symposium Intro: Day 2
9:15	Garrett Hopper et al.	Long-term trajectories for mussel communities from three different rivers
9:45	Astrid Schwalb et al.	Assessing the Effects of Extreme Climatic Events on Unionid Mussel
10:15	Break	
10:45	Jason Wisniewski	Estimating Occupancy to Assess the Status and Distribution of Freshwater Mussels
11:15	Kayla Key et al.	Using a Hierarchical Species Distribution Modeling Approach to Better Understand Risks and Threats to Freshwater Mussels: A Case Study of the Meramec River Basin, Missouri
11:45	Lunch	Restaurant for Box Lunch Pickup
1:00	Danielle Kreeger	Ecosystem Services of Mussel Assemblages and Biofiltration Case Studies
1:30	Brandon Sansom	Developing a Hydrodynamic Toolset to Advance Freshwater Mussel Ecology and Conservation
2:00	Protocol discussion II	Standardized assessment guidelines and techniques
4:00	End of day	

Tuesday Morning (9:30 – 11:45AM)

REGIONAL COMMUNITY ASSESSMENT TOOL FOR NATIVE FRESHWATER MUSSELS

Teresa Newton[1] and Heidi Dunn[2]
[1] U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI
[2] EcoAnalysts, Inc., O'Fallon, MO

Abstract: Upper Mississippi River (UMR) resource managers need a quantitative means of evaluating the health of mussel assemblages to measure effects of management and regulatory actions, assess restoration techniques and inform regulatory tasks. Our objective was to create a mussel community assessment tool (MCAT), consisting of a suite of metrics and scoring criteria, to compare the relative health of UMR mussel assemblages. We developed an initial MCAT using quantitative data from 25 sites and 10 metrics. Metrics fell in five broad groups: conservation status and environmental sensitivity, taxonomic composition, population processes, abundance, and diversity. Metric scoring categories were based on quartile analysis: 25% scoring as good, 50% scoring as fair, and 25% scoring as poor. Scores were meant to facilitate establishing management priorities and mitigation options for mussel conservation. Scoring categories assumed that a healthy mussel assemblage consists of species with a variety of reproductive and life-history strategies, a low percentage of tolerant species, and a high percentage of sensitive species; shows evidence of adequate recruitment, a variety of age classes, and low mortality; and has high abundance, species richness, and species and tribe evenness. Metrics were validated using a modified Delphi technique. MCAT metrics generally reflected the professional opinions of UMR resource managers and provided a consistent evaluation technique with uniform definitions that managers could use to evaluate mussel assemblages. Additional data sets scored a priori by UMR resource managers were used to further validate metrics, resulting in data from 33 sites spanning over 980 km of the UMR. Initial and revised MCAT scores were similar, indicating that data represent the range of mussel assemblages in the UMR. This tool is flexible, allowing managers to evaluate assemblages using individual metrics or a composite score. With additional information and metric calibration, this tool could be broadened to other river systems.

A BROADLY APPLICABLE, OBJECTIVE MUSSEL ASSEMBLAGE HEALTH INDEX (MAHI)

Wendell R. Haag[1], Angela K. Burrow[2], and Steven J. Price[3]
[1] US Forest Service, Southern Research Station
[2] ORISE Postdoctoral Research Fellow, US Forest Service and University of Kentucky
[3] University of Kentucky, Department of Forestry and Natural Resources

Abstract: Freshwater mussel declines range from dramatic to subtle, but there are few methods for objectively quantifying the extent of decline and the overall health of mussel assemblages. Well-established tools for assessing fish and insect assemblage health (e.g., Indices of Biological Integrity) are not consistently reflective of mussel assemblage health. Available mussel assessment tools have the following weaknesses: 1) they are specific to a particular stream or region; 2) they require an abundance of fine-scale data that may not be practicably attained; and 3) they are based on untested assumptions or subjective assessments of individual species' sensitivity to various factors. We describe a broadly applicable, objective mussel assemblage health index (MAHI). MAHI can be applied to streams across North America using commonly collected mussel survey

data, such as species richness, size structure (a proxy for recruitment strength), and mussel abundance. MAHI is largely free of assumptions about individual species' sensitivity to anthropogenic factors, and it accounts for expected differences in mussel assemblages due to stream size, biogeographic region, and other intrinsic factors. MAHI will be a valuable tool for early detection of mussel declines, better understanding the causes of declines, and evaluating the effectiveness of conservation strategies and management actions.

USING CONSERVATION GENOMICS TO ASSESS RESILIENCY, REDUNDANCY, AND REPRESENTATION IN SPECIES STATUS ASSESSMENTS

David J. Berg[1], Kevin J. Roe[2], and Steven R. Hein[3]
[1] Department of Biology, Miami University, Hamilton, OH
[2] Department of Natural Resource Ecology and Management, Iowa State University, Ames, IA
[3] Department of Biology, Miami University, Oxford, OH

Abstract: Species status assessments consider the life history and ecology of target species, and the causes of current conditions to predict the probability of persistence into the future. The process utilizes the 3 Rs of conservation biology: resiliency, redundancy, and representation. We consider how population genetic/genomic theory and practice, based primarily on the Hardy-Weinberg Principle, can inform understanding of the 3 Rs in the SSA process. Resiliency measures population health, with highly resilient populations exhibiting positive demographic factors, high genetic variation, and large population size. Genetic factors contributing to resiliency include inbreeding, assortative mating, and genetic drift. Metrics for evaluating resiliency include descriptive measures (allelic richness, heterozygosity), inbreeding coefficients (FIS), genetically effective population size (Ne), and detection of bottlenecks. Management activities increasing resiliency decrease mortality, increase recruitment, and augment populations from captive or wild sources. Redundancy is primarily concerned with maintaining multiple populations. As such, the focus is on among-population genetic variation and gene flow connecting populations at various spatial scales. Redundancy can be evaluated using measures of population divergence (FST, Jost's D), STRUCTURE to quantify admixture among populations, and phylogeographic methods. Management activities that increase redundancy include population re-establishment and assisted migration. Representation focuses on the responses of a species to changing environments using diversity as a proxy for adaptive potential, which itself is determined by genetic variation in fitness-related traits. Identification of such traits and measurement of selection coefficients for genes coding for these traits are the primary metrics for evaluating representation and these typically rely on newly emerging genomic techniques. Preservation of variation in loci under selection, along with identification and conservation of adaptive units, are the primary management activities for maintaining adaptive potential. We illustrate the application of population genetic/genomic theory and practice for assessing the 3 R's using case-studies derived primarily from work with freshwater mollusks.

MAKING YOUR SURVEY EFFORT COUNT FOR THE USFWS SPECIES STATUS ASSESSMENT PROCESS

Amanda E Rosenberger[-1], Daniel B Fitzgerald[2], Kristin Irwin Womble[3], and David R Smith[4]
[1] US Geological Survey TN Cooperative Fishery Research Unit, Cookeville TN
[2] US Fish and Wildlife Service, Division of Conservation and Classification, Kearneysville WV
[3] TN Cooperative Fishery Research Unit
[4] US Geological Survey, Eastern Ecological Science Center, Kearneysville WV

Abstract: The US Fish & Wildlife Service's Species Status Assessment (SSA) framework provides a mechanism for researchers to contribute key information to assist the Endangered Species Act decision-making process and post-decision management for recovery or continued monitoring of the species. For scientists interested in advancing freshwater mussel conservation, it is important to know how your research can support and improve the SSA process. We review the key stages of the SSA framework, with a focus on the type of data and analyses that are most useful for assessing range-wide extinction risk. Case studies on the Cumberland moccasinshell (*Medionidus conradicus*), Tennessee clubshell (*Pleurobema oviforme*), Tennessee Pigtoe (*Pleuronaia barnesiana*), and Slabside Pearlymussel (*Pleuronaia dolabelloides*) will be used to illustrate how non-standardized data have been used previously and what improvements could be made with focused data collection. Major topics of discussion include recording survey effort and estimating detectability, repeat sampling, identifying evidence of recent reproduction, when categorical or quantitative approaches are most appropriate, and how single-species or community-wide sampling can inform the assessment process. Allocating conservation effort across the many freshwater mussel species currently at risk will depend in part on the quality of data and assessments supporting these decisions. We discuss paths forward, including the benefits of a state-wide mussel database for TN.

Tuesday Afternoon (1:00PM – 4:30PM)

THE LONG GAME: THE IMPORTANCE OF LTM FOR FRESHWATER MUSSEL POPULATION ASSESSMENTS

Caitlin Carey[1] and Jess Jones[2]
[1] Conservation Management Institute, Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA
[2] U.S. Fish and Wildlife Service, Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA

Abstract: We demonstrate the utility of a 40-year long-term monitoring (LTM) quantitative data set for assessing freshwater mussel population trends in the Clinch River, Tennessee and Virginia, of the Upper Tennessee River Basin—a globally significant biodiversity hotspot for rare and endangered mussels. Estimation of demographic parameters, such as recruitment and population growth rates, from LTM datasets is essential to filling in knowledge gaps on species population dynamics, informing 5-year status reviews, and evaluating success or failure of recovery efforts. Our ongoing LTM in the Clinch River has been conducted on a nearly annual basis since 2004, but historical surveys at 5-year intervals were initiated as early as 1979. Of the nearly 35 species detected in the LTM quadrat sampling, only 6 species occur at densities ($\geq$1 per m^2) sufficient for robust parameter estimation. A key finding from our data is how rapidly populations of some

species can change. For example, the endangered oyster mussel (*Epioblasma capsaeformis*) has gone through boom and bust cycles, reaching densities as high as 40 individuals per m^2, whereas the historically stable and abundant Pheasantshell (*Actinonaias pectorosa*) population has undergone a severe decline since 2014. We explore this dataset and show how it can be used to estimate and detect demographic changes over time for parameters such as species diversity, population size and growth, recruitment and survival rates, sex ratios, and age-class structures. LTM data collected over multiple years or events can provide robust estimates of these key population parameters of interest with improved precision, ultimately resulting in more reliable inferences about population status and trends for species status assessments and reviews. In addition, implementing LTM of reintroduced or augmented populations is crucial to documenting successes and failures and improving the effectiveness of future restoration efforts. Implementation and success of LTM efforts requires multi-stakeholder participation across state and federal agencies, academia, non-governmental organizations, and volunteers, with data archiving and sharing critical to transparency and validity of results.

DESIGNING A MULTI-STATE MUSSEL SURVEY PROTOCOL: LESSONS FROM THE BROOK FLOATER WORKING GROUP

Peter D. Hazelton[1], Allison H. Roy[2], Jason Carmignani[3], and Sean Sterrett[4]
[1] Warnell School of Forestry & Natural Resources, University of Georgia, Athens, GA 30602
[2] U. S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts, Amherst, MA 01003.
[3] Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, Westborough, MA 01581
[4] Biology Department, Monmouth University, West Long Branch, NJ 07764

Abstract: Protocols for assessing the presence and abundance of stream-dwelling mussels often vary among agencies and investigators, making it difficult to assess range-wide occupancy, threats, and habitat needs. The Brook Floater (*Alasmidonta varicosa*) is an at-risk species residing in small to medium-sized streams along the Atlantic coast that, like many species in the eastern U.S., has experienced declines in abundance and currently resides in low-density pockets in most states. State biologists were interested in developing a standardized survey protocol allowing comparison of mussel distribution and demographic data across watersheds and political boundaries. We developed the Brook Floater Rapid Assessment Monitoring Protocol (Cooperator Science Series #132-2018) to (1) estimate occupancy of Brook Floater within HUC10 watersheds, (2) estimate the effects of reach and watershed scale habitat on Brook Floater occupancy, and (3) understand how survey covariates influence detection of Brook Floater. The protocol was designed for use in wadeable streams by teams of 3 or more observers, and incorporates random site selection within a HUC10 watershed, randomized surveyor field assignments, and guidance on collection of habitat and mussel demographic data. The protocol has been used at 268 sites across 10 watersheds and 7 states from 2017-2021, and additional surveys are planned over the next three years. We are still evaluating the utility of this approach for use in occupancy or abundance modelling (e.g., N-mixture models), but promote the protocol as an adaptable tool for a standardized mussel surveys aimed at distribution and abundance of common and rare freshwater mussels. In this talk we will highlight the rationale and utility of the protocol, present preliminary data analyses, and discuss the lessons learned from protocol design and implementation.

EFFORTS TOWARD DEVELOPMENT OF A STANDARDIZED VISUAL SURVEY PROTOCOL FOR WESTERN NORTH AMERICAN FRESHWATER MUSSELS

Emilie Blevins[1], Alexa Maine[2], Bryce Frank[3], Emily Johnson[3], Scott Miller[3], Jeff Moss[3], Anna Smith[3], John Erhardt[4], Doug Nemeth[4], Courtney Newlon[5], and Barbara Adams[6]

[1] Xerces Society for Invertebrate Conservation, 628 NE Broadway Suite 200 Portland, OR 97232

[2] Confederated Tribes of the Umatilla Indian Reservation, 500 Tausick Way, Walla Walla, WA 99362

[3] U.S. Bureau of Land Management, Oregon/Washington State Office, P.O. Box 2965 Portland, OR 97208

[4] U.S. Fish and Wildlife Service, Idaho Fish and Wildlife Conservation Office, Orofino, ID 83544

[5] U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Conservation Office, 2600 SE 98th Ave # 100, Portland, OR 97266

[6] U.S. Forest Service, Pacific Northwest Region, 1220 SW 3rd Avenue Portland, OR 97204

Abstract: Freshwater mussels are among the most endangered organisms globally. Several species of freshwater mussels occur across the Pacific Northwest region in a range of aquatic habitats, although recent evidence indicates their populations may be declining in both abundance and range. Data collected through recent survey efforts by federal, state, tribal, and NGO biologists, using both traditional techniques and emerging technologies such as eDNA, have improved understanding of species' current ranges. However, better understanding of population-level trends has been limited without standardized protocols and metrics for surveying and evaluating western mussel species. While protocols exist for freshwater mussel species elsewhere, these are generally aimed at accurately assessing populations in biologically diverse watersheds, and sampling mussel beds where handling is necessary for species identification. In western North American watersheds, the freshwater mussel fauna is less speciose, visual surveys are generally sufficient for identification, and freshwater habitat varies widely across the species' range, spanning both large river basins and ecoregions. As a result, there is a need for survey protocols that account for these differences. Recent collaborative efforts to develop a visual survey protocol for western species of freshwater mussels, with the intent to help standardize data collection, are described here and should serve to improve status and trend analyses to support conservation efforts.

ENVIRONMENTAL DNA APPLICATIONS AND BEST PRACTICES

Katie Bockrath

U.S. Fish and Wildlife Service, San Marcos Aquatic Resources Center, San Marcos, TX 78666

Abstract: Environmental DNA (eDNA) surveys are an indirect and non-invasive way to detect a target species or assess community biodiversity. Often, eDNA surveys can be more sensitive and cost effective than tradition sampling. Because of this, eDNA surveys are quickly becoming a common and routinely used tool for the detection of both rare and invasive species, including mollusks. Unfortunately, eDNA surveys are not one size fits all. There is a lot of variation across eDNA methods and standardization remains a challenge. For those interested in deploying eDNA surveys, choosing the best methods can be overwhelming and uncertainty around the limits of eDNA surveys can lead to uncertainty in eDNA detection results. Here, we will discuss the common applications for eDNA, eDNA strengths and weaknesses, basics of study design, data interpretation, and minimum standards for deploying eDNA surveys.

Wednesday Morning (9:00AM – 11:45AM)

COMMUNITY TRAJECTORIES FOR MUSSEL COMMUNITIES FROM THREE DIFFERENT RIVERS

Garrett W. Hopper[1], Edwin J. Miller[2], Wendell R. Haag[3], Caryn C. Vaughn[4], and Carla L. Atkinson[1]
[1] Department of Biological Sciences, University of Alabama, Tuscaloosa, AL, USA
[2] Kansas Department of Wildlife and Parks, Independence, KS, USA
[3] U.S. Forest Service, Southern Research Station, Center for Bottomland Hardwoods Research, KY, USA
[4] Oklahoma Biological Survey and Department of Biology, University of Oklahoma, Norman, OK, USA

Abstract: Quantifying changes to communities over time is fundamental to developing appropriate management and conservation plans. Community change for mussels likely takes place on a decadal timescale given their longevity and continuous, long-term monitoring data can help understand community dynamics. We used long-term quantitative survey data (1991-2021) for multiple mussel beds from three systems (Verdigris, Sipsey, and Kiamichi Rivers, USA) to evaluate population trends and address community stability within the Community Trajectory Analysis framework. Species rank abundances were similar over time in the Sipsey River, whereas rank abundances changed in the other two rivers, but the same group of core species persisted over time in all three rivers. Mussel beds had trajectories reflecting gradual-directional community change. Gradual-directional change appears to be driven by changes in rank order of common species in the Verdigris River, increasing dominance by two species in the Sipsey River, and drought induced die-offs in the Kiamichi River. Species representing the equilibrium life history strategy, which is favored by stable environments comprised the largest proportion of all three communities. Community trajectories for mussels from more heavily modified or frequently disturbed rivers, or those characterized by different life history strategies may have more complex trajectories and may foretell future dynamics if disturbance events become more frequent or severe. Systematically monitoring mussel communities over time is key to furthering our knowledge and understanding of mussel community dynamics.

ASSESSING THE EFFECTS OF EXTREME CLIMATIC EVENTS ON UNIONID MUSSELS

Astrid N. Schwalb[1], (co-authors in alphabetical order): Lyubov E. Burlakova[2], David Ford[3], Juergen Geist[4], Alexander Y. Karatayev[2], Zachary A. Mitchell[5], Alison A. Tarter[6]
[1] Biology Department, Texas State University, San Marcos, Texas
[2] SUNY Buffalo State Great Lakes Center, Buffalo, New York
[3] Edge Engineering and Science, Houston, Texas
[4] Aquatic Systems Biology Unit, Technical University of Munich, Germany.
[5] Biology Department, Eastern New Mexico University
[6] Texas A&M, College Station, Texas

Abstract: An increase in extreme droughts and floods is expected with current and future climate changes. Such extreme climate events may have long-lasting impact on unionid freshwater mussels. The objective was to test specific predictions for (1) the impact of an extreme drought in

2011/2012 in the Colorado and Neches River basins in Texas and in 2018/2019 in Germany, and (2) the impact of extreme flooding in 2017 and long-term changes in the Neches River basin by comparing recent and historical mussel community data. Drought had the most detrimental impact leading to community-wide declines, indicated by a significant decline of abundances, species richness and occupied sites, especially in tributaries with lower discharge. In Germany, management efforts such as water transportation were initiated in response to the extreme drought to avoid the complete drying of headwaters with mussel populations. Flooding led to shifts in community composition and spatial distribution. Both severe declines and a distinct community shift occurred over the long-term, where the dominance of species shifted to those more tolerable of disturbance. Saltwater intrusion in the lower Neches River likely caused a significant increase post-flood of a species known to be tolerant of brackish water (*Glebula rotundata*). The impact of flooding was likely buffered by connectivity with extensive backwater areas, forming large wetlands, which may act as crucial refuges for mussels during extreme climatic events. Thus, protecting wetlands is crucial to protect freshwater mussels and the ecosystem services they provide.

ESTIMATING OCCUPANCY TO ASSESS THE STATUS AND DISTRIBUTION OF FRESHWATER MUSSELS

Jason Wisniewski
Biodiversity Division, Tennessee Wildlife Resources Agency. Nashville, TN 37211

Abstract: A variety of methodologies are available to sample freshwater mussels and analyze data collected in order to draw inferences regarding their ecology and management. These methodologies often utilize detection/non-detection sampling such as timed searches to document species presence or relative abundance within study reaches. However, this approach can result in inaccurate interpretations regarding species ecology and status because they provide biased indices of occurrence, abundance, and species richness due to incomplete detection of one or more species/individuals at a site. Occupancy estimation, incorporating detection probabilities provides a better representation of important parameters of interest for monitoring populations. Despite their increased use with numerous taxa, occupancy approaches have been infrequently utilized for studying freshwater mussels. I present a case study describing several sources of bias in traditional timed mussel searches and why I utilize occupancy approaches as a substitute. I also provide several applications and findings from these approaches for better understanding mussel populations, trends, and their ecological relationships. Lastly, I provide a simple and practical solution that will allow researchers and managers to minimally modify their timed search methodologies in order to collect data that will allow for the estimation of species occupancy and detection, ultimately increasing the long-term utility for data in monitoring population trends over time.

USING A HIERARCHICAL SPECIES DISTRIBUTION MODELING APPROACH TO BETTER UNDERSTAND RISKS AND THREATS TO FRESHWATER MUSSELS: A CASE STUDY OF THE MERAMEC RIVER BASIN, MISSOURI

Kayla M. Key[1], Amanda E. Rosenberger[2], and Kristin Bouska[3]
[1] Environmental Consultant, West Tennessee River Basin Authority, Cookeville, TN
[2] U.S. Geological Survey TN Cooperative Fishery Research Unit, Cookeville, TN
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Abstract: Effective conservation of a taxonomic group requires the identification of the fundamental requirements that allow it to persist and factors best suited to predict its distribution. Freshwater mussels are among the most imperiled taxa in the United States. The unique life history and habitat requirements of unionid mussels complicate efforts to model their distributions, an obstacle to mussel conservation. Given limited resources, a strategic approach including these factors to describe mussel requirements and spatially explicit identification of threats and their effect on occupancy in otherwise suitable habitat will improve effectiveness and lower cost of mussel conservation and monitoring programs. Elucidating relationships between community metrics (e.g., species richness) within otherwise fundamentally suitable habitats helps to inform management and pinpoint threats to mussel communities. Information on threats to mussels gained through this process may be used to categorize reaches suitable for mussel communities, with conservation prioritization as the focus. Monitoring suggestions tailored to these categories are provided, and areas of potential reintroduction and restoration are identified. The results of this work on the Meramec River project provided information for managers on where mussel strongholds occur, why mussels are not present in areas that are otherwise fundamentally suitable, what threats affect mussel communities, and what monitoring strategies will efficiently track mussel communities through time.

Wednesday Afternoon (1:00PM – 4:00PM)

ECOSYSTEM SERVICES OF MUSSEL ASSEMBLAGES AND BIOFILTRATION CASE STUDIES

Danielle Kreeger
Partnership for the Delaware Estuary, Wilmington, DE

Abstract: Natural mussel assemblages are often comprised of a mix of common and rare species that aggregate. These "mussel beds" can furnish diverse structural and functional benefits to the ecosystem and people. Scientists and managers are increasingly interested in quantifying these benefits to advance various conservation, restoration, and enhancement goals. Mussel-mediated ecosystem services will be briefly summarized, illustrated with case studies of their biofiltration and transformation of particulate pollutants. Practical applications, monitoring methods, and future research needs will be discussed to assist with quantifying the water quality benefits of mussel beds.

DEVELOPING A HYDRODYNAMIC TOOLSET TO ADVANCE FRESHWATER MUSSEL ECOLOGY AND CONSERVATION

Brandon J. Sansom
USGS Columbia Environmental Research Center, 4200 New Haven Rd., Columbia, MO 65201

Abstract: The structure and function of aquatic ecosystems are largely controlled by an interplay between biological, physical, and chemical process across multiple scales. The ecological role of mussels in rivers and lakes is well studied. However, studies aimed at quantifying suitable mussel habitat remain inconclusive and even less is known about the physical interactions between mussels, turbulent flow, and substrate dynamics. Integrating hydrodynamic data to inform mussel studies has the potential to provide a process-based understanding of how mussels interact with and influence habitat and transport phenomena across multiple scales. In this talk, I will present a multidisciplinary framework of hydrodynamic tools that are being used to better understand the complex interaction between mussels and the habitat they occupy. Case studies will be presented that feature a hydrodynamic toolset applied across multiple scales and include: 1) field studies to quantify hydraulic characteristics and bed stability within mussel aggregations, 2) hydrodynamic models to improve understanding of sediment transport dynamics within mussel aggregations, and 3) laboratory studies to examine mussel-flow interactions. Additional examples will be presented to demonstrate how these tools are being used to identify potentially suitable habitat for mussel restoration and to inform sampling strategies for mussel eDNA. Mussel studies that incorporate hydrodynamic data can characterize important process-based interactions, advance ecological theory related to mussel ecology, and provide a framework to guide mussel restoration and conservation.

Fundamental Survey Techniques Schedule and Abstracts

Tuesday		
Time	Session	Location
9:30-12:30pm	Session 1 Classroom Sampling (Group A)	Conference Room A
	Session 2 Mussel ID, Finding Mussels, and Mussel Processing (Group B)	Conference Room B
12:30-1:30pm	Lunch	Restaurant Box Lunch Pickup
1:30-4:30pm	Session 1 Classroom Sampling (Group B)	Conference Room A
	Session 2 Mussel ID, Finding Mussels, and Mussel Processing (Group A)	Conference Room B

Wednesday		
Time	Session	Location
9-12pm	Session 3 Field Sampling (Group A)	River Access
	Session 4 Mussel Habitat and Sampling Design (Group B)	Conference Room A
12-1pm	Lunch	Restaurant Box Lunch Pickup
1-4pm	Session 3 Field Sampling (Group B)	River Access
	Session 4 Mussel Habitat and Sampling Design (Group A)	Conference Room A

Tuesday

Session 1

CLASSROOM SAMPLING

Megan Bradley (USFWS Genoa Fish Hatchery) and Mark Hove (Retired- Univ of Minnesota)

Classroom sampling allows students to learn standard sampling techniques in a classroom environment. The objective of classroom sampling is to find and delineate mussel beds in a mock river using semi-quantitative sampling. Once the bed(s) are delineated, students will calculate standard mussel bed metrics. We will compare standard metrics among samplers and evaluate causes of sampling errors. Standard metrics will include density, standard deviation, and 95% confidence intervals and precision of the density estimate, species richness, species relative abundance, and % juveniles.

Session 2

DUCK RIVER MUSSEL ID, FINDING MUSSELS, AND MUSSEL PROCESSING

Janet Clayton (Retired, WVDNR) and David Foltz (Edge Engineering and Science)

In this session, students will learn techniques for identifying mussels in a new area they might plan on sampling; in this case the Duck River at Henry Horton State Park. This session will also cover tricks for finding mussels, and how to handle and process mussels in the field without causing the animals undo stress. We will practice measuring, aging, and marking mussels using various techniques (etching, shell fish tags, PIT tags).

Wednesday

Sessions 3

FIELD SAMPLING

Phil Mathias (Enviroscience), Lisie Kitchel (WIDNR), Clarissa Lawlis (Lewis Environmental), Joe Snavely (Normandeau Associates)

Students will practice semi-quantitative, quantitative, and qualitative sampling in the field using techniques learned in the classroom sampling and ID and processing sessions from the previous day. Semi-quantitative sampling will be used to determine unionid distribution within the Duck River, quantitative sampling will be used to determine density, and qualitative sampling will be used to supplement the list of species. Students will also assess habitat conditions using visual estimates and pebble counts for substrate to evaluate substrate types. Results of each method will be compared.

Sessions 4

MUSSEL HABITAT AND STUDY DESIGN

Heidi Dunn (Ecoanalysts) and Dan Scoggin (Ecoanalysts)

In this session, students will learn the attributes of unionid mussel habitat. We will discuss ways to identify areas that might harbor mussels in small and large rivers before going into the field and what to measure in the field. We will also discuss the various types of sampling and the pros and cons of each method. Students will learn how to design a field survey based on the survey objectives. We will also discuss various techniques for determining sample size based on data objectives.

Poster Session Abstracts

Tuesday 7-10pm in the Visitors Center adjoining the Restaurant

Poster 1

ASSESSING AMMONIA TOXICITY OF UNIONID MUSSELS IN TEXAS.

Ericah Beason[1] and Astrid Schwalb[1]. [1]Department of Biology, Texas State University, San Marcos, TX 78666.

Freshwater mussels (family Unionidae) are a highly imperiled group of organisms and water pollution is one of the major threats to their persistence in Texas rivers. Early live history stages of freshwater mussels are known to be highly sensitive to ammonia, yet ammonia toxicity of freshwater mussels in Texas has not been examined. Ammonia toxicity is largely dependent on the amount of total ammonia nitrogen present, pH, and temperature. Texas offers an interesting study area, as pH values where mussels are present can range from 7-9.1 and summer temperatures can reach 30°C or higher. The goal of this study was to examine ammonia toxicity of mussel larvae (glochidia). Brooding female mussels were collected in the field to extract glochidia for toxicity tests and toxicity tests followed the Standard Guide for Conducting Laboratory Toxicity Tests with Freshwater Mussels (ASTM E2455-06(2013). Our preliminary results show that unionid mussels in Texas are as sensitive or more sensitive than previously tested species in the same genera. Our study also highlights difficulties of determining LC50 values for short-term brooders which may be useful in re-evaluating certain ASTM recommendations for unionid toxicity testing. The results of this study will inform wastewater discharge criteria for ammonia that limits detrimental effects on freshwater mussels. The next step of this project is to determine ammonia toxicity of juvenile mussels of mussel species in Texas. edb83@txstate.edu

Poster 2

IDENTIFYING, PROMOTING, AND SUPPORTING DIVERSITY IN THE FRESHWATER MOLLUSK CONSERVATION SOCIETY.

Traci P DuBose[1], Tamara A. Smith[2], Sara R. Craft[3], Jer Pin Chong[4], Mark Hove[5], Alex J. Franzen[6], Daelyn A. Woolnough[7], Xenia Rangaswami[8], John M. Pfieffer[9], Megan E. Bradley[10], Kentaro Inoue[11], and Jeremy S. Tiemann[12]. [1]Virginia Tec, Blacksburg, VA, [2]U.S. Fish & Wildlife Service, Bloomington, MN, [3]Kentucky Division of Water, Frankfurt, KY, [4]University of Illinois, Chicago, IL, [5]University of Minnesota and Macalester College, St. Paul, MI, [6]University of Oklahoma, Norman, OK, [7]Central Michigan University, Mt. Pleasant, MI, [8]Texas A&M University, College Station, TX, [9]National Museum of Natural History, Washington, D.C., [10]U.S. Fish & Wildlife Service, Genoa, WI, [11] Shedd Aquarium, Chicago, IL, and [12]Illinois Natural History Survey, Champaign, IL.

Increasingly, barriers to education and careers in biological sciences are being removed. Race, ethnicity, sexual orientation, and ability, among other factors, lack diverse representation in the sciences and the Freshwater Mollusk Conservation Society (FMCS) is no exception. The Diversity, Equity, and Inclusion (DEI) committee was established in 2017 to entrench diversity and inclusion as core values of FMCS. Currently, we use social media to highlight topics related to DEI and to provide resources for allyship and mentoring. In 2020, the DEI committee distributed a survey assessing demographics and attitudes of members regarding FMCS policies and activities. Demographic questions confirmed that >90% of 122 survey participants were straight, white, and with no identified disability. Most members had received a post-secondary degree with gender almost evenly distributed between male and female. Most survey respondents felt that FMCS was

a safe and tolerant environment, although many members indicated a need for more diverse participation within FMCS. The two most common suggestions for improvement were to increase outreach to diverse communities and to increase funding for scholarships, travel grants, and mentoring opportunities for underrepresented groups. Following the survey, the DEI committee started developing a scholarship for malacological research aimed at underrepresented high school students and an award to recognize DEI efforts of members. The DEI committee will repeat the survey biennially to track changes in demographics and attitudes. Comments collected will direct future efforts of the DEI committee and help FMCS plan activities and develop an organizational culture that promotes more diverse participation in FMCS moving forward. sara.andree@ky.gov

Poster 3

WHEN RIVERS RUN DRY: PERENNIAL POOLS AS ECOLOGICAL REFUGES FOR FRESHWATER MUSSELS. Kiara C. Cushway1 and Astrid N. Schwalb1. 1Department of Biology, Texas State University, San Marcos, TX 78666.

**STUDENT PRESENTATION*

The intensity and frequency of droughts are predicted to increase with climate change, which together with increased water extraction for agriculture and domestic use poses a major threat for aquatic organisms as rivers are more likely to go dry. Drying of rivers is especially challenging for organisms like freshwater mussels that have limited movement abilities. Pools where water persists while other parts of the stream dry out can provide an important refuge for aquatic organisms, but this is not well studied in freshwater mussels. We examined mussel distribution and abundance and habitat conditions in perennial pools in different parts of the middle section of the San Saba River, Texas which can go dry in late summer due at least in part to agricultural water use. Few individuals (range: 0-12) were found during timed searches (2.5 – 10 person-hours), and almost three quarters of mussels found were *Lampsilis bracteata*, an endemic species up for ESA listing. Mussel abundance in pools was negatively correlated with maximum pool temperature. A slight negative relationship was found between mussel abundance and pool length, but most sampled pools were small, and considerably larger pools will be surveyed this summer. The presence of groundwater inputs and additional data such as adjacent land use will also be examined to determine associations with freshwater mussel abundance. The results of this study will inform management and conservation strategies of freshwater mussels by providing insight into the characteristics of habitats that may offer refuge for mussels from disturbances like drought. Kxa7@txstate.edu

Poster 4

INTERPRETING GEOCHEMICAL SIGNATURES OF FRESHWATER BIVALVES TO UNDERSTAND HISTORICAL INDUSTRIAL POLLUTION AND ENVIRONMENTAL DISTURBANCE IN THE LOWER ALLEGHENY RIVER WATERSHED, PENNSYLVANIA.

Kristi S. Dobra1,2, Brian W. Stewart1, Rosemary C. Capo1. 1 Department of Geology and Environmental Science, University of Pittsburgh, Pittsburgh, PA 15260, 2Pittsburgh District, U.S. Army Corps of Engineers, Pittsburgh, PA 15222.

**STUDENT PRESENTATION*

The Allegheny River is home to a diverse assemblage of freshwater bivalves which are potentially sensitive recorders of riverine biogeochemical systems due to their sessile existence, long lifespan, and carbonate shells precipitated over their lifetimes. The objective of this study is to assess the

trace metal and barium isotope composition of freshwater mussel shells as biomonitors of environmental disturbances in the Allegheny River watershed. Because metals such as lead, barium, and zinc are incorporated into the shell's carbonate mineral lattice, they can record temporal trends and may prove useful in identifying impacts from industrial pollution or energy extraction. The Allegheny River's long history of steel and glass manufacturing, oil and gas development, and coal mining, as well as its use as a drinking water source for over half a million people, makes it a unique watershed to study these effects over time.
Our study area includes the lower Allegheny River and several tributaries: Kiskiminetas River, Buffalo Creek, and Pine Creek. In 2021-2022 we collected water samples from eight sites and live specimens of *Corbicula fluminea* from two tributaries. Water samples and whole valves of three *Corbicula* individuals were analyzed for Ba isotope composition and trace metals. Preliminary results suggest that the Ba concentration and isotope composition in shells reflect that of the co-located stream water, indicating shells could serve as valuable biomonitors of river chemistry. This ongoing study includes monthly water sampling to establish seasonal variability and annual to decadal records from the analysis of mussel shells. Native mussels will be collected at each location and analyzed for trace metals to determine interspecies variation. We are also analyzing archived mussel shells collected from the Allegheny watershed in the early 1900s, which may provide a record of water quality changes in the watershed over the last 100-150 years. hmsbeagle@pitt.edu

Poster 5

A REVIEW OF NORTH AMERICAN FRESHWATER MUSSEL (BIVALVIA: UNIONOIDA) LETHAL THERMAL TOLERANCE.

Kaelyn J. Fogelman[1], Jennifer Archambault[2], Elise Irwin[3], Maureen Walsh[4], Shannon Brewer[1,3], and James A. Stoeckel[1]. [1]School of Fisheries, Aquaculture, and Aquatic Sciences, Auburn University, Auburn, Alabama 36849, USA, [2]Eastern North Carolina Ecological Services, U.S. Fish and Wildlife Service, Raleigh, North Carolina 27606, USA, [3]U.S. Geological Survey, Alabama Cooperative Fish and Wildlife Research Unit, Auburn University, Auburn, Alabama 36849, USA, [4]Ecological Services, U.S. Fish and Wildlife Service, Panama City, Florida 32405, USA.
Freshwater mussels of the order Unionoida are currently one of the most imperiled group of organisms in North America. Accurate risk assessments and development of effective management strategies for remaining populations requires knowledge of thermal limits in the face of increasing surface water temperature due to climate change and various anthropogenic factors. We conducted a systematic literature review to (1) summarize lethal thermal tolerance data for unionids by life stage and taxonomy, (2) discuss ecological and climate change implications of existing lethal tolerance data (3) identify needs for future research and methodological standardization. Our literature review has identified lethal tolerance estimates for only 31 of 305 species in the families Unionidae and Margaratiferidae. The 90th percentile of acute median lethal temperatures was 31.7°C for glochidia (19 species), 36.5 °C for juveniles (13 species), and 37.8°C for adults (4 species). Generally, glochidia were less tolerant than juveniles or adults of the same species – but there were several exceptions. Generally, Quadrilini had the highest acute and chronic thermal tolerance of all tribes followed by Pleurobemini, Lampsilini, Amblemini, and Anodontini. Acclimation temperature affected lethal tolerance endpoints in less than half of the studies examined. Lethal tolerance data for additional species, combined with a comprehensive database of stream temperatures would be of great use in modeling the frequency and duration of lethal

limit exceedance in North American systems and which taxa and populations are currently living at or near their upper lethal limits. kjf0021@auburn.edu

Poster 6

ASSESSING THE FILTERING POTENTIAL OF FRESHWATER BIVALVES USING 16S rRNA GENE SEQUENCING AND GUT MICROBIOME ANALYSIS.

Mary Foley[1], Wendel Haag[2], David Weisrock[1], and Luke Moe[3]. [1]Department of Biology, University of Kentucky, Lexington, KY 40506, [2]U.S. Forest Service, Frankfort, KY 40601, [3]Department of Plant Sciences, University of Kentucky, Lexington, KY 40506.

**STUDENT PRESENTATION*

The water quality and ecosystem function of Kentucky's rivers and streams are at risk of contamination by algal blooms. Harmful algal blooms (HABs), caused primarily by cyanobacteria, and rarely by diatoms and dinoflagellates, release toxins into the water linked to the death of both fish and livestock. Non-harmful algal blooms block light to benthic plants and result in oxygen dead zones upon die-off. Bivalve species are the primary filter of silt and microorganisms in our water system and are natural mitigators of algal blooms. Here, we use 16S rRNA gene sequencing and microbiome analysis to identify the planktonic species consumed by five Kentucky native freshwater mussels and the invasive bivalve, *Corbicula fluminea*, commonly known as the Asian clam. The introduction of *C. fluminea* to Kentucky waterways is thought to play a role in the recent decrease of native mussel populations, possibly due to resource competition. Hence, we will look for evidence of food niche overlap between the native mussels and the Asian clam. Our results are important for assessing the effects mussel species loss will have on Kentucky stream water quality and can be applied to mussel conservation efforts. mary.foley@uky.edu

Poster 7

FRESHWATER MUSSEL COMMUNITY COMPOSITION AND POPULATION DEMOGRAPHICS OF ESA-CANDIDATE PLEUROBEMA RIDDELLII IN AN EAST TEXAS CANAL SYSTEM.

Bradley M. Littrell[1], Kyle T. Sullivan[1], Terry Corbett[2], and Jason Watson[2]. [1]BIO-WEST, Inc., 1405 United Drive, Suite 111, San Marcos, TX 78666 USA, [2]Lower Neches Valley Authority, 7850 Eastex Fwy, Beaumont, TX 77708 USA.

The Lower Neches Valley Authority (LNVA) canal system diverts water from the lower Neches River, Pine Island Bayou, and the lower Trinity River through approximately 965 kilometers of canals to municipal, industrial, and agricultural users in multiple counties of southeast Texas. In spring 2021, we surveyed 24 sites in canal segments of the LNVA system with varying flow regimes (i.e., perennial and intermittent) using a combination of timed survey methods. During 80 person-hours (p-hr) of survey effort, 11,200 mussels represented by 21 species were collected, including ESA-candidate Louisiana Pigtoe (*Pleurobema riddellii*). Mussel assemblages in perennial canals were more diverse and had higher catch rates compared to intermittent canals, suggesting flow permanence has a large effect on structuring this canal system's mussel community. Louisiana Pigtoe were documented at 58% of sites surveyed and ranked second among species in total abundance (1,984 individuals [ind]) and mean catch-per-unit effort (CPUE; 20.76 ind/p-hr). At perennial canal sites, mean Louisiana Pigtoe catch rates (29.18 ind/p-hr) were considerably higher than those observed during recent survey efforts in natural riverine habitats (0.00 – 8.75 ind/p-hr). Observations of gravid females and presence of individuals as small as 16

millimeters in length suggest successful spawning and recent recruitment in this population. Further research on Louisiana Pigtoe within the LNVA canal system will provide an opportunity to inform conservation and management efforts of this species in natural riverine systems. blittrell@bio-west.com

Poster 8

FRESHWATER MUSSELS DIFFER IN SUBSTRATE PREFERENCE: OBSERVATIONS FROM A BEHAVIORAL CHOICE EXPERIMENT.

Meghan E. Martinski[1] and Astrid N. Schwalb[1]. [1]Department of Biology, Texas State University, San Marcos, TX 78666.

**STUDENT PRESENTATION*

Freshwater mussels (Unionidae), a highly imperiled group of organisms, is rather sessile, yet they can move and burrow to avoid adverse conditions. Their horizontal movement is generally considered to be limited, but it may allow them to actively seek out suitable habitat patches, which is not well studied in freshwater mussels. In laboratory experiments we compared substrate preference of four common species across Texas: one opportunistic species (*Lampsilis teres)*, two equilibrium species (*Amblema plicata* and *Plectomerus dombeyanus*), and one periodic species (*Lampsilis hydiana*). Pairwise choice tests were carried out for 48-hr and 72-hr trials, where mussels could move within a tank into either fine grain mud, sand, or mid-sized pea gravel. During the experiment L. teres was most mobile, moving up to a maximum of 1.1 meters, and showing a clear preference towards finer substrate, choosing fine grain sand 79.6% of the time. In contrast, *P. dombeyanus* was the least mobile species, remaining at the initial point (not choosing a substrate) 73.5% of the time. The position that *L. teres*, *A. plicata*, *P. dombeyanus*, and *L. hydiana* were found in (in relation to substrate choice) were not random ($p < 0.05$). As a next step, substrate selection of additional species will be tested. The goal of this ongoing project is to examine potential associations between substrate selection and ecological characteristics of various species, such as life history strategies and shell morphology. Findings of this study will help to better understand how habitat selection may affect niche overlap and distribution of mussels. martinskim7@gmail.com

Poster 9

IN-SITU SURVIVAL AND GROWTH OF FEDERALLY ENDANGERED CAROLINA HEELSPLITTER (LASMIGONA DECORATA).

Olivia M. Poelmann[1], Catherine M. Bodinof Jachowski[1], Brandon K. Peoples[1], Morgan A. Kern[2], and Morgan K. Wolf[3]. [1]Department of Forestry and Environmental Conservation, Clemson University, Clemson, SC 29634, [2]South Carolina Department of Natural Resources, Freshwater Fisheries, 2726 Fish Hatchery Ln, West Columbia, SC 29172, [3]U.S. Fish and Wildlife Service, South Carolina Ecological Services Field Office, 176 Croghan Spur Road, Suite 200, Charleston, SC 29407.

**STUDENT PRESENTATION*

North America hosts the largest number of freshwater mussel species globally, with the majority currently listed as endangered, threatened, or under special concern. Carolina Heelsplitter (*Lasmigona decorata*) is an endangered mussel endemic to the Carolinas with a restricted range and 11 known populations. This study aims to assist in priority research detailed in the recovery plan for the species by quantifying survivorship and growth of laboratory propagated *L. decorata* following translocation into natural streams and determining the impact of habitat attributes. We

are evaluating in-situ exposure of juvenile *L. decorata* (12 months; October 2021-October 2022) at four sites in two basins in South Carolina. We are also investigating potential surrogacy by including Eastern Creekshell (*Villosa delumbis*) in cohabitation with the *L. decorata* juveniles to determine if the species has a similar response to conditions. We are housing mussels in silo structures (30 mussels per site - 20 *L. decorata*, 10 *V. delumbis*), which exposes mussels to the ambient conditions of the stream and allows us to track growth and survival. Extensive water and sediment chemistry data is being taken monthly to evaluate the relationship between analytes and mussel success. We will quantity mussel survivorship using the known fate model using program MARK. Finally, a multi-model approach will be used to investigate associations between site, species, basin origin, habitat parameters, water quality parameters, and individual mussels' attributes and survivorship. The results from this study will help meet federal recovery plan needs and aid in maximizing the success of future augmentation efforts. opoelma@g.clemson.edu

Poster 10

QUANTIFYING HYDRAULICS AND STABILITY OF MUSSEL BEDS ACROSS DYNAMIC FLOW REGIMES.

Maura O. Roberts[1], Brandon J. Sansom[1], and Robert B. Jacobson[1]. [1]USGS Columbia Environmental Research Center, 4200 New Haven Rd., Columbia, MO 65201.

Mussel beds often persist for many decades at the same location within a river, and bed sediment stability on the order of decades or longer has been thought to be critical to their ecological success. Yet theory and data indicate that sand- and gravel-dominated rivers occupied by mussels experience floods that fully mobilize the bed relatively frequently, on the order of every 1-2 years. This research addresses the fundamental question of what defines mussel habitat, with specific focus on the role of bed stability. We deployed radio frequency identification (RFID) and accelerometer tracers in Fall and Winter 2021 to track movement of live mussels (n = 79 RFID), sediment (gravel and cobble; n = 125 RFID, 20 accelerometer), and surrogate mussels (n = 40 RFID; 30 accelerometer) within and near a ~18,000 m2 mussel bed in the lower Osage River, MO, ~16 km downstream from Bagnell Dam. This hydroelectric dam can produce 25 – 1130 m3/s daily peaks, abrupt discharge fluctuations, extended periods of relatively high discharge, and multiple flood stage peaks each year. RFID surveys with high-resolution positioning and an antenna array mounted on a remotely piloted boat were conducted after high discharge events to relocate rock and mussel tracers to measure net movements. After a typical ~820 m3/s winter peak, we observed a small (~1 m distance) downstream rock displacement upstream from the mussel bed, but no identifiable movement of live mussels, surrogate mussels, or sediment within the bed. Relocation rates within the bed for the same survey were 44% for live mussels, 90% for surrogate mussels, and 52% for rocks. Future surveys will focus on recovering tracers in the surrounding reach following an extended period of high discharge dam releases in Spring 2022. Logged data from accelerometers (rocks and surrogate mussels) will provide timing of transport events. mroberts@usgs.gov

Poster 11

CAN SHELL MORPHOLOGY PREDICT ECOLOGY? A CLASSIFICATION SYSTEM FOR FRESHWATER MUSSELS.

Irene Sánchez González[1], Garrett W. Hopper[1], Jamie Bucholz[1], and Carla L. Atkinson[1]. [1]Department of Biological Sciences, University of Alabama

**STUDENT PRESENTATION*

Shell morphology is the most easily recognizable aspect of freshwater mussel (Unionidae) diversity and varies greatly inter and intraspecifically. Differences in size and sculpturing such as ridges or pustules can be associated with specific organismal functions, responses to environmental variation, and may play a role in microhabitat occupancy and species distributions. We aimed to modify an existing shell morphological classification system (Watters ,1994) by combining length, height, width, mass, and sculpture data using a robust dataset of ~1000 individuals representing 35 species spanning five phylogenetic tribes collected from 22 mussel beds in seven rivers within the Mobile and Tennessee Basins. Using multivariate techniques, we attempted to classify species based on trait similarities that might explain species distributions and habitat associations. We tested the classification using paired environmental and quantitative survey data collected at fine- (0.25 m2) and broad spatial scales (40-150 m reach). Overall, species clustered into four different categories. 1) small species that are round or triangular, 2) species with winged structures, 3) elliptical unsculptured species, 4) mussels with the greatest body size. Habitat separation at the quadrat scale was hard to observe but abundance and distribution of the different clusters greatly differed within and among rivers. Rivers with similar hydrological and channel characteristics had also similar mussel communities based on the relative abundance of each morphology type and clustered together in ordination space. We plan to continue developing the classification by incorporating data from 41 more species from museum collections, which will provide a broader representation of some genera. By improving our classification, we hope to obtain stronger associations between morphological categories and microhabitat when we apply it to paired environmental datasets. Using classification systems accounting for morphological variation and performance associated with habitat types could help to understand shell diversity and its relation to function. isanchezgonzalez@crimson.ua.edu

Poster 12

MUSSELS OF THE WOLF RIVER, TN: A RESURVEY OF UNIONIDS IN AN INUDATED CUMBERLAND TRIBUTARY

J. G. Fetters[1], A. E. Rosenberger [1, 2], A. Ford [3]. [1]Tennessee Technological University, Tennessee Cooperative Fishery Research Unit, Cookeville, TN 3850, [2] U.S. Geological Survey, Tennessee Cooperative Fishery Research Unit, Tennessee Tech, University, Cookeville, TN 38505, [3] U.S. Fish and Wildlife Service, Tennessee Ecological Services Field Office, Cookeville, TN 38501

**STUDENT PRESENTATION*

Tennessee has the second most diverse freshwater mussel fauna in the United States, most of which have some form of conservation status. The Cumberland River system in Tennessee and Kentucky has one of the most diverse assemblages in the world, including several species that are federally listed as endangered. The Obey River system, a large tributary of the Cumberland River, once contained 35 species. Now most of these historical occurrences are inundated by Dale Hollow Lake and have been nearly eliminated due to acid mine drainage in the river headwaters. The Wolf River, the largest tributary of the Obey River, remains a critically important stronghold of the Cumberland River mussel fauna. In 2005-2006, the Wolf River was surveyed using visual and tactile methods. They located nine live mussel species, and 24 of 45 sites sampled contained mussels with signs of recruitment. For this study, we resurveyed all 45 previously investigated sites. Using similar, but more intensive methods, we were able to locate seven of the nine species found in 2005-2006, with live mussels at 33 of the 45 sites. Moreover, we located several species rich sites with the federally endangered Fluted Kidneyshell *Ptychobranchus subtentus* as the most abundant species. Future direction for this project will include returning to areas with high abundances and species richness to determine densities and size-structure with more quantitative

survey methods. These preliminary findings emphasize the importance of the Wolf River Mussel fauna due to its unique mussel assemblages and high potential for restoration.

Poster 13

MOLLUSK SAMPLING IN LARGE CONNECTING RIVERS OF THE LAURENTIAN GREAT LAKES

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**STUDENT PRESENTATION*

Tennessee has the second most diverse freshwater mussel fauna in the United States, most of which have some form of conservation status. The Cumberland River system in Tennessee and Kentucky has one of the most diverse assemblages in the world, including several species that are federally listed as endangered. The Obey River system, a large tributary of the Cumberland River, once contained 35 species. Now most of these historical occurrences are inundated by Dale Hollow Lake and have been nearly eliminated due to acid mine drainage in the river headwaters. The Wolf River, the largest tributary of the Obey River, remains a critically important stronghold of the Cumberland River mussel fauna. In 2005-2006, the Wolf River was surveyed using visual and tactile methods. They located nine live mussel species, and 24 of 45 sites sampled contained mussels with signs of recruitment. For this study, we resurveyed all 45 previously investigated sites. Using similar, but more intensive methods, we were able to locate seven of the nine species found in 2005-2006, with live mussels at 33 of the 45 sites. Moreover, we located several species rich sites with the federally endangered Fluted Kidneyshell *Ptychobranchus subtentus* as the most abundant species. Future direction for this project will include returning to areas with high abundances and species richness to determine densities and size-structure with more quantitative survey methods. These preliminary findings emphasize the importance of the Wolf River Mussel fauna due to its unique mussel assemblages and high potential for restoration.

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