12th Biennial Symposium

April 12 – 14, 2021

Program and Abstracts

Table of Contents

Photo: Ryan Hagerty (USFWS)

Freshwater Mollusk Conservation Society

Virtual Symposium

April 12 – 14, 2021

Back to the Future: The Virtual Unknown

Meeting at a Glance

Day 1

Monday (12 April 2021)

8:00am: Symposium Web Page Opens
Recorded Oral/Poster Presentations Visible

11:00am - 1:00pm: Board Meeting
Live Session

1:00pm - 1:15pm: Coffee Break

1:15pm – 2:30pm: Welcome and Plenary Session
Live Session

2:30pm - 2:45pm: Coffee Break

2:45pm - 3:45pm: Networking Break Out 1
Live Networking Sessions

End of Day 1

Note: 1) All times are Eastern Daylight Time
2) All live Sessions hosted on Zoom
3) Recorded presentations available 24 hours a day during the symposium

Day 2

Tuesday (13 April 2021)

9:45am – 10:45am: Breakfast at FMCS
Live Networking Sessions

10:45am - 11:00am: Coffee Break

11:00am - 12:00pm: Oral and Poster Presentations Discussion Forum 1
Live Sessions

12:00am - 12:15m: Coffee Break

12:15pm - 2:00pm: Committee Meetings 1
Live Sessions

2:00pm - 2:15pm: Coffee Break

2:15pm - 3:15pm: Mentor/Student Mixer
Live Sessions

3:15pm - 3:30 pm: Coffee Break

3:30pm - 4:30pm: Networking Break Out 2
Live Networking Sessions

8:00pm: Judging for Student Awards Ends

End of Day 2

Day 3

Wednesday (14 April 2021)

9:45am – 10:45am: Breakfast at FMCS
Live Networking Sessions

10:45am - 11:00am: Coffee Break

11:00am - 12:00pm: Oral and Poster Presentations Discussion Forum 1
Live Sessions

12:00am - 12:15m: Coffee Break

12:15pm - 2:00pm: Committee Meetings 2
Live Sessions

2:00pm - 2:15pm: Coffee Break

2:15pm - 4:00pm: Business Meeting/Awards
Live Session

8:00pm: Symposium Web Page Closes
Recorded Oral/Poster Presentations No Longer Visible

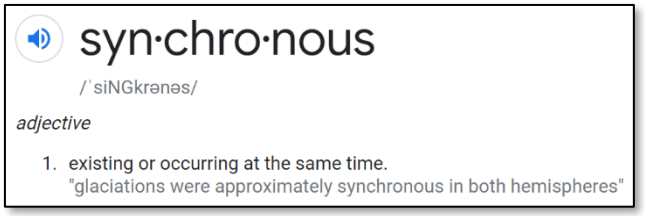
End of Day 3

Definitions

Because this is the first-ever virtual Symposium of the Freshwater Mollusk Conservation Society, the planning committee thought it might be helpful to provide some definitions to help guide participants through the Symposium Program.

1) Live Sessions (Synchronous)

All sessions listed as "live" or "synchronous" will be held at a set time on a set day via the Zoom platform. Zoom links for all synchronous sessions will be provided to all registered participants via e-mail.



2) Contributed Presentations (Asynchronous)

All contributed presentations (12-minute traditional presentations, 5-minute lightning presentations, and posters) will be pre-recorded and available on the Symposium website starting at 8AM on April 12th and ending at 8PM on April 14th. A link to the Symposium webpage will be provided to all registered participants via e-mail.

3) Coffee Break

Coffee breaks have been built into the Symposium schedule to provide transition time for the technical staff behind-the-scenes. There are no official events or activities during these times. Please use this time to for a bio-break or to refill your coffee.

4) Networking Break Out Sessions

Networking Break Out Sessions will provide a space to have informal, social interaction with other Symposium participants. Each break out session will have a topic or event and a facilitator to get the discussion going. So, bring a beverage and just hang out together on Zoom!

5) Breakfast at FMCS

Breakfast at FMCS is an attempt to recreate the informal gatherings that always happen at FMCS prior to the start of the morning session. There will be no structure to these rooms in Zoom. Just bring your coffee and strike up a conversation.

6) Mentor/Student Mixer

The Student/Mentor Mixer will bring together Symposium participants new to the field with the seasoned veterans. These sessions are a great chance for students to learn the ropes and for the seasoned veterans to pick up new ideas.

7) Oral and Poster Presentation Discussion Forum

These discussion forums will provide a live question and answer session for each category of Contributed Presentations.

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Acknowledgements:

Robert “Walt” Householder (Virtual Symposium logo)

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Teresa Newton (U.S. Geological Survey) - tnewton@usgs.gov

Common and Scientific Names of Freshwater Mollusks
Chair (Gastropods): Paul Johnson (Alabama Department of Conservation and Natural Resources) - Paul.Johnson@dcnr.alabama.gov
Chair (Bivalves): John Harris (Arkansas State University) - Omibob1@gmail.com

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Co-Chairs: Garrett W. Hopper, Astrid Schwalb, Jennifer Archambault, Danielle Kreeger, and Caryn C. Vaughn.

Plenary Session

Four Reasons Your Green Organization is Still Predominantly White (and What to Do About it)

In this talk, August M. Ball, founder and CEO of Cream City Conservation will outline why the environmental industry remains racially homogenous (despite recent efforts to diversify). August will unpack commonly held myths keeping conservation organizations stagnant and exclusive and offer actions for cultivating the environment necessary to not only attract diverse pools of candidates and volunteers but also retain them.

August M. Ball is the founder of Cream City Conservation. Her two-prong social enterprise helps organizations attract diverse candidate pools and institute strategies that attract and retain top talent, making their workforce stronger and smarter and their programs more sustainable and relevant. Simultaneously, Cream City Conservation Corps cultivates the next generation of land stewards by introducing and training traditionally underrepresented teens and young adults in ecological careers.

With over 15 years of youth program management experience and 10 years of supporting local and national organizations, such as the Student Conservation Association, Urban Ecology Centers, US Forrest Service, Americorps and Milwaukee County Parks develop environmental programs that are culturally relevant and inclusive; August has connected thousands of youth and young adults to hands-on service to public lands, outdoor recreation and first time employment experiences.

CREAM CITY CONSERVATION

August received her formal education from UW-Parkside and UW-Milwaukee, having studied Sociology, Community Education and Non-Profit Management. She has also continued her education informally via organizations such as Center for Diversity in the Environment, Paradigm and the National Outdoor Leadership School (NOLS)

A native of Southeastern Wisconsin but citizen of the world, speaking three languages (Visayan, Tagalog and English), when she is not teaching, August enjoys being a student and traveling the globe.

Networking Break Out Sessions

Networking Break Out Session #1 **2:45 – 3:45 PM Eastern Time** **Monday, April 12th**

Break Out Room #1: Discussion Topic: Favorite Dive Site… come share stories about your favorite place to put on the SCUBA gear… freshwater or saltwater stories are welcome (Moderator: Tyler Hern)

Break Out Room #2: Discussion Topic: Fun and exciting stories from the field… everybody has their favorite stories of funny things that have happened while doing field work… we want to hear your stories (Moderator: Lisie Kitchel)

Break Out Room #3: Discussion Topic: Best moment of discovery…as James Joyce said, "Mistakes are the portals of discovery". Come share your moments of discovery from the field, lab, reading, personal, beer-related, etc. (Moderator: Kathryn E. Perez)

Break Out Room #4: Discussion Topic: Recent favorite or recommended book… gotta love a good book and no doubt a lot people have had a chance to catch up on their reading list during the pandemic. Come discuss your favorite read during the COVID era. (Moderator: Emilie Blevins).

Networking Break Out Session #2 **3:30 – 4:30 PM Eastern Time** **Tuesday, April 13th**

Break Out Room #1: Discussion Topic FMCS: Mollusc Trivia Hour… put on those thinking caps and get your Trivia game face on for the first ever in the history of FMCS virtual trivia hour - Zoom Style. The Mollusc Trivia Hour will include some time to say hello and meet the competition, followed by various rounds of trivia categories that might include FMCS Meetings Past and Present, historic mollusc facts, first-evers, and more! Grab your beverage(s) of choice and join us. (Moderator: Becca Winterringer)

Break Out Room #2: Discussion Topic: Engagement stories… not the marriage proposal kind, but come share your examples of events or activities where you have educated people about freshwater molluscs and built support for conservation (Moderator: Diane Waller)

Break Out Room #3: Discussion Topic: The Global Pandemic …. How did you survive? Stories from 2020… what a long strange year it has been. Growing mushrooms, baking bread, learning Spanish? Come tell us how you survived 2020. (Moderator: Heidi Dunn)

Break Out Room #4: Discussion Topic: In Search of Time Series Data…Got any old survey data you would love to see put to use? Know of any survey data stored in the archives of museums, state agencies, or in other hidden gems? Let's talk... We are looking for time-series data to help us understand what is a healthy or growing mussel population? What are you monitoring on a regular basis? (Moderator: Catherine Gatenby)

Oral and Poster Presentations Discussion Forum

All recorded oral and poster presentations will be posted on the Symposium website. Each presentation will include a Google Document where Symposium participants can ask the authors questions. These discussion forums will provide an additional opportunity to ask questions in a live setting. The discussion forum rooms will be broken up based on topic area as seen below.

Oral and Poster Presentations Discussion Forum #1
11:00 – 12:00 PM Eastern Time
Tuesday, April 13th

Break Out Room #1: Against the Odds: Status of Native Freshwater Mussels in the Upper Mississippi River (Moderator: Teresa Newton)
Break Out Room #2: Life History, Morphology and Ecology (Moderator: Dave Stagliano)
Break Out Room #3: Status and Distribution of Mollusks (Moderator: Kevin Cummings)
Break Out Room #4: Surveys and Monitoring (Moderator: Brett Ostby)
Break Out Room #5: Propagation, Restoration and Reintroduction (Moderator: Megan Bradley)
Break Out Room #6: Ecosystems and Community Ecology (Moderator: Daelyn A. Woolnough)
Break Out Room #7: Genetics and Phylogeny (Moderator: Nathan Whelan)

Oral and Poster Presentations Discussion Forum #2
11:00 – 12:00 PM Eastern Time
Wednesday, April 14th

Break Out Room #1: Ecosystem Services (Moderator: Danielle Kreeger)
Break Out Room #2: Contaminants and Ecotoxicology (Moderator: Patty Gillis)
Break Out Room #3: Outreach, Education and Inclusion (Moderator: Sara Andree)
Break Out Room #4: Climate Change and Human Impacts (Moderator: Franchesca Perez)
Break Out Room #5: Invasive Mollusks (Moderator: Cayla Morningstar)
Break Out Room #6: Mollusk Disease, Parasitism, and Die-Offs (Moderator: Jordan Richard)
Break Out Room #7: Natural History Collections (Moderator: John Pfieffer)

Committee Meetings

Committee Meetings Session #1
12:15 – 2:00 PM Eastern Time
Tuesday, April 13th

Break Out Room #1: Awards
Break Out Room #2: Environmental Quality & Affairs
Break Out Room #3: Gastropod Status and Distribution
Break Out Room #4: Genetics
Break Out Room #5: Guidelines and Techniques
Break Out Room #6: Information Exchange
Break Out Room #7: Mussel Status and Distribution
Break Out Room #8: Outreach

Committee Meetings Session #2
12:15 – 2:00 PM Eastern Time
Wednesday, April 14th

Break Out Room #1: Propagation, Restoration & Introduction
Break Out Room #2: Symposium
Break Out Room #3: Ad Hoc National Strategy Committee
Break Out Room #4: Common and Scientific Names of Freshwater Mollusks
Break Out Room #5: Nominations (Elections)
Break Out Room #6: Diversity, Equity, and Inclusion Committee
Break Out Room #7: Professional Development
Break Out Room #8: Ecosystem Services

Contributed Presentations

(Titles and Authors)

NOTE: PRESENTATION TITLES IN ORANGE INDICATE A STUDENT PRESENTATION.

Special Session

Against the Odds: Status of Native Freshwater Mussels in the upper Mississippi River

STATE OF THE MUSSELS: BROAD SCALE POPULATION ASSESSMENTS OF NATIVE MUSSELS IN THE UPPER MISSISSIPPI RIVER. Teresa J. Newton[1], Danielle Schultz[2], & Robert Francis[1]. [1]U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI; [2]University of Wisconsin – La Crosse, La Crosse, WI.

LANDSCAPE SCALE ANALYSIS OF FRESHWATER MUSSEL DENSITIES IN THE UPPER MISSISSIPPI RIVER: VARIATION WITHIN AND AMONG NAVIGATION POOLS. Danielle E. Schultz[1], Robert A. Francis[2], & Teresa J. Newton[2]. [1]University of Wisconsin – La Crosse, La Crosse, WI; [2]U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI.

DIFFERENCES IN SPECIES COMPOSITION AND SPECIES ABUNDANCE OF NATIVE FRESHWATER MUSSELS DRIVES COMMUNITY STRUCTURE AMONG NESTED SPATIAL SCALES IN THE UPPER MISSISSIPPI RIVER. Robert Francis[1], Teresa J. Newton[1], & Danielle Schultz[2]. [1]U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI; [2]University of Wisconsin – La Crosse, La Crosse, WI.

TWENTY YEARS OF MONITORING FRESHWATER MUSSELS AND *DREISSENA POLYMORPHA* IN *LAMPSILIS HIGGINSII* ESSENTIAL HABITAT AREAS OF THE UPPER MISSISSIPPI RIVER. Heidi L. Dunn[1], Daniel E. Kelner[2], Aaron M. McFarlane[2], Joseph W. Jordan[3]. [1]EcoAnalysts, Inc., O'Fallon, MO; [2]U.S. Army Corps of Engineers, St. Paul District, St. Paul, MN; [3]U.S. Army Corps of Engineers, Rock Island District, Rock Island, IL.

CHARACTERIZATION OF THE MUSSEL MICROBIOME: ASSESSMENT OF MICROBE BIODIVERSITY ACROSS SPECIES, INDIVIDUALS, AND ENVIRONMENTAL COMPARTMENTS. Katie Bockrath[1], Maren Tuttle-Lau[1] and Teresa Newton[2]. [1]U.S. Fish and Wildlife Service, Midwest Fisheries Center, Whitney Genetics Lab, Onalaska WI; [2]U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse WI.

Life History and Ecology

12-Minute Traditional Presentations

THE EFFECT OF FLOW AND MUSSEL SPECIES TRAITS ON THE OCCURRENCE OF RARE MUSSELS: A CASE STUDY WITHIN SELECT RIVERS OF THE WEST GULF COASTAL PLAIN. Alexander H. Kiser[1], Jennifer M. Khan[2], Clinton R. Robertson[3], Roel Lopez[4] & Charles R. Randklev[1]. [1]Texas A&M Natural Resources Institute, Dallas, Tx; [2]U.S. Fish & Wildlife Service, Arlington, TX; [3]Texas Parks & Wildlife Department, River Studies Program, San Marcos, TX; [4]Texas A&M Natural Resources Institute, College Station, TX.

EVOLUTION OF INTERSPECIFIC EGG-LAYING STRATEGIES IN THE FRESHWATER GASTROPOD FAMILY PLEUROCERIDAE (CAENOGASTROPODA: CERITHIOIDEA). Nicholas S. Gladstone[1]; Paul D. Johnson[2]; Nathan V. Whelan[1,3]

LINKAGES BETWEEN BEHAVIOR, METABOLIC DEPRESSION, AND MORTALITY OF UNIONID MUSSELS EXPOSED TO THERMAL STRESS. Patrick Jordan, Kaelyn Fogelman and James Stoeckel. Auburn University, Auburn, AL, USA.

LONG-TERM TEMPERATURE ASSESSMENT OF STREAMS INHABITED BY THE THREATENED TENNESSEE HEELSPLITTER (*LASMIGONA HOLSTONIA*). Alissa M Ganser[1], Eric M Hallerman[1], & Jess W Jones[1,2]. [1]Virginia Tech, Blacksburg, VA; [2]U.S. Fish and Wildlife Service, Blacksburg, VA.

HABITAT SELECTION, HOST DETECTION, AND HYPOXIC RESPONSE IN THE SALAMANDER MUSSEL, *SIMPSONAIAS AMBIGUA*. Eric Stegmann[1], Chris Barnhart[1], & Megan Bradley[2]. [1]Missouri State University, Springfield, MO; [2]Genoa National Fish Hatchery, Genoa, WI.

REPRODUCTIVE PHENOLOGY AND LIFE-HISTORY TRAITS OF WESTERN PEARLSHELL MUSSELS IN MONTANA. Kristen Cook[1], Al Zale[2], Dave Stagliano[3], Michelle Anderson[4], Chris Barnhart[5], Chris Guy[2] & Lindsey Albertson[1]. [1]Montana State University, Bozeman, MT; [2]U.S.G.S. Montana Cooperative Fishery Research Unit, Bozeman, MT; [3]Montana Biological Survey, Helena, MT; [4]University of Montana Western, Dillon, MT; [5]Missouri State University, Springfield, MO.

EFFECT OF SUBSTRATE PARTICLE SIZE ON BURROWING OF THE JUVENILE FRESHWATER PEARL MUSSEL *MARGARITIFERA MARGARITIFERA*. Heini Hyvärinen, Mari Saarinen-Valta[1], Eero Mäenpää[2], and Jouni Taskinen[1]. [1]Department of Biological and Environmental Science, University of Jyväskylä, P.O. Box 35, FI-40014 University of Jyväskylä, Finland; [2]West Finland Regional Environment Centre, P.O. Box 77, FI-67100 Kokkola, Finland.

QUANTIFYING MOVEMENT PATTERNS AND DISTRIBUTION TRENDS OF THE UNDERSTUDIED BLACK SANDSHELL (*LIGUMIA RECTA*): A MICHIGAN ENDANGERED SPECIES IN NEED OF CONSERVATION. Meghan E. Martinski[1,2], and Daelyn A. Woolnough[1]. [1]Biology Department and Institute for Great Lakes Research, Central Michigan University, Mount Pleasant, MI; [2]Honors Program, Central Michigan University, Mount Pleasant, MI.

A LIFE-HISTORY GUILD APPROACH TO FRESHWATER MUSSEL RISK ASSESSMENT: DYNAMIC ENERGY BUDGET MODEL AND INDIVIDUAL-LEVEL RESPONSES. Adrian P. Moore[1], Nika Galic[2], Richard A. Brain[2], Daniel J. Hornbach[3], Valery E. Forbes[1]. [1]College of Biological Sciences, University of Minnesota – Twin Cities, St. Paul, MN 55108; [2]Sygenta Crop Protection LLC, Greensboro, NC 27409; [3]Department of Environmental Studies, Macalester College, St. Paul, MN 55105.

EVALUATING WESTERN PEARLSHELL MUSSEL POPULATIONS FOR VIABILITY, REPRODUCTION AND HOST FISH GLOCHIDIA INFESTATIONS ACROSS FIVE WATERSHEDS IN WESTERN MONTANA. David M. Stagliano[1], Michelle Anderson[2] & Kristen Cook[3]; [1] Montana Biological Survey, Helena, MT; [2]University of Montana Western, Dillon, MT; [3] Montana State University, Bozeman, MT

5-Minute Lightning Presentations

MODELLING THE RELATIONSHIP BETWEEN HOST FISH AVAILABILITY AND THE REPRODUCTION SUCCESS OF MUSSELS. Vishnupriya Kasireddy[1], Thomas Jones[1], Alyssa Jones[1], & Mitchell Kriege[2]. [1]Marshall University, Huntington, WV; [2] EDGE Engineering & Science, LLC.

LINKING AGE DISTRIBUTION AND GROWTH RATES OF FRESHWATER MUSSELS TO ANTECEDENT FLOW CONDITIONS. Leah A. Woolam, Zachary A. Mitchell, and Astrid N. Schwalb. Department of Biology – Texas State University, San Marcos, Texas 78640

A COMPARISON OF UNIONID FEEDING ECOLOGY BETWEEN LENTIC AND LOTIC SYSTEMS. Kaelyn J. Fogelman[1], James Stoeckel[1], Hisham A. Abdelrahman[1,2], and Brian Helms[3]. [1]Auburn University, Auburn, AL, USA; [2]Cairo University, Giza, Egypt; [3]Troy University, Troy, AL, USA.

TEMPORAL DYNAMICS OF FRESHWATER MUSSEL LARVAE. Stephanie Smodis[1] and Joe Ackerman[1]. [1]University of Guelph, Guelph, ON.

USE OF NATIVE AND NONNATIVE FISH HOSTS BY THE WESTERN FRESHWATER MUSSEL *ANODONTA CALIFORNIENSIS* (CALIFORNIA FLOATER) IN THE COLUMBIA RIVER BASIN. Alexa N. Maine[1] and Christine O'Brien[2]. [1]Confederated Tribes of the Umatilla Indian Reservation, Freshwater Mussel Research and Restoration Project, Walla Walla, WA. [2]Browns River Consultants LLC, Waynesville, NC.

POPULATION DENSITY AND REPRODUCTIVE SEASONALITY OF *TRYONIA CHEATUMI* (GASTROPODA; COCHLIOPIDAE), THE PHANTOM TRYONIA. Kathryn E. Perez[1], Nina Noreika[2,3], Chad Norris[4], Marty Kelly[5], Melissa Lopez[1], Christina Ortega[1], Salma Ruiz Sandoval[1], Samantha Gonzalez[1], and Weston Nowlin[2]. [1]University of Texas Rio Grande Valley, Edinburg, TX, 78542, USA; [2]Texas State University, San Marcos, TX 78666 USA; [3]Czech Technical University in Prague, Prague 16629 Czech Republic; [4] Guadalupe-Blanco River Authority, Seguin, TX 78155, USA; [5]Texas Parks and Wildlife Department, Austin, TX, 78744, USA.

TAKING A CLOSER LOOK: *QUADRULA FRAGOSA* MANTLE MAGAZINE AND PAPILLAE STRUCTURES IN MACRO IMAGES. Megan Bradley and Elizabeth Glidewell. USFWS, Genoa National Fish Hatchery, Genoa, WI.

Posters

SEXUAL DIFFERENTIATION IN SOMATIC GROWTH WITHIN *LAMPSILIS CARDIUM* (BIVALVIA: UNIONIDAE), AS A FUNCTION OF ENVIRONMENTAL IMPACTS. Mariah Scott[1] and Rüdiger Bieler[2]. [1] University of Chicago, Chicago, IL; [2] Field Museum, Chicago, IL.

Status and Distribution of Mollusks

12-Minute Traditional Presentations

INVENTORY AND ASSEMBLAGE CLASSIFICATION OF THE FRESHWATER MUSSELS (MOLLUSCA: UNIONIDAE) OF THE STRAWBERRY RIVER, ARKANSAS WITH IMPLICATIONS FOR CONSERVATION PLANNING. Alan D. Christian[1], Sean McCanty[2], Sujata Poudel[2], Steve Chordas[3], and John L. Harris[4]. [1] Clarkson University, Potsdam, NY, USA; [2]University of Massachusetts Boston, Boston, MA, USA; [3]Ohio State University, Columbus, OH, USA; [4]Arkansas State University, State University, AR, USA.

EXPANDING RESEARCH AND SURVEY EFFORTS TO SUPPORT CONSERVATION OF THE IMPERILED WESTERN RIDGED MUSSEL (*GONIDEA ANGULATA*). Emilie Blevins[1] & Sarina Jepsen[1]. [1]Xerces Society for Invertebrate Conservation, Portland, OR.

STABLE HABITAT IN A DYNAMIC LANDSCAPE: GEOMORPHOLOGY AND FRESHWATER MOLLUSK RADIATIONS. David Campbell[1]. [1] Gardner-Webb University, Boiling Springs NC.

FRESHWATER MUSSELS (UNIONDAE & MYCETOPODIDAE) OF THE PÁNUCO AND USUMACINTA BASINS, MÉXICO. Kevin S. Cummings[1], Jeremy S. Tiemann[1], John Pfeiffer[2], Nathan A. Johnson[3], Chase H. Smith[4], Alex Kiser[5] and Charles R. Randklev[5] [1]Illinois Natural History Survey, University of Illinois at Urbana-Champaign, Champaign, IL; [2]Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, IL; [3]Wetland and Aquatic Research Center, U.S. Geological Survey, Gainesville, FL; [4]Department of Integrative Biology, University of Texas at Austin, Austin TX; [5]Natural Resources Institute, Texas A&M University, Dallas, TX.

HUNTING FOR PURPLE CATSPAW (*EPIOBLASMA OBLIQUATA*) ON THE WALHONDING RIVER: A PRESENTATION OF EFFORTS AND RESULTS. David A. Foltz II[1,2], Adam K. Benshoff[2], & Michelle Shively[3]. [1]EDGE Engineering & Science, LLC, Cincinnati, OH; [2]West Liberty University, West Liberty, WV; [3]Rural Action, The Plains, OH.

THE BIOGEOGRAPHY OF UNIONID FRESHWATER MUSSELS IN TEXAS AND ITS IMPLICATIONS FOR CONSERVATION. Mike DeMoulpied[1], Chase H. Smith[2], Clint Robertson[3], Nathan A. Johnson[4], Roel Lopez[1], and Charles R. Randklev[1]. [1]Texas A&M Natural Resources Institute, Texas A&M AgriLife Research Center at Dallas, Dallas, Texas; [2]Department of Integrative Biology, University of Texas at Austin, Austin, TX; [3]Texas Parks & Wildlife Department, River Studies Program, San Marco, Texas; USA.[4]Wetland and Aquatic Research Center, US Geological Survey, Gainesville, Florida.

UNDERSTANDING FRESHWATER MUSSEL DISTRIBUTION, ABUNDANCE, AND DEMOGRAPHY IN THE SOUTH UMPQUA RIVER BASIN, OREGON: IMPACTS OF LAND USE AND STREAM HYDRAULICS. Laura Johnson, Dr. Patricia McDowell, Dr. Lauren Hallett. University of Oregon, Eugene, Oregon.

A HABITAT SUITABILITY MODEL FOR THE TENNESSEE HEELSPLITTER (*LASMIGONA HOLSTONIA*). Kristin I Womble[1] & Amanda E Rosenberger[2]. [1]Tennessee Cooperative Fishery Research Unit, Tennessee Technological University, Box 5114, Cookeville, TN 38505. [2]U.S. Geological Survey, Tennessee Cooperative Fishery Research Unit, Tennessee Technological University, Box 5114, Cookeville, TN 38505.

CONSERVATION FOR AN ENDEMIC SPRINGSNAIL IN UTAH'S WEST DESERT. Kate Holcomb[1], Paul Abate[2], Paul Badame[1], Rick Fridell[1], Richard Hepworth[1], Cassie Mellon[3], Paul Thompson[1], George Weekley[2], Kevin Wheeler[1]. [1]Utah Division of Wildlife Resources; [2]U.S. Fish and Wildlife Service, Salt Lake City, UT; [3]Bureau of Land Management, Salt Lake City, UT.

USING MOLECULAR APPROACHES TO DELIMIT CONSERVATION UNITS FOR MULTIPLE SPECIES OF *POTAMILUS*. Chase H. Smith[1,2,3], Charles R. Randklev[3], Clint R. Robertson[4], Nathan A. Johnson[5]. [1]University of Texas at Austin, Austin, TX; [2]Baylor University, Waco, TX; [3]Texas A&M Natural Resources Institute, Texas A&M AgriLife Research Center at Dallas, Dallas, TX; [4]Texas Parks and Wildlife Department, Rivers Studies Program, San Marcos, TX; [5]U.S. Geological Survey, Wetland and Aquatic Research Center, Gainesville, FL, USA.

DISTRIBUTION AND RELATIVE ABUNDANCE OF THE GASTROPOD FAUNA OF THE NORTH AND SOUTH ESK, DALKEITH COUNTRY PARK, MIDLOTHIAN, SCOTLAND. Rex A. Hanger & Lindsey Walker. University of Wisconsin-Whitewater, Whitewater, WI.

LINEAR RELATIONSHIPS BETWEEN ANTHROPOGENIC IMPACTS AND FRESHWATER MUSSEL COMMUNITIES IN THE OHIO RIVER. Mitchell Kriege[1], Thomas Jones[2], Alyssa Jones[2], Jacob Miller[2]. [1]EDGE Engineering and Science, LLC., Cincinnati, OH. [2]Marshall University, Huntington, WV.

BRIDGING THE DATA GAP IN THE PENNSYLVANIA DEPARTMENT OF TRANSPORTATION PROGRAMMATIC AGREEMENT (PART II). Ryan Schwegman[1], Dale Dunford[1], Phil Mathias[1], Becca Winterringer[1], Toni Zawisa[2], and Gregory Zimmerman[1]. [1]EnviroScience, Inc. Stow, OH. [2]Pennsylvania Department of Transportation Environmental Policy and Development Section, Clearfield, PA.

LANDSCAPE-SCALE DRIVERS OF CURRENT CONDITIONS ACROSS FIVE FRESHWATER MUSSEL SPECIES. Daniel B Fitzgerald[1] & David R Smith[1]. [1]US Geological Survey, Leetown Science Center, Kearneysville WV

TRENDS IN MUSSEL ABUNDANCE AND HABITAT CHANGE 5-YEARS POST DAM REMOVAL. Peter Hazelton[1,4], Allison Roy[2], Ayla Skorupa[3], Jason Carmignani[4]. [1]Warnell School of Forestry & Natural Resources, University of Georgia, Athens, GA; [2]U. S. Geological Survey, Massachusetts Cooperative Fish & Wildlife Research Unit, University of Massachusetts, Amherst, MA; [3] Massachusetts Cooperative Fish & Wildlife Research Unit, University of Massachusetts, Amherst, MA; [4]Massachusetts Division of Fisheries and Wildlife, Westborough, MA

5-Minute Lightning Presentations

THE EXPANDING RANGE OF SOME MUSSELS IN MINNESOTA AND REVISION OF THE HISTORICAL MISSISSIPPI HEADWATERS FAUNA. Bernard E Sietman and Mike Davis. Minnesota Department of Natural Resources, Center for Aquatic Mollusk Programs, Lake City, MN.

FRESHWATER MUSSEL STATUS ASSESSMENT USING A SUITABLE HABITAT MODEL FOR THE GASCONADE RIVER, MO. Brittany Bajo[1], Jordan Hartman[2], Amanda Rosenberger[3]. [1] Tennessee Technological University, Cookeville, TN; [2] University of Illinois Urbana-Champaign, Champaign, IL; [3]U.S. Geological Survey, Tennessee Cooperative Fisheries Research Unit, Department of Biology, Cookeville, TN.

CHARACTERIZING *EPIOBLASMA TRIQUETRA* COOCCURRING UNIONID COMMUNITY AND WATERSHED SCALE ANALYSES IN MICHIGAN. Scott M. LaValley[1] and Daelyn A. Woolnough[1]. [1]Central Michigan University, Biology Department and Institute for Great Lakes Research, Mount Pleasant, MI.

FIRST CONTEMPORARY OBSERVATION OF YELLOW LANCE (*ELLIPTIO LANCEOLATA*; LEA 1928) IN THE PATUXENT RIVER, MARYLAND, USA. Jessica N. Woodall[1], Matthew J. Ashton[2], and Jackie Sivalia[2]. [1]Chesapeake Bay Trust, Annapolis, MD; [2]Maryland Department of Natural Resources, Annapolis, MD.

Surveys and Monitoring

12-Minute Traditional Presentations

REPORT ON TWO SAMPLING SITES FOR FRESHWATER MUSSELS ON THE MELDAHL POOL OF THE OHIO RIVER: COMPARISON AND DISCUSSION. David A. Foltz II[1,2], Aaron M. Prewitt[1]. [1]EDGE Engineering & Science, LLC, Cincinnati, OH; [2]West Liberty University, West Liberty, WV.

DEVELOPMENT OF A TRANSPORT MODEL TO UNDERSTAND eDNA DETECTIONS OF FRESHWATER MUSSELS TO AID IN THEIR CONSERVATION. Katy Klymus, Dannise Ruiz, Nathan Thompson, Cathy Richter; Columbia Environmental Research Center, U.S. Geological Survey.

DETECTION AND HABITAT ASSOCIATIONS OF WAVYRAYED LAMPMUSSEL IN ONTARIO, CANADA. Karl A Lamothe, Kelly A McNichols-O'Rourke & Todd J Morris. Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, ON Canada.

ALTERNATIVE METHODS TO DETECT *SIMPSONAIAS AMBIGUA,* SALAMANDER MUSSEL. Isabel P. Hannes[1,2], Lauren Sassoubre[2,3], Todd J. Morris[1]. [1]Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, 867 Lakeshore Drive, Burlington, ON L7S 1A1. Canada; [2]Department of Civil, Structural and Environmental Engineer, University at Buffalo, Jarvis Hall, Buffalo NY 14260. USA; [3]Department of Engineering, University of San Francisco, 2130 Fulton St. San Francisco, CA 94117

MODELING DENSITIES, APPARENT SURVIVAL AND POPULATION SIZE OF LOUISIANA PIGTOE (*PLEUROBEMA RIDDELLII*, MOLLUSCA, UNIONIDAE) AT THREE DIFFERENT SITES IN THE NECHES RIVER BASIN OF EAST TEXAS. David F. Ford[1], Edith D. Plants-Paris[2], and Neil B. Ford[2]. [1]Edge Engineering and Science, 16285 Park Ten Pl #400, Houston, TX 77084, [2.] Department of Biology, University of Texas at Tyler, Tyler, TX, 75799.

RESULTS FROM RECENT SURVEYS AND CAPTURE-RECAPTURE MONITORING OF DWARF WEDGEMUSSEL IN NANJEMOY CREEK, MARYLAND. Jessica N. Woodall[1], Matthew J. Ashton[2], & James M. McCann[2]. [1]Chesapeake Bay Trust, Annapolis, MD; [2]Maryland Department of Natural Resources, Annapolis, MD.

A REVIEW OF OHIO PROTOCOL APPLICATION IN 2020 WITH A FOCUS ON SURVEYS OF ROUND HICKORYNUT (*OBOVARIA SUBROTUNDA*). Becca Winterringer[1] and Megan Michael[2]. [1]Enviroscience, Stow, Ohio 44224; [2]Ohio Department of Transportation, Columbus, Ohio 43222.

***VILLOSA FABALIS* (RAYED BEAN), A DISCUSSION AND UPDATE OF RECENT RECORDS AND RANGE EXPANSION IN THE UPPER ALLEGHENY RIVER ABOVE KINZUA DAM IN PENNSYLVANIA, NEW YORK, AND THE SENECA NATION OF INDIANS**. Ryan J Schwegman[1], Dale P Dunford[1], Philip T Mathias[1]. [1]EnviroScience Inc., Stow, OH.

COMPARING CONVENIENCE AND PROBABILITY SAMPLING DESIGNS FOR DESCRIBING RIVERINE MUSSEL COMMUNITIES. Zachary A. Mitchell, Astrid N. Schwalb. Biology Department, Texas State University, San Marcos, TX 78666.

5-Minute Lightning Presentations

PRELIMINARY FRESHWATER MUSSEL SURVEYS ON EAGLE CREEK: AN UNDERSTUDIED WATERSHED IN NORTHERN KENTUCKY. Mitchell Kriege[1], Mike Compton[2], and John Spaeth[1]. [1]EDGE Engineering and Science, LLC., Cincinnati, OH. [2]Kentucky State Nature Preserve, Frankfort, KY.

LONG-TERM MONITORING REVEALS ASYMMETRIC RESPONSES OF MUSSEL AND HOST FISH COMMUNITIES IN A BIODIVERSITY HOTSPOT. Irene Sanchez Gonzalez[1], Garrett W. Hopper[1], Jamie Bucholz[1], and Carla L. Atkinson[1]. [1]Department of Biological Sciences, University of Alabama, Tuscaloosa, AL, USA

MONITORING A RECOVERING MUSSEL ASSEMBLAGE IN A FORMER "DEAD ZONE" OF THE MISSISSIPPI RIVER. Mike Davis[1], Lindsay Ohlman[1], Madeline Hayden[1], Anna Scheunemann[1], Zeb Secrist[1], Bernard Sietman[1], Dan Kelner[2], and Olivia Poelmann[3]. [1]Minnesota Department of Natural Resources, Center for Aquatic Mollusk Programs (CAMP), Lake City, MN; [2]US Army Corps of Engineers, St. Paul District; [3]Clemson University Graduate School, Clemson, SC.

SIMPLE DEVICE TO COLLECT GLOCHIDIA AND JUVENILE MUSSELS FALLING FROM HOSTS IN THE FIELD. Karel Douda[1], Felipe Escobar-Calderón[1], Barbora Vodáková[1], Pavel Horký[1], Ondřej Slavík[1] and Ronaldo Sousa[2]. [1] Department of Zoology and Fisheries, Czech University of Life Sciences Prague, Czech Republic; [2] CBMA - Centre of Molecular and Environmental Biology, University of Minho, Portugal.

MONITORING SURVIVAL OF FEDERALLY ENDANGERED MUSSELS RELOCATED FROM PIPELINE CROSSING IN THE CLINCH RIVER, VIRGINIA. Brett J. K. Ostby and Braven B. Beaty. Daguna Consulting, LLC, Bristol, VA.

USE OF QUALITATIVE AND QUANTITATIVE SURVEYS TO DESCRIBE WESTERN PEARLSHELL MUSSEL DISTRIBUTION AND ABUNDANCE IN IDAHO. Doug Nemeth and John Erhardt. U.S. Fish and Wildlife Service, Idaho Fish and Wildlife Conservation Office, Orofino, Idaho.

Posters

DIRECTING FIELD SURVEYS FOR CALIFORNIA FLOATER (*ANODONTA CALIFORNIENSIS/NUTTALLIANA* CLADE) AND WESTERN PEARLSHELL (*MARGARITIFERA FALCATA*) USING eDNA IN THE BEAR RIVER BASIN. Lusha Tronstad[1], Madison Crawford[1], Torrey Rodgers [2] and Stephen Siddons [3]. [1]Wyoming Natural Diversity Database, University of Wyoming, Laramie, Wyoming; [2] Molecular Ecology Laboratory, Utah State University, Logan, Utah; [3] Wyoming Game and Fish Department, Laramie, Wyoming.

DISTRIBUTION OF MUSSELS AND PLEUROCERID GASTROPODS IN THE LOCUST FORK OF THE BLACK WARRIOR RIVER, ALABAMA. Michael L. Buntin[1], Jesse T. Holifield[1], Thomas A. Tarpley[1], Jeffery T. Garner[2], and Paul D. Johnson[1]. [1]Alabama Department of Conservation and Natural Resources (ADCNR), Marion, AL; [2]ADNCR, Florence, AL.

LONG-TERM MONITORING OF FRESHWATER MUSSEL ASSEMBLAGES (BIVALVIA: UNIONIDAE) IN THE BUFFALO NATIONAL RIVER, AR. Anna M Pieri[1], John L Harris[1], Brook L Fluker[1], James L Kunz[2], Ashley R Rodman[3], Shawn W Hodges[3], Jeffery A Steevens[2], and Jennifer L Bouldin[1]. [1]Arkansas State University, Jonesboro, AR; [2]U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO; [3]U.S. National Park Service, Buffalo National River, Harrison, AR.

Propagation, Restoration and Reintroduction

12-Minute Traditional Presentations

OFFSPRING FROM A SINGLE FEMALE RETAINS POPULATION-LEVEL GENETIC VARIATION BUT ALTERS GENETIC STRUCTURE. Jillian M Snow[1], Kristine M Schoenecker[2], Jessi DeMartini[3], Kentaro Inoue[4]. [1]John G. Shedd Aquarium, Chicago, IL; [2]University of Illinois, Champaign, IL; [3]Forest Preserve District of DuPage County, Wheaton, IL; [4]John G. Shedd Aquarium, Chicago, IL.

MITIGATING CONTAMINATION FOR IN-VITRO PROPAGATION OF DWARF WEDGEMUSSEL. Jennifer E. Ryan[1], Allison H. Roy[2], Peter D. Hazelton[3], David L. Perkins[4] and Timothy M. Warren[4]. [1]Massachusetts Cooperative Fish and Wildlife Research Unit, Department of Environmental Conservation, University of Massachusetts Amherst, Amherst, Massachusetts; [2]U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst, Amherst, Massachusetts; [3]Daniel B. Warnell School of Forestry and Natural Resources, University of Georgia; [4]U.S. Fish and Wildlife Service, Richard Cronin Aquatic Resource Center, Sunderland, Massachusetts.

PLANNING FOR THE CONTROLLED PROPAGATION AND REINTRODUCTION OF SPECTACLECASE (*CUMBERLANDIA MONODONTA*) USING IUCN GUIDELINES. Tamara A Smith[1], Megan E Bradley[2], Mike Davis[3], Barb Douglas[4], Heidi Dunn[5], Nathan Eckert[6], Alex Franzen[7], Mark Hove[7], Byron Karns[8], Dan Kelner[9], Lisie Kitchel[10], Madeline Pletta[3], Andy Roberts[11], Bernard Sietman[3], Jeremy Tiemann[12], and Jesse Weinzinger[10]. [1]U.S. Fish and Wildlife Service, Bloomington, MN;[2]U.S. Fish and Wildlife Service, Genoa, WI; [3]Minnesota Department of Natural Resources, Lake City, MN; [4]U.S. Fish and Wildlife Service, Davis, WV; [5] EcoAnalysts, Inc., O'Fallon, MO; [6]U.S. Fish and Wildlife Service, Neosho, MO; [7] University of Minnesota, St. Paul, MN; [8]National Park Service, St. Croix Falls, WI; [9]Army Corps of Engineers, St. Paul, MN; [10]Wisconsin Department of Natural Resources, Madison, WI; [11]U.S. Fish and Wildlife Service, Columbia, MO; [12]Illinois Natural History Survey, Champaign, IL.

MODELING SURROGATE MUSSEL ABUNDANCE AND OCCUPANCY TO DETERMINE SUITABLE HABITAT FOR THE TRANSLOCATIONS OF TWO FEDERALLY ENDANGERED MUSSELS IN CENTRAL ILLINOIS. Hugo Y. Ruellan[1], Kirk Stodola[1], Alison P. Stodola[1], Jeremy S. Tiemann[1]; [1]University of Illinois at Urbana-Champaign, Champaign, IL.

ASSISTED POPULATION VIABILITY AS A STRATEGY TO RESTORE AND MAINTAIN FRESHWATER MUSSEL POPULATIONS. Jess W. Jones[1] and John Sweka[2], [1]U.S. Fish and Wildlife Service, Virginia Field Office, Blacksburg, VA; and [2]U.S. Fish and Wildlife Service, Northeast Fishery Center, Lamar, PA.

RESTORATION DESIGN FOR FRESHWATER MUSSELS. Laura McMullen, Janel Sobota, Celeste Mazzacano, and Kevin MacKay, ICF, Portland, OR.

***IN VITRO* CULTURE AND PROPAGATION OF THE ENDANGERED CUMBERLAND BEAN, *VENUSTACONCHA TROOSTENSIS*, USING A COMBINATION OF SERUM MIXTURES IN A PHYSIOLOGICAL NUTRIENT SOLUTION**. Monte McGregor and Julieann Jacobs. Kentucky Department of Fish and Wildlife Resources, Center for Mollusk Conservation, Frankfort, KY.

LIFE HISTORY OF THE KENTUCKY CREEKSHELL, *VILLOSA ORTMANNI*. Monte McGregor[1], Adam Shepard[1], Wendell Haag[2], Julieann Jacobs[1], Travis Bailey[1], Mike Compton[3], Travis Williams[1]. [1]Kentucky Department of Fish and Wildlife Resources, Center for Mollusk Conservation, Frankfort, KY. [2]US Forest Service, Southern Research Station, Frankfort, KY, and [3] Office of Kentucky Nature Preserves, Frankfort, KY.

COMMUNITY CHANGES IN A FRESHWATER MUSSEL BED FROM 2004 TO 2019 IN THE GREEN RIVER, KENTUCKY, AFTER SUCCESSFUL AUGMENTATION OF THE PINK MUCKET, *LAMPSILIS ABRUPTA*. Monte A. McGregor, Adam C. Shepard, Travis Bailey, and Julieann M. Jacobs. Kentucky Department of Fish and Wildlife Resources, Center for Mollusk Conservation, Frankfort Kentucky, 40601.

SALAMANDER MUSSEL HEAD STARTING; OBSERVATIONS ON GLOCHIDIA ATTACHMENT AND HABITAT PARAMETERS IN THE CHIPPEWA RIVER, WI. Megan Bradley[1], Elizabeth Glidewell[1], Nathan Eckert[2] Doug Aloisi[1]. USFWS, [1]Genoa National Fish Hatchery, Genoa, WI, [2]Neosho National Fish Hatchery, Neosho, MO.

ASSESSING THE FEASIBILITY OF A FRESHWATER MUSSEL INTRODUCTION IN THE URBAN SAN ANTONIO RIVER USING A HOLISTIC STUDY DESIGN. Chris R Vaughn[1], Zoe G Nichols[1], Austin M Davis[1]. [1]San Antonio River Authority, San Antonio, TX.

SURVIVAL AND GROWTH OF JUVENILE *LAMPSILIS RADIATA* DEPLOYED IN THE TIDAL ANACOSTIA RIVER WATERSHED. Alfred E. Pinkney[1], Luis A. Chevez[1], Jack Stanton[1], Lance Yonkos[2], Danielle A. Kreeger[3], Roger L. Thomas[4], Rachel A. Mair[5], and Michael A. Rutter[6]. [1]U.S. Fish and Wildlife Service, Annapolis, MD [2]University of Maryland, College Park, MD, [3]Partnership for the Delaware Estuary, Wilmington, DE, [4]The Academy of Natural Sciences of Drexel University, Philadelphia, PA, [5]U.S. Fish and Wildlife Service, Charles City, VA, [6]Penn State Behrend, Erie, PA.

PROPAGATION AND CULTURE AT VIRGINIA FISHERIES AND AQUATIC WILDLIFE CENTER. Amy Maynard[1], Rachel Mair[3], Bryce Maynard[3], Brian Watson[2], Michael Odom[3], Jace Nelson[1], Jennifer Ryan[1], John-Reid Ryan[3], Raquel Wetzell[4]. [1]Conservation Management Institute, Virginia Polytechnic Institute & State University, Charles City, VA 23030; [2]Virginia Department of Wildlife Resources, Forest, VA 24551; [3]U.S. Fish and Wildlife Service, Charles City, VA 23030. [4]Virginia Commonwealth University, Richmond, VA, 23284.

PROPAGATION OF FRESHWATER MUSSELS IN FLOATING CAGES AT LAKE CUMBERLAND, KY. Travis Bailey[1], Adam Shepard[1], Monte McGregor[1], Julieann Jacobs[1], Travis Williams[1], Meghan Owings[1], James Gray[2], and Shelia Kirk[2]. [1]KDFWR, Center for Mollusk Conservation, Frankfort, KY; [2]USFWS, Wolf Creek Hatchery, Jamestown KY.

CULTURE OF THREE SPECIES OF FRESHWATER ALGAE USED IN THE PROPAGATION OF FRESHWATER MUSSELS. Julieann Jacobs, Travis Williams, and Monte McGregor. KDFWR, Center for Mollusk Conservation, Frankfort, KY 40601

THE FRESHWATER MUSSEL REARING FACILITY AT THE MILL OF KALBORN IN LUXEMBOURG, A GUIDED TOUR. Frankie Thielen, Karin Michels, Sonja Heumann, Michel Frisch. all: natur & ëmwelt / Fondation Hëllef fir d'Natur, Kierchesstross 2, L-9753 Heinerscheid, Luxembourg.

RESPONSE OF EASTERN ELLIPTIO (ELLIPTIO COMPLANATA) POPULATIONS TO THE REINTRODUCTION OF AMERICAN EEL (ANGUILLA ROSTRATA) IN THE SUSQUEHANNA RIVER BASIN. Julie Devers[1], Heather Galbraith[2], Jeff Cole[3], and Steve Minkkinen[1]. [1]U.S. Fish and Wildlife Service, Annapolis, MD; [2]U.S. Geological Survey, Wellsboro, PA; Current address, Pennsylvania Fish and Boat Commission, Bellefonte, PA; [3]U.S. Geological Survey, Williamsport, PA

5-Minute Lightning Presentations

EFFECTS OF WATER TEMPERATURE ON GLOCHIDIA VIABILITY OF *UNIO CRASSUS* (PHILIPSSON, 1788) AND *SINANODONTA WOODIANA* (LEA, 1834): IMPLICATIONS FOR CONSERVATION, MANAGEMENT, AND CAPTIVE BREEDING. Alia Benedict[1] and Juergen Geist[1]. [1]Aquatic Systems Biology Unit, School of Life Sciences, Technical University of Munich, Muehlenweg 22, D-85354 Freising, Germany.

BEYOND RESTORATION: FRESHWATER MUSSEL GROWTH AND SURVIVAL IN STORMWATER PONDS. Kurt M. Cheng[1], Danielle A. Kreeger[1], Matthew J. Gentry[1]. [1]Partnership for the Delaware Estuary, Wilmington, DE.

AN UPDATE ON MUSSEL CULTURE AND MUSSEL-ADJACENT WORK AT GENOA NATIONAL FISH HATCHERY. Elizabeth Glidewell, Megan Bradley, and Doug Aloisi. USFWS, Genoa National Fish Hatchery, Genoa, WI.

IN VITRO-CULTURED FRESHWATER MUSSELS GROW TO MATURITY AND PRODUCE JUVENILES NATURALLY ON FISHES. Karel Douda[1], Wendell R. Haag [2], Felipe Escobar-Calderón[1], Barbora Vodáková[1], Martin Reichard[3,4,5], Xiubao Chen[6], Monte McGregor[7], Jian Yang[6] and Manuel Lopes-Lima [8,9,10]. 1 Department of Zoology and Fisheries, Czech University of Life Sciences Prague, Czech Republic; [2]US Forest Service, Southern Research Station, Frankfort, KY; [3] Institute of Vertebrate Biology, Czech Academy of Sciences, Czech Republic; [4] Department of Botany and Zoology, Masaryk University, Czech Republic; [5] Department of Ecology and Vertebrate Zoology, University of Łódź, Poland; [6] Key Laboratory of Fishery Eco-Environment Assessment and Resource Conservation in Middle and Lower Reaches of the Yangtze River, Chinese Academy of Fishery Sciences, China; [7] Kentucky Dept. of Fish & Wildlife Resources, Center for Mollusk Conservation, Frankfort, KY; [8] CIBIO/InBIO – Research Center in Biodiversity and Genetic Resources, University of Porto, Portugal; [9] CIIMAR/CIMAR – Interdisciplinary Centre of Marine and Environmental Research, University of Porto, Portugal; [10] SSC/IUCN – Mollusc Specialist Group, International Union for Conservation of Nature, United Kingdom.

GROWTH, SURVIVORSHIP, AND BYSSUS RESPONSE OF JUVENILE BLACK SANDSHELL AND MUCKET MUSSELS (BIVALVIA: UNIONIDEA) TO DIFFERENT GRADES OF SEDIMENT. Ben J. Minerich[1,2] and Seth P. Stapleton[1,3]; [1]Conservation Department, Minnesota Zoo, Apple Valley, MN; [2]College of Continuing and Professional Studies, University of Minnesota, St. Paul, MN; [3]Fisheries, Wildlife and Conservation Biology, University of Minnesota, St. Paul, MN.

WINGED MAPLELEAF (*QUADRULA FRAGOSA*) PROPAGATION EFFORTS: REVISITED. Michelle Bartsch[1], Diane Waller[1], Steve Houdek[1], Doug Aloisi[2], Megan Bradley[2], Elizabeth Glidewell[2], Mike Davis[3], Bernard Sietman[3], Madeline Pletta[3], Lindsay Ohlman[3], Zeb Secrist[3], Dan Hornbach[4], Mark Hove[5], Dan Kelner[6], Tamara Smith[7], Lisie Kitchel[8], Jesse Weinzinger[8], Nathan Eckert[9], and Marian Shaffer[10]. [1]U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI ; [2]U.S. Fish and Wildlife Service (USFWS), Genoa National Fish Hatchery, Genoa, WI; [3]Minnesota Department of Natural Resources, Center for Aquatic Mollusk Programs, Lake City, MN; [4]Macalester College, Department of Environmental Studies, St. Paul, MN; [5]University of Minnesota Department of Fisheries, Wildlife and Conservation Biology, St. Paul, MN; [6]U.S. Army Corps of Engineers, St. Paul District, St. Paul, MN; [7]USFWS, Minnesota-Wisconsin Ecological Services Field Office, Bloomington, MN; [8]Wisconsin Department of Natural Resources, Madison, WI; [9]USFWS, Neosho National Fish Hatchery, Neosho, MO; [10]St. Croix National Scenic Riverway, National Park Service, St. Croix Falls, WI.

FRESHWATER MUSSEL MASTER SUPPLEMENTATION PLAN: CHALLENGES OF RESTORING A CRYPTIC AND COMPLEX AQUATIC ORGANISM. Alexa N. Maine[1], Brian McIlraith[2], and Christine O'Brien[3]. [1]Confederated Tribes of the Umatilla Indian Reservation, Freshwater Mussel Research and Restoration Project, Walla Walla, WA. [2]HDR Engineering, Inc. [3]Browns River Consultants LLC, Waynesville, NC.

Posters

REPRODUCTIVE CHARACTERISTICS AND HOST FISH DETERMINATION OF CANOE CREEK CLUBSHELL, *PLEUROBEMA ATHEARNI*, IN BIG CANOE CREEK SYSTEM, ST. CLAIR AND ETOWAH COUNTIES, ALABAMA. Todd B. Fobian[1], Michael L. Buntin[1], and Paul D. Johnson[1]. [1]Alabama Department of Conservation and Natural Resources (ADCNR), Division of Wildlife and Freshwater Fisheries, Alabama Aquatic Biodiversity Center, Marion, AL.

COOPERATIVE PROPAGATION OF MUSSELS FOR RESTORATION IN VIRGINIA'S SOUTH RIVER. Jace Nelson[1], Jennifer Ryan[1], Rachel Mair[2], Brian Watson[3], Amy Maynard[1], Bryce Maynard[2], John-Reid Ryan[2], and Michael Odom[2]. [1]Conservation Management Institute, Virginia Polytechnic Institute & State University, Charles City, VA. [2]U.S. Fish and Wildlife Service, Charles City, VA. [3]Virginia Department of Wildlife Resources, Forest, VA.

SUCCESSFUL CULTURE OF JUVENILE WESTERN PEARLSHELL (*MARGARITIFERA FALCATA*) IN A PULSE FLOW THROUGH SYSTEM. James Kunz[1], Alexa Maine[2], and Jeff Steevens[1] United States Geological Survey, Columbia Environmental Research Center, Columbia, MO; Confederated Tribes of the Umatilla Indian Reservation, Freshwater Mussel Research and Restoration Project, Walla Walla, WA.

PROPAGATION OF FRESHWATER MUSSELS AT VIRGINIA FISHERIES AND AQUATIC WILDFLIFE CENTER FOR RESORATION IN THE DAN RIVER. John-Reid Ryan[1], Rachel Mair[1], Amy Maynard[2], Bryce Maynard[1], Brian Watson[3], Jennifer Ryan[2], Jace Nelson[2], Raquel Wetzell[4], and Michael Odom[1]. [1]U.S. Fish and Wildlife Service, Charles City, VA 23030; [2]Conservation Management Institute, Virginia Polytechnic Institute & State University, Charles City, VA 23030; [3]Virginia Department of Wildlife Resources, Forest, VA 24551; [4]Virginia Commonwealth University, Richmond, VA 23284.

FISH BEHAVIORAL RESPONSE TO LURES PRODUCED BY THE PLAIN POCKETBOOK MUSSEL (*LAMPSILIS CARDIUM*). Leonard Steinert[1] and Todd Levine[1]. [1]Carroll University, Waukesha WI.

CONSERVATION AGREEMENT AND STRATEGY FOR SPRINGSNAILS IN NEVADA AND UTAH. Chris Crookshanks[1], Jon Sjöberg[1], Eric Miskow[2], Kristen Szabo[2], Kate Holcomb[3], Kevin Wheeler[3], Larry Stevens[4], Cassie Mellon[5], Chad Mellison[6], Michael Schwemm[6], Laurel Saito[7], Rachel Van Horne[8], Matthew Phillippi[9], and John Wullschleger[10]. [1]Nevada Department of Wildlife, [2]Nevada Division of Natural Heritage, [3]Utah Division of Wildlife Resources, [4]Springs Stewardship Institute, [5]Bureau of Land Management, [6]U.S. Fish and Wildlife Service, [7]The Nature Conservancy, [8]U.S. Forest Service, [9]USDA Natural Resources Conservation Service, [10]National Park Service.

COLLABORATION IS THE KEY TO FISH LADDER PROPAGATION OF *EPIOBLASMA TRIQUETRA*. Hanna B. Muntz[1], Scott Hanshue[2], and Daelyn A. Woolnough[1]. [1]Department of Biology and Institute for Great Lakes Research, Central Michigan University, Mount Pleasant, MI, [2]Michigan Department of Natural Resources, Plainwell, MI.

Ecosystems and Community Ecology

12-Minute Traditional Presentations

EFFECTS OF *CORBICULA FLUMINEA* ON JUVENILE MUSSEL SURVIVAL AND GROWTH IN LABORATORY EXPERIMENTS. Drew White[1,4], Wendell R. Haag[2], Monte A. McGregor[3], and Steven J. Price[1]. [1]University of Kentucky, Department of Forestry and Natural Resources, Lexington, KY; [2]U.S. Forest Service, Southern Research Station, Frankfort, KY; [3]Kentucky Department of Fish and Wildlife Resources, Center for Mollusk Conservation, Frankfort, KY; [4]EcoAnalysts, Inc., O'Fallon, MO.

HABITAT PREDICTS ABUNDANCE OF FIVE FRESHWATER MUSSEL SPECIES IN MASSACHUSETTS. Ayla Skorupa[1], Allison H. Roy[2], Peter D. Hazelton[3], Andrew Fisk[4], David Perkins[5] and Timothy Warren[5]. [1]Massachusetts Cooperative Fish and Wildlife Research Unit, Department of Environmental Conservation, University of Massachusetts, Amherst, MA 01003; [2]U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, Department of Environmental Conservation, University of Massachusetts, Amherst, MA 01003; [3]University of Georgia, Daniel B. Warnell School of Forestry and Natural Resources, Athens, GA 30602; [4]Connecticut River Conservancy, Greenfield, MA 01301 [5]U.S. Fish and Wildlife Service, Cronin Aquatic Resource Center, Sunderland, MA 01375.

BIODEGRADABLE TRACER PARTICLE TO STUDY THE DISPERSAL OF LARVAL MUSSELS. Christopher Farrow[1], Loong-Tak Lim[1] & Josef Ackerman[1]. [1]University of Guelph, Guelph, ON.

ONE SHELL SHAPE TO RULE THEM ALL? THE EFFECTS OF HYDRODYNAMIC FORCES ON THE SHAPE OF FRESHWATER MUSSELS. Emile Sabeti-Mehr*[1] & Josef D. Ackerman.[1] [1]Department of Integrative Biology, University of Guelph, Guelph, ON, Canada N1G 2W1.

DOES IT TAKE A COMMUNITY TO SAVE A SPECIES? INVESTIGATING COMMUNITY INTERACTIONS AMONG AT-RISK UNIONID SPECIES IN THE GREAT LAKES BASIN. Roland A Eveleens[1], Todd J Morris[2] & Catherine M Febria[1]. [1]Great Lakes Institute for Environmental Research, University of Windsor, Windsor, Canada; [2]Fisheries and Oceans Canada, Burlington, Canada

PHYSIOLOGICAL CONDITION AND SPATIAL DISTRIBUTION OF UNIONIDS AND CORBICULIDS CO-OCCURING IN A LAURENTIAN GREAT LAKES WATERSHED, MI, USA. Nathan S. Ring[1,2] & Daelyn A. Woolnough[1].[1]Central Michigan University, Department of Biology and Institute for Great Lakes Research 1455 Calumet Ct., Mount Pleasant, MI. [2]Golder Associates Inc. 15851 South US 27 Suite 50, Lansing, MI.

STUDIES ON THE PEARLSHELL MUSSEL (*Margaritifera margaritifera*) DISCOVERED IN TWO RIVERS OF THE KENAUK FOREST (OTTAWA RIVER WATERSHED, EASTERN CANADA), AND CO-EXISTING FISH COMMUNITY INCLUDING THE BROOK TROUT (*Salvelinus fontinalis*). André L. Martel[1], Jessica Reid[5], Noel Alfonso[1], Annie Paquet[2], Sofie Hemprich[3], Jacqueline Madill[1], Katriina Ilves[1], Liane Nowell[4], Juergen Geist[3] and Steven Cooke[5] [1]Beaty Centre for Species Discovery and Zoology, Research & Collections, Canadian Museum of Nature, Ottawa, ON, Canada, [2]Ministère des Forêts, de la Faune et des Parcs, Québec, QC, Canada, [3]Technical University of Munich, Freising, Germany, [4]Kenauk Institute, Montebello, QC, Canada, [5]Environmental Science and Biology, Carleton University, Ottawa, ON, Canada

5-Minute Lightning Presentations

DIFFERENTIAL VULNERABILITY OF NATIVE AND NON-NATIVE MOLLUSKS TO PREDATION BY JUVENILE BLACK CARP. Jeremy S. Tiemann[1], Anthony P. Porreca[2], Steven E. Butler[2], and Joseph J. Parkos III[2]. [1]Illinois Natural History Survey, Prairie Research Institute at the University of Illinois, 1816 South Oak Street, Champaign, Illinois 61820 USA [2]Kaskaskia Biological Station, Illinois Natural History Survey, Prairie Research Institute at the University of Illinois, 1235 CR 1000 N, Sullivan, IL, 61951 USA.

Genetics and Phylogeny

12-Minute Traditional Presentations

GEOMETRIC MORPHOMETRIC ANALYSES AND DNA BARCODING DISTINGUISH AMONG VARIOUS GREAT LAKES FRESHWATER MUSSEL SPECIES (BIVALVIA: UNIONIDAE). Julia A. Willsie[1], Madison R. Layer[1], Tyler W. Beyett[1], Kate C. Beauchamp[1], & David T. Zanatta[1,2]. [1]Department of Biology, Central Michigan University, Mount Pleasant, MI; [2]Institute for Great Lakes Research, Central Michigan University, Mount Pleasant, MI.

GENETIC DIVERSITY MAINTAINED IN COMPARISON OF CAPTIVE-PROPAGATED AND WILD POPULATIONS OF *LAMPSILIS FASCIOLA* AND *PTYCHOBRANCHUS FASCIOLARIS* (BIVALVIA: UNIONIDAE). Nichelle M. VanTassel[1], Todd J. Morris[2], Christopher G. Wilson[3], Nicholas M. Sard[4], and David T. Zanatta[1].[1]Biology Department, Institute for Great Lakes Research, Central Michigan University, Mount Pleasant MI USA; [2] Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington ON Canada; [3]Ontario Ministry of Natural Resources and Forestry, Peterborough ON Canada, [4]State University of New York-Oswego, Oswego NY USA.

PHENOTYPIC PLASTICITY IN FRESHWATER GASTROPODS INFLUENCES SHELL SHAPE LESS THAN YOU THINK. Nathan V. Whelan[1,2]. [1]United States Fish and Wildlife Service, Auburn, AL. [2]Auburn University, Auburn, AL.

COMPARATIVE LANDSCAPE GENOMICS OF EIGHT IMPERILED MUSSEL SPECIES IN NORTH CAROLINA. Scott Meyer[1], Christian Cox[2], Rachael Hoch[3], Michael Perkins[3] & Jamie Roberts[1]. [1]Georgia Southern University, Statesboro, GA; [2]Florida International University, Miami, FL; [3]North Carolina Wildlife Resources Commission, Marion, NC.

HIGHLY STRUCTURED POPULATIONS OF *VENUSTACONCHA ELLIPSIFORMIS* REVEAL NEED FOR CONSERVATION MANAGEMENT. Kentaro Inoue[1], Bernard E. Sietman[2], Stephen E. McMurray[3], J. Scott Faiman[3], David T. Zanatta[4]. [1]John G. Shedd Aquarium, Chicago, IL; [2]Minnesota Department of Natural Resources, Lake City, MN; [3]Missouri Department of Conservation, Columbia, MO; [4]Biology Department and Institute for Great Lakes Research, Central Michigan University, Mount Pleasant, MI.

5-Minute Lightning Presentations

INSIGHTS INTO THE BIOLOGY, BIOGEOGRAPHY, CONSERVATION AND SYSTEMATICS OF PLEUROCERIDAE (GASTROPODA: CERITHIOIDEA) WITHIN A NEW PHYLOGENOMIC FRAMEWORK. Nathan V. Whelan[1,2], Paul D. Johnson[3], Jeffrey T. Garner[4], Nicole L. Garrison[2,5] and Ellen E. Strong[6]. [1]Southeast Conservation Genetics Lab, Auburn, AL; [2]Auburn University, Auburn, AL; [3]Alabama Aquatic Biodiversity Center, Marion, AL; [4]Alabama Department of Conservation and Natural Resources, Florence, AL; [5]West Liberty University, West Liberty, WV; [6]National Museum of Natural History, Washington, DC.

MOLECULAR PHYLOGENTICS OF INTERIOR HIGHLAND FUSCONAIA REVEALS EVIDENCE OF ANCIENT STREAM CAPTURE IN WESTERN OZARKS. Logan T. Phelps[1], John L. Harris[2], J. Scott Faiman[3], Stephen E. McMurray[3], & David M. Hayes[1]. [1]Eastern Kentucky University, Richmond, Ky; [2]Arkansas State University, Jonesboro, AR; [3]Missouri Department of Conservation, Columbia MO

EFFECTS OF DAMS ON FRESHWATER MUSSEL GENEFLOW IN THE RAQUETTE RIVER, NEW YORK. Olivia R. Brown[1] and Alan D. Christian[1]. [1]Clarkson University, Potsdam, NY, USA.

Posters

REDISCOVERY AND GENETIC CONFIRMATION OF THE THREERIDGE MUSSEL, *AMBLEMA PLICATA*, IN THE CHOCTAWHATCHEE RIVER, FLORIDA, USA. Lauren N Patterson[1], Susan R Geda[1], and Nathan A Johnson[2]. [1]Florida Fish and Wildlife Conservation Commission, Milton, FL; [2]U.S. Geological Survey, Gainesville, FL.

METAGENOMICS OF GILL TISSUE FROM TWO FRESHWATER MUSSEL SPECIES. Ieva Roznere[1], Heather Glon[1], and Marymegan Daly[1]. [1]Ohio State University, Columbus, OH.

BACK TO WEST TEXAS: THE VIRTUALLY UNKNOWN PHYLOGENETICS AND MORPHOMETRICS OF TEXAN *PYRGULOPSIS* POPULATIONS. Rebecca T. Chastain[1] and Kathryn Perez[1]. [1]University of Texas Rio Grande Valley, Edinburg, TX.

SPECIES DELIMITATION IN THE DOMED CAVESNAIL (*PHREATODROBIA NUGAX*) USING INTEGRATIVE TAXONOMY. Taylor B Villanueva and Kathryn E Perez. University of Texas-Rio Grande Valley, Edinburg, TX.

INVESTIGATING *TRYONIA* SPRINGSNAILS THROUGH PHYLOGENY AND MORPHOMETRICS. Houston A Glover[1] and Kathryn E Perez[1]. [1]University of Texas Rio Grande Valley, Edinburg, TX.

POPULATION GENOMIC AND SPECIES DIVERSITY IN UNIONID COMMUNITIES IN THE MOBILE BASIN, AL. Jamie Bucholz[1], Irene Sanchez Gonzalez[1], Garrett W. Hopper[1], Carla L. Atkinson[1], and Jeffrey D. Lozier[1] [1] The University of Alabama, Tuscaloosa, AL.

USING ENVIRONMENTAL DNA (eDNA) TO DETECT ENDANGERED *EPIOBLASMA TRIQUETRA* (SNUFFBOX). Dylan T. Powell[1], Jessica J. Collier[2], Katy E. Klymus[3], Daelyn A. Woolnough[1], and David T. Zanatta[1]. [1]Biology Department and Institute for Great Lakes Research, Central Michigan University, Mt. Pleasant, MI; [2]U.S. Fish and Wildlife Service, Green Bay Fish and Wildlife Conservation office, Green Bay, WI. [3]U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO.

MOLECULAR AND PHYLOGENETIC ANALYSIS OF *TRYONIA DIABOLI* AND *TEXAPYRGUS LONGELYI*. Christina Ortega[1] and Kathryn E. Perez[1]. [1]University of Texas Rio Grande Valley, Edinburg, TX, 78542, USA.

PRELIMINARY DE NOVO GENOMES AND TRANSCRIPTOMES OF FOUR UNIONID SPECIES (UNIONIDAE: *FUSCONAIA SP.* AND *VILLOSA SP.*). Joshua D. Millwood[1], Janna L. Fierst[1], Carla L. Atkinson[1], Jeffrey D. Lozier[1], and Matthew J. Jenny[1]. [1]University of Alabama, Tuscaloosa.

DOES HISTORICAL CLIMATE EXPLAIN LIMITED POPULATION STRUCTURE IN AN ENDANGERED UNIONID? Steven R. Hein[1] and David J. Berg[2]. [1]Miami University, Oxford, OH; [2]Miami University, Hamilton, OH.

GEOMETRIC MORPHOMETRIC ANALYSES REVEAL MORPHOLOGICAL VARIATION AMONG A COMPLEX OF SPHAERIID BIVALVES IN NEW MEXICO, USA. Kayla E. Childs[1], Zachary J. Samsa[2], Andrew G. Cannizzaro[2], Mary P. Jones[2], Steven R. Hein[2], Daniel A. Trujillo[3], and David J. Berg[1]. [1]Miami University, Hamilton, OH; [2]Miami University, Oxford, OH; [3]New Mexico Department of Game & Fish, Santa Fe, NM.

DEMOGRAPHIC MONITORING OF TWO SPECIES OF ENDANGERED SPRINGSNAILS (CAENOGASTROPODA: HYDROBIIDAE) USING SHELL SIZE AND MACRO-PHOTOGRAPHY. Mary P. Jones[1], Dan A. Trujillo[2], and David J. Berg[3]. [1]Miami University, Oxford, OH; [2]New Mexico Department of Game & Fish, Albuquerque, NM; [3]Miami University, Hamilton, OH.

Ecosystem Services

12-Minute Traditional Presentations

PATCH-DYNAMICS DETERMINES THE ROLE OF FRESHWATER MUSSELS ON BIOGEOCHEMICAL FLUXES. Carla L. Atkinson[1] & Kenneth Forshay[2]. [1]Department of Biological Sciences, University of Alabama, Tuscaloosa, AL; [2]Robert S. Kerr Environmental Research Center, Office of Research and Development, United States Environmental Protection Agency, Ada, OK.

ABILITY OF ASIAN CLAMS (*CORBICULA FLUMINEA*) TO CLEAR AND DIFFERENTIATE BETWEEN TOXIC BLOOM-FORMING CYANOBACTERIA AND OTHER ALGAE. Nora RW Straquadine & Christopher J Gobler. Stony Brook University Southampton, School of Marine and Atmospheric Sciences, Southampton, NY 11968.

ECOSYSTEM SERVICES OF FRESHWATER MUSSELS: BACTERIA REMOVAL BY *ANODONTA ANATINA*. Mahsa Hajisafarali, Sari Aaltonen, Katja Pulkkinen, and Jouni Taskinen. Department of Biological and Environmental Science, P.O. Box 35, 40014, University of Jyväskylä, Finland.

EMERGENT HYDRODYNAMICS AND INCREASED BED ROUGHNESS IN MUSSEL-COVERED BEDS. Brandon J Sansom[1], Sean J Bennett[2], Joseph F Atkinson[2]. [1]United States Geological Survey, Columbia Environmental Research Center, Columba, MO; [2] SUNY University at Buffalo, Buffalo, NY.

GLOCHIDIA OF THE ENDANGERED FRESHWATER PEARL MUSSEL, *MARGARITIFERA MARGARITIFERA*, LOWER VIRULENCE OF A FISH PATHOGEN. M. Motiur R. Chowdhury[1], Amitav Roy[1], Kalle Auvinen[2], Katja Pulkkinen[1], Hanna Suonia[1] and Jouni Taskinen[1]. [1]Department of Biological and Environmental Science & [2]Department of Mathematics and Statistics, University of Jyväskylä, P.O. Box 35, FI-40014 University of Jyväskylä, Finland.

FRESHWATER MUSSEL BED ASSEMBLAGE STRUCTURE GOVERNS THE FLUX AND STOICHIOMETRY OF LOCALLY AVAILABLE ORGANIC AND INORGANIC NUTRIENTS IN RIVERS. Garrett W. Hopper, Shuo Chen, Irene Sanchez Gonzalez, Jamie Bucholz, Yuhan Lu, Carla L. Atkinson. University of Alabama, Tuscaloosa, AL, USA.

5-Minute Lightning Presentations

NEAR REAL-TIME TRACKING OF MUSSEL FILTRATION AND CLEARANCE RATES: A REVIEW OF THE BENEFITS AND DOWNFALLS OF USING A BECKMAN-COULTER MULTISIZER. Meredith L. Shehdan[1], Sean B. Buczek[2], and W. Gregory Cope[1]. [1]North Carolina State University, Raleigh, NC; [2]North Carolina Department of Environmental Quality, Raleigh, NC.

METHODS FOR MEASURING BIOENERGETIC PARAMETERS OF SMALL BIVALVES. Evelyn Pieper[1], Wendell Haag[2], and James Stoeckel[1]. [1]Auburn University, Auburn, AL; [2] US Forest Service, Southern Research Station, Frankfort, KY.

MUSSELS IN THEIR ELEMENT: MUSSEL BEDS ASSOCIATED WITH CHANGES IN MACRO- AND MICRONUTRIENT AVAILABILITY. Jonathan W. Lopez[1,2], Rachel N. Hartnett[3], Thomas B. Parr[4], and Caryn C. Vaughn[1,2]. [1]Department of Biology, University of Oklahoma, Norman, OK; [2]Oklahoma Biological Survey, Norman, OK; [3]Department of Integrative Biology, Oklahoma State University, Stillwater, OK; [4]U.S. National Park Service, Ashland, WI.

Posters

DO NATIVE AND INVASIVE FRESHWATER BIVALVES DIFFERENTIALLY INFLUENCE MICROBIALLY MEDIATED LITTER DECOMPOSITION DYNAMICS? AN EXPERIMENTAL APPROACH. Matthew B. Lodato[1] and Carla L. Atkinson[1]**.** University of Alabama[1]**.**

FRESHWATER MUSSELS: AN INTEGRAL LINK BETWEEN BROWN AND GREEN FOOD WEBS. Megan E. Kubala[1], Garrett W. Hopper[1], Irene Sanchez Gonzalez[1], and Carla L. Atkinson[1]. [1]The University of Alabama, Tuscaloosa, AL.

EFFECTS OF MUSSEL PHYSICAL ACTIVITY ON N-REMOVAL POTENTIAL. Madison Knapp[1], Megan Kubala[1], and Carla L. Atkinson[1]. [1]University of Alabama, Tuscaloosa, AL.

Contaminants and Ecotoxicology

12-Minute Traditional Presentations

ASSESSING THE RELATIVE TOXICITY OF ROAD SALT ALTERNATIVES TO FRESHWATER MUSSEL GLOCHIDIA. Patricia L. Gillis[1], Joseph Salerno[1], C. James Bennett[1], Yaryna Kudla[1], and Margo Smith[2]; [1]Aquatic Contaminants Research Division, Environment and Climate Change Canada, Burlington, ON, Canada; [2]Species at Risk Program, Department of Fisheries and Oceans, Burlington, ON, Canada.

WASTEWATER TREATMENT OUTFALL AS A LIMITING FACTOR TO FRESHWATER MUSSEL REINTRODUCTION AND RECOLONIZATION. Kristin A. Stockton. West Virginia University, Morgantown, WV.

BUT FIRST, LET ME TAKE A 'SHELL-FIE': ASSESSING METAL TOXICITY IN SNAIL EMBRYOS USING TIME-LAPSED PHOTOGRAPHY. Rebecca K. Osborne[1], Carmen Venier[1], & Ryan S. Prosser[1]. 1 University of Guelph, Guelph, ON, CAN.

FUNCTIONAL PROCESSING OF TOXIC HEAVY METALS BY MUSSELS: IMPLICATIONS FOR FRESHWATER ECOLOGY AND ECOSYSTEM SERVICE DELIVERY. Jennifer M. Archambault[1], Meredith L. Shehdan[1], Clayton L. Lynch[1], Sean B. Buczek[2], and W. Gregory Cope[1]. [1]Department of Applied Ecology, North Carolina State University, Raleigh, NC; [2]North Carolina Division of Environmental Quality, Raleigh, NC. *Current affiliation: US Fish and Wildlife Service, Ecological Service Field Office, Raleigh, NC.

RECRUITMENT IMPACTS OF CONTAMINANTS OF EMERGING CONCERN: SIMULATING POPULATION DYNAMICS BASED ON EMPIRICAL EXPOSURE STUDIES. Lacey D. Rzodkiewicz [1,2], Mandy Annis[3] and Daelyn A. Woolnough[1]. [1]Department of Biology and Institute for Great Lakes Research, Central Michigan University, Mt. Pleasant, MI, 48859. [2] Department of Biological Sciences, University of Pittsburgh, Pittsburgh, PA, 15260. [3] US Fish & Wildlife Service, Michigan Ecological Services Field Office, 2651 Coolidge Road, Suite 101, East Lansing, MI, 48823.

ASSESSMENT OF IMPACTS TO MUSSEL COMMUNITY STRUCTURE FROM A NEW INDUSTRIAL DISCHARGE IN THE UPPER SABINE RIVER, TEXAS. Clinton R Robertson[1] & Adam Whisenant[2]. [1]Texas Parks and Wildlife Department - River Studies Program, San Marcos, TX; [2]Texas Parks and Wildlife Department – Water Quality Program, Tyler, TX.

5-Minute Lightning Presentations

COMPARATIVE TOXICITY ASSESSMENT OF MUNICIPAL EFFLUENT AND RAINFALL OVERFLOW DISCHARGE SITES IN *ELLIPTIO COMPLANATA* USING A NOVEL QPCR ARRAY APPROACH. Chantale André and François Gagné. Aquatic Contaminants Research Division, Environment and Climate Change Canada, Montréal, Québec.

Posters

CAN CRAPPY WATER QUALITY GROW MUSSELS? A MUSSEL GROWTH ANALYSIS OF PAINT LICK CREEK. Taylor Fagin[1], Caroline Chan[2], Chelsea Durbin[2], and Marty Marchaterre[1]. [1]Copperhead Environmental Consulting, Paint Lick, KY; [2]Kentucky Division of Water, Frankfort, KY.

METHODS FOR TESTING THE INFLUENCE OF CONTAMINANTS OF EMERGING CONCERN ON THE LIFE CYCLE OF NATIVE FRESHWATER MUSSELS. Mandy Annis[1] and Daelyn A. Woolnough[2] [1]US Fish & Wildlife Service, Michigan Ecological Services Field Office, 2651 Coolidge Road, Suite 101, East Lansing, MI, 48823., [2]Department of Biology and Institute for Great Lakes Research, Central Michigan University, Mt. Pleasant, MI, 48859.

EVALUATION OF CHRONIC SENSITIVITY OF A FRESHWATER MUSSEL USING PARTIAL LIFE-CYCLE TOXICITY TEST AND LONG-TERM TOXICITY TEST. Ning Wang[1], James L. Kunz[1], Danielle M Cleveland[1], Jeffery A Steevens[1], Sandy Raimondo[2], Tom Augspurger[3], and M. Chris Barnhart[4]. [1]US Geological Survey, Columbia, MO; [1]US Environmental Protection Agency, Gulf Ecology Division, Gulf Breeze, FL; [3]US Fish and Wildlife Service, Raleigh, NC; [4]Missouri State University, Springfield, MO.

DO MUSSELS BIOACCUMULATE THE FOREVER CHEMICAL, PFAS, DIFFERENTLY THAN OTHER AQUATIC ORGANISMS? Jeffery A Steevens[1], Rebecca Dorman[1], Nile Kemble[1], James Kunz[1], Rebecca Burket[2], Kevin Stroski[2], Jaylen Sims[2], and Bryan Brooks[2]. [1]U.S. Geological Survey, Columbia, MO; [2]Baylor University, Waco, TX

Outreach, Education and Inclusion

12-Minute Traditional Presentations

R SHINY: A SHINY INNOVATIVE TOOL FOR OUTREACH AND COLLABORATION. Kiara C. Cushway[1,2], Amanda J. Chambers[3], Nathan S. Ring[1,4] & Daelyn A. Woolnough[1]. [1]*Central Michigan University, Department of Biology and Institute for Great Lakes Research 1455 Calumet Ct., Mount Pleasant, MI;* [2]*Central Michigan University, Honors Program, Mount Pleasant, MI;* [3]Michigan Department of Environment, Great Lakes, and Energy, Lansing, MI. [4]Golder Associates Inc. 15851 South US 27 Suite 50, Lansing, MI.

THE EXTREME CLIFFS NOTES FOR TRAINING NEW MUSSEL HEADS: 5 STEPS FOR DEVELOPING EFFECTIVE HANDS-ON TRAINING IN FRESHWATER MUSSEL CONSERVATION. Matthew Patterson. United States Fish and Wildlife Service, National Conservation Training Center. Shepherdstown, West Virginia.

PUBLIC UNDERSTANDING OF NATURE'S INFLUENCES ON WATER QUALITY AND IMPLICATIONS FOR COMMUNICATING ABOUT ECOSYSTEM SERVICES. Jennifer M. Archambault[1], Catherine E. LePrevost[2], W. Gregory Cope[2], and Jane L. Harrison[3]. [1]US Fish and Wildlife Service, Ecological Services Field Office, Raleigh, NC; [2]Department of Applied Ecology, North Carolina State University, Raleigh, NC; [3]North Carolina Sea Grant, Raleigh, NC.

ESTABLISHING A BASELINE FOR SOCIETY DEMOGRAPHICS AND ATTITUDES TOWARDS DIVERSITY, EQUITY, AND INCLUSIVENESS. Sara R Andree[1], Megan E Bradley[2], Kentaro Inoue[3], John Pfeiffer[4], Tamara A Smith[5], Jeremy S Tiemann[6]. [1]Kentucky Division of Water, Frankfort, KY; [2]U.S. Fish and Wildlife Service, Genoa, WI; [3]Shedd Aquarium, Chicago, IL; [4]National Museum of Natural History, Washington, D.C.; [5]U.S. Fish and Wildlife Service, Bloomington, MN; [6]Illinois Natural History Survey, Champaign, IL.

HOW DO ARTISTS UTILIZE CONSERVATION RESEARCH TO INFORM CONCERNED PUBLICS? Laura C. Carlson. Program Coordinator, Art and Ecology Program, Department of Art, University of New Mexico, Albuquerque, NM.

5-Minute Lightning Presentations

INCLUSIVE AND EXCITING CHANGES TO THE FMCS WEBSITE. Nora RW Straquadine. FMCS Website Manager. Stony Brook University Southampton, School of Marine and Atmospheric Sciences, Southampton, NY 11968. nrstraquadine@gmail.com

Climate Change and Human Impacts

12-Minute Traditional Presentations

ARE PEAK STREAM FLOWS SHRINKING HABITAT FOR WESTERN PEARLSHELL MUSSELS IN THE STILLAGUAMISH WATERSHED? Franchesca Perez, Stillaguamish Tribe of Indians, Arlington, WA.

THERMAL TOLERANCES OF *POPENAIAS POPEII* (TEXAS HORNSHELL) AND THEIR HOST FISH FROM THE RIO GRANDE BASIN, TEXAS: A RELATIONSHIP IN JEOPARDY. Xenia L. Rangaswami[1], Amanda M. Goldsmith[1], Jennifer M. Khan[2], Clinton R. Robertson[3], Roel Lopez[1], & Charles R. Randklev[1]. [1]Texas A&M Natural Resources Institute, Texas A&M AgriLife Research Center at Dallas, Dallas, TX; [2]U.S. Fish & Wildlife Service, Arlington, TX; [3]Texas Parks & Wildlife Department, River Studies Program, San Marcos, TX.

THE EFFECTS OF MULTIPLE STRESSORS ON THE ECOPHYSIOLOGY OF *LAMPSILIS SILIQUOIDEA*: EFFECTS AND INTERACTIONS AMONG WATER TEMPERATURE, VELOCITY AND SUSPENDED SOLID CONCENTRATION. Kirsten M Luck[1] & Josef D Ackerman[1]. [1]University of Guelph, Guelph, ON.

EVALUATING THE THERMAL TOLERANCE OF AQUATIC INVERTEBRATES USING AEROBIC SCOPE. Kaelyn J. Fogelman[1], Aya S. Hussain[1,2], Kayla Boyd[1], Patrick Jordan[1], Hisham A. Abdelrahman[1,3], Luke A. Roy[1] and James Stoeckel[1]. [1]Auburn University, Auburn, AL, USA; [2]Suez University, Suez, Egypt; [3]Cairo University, Giza, Egypt.

USING UPPER THERMAL LIMITS OF *LAMPSILIS BRACTEATA* (TEXAS FATMUCKET) FROM THE NORTH LLANO AND SAN SABA RIVERS, TEXAS TO INFORM WATER MANAGEMENT PRACTICES IN THE EDWARDS PLATEAU. Amanda Goldsmith[1], Jennifer M. Khan[2], Clinton R. Robertson[3], Roel Lopez[1], & Charles R. Randklev[1]. [1] Texas A&M Natural Resources Institute, Texas A&M AgriLife Research Center at Dallas, Dallas, TX; [2] U.S. Fish & Wildlife Service, Arlington, TX; [3] Texas Parks & Wildlife Department, River Studies Program, San Marcos, TX.

Invasive Mollusks

12-Minute Traditional Presentations

IN THE FOOTSTEPS OF EILEEN JOKINEN: RECENT PROGRESS IN UNDERSTANDING INVASIVE GASTROPODS IN THE ADIRONDACK PARK. Andrew A. David. Clarkson University, Potsdam, New York.

IMPACTS OF ZEBRA MUSSELS ON TEXAS UNIONID MUSSELS. Ericah D. Beason, Astrid N. Schwalb. Biology Department, Texas State University, San Marcos, TX 78666.

"ENEMY RELEASE" OF INVASIVE FRESHWATER MUSSELS. Binglin Deng[1], Pin Nie[2], Jouni Taskinen[1], Maria Urbańska[3], Nicoletta Riccardi[6], Fabio Ercoli[1,4], Wojciech Andrzejewski[3], Małgorzata Ożgo[5], Jocelyn M. Choo[1]. [1]Department of Biological and Environmental Science, P.O. Box 35, 40014, University of Jyväskylä, Finland; [2]State Key Laboratory of Freshwater Ecology and Biotechnology, Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan 430072, China; [3]Institute of Zoology, Poznań University of Life Sciences, ul. Wojska Polskiego 28, 60-637 Poznań, Poland; [4]Chair of Hydrobiology and Fishery, Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences, Kreutswaldi 5, 51006 Tartu, Estonia; [5]Department of Evolutionary Biology, Kazimierz Wielki University, Ossolińskich 12, 85-093 Bydgoszcz, Poland; [6]CNR Institute of Water Research, Largo Tonolli 50, 28922 Verbania, Pallanza, Italy.

SEXUAL DIFFERENTIATION IN SOMATIC GROWTH WITHIN *LAMPSILIS CARDIUM* (BIVALVIA: UNIONIDAE), AS A FUNCTION OF ENVIRONMENTAL IMPACTS. Mariah Scott[1] and Rüdiger Bieler[2]. [1] University of Chicago, Chicago, IL; [2] Field Museum, Chicago, IL.

DISTRIBUTIONS AND HABITAT MODELING OF NATIVE AND INVASIVE MUSSELS IN TWO LARGE RIVER SYSTEMS. Shay S. Keretz[1], Daelyn A. Woolnough[1], Todd J. Morris[2], and David T. Zanatta[1] [1]Department of Biology and Institute for Great Lakes Research, Central Michigan University, Mount Pleasant, Michigan, USA, 48859 [2]Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, Ontario, Canada, L7S 1A1.

***CORBICULA* EFFECTS ON SURVIVORSHIP, GROWTH, AND DRIFT OF JUVENILE *LAMPSILIS SILIQUOIDEA* IN LABORATORY EXPOSURES.** Allison N. Sieja & Chris Barnhart. Missouri State University, Springfield, MO.

MAPPING INVASIVE GASTROPOD OCCURRENCES IN NATIVE GASTROPOD HOTSPOTS ACROSS THE UNITED STATES. Cayla Morningstar[1] & Wesley Daniel[2]; Cherokee Nation System Solutions[1], U.S. Geological Survey[2]; Wetland and Aquatic Research Center, 7920 NW 71st Street, Gainesville, Florida 32653

THE VALUE OF HORIZON SCANS: LOOKING FOR FUTURE THREATS TO NATIVE MOLLUSKS IN U.S. WATERS. Wesley Daniel[1], Cayla Morningstar[2], Lindsey Reisinger[3], Jennifer Howeth[4] & Deah Lieurance[5]; U.S. Geological Survey; Wetland and Aquatic Research Center, 7920 NW 71st Street, Gainesville, Florida 32653[1]; Cherokee Nation Strategic Solutions; Wetland and Aquatic Research Center, 7920 NW 71st Street, Gainesville, Florida 32653[2]; University of Florida; School of Forest Resources and Conservation, Fisheries and Aquatic Sciences Program, 7922 NW 71st St, Gainesville, FL 32653[3]; University of Alabama, Department of Biological Sciences, 1106 Bevill Building, 201 7th Ave. Tuscaloosa, AL 35487[4]; University of Florida[5]

5-Minute Lightning Presentations

NONINDIGENOUS AQUATIC MOLLUSKS IN ILLINOIS. Jeremy S. Tiemann[1], Alison P. Stodola[1], Sarah A. Douglass[1], Rachel M. Vinsel[1], and Kevin S. Cummings[1]. [1]Illinois Natural History Survey, Prairie Research Institute at the University of Illinois, 1816 South Oak Street, Champaign, Illinois 61820.

Posters

HIGHER DENSITY OF INVASIVE CLAM (*CORBICULA FLUMINEA*) CONTRIBUTES MORE TO NUTRIENT AVAILABILITY THAN NATIVE MUSSELS. Jonathan Buchanan, Garrett W. Hopper, and Carla L. Atkinson. Department of Biological Sciences, University of Alabama, Tuscaloosa, AL, USA

DISTRIBUTION OF *CORBICULA FLUMINEA* AND FRESHWATER MUSSELS ACROSS SPATIAL SCALES. Taylor Kelley[1], Garrett Hopper[1], and Carla Atkinson[1]. Department of Biological Science, University of Alabama, Tuscaloosa, AL

Mollusk Disease, Parasitism, and Die-Offs

12-Minute Traditional Presentations

UNDERSTANDING MUSSEL MICROBIOMES: RELATIONSHIPS BETWEEN VIRAL AND BACTERIAL COMMUNITIES FROM FRESHWATER MUSSEL MORTALITY EVENTS. Jordan C. Richard[1,2], Eric Leis[3], Joel G. Putnam[4], Diane L. Waller[4],Susan Knowles[5], and Tony L. Goldberg[6,7]. [1]U.S. Fish and Wildlife Service, Southwestern Virginia Field Office, 330 Cummings Street, Abingdon, VA, 24210, [2]Department of Freshwater and Marine Science, University of Wisconsin-Madison, [3]La Crosse Fish Health Center, Midwest Fisheries Center, U.S. Fish and Wildlife Service, 555 Lester Ave, Onalaska, WI, 54650. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, 2630 Fanta Reed Rd, La Crosse WI, 54603, [5]U.S. Geological Survey, National Wildlife Health Center, 6006 Schroeder Rd, Madison, WI 53711. [6]Department of Pathobiological Sciences, University of Wisconsin-Madison, 1656 Linden Drive, Madison WI 53706, [7]Global Health Institute, University of Wisconsin-Madison, 1300 University Avenue, Madison WI 53706

THE POPULATION-LEVEL CONSEQUENCES OF PARASITISM IN FRESHWATER MUSSELS: FIELD DATA AND A CONCEPTUAL HYPOTHESIS. Joshua I. Brian[1], Sebastian Dunne[1], Christine L Ellis[1] & David C Aldridge[1]. [1]University of Cambridge, Cambridge, UK

METABOLOMIC CHARACTERIZATION OF PHEASANTSHELL MUSSEL (*ACTINONAIAS PECTOROSA;* ORDER UNIONIDA) FROM A MORTALITY EVENT IN THE CLINCH RIVER, VA AND TN. Joel G. Putnam[1], John N. Steiner[1], Diane L. Waller[1*],Jordan C. Richard,[2,4] Eric Leis[3], Christopher D. Dunn[4], Rose Agbalog[2] and Susan Knowles,[5] and Tony L. Goldberg[4,6] . [1]U.S. Geological Survey, Upper Midwest Environmental Sciences Center. [2]U.S. Fish and Wildlife Service, Southwestern Virginia Field Office. [3]La Crosse Fish Health Center, Midwest Fisheries Center, U.S. Fish and Wildlife Service.[4]Department of Pathobiological Sciences, University of Wisconsin-Madison. [5]U.S. Geological Survey, National Wildlife Health Center. [6]Global Health Institute, University of Wisconsin-Madison.

Posters

HISTOPATHOLOGY OF FREE-LIVING POPULATIONS OF THREE SPECIES OF FRESHWATER BIVALVES IN INDIANA. Grant N. Burcham[1,3], Brant Fisher[2], and Nancy Boedeker[2,3]. [1]Animal Disease Diagnostic Laboratory, College of Veterinary Medicine, Purdue University, [2]Indiana Department of Natural Resources, [3]Department of Comparative Pathobiology, College of Veterinary Medicine, Purdue University

Natural History Collections

12-Minute Traditional Presentations

PATTERNS OF U.S. FRESHWATER MUSSEL COLLECTING. John M Pfeiffer[1] and Traci P DuBose[2]. [1] Smithsonian Institution, National Museum of Natural History, Washington, [2] Department of Biological Sciences, Virginia Tech, Blacksburg, VA.

5-Minute Lightning Presentations

NEW DIGS FOR A REGIONAL MOLLUSK COLLECTION: UPDATE ON THE BRANLEY A. BRANSON MUSEUM OF ZOOLOGY AT EASTERN KENTUCKY UNIVERSITY. Aaron L. Devine[1] and David M. Hayes[1]. [1]Eastern Kentucky University, Richmond, KY.

STEP BY STEP, BIT BY BIT, SHELL BY SHELL, THE MOLLUSKS WERE (MOSTLY) MOVED. Alison P. Stodola[1], Rachel M. Vinsel[1], Jeremy S. Tiemann[1], Sarah A. Douglass[1], and Kevin S. Cummings[1]. [1]Illinois Natural History Survey, Prairie Research Institute, University of Illinois.

MUSSEL MEMORY: DIGITIZATION OF THE UNIONOIDA AT THE BUFFALO MUSEUM OF SCIENCE. Marisa C Turk[1], Paige R Langle[1], and Isabel P Hannes[1]. Buffalo Museum of Science, Buffalo, NY.

FMCS Committees

5-Minute Lightning Presentations

OVERVIEW OF THE FRESHWATER MOLLUSK CONSERVATION SOCIETY'S PROPAGATION AND RESTORATION COMMITTEE. Rachael A Hoch[1], Tim W. Lane[2], & Madeline E. Pletta[3]. [1]North Carolina Wildlife Resources Commission, Marion, NC; [2]Virgina Department of Wildlife Resources, Marion, VA; [3]Minnesota Department of Natural Resources, Lake City, MN.

SUMMARY OF THE PURPOSE AND ACTIVITIES OF THE FMCS GENETICS COMMITTEE. Kevin J. Roe[1], David Zanatta[2], (on behalf of the committee). [1]Iowa State University, Ames, IA. [2]Institute for Great Lakes Research, Central Michigan University, Mount Pleasant, MI.

EXPLORING THE FRESHWATER MOLLUSK CONSERVATION SOCIETY'S OUTREACH COMMITTEE. Amy Maynard[1], Daniel Symonds[2], and Jennifer Archambault[3]. [1]Conservation Management Institute, Virginia Polytechnic & State University, Charles City, VA 23030; [2]Stantec Consulting, Cincinnati, OH 45241; [3]US Fish and Wildlife Service, Ecological Services Field Office, Raleigh, NC 27636.

ROLES AND ACTIVITIES OF THE GASTROPOD STATUS AND DISTRIBUTION COMMITTEE. Nathan V. Whelan[1,2] and Wesley Daniel[3]. [1]United States Fish and Wildlife Service, Auburn, AL; [2]Auburn University, Auburn, AL; [3]United States Geological Survey, Gainesville, FL 32653.

FRESHWATER MOLLUSKS: WHAT ARE THEY GOOD FOR? ABSOLUTELY ECOSYSTEM SERVICES! Carla L. Atkinson[1], Garrett W. Hopper[1], Astrid Schwalb[2], Jennifer Archambault[3], Danielle Kreeger[4], and Caryn C. Vaughn[5]. [1]Dept. of Biological Science, University of Alabama; [2]Biology Department, Texas State University, San Marcos, TX; [3]US Fish and Wildlife Service, Raleigh Ecological Services Field Office; [4]Partnership for the Delaware Estuary; [5]Oklahoma Biological Survey & Department of Biology, University of Oklahoma.

Full Abstracts

(Listed Alphabetically by Author)

COMPARATIVE TOXICITY ASSESSMENT OF MUNICIPAL EFFLUENT AND RAINFALL OVERFLOW DISCHARGE SITES IN *ELLIPTIO COMPLANATA* USING A NOVEL QPCR ARRAY APPROACH

Chantale André and François Gagné. Aquatic Contaminants Research Division, Environment and Climate Change Canada, Montréal, Québec.

Municipal effluents have the potential to disrupt the endocrine system involved in reproduction in aquatic organisms. During heavy rainstorm or snowstorms, the volume of water sometime exceeds the wastewater treatment plant's capacity thus activating overflow points that redirect untreated sewage into waterways. In the context of climate changes, increased events and severity of rainfall overflows are expected to occur. The purpose of this study was to develop a novel quantitative polymerase chain reaction (qPCR) array for the freshwater mussel *Elliptio complanata* to compare the toxic properties of municipal effluents and rainfall overflows. Mussels were caged for 3 months at upstream and downstream sites of a municipal effluent discharge point and at 2 rainfall overflow sites in the Saint-Lawrence River. The data revealed that exposure to municipal effluents and overflow sites lead to increased expression of vitellogenin (VTG) in male mussels, altered sexual differentiation in females, gene expression involved in oxidative stress (superoxide dismutase, glutathione S-transferase) and DNA damage (chromosome mismatch and repair of covalently-bound DNA adducts). Mussels at the downstream site also accumulated large amounts of heterotrophic bacteria but not at the overflow sites. However, mussels at the overflow sites had decreased expression in ABC transporter gene expression. In conclusion, exposure to rainfall overflow sites have similar effects to municipal effluents based on VTG and oxidative stress responses at the transcriptomic level. Genes involved in gametogenesis (NASP, VTG, PCH2), oxidative stress and DNA damage were the most important responses under multivariate analyses where rainfall overflow sites differed from the responses of downstream sites especially in respect to SOD, NOS and PCH2 gene expressions. Further research is underway to examine more closely the influence of rainfalls over the years.

ESTABLISHING A BASELINE FOR SOCIETY DEMOGRAPHICS AND ATTITUDES TOWARDS DIVERSITY, EQUITY, AND INCLUSIVENESS.

Sara R Andree[1], Megan E Bradley[2], Kentaro Inoue[3], John Pfeiffer[4], Tamara A Smith[5], Jeremy S Tiemann[6]. [1]Kentucky Division of Water, Frankfort, KY; [2]U.S. Fish and Wildlife Service, Genoa, WI; [3]Shedd Aquarium, Chicago, IL; [4]National Museum of Natural History, Washington, D.C.; [5]U.S. Fish and Wildlife Service, Bloomington, MN; [6]Illinois Natural History Survey, Champaign, IL.

The need to broaden the accessibility of biological sciences as an educational resource and a potential career has become increasingly apparent in recent years. Race, ethnicity, sexual orientation, and ability (among other factors) tend to lack diverse representation in the sciences, and the Freshwater Mollusk Conservation Society (FMCS) is no exception. As a first step in quantifying this lack of representation, the Diversity, Equity, and Inclusiveness (DEI) committee distributed a survey assessing current demographics as well as attitudes of FMCS members with regard to past, current, and future policies and activities. The survey included 17 multiple choice questions and one open-ended opportunity for comment. In total, 122 survey responses were collected, and 56 of those participants submitted comments. Demographic questions confirmed that >90% of FMCS survey participants were straight, white, and with no identified disability. Additionally,

over 85% had received a 2- or 4-year graduate degree. Gender was evenly split between male and female. Age and years of experience were evenly distributed across multiple categories. When it came to attitudes, most members felt that the Society was a safe and tolerant environment, although in general members agreed that there was a need for more diverse participation within the Society. The two most common suggestions for improvement were to increase outreach to diverse communities at young ages and to increase funding for scholarships, travel grants, or mentoring opportunities. The DEI committee plans to repeat this survey biennially to track changes in demographics and attitudes. Comments collected from this survey will help direct future efforts of the DEI committee. This survey will also help FMCS plan activities, encourage a more representative member base, and facilitate discussions on relevant topics within the Society.

METHODS FOR TESTING THE INFLUENCE OF CONTAMINANTS OF EMERGING CONCERN ON THE LIFE CYCLE OF NATIVE FRESHWATER MUSSELS.

Mandy Annis[1] and Daelyn A. Woolnough[2] [1]US Fish & Wildlife Service, Michigan Ecological Services Field Office, 2651 Coolidge Road, Suite 101, East Lansing, MI, 48823., [2]Department of Biology and Institute for Great Lakes Research, Central Michigan University, Mt. Pleasant, MI, 48859.

Unionids are declining globally due to a variety of reasons including the potential effects of contaminants. Contaminants of emerging concern (CECs) is a term used to define a large class of chemicals for which regulatory levels, to avoid impacts on aquatic life, have not yet been established. CECs include chemicals such as pharmaceuticals, current use agricultural and industrial chemicals, and personal care products. Unionids' unique life cycle, including the obligate parasitic larval stage on host fish, are vulnerable at multiple stages to the impact(s) of CECs. We performed controlled laboratory experiments with *Lampsilis cardium* and host fish, *Micropterus salmoides*, to consider the influence of representative urban and agricultural CEC mixtures which mirrored a subset of common chemicals and concentrations found in the rivers of Great Lakes watersheds. Chronic 100- and 40-day exposures of mixes to gravid *L. cardium* and host fish were performed at ecological concentrations (x) as well as levels of 1/10x and 10x. This novel approach mimicked multiple chronic waterborne life stage exposure of mussel adults, brooding glochidia, pre- and post- parasitic glochidia, host fish, and transformed juvenile mussels. Additionally, 21-day exposures of of adult unionids to natural waters of varying CEC gradients in both agricultural and urban watersheds were performed streamside. We considered a suite of traditional mussel and fish health endpoints as well as possible emerging biological and behavioral endpoints for mussels. We will highlight our lessons learned and which parameters were valuable in explaining potential influences of CECs. We will highlight the inherent variability we observed in these experiments due to the rarity of these organisms and limited unionid biomarkers. Methods used during these studies provide insights to future mussel toxicology and conservation research and will aid in determining possible reasons for the mussel declines.

PUBLIC UNDERSTANDING OF NATURE'S INFLUENCES ON WATER QUALITY AND IMPLICATIONS FOR COMMUNICATING ABOUT ECOSYSTEM SERVICES.

Jennifer M. Archambault[1], Catherine E. LePrevost[2], W. Gregory Cope[2], and Jane L. Harrison[3]. [1]US Fish and Wildlife Service, Ecological Services Field Office, Raleigh, NC; [2]Department of Applied Ecology, North Carolina State University, Raleigh, NC; [3]North Carolina Sea Grant, Raleigh, NC.

Aquatic species are integral to ecosystem functioning and maintenance of water quality. The public, however, may not readily perceive many aquatic species and therefore may not realize species' relevance in regulating healthy waterways for human use and well-being. Because an understanding of community values is critical in promoting effective watershed management, it is imperative to discern how aquatic resources are valued by human communities. Social science research methods are increasingly employed to investigate public understanding and beliefs about conservation and natural resource issues. A first step in understanding community valuation of ecosystem services related to water quality is investigating perceptions of water quality's mediating factors. We engaged 57 residents of central and eastern North Carolina in six focused small group discussions, using a series of photographs of plants and animals, including freshwater mollusks, to examine communities' beliefs about whether and how those flora and fauna relate to maintenance of water quality. Several prevailing themes emerged from the focus group discussions, including positive effects that flora and fauna have on water quality, dualistic "good and bad" or negative effects, flora and fauna as indicators of water quality, and balance in nature. Participants also expressed uncertainty at times, and we identified a number of misconceptions. Participants regularly relied on their prior experiences to explain their understanding of factors affecting water quality. Our findings show that people identified several effects that flora and fauna have on water quality, including ecosystem functions that provide essential ecosystem services (e.g., regulating services, such as water purification through filtering and cleaning). These findings suggest an encouraging congruence of public beliefs with expert science, offering some common ground, similar language, and opportunities for connecting with communities on important issues that highlight or threaten ecosystem functioning and the resulting ecosystem services that link environmental and human well-being.

FUNCTIONAL PROCESSING OF TOXIC HEAVY METALS BY MUSSELS: IMPLICATIONS FOR FRESHWATER ECOLOGY AND ECOSYSTEM SERVICE DELIVERY.

Jennifer M. Archambault[1]*, Meredith L. Shehdan[1], Clayton L. Lynch[1], Sean B. Buczek[2], and W. Gregory Cope[1]. [1]Department of Applied Ecology, North Carolina State University, Raleigh, NC; [2]North Carolina Division of Environmental Quality, Raleigh, NC. *Current affiliation: US Fish and Wildlife Service, Ecological Service Field Office, Raleigh, NC.

The functional ecology of freshwater mussels (Unionida) is essential to the ecological integrity of freshwater ecosystems. Because these ecosystems are inundated with exogenous compounds, we explored the functional role of mussels in ecological partitioning of pollutants. We conducted 28-d laboratory experiments exposing mussels to environmentally relevant concentrations of Ni (0 to 100 µg/L) and Cd (0 to 2

µg/L) – two toxic heavy metals of both human and environmental health concern. We evaluated the percentage of metals mussels removed from water; how much was egested in biodeposits; how filtration rates were affected by metal exposure; and finally, how these estimates were affected by metal concentration or exposure duration. Mussels removed up to 36% of waterborne Ni and up to 77% of waterborne Cd. Mussels also bound and bioconcentrated metals in egested materials (e.g., feces). [Ni] in biodeposits were 2 to 7X higher than exposure concentrations, and [Cd] in biodeposits were 7 to 40X higher. These pollutant-processing functions varied significantly over 28 d, and changes in functional processing manifested differently for Ni and Cd. Mussels were more efficient at processing Ni at lower concentrations (i.e., when exposed to less pollution), while the duration of exposure was an important factor for Cd processing. Moreover, this ability of mussels to influence the environmental fate and transport of metals was in turn affected by the metal concentrations to which they were exposed. Metal exposure reduced filtration capacity, and filtration rates were affected differently under the stress of both metals combined compared to just Ni or Cd, suggesting that pollution may impede other beneficial ecosystem services that mussels provide. This research demonstrates the active role of mussels in environmental fate and transport of toxic heavy metals in aquatic ecosystems, and that pollution negatively affects freshwater mussel filtration and the ecosystem services they provide.

PATCH-DYNAMICS DETERMINES THE ROLE OF FRESHWATER MUSSELS ON BIOGEOCHEMICAL FLUXES.

Carla L. Atkinson[1] & Kenneth Forshay[2]. [1]Department of Biological Sciences, University of Alabama, Tuscaloosa, AL; [2]Robert S. Kerr Environmental Research Center, Office of Research and Development, United States Environmental Protection Agency, Ada, OK.

Freshwater mussels occur in spatially heterogeneous, dense aggregations in many river ecosystems. When animals such as freshwater mussels occur in high densities, these effects can result in dramatic changes in the physical and biogeochemical environment. However, most research to date has focused on the direct role of animals in biogeochemical cycles, while few have examined how animals indirectly influence biogeochemical cycles. Here we examined how mussels (1) directly influence the flux of particulate and dissolved nutrients and (2) indirectly effect the flux of N_2 production, via denitrification, across a gradient of mussel biomass and differences in community composition at the stream reach (60-80 m) and patch scale (0.25 m^2). We combined measurements of ammonium (N) and soluble reactive phosphorous (P) excretion and C, N, and P biodeposition rates for 11 species with biomass and distribution estimates for 6 mixed-species aggregations to quantify the direct contributions and the spatial heterogeneity of mussels to biogeochemical cycling. Additionally, we measured potential denitrification rates at the patch- and reach- scales to determine how mussel biomass and richness influence these indirect fluxes. We predicted that increasing mussel biomass would lead to greater direct and indirect fluxes of nutrients, manifesting in heterogeneous nutrient redistribution within and among mussel aggregations. Our results indicate that mussel aggregations directly influence nutrient fluxes as excretion often exceeds ambient concentrations and they indirectly influence nutrient fluxes as greater mussel biomass results in higher denitrification rates likely mediated by their interactions with the sediments and enhancement of nutrient availability. Combining our results with previously published data highlight that a single mussel aggregation can redistribute approximately 16% of particulate flux, contribute ~0.5% of background dissolved nutrient flux, and higher mussel biomass results in higher denitrification rates. Our study demonstrates that mussels have both extensive direct and indirect effects on biogeochemical cycling.

FRESHWATER MOLLUSKS: WHAT ARE THEY GOOD FOR? ABSOLUTELY ECOSYSTEM SERVICES!

Carla L. Atkinson[1], Garrett W. Hopper[1], Astrid Schwalb[2], Jennifer Archambault[3], Danielle Kreeger[4], and Caryn C. Vaughn[5]. [1]Dept. of Biological Science, University of Alabama; [2]Biology Department, Texas State University, San Marcos, TX; [3]US Fish and Wildlife Service, Raleigh Ecological Services Field Office; [4]Partnership for the Delaware Estuary; [5]Oklahoma Biological Survey & Department of Biology, University of Oklahoma.

Ecosystem services are the benefits that people obtain from the natural functioning of ecosystems. Freshwater gastropods and mussels serve as key components of functioning aquatic ecosystems while also acting as sentinels of environmental change. As such, freshwater mollusk roles in provisioning ecological functions can be viewed as ecosystem services. Mollusks provide several supporting, regulating, provisioning, and cultural ecosystem services. They provide supporting services including nutrient cycling, structural habitat, and affect food web structure as well as regulating services such as water filtration. Provisioning and cultural services provided by mollusks include the use as a food resource, building materials, jewelry, and for spiritual enhancement. Given the importance of mollusks to the healthy functioning of ecosystems, the FMCS Ecosystem Services committee goals include: 1) Quantifying and communicating the impact of freshwater mollusks on ecosystem services; 2) Defining future research goals and data gaps for integrating freshwater mollusks into an ecological services framework; 3) Engaging researchers, social scientists, and policy-makers outside of biology with FMCS. Additionally, to date, much of the research regarding the role of mollusks on ecosystem services has been focused on bivalves with little emphasis on gastropods. We urge research groups to also consider the critical functions gastropods play in freshwater ecosystem functioning. As freshwater mollusks have been particularly impacted by human activities, we encourage any interested society members to engage with and join our committee to help further understand the consequences of their imperilment and decline and their importance to society.

PROPAGATION OF FRESHWATER MUSSELS IN FLOATING CAGES AT LAKE CUMBERLAND, KY.

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Freshwater mussel propagation has traditionally included artificial raceways, laboratory tanks/trays, and most recently pond systems. We examined a practical method using cages suspended on a floating rack system in a large reservoir, Lake Cumberland, KY. The 20,000-hectare reservoir is impounded by Wolf Creek Dam on the Cumberland River and is home to the Wolf Creek National Fish Hatchery (WCNFH). In 2016, the Center for Mollusk Conservation collaborated with WCNFH to raise freshwater mussels in floating cages. Each rack has five cages (60cm x 60cm x 90cm) and is approximately 4m x 0.75m x 0.75m with two sealed 50-gallon drums attached to the end for flotation. Each cage is made of aluminum (frame) and galvanized hardware cloth (sides). The bottom pan (solid aluminum) on each cage was covered with about 3cm of small gravel and sand. Racks were placed in the reservoir 2 weeks prior to adding infested fish or juvenile mussels into the cages. Every 2 weeks the cages and racks were visually inspected and cleaned with a brush or broom. Over the past four years, we have raised over 10,000 mussels from 17 species in 40 cages including eight federally endangered or threatened (*Epioblasma brevidens*, *E.obliquata*, *E. triquetra*, *E.*

walkeri, *Venustachoncha troostensis*, *Lampsilis abrupta*, *Ptychobranchus subtentus*, *Theliderma cylindrica*, and *Cyprogenia stegaria*). Floating cages provide several advantages over intense hatchery culture methods such as lower cost, limited handling of juveniles, low maintenance, and natural growing conditions. Most cages exhibited high survival rates (up to 80%) and faster growth (25-35 mm in 5 months) than traditional methods. Future expansion includes additional cages located on a private covered dock.

FRESHWATER MUSSEL STATUS ASSESSMENT USING A SUITABLE HABITAT MODEL FOR THE GASCONADE RIVER, MO

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We aim to use our understanding of a mussel's sessile tendencies, clustered distribution in high density beds, benthic habitat preferences, and sensitivity to temporal and spatial disturbances to draw inferences about the limitations of mussel aggregations. These limitations can be applied to statistical models which incorporate broader landscape level hydrogeomorphological variables such as channel stability and drought refugia. The use of hydrogeomorphological habitat characteristics in statistical models may provide insight into mussel distribution patterns, narrow down causes of mussel decline, and highlight suitable areas for focused management. The Gasconade River in Missouri is an ideal candidate for such a model in that it contains known mussel communities and has opportunities for management and restoration. Our first objective was to verify if a previously constructed habitat model correctly identified potential mussel habitat by confirming the presence of mussels in areas deemed suitable. Our second objective was to perform a general status assessment for freshwater mussels of the Gasconade River by comparing the current mussel beds with historical records. Timed bank surveys were performed on gravel bars and the surrounding water in areas deemed suitable by the overarching model. Shells and live organisms were then categorized and recorded. Based on our results, the habitat model appears to predict potential mussel habitat more accurately in the mid and lower reaches, while the headwater modeling seemed to be less accurate in determining where mussel aggregations could occur. Our results indicate that the freshwater mussels of the headwaters may be responding differently to the hydrogeomorphological variables, and may require a different set of modeled habitat parameters to assess habitat suitability in these areas.

WINGED MAPLELEAF (*QUADRULA FRAGOSA*) PROPAGATION EFFORTS: REVISITED

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The St. Croix National Scenic Riverway (SACN) in Minnesota and Wisconsin supports the only known self-sustaining population of the federally endangered Winged Mapleleaf mussel (*Quadrula fragosa*) in the upper Mississippi River basin. Since the species was federally listed in 1991, our knowledge of the breeding behavior and life history characteristics of *Q. fragosa* has increased substantially. *Quadrula fragosa* is one of the few species that are fall, short-term (~6 weeks) brooders, and in the SACN, Channel Catfish (*Ictalurus punctatus*) are the only known host. *Quadrula fragosa* glochidia are assumed to overwinter on their host fish and transform into free-living juveniles the following spring. Propagation efforts for this species began in 2003, when an interagency Mussel Coordination Team (MCT), made up of personnel from federal and state resource agencies and universities, was tasked by the US Army Corps of Engineers (USACE) to implement a plan to propagate, augment, and reintroduce the species within its historic range. Thousands of juvenile *Q. fragosa* have been successfully produced through hatchery efforts; however relatively few subadults have been released into the wild, suggesting that alternative propagation methods may be required. Our research is novel in that we will compile historic data from >14 years of *Q. fragosa* propagation efforts into a searchable database to identify potential knowledge gaps that may be limiting its success. We will use this information to direct *in situ* and *ex situ* propagation techniques to optimize production of *Q. fragosa* juveniles. Lastly, we will characterize the movement pattern of wild-caught Channel Catfish that are artificially inoculated with the SACN strain of *Q. fragosa* to identify potential juvenile release survey locations in future years. Our progress thus far and future direction will be discussed.

IMPACTS OF ZEBRA MUSSELS ON TEXAS UNIONID MUSSELS

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Zebra mussels are known to detrimentally affect unionid mussels by fouling (infestation of the shells) and competing for food. Previous studies have shown that both fouling and competition for food can affect the body condition of unionid mussels, but to the best of our knowledge no study has compared the impact of zebra mussel presence and fouling on glycogen storage under controlled conditions. Hence, the objective of this study was to test this experimentally with *Amblema plicata* between treatment tanks where (1) *A. plicata* was artificially

infested with zebra mussels, (2) zebra mussels were present but no fouling occurred, and (3) control tanks where no zebra mussels were present. There were four replicate tanks for each treatment and control. A total of 60 *A.* plicata were collected from a field site where zebra mussels were absent. Five *A.* plicata were placed in each treatment tank and between 100 and 125 zebra mussels were added to each treatment tank (44 ± 14 g wet biomass), comparable to average field observations of zebra mussel biomass infesting unionid mussel shells. Mussels in lab experiments were fed with commercial algae via peristaltic pumps to mimic chlorophyll-a concentrations measured in the field. Burrowing depth and mobility of mussels was also recorded. In addition, glycogen concentrations of mussels with different number of infested zebra mussels from field sites with different zebra mussel densities and control sites without zebra mussels were examined. Preliminary results show that more unionid mussels burrowed in tanks where fouling occurred than those in no fouling and control tanks. Glycogen and glucose analyses are currently being conducted on all mussel foot tissue samples.

EFFECTS OF WATER TEMPERATURE ON GLOCHIDIA VIABILITY OF *UNIO CRASSUS* (PHILIPSSON, 1788) AND *SINANODONTA WOODIANA* (LEA, 1834): IMPLICATIONS FOR CONSERVATION, MANAGEMENT, AND CAPTIVE BREEDING

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The global decline of freshwater bivalves has prompted many programs for their conservation and augmentation, which often include a captive breeding component. One key point to such programs is the collection, maintenance, and use of mussel glochidia larvae, which require attachment to a fish host in a sensitive parasitic stage of their lifecycle. Understanding the thermal limits of glochidia can increase knowledge of mussel larval survival and ultimately aid in the development of conservation programs. Glochidia of the endangered thick-shelled river mussel *Unio crassus* and the non-native Chinese pond mussel *Sinanodonta woodiana* were observed for active clamping ability at 5, 15, 17, 20, and 25°C over the course of a 7-day period. The results from this study confirm that an inverse relationship between water temperature and larval survival can be observed in both species. Additionally, the significantly higher thermal tolerance of *S. woodiana* indicates that the species exhibits competitive invasive behavior beginning from the larval level. These findings also suggest that the collection and transportation of glochidia from genetically important yet distant populations is feasible if glochidia can be maintained at temperatures between 5 and 15 °C.

EXPANDING RESEARCH AND SURVEY EFFORTS TO SUPPORT CONSERVATION OF THE IMPERILED WESTERN RIDGED MUSSEL (*GONIDEA ANGULATA*).

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The western ridged mussel (*Gonidea angulata*) is a species endemic to western North America and the only member of the genus *Gonidea*. Very little is known about the species' biology and life history. The authors and fellow collaborators (J. Brim Box, D. Nez, J. Howard, A. Maine, and C. O'Brien) recently conducted and published an analysis of the species' distribution, which indicated that the western ridged mussel has declined by as much as 43% across its range. Additionally, recent surveys have been completed at more than half of all historically-documented sites by the authors and other biologists and researchers, but these surveys failed to detect live western ridged mussels at 46% of those visited sites. More rapid declines have also been observed at multiple enigmatic die-off sites in Oregon, Washington, and potentially Idaho, and these findings, in addition to the recognition of multiple threats to the species and its habitat, led to a 2020 petition by the Xerces Society to the US Fish and Wildlife Service to list the species as federally endangered under the US Endangered Species Act (ESA). If listed, this would be the first freshwater mussel species in the western US to receive ESA protection. In order to support conservation and recovery actions for the species, Xerces Society biologists and partners have collaborated on focused research and survey efforts to document the species' current distribution, abundance, and habitat. These efforts include surveys, die-off investigations, and establishment of population monitoring projects, which support the development and implementation of a strategy to conserve the western ridged mussel across its range.

CHARACTERIZATION OF THE MUSSEL MICROBIOME: ASSESSMENT OF MICROBE BIODIVERSITY ACROSS SPECIES, INDIVIDUALS, AND ENVIRONMENTAL COMPARTMENTS.

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A mussels' body is full of bacteria and fungi that are collectively known as the microbiome. While some bacteria are associated with disease, others play beneficial roles. In marine mussels, fitness is linked to the stability of its associated microbiota and the diversity of mussel-associated bacteria decreases when mussels are exposed to environmental stress. Identification of these key bacteria and fungi in mussels will be critical in understanding mussel health and could enhance the success of captive propagation and restoration efforts. We explored the mussel microbiome, the community of microbes that live in and on mussels, across a well-studied mussel assemblage in the upper Mississippi River (UMR). This assemblage has been surveyed annually for over a decade and data on density, diversity, recruitment, and demography show this is a robust and healthy assemblage. The microbiome of four abundant species was assessed by comparing microbial diversity across multiple biological (hemolymph, excurrent siphon, gill, and foot) and environmental (overlaying water, pore water, and sediment) samples. Using a metabarcoding approach on a MiSeq, we used the ITS and 16S microbial genetic markers to assess the microbiome. Operational

taxonomic units and estimates of α- and β-diversity were compared using established microbial metabarcoding pipelines in QIIME2. Preliminary data suggests there are different microbial communities associated with each biological component. Additionally, the bacterial communities within mussels differ from those in environmental samples. These data will provide a baseline characterization of microbiomes associated with native mussels that will serve as a reference of what microbiomes may look like across mussels in a stable assemblage in the UMR and can be used as a benchmark for future studies.

TAKING A CLOSER LOOK: *QUADRULA FRAGOSA* MANTLE MAGAZINE AND PAPILLAE STRUCTURES IN MACRO IMAGES

Megan Bradley and Elizabeth Glidewell. USFWS, Genoa National Fish Hatchery, Genoa, WI.

Quadrula fragosa is a federally endangered species that remains in only a few locations distributed across the midwestern United States. The population found in the St. Croix River has been observed for broodstock collection for head starting juveniles for more than a decade. Over time, individuals have been photographed during the period of gravidity, but typically after handling for transport. 2020 presented low water during the gravid period, allowing for brighter light in the field and less color shift from the tannins of river water. An Olympus TG-5 provided a waterproof, sturdy camera for photographs during snorkeling. The macro camera setting allowed for high quality images of the mantle magazine but also the folded incurrent aperture papillae, a structure that is typically unobserved due to the species' burrowing behavior. These images present an opportunity to share the aesthetic pleasure of endangered nature while making new discoveries about treasured conservation targets.

SALAMANDER MUSSEL HEAD STARTING; OBSERVATIONS ON GLOCHIDIA ATTACHMENT AND HABITAT PARAMETERS IN THE CHIPPEWA RIVER, WI.

Megan Bradley[1], Elizabeth Glidewell[1], Nathan Eckert[2] Doug Aloisi[1]. USFWS, [1]Genoa National Fish Hatchery, Genoa, WI, [2]Neosho National Fish Hatchery, Neosho, MO.

The Genoa National Fish Hatchery (GNFH) has been involved in the rearing of freshwater mussels in the Upper Mississippi River Basin since efforts began in 2000. The program has expanded from working with a single species, using a single technique, to working with as many as 18 species in as many 6 locations, and the techniques used have evolved and been made to suit the culture location or species specific needs. Salamander mussels are a unique species that use a non-fish host and that are found in a narrow, shared habitat with that host species. The Chippewa River, WI population is large and provides broodstock for experimental restoration of reaches where habitat persists but where individuals haven't been found in survey efforts. Persistent observation of the habitat in the Chippewa River has clarified occupied habitat and multiple infestation events have demonstrated attachment.

THE POPULATION-LEVEL CONSEQUENCES OF PARASITISM IN FRESHWATER MUSSELS: FIELD DATA AND A CONCEPTUAL HYPOTHESIS.

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Parasitism and disease are ubiquitous features of ecosystems, but have only recently begun to be considered in the context of unionid mussel conservation. While the scope of unionid pathogens is beginning to be understood, the functional consequences of this for populations and species remains uncertain. In order to explore the impact of parasites on mussels, and how this may vary between populations, we quantified the impact of three parasites (the trematode *Rhipidocotyle campanula*, the mite *Unionicola intermedia* and the ectoparasitic invasive mussel *Dreissena polymorpha*) on the reproductive performance of the native *Anodonta anatina* at two different sites. We found that prevalence and intensity of the parasites varied unpredictably between the two sites, with one site having over three times as many native mussels infected by trematodes and mites than the other, but over four times fewer mussels afflicted by invasive zebra mussels. However, in the site with lower trematode prevalence, those native mussels that were infected had an infection intensity twice that of the high-prevalence site. We also showed site-specific impacts on reproductive output: trematodes castrated mussels at both sites, and mites reduced glochidial viability of gravid mussels, but only at one site. Incorporating our results into a model, we find that parasitism alone reduces the total production of glochidia by >10% at both sites. We suggest that parasitism by macroparasites has a role to play in recent mass die-offs: while in isolation they cannot explain population collapse, they serve as an additional source of stress which not only reduces recruitment in healthy populations, but also severely limits the capacity of a population to recover from other stressors, such as viral or bacterial disease or environmental perturbation.

EFFECTS OF DAMS ON FRESHWATER MUSSEL GENEFLOW IN THE RAQUETTE RIVER, NEW YORK

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Dams have been shown to have a variety of effects on stream ecosystems including contributing to habitat fragmentation through creating barriers and changing habitats. Freshwater mussels are particularly susceptible to the effects of dams and habitat fragmentation through direct effects of habitat modification and indirect effects through limited host fish movement due to the obligatory larval life cycle of freshwater mussels. The limitation of host fish movement is likely to effect geneflow of freshwater mussel populations. Because *Elliptio complanata* is a common species in the northern Atlantic slope, is considered a habitat generalist in streams and lakes, and uses a wide range of Centrarchidae species as host, it can serve as a model organism to study the effects of dams on gene flow and population genetics. The objective of this project is to study *E. complanata* populations to provide additional information on the effects of dams on genetic diversity and population genetics differentiation of freshwater mussels. To examine this phenomenon, we procured DNA through swabs of 15 *E. complanata* individuals each from two sites upstream and one site downstream of the East and West Potsdam Dams in Potsdam, New York. We have extracted genomic DNA and will amplify and sequence the DNA using primers for 14 published microsatellite fragments. We expect that since dams prevent fish from moving upstream, geneflow will be affected and will influence genetic diversity in these populations.

HIGHER DENSITY OF INVASIVE CLAM (*CORBICULA FLUMINEA*) CONTRIBUTES MORE TO NUTRIENT AVAILABILITY THAN NATIVE MUSSELS.

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Freshwater mussels play an important role in stream nutrient cycling through excretion. *Corbicula fluminea* is a freshwater clam native to Asia but has become widespread throughout North America and can reach high abundances where mussels occur. Considering native and invasive bivalve nutrient excretion rates together may offer a more complete understanding of stream nutrient cycling. We surveyed four mussel beds each in the Duck River and Cahaba River, estimated mussel and *C. fluminea* biomass, and measured nitrogen (N) and phosphorus (P) excretion rates. In these sites, we found that *C. fluminea* had smaller body sizes, but higher mass-specific N and P excretion rates compared to mussels. In general, smaller organisms have a higher BMR (Basal Metabolic Rate) than larger organisms and as a result, individual *C. fluminea* excrete more N and P per unit mass compared to the surrounding mussels. Using our individual-level mass specific rates in combination with the quantitative survey data, we were able to scale these nutrient excretion rates to the community-level by estimating areal excretion rates. Across our sites, we found that some sites experienced more nutrient excretion from *C. fluminea* rather than the native mussel species. We found that the invasive clam and native mussels vary greatly in their nutrient cycling rates and stoichiometry and thus contribute differently to nutrient availability in rivers. As such, *C. fluminea* appears to alter nutrient limitation patterns in these systems. If the invasive *C. fluminea* manages to become the dominant bivalve, the community composition of algae and microbial community composition and productivity could be greatly affected. Our study highlights the difference between functionally similar invasive species in comparison to native bivalve communities.

POPULATION GENOMIC AND SPECIES DIVERSITY IN UNIONID COMMUNITIES IN THE MOBILE BASIN, AL.

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Diversity has been shown to confer ecosystem stability. Freshwater mussels often exist in species rich assemblages in aquatic systems and can enhance the ecological function of the stream community. Today, many species of freshwater mussels face enigmatic declines while little to no genome-wide estimates of genetic diversity exist for many species. Understanding species diversity at both the taxonomic and population genetic level in communities can shed light on how genetic and species diversity relate to community function and stability. Using both quantitative survey methods and Restriction-site associated DNA sequencing, we examined species diversity at the taxonomic and genomic level at 5 sites (4 species) in the Sipsey River (Mobile Basin, AL). We find that as estimated species richness increases, so does observed and expected heterozygosity, and two species that are sampled at all sites (*Cyclonaias asperata, Tritogonia verrucosa*) showing markedly reduced genetic diversity at the most species poor site. Our work suggests that species-genetic diversity correlations exist in Unionid mussel communities and therefore genetic diversity metrics should be considered during species recovery and management planning.

DISTRIBUTION OF MUSSELS AND PLEUROCERID GASTROPODS IN THE LOCUST FORK OF THE BLACK WARRIOR RIVER, ALABAMA.

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The Locust Fork of the Black Warrior River historically contained 32 species of freshwater mussels including six federally listed taxa. Additionally, the last remaining population of *Leptoxis plicata*, a federally endangered freshwater gastropod, remains only in the Locust Fork. Mollusk populations have been impacted by decades of non-point source water quality issues including sedimentation and chemical runoff from extensive surface coal mining and agriculture. Recent survey efforts focused on tributaries within the Black Warrior River basin leaving the majority of the Locust Fork mainstem unsampled since 2002. In 2020, ADCNR staff surveyed mollusks at 45 sites along a 186 km section of the Locust Fork utilizing a combination of point and float surveys. Twenty-six unionids and six pleurocerids were observed including four federally listed species (*Hamiota perovalis*, *Pleurobema rubellum*, *Ptychobranchus greenii*, and *L. plicata*). *Pleurobema rubellum* had not been observed in the Locust Fork since 1903 until it was found by ADCNR at a single site in 2014. The range of this population was found to be approximately 3.7 KM in 2020 and a second population discovered 47.4 km downstream. *Ptychobranchus greenii* was observed at two sites extending the range of this occurrence to 1.9 km. *Hamiota perovalis* was found only as weathered shell but it was the first observation of wild individuals in the Locust Fork since 1998, though stocking of hatchery reared juveniles has been taking place since 2014. *Leptoxis plicata* was observed at 12 localities with a total range of 60.5 km in two disjunct populations separated by a 23 km unoccupied section. In summary, the Locust Fork, even after suffering decades of water quality problems, still contains one of the most diverse mollusk assemblages in Alabama and appears to be improving as mining activities decline in the basin.

HISTOPATHOLOGY OF FREE-LIVING POPULATIONS OF THREE SPECIES OF FRESHWATER BIVALVES IN INDIANA.

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Freshwater mussels are one of the most endangered groups of animals in Indiana, with nearly half of the native species either extirpated or listed as “state endangered” or of “special concern.” Nationally, numerous freshwater mussel species are considered threatened. Freshwater mussel diseases are not well understood and few published accounts of freshwater mussel diseases with histopathology exist. Mass mortality events within mussel populations are increasingly recognized, often with undetermined etiology. Our objectives were to determine baseline histopathology in free-living populations of freshwater bivalves. One-hundred eighty individual bivalves representing three species were collected from three different locations within the Wildcat Creek watershed in central Indiana during June and July 2019. A cross-section through the visceral mass was obtained and immersed in 10% neutral-buffered formalin. Tissue was processed for routine histopathology and stained with HE. A range of histopathologic changes were observed. Branchial acariasis occurred in 43/60 Fatmuckets and 22/60 Plain

Pocketbooks. Infection with the trematode *Bucephalus polymorphus* was recognized in 18/60 Fatmuckets, while infection of the gonadal duct with an unidentified trematode species was identified in 4/60 Fatmuckets and 18/60 Plain Pocketbooks. Additional infections with unidentified trematodes, bacteria, fungi, and ciliates were observed. A range of histopathologic changes were observed, including infectious and degenerative lesions. Awareness of baseline lesions should inform future diagnostic investigations of mussel mortality events.

STABLE HABITAT IN A DYNAMIC LANDSCAPE: GEOMORPHOLOGY AND FRESHWATER MOLLUSK RADIATIONS.

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Although most groups of organisms have their highest diversity in the tropics, freshwater mollusks have the greatest diversity in riverine habitats of southeastern North America. Rivers are usually highly dynamic, changing dramatically as they erode over time. However, the combination of a humid climate and rising mountain ranges has led to long-term persistence of large, fast-flowing, clear rivers. The Appalachians have long been thought of as mere erosional remnants, otherwise unchanged since the formation of Pangea, but recent evidence indicates a much more dynamic history of tectonic adjustment. The resulting range of stable habitats enabled diversification of freshwater mollusks, including the varied host attraction techniques of unionids. Similar factors also contributed to the concentration of diversity in southeastern Asia.

HOW DO ARTISTS UTILIZE CONSERVATION RESEARCH TO INFORM CONCERNED PUBLICS?

Laura C. Carlson. Program Coordinator, Art and Ecology Program, Department of Art, University of New Mexico, Albuquerque, NM.

In what ways can artists and biologists collaborate to create expanded understandings of our world amidst the extinction crisis? How do artists ask paramount questions of strategic possibilities for reorienting worldviews for care and responsibility of environments?Artist-researcher and writer laura c carlson (they/them) presents their working series “Becoming Benthic,” a mythopoeic embodiment of freshwater mussels’ ancient and continued stewardship of waterways. Through speculative metamorphosis, carlson becomes “naiad”, a human-mussel spirit who calls through geologic time to illustrate the ancient role of freshwater mussel and detailing colonial praxes of damming, dredging, and runoff that threaten mussel lives and entire freshwater ecosystems. carlson works to encounter publics through embodied research, curiosity, and concern to build awareness of freshwater imperilment through collaboration with scientists and scientific research, community building, and emergent processes. Their work asks questions of anthropomorphism, speculative possibilities, and human/non-human intimacies. carlson will share doowop music video, flow through me, a love song between Alasmidonta varicosa and their river habitats; We of the Benthos, a painting catalog of 280 of the imperiled species of mussel in the U.S.; Lotic Possibilities, a material investigation of the Rio Grande watershed; and excerpts from their recent essay “Becoming Benthic: i am naiad” from 2021 Lexington Press edited volume, Communicating in the Anthropocene: Intimate Relations, (eds C. Vail Fletcher + Alexa M. Dare).

BEYOND RESTORATION: FRESHWATER MUSSEL GROWTH AND SURVIVAL IN STORMWATER PONDS

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Freshwater mussel propagation and grow-out is expected to help address the supply bottleneck for restoring both common and rare species. The majority of hatchery propagated mussels require considerable space for grow-out prior to use in research and restoration projects. This necessitates large growing facilities to support up to millions of juvenile mussels of different species while avoiding overstocking and food limitation issues. Hatcheries often utilize tailor-made and well-managed ponds for mussel grow-out. The goal of this study was to determine if juvenile mussels can survive and grow in engineered pond systems that were designed for other purposes, e.g. stormwater management. Starting in 2017, propagated cohorts of the Alewife Floater (*Utterbackiana implicata*) from Delaware River broodstock have been grown in private ponds. In 2019, rearing locations were expanded to include diverse stormwater ponds throughout New Castle County, Delaware. Four stormwater ponds and a reference pond were stocked with floating baskets (*N*=3) each containing 15 mussels. Mussels were monitored throughout the study for survival and growth. Water quality was monitored via *in situ* measurements and grab samples. Water grab samples were filtered to collect seston, which was used to assess the concentration of total suspended solids (TSS) and seston organic content. Mean shell length of mussels was 59 mm at the start and ranged between 71 – 90 mm among ponds upon completion. All stormwater ponds supported greater growth rates than the reference pond. Mussel mortality was below 4% overall. Superior growth rates were associated with increased concentration of bioavailable food (particulate organic concentration) but not with TSS or percent organic content. Stormwater ponds may therefore provide additional mussel rearing locations at nominal cost. The temporary or permanent addition of native mussels into stormwater ponds may also promote water quality in man-made systems that are not typically considered in mussel recovery programs.

BACK TO WEST TEXAS: THE VIRTUALLY UNKNOWN PHYLOGENETICS AND MORPHOMETRICS OF TEXAN *PYRGULOPSIS* POPULATIONS.

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Pyrgulopsis (Gastropoda: Hydrobiidae) are a speciose genus of small snails found in freshwater springs throughout North America and exhibit high levels of endemism that are at an elevated risk of extinction. Four species are known to occur within the state of Texas: *P. texana*, *P. ignota*, *P. metcalfi*, and *P. davisi*, all of which are considered endangered and are restricted to only a few localities each, all of each in west Texas. They are understudied and their relationships to each other as well other members of their genus are unresolved, posing obstacles to their conservation. They are of particular importance due to their inhabitance of Texas spring systems and ciénegas, which are declining due to groundwater withdrawal and pollution among other anthropogenic stressors; therefore, their protection would be of benefit to efforts to conserve these unique ecological assemblages. Our project aims to collect and analyze morphometric and phylogenetic data concerning each population of these four species in order to establish conservation units which may be considered in future management and policymaking.

GEOMETRIC MORPHOMETRIC ANALYSES REVEAL MORPHOLOGICAL VARIATION AMONG A COMPLEX OF SPHAERIID BIVALVES IN NEW MEXICO, USA.

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Pea clams (Heterodonta: Sphaeriidae) represent one of the most abundant and wide-ranging freshwater bivalve taxa known, boasting a cosmopolitan distribution and occurring in most slow-moving aquatic habitats. Despite their impressive distribution, little effort has been given to the understanding of their richness and taxonomy. Within the family, single species have been reported from localities spanning multiple different continents, and in many areas species richness and distribution(s) remain unknown. Attempts to investigate species boundaries within the Sphaeriidae have been confounded by the complex morphology observed within the taxon, where single species often show high levels of phenotypic variation when examined using traditional taxonomic characteristics. Incorporating geometric morphometric techniques into taxonomy allows for the identification of differences in shape between species or populations that might not be obvious to the human eye and could go unnoticed using traditional methods of identification. To test the utility of geometric morphometric characters within the family, we examined 11 populations of sphaeriid bivalves from seven counties across New Mexico, USA. Images of up to 10 individuals per population were obtained using a stereo-microscope and shell outlines were generated. To quantify differences in valve shape within and between populations, these outlines were compared using a Fourier Analysis. The utilization of these methodologies allowed for the detection of differences in shape between populations along with quantification of variation observed within populations. These morphological results were compared to species determinations made through molecular phylogenetic analyses. Effects of environment on phenotypic plasticity were also tested by examining shape differences for each habitat type occupied by each population. Gaining an understanding of morphological variation among different populations of sphaeriids marks the first step in better understanding their diversity and has important implications for their conservation.

GLOCHIDIA OF THE ENDANGERED FRESHWATER PEARL MUSSEL, *MARGARITIFERA MARGARITIFERA*, LOWER VIRULENCE OF A FISH PATHOGEN.

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Freshwater bivalves are the most threatened animal group globally causes loss of biodiversity and the potential ecosystem services provided by these bivalves. Parasitic glochidia of the Freshwater Pearl Mussel (FPM, *Margaritifera margaritifera*) is attached to salmonid fish's gills (*Salmo trutta* and *S. salar*) for up to 11 months. Co-infections are common in host-parasite interactions, but studies on their impact on virulence of parasites/diseases are still scarce. We compared mortality induced by a bacterial pathogen, *Flavobacterium columnare* (causative agent of one of the biggest disease problems in freshwater salmonid farming) between brown trout infected with glochidia of the endangered FPM, *M. margaritifera*, and uninfected control fish during the parasitic period and after the parasitic period (glochidia detached) in a laboratory experiment. The highly virulent strain of *F. columnare* caused a strong disease outbreak where mortality reached 100% (N=150), whereas only one fish died (0.7%, N=146) from the unexposed control group within 29 hours. In both cases (parasitic and post-parasitic period), glochidia prolonged the fish host's survival statistically significantly compared to the control fish. Furthermore, fish survival time increased with glochidia abundance. This protective effect could be connected to an enhanced non-specific immunity or changed gill structure of fish, as *F. columnare* enters fish body mainly via gills which is also the attachment site of glochidia. The result increases our knowledge of the interactions between freshwater mussels, their (commercially important) fish hosts and fish pathogens. It emphasizes the importance of (unknown) ecosystem services potentially associated with imperiled freshwater mussels.

INVENTORY AND ASSEMBLAGE CLASSIFICATION OF THE FRESHWATER MUSSELS (MOLLUSCA: UNIONIDAE) OF THE STRAWBERRY RIVER, ARKANSAS WITH IMPLICATIONS FOR CONSERVATION PLANNING.

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Spatial hierarchical approaches to classify freshwater systems can add to our understanding of biogeographical patterns and can be used for biodiversity conservation planning. The Strawberry River is in the Ozark Mountains of northeast Arkansas and has been designated an Extraordinary Resource Water, an Ecological Sensitive Water Body, and a Natural Scenic Waterway. The goals of this study were to document Strawberry River, Arkansas freshwater mussels to aid in conservation planning. Our first objective was to inventory freshwater mussel species in the Strawberry River. Our second objective was to use this stream-wide dataset to classify the freshwater mussel assemblages. We used unpublished survey data of 59 sites distributed from the headwaters to mouth to inventory species occurrence, classified mussel assemblages using non-metric multi-dimensional scaling (NMS), and conducted indicator species analysis on resulting assemblages. We

observed 39 taxa across the 59 survey sites that included two S1, five S2, 16 S3, 11 S4, four S5, and one state non-ranked conservation rank species. Furthermore, our assemblage NMS classification revealed two distinct freshwater mussel assemblages roughly organized by an upstream (sites 1-31) to downstream (sites 32-59) gradient. All five upstream indicator species–*Lampsilis reeveiana, Ptychobranchus occidentalis*, *Fusconaia ozarkensis*, *Lampsilis siliquoidea and Venustaconcha pleasii* –were dominant (≥2.99%) in the upstream group. Furthermore, six of the 13 downstream indicator species–*Potamilus purpuratus*, *Cyclonaias pustulosa*, *Actinonaias ligamentina*, *Fusconaia flava*, *Theliderma metanevra, and Lampsilis teres*–were dominant in the downstream group. This study provides an additional case study adding to our understanding of freshwater mussel fauna classification and can be used for conservation planning.

REPRODUCTIVE PHENOLOGY AND LIFE-HISTORY TRAITS OF WESTERN PEARLSHELL MUSSELS IN MONTANA.

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The Western Pearlshell mussel is the only native freshwater mussel inhabiting trout streams of western Montana; it has been designated a state Species of Concern because of declines in abundance and distribution. Fundamental information on the reproductive biology and life-history of the species needed to conserve it is currently lacking. We investigated the timing and duration of reproductive events (gonadal development, fertilization, brooding of eggs and embryos, glochidial release, and glochidial infestation of hosts) at frequent intervals and the incidence of hermaphroditism in Western Pearlshells in the Big Hole and Rock Creek watersheds in western Montana in 2019 and 2020. The reproductive phenology of Montana Western Pearlshells differed among populations and from that of populations in coastal states. Western Pearlshells brooded embryos for several weeks starting by mid-May or mid-June, and released glochidia in mid-May to mid-July, depending on the population. Fish hosts were infested with glochidia from mid-May to early-September, depending on the stream. Infestations persisted for about 7 weeks during which glochidia grew about five-fold in size before excystment. Of 31 mature mussels histologically examined, all but one were gonadal hermaphrodites. Mussels reached sexual maturity at about 35 mm in size. Our findings will inform future propagation and conservation efforts in Montana.

CONSERVATION AGREEMENT AND STRATEGY FOR SPRINGSNAILS IN NEVADA AND UTAH.

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There is an increasing concern and need for the conservation of springsnails and the unique spring and springbrook habitats on which they depend. Nationwide, several of these species have been listed as endangered or threatened under provisions of the Endangered Species Act; others are undergoing review by the U.S. Fish and Wildlife Service for possible future listing actions. These species can be particularly susceptible to localized threats such as water diversion, invasive species, development, or trampling by ungulates. In 2017, multiple agencies, stakeholders, and other interested parties in Nevada and Utah completed a Conservation Agreement for springsnails. The corresponding conservation Strategy was completed in 2020. The conservation actions described in the Strategy are expected to lead to the protection and enhancement of 103 springsnail species and their associated habitats in Nevada and Utah. Conservation Agreements and Strategies have been an important conservation tool for Nevada and Utah for more than 20 years and, in many cases, have resulted in precluding the need to list at-risk species.

FRESHWATER MUSSELS (UNIONDAE & MYCETOPODIDAE) OF THE PÁNUCO AND USUMACINTA BASINS, MÉXICO.

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Mesoamerica is a global hotspot of freshwater mussel (Unionida) diversity. However, the mussel fauna of Central America in general is poorly known and is badly in need of revision. The last comprehensive treatments of the fauna were made by Fischer & Crosse (1870-1902) and von Martens (1890-1901). Frierson (1927) provided a checklist of species from México and placed many of the “species” in the genera of Crosse & Fischer without comment. The Central American mussel fauna is composed of species in the families Unionidae and Mycetopodidae. With the exception of a few species, the Mesoamerican mussel assemblage is distinct from that of North America and consists of a large number of endemic species, making it a transition zone between Nearctic and Neotropic faunas. However, little information is currently available regarding the distribution and evolutionary history of the Central American mussel fauna. We will present an overview on the history of research on freshwater mussels in Central America and discuss the results of mussel surveys we conducted in selected rivers in the Río

Pánuco basin in San Luis Potosí, Mexico in December 2017-2018, and in streams in the Río Usumacinta drainage in the states of Chiapas and Tabasco, Mexico surveyed in 2019.

R SHINY: A SHINY INNOVATIVE TOOL FOR OUTREACH AND COLLABORATION.

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The Shiny package in R is a useful tool for sharing scientific data and allows users to build an informative and interactive interface for the communication of these data in a meaningful and accessible fashion. We created a Shiny web application to represent and share data from 69 sites where live freshwater mussels (Bivalvia: Unionidae) were found during surveys conducted in the Kalamazoo River watershed, MI, USA in 2018 and 2019. Data were collected using standardized timed and quadrat surveys. An interactive map and graph allow users to select sites of interest on the map or from a drop-down menu and gain information regarding species presence and abundance. The Shiny app program offers an innovative and effective way to share data with users from a variety of backgrounds and has the potential to be tailored to audiences such as stakeholders, researchers and scientists, local governments, and the general public as a means of education, outreach, or data sharing. We will present how we developed the Shiny app to share the Kalamazoo River unionid data, decisions that were made throughout the development process including how to present rare data, and caveats that are required when presenting survey data for outreach. The Shiny web interface is a free tool and has great potential as an option for communicating results in a versatile and user-friendly fashion to effectively disseminate data suitable for interpretation by individuals with varying scientific backgrounds. This makes the Shiny app an effective and exciting instrument by which researchers can share their data, knowledge, and passions in efforts to foster collaboration and investment into aquatic organisms like mollusks that are in need of conservation.

THE VALUE OF HORIZON SCANS: LOOKING FOR FUTURE THREATS TO NATIVE MOLLUSKS IN U.S. WATERS.

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Researchers and managers are utilizing horizon scanning as a preemptive method to identify emerging non-native invaders and their pathways for introduction. The technique systematically reviews a non-native species' likelihood of arrival, establishment, and potential negative impact on biodiversity/ecosystems or economy of the United States (U.S.). In this presentation, I will discuss the value of horizon scans as a tool for mollusk conservation, providing an overview of the process and examples from ongoing regional and national horizon scan projects from the U.S. Geological Survey, U.S. Fish and Wildlife Agency, and the University of Florida. I will also highlight identified high-risk species that are not currently in the U.S., but that could be detrimental to mollusks should they be introduced and become established.

IN THE FOOTSTEPS OF EILEEN JOKINEN: RECENT PROGRESS IN UNDERSTANDING INVASIVE GASTROPODS IN THE ADIRONDACK PARK.

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In 1992, biologist Dr. Eileen Jokinen published one of the most comprehensive malacological surveys of any region at the time, compiling an impressive voucher-linked dataset on gastropods across New York State, including a number of sites in the Adirondack Park – the largest protected forest reserve in the contiguous United States. In recent years, the increased frequency of invasion events in freshwater systems has stimulated an interest in not only understanding the vectors and drivers of such events but also biomonitoring for early detection of alien species. Since Dr. Jokinen's seminal survey on gastropod diversity in New York, several high-profile invasion events have occurred in the St. Lawrence River, which is directly connected to smaller rivers originating in the Adirondack Park. Considering the importance of this region to boaters and recreational anglers, the potential for introductions and invasions is relatively high. Here, I will present data on gastropod diversity that was collected over the past three years from various lakes and rivers in the Adirondack region. Using a combination of conchological analysis along with DNA barcoding, our research group found that invasive gastropods now dominates the soft bottom shallows of at least six major lakes in the Adirondack Park. The results indicate that there are serious biosecurity issues in this region, which are partly the result of knowledge gaps in terms of our understanding of vectors, dispersal pathways and connectivity.

MONITORING A RECOVERING MUSSEL ASSEMBLAGE IN A FORMER "DEAD ZONE" OF THE MISSISSIPPI RIVER

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Navigation Pool 3 of the Mississippi suffered from severe water quality and riverbed degradation from the late 1800s through the early 1980s. As the Clean Water Act was implemented point source toxic discharges and improvements in wastewater treatment coupled with separation of storm and sanitary sewer lines led to significant improvements in water quality. Increased dissolved Oxygen and lowered ammonia in sediments have since resulted in a significant recovery of aquatic life in the river. A species rich freshwater mussel aggregation, or bed, in the lower third of Pool 3 was identified in 2001 and subsequently mapped in 2006. This became one of several reintroduction sites for the federally listed *Lampsilis higginsii* beginning with the release of propagated juveniles in 2003. Quantitative monitoring was completed in 2010, 2014, 2017 and 2020. Species richness and mean mussel density has increased and natural recruitment of *L. higginsii* was documented in 2020.

THE BIOGEOGRAPHY OF UNIONID FRESHWATER MUSSELS IN TEXAS AND ITS IMPLICATIONS FOR CONSERVATION.

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Biogeography seeks to identify and explain the spatial distributions of species and has become an important tool used by conservationists to protect and manage aquatic organisms. Texas, located in the southwestern United States, is home to ~52 species of freshwater mussels, several of which are endemic to the state. There have been two major attempts to classify this fauna into biogeographical provinces, however both efforts relied on limited distribution information. To complicate matters there have been a number of recent taxonomic changes, resulting in the recognition of new species and synonymy of several endemics with more widely distributed taxa. Based on these changes plus the availability of comprehensive distribution and molecular datasets, we re-examined the biogeography of mussels in Texas. To do this, we compiled species occurrence data from Mussels of Texas database, which is comprised of 25,000 contemporary and historical specimen-based records from across the entire state. Using this dataset, we created a species by river drainage matrix using presence/absence data for 48 of the 52 species that occur in Texas. The remaining 4 taxa were omitted due to unresolved taxonomy or lack of distribution information. Using this matrix, we then performed algorithmic hierarchal cluster analysis (HCA) and non-metric multidimensional scaling (NMDS) based on Euclidean distance to identify biogeographic groupings. We conducted a similar analysis using molecular sequence data for our target species. Based on the results from the HCA and NMDS using community and molecular data, we

identified the following seven geographic provinces: Great Plains, Mississippi Embayment, Sabine-Neches, Trinity-San Jacinto, Central Texas, Rio Grande, and the Coastal province. These findings shed light on the ecological and evolutionary relationships amongst the mussel fauna in Texas, which will be important for the conservation of existing biodiversity within the state.

"ENEMY RELEASE" OF INVASIVE FRESHWATER MUSSELS.

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An increasing threat to local, native freshwater mussels (Unionida) is the invasion by exotic bivalves. The Enemy Release Hypothesis predicts that introduced species benefit from enemy-mediated competition because they are less likely to be harmed by natural enemies, such as parasites, than their native competitors. We investigated within-site differences in parasitism between sympatric native and invasive bivalves in 8 European waterbodies, harbouring 5 native (*A. anatina*, *A cygnea*, *P. complanata*, *U.pictorum* and *U. tumidus*) and 3 invasive (*S.woodiana*, *D. polymorpha* and *C. fluminea*) freshwater bivalve species, and totally 15 parasite taxa. Large variation between populations and species was evident, but in paired comparisons using within-site averages, the mean number of parasite species in the native bivalves was 2.3 times higher, and the sum of parasites' infection prevalences 2.4 times higher, than in the invasive bivalves. This may lead to enemy-mediated competitive release of invaders and contribute to the success of invasive freshwater bivalves. To test the possible "enemy loss" during the invasion process, we have started investigating parasitism of the invasive bivalves (*S.woodiana*, and *C. fluminea*) in their original region in China. While the invasive clam *C. fluminea* was completely free from parasites in Europe, a total of 6 parasite taxa has been found, so far, in two water bodies in its original distribution area in China, indicating parasite loss during invasion. Results support Enemy Release Hypothesis and suggest that parasitism can possibly contribute to success of invasive freshwater bivalves, such as *C. fluminea*. Understanding the factors affecting success of freshwater bivalve invasions, such as parasitism, can aid invasion control and conservation of local, native (endangered) bivalves.

RESPONSE OF EASTERN ELLIPTIO (*ELLIPTIO COMPLANATA*) POPULATIONS TO THE REINTRODUCTION OF AMERICAN EEL (*ANGUILLA ROSTRATA*) IN THE SUSQUEHANNA RIVER BASIN.

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Eastern Elliptio (*Elliptio complanata*) can improve water quality and are numerous in most tributaries along the Atlantic slope. Their lower abundance and recruitment in the Susquehanna River basin compromises ecosystem function compared to nearby river basins. Populations of Eastern Elliptio are often coupled with the American eel (*Anguilla rostrata*), a host fish for Eastern Elliptio that starts life in the Atlantic Ocean and migrates up freshwater tributaries during their juvenile stage before returning to the ocean to spawn. Migration up the Susquehanna is challenging because passage is blocked by large mainstem dams. Qualitative and quantitative field and laboratory efforts were used to observe the response of Eastern Elliptio populations since American eel introduction began in 2010. In 2014 and 2015, within five years of experimental reintroduction of over 200,000 American eels in two targeted Susquehanna River tributaries upstream of dams, an increase in Eastern Elliptio recruitment was observed. In 2018 and 2019, five years after eel stocking ended in 2013 in the targeted tributaries and maturation of reintroduced eels, Eastern Elliptio demographics were reassessed. Increases were found not only in Eastern Elliptio recruitment, but also Eastern Elliptio population estimates in tributaries with targeted eel reintroduction. In addition, increases in Eastern Elliptio recruitment in populations closest to eel stocking sites were noted when compared to survey data collected before eel stocking. Results of recent surveys suggest that previously documented increases in Eastern Elliptio recruitment were not isolated. Increased Eastern Elliptio recruitment at targeted eel stocking sites and in tributaries closest to eel stocking sites lends further evidence that reuniting host fish with appropriate mussel species can be a useful management tool for restoring freshwater mussels. American eel stocking and the resulting increase in Eastern Elliptio abundance could lead to restored ecosystem function and improved water quality throughout the Susquehanna River basin.

NEW DIGS FOR A REGIONAL MOLLUSK COLLECTION: UPDATE ON THE BRANLEY A. BRANSON MUSEUM OF ZOOLOGY AT EASTERN KENTUCKY UNIVERSITY

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The Branley A. Branson Museum of Zoology has been an important resource for regional researchers, agencies, and consultants for many decades. The collections, which consist mainly of mollusks, crayfish, and vertebrates, were recently re-housed in a newly constructed science building on the campus of Eastern Kentucky University. The new space contains compacting shelving and new tools for digital imaging of specimens. The bivalve collection (mainly Unionidae) contains nearly 6,000 lots representing approximately 122 species. The collections are from 1960-present and are mainly from Kentucky, but also with significant holdings from Illinois, Indiana, and Tennessee. Major collectors include B.A. Branson, D.L. Batch, G.A. Schuster, R.R. Cicerello, J.C. Williams, and R.S. Butler. All accessioned bivalve collection records are

publicly available at the InvertEBase Symbiota Portal and are available through data aggregators such as iDigBio and GBIF. The collection continues to grow as we accession a large backlog of specimens obtained from state agencies and environmental consulting companies. The collection of gastropods (terrestrial and freshwater) is estimated at approximately 5,000 lots, most of which have been accessioned but not yet digitized. The new facility can support collection expansion by up to 2/3rds its current size. Future work will include continued expansion with an increased focus on preservation of genetic material made available for loans to researchers and digitization of the gastropod collection.

SIMPLE DEVICE TO COLLECT GLOCHIDIA AND JUVENILE MUSSELS FALLING FROM HOSTS IN THE FIELD

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The monitoring and collection of glochidia and juvenile mussels detaching from its host is a difficult task based on technical solutions that can mostly be applied only under hatchery or laboratory conditions. We present a new simple device for mussel glochidia/juvenile collection and monitoring based on an airlift pump principle applied to floating cages which can be deposited in natural habitats. The technique enables the monitoring of temporal dynamics of juvenile detachment and their continuous collection both in the laboratory and in situ, allowing the fish to be kept under natural water quality regimes and reducing the need for handling and transport. The efficiency of the technique for glochidia and juvenile collection is demonstrated using two freshwater mussels (*Margaritifera margaritifera* and *Sinanodonta woodiana*) dropping from experimentally infested host fish (*Salmo trutta* and *Rhodeus amarus*, respectively). The device enables to study the physiological compatibility of glochidia and their hosts, which is an essential but understudied autecological feature in mussel conservation programs worldwide. Field placement of the device can also aid in outreach programs with pay-offs in the increase of scientific literacy of citizens concerning neglected issues such as the importance of fish hosts for the conservation of freshwater mussels.

IN VITRO-CULTURED FRESHWATER MUSSELS GROW TO MATURITY AND PRODUCE JUVENILES NATURALLY ON FISHES

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A better understanding of the consequences of freshwater mussel captive breeding is necessary to evaluate which methods are appropriate for use in conservation. We evaluated differences between in vitro- and in vivo–produced individuals of two mussel species concerning traits that can directly affect the success of conservation efforts. In six streams, survival and growth did not differ between in vitro- and in vivo-produced *Lampsilis cardium*. Metamorphosis of *Sinanodonta woodiana* differed sharply between two different in vitro methods, but metamorphosis for one of the in vitro protocols was twice as high as in vivo. Survival and growth after eight days post metamorphosis was also decreased in the suboptimal in vitro method, documenting persisting effects of inferior in vitro methods in the early juvenile stage. However, survival and growth did not differ among methods by the end of the first and second growing seasons. Most importantly, in vitro-produced mussels survived, grew to maturity, and produced juveniles naturally on fishes, all at rates that did not differ from in vivo-produced mussels. We detected no strong side effects of the in vitro culture technique, but studies of additional mussel species using this or similar approaches are needed for developing emergency conservation culture methods for freshwater mussels, particularly those that are difficult to culture in vitro. Verification of the performance of artificially bred mussels after release into the wild, as well as the success of their reproduction is still uncommon but will be increasingly important for the success of conservation programs.

TWENTY YEARS OF MONITORING FRESHWATER MUSSELS AND *DREISSENA POLYMORPHA* IN *LAMPSILIS HIGGINSII* ESSENTIAL HABITAT AREAS OF THE UPPER MISSISSIPPI RIVER.

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In 2000, USFWS determined the continued operation and maintenance of the navigation pools and project-dependent commercial barge transportation would facilitate a continued and maintained source of *Dreissena polymorpha* in the Upper Mississippi River and appreciably reduce the likelihood of survival and recovery of the federally endangered *Lampsilis higginsii*, endemic to the Upper Mississippi River system. The US Army Corps of Engineers monitors 14 areas designated as *L. higginsii* Essential Habitat Areas (EHAs) since 2000; three in the St. Croix, one in the Wisconsin River, and 10 in the Mississippi River. Some sites were monitored prior to the USFWS determination (1988 to 2000). Twenty years of monitoring data from these 14 sites, along with pre-2000 data were synthesized using PCA and trend analysis to detect how unionid assemblages responded to *D. polymorpha* infestation. *Dreissena polymorpha* were first reported in the Prairie du Chien, WI EHA in 1993. By 1996, *D. polymorpha* density exceeded 10,000/m^2. A decline in unionid density at sites monitored in the 1990's was attributed to heavy *D. polymorpha* infestation; however, not all sites were affected. Despite heavy infestation in the late 1990's through approximately 2002, and possibly between 2007 and 2011 in some of the EHAs, unionids and *L. higginsii* persist in all 14 sites. EHAs not or minimally affected include Interstate, Hudson, Hidden Falls, and Orion. Whiskey Rock, PDC, and Cassville are persisting at lower density, but still meet EHA criteria. Harpers and Cordova may be recovering. Changes in unionid assemblages were also noted at Prescott, Winters Landing, McMillan, Bellevue, and Buffalo EHAs with some of these changes perhaps being more related to changes in habitat stability rather than *D. polymorpha* infestation.

DOES IT TAKE A COMMUNITY TO SAVE A SPECIES? INVESTIGATING COMMUNITY INTERACTIONS AMONG AT-RISK UNIONID SPECIES IN THE GREAT LAKES BASIN

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Freshwater unionid mussels contribute to numerous aquatic ecosystem functions. They exert considerable influence across multiple trophic levels through interactions with host fishes during juvenile stages, feeding on algae and organic matter, and through interactions with other filter-feeding species. These influences may qualify them as a keystone species and potentially contribute to their susceptibility for population declines. To date, much research on mussel species interactions has focused on mussel-host fish interactions and early life-stage (i.e., glochidial) processes. However as numerous species face significant declines, improved understanding of other interactions could be critical in management. In the Laurentian Great Lakes of North America, 16 of the 41 unionid mussel species found in Ontario, Canada are

federally assessed as at risk of extinction. To explore community interactions between different mussel species and benthic macroinvertebrates, we carried out a field survey within the highly mussel diverse Sydenham River in Southwestern Ontario. Through partnerships with federal and local conservation authorities, we used a hybrid timed search/quadrat approach to survey both existing monitoring sites and randomly selected sites. Mussel communities were assessed for abundance, size, and co-occurrence with macroinvertebrate taxa, alongside environmental data. Here we present data on patterns of species co-occurrence across multiple environmental gradients. Preliminary results show clear differences in communities across sites and with waterway size. Some common mussel species were nearly ubiquitous across all sites, while other species were only found at a few sites, including listed species at risk. Combining efforts across agencies allowed us to bolster existing datasets and provide additional insight into species coexistence and the presence of potential indicator species. These types of interactions are not often considered in conservation or restoration efforts. As a result, this study will improve local mussel knowledge and aid in the success of future freshwater mussel management efforts across multiple scales.

CAN CRAPPY WATER QUALITY GROW MUSSELS? A MUSSEL GROWTH ANALYSIS OF PAINT LICK CREEK.

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In 2021, an in-situ exposure study of surrogate juvenile *Corbicula* is planned to investigate degraded water quality on freshwater mussel growth and survival in Upper Paint Lick Creek, KY. Based on a 12-month water quality analysis, the upper Paint Lick Creek is heavily polluted with *E. coli* from cattle farms and failing septic and sewer systems throughout the basin as well as a wastewater effluent source in a major tributary. A desktop analysis of the riparian buffer width throughout the watershed showed 65% of the stream miles have poor to moderate riparian buffers. In spring 2021, concrete mussel silos will be placed throughout the watershed at four key locations, three of which have evidence of resident mussels. The in-situ silos with clams will be placed at two sites downstream of the wastewater effluent, one defaunated tributary primarily draining cattle farms, and one site downstream of the whole basin at a known mussel bed that will look at cumulative basin effects. We expect survival to be high and consistent given evidence of resident mussels at most sites. Due to the warm, well-buffered waters of this Bluegrass stream coupled with the elevated *E. coli* and total organic carbon, we expect all mussel to have a relatively fast growth rate compared to nearby Appalachian streams. However, we expect slower growth rates the closer the site is to the wastewater effluent discharge and the slowest growth rates in the defaunated tributary. This project will provide valuable information to the Paint Lick Watershed Alliance for water quality improvement efforts at the watershed scale.

BIODEGRADABLE TRACER PARTICLE TO STUDY THE DISPERSAL OF LARVAL MUSSELS.

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The effects of human land use changes on hydrology and riverbed habitat are pervasive for some organisms. Freshwater mussels may be especially sensitive to these changes since their juveniles are transported freely in the water column and must settle in viable habitat on the riverbed to recruit. Consequently, the physical processes determining where settlement occurs are important for recruitment but have received limited attention. Physical models are used to study hydrodynamically-mediated dispersal when it is not possible or appropriate to release live organisms or their propagules. Large quantities of particles are required, which has historically limited the application of microscopic physical models to non-biodegradable plastics. We developed a novel biodegradable and non-toxic physical model (alginate microbeads) with modifiable size and density. We specifically designed the microbeads to simulate the physical characteristics of juvenile freshwater mussels (Unionidae) to model their dispersal in the field. The microbeads were loaded with a natural fluorescent pigment (riboflavin) to aid with detection. We released the microbeads at a site with measurements of high-resolution riverbed elevation survey data. Microbead captures in drift nets and specially designed sedimentation traps revealed patterns of transport and entry into the riverbed. The decline in microbead capture rates with distance downstream correlated with negative exponential and power model predictions, which is consistent with dispersal studies on larval mussels and other taxa. Our work thus far has also found good correspondence between our microbead captures and the predictions made by a mathematical model that accounts for turbulence. The physical model developed in this study provides an environmentally-friendly resource to study the dispersal of aquatic organisms. This study informs management and conservation efforts on population augmentation planning, and how land use changes to river habitats may affect mussel dispersal.

LANDSCAPE-SCALE DRIVERS OF CURRENT CONDITIONS ACROSS FIVE FRESHWATER MUSSEL SPECIES.

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Understanding the factors leading to declines in freshwater mussels is a critical component of developing conservation strategies; yet, the lack of standardized surveys across the range of many species hinders our ability to make direct comparisons of the impacts of various stressors. This study uses a landscape modeling approach to compare the effects of potential threats to five species ranging across several physiographic provinces, including the Cumberland moccasinshell (*Medionidus conradicus*), Tennessee clubshell (*Pleurobema oviforme*), Tennessee pigtoe (*Pleuronaia barnesiana*), Green floater (*Lasmigona subviridis*), and Rabbitsfoot (*Quadrula cylindrica*). For each species, watersheds were assigned an ordinal condition (extirpated, low, medium, high) based on demographic and distributional criteria that reflect the probability of persistence. An ordinal regression model was then used to determine which stressors from a set of candidate predictors best explained species' current conditions. A negative effect of developed land use was found across all species. Consistent with previous studies on the effects of impervious cover on aquatic fauna, the probability of being classified as extirpated or low condition became nearly certain in watersheds with more than 10-15% developed land use. Conversely, the condition of most species was positively influenced by the

heterogeneity of the surrounding landscape. The relative effects of other stressors (e.g., number of dams, runoff rate, amount and density of agricultural land use) varied across species or were highly uncertain. Despite this variation, all five species were more likely than not (mean probability >0.5) to be classified as extirpated or low condition throughout most of their range based on current land use practices. We discuss how range sizes, current risk profiles, data resolution, and local-scale processes impact inferences on the factors affecting mussel status at the landscape scale, as well as the implications for extinction risk assessments.

REPRODUCTIVE CHARACTERISTICS AND HOST FISH DETERMINATION OF CANOE CREEK CLUBSHELL, *PLEUROBEMA ATHEARNI*, IN BIG CANOE CREEK SYSTEM, ST. CLAIR AND ETOWAH COUNTIES, ALABAMA.

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Canoe Creek Clubshell, *Pleurobema athearni*, was proposed for listing and designation of critical habitat under the Endangered Species Act in 2020 by United States Fish and Wildlife Service (USFWS). It is a Coosa River endemic, historically known only from the Big Canoe Creek watershed in Alabama. In 2017, ADCNR determined *P. athearni* remains in a few scattered occurrences within the Big Canoe watershed and fewer than 50 specimens have been reported since the early 1970's. ADCNR and USFWS have identified artificial propagation and reintroduction as recovery priorities for *P. athearni*. This study determines reproductive periodicity and fish host relationships to initiate the recovery process. Gravid females were first observed in mid-May at water temperatures between 16 - 22°C. Viable glochidia were released in late May and early June while the water temperature in the laboratory incubator was 22°C. Demibranchs of non-gravid animals were thin, tan, and slightly transparent, in contrast gravid demibranchs were slightly inflated and white, orange or pink coloration. Female *P. athearni* released white or orange lanceolate-shaped conglutinates with developed glochidia scattered throughout unfertilized structural eggs. Infective glochidia releases ranged from 5,400 to 59,200 glochidia per female. Glochidia were unhooked with a mean (± SE) length of 180 ± 2 µm and mean height of 171 ± 2 µm. We assessed host suitability of 26 fish species across 7 families in multiple laboratory trials. Successful metamorphosis of glochidia occurred on 13 species of fish from 3 families. Four species were suitable hosts (≥ 30% metamorphosis success) for hatchery production: Alabama Shiner (*Cyprinella callistia*), Blacktail Shiner (*Cyprinella venusta*), Striped Shiner (*Luxilus chrysocephalus*) and Tricolor Shiner (*Cyprinella trichroistia*). Further research is ongoing to improve propagation techniques and reintroduction strategies for this rare species.

A COMPARISON OF UNIONID FEEDING ECOLOGY BETWEEN LENTIC AND LOTIC SYSTEMS.

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Understanding the feeding ecology of unionids is necessary to fully comprehend their role in ecosystem processes, causes of decline and to aid in propagation and relocation programs. Unionids are generally regarded as filterers feeding on planktonic algae. There also is evidence suggesting mussels can utilize benthic food resources in addition to suspended material, although the relative contributions of different dietary constituents may vary depending on habitat. Using a stable isotope approach, we quantified feeding relationships of five mussel species from lotic systems (*Cyclonaias petrina*, *C. necki, C. pustulosa*, *Lampsilis bergmanni* and *L. bracteata*) and three mussel species from a lentic system (*Fusconia escambia, Utterbackiana hartfieldorum*, and *Elliptio pullata)* to determine the relative dietary contribution of fine particulate organic matter (FPOM) associated with benthic sediments, suspended particulate organic matter (SPOM), and detrital coarse particulate organic matter (CPOM). We collected tissue samples of mussels and environmental samples of putative food resources from four lotic systems in Texas and a lentic system in Alabama. Stable carbon isotope ratios ($\delta^{13}C$) and stable nitrogen isotope ratios ($\delta^{15}N$) values suggested lotic mussel species were feeding similarly, as all lotic species derived the majority of assimilated carbon from CPOM and SPOM, but not FPOM. Preliminary analyses of lentic systems suggests that species associated with lentic conditions were primarily utilizing CPOM and FPOM, but not SPOM as food resources. SPOM was never the dominant carbon source across species and habitats, and surprisingly, appeared to be even less important in lentic, as compared to lotic systems. This suggests that mussels from both lentic and lotic systems, across a wide geographical area, are capable of exploiting multiple carbon sources but their primary carbon sources appear to be coming from benthic rather than planktonic sources.

EVALUATING THE THERMAL TOLERANCE OF AQUATIC INVERTEBRATES USING AEROBIC SCOPE.

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Understanding the physiological mechanisms behind thermal tolerance is of increasing importance in the face of ongoing climate change. Aerobic scope may be an important driver underlying thermal tolerance and geographic range of aquatic ectotherms. Aerobic scope represents the excess capacity of an organism to deliver oxygen in support of activity, growth, and reproduction. It can be calculated as the difference between resting metabolic rate (RMR: metabolism required for basic maintenance) and maximum metabolic rate (MMR: maximum metabolic rate an organism is capable of). Aerobic scope exhibits a unimodal relationship with temperature. In theory, the temperature at which aerobic scope equals zero represents the critical thermal maximum (CTM) of an organism where it is no longer physically capable of meeting its energetic needs. We are currently comparing aerobic scope and CTM among various sessile and mobile taxa including unionid mussels (*Pygonadon grandis* and *Lampsilis straminea*), crayfish (*Cambarus latimanus*) and saltwater shrimp (*Litopenaeus*

vannamei). We hypothesize that sessile taxa will exhibit greater aerobic scope at high temperatures than mobile taxa, and this will be reflected by a higher thermal tolerance. To test the concept of aerobic scope, we exposed shrimp, crayfish, and mussels to increasing temperature (1-2°C/hr) from 25 - 50°C. At each temperature, RMR was estimated via respirometry and MMR was estimated via the electron transport system (ETS) assay. Aerobic scope was calculated as RMR-MMR. CTM was estimated as the temperature at which shrimp and crayfish could be flipped over and were unable to right themselves for at least 30 seconds and mussels had an extended foot, gaping shell, retracted mantle tissue and siphons and were unresponsive to touch. Data is currently being analyzed to estimate aerobic scope of mussels, crayfish, and shrimp to determine whether aerobic scope is an important, physiological driver of thermal tolerance among taxa.

REPORT ON TWO SAMPLING SITES FOR FRESHWATER MUSSELS ON THE MELDAHL POOL OF THE OHIO RIVER: COMPARISON AND DISCUSSION.

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Historic mussel survey efforts for sites can be used to document former presence and absence of species; however, data showing species abundance at sites are often lacking. In addition to this, survey efforts for freshwater mussel species across the country are often uneven. Disparities in data availability can be caused by time period, site accessibility and characteristics, proximity to sites, sampling efforts and gear required, regulatory requirements warranting surveys, and even perceived value of efforts expended (i.e., cost/benefit ratio). Due to these factors, some streams receive greater sampling efforts while other streams receive little to no sampling effort. The Meldahl Pool of the Ohio River borders Ohio and Kentucky and arguably falls into the latter category due to limited access, riverine commercial development, and metropolises. Very limited information is available regarding the abundance, distribution, and diversity of mussel resources in the Pool. To combat these disparities, we present mussel survey data for two sites in Meldahl Pool, with one site located in the middle section and another located in the upper section. While sites differ in size and scope, a comparison of the two provides a recent snapshot of mussel abundance and diversity in a portion of the Ohio River that is relatively destitute of survey information in the 21st century. In total, 3,446 individuals were collected from both sites representing 23 live species. In the middle pool 2,462 mussels were found and represented 20 live species. In the upper pool, 984 live mussels were found and represented 20 live species. Sites exhibited similarities (e.g., richness) and differences (e.g., relative abundances) in the mussel assemblage characteristics. These data represent a subset of the historical mussel fauna in this section of the Ohio River and identify the importance and necessity for more mussel inventory surveys in North America's large river systems.

HUNTING FOR PURPLE CATSPAW (*EPIOBLASMA OBLIQUATA*) ON THE WALHONDING RIVER: A PRESENTATION OF EFFORTS AND RESULTS.

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The Purple Catspaw mussel (*Epioblasma obliquata*) is arguably one of the rarest freshwater mussel species listed under the Endangered Species Act (ESA), with its only known extant, wild population in Killbuck Creek, a drainage in east-central Ohio. Killbuck Creek is a direct tributary to the Walhonding River. Hoggarth (1991) found a deadshell in the Walhonding River and eventually led to the discovery of the only known wild population in Killbuck Creek. Although live Purple Catspaw have not been located in the Walhonding River, it is known for its abundant mussel resources and rich mussel community including several other species listed under the ESA. We partnered with Rural Action to perform surveys throughout the Walhonding River in hopes of discovering another extant population of Purple Catspaw. Habitat assessments and scouting trips were conducted in 2018 and surveys were performed at selected sites in 2019. In total, 3,188 live mussels were collected representing 24 species of live mussels with two species listed as Threatened or Endangered under the ESA. Additionally, seven other species were represented through deadshell material.

MODELING DENSITIES, APPARENT SURVIVAL AND POPULATION SIZE OF LOUISIANA PIGTOE (*PLEUROBEMA RIDDELLII*, MOLLUSCA, UNIONIDAE) AT THREE DIFFERENT SITES IN THE NECHES RIVER BASIN OF EAST TEXAS.

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North American unionids are one of the most imperiled organismal groups in the world, with more than 70% considered at least imperiled. This includes several Texas species, such as the Louisiana Pigtoe, *Pleurobema riddellii*, which has been proposed for federal protections and is currently under review by the US Fish and Wildlife Service. Understanding this species' population dynamics, such as apparent survival, densities, and population size is vital to their conservation, however, much of this information is currently lacking. We used previous survey efforts within the Neches River Basin of Texas to identify three sites with locally high abundances of this species. At each site we selected a 25 m^2 area with the greatest *P. riddellii* density and excavated the area. All *P. riddellii* were collected and given a unique identifying PIT tag. We returned each summer to excavate the area and collected all marked individuals and any new *P. riddellii* which were also given a unique tag. This mark-recapture data was then utilized with the computer program MARK to create models to estimate the apparent survival, population size and density at each site. These variables were then compared between sites. A total of 392 *P. riddellii* were collected and marked over the five-year period. Apparent survival was constant across time, and was approximately 85.7 ± 1.8%, with no significant difference between sites. Density was 1.7/m^2 in 2014 and 5.2/m^2 in 2019, while the population size for the three locations combined was 425 ± 10 individuals. Recapture rates were significantly different between years but not sites. These data offer insights into the current status of *P. riddellii* within the Neches River Basin, and some of the first population dynamic information for this species, which is crucial for its conservation.

DIFFERENCES IN SPECIES COMPOSITION AND SPECIES ABUNDANCE OF NATIVE FRESHWATER MUSSELS DRIVES COMMUNITY STRUCTURE AMONG NESTED SPATIAL SCALES IN THE UPPER MISSISSIPPI RIVER.

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Impoundments have adversely affected native freshwater mussel communities both upstream and downstream of the dam structure. The upper Mississippi River was altered by a series of locks and dams in the 1930s to facilitate commercial navigation; this massive alteration likely influenced species composition and abundance of the freshwater mussel community. The lock and dam system created three novel habitats within each navigation pool (the reach of river between two consecutive locks and dams): (1) a riverine portion directly below a dam, (2) a braided channel in the middle, and (3) a lentic environment directly above a dam. Our objective was to quantify differences in species composition and species abundance among pools, among pool thirds, and among unique aquatic areas within pools. PERMANOVA on Jaccard's (species composition) and Bray-Curtis (species abundance) dissimilarity indices were used to examine differences among and within pools, and among aquatic areas. We also examined species contributions to differences in species composition and species abundance. Dissimilarity indices varied significantly among pools and pool thirds indicating a difference in species composition and species abundance. Species composition and abundance in contiguous floodplain lakes were statistically different than all other aquatic areas except tertiary channels. Differences in species composition and abundance were driven by *Amblema plicata, Utterbackia imbecillis,* and *Obliquaria reflexa*. These analyses indicate a nested mussel community structure among pools, pool thirds, and multiple habitat types. Collectively these analyses indicate that given observed differences in species composition and abundance of mussels at three ecologically relevant spatial scales, managers would benefit from consideration of spatial context in future management actions. Understanding the scale(s) at which freshwater mussel communities differ is critical in developing an effective management strategy to restore freshwater mussel communities in the upper Mississippi River.

LONG-TERM TEMPERATURE ASSESSMENT OF STREAMS INHABITED BY THE THREATENED TENNESSEE HEELSPLITTER (*LASMIGONA HOLSTONIA*).

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The Tennessee heelsplitter (*Lasmigona holstonia*) is endangered in Virginia and is a candidate for listing under the U.S. Endangered Species Act. It is a coolwater species that resides in headwater streams prone to flow fluctuations during heavy precipitation events. Our current understanding of *L. holstonia* behavior suggests that individuals may remain buried in the sediment for extended periods of time, particularly during summer months in an effort to find thermal refuge from warmer water temperatures. To establish a baseline temperature tolerance range for this species, temperature loggers were deployed in summer 2019 in five *L. holstonia* streams, four in southwestern Virginia and one in southern Tennessee. At all sites, a logger was placed in-stream about 20 cm above the sediment-water interface, and recorded

temperatures every 90 minutes. Daily water temperatures ranged between 0.5°C – 28.5°C from June 2019 – June 2020 across all four Virginia streams and between 8°C – 21.5°C from July 2019 – May 2020 in the Tennessee stream. Within a 24-hour period, 5°C – 7°C temperature shifts were frequently observed, which exceeds the daily temperature shifts recommended for mussel laboratory assessments (≤3°C). At one Virginia site (South Fork Clinch) and the Tennessee site (Cloud Branch), an additional logger was buried ≥20 cm below the sediment-water interface. Sediment temperature ranged between 3°C – 24.5°C (South Fork Clinch, VA) and between 8.5°C – 20°C (Cloud Branch, TN) and daily temperature shifts were generally less variable than in-stream temperature, suggesting that burrowing into sediments may allow *L. holstonia* to withstand stream temperature fluctuations. Furthermore, below-sediment temperatures remained 0.5°C – 8°C cooler than in-stream temperatures during summer months, suggesting that the sediments may act as a thermal buffer for *L. holstonia* during warmer months. Results from this study have guided a companion laboratory thermal tolerance assessment and will provide critical habitat information needed for possible listing of this species.

ASSESSING THE RELATIVE TOXICITY OF ROAD SALT ALTERNATIVES TO FRESHWATER MUSSEL GLOCHIDIA.

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The increasing salinity of freshwater in temperate regions is related to the use of road salt for winter road maintenance. Freshwater mussels have a heightened sensitivity to salt. Winter road runoff is acutely toxic to early life stage mussels and reduced wild mussel abundance has been observed in the receiving environment. Best management practices have been implemented to reduce road salt use and there is growing interest in alternative de-icing products. A number of “eco-friendly” de-icing products including those made from fermented beets are currently in use in some jurisdictions. Salt sensitive organisms would be expected to benefit from a move to alternative de-icing products, however there is a need to assess whether the alternatives pose a risk to biota. The toxicities of three road salt alternatives including a salt brine, a beet juice product, and a brine-beet juice product were examined. Following standard methods, *Lampsilis fasciola* glochidia were exposed to dilutions (0-2%) of de-icing products, and viability was assessed after 48 hours. Beet juice-containing products were more toxic than salt brine on a per volume basis. The concentrations that affected half of the exposed glochidia (i.e. EC50) were: brine, 0.42%; beet juice, 0.03%; and brine-beet juice product, 0.02%. Unlike brine, the toxicity of beet juice-containing products does not appear to be related to the chloride concentration in the exposure. While elevated trace metals (Cu, Fe, Zn) and reduced water quality (decreased dissolved oxygen) occurred in the 1 and 2% beet juice exposures, toxicity occurred at much lower dilutions (≤0.05%). In contrast, potassium concentrations in exposures where toxicity occurred aligned with previously reported EC50s, suggesting that potassium is at least contributing to the observed toxicity. While further study is needed to investigate whether mussels in environments that receive runoff from beet juice de-icing products are impacted, this study found that on a per volume basis, beet juice-containing products were 10 times more toxic and thus would not pose a lower risk to early life stage mussels than a salt-based de-icing product.

EVOLUTION OF INTERSPECIFIC EGG-LAYING STRATEGIES IN THE FRESHWATER GASTROPOD FAMILY PLEUROCERIDAE (CAENOGASTROPODA: CERITHIOIDEA)

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Freshwater gastropods exhibit a diverse range of life history strategies, such as laying eggs or giving live birth. It has been shown that several freshwater gastropod life history traits (e.g., reproductive timing, clutch size) can significantly vary throughout a species' range in response to both biotic and abiotic changes. However, few studies have examined life history traits that vary among but not within species. Such traits may influence contemporary biodiversity patterns by creating or reinforcing reproductive barriers. As such, evaluating these traits in a robust phylogenetic context may shed light on the ecology and evolution of freshwater gastropods. One family that displays among species variation in life history is the Pleuroceridae (Caenogastropoda, Cerithioidea) – a biodiverse and geographically widespread family of North American freshwater gastropods that occupy rivers and streams east of the Rock Mountains. Specifically, pleurocerid egg-laying strategies can be sorted into several unique modalities: singly-laid eggs, small individual lines of eggs, circular egg clutches, and eggs laid together in large strip-clutch formations. Here, we examine the evolution of egg-laying behaviors using a phylogeny generated with hundreds of loci via anchored hybrid enrichment methods. Our results indicate that egg-laying strategy in pleurocerids exhibits significant phylogenetic signal. Moreover, ancestral character reconstruction analyses demonstrates that circular egg clutches are the likely ancestral state for pleurocerids, and the transition to either singly-laid eggs or single lines of eggs has independently evolved among pleurocerids multiple times with no reversals. The strip-clutch mode evolved only once, also with no reversal. Convergence has likely shaped contemporary patterns of egg-deposition within pleurocerids, and the general evolutionary trajectory of this trait has gone from more parental investment in egg-deposition to less. However, trade-offs may exist concerning site selection for eggs and/or clutch size. Information on egg-laying should inform captive propagation efforts, a potentially important tool in pleurocerid conservation.

AN UPDATE ON MUSSEL CULTURE AND MUSSEL-ADJACENT WORK AT GENOA NATIONAL FISH HATCHERY

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Genoa National Fish Hatchery (GNFH) has been involved in the culture of freshwater mussels in the Upper Mississippi River Basin since efforts began in 2000. The program has expanded from working with a single species, using a single technique, to working with as many as 18 species in as many 6 locations, and the techniques used have evolved and been made to suit the culture location or species specific needs. While many of the species' life cycle depends on game fish species, others, such as Salamander Mussel and Snuffbox use non-game or protected species, and require very different culture conditions. The Common Mudpuppy *(Necturus maculosus),* host for Salamander

Mussel, requires specialized culture and rearing efforts. Overturned cage bases with a slightly raised, flat plywood surface were used as spawning structures for a cohort produced in 2017, with recirculating systems used for juvenile rearing, inoculated adult housing, and juvenile mussel collection post-infestation. Logperch (*Percina caprodes)*, fish host for Snuffbox, were spawned on station in 2020, with intention to utilize pond culture to maintain a sustainable source of host fish on station. Tools and techniques from mussel culture can be applied to the recovery of other invertebrate species. Hine's Emerald Dragonfly (*Somatochlora hineana*) have been reared on station since 2015, and 2020 saw the addition of Devils Crayfish (*Cambarus diogenes*), a burrowing crayfish that seems to create habitat for Hine's Emerald larval development. The overlap of culture needs and the ability to share supplies such as rearing trailers, tanks, cages, and temperature controlled recirculating systems can make for a more efficient use of staff time for a diverse hatchery's non-traditional species culture program.

INVESTIGATING *TRYONIA* SPRINGSNAILS THROUGH PHYLOGENY AND MORPHOMETRICS.

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The isolated, spring-fed desert marshlands—or cienegas—of west Texas are home to a wide assortment of invertebrate life forms. The diversity of species in these cienegas is indicative of water quality, both in the springs themselves, as well as in the aquifer from which they are fed. Many of these invertebrates are members of closely related groups but have been geographically separated for so long as to have diverged both genetically and morphologically to form distinct species. Because these species are often endemic to only a handful of sites, many of them are under threat of extinction. One such group that is relatively understudied is the genus of springsnails called *Tryonia*. Here, I present the beginnings of an ongoing study that will add to the knowledge base for this genus by constructing a phylogeny based on gene sequencing and morphometric data. Once complete, this work will aid in the construction of a broader phylogeny that will be a constructive part of the knowledge base necessary to conserve this genus and the threatened species within it.

USING UPPER THERMAL LIMITS OF *LAMPSILIS BRACTEATA* (TEXAS FATMUCKET) FROM THE NORTH LLANO AND SAN SABA RIVERS, TEXAS TO INFORM WATER MANAGEMENT PRACTICES IN THE EDWARDS PLATEAU.

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Increased human demand for freshwater resources coupled with climate change can impact natural temperature regimes in rivers, which can be catastrophic for aquatic biota and ecosystem function. The San Saba and Llano rivers, located in central Texas, exemplify this issue. Increased water demands coupled with variable hydrology have resulted in persistent low flows and stream dewatering. These hydrological changes are problematic because both systems harbor species, including *Lampsilis bracteata*, Texas Fatmucket, under review for protection under the U.S. Endangered Species Act. It is suspected elevated water temperatures are a contributing factor in its decline. To test this

hypothesis, we evaluated the upper thermal tolerances of glochidia (larval) and juvenile life stages from one population within each river. Mussels were acclimated to 27˚C and tested across a range of experimental temperatures (30 - 39˚C) in standard acute (24-h and 96-h) laboratory tests. The thermal thresholds for both glochidia (24-h) and juveniles (96-h) were then related to *in situ* water temperature and discharge data using a uniform continuous above-threshold (UCAT) analysis. In the North Llano, 24-h LT50 was 31.8˚C (CI: 31.5˚C - 32.1˚C), while the 96-h LT50 was 32.4˚C (CI: 32.1˚C - 32.8˚C). In the San Saba, 24-h LT50 was 34.7˚C (CI: 34.5˚C - 35.0˚C), while the 96-h LT50 was 32.5˚C (CI: 32.2˚C - 32.9˚C). Analysis showed LT50 thresholds were not exceeded for *L. bracteata* within the San Saba, but LT05 thresholds were exceeded. Temperature loggers were lost in the Llano River due to a large flood; however, water temperature samples reported by the Texas Commission on Environmental Quality show thermal thresholds are being exceeded in the Llano River basin. Findings from this study indicate thermal tolerances of *L. bracteata* vary by population and low flows may be contributing to its decline in the San Saba and Llano rivers.

ECOSYSTEM SERVICES OF FRESHWATER MUSSELS: BACTERIA REMOVAL BY *ANODONTA ANATINA*.

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Decline of freshwater mussels (Unionida) is a global phenomenon, threatening biodiversity and the essential ecosystem services that mussels provide. Freshwater mussels can clear the water by filtering suspended particles, such as phytoplankton, but they can also remove bacteria from the water and therefore decrease the risk of infections in aquatic organisms. Here, we studied if the common freshwater bivalve *Anodonta anatina* (duck mussel) can remove *Flavobacterium columnare* from water. This bacterium is the causative agent of columnaris disease in fish, which causes serious problems in aquaculture. Mussels removed bacteria from the water in two experiments performed, so that after 96-h monitoring, the concentration in mussel treatments was only 0.3–0.5 times that of the controls. Mussel behavior (shell openness, foot position, and movement) was not affected by the presence of bacteria or algae. Biodeposition formation was higher with algal diet than with bacterial diet, and lowest in clean water. The intestines of *A. anatina* that were offered bacteria, harbored *F. columnare*, suggesting that mussels ingested the bacteria. From the ecosystem services angle, present result supports the view that freshwater mussels can have an influence on bacteria, and suggests that freshwater mussels have a potential to mitigate problems caused by aquaculture pathogens as well as to play a role in water quality management.

DISTRIBUTION AND RELATIVE ABUNDANCE OF THE GASTROPOD FAUNA OF THE NORTH AND SOUTH ESK, DALKEITH COUNTRY PARK, MIDLOTHIAN, SCOTLAND.

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The confluence of the North Esk and the South Esk occurs in the Dalkeith Country Park in the Edinburgh suburb of Dalkeith within the Midlothian Council Area. Both rivers have a long history of coal mining and subsequent acid mine drainage which has affected their invertebrate faunas. From April to June in 2020, tens of thousands of gallons of acid mine drainage flowed daily into the South Esk from Junkie's Adit, a pipe draining a disused coal mining operation. The benthic habitat has turned a bright orange color from the now abundant iron ochre coating on all surfaces. An ecological baseline for the gastropod fauna exists for both streams. The rivers were sampled for gastropods monthly from August through November in 2016 with timed, hand sampling in two, wadeable reaches for each stream. In addition, water quality was assessed for dissolved oxygen (DO), pH, electrical conductivity (EC) , total dissolved solids (TDS) and water temperature. Over the entire collecting period, 377 gastropod individuals were collected in North Esk, and 136 in the South Esk. The impoverished fauna contained only three species: *Radix balthica*, *Potamopyrgus antipodarum* and *Ancyclus fluviatilis*, with *R. balthica* dominant in both North Esk (92%) and South Esk (89%). Size frequency distributions (shell width) for South Esk are significantly smaller. Despite signage in the Dalkeith Country Park that proclaims South Esk to be "… much cleaner and supports much more varied aquatic life", the pH was more acidic (mean 7.74) than for North Esk (mean 8.16). In addition, South Esk had higher EC and TDS, traditional signals of stream pollution, suggesting previous leakage from Junkie's Adit before the 2020 event.

ALTERNATIVE METHODS TO DETECT *SIMPSONAIAS AMBIGUA,* SALAMANDER MUSSEL.

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Simpsonaias ambigua, Salamander Mussel, was assessed as Endangered in Canada in 2001. *Simpsonaias ambigua* was historically known from several locations within the province of Ontario; however, its current distribution is believed restricted to the East Sydenham River. Timed searches "Rock Flipping", to detect extant occurrences of *S. ambigua* at large scales (e.g., within a river) can be time consuming and expensive as this species is small, rare and occupies a specialized habitat. There is a critical need for less costly and more effective methods to find locations where *S. ambigua* is present at larger scales to effectively manage and recover this imperiled species. The goals of this project were 1) to develop two additional methods to identify sites (e.g., reach) where live *S. ambigua* are present and 2) to compare the effectiveness of each method. The first additional method "Mudpuppy Capture", consisted of trapping *S. ambigua*'s host, *Necturus maculosus*, Mudpuppy, and inspecting for signs of encysted glochidia. The second method was detection of *S. ambigua* environmental DNA (eDNA). Rock Flipping and eDNA sampling were conducted in four rivers in Ontario, Canada where there are records (live or spent shells) of *S. ambigua.* Live individuals and eDNA were detected only in the Sydenham River. Mudpuppy Capture was only conducted at the Sydenham River, and encysted glochidia were observed during the month of March. Rock Flipping in wadable rivers was shown to be the best method for detecting extant populations of *S. ambigua* and was the only method that allowed for an estimation of population health (direct handling permitting counting measuring of individuals). The other two methods are suitable when exploring large areas for the first time, as they help narrow the search area using traditional surveys or when Rock Flipping is not possible.

TRENDS IN MUSSEL ABUNDANCE AND HABITAT CHANGE 5-YEARS POST DAM REMOVAL.

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Uncertainty surrounding the benefits and risks of dam removals to Unionidae are of continued concern for management agencies faced with weighing competing conservation objectives. Despite the obvious hypothetical benefit of increased distribution potential following dam removal, evidence of improved population or habitat for mussels following dam removal is lacking. We present a data of change in mussel abundance and habitat availability spanning 5-years following a 2015 dam removal on the Nissitissit River in Massachusetts. We monitored seven sites in 2015 (prior to removal), 2018, and 2020. Sites were located in the impoundment (n=2), downstream of the dam (n=2), and upstream of the influence of the impoundment (n=33). Using a before-after-control-impact (BACI) design, we tested semi-quantitative differences in *Elliptio complanata* abundance. Catch per unit effort (CPUE) of *E. complanata* in upstream reference sites decreased across years; however, we observed significant increases in CPUE in impounded and downstream sites following the dam removal, which is likely an artifact of reduced wetted stream widths in impounded sites. Change in habitat availability for *A. varicosa* was evaluated using multivariate ordination to compare 26 microhabitat variables (e.g., substrate composition, depth, sediment penetration) at 24, 1-m^2 quadrats randomly stratified per site, compared to habitat data constrained to the location of *A. varicosa*. We observed habitat transition in impoundment sites from before to after dam removal toward habitat occupied by *A. varicosa*, while downstream sites and upstream reference sites experienced little habitat change over the same period. We present our findings in the context of other work on dam removals and mussels and discuss opportunities to further identify risk factors and management options to reduce risk.

DOES HISTORICAL CLIMATE EXPLAIN LIMITED POPULATION STRUCTURE IN AN ENDANGERED UNIONID?

Steven R. Hein[1] and David J. Berg[2]. [1]Miami University, Oxford, OH; [2]Miami University, Hamilton, OH.

The Neosho Mucket, *Lampsilis rafinesqueana*, is a federally endangered unionid native to the central region of the United States. Extant populations of this species have been both severely reduced and fragmented due to impoundment and habitat alteration. Contemporary migration amongst populations is likely to be severely limited as a result. Current conservation efforts include translocations and the release of captively bred individuals. While these are both commonplace and reliable strategies, their efficacy can be further improved by incorporating genetic information from wild populations into management efforts. Measures of population structure or gene flow are normally more reflective of historical migration patterns rather than recent anthropogenetically influenced patterns. By incorporating the evolutionary history of populations into conservation strategies, managers can help to avoid threats such as outbreeding depression. We sampled 140 individuals from six of the seven rivers occupied by *L. rafinesqueana*. Samples were then sequenced using both next-generation

and Sanger sequencing methods to assess genetic diversity, population structure, and geneflow. Furthermore, we used ecological niche modeling to understand current and historical habitat suitability in the region. We found that basic measures of diversity and estimates of genetically effective population size are correlated with estimates of total census size for each river. There is also no population structure amongst the six rivers indicating a panmictic or single genetic population shared amongst the rivers. This pattern is often observed in species above or near the Pleistocene glacial boundary, where populations rapidly moved northward following glacial retreat. We are currently testing for further genetic evidence of a recent population expansion, as well as the role of historical climatic conditions via niche modeling. A single genetic population allows managers to have less restrictive conservation strategies that can include moving of individuals among extant populations.

OVERVIEW OF THE FRESHWATER MOLLUSK CONSERVATION SOCIETY'S PROPAGATION AND RESTORATION COMMITTEE.

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Since the official formation of the Freshwater Mollusk Conservation Society in 1998, propagation and restoration have been central components of the Society's mission and the National Strategy for the Conservation of Freshwater Mollusks. Propagation and restoration activities serve a vital role in the overall conservation of mollusks and have contributed to a better understanding of life history requirements, toxicological research, and species and community restoration. The current mission statement of the Propagation and Restoration Committee is to support the conservation of mollusks through propagation and restoration by developing recommendations for best science and management practices, supporting outreach and research on mollusk conservation, and facilitating coordination of propagation and restoration efforts among the Society's membership. Activities and goals of the Committee include 1) development and publication of techniques and guidelines for mollusk propagation, reintroduction, augmentation, translocation, facility protocols, and habitat restoration; 2) compiling, managing, and disseminating the FMCS Propagation and Restoration Database 3) providing data for mollusk replacement values; and 4) supporting collaboration and coordination between Propagation and Restoration Committee members worldwide. The Committee has grown from a handful of members to over 100 members in the last 30 years, representing the growing interest in and need for propagation and restoration activities. For this reason, the committee members recently voted to form two subcommittees: 1) Aquaculture and Population Restoration and 2) Habitat Restoration. At the 2021 Virtual Symposium, committee members will elect chairs and define the mission statements and goals for the newly formed subcommittees. We encourage any society member interested in mollusk propagation and habitat restoration to consider joining and/or contributing to the Propagation and Restoration Committee.

CONSERVATION FOR AN ENDEMIC SPRINGSNAIL IN UTAH'S WEST DESERT.

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The Sub-globose Snake Pyrg *Pyrgulopsis saxatilis* is a springsnail found only in one spring complex in the West Desert of Utah. It is considered a sensitive species in Utah due to its endemism and was petitioned for listing under the Endangered Species Act (ESA) in 2019. Springsnail surveys in 2019 found that the current abundance and distribution of this species had declined and non-native fishes were present for the first time. Biologists were concerned that Armored Catfish (*Ancistrus* sp., most likely *A. cirrhosus*) could be directly consuming snails or indirectly competing for food, which could be contributing to the lower observed springsnail densities. In 2020 the Utah Division of Wildlife Resources, along with federal partners, developed a Conservation Agreement and Strategy (CAS) that committed all partners to conservation actions to help ensure the persistence of this springsnail. Efforts are already underway to implement the CAS. A total of 1,758 Armored Catfish have been mechanically removed from the spring complex since December 2020. Some of these Armored Catfish (568) were marked and released below a newly constructed barrier to assess its effectiveness at preventing upstream movement of non-native fishes. To date, none of the tagged fish have been found upstream of the barrier. Future rotenone treatments are planned for non-native fish eradication efforts, and bioassays suggest that a 4 ppm treatment over 8 hours should achieve 100% mortality of all non-native fishes. Examination of 56 Armored Catfish stomachs found seven springsnail shells in six stomachs. The Sub-globose Snake Pyrg was determined to be not warranted for listing under the ESA in 2020 due, in part, to the partner commitments identified in the CAS. The CAS partners plan to continue conservation efforts to ensure the persistence of this species into the future.

FRESHWATER MUSSEL BED ASSEMBLAGE STRUCTURE GOVERNS THE FLUX AND STOICHIOMETRY OF LOCALLY AVAILABLE ORGANIC AND INORGANIC NUTRIENTS IN RIVERS.

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Much research has shown the importance of mussels in mediating inorganic N and P cycling in green food webs, yet limited work has tested whether mussels supply dissolved organic matter (DOM) that may positively influence brown food webs via enhancing microbial production. We used parallel-factor analysis to quantify DOM fluorescent components composition of mussel excretion and expected excretion of labile DOM following digestive breakdown of particulate food. Next, we combined measured excretion rates of DOM, ammonium (NH_4^+, N), and phosphorus (P) for 22 species with biomass estimates for 14 aggregations to quantify contributions of DOM, N, and P to local availability. Because mussels occupy distinct stoichiometric niches, we anticipated that differences in species biomass and assemblage structure would elicit different flux and stoichiometries of aggregate excretion. Aggregate dissolved organic carbon (DOC) excretion was minor (1-11%) compared to N (12-2860%) and P (1-97%), yet generalities across assemblages emerged regarding organic matter transformation by mussels towards labile, protein-like compounds compared to abundant aromatic, humic compounds in ambient water. Aggregate excretion of labile DOM was a substantial pool of bioavailable energy, contributing 2 – 114% of local labile DOM. Spatial differences in assemblage structure led to differences in aggregate flux and stoichiometry driven by biomass and stoichiometric trait expression of species with contrasting dominance patterns. Under the nutrient conditions of our study (high C:nutrient), biogeochemical hotspots associated with mussel biomass may indirectly control energy flow to the brown food web by shifting C:nutrient stoichiometry available to microbes or directly by increasing the flux of microbially available DOM. Collectively, our results highlight a potentially substantial flux of labile energy and nutrients to microbial communities through the transformation of ingested organic matter by mussels and emphasize that shared functional trait classification may not translate into shared ecological function.

EFFECT OF SUBSTRATE PARTICLE SIZE ON BURROWING OF THE JUVENILE FRESHWATER PEARL MUSSEL *MARGARITIFERA MARGARITIFERA.*

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Juveniles of the endangered freshwater pearl mussel (FPM, *Margaritifera margaritifera*) live the first years of their life burrowed in the stream bed. Previous studies indicate that stream substrate composition is the most important factor limiting the recruitment of FPM. Fine sediments impede water exchange between the free water body and microhabitats within substrate and may cause juvenile mortality and recruitment failure. To better understand the connection between success of juvenile FPM and substrate composition, it would be important to understand how substrate particle size affects FPM behaviour at this vulnerable life stage. We placed newly metamorphosed juvenile FPM

in a 7-mm layer of sand (particle sizes <120, 120–200, 200–250, 250–500 and 500–650 µm), applying each substrate treatment to 10 replicates, ten juveniles per replicate, and monitored the burrowing status of juveniles for 96 h. Mean dish-specific proportion burrowed (PB) was significantly affected by substrate particle size, increasing from 52 % in the finest sand to 98 % in the coarsest sand. The significant substrate × time interaction was due to dropped PB (30-34 %) in finest sand at 2 and 4 h time points. The results indicate a clear behavioural response by juvenile FPM to substrate particle size, fine substrates triggering surfacing behaviour. Surfacing behaviour may indicate stress and exposes juveniles to predators and drift. Thus, our results show that substrate particle size is an essential measure of FPM habitat quality.

HIGHLY STRUCTURED POPULATIONS OF *VENUSTACONCHA ELLIPSIFORMIS* REVEAL NEED FOR CONSERVATION MANAGEMENT.

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Analysis of genetic variation within species provides insight into the ecological and evolutionary forces that produce patterns of population structure in time and space. Additionally, genetic information is necessary for assessing genetic erosion within and among populations and developing effective conservation strategies for at-risk species. *Venustaconcha ellipsiformis*, Ellipse, occurs throughout the American Midwest. Populations of this species are prone to isolation because its distribution is patchy and hosts are small and less mobile. Many states list this species under some sort of protection due to a reduction of populations. To understand current genetic diversity and structure, we conducted a range-wide population genetic analysis of *V. ellipsiformis* using 14 microsatellite loci. Twenty-one locations were sampled in the Mississippi River and Great Lakes basins. Genetic diversity varied greatly among locations. High genetic divergence indicates that gene flow is currently limited among locations. Cluster analysis identified multiple genetic populations corresponding to major drainage basins. Current genetic diversity and highly structured populations are likely a reflection of both past geological events such as glaciation and more recent habitat fragmentation. Genetic variability within the species needs to be considered in the development of conservation strategies and species recovery plan.

CULTURE OF THREE SPECIES OF FRESHWATER ALGAE USED IN THE PROPAGATION OF FRESHWATER MUSSELS.

Julieann Jacobs, Travis Williams, and Monte McGregor. KDFWR, Center for Mollusk Conservation, Frankfort, KY 40601

Microalgae have an important role in the culture of freshwater mollusks since they provide the majority of their nutritional requirements. At the Center for Mollusk Conservation, we cultured two freshwater green algae species, *Neochloris oleoabundans* (UTEX 1185, University of Texas Culture Collection of Algae.) and *Chlorella sorokiniana* (UTEX 1230) as well as a freshwater diatom, *Phaeodactylum tricornutum* (UTEX 646) to use in a freshwater mussel diet. We cultured algal species in a sterile environment to keep cultures pure and free of large amounts of microorganisms. To accomplish this, the beginning stages (test tubes and small flasks) are kept in a sterile, temperature controlled incubator

with a 24-hour light cycle and sterile air. We also used autoclaved water and sterile filtered nutrients mixed in a biosafety cabinet and/or laminar flow hood. Cultures of freshwater green algae multiplied to an appropriate density for the next growth stage in about 3-4 days, whereas freshwater diatoms took about 6-9 days. We used Guillard's f/2 part A and B medium, a sodium metasilicate solution, a secondary salt solution, and calcium chloride solution (recipe from the WSS National Fish Hatchery) to supplement essential nutrients for the algae. Cultures were grown in 50 mL, 250 mL, 500 mL, 2L, 12L, 30L, 100L, and 450L at various successive stages. We also used a 1000L Industrial Plankton® photobioreactor to aid in large harvests of *P. tricornutum.* Algae cultured in the larger volumes were harvested using a 300L cream separator and 750L algae centrifuge (US Filtermax) to remove the water and fertilizer, thus concentrating the liquid algae into a paste. We then reconstituted the paste into a solution of known volume to feed in our freshwater mussel diet along with three species of commercially available marine algae.

UNDERSTANDING FRESHWATER MUSSEL DISTRIBUTION, ABUNDANCE, AND DEMOGRAPHY IN THE SOUTH UMPQUA RIVER BASIN, OREGON: IMPACTS OF LAND USE AND STREAM HYDRAULICS.

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Freshwater mussels are both keystone and indicator species within aquatic ecosystems and are declining across their historic ranges within the Pacific Northwest (PNW). A current lack of baseline information regarding freshwater mussel distributions, abundances, and bed demographies in the PNW limits the ability of resource managers to effectively monitor and conserve populations. We sought to address this knowledge gap in the South Umpqua River basin by documenting freshwater mussel abundance at 13 site locations and by systematically sampling 4 mussel beds on both the South Umpqua River and a major tributary, Cow Creek. We documented all three PNW genera, but only one species (*Margaritifera falcata*) was widespread. On the South Umpqua River, species richness and mussel abundances were lowest at downstream sites and increased upstream. We found widespread evidence of recent *M. falcata* reproduction, but the lower South Umpqua River population is likely non-viable. The percentage of forest cover within the drainage basin area was the best predictor of mussel abundance, and indicates that the cumulative impact of anthropogenic land use may be degrading mussel habitats. Our data also suggested a relationship between invasive Asian clams (*Corbicula fluminea*) and suppressed mussel abundances, but additional research is needed to understand the competition dynamics between these species.

ASSISTED POPULATION VIABILITY AS A STRATEGY TO RESTORE AND MAINTAIN FRESHWATER MUSSEL POPULATIONS.

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Hatchery programs in the United States now have the capacity to rear and stock large quantities of mussels to stream sites throughout the country. Stocking efforts are ongoing to establish, build-up and maintain populations of rare and endangered species to increase their chances for long-term persistence. As biologists attempt to restore mussel populations throughout the country, development of stocking strategies and population size targets will be critical to determining the success of these restoration and recovery efforts. As practitioners we often have more questions than answers when we start thinking about mussel stocking strategies such as how quickly should we build-up a population, how big should it ultimately be, and how best to maintain it over time? Further, when can we stop stocking and redirect resources to a different population or priority species? In this talk, we use an age-structured population model to demonstrate how assumptions regarding survival of released mussels, growth rate, and population size targets affect stocking strategies and outcomes. Once a population reaches a target size, we demonstrate how supplemental stocking (i.e., "assisted population viability") can be used to maintain long-term viability even under a scenario of declining growth. A strategy of assisted population viability is prudent and likely needed for many species until the long-term probability of persistence of a newly established population can be determined via monitoring. We also demonstrate this strategy with demographic, stocking and monitoring data combined with modeling results from the federally endangered oyster mussel (*Epioblasma capsaeformis*) in the Clinch River, Virginia.

DEMOGRAPHIC MONITORING OF TWO SPECIES OF ENDANGERED SPRINGSNAILS (CAENOGASTROPODA: HYDROBIIDAE) USING SHELL SIZE AND MACRO-PHOTOGRAPHY.

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Collecting demographic and life history information of any species can be challenging. This is especially true of tiny hydrobiid springsnails which typically require preservation and dissection to collect demographic data. An additional challenge arises when working with endangered or threatened species as collecting and handling individuals should be limited. This current study was undertaken to develop an efficient and sustainable means of monitoring the population structure of two species of springsnails over time. These two species, the Chupadera springsnail (*Pyrgulopsis chupaderae*) and the Alamosa springsnail (*Tryonia alamosae*) are federally endangered, single-spring endemics from south-central New Mexico. The first objective was to determine the efficacy of taking high resolution macro photographs of the live organisms, on-site from which we could later measure. The second objective was to test the ability to determine the sex of each species while it was still alive. Springsnails were sampled at intervals at transects across the extent of the spring habitat, photographed, observed, and then preserved in 95% ethanol. Each preserved snail was then examined under a stereo microscope and photographed using

standard methods for gastropod shells. Shell length was measured on each photograph using the software ImageJ. Data from field and lab photographs were compared to determine if macro photography in the field could produce accurate shell length measurements. Measurements taken from field photographs were not statistically different from those taken from microscope photographs (t_{38} = 1.3086, p = 0.1985). Results of this pilot study indicate that shell size data can be obtained from macro photography but sex determination from observations of live springsnails was thus far unsuccessful. Ongoing investigations will continue to guide the development of methods for long-term demographic monitoring.

LINKAGES BETWEEN BEHAVIOR, METABOLIC DEPRESSION, AND MORTALITY OF UNIONID MUSSELS EXPOSED TO THERMAL STRESS.

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Understanding the linkages between behavior, physiology, and mortality may help to reduce the number of assays required to understand environmental limits of unionid species, identify appropriate surrogates for rare species, and replace lethal assays with predictive sublethal assays. To investigate linkages, we used a surrogate thermally sensitive species (*Pyganodon grandis*), a surrogate tolerant species (*Lampsilis straminea*) and a federally threatened species (*Popenaias popeii*). Individuals were exposed to increasing temperature at a rate of 2℃/hr from 25 - 50℃ and respiration rates measured for 7 *P. grandis*, 7 *L. straminea*, and 6 *P. popeii*. Ten additional individuals of *P. grandis* and *L. straminea* were observed outside of the respiration chambers for behavior (foot extension, valve gaping) and temperature at death. *Pyganodon grandis* (sensitive) initiated foot-extension behavior at 37℃, metabolic depression (reduction in respiration with increasing temperature) at 40℃ and valve gaping and death at 43 ℃. *Lampsilis straminea* (tolerant) experienced metabolic depression at a lower temperature (38℃) but did not exhibit foot extension until 41℃. Foot extension was followed by valve closure, rather than gaping, at 43℃, and only one individual had died before the experiment was halted at 50℃. *Popenaias popeii* (endangered) most closely resembled the sensitive surrogate species with individuals in the respiration chambers initiating foot extension at 35℃, and metabolic depression at 40℃. Gaping was initiated at 40℃ with 6 individuals observed to be deceased after removal from the chambers at 43℃. More trials need to be conducted with additional species, but current results suggest that linkages between sublethal behavioral and physiological endpoints may be useful for predicting differences in thermal tolerance among species and identification of appropriate surrogates for threatened and endangered species.

MODELLING THE RELATIONSHIP BETWEEN HOST FISH AVAILABILITY AND THE REPRODUCTION SUCCESS OF MUSSELS.

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The diverse community of North American freshwater mussels are declining rapidly; nearly 70 percent are considered extinct or imperiled due to water pollution and dams. Mussels act as a keystone species in determining water quality by continuously filtering out algae, bacteria, and other organic and inorganic matter from the water column as they feed. Undigested material is expelled from the mussel as pseudo-feces and inorganic materials are held in a matrix which reduces their resuspension. This pseudo-feces is a food source for many other invertebrates. Mussels and fish exhibit a parasitic relationship requiring each mussel species to have a specific fish host to complete their life cycle. A binomial probability model was developed using the freshwater mussel population native to the Greenup Pool of the Ohio River to facilitate investigation of the relationship between host fish availability and the reproductive success of mussels. The model assumes two possible outcomes; one in which the host fish comes in contact with the mussel, defined by the visibility radius, and the other when it does not. Twenty sites were randomly chosen and sampled using electrofishing for 48 different Osteichthyes species by the Ohio River Valley Water Sanitation Commission (ORSANCO). A subset of nineteen sites were also sampled for 23 mussel species over six perpendicular 100 meter transect lines using SCUBA. The probability model predicts the effects of change in host fish availability and the visibility in the river on the overall reproductive success of mussels.

DISTRIBUTION OF *CORBICULA FLUMINEA* AND FRESHWATER MUSSELS ACROSS SPATIAL SCALES.

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Freshwater mussels are crucial for ecosystem function in the Southeastern United States, filtering water and excreting nutrients. Whether the invasive Asian clam, *Corbicula fluminea*, and native freshwater mussels can co-exist is an important question in mussel ecology. Speculations that *C. fluminea* impact native mussels comes primarily from studies reporting non-overlapping distributions, such that native mussels are abundant where *C. fluminea* abundance is low. We predicted that *C. fluminea* inhabits the same general niche as native mussels and competes with them because they are both benthic, filter-feeding bivalves. To test this prediction, we quantitatively sampled 21 mussel aggregations across the Tennessee River and Mobile River basins. We used quadrat-level (0.25 m^2) data and reach averages to test our hypothesis at fine spatial and broad spatial scales, respectively. We found no relationship between *C. fluminea* and mussel densities at the reach scale. At quadrat scale, there was a positive relationship between *C. fluminea* density and native freshwater mussel biomass and densities in two of the five rivers we surveyed. Specifically, the Duck (Tennessee basin) and Cahaba Rivers (Mobile basin) showed a positive relationship between *C. fluminea* and native freshwater mussels. Although spatial overlap between mussels and *C. fluminea* appears to be variable among systems, particularly at scales where species interactions are strongest, overlap might suggest preferential invasion into habitats where mussel populations have been reduced.

DISTRIBUTIONS AND HABITAT MODELING OF NATIVE AND INVASIVE MUSSELS IN TWO LARGE RIVER SYSTEMS.

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The introduction and establishment of dreissenid mussels (*Dreissena polymorpha* and *D. rostriformis bugensis*) to Lake St. Clair in the mid-1980s to early-1990s seemingly pushed native freshwater mussels (Bivalvia: Unionidae) to the brink of extirpation in the Laurentian Great Lakes region. Specifically, in the St. Clair–Detroit River system, unionids have been considered extirpated from the Detroit River since 1998. However, since then, several unionid refuges (i.e., areas with surviving unionids) have been found in coastal areas of lakes St. Clair and Erie but no documentation currently exists in either the Detroit or St. Clair rivers. To assess the status of any remnant unionids present and the dominance of dreissenids in these rivers, the Detroit River was surveyed in 2019 using a mixture of stratified random, historical, and potential refuge sites (n = 56). A total of 220 live unionids from 11 species were found among 5 sites. More than 2,000 unionid shells of 31 species, including federally endangered *Epioblasma rangiana*, were collected throughout the river, confirming the large and diverse unionid populations that once existed. For 98% of the live unionids found there was evidence of past or active dreissenid attachment and estimated dreissenid densities ranged from 0 to 5,673 live dreissenids per m^2. The highest dreissenid densities were concentrated in the upper half of the Detroit River, where the proportion of *D. r. bugensis* was much larger than *D. polymorpha*. Species distribution models have been created for unionids and dreissenids using the data collected from the Detroit River in 2019 and MaxEnt modeling. These predictive models will be validated by surveys in the St. Clair River in summer 2021 and will facilitate further understanding of native and invasive mussel distributions in large river systems.

THE EFFECT OF FLOW AND MUSSEL SPECIES TRAITS ON THE OCCURRENCE OF RARE MUSSELS: A CASE STUDY WITHIN SELECT RIVERS OF THE WEST GULF COASTAL PLAIN.

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Unionid mussels are imperiled worldwide due, in part, to altered flows. We evaluated the role of extreme flow events in shaping the occurrence of *Potamilus amphichaenus* (Texas Heelsplitter), *Pleurobema riddellii* (Louisiana Pigtoe), and *Truncilla macrodon* (Texas Fawnsfoot) in East Texas. These species were chosen because they are under consideration for listing under the Endangered Species Act and represent two different life-history strategies (i.e., *r*- vs. *K*-selected) for coping with environmental change. We identified USGS stream gauge stations located within 20 km of our focal species to calculate hydrological parameters that describe the magnitude, frequency, and duration of high and low flow events. We used Indicators of Hydrologic Alteration to calculate 48 parameters derived from discharge data for 28 selected gauges. We then evaluated changes in flow over time by river basin using a linear regression. We further explored relationships

between the same parameters with our focal species using random forest (RF) classification models. The RF models were significant and had low out of the bag error rate (10.71 to 21.43%). Mean decrease in Gini and mean decrease in accuracy, used to identify important parameters from RF models, showed that occupancy for *P. amphichaenus* was influenced by base flow index, one-day minimum, date of minimum, and flow predictability. For *T. macrodon*, base flow index, one-day minimum, mean August flows, and three-day minimum flows were important. For *P. riddellii* mean monthly flows from January to March were the most influential. Using life-history strategy to interpret these results, we found *K*-selected strategist were likely to occur in rivers with a more natural flow regime, which were typically unregulated, whereas *r*-selected strategists were most likely to occur in rivers with altered flows, which were often highly regulated. The findings indicate species traits are useful for explaining how mussel species cope with hydrologic variation.

DEVELOPMENT OF A TRANSPORT MODEL TO UNDERSTAND eDNA DETECTIONS OF FRESHWATER MUSSELS TO AID IN THEIR CONSERVATION.

Katy Klymus, Dannise Ruiz, Nathan Thompson, Cathy Richter; Columbia Environmental Research Center, U.S. Geological Survey

Freshwater mussels of the Unionoida order are a group of high conservation concern due to their high level of endemism in North America, the large number of federally listed species, their importance in freshwater ecosystems, their utility as water quality indicators, and their unique natural history. Improving our ability to detect and monitor these species is crucial to their continued conservation. Environmental DNA (eDNA) is a non-invasive tool that can allow the detection and monitoring of species of interest through the identification of species-specific DNA that is shed into the environment. Understanding how eDNA moves through a riverine system and how eDNA detection is affected by this movement is important in developing eDNA survey methods for management applications. Here we discuss ongoing work on the development and field validation of an eDNA transport model using four freshwater mussel species in two rivers, the Clinch River in Virginia and Tennessee and the Big Piney River in Missouri. We developed and tested species-specific quantitative PCR assays to identify and quantify the amount of DNA from our four focal species. These assays are being used in laboratory experiments to understand the eDNA shedding and degradation rates of these species. Hydrological and geomorphological data are also being measured in each river to develop a one-dimensional hydrodynamic model. The resulting transport model will be validated with eDNA data from our field sampling. We will present the results of some of our laboratory shedding and degradation studies and plans for incorporating these results into the transport model. The overarching goal is to develop a tool that can improve managers' understanding of mussel bed location and relative biomass.

EFFECTS OF MUSSEL PHYSICAL ACTIVITY ON N-REMOVAL POTENTIAL.

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Freshwater mussel (Unionidae) aggregations can create 'hotspots' of biogeochemical activity. Mussel biological processes and physical activities affect hydrology, redox conditions, and the stoichiometry of the sediment, in turn influencing microbially-mediated nutrient transformations. This is evident in the benthic nitrogen (N) cycle. Mussels occupy and move within the sediment-water interface and also excrete and egest biologically reactive nutrients, creating favorable conditions for denitrification and anammox to occur. Denitrification and anammox are important biogeochemical processes because they result in the permanent removal of N from aquatic ecosystems. In this study, we explored the role of mussel physical activity on denitrification and anammox potentials. Our study consisted of 16 total mesocosms, with four control, no-mussel mesocosms as well as 12 treatment mesocosms, each containing one of the following mussel species common in the Mobile Basin: *Cyclonaias asperata*, *Fusconaia cerina*, and *Lampsilis ornata*. We studied the lateral and vertical movement patterns of individual mussels over six weeks using a grid overlay to record location and fly fishing line tags to record burial depth. At the conclusion of the study, we sampled sediment from each tank and measured denitrification and anammox potentials using a membrane inlet mass spectrometer. We found a positive correlation between mussel physical activity and sediment N-removal potential. Our results also showed significant differences between the physical activity and denitrification potential of different species, and that denitrification potential is higher where mussels are present. Our results indicate that a species' activity level impacts its role in biogeochemical nutrient cycling and highlights that species composition affects ecosystem function.

PRELIMINARY FRESHWATER MUSSEL SURVEYS ON EAGLE CREEK: AN UNDERSTUDIED WATERSHED IN NORTHERN KENTUCKY.

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Eagle Creek is a 6th order tributary of the Kentucky River and drains portions of the outer Bluegrass region in northern Kentucky. The rural watershed is situated in the triangular vertex of the three large metropolises of Lexington, Louisville, and Cincinnati; however, despite proximity to these areas, its biological community is sorely understudied. Deadshell collections were made at 10 sites by Dr. Ralph Taylor in 1981 and he reported 22 species, including subfossil specimens of the federally endangered Clubshell (*Pleurobema clava*). We teamed with the Kentucky Nature Preserve to perform preliminary surveys in the best available habitat at two of Taylor's sites in the lower Eagle Creek mainstem to assess the contemporary freshwater mussel fauna. Combined survey efforts from both sites, totaling 10 hours and 50 minutes, recovered 425 individuals (39.2 ind./hour CPUE) representing 15 live species. Qualitative surveys at the upper site, where subfossil Clubshell specimens were encountered in 1981, included 90 minutes of substrate excavations to possibly account for endobenthic Clubshell. No live Clubshell specimens were encountered; however, subfossil Clubshell and Round Hickorynut (*Obovaria subrotunda*) (Proposed for federal listing) specimens were collected. Other notable collections include 1 live Black Sandshell (*Ligumia recta*) (the first record of this species in

the system), live Slippershell (*Alasmidonta viridis*), and multiple specimens of fresh-dead Salamander Mussel (*Simpsonaias ambigua*). These brief qualitative surveys act as preliminary efforts to document the diverse mussel fauna in Eagle Creek and identify sensitive areas that warrant further investigation and potential protection.

LINEAR RELATIONSHIPS BETWEEN ANTHROPOGENIC IMPACTS AND FRESHWATER MUSSEL COMMUNITIES IN THE OHIO RIVER.

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The Greenup Pool is a 62-mile Ohio River Navigational Pool spanning portions of West Virginia, Ohio, and Kentucky. The Port of Huntington Tri-state encompasses the entire Greenup Pool and as of 2011, was the busiest inland port by tonnage in the United States. Between 2017 and 2019, freshwater mussel surveys were performed at 37 sites throughout the Greenup Pool. These surveys documented 7,750 live individuals representing 24 species. Although the Greenup Pool supports a healthy mussel fauna, unionid communities showed a strong propensity to the upper pool which lacks urban centers and heavy industrialization. Using Google Earth, we documented all industrial terminals along the riverbank in the pool. We are employing a Canonical Correspondence Analysis (CCA) to relate potential anthropogenic impacts to the mussel communities across the Greenup Pool. The impact scoring is based on the first axis of a Principal Component Analysis (PCA) of 20 impact metrics. Although results are not yet available, the ongoing analysis aims to identify linear distances at which point-source anthropogenic impacts affect mussel communities in a large river system.

FRESHWATER MUSSELS: AN INTEGRAL LINK BETWEEN BROWN AND GREEN FOOD WEBS.

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In aquatic systems, microbes (e.g., bacteria and fungi) are important agents of nutrient cycling that facilitate spatial hotspots of nutrient transformations across ecosystems. However, nutrient processing by consumers can also elicit strong effects on food webs and biogeochemical cycling. Freshwater mussels (Bivalvia: Unionidae) are a guild of burrowing, filter-feeding bivalves that dominate benthic biomass in some aquatic systems. As a result, mussels create biogeochemical hotspots that control ecosystem structure and function through direct and indirect pathways. Mussel nutrient excretion can stimulate benthic primary production and alter algal species composition (i.e., 'green food webs' based on primary producers). In addition, bioturbation of sediment alters Nitrogen and Phosphorus dynamics by indirectly stimulating denitrification and microbial growth which enhances respiration and decomposition rates (i.e., 'brown food webs' based on decomposers). Here, we used mesocosms to evaluate how monoculture and polyculture treatments of three phylogenetically distinct species of freshwater mussels influence components of green and brown food webs. We measured ecosystem responses of green food webs such as gross primary productivity and nutrient stoichiometry of benthic algal accrual. Additionally, we measured factors of brown food web responses which included ecosystem respiration rates, leaf litter decomposition rates, and fungal biomass measured as ergosterol

production. Our findings indicate that compared to controls without mussels, mussel treatments had increased levels of microbial activity on leaf litter, greater fungal biomass production, increased benthic chlorophyll concentrations, as well as greater sediment nitrogen removal potentials. Our results suggest that freshwater mussels have bottom-up effects on both brown and green food webs via microbial priming and nutrient regeneration. This study highlights how consumers impact ecosystem functions such as primary production and decomposition through altering nutrient availability for both autotrophic and heterotrophic microbes.

SUCCESSFUL CULTURE OF JUVENILE WESTERN PEARLSHELL (*MARGARITIFERA FALCATA*) IN A PULSE FLOW THROUGH SYSTEM.

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Western Pearlshell (*Margaritifera falcata*) mussels have been historically difficult to culture. Previous efforts to produce Western Pearlshell juveniles have been successful but resulted in low survival when rearing them in the laboratory to an appropriate size for restoration purposes. The current study was a collaboration between the USGS Columbia Environmental Research Center (CERC) and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) designed to evaluate growth and survival of juvenile Western Pearlshell using optimized culturing conditions in a laboratory setting. Mussels were maintained in 300 ml beakers with a thin layer of sand substrate. Culture water was renewed using a pulse flow-through system recently developed by CERC that delivers a pulse of culture water every 45-60 minutes. The system also employs a peristaltic pump to deliver food to multiple mixing cells where the water and food are automatically mixed just before the water is delivered to the beakers. In the first trial using this system, the overall survival was approximately 93% after 7 months. Growth rates are being determined using image analysis of images collected monthly. Cultures are ongoing and expansion to additional western species is planned. Results of this study will help propagation facilities, such as the one at CTUIR, to increase the production of high-quality freshwater mussels for reintroduction trials and restoration.

DO NATIVE AND INVASIVE FRESHWATER BIVALVES DIFFERENTIALLY INFLUENCE MICROBIALLY MEDIATED LITTER DECOMPOSITION DYNAMICS? AN EXPERIMENTAL APPROACH.

Matthew B. Lodato[1] and Carla L. Atkinson[1]**.** University of Alabama[1]**.**

Nutrient regeneration by macroconsumers is an important ecosystem function that can influence processes such as primary production and decomposition. In particular, filter-feeders have been shown to increase water column nutrient concentration and heterogeneity, stimulating autotrophic and heterotrophic microbial activities. The aim of this study is to investigate how the nutrients released by filter-feeders, including native Unionid mussels and the invasive Asian clam, *Corbicula fluminea*, might differentially influence microbially mediated litter decomposition. We hypothesize (**H1)** that the excretion and egestion produced by both native and invasive bivalves will stimulate algal and fungal metabolic activities and increase litter mass loss by subsidizing these communities with carbon (C), nitrogen (N), and phosphorus (P).

Additionally, we hypothesize **(H2)** the magnitudes of influence will vary between bivalve groups due to behavioral and physiological differences. To test these hypotheses, we will perform a repeated measure manipulation experiment in the Sipsey River, AL., to test the effect of time, light, and bivalve assemblage on litter associated microbial metabolic activities (biomass accrual, ecosystem respiration, primary production), CNP content, and mass loss. The experimental treatments will be as follows: 1). Native (polyculture: *Cyclonais asperata* and *Fusconia cerina*), 2). Invasive (monoculture: *C. fluminea*), 3). Mixed (native and invasive), 4). Control (sediment only). Experimental treatments will be deployed in light and dark plots to disentangle how freshwater bivalves impact autotrophic and heterotrophic microorganisms, respectively. Additionally, real-time ecosystem respiration, production, and nutrient (NH_4,N_2, NO_3) fluxes associated with a subset of treatments will be estimated using metabolic chambers. Leaf litter species will include a relatively labile species, Tulip poplar(*Lirodendron tulipfera*), and a recalcitrant one, Water Tupelo (*Nyssa aquatica*). This experiment aims to provide insight as to how differences between native and invasive bivalve species might confer variations in the influence that macroconsumer nutrient recycling has on ecosystem processes such as litter decomposition.

DETECTION AND HABITAT ASSOCIATIONS OF WAVYRAYED LAMPMUSSEL IN ONTARIO, CANADA.

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Freshwater mussels (Bivalvia: Unionidae) are the most imperilled taxon in Canada. To facilitate species recovery efforts, a thorough understanding of the habitat conditions that support species persistence is needed. Detecting mussels presents unique challenges, however, requiring substantial effort due to their complex life-histories and widespread declines in abundance and distribution. Here, observational data of the imperilled Wavyrayed Lampmussel (*Lampsilis fasciola* Rafinesque 1820) from the Grand and Thames rivers, Ontario, Canada were used to quantify species detection and occupancy probabilities, and the relationship between occupancy probability and substrate size. The best model for the data included a river-specific covariate for detection and an intercept model for occupancy, where the probability of detection was higher for the species in the Grand River than the Thames River. However, given the exhaustive sampling effort per site, the current sampling design was likely adequate to overcome detection issues in both rivers when monitoring for Wavyrayed Lampmussel. Furthermore, a positive relationship was observed between occupancy probability and substrate size, confirming expectations. Overall, understanding species detection and occupancy probabilities of Wavyrayed Lampmussel in these systems will not only enhance the understanding of the species ecology and habitat associations, but also ensure that its response to threats and recovery efforts are captured.

CHARACTERIZING *EPIOBLASMA TRIQUETRA* COOCCURRING UNIONID COMMUNITY AND WATERSHED SCALE ANALYSES IN MICHIGAN

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Michigan waters are inhabited by 43 unionid species, with each watershed and river system being comprised of a unique unionid community. *Epioblasma triquetra*, the snuffbox mussel, is among the rarest and most imperiled unionids in North America and was listed as federally endangered in 2012 in the United States. Throughout North America, *E. triquetra* are at extirpation risk and their range has been reduced by over 60 percent. Within Michigan, *E. triquetra* are known to inhabit 11 different rivers of varying population sizes. This study seeks to characterize unionid communities within the habitat used by *E. triquetra* at a fine scale using 1 m X 1 m quadrats and compare fine scale data with the broader unionid community data collected from the same sites. Communities will also be assessed at a watershed scale by using ordinations to compare *E. triquetra* community differences across watersheds. Quadrat data were collected in summer 2020 from 6 of the 11 known *E. triquetra* rivers and community data will be compiled from summer 2020 and past survey data from Central Michigan University. Watershed scale analysis will be done using ArcGIS to find potential correlations between *E. triquetra* populations and surficial geology, land use, and potential barriers for host fish passage. We will present the preliminary data from year one of this two-year project.

MUSSELS IN THEIR ELEMENT: MUSSEL BEDS ASSOCIATED WITH CHANGES IN MACRO- AND MICRONUTRIENT AVAILABILITY

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Hotspots of nutrient cycling created by freshwater mussel beds have cascading effects on food webs and ecosystem function. Studies of these ecosystem-level effects have thus far been focused on changes in macronutrient – nitrogen (N) and phosphorus (P) – availability driven by mussel excreta. However, mussel beds may alter the cycling of other biologically necessary, but less abundant elements. For example, calcium (Ca) cycling may be affected by the balance between sequestration and dissolution of Ca in mussel shells. Cycling of micronutrients such as iron (Fe) and other transition metals may be altered by mussel burrowing and the associated oxidation of the sediment. Our objective was to explore the elemental landscape of mussel beds and the surrounding environment by sampling for a suite of elements in nearby water, sediments, and macrophytes. We hypothesized that Ca availability would be elevated near mussel beds, due to the need for Ca to form shells and the associated buildup and dissolution of shell material from deceased mussels over time. Furthermore, mussel burrowing should alter the availability of metal micronutrients in the environment by oxidizing the sediment. In 2018-2020 we sampled mussel bed and non-mussel sites in the Kiamichi, Little, and Glover Rivers in Oklahoma to evaluate the availability of N, P, and a suite of 16 other elements in both the water column and gravel bars. We found differences in Ca, P, and Fe availability in the environment between mussel bed sites and non-mussel sites. The influence of mussel beds on nutrient element availability has important implications for riverine and riparian

ecosystems. Vertebrates require Ca and P for bone formation; both of which were elevated in some parts of the environment when mussels were present. This may benefit important species from fish to game and livestock species which use the river for drink and forage.

THE EFFECTS OF MULTIPLE STRESSORS ON THE ECOPHYSIOLOGY OF *LAMPSILIS SILIQUOIDEA*: EFFECTS AND INTERACTIONS AMONG WATER TEMPERATURE, VELOCITY AND SUSPENDED SOLID CONCENTRATION.

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Freshwater unionid mussels are considered ecosystem engineers in aquatic ecosystems, but they are highly endangered because of land-use changes that have altered their habitat and negatively impacted their ecophysiology. The environmental factors that affect mussels do not act alone, rather they interact, and are better understood using a multiple stressor approach. The goal of this study was to examine how changes in water temperature, turbidity (total suspended solids; TSS) and velocity affected the clearance rates (*CR*), oxygen consumption rates (*OC*), and resultant Scope for Growth (*SFG*) of *Lampsilis siliquoidea* in laboratory experiments. The *CR*, *OC* and *SFG* of *L. siliquoidea* increased with acclimation temperature and velocity, and decreased with TSS concentration and acute temperature exposure, although these responses were more variable when factors were combined. The primary factor affecting *CR* and *OC* varied with acclimation temperature, with warmer temperature and high TSS leading to strong declines. A worst-case scenario would involve a summer season where temperatures and TSS loads are above-average, and water velocities are either below- or above- average, with increased frequency of storm, flood, or drought events. These situations, which are unfortunately becoming more common through the consequences of climate change and land-use changes, would describe the worst possible effects on freshwater mussel feeding, respiration and scope for growth. This makes it imperative that protection plans account for these potential scenarios and protect unionid habitat so as to preserve not only species at risk, but also the freshwater systems they inhabit.

USE OF NATIVE AND NONNATIVE FISH HOSTS BY THE WESTERN FRESHWATER MUSSEL *ANODONTA CALIFORNIENSIS* (CALIFORNIA FLOATER) IN THE COLUMBIA RIVER BASIN

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Populations of native freshwater mussels such as the California Floater *Anodonta californiensis* are declining in the Columbia River Basin in the western United States. The reason(s) for these declines are unknown, but the increased presence of nonnative fish, especially piscivores, that displace and reduce the abundance of native fish species, could be negatively influencing the reproductive success of *A. californiensis*. While *Anodonta* spp. can use nonnative fish as hosts with limited success, the extent of this for *A. californiensis* is not well understood and is the focus of this study. We determined if certain nonnative fishes can host the glochidia of *A. californiensis* and quantified differences in host effectiveness between native and nonnative species. Overall, native fish species hosted an average of 107.4 ± 39.9 (mean ± SE) juvenile

mussels per fish while nonnative species hosted an average of 5.5 ± 4.9 juveniles per fish. This conclusion was unchanged when standardized for fish size; native fishes produced an average of 1.0 ± 0.1 juveniles/mm^2, while nonnative fishes produced an average of 0.16 ± 0.1 juveniles/mm^2 of attachable surface area. Because the nonnative Channel Catfish *Ictalurus punctatus* did not produce any juvenile mussels, it was identified as a nonhost species for *A. californiensis*. The other nonnative fishes tested were determined to be poor or marginal hosts. All native fishes tested were determined to be primary or secondary hosts for *A. californiensis*. We conclude that the nonnative fishes tested in this study are poor hosts, and they may not contribute significantly to the reproduction of *A. californiensis*. Some nonnative fish are known to prey on native fish thereby reducing the abundance of native host fishes available for mussel reproduction, contributing to the decline of mussel populations in the Columbia River Basin. Future conservation plans for *A. californiensis* must consider the potential negative influence of nonnative fishes on the reproductive success of *A. californiensis*.

FRESHWATER MUSSEL MASTER SUPPLEMENTATION PLAN: CHALLENGES OF RESTORING A CRYPTIC AND COMPLEX AQUATIC ORGANISM

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Freshwater mussels are important components of intact lotic ecosystems and are culturally important to Native Americans. Over the past 200 years, Columbia River basin mussel populations have been impacted by a myriad of factors, including channel modifications, habitat alterations, agriculture and forestry practices, and the loss of host fish species. Since its inception in 2002, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) Freshwater Mussel Project has conducted research to understand the biology and ecology of declining mussel populations within the Columbia River basin. The Project has focused on four main components: 1) the status and distribution of mussels on CTUIR ceded lands; 2) factors controlling the distribution and abundance of mussels, 3) genetic structure among western mussel species, and 4) developing propagation techniques for raising mussels for restoration. The CTUIR Freshwater Mussel Project is developing a Freshwater Mussel Master Conservation, Supplementation, Aquaculture, Restoration, and Research Plan which will align research outcomes with potential freshwater mussel restoration strategies. The long-term goal of the CTUIR Freshwater Mussel Project has been to restore freshwater mussels to the Umatilla River (in Oregon) and other Columbia River tributaries, as part of ongoing efforts to rebuild mussel diversity, ecosystem services, and traditional harvest opportunities. This presentation will describe the history of the CTUIR Freshwater Mussel Project, the ongoing development of the Freshwater Mussel Master Plan, and the challenges associated with restoring a cryptic and complex aquatic organism.

STUDIES ON THE PEARLSHELL MUSSEL (*Margaritifera margaritifera*) DISCOVERED IN TWO RIVERS OF THE KENAUK FOREST (OTTAWA RIVER WATERSHED, EASTERN CANADA), AND CO-EXISTING FISH COMMUNITY INCLUDING THE BROOK TROUT (*Salvelinus fontinalis*).

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The Eastern pearlshell (*Margaritifera margaritifera*) was first discovered in the Kinonge River, the main river of the Kenauk property, in September 2018. It represents Canada's westernmost distribution for this species. The Kenauk property is one of North America's largest and longest-established private fish and game reserves, encompassing 265 km^2 of mostly pristine wildlife reserve protected in part by the Nature Conservancy of Canada (NCC). During 2019 and 2020, our teams met in the study area with the following goals: (i) document the distribution and abundance of the pearlshell in the Kinonge River and its largest tributary, the West Kinonge River, (ii) determine whether the population was functional with recent recruitment, (iii) characterize the habitat properties at sites with recent recruitment, (iv) study the genetic diversity and differentiation, and (v) characterize the co-existing fish community and identify the host fish. Methods included mussel searches using snorkeling and aquascopes including excavation of 0.25 m^2 quadrats, substrate redox profiles and granulometry along with abundance of buried small juveniles, haemolymph sampling for genetic analysis (J. Geist method), and electrofishing for fish monitoring. Results showed that the main Kinonge River had a low density of pearlshells (highly scattered adult individuals, 0 to < 5 ind. / m^2) and that its population is not functional, with no evidence of juvenile recruitment. By contrast, the West Kinonge tributary, a narrow river with an extensive and highly shaded riparian zone, had high rates of juvenile recruitment, oxygenated substrate and water temperature regime most favorable to both the mussel and the salmonid present in the system, the Brook trout. The West Kinonge had the highest densities of pearlshells, with values commonly reaching 15-40 ind. / m^2. Haemolymph samples revealed that pearlshells from the Kinonge and West Kinonge had lower genetic diversity (allelic richness, observed heterozygosity) and form a distinct group from all other North American populations. The sampled fish community of the main stem Kinonge River included 20 fish species, including many cyprinids and three centrarchids, but no salmonid. By contrast, the functional West Kinonge population included only six fish species and the Brook trout was commonly captured and the likely host. The observed very low density, non-functional population of pearlshells in the main Kinonge River may result from historical episodic recruitment years involving downstream movements of glochidia-bearing Brook trout from upstream West Kinonge habitats.

QUANTIFYING MOVEMENT PATTERNS AND DISTRIBUTION TRENDS OF THE UNDERSTUDIED BLACK SANDSHELL (*LIGUMIA RECTA*): A MICHIGAN ENDANGERED SPECIES IN NEED OF CONSERVATION.

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Many freshwater mussel species are endangered on the state and federal level, yet basic life history and distribution data is still lacking in order to aid in their conservation. In this study the movement and distribution trends of the Black Sandshell (*Ligumia recta;* Lamarck,1819*)*, a state endangered mussel in Michigan, was quantified for the first time in central Michigan, USA. This is a species that lacks recent and updated research, with their life history in central Michigan remaining unexplored. The predictability and difference in distribution, life history, and movement between *Ligumia recta* found in two Great Lakes watersheds was analyzed to gain a better understanding of this species. Data were collected through weekly Biomark™ monitoring in the Chippewa, Pine, Maple, and Grand rivers over summer 2020. A total of 24 *L. recta* individuals were found and tagged with Passive Integrated Transponder (PIT) tags, yielding equal male and female ratios. Movement of these individuals was analyzed using minimum convex polygons in ArcGIS, which was compared across rivers in relation to continuous flow and depth criterion. Continuous data collection via installed flow gauges showcased how burrowing and movement patterns of *L. recta* varied by watershed. The preferred substrate type and abiotic factors of *L. recta* were also assessed. How these factors impact the distribution of *L. recta* were all taken into consideration. Further, conclusions were drawn on how this species was impacted by hydraulic changes and flow-altering infrastructure. It was found that *L. recta* moved on average 81.19 m^2 over a period of 59-69 days, and sites with low flow had the greatest variation in horizontal movement. These data help to identify basic distribution patterns of *L. recta*, contributing to survey success in the future and providing a better understanding of the status of *L. recta* and their decline in Michigan.

EXPLORING THE FRESHWATER MOLLUSK CONSERVATION SOCIETY'S OUTREACH COMMITTEE

Amy Maynard[1], Daniel Symonds[2], and Jennifer Archambault[3]. [1]Conservation Management Institute, Virginia Polytechnic & State University, Charles City, VA 23030; [2]Stantec Consulting, Cincinnati, OH 45241; [3]US Fish and Wildlife Service, Ecological Services Field Office, Raleigh, NC 27636.

The Outreach Committee is charged with dissemination and curation of information, both internal to FMCS and for the Society's external engagement with the public. The Outreach Committee is responsible for managing and updating the FMCS website and social media accounts (currently on the Facebook, Twitter, and Instagram platforms). One recurring major event that the Outreach Committee initiated in 2017 is coordinating and hosting the student/mentor mixer at FMCS conferences. We also work to produce outreach materials (presentation slide decks, posters, etc.) that would be made available to members for use during their own engagement with the public. We are a very approachable committee to join and are looking for people to help with social media posting, updating website content, and generating outreach materials. This is a fantastic committee for new or established FMCS members interested in becoming more involved in professional

service. During this virtual meeting, look for our live committee meeting in the program schedule. Bring your ideas or just come see if we fit your interests.

PROPAGATION AND CULTURE AT VIRGINIA FISHERIES AND AQUATIC WILDLIFE CENTER.

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Virginia Fisheries and Aquatic Wildlife Center (VFAWC) is a cooperative freshwater mussel propagation facility. Together, the United States Fish and Wildlife Service and the Virginia Department of Wildlife Resources have produced 16 species of freshwater mussels from the Atlantic Slope since 2008, and have released 311,359 mussels since 2010. VFAWC is located at Harrison Lake National Fish Hatchery. Newly metamorphosed juveniles are currently reared in pulsed-flow and static sediment systems. Juveniles exceeding 2.0mm are reared in sediment pans of multiple sizes, raceways, and floating baskets. Largely guided by project funding to restore freshwater mussel populations in the Dan and South River watersheds, we produced nearly 1.5 million juvenile mussels of 13 species, including 1 Federal Endangered species *Parvaspina collina* (James Spinymussel), 1 State Endangered species *Alasmidonta varicosa* (Brook Floater), 1 State Threatened species, *Lasmigona subviridis* (Green Floater), and six species listed as Species of Greatest Conservation Need in Virginia's Wildlife Action Plan. We now utilize *in vitro* propagation methods to supplement our production of species with low fecundity or with troublesome species. This year, we propagated four species using *in vitro* methods. In 2020, VFAWC released 31,119 mussels of 8 mussel species into the South, South Fork Shenandoah, Dan, James, and Nottoway Rivers, as well as Broad Run and Goose Creek, tributaries of the Potomac and James River, respectively, in Virginia.

***IN VITRO* CULTURE AND PROPAGATION OF THE ENDANGERED CUMBERLAND BEAN, *VENUSTACONCHA TROOSTENSIS*, USING A COMBINATION OF SERUM MIXTURES IN A PHYSIOLOGICAL NUTRIENT SOLUTION**.

Monte McGregor and Julieann Jacobs. Kentucky Department of Fish and Wildlife Resources, Center for Mollusk Conservation, Frankfort, KY.

In vitro culture is a process by which glochidia are removed from the adult mussels, placed in nutrient solutions in incubators, and allowed to metamorphose to the juvenile stage. We tested the method with the endangered Cumberland bean, *Venustaconcha troostensis*, a Cumberland River endemic species, by using a mixture of serum types from rabbit (R), carp (C), buffalo (B): R only, RB (50:50), RC (50:50), RBC (50:25:25). We removed 54,000 larvae from 3 females into nine 100mm petri dishes with 14.6 ml of M199 media, serum mixture (ratio of 2:1), and antibiotics. Dishes were incubated in CO_2 temperature controlled incubators at 24° C. On days 16-23, dishes were diluted with sterile pond water to trigger final transformation (detectable foot movement). The RBC formula had 27% of larvae transform to juveniles in

17-23 days (average of 19 days). Other mixtures had little or no transformation. Transformation rates ranged from 26 to 66% per dish, with 15,772 juveniles transforming from the original 54,000 larvae (29%). Juveniles were placed in 8 L trays at a rate of 1,000 to 2,000 juveniles/tray and fed daily 1-2 ml of a mixed diet of cultured 2 parts freshwater algae (*Phaeodactylum tricornutum*, *Neochloris oleoabundans*, and *Chlorella sorokiniana*-ratio of 2:1:1) and 1 part commercially available marine algae (Reed Mariculture, Nanno 3600, TW1800, and Shellfish Diet 1800-ratio of 2:1:0.5), and a trace of probiotic. Trays were aerated and contained biomedia to reduce ammonia levels, and automatic water changes were cycled every 8 hours to provide a complete full water change daily. After three months, 1,861 juveniles remained (11.8% of transformed juveniles) and averaged 3.68 mm in length. *In vitro* culture is an alternative to traditional culture and may enhance mussel conservation efforts even if host fish are not available or unknown.

LIFE HISTORY OF THE KENTUCKY CREEKSHELL, *VILLOSA ORTMANNI*.

Monte McGregor[1], Adam Shepard[1], Wendell Haag[2], Julieann Jacobs[1], Travis Bailey[1], Mike Compton[3], Travis Williams[1]. [1]Kentucky Department of Fish and Wildlife Resources, Center for Mollusk Conservation, Frankfort, KY. [2]US Forest Service, Southern Research Station, Frankfort, KY, and [3] Office of Kentucky Nature Preserves, Frankfort, KY.

The Kentucky Creekshell (*Villosa ortmanni*) is endemic to the Green River drainage, Kentucky and Tennessee. We examined host fish use, glochidia size and morphology, mantle lure and aperture anatomy, brooding, and fecundity. We conducted laboratory trials to identify host fishes using females from four sites, Rough River, Brush Creek (Barren River system), Russell Creek, and Walters Creek (Nolin River system), KY. We tested the suitability of 21 fish species including sculpin, sunfishes, darters, and minnows, by pipetting 100-300 glochidia onto the gill filaments and monitoring infections for glochidial metamorphosis. *Cottus carolinae* (Banded Sculpin) appeared to be a primary host and was the only fish species that produced robust and consistent metamorphosis (about 50-100 juveniles/sculpin). One *Lepomis macrochirus* produced a single juvenile, indicating that this species may be a marginal host. Females were long-term brooders, gravid from September to June. Eggs (350 µm diameter) and glochidia were packaged in teardrop-shaped placentae about 4 14 mm. Across six females from three sites, glochidia averaged 311.0 µm (± 6.9 SD) height, 226.3 µm (± 7.7) length, and 120.9 µm (± 4.1) hinge length. However, glochidia size differed slightly but significantly among females, mainly due to 3-7% smaller glochidia in all dimensions at Russell Creek and for two of four females from Walters Creek. Each glochidial valve had two ventral and two dorsal chemosensory hairs. Glochidia were brooded in 8-20 gill chambers in the posterior half of each outer demibranch. Fecundity was 10,473 to 63,350/female. Incurrent apertures of males and females were ornamented with 20-24 simple, tan, brown, or black papillae, and excurrent apertures had shorter papillae or peripheral knobs. Gravid females possessed 14-24 additional papillae ventral to the incurrent aperture that were absent in males. These papillae undulated in a zipper-like fashion, suggesting that they represent a cryptic lure for infesting host fishes.

COMMUNITY CHANGES IN A FRESHWATER MUSSEL BED FROM 2004 TO 2019 IN THE GREEN RIVER, KENTUCKY, AFTER SUCCESSFUL AUGMENTATION OF THE PINK MUCKET, *LAMPSILIS ABRUPTA*.

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The Green River is a large tributary of the Ohio River historically supporting 71 species of freshwater mussels. We assessed the mussel population at one mussel bed in the upper Green River in a 1,000 m^2 area with the use of 1m^2 quadrats (n=180 for each event) in the summer 2004, 2009, 2013, and 2019. We determined species presence, abundance, and distribution patterns for all species. We collected 34 species (5,816 individuals) for all four events. Average mussel density for all species from all years ranged from 6.5 to 10.1/m^2. Mean densities by species ranged from 0.001 to 5.48/m^2. In 2004, only 1 species was present at densities > 0.5/m^2, compared to 3 in 2009, 4 in 2013, and 6 in 2019. The most dominant species was the mucket, *Actinonaias ligamentina* (26% to 71% of the total abundance) with densities ranging from 5.48 (2004), 2.12 (2009), 2.92 (2014), to 2.69/m^2 (2019). Other abundant species were the spike, *Eurynia dilatata* (1.3 – 13.5%), purple wartyback, *Cyclonaias tuberculata* (4.6-13.9%), threeridge, *Amblema plicata* (4.9-6.7%), round pigtoe, *Pleurobema sintoxia* (1.4-7.7%), and pimpleback, *Cyclonaias pustulosa* (1.3-8.5%) collectively 70-85% of the individuals. A total of 22 species were rare (< 0.1/m^2) in 2004 (4 T&E), 22 in 2009 (4 T&E), 20 in 2013 (4 T&E), and 15 in 2019 (4 T&E). Five threatened/endangered species, the fanshell, sheepnose, rough pigtoe, rabbitsfoot, and pink mucket, were detected at densities from 0.006-0.461/m^2. The pink mucket, *Lampsilis abrupta*, which had not been seen in several decades in the area, was first detected in 2013 (0.033/ m^2) after just 1 year post stocking. We stocked 562 cultured juveniles of the pink mucket in 2012 (212-age 2,16mm), 2013 (150-age 2y, 25mm), and 2018 (200-age 2, 30mm). In 2019, pink muckets were detected at 0.2/m^2, and made up 2.0% of the abundance.

RESTORATION DESIGN FOR FRESHWATER MUSSELS.

Laura McMullen, Janel Sobota, Celeste Mazzacano, and Kevin MacKay, ICF, Portland, OR.

Loss of quality habitat for freshwater mussels in the Pacific Northwest has contributed to the decline of mussel populations in recent decades. Channelization, bank hardening, changes in river flow and temperature regimes, changes in sediment regimes, and poor water quality all degrade potential habitat for freshwater mussels. Watershed restoration actions themselves can also cause challenges to freshwater mussel populations through stranding due to flow changes or diversions, sediment pulses, or trampling, among other actions. Also, many restoration practitioners in the West are unfamiliar with best practice mussel survey and translocation methodologies. While many watershed restoration programs in the Pacific Northwest focus on providing benefits to anadromous salmonids, few consider enhancing freshwater mussel populations a primary restoration goal. Here, we review the qualities of freshwater habitat that are associated with healthy freshwater mussel populations and present restoration treatments that could be integrated to provide multiple benefits for both salmonids and mussels.

COMPARATIVE LANDSCAPE GENOMICS OF EIGHT IMPERILED MUSSEL SPECIES IN NORTH CAROLINA.

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For many unionid species, population genetic structure, relationships, and viability are poorly characterized, which complicates plans to recover populations. We used a recently developed single-nucleotide polymorphism (SNP) discovery approach (Illumina sequencing of 3RAD libraries) to characterize and compare genomic diversity and differentiation in eight imperiled unionids (*Alasmidonta heterodon*, *A. raveneliana*, *A. varicosa*, *Elliptio lanceolata*, *Fusconaia masoni*, *Parvaspina collina*, *P. steinstansana*, and *Pleurobema oviforme*). We focused on North Carolina populations, but included outgroups from neighboring states where available. Even after rigorous filtering, an average of >6000 neutral SNP loci were identified per species. Using a variety of intraspecific and interspecific analyses of these SNP data, we asked 1) at what spatial grain (sites, streams, or watersheds) are populations typically structured, 2) how do hydrologic connectivity, stream size, and land use affect genetic diversity and gene flow, and 3) are these responses predictable from species' life-history traits? Across species, we saw little evidence for fine-grained within-river population structure; rather, structure tended to emerge at the grain of whole watersheds, implying geographically extensive gene flow. Genetic differentiation *between* pairs of individuals increased with both the spatial distance and accumulation of movement barriers between individuals. The slopes of these relationships varied among species, but not consistently among life-history groups. In contrast, life-history traits, and to a lesser extent stream size, were the most important predictors of genetic diversity *within* individuals. Heterozygosity was higher in species with slow to intermediate life-histories (longer lived, lower fecundity) occupying smaller streams, but was lower in species with fast life-histories (shorter lived, higher fecundity) occupying larger streams. Contemporary urban and agricultural land use had ambiguous and generally weak influences on diversity and gene flow. These findings suggest it may take many decades to detect the genomic impacts of recent habitat degradation and fragmentation, particularly for longer-lived unionid species.

PRELIMINARY DE NOVO GENOMES AND TRANSCRIPTOMES OF FOUR UNIONID SPECIES (UNIONIDAE: *FUSCONAIA SP.* AND *VILLOSA SP.*).

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Elucidating mechanisms underlying species-specific responses to environmental stressors is of significant interest to the scientific community but is seldom studied within the context of biogeography. The diversity of freshwater mussels (Unionidae) provides an excellent system for comparative genetic studies of species which occupy different geographic range breadths and display different physiological responses to abiotic variation. In this study, we seek to compare four unionid species that differ in geographic distribution and life history characteristics. We focused on *Fusconaia escambia* and *F. cerina* which are short-term brooders, while *Villosa lienosa* and *V. nebulosa* are long-term brooders. Furthermore, *F. cerina* and *V. lienosa* inhabit a broader geographic range, while *F. escambia* and *V. nebulosa* inhabit more narrow ranges compared to their respective congener species. Here we present preliminary, *de novo* genome (using the Illumina and Oxford Nanopore platforms) and transcriptome (using the Illumina platform) assemblies for all four species. For both *Fusconaia* spp. and *V. lienosa* the mean genome coverage derived from nanopore sequencing is 5.1X, while *V. nebulosa* is currently at 14.8X. Illumina sequencing has

generated a mean genome coverage of 51.6X for all four species. Based on the current assemblies, mean estimated genome and transcriptome sizes for all four species is 2.4 Gb and 420 Mb, respectively. Additional sequencing efforts will provide high quality genomes that will be invaluable for future comparative studies and will support mussel conservation and restoration efforts.

GROWTH, SURVIVORSHIP, AND BYSSUS RESPONSE OF JUVENILE BLACK SANDSHELL AND MUCKET MUSSELS (BIVALVIA: UNIONIDEA) TO DIFFERENT GRADES OF SEDIMENT

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Freshwater mussels are important keystone species of aquatic ecosystems that clarify water via filter feeding, provide food for animals by bio-concentrating suspended particulate, and create habitat by stabilizing sediments and providing benthic structure. However, they are also one of the most at-risk taxa in North America due to anthropogenic habitat alteration. Effective propagation methods accelerate the return of mussels to rehabilitated waterways to provide these ecosystem services. To inform head-starting and improve propagation results, I evaluated survival, growth, and byssus production of juvenile black sandshell Ligumia recta (346 days old, starting size $\bar{x}$: 5.9 mm) and mucket Actinonaias ligamentina (438 days old, starting size $\bar{x}$: 31.0 mm) mussels in response to 4 sediment types: silt, sand, pebble, or a mixture of the 3. In all sediments, black sandshells experienced mortality of the smallest individuals during the first 2 months, but no additional mortality occurred during the subsequent 18 months of the experiment. Mean growth (in mm) of black sandshells was significantly greater in silt ($\bar{x}$: 42.6) and mixed sediments ($\bar{x}$: 41.7) compared to other treatments (sand: $\bar{x}$: 40.7, pebble: $\bar{x}$: 38.12). Mucket survival, mean growth, and byssus production did not significantly differ among rearing sediment types. For both mussel species, logistic regression identified that length was a statistically significant predictor of byssus presence, such that the presence of byssus decreased as mussels grew. Byssus presence as an indicator of growth in sediment type was not supported. These data suggest that growth of younger, smaller black sandshell mussels is improved by the presence of fine silt but not for older, larger muckets. Head-starting black sandshells in fine sediment can expedite their growth and subsequent reintroduction to their natural habitats and may similarly benefit the recovery of other mussel species.

COMPARING CONVENIENCE AND PROBABILITY SAMPLING DESIGNS FOR DESCRIBING RIVERINE MUSSEL COMMUNITIES.

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Accurate descriptions of riverine communities rely on rigorous probabilistic sampling designs. However, logistical constraints and limited site access are often difficult to overcome in ecological studies. This often leads to the implementation of convenience sampling designs (e.g., sampling only at bridge crossings) which can result in findings that are not representative of the community being studied. Thus, the objective of this project was to compare convenience and probability sampling designs for describing mussel communities in two central Texas rivers. Mussels were systematically collected every 100 m in four 20 km segments within the San Saba (n = 2) and Llano Rivers (n = 2). During field sampling the locations of all convenient points of access (i.e., bridge crossings) were recorded. Two datasets were compiled for comparison: 1) the systematic dataset containing all data that was collected and 2) the convenience dataset that only contained data from sites located within 1 km of bridge crossings. Community assemblages between the two datasets differed significantly within all study segments. On average, the diversity, relative abundance, and species richness was higher in the systematic dataset compared to the convenience dataset for all segments except for the lower San Saba River which had similar relative abundances. This study highlights that crucial information about critical habitats and distribution patterns can be lost with inadequate sampling designs. We also discuss how spatially explicit rarefaction curves can be a useful tool to limit sampling intensity while still accurately describing mussel communities.

A LIFE-HISTORY GUILD APPROACH TO FRESHWATER MUSSEL RISK ASSESSMENT: DYNAMIC ENERGY BUDGET MODEL AND INDIVIDUAL-LEVEL RESPONSES.

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Freshwater mussels are a highly diverse faunal group, and many species are imperiled. In the United States there are approximately 90 species listed under the Federal Endangered Species Act (ESA), exhibiting a wide range of life-history traits. Evaluation of potential risks associated with the registration of pesticide active ingredients is required under ESA and population modeling offers a mechanism to facilitate translation of individual to population-level responses. However, this process is time consuming and requires large amounts of, often unavailable, data. One solution is to select and use species that may be representative of a wider group. Building on previous work, we were able to group mussels according to three general life-history strategies and identify representative species from each group for which models could be developed and parameterized. Our models are based on Dynamic Energy Budget Theory which is a generic metabolic theory describing the flow of energy within an individual organism. It is useful for testing stressor effects at the individual level and can be coupled with a population model to assess potential population-level impacts. The objective of this study was to compare the effects of hypothetical stressors on individual-level endpoints of freshwater mussels with different life-history strategies. Using previously described life-history

strategies, we selected a federally-listed and non-listed species from each guild. We then parameterized these species in a dynamic energy budget model. We applied hypothetical stressors using predefined physiological modes of action within the energetic model and measured effects on individual-level endpoints, such as shell length and fecundity. We compared results between species to determine 1) if the listed and non-listed species in the same category responded similarly to the stressors and 2) if species in different life-history categories responded differently. These analyses are intended to help inform whether non-listed species of a particular life-history category can serve as appropriate surrogates for listed species in those same categories within the context of risk assessment, as implemented using population modeling.

MAPPING INVASIVE GASTROPOD OCCURRENCES IN NATIVE GASTROPOD HOTSPOTS ACROSS THE UNITED STATES.

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One of the primary concerns for the conservation of aquatic gastropod species in the U.S. is the introduction of nonnative species. Nonnative and invasive gastropods have been known to outcompete and spread disease to native species. In consideration of this growing threat, tracking and mapping nonnative gastropod populations and their known vectors can provide a decision support tool to inform resource managers and potentially prevent future spread. In order to help resource managers pinpoint areas of the highest invasion-potential in native, species-rich areas in the contiguous U.S., the U.S. Geological Survey's Nonindigenous Aquatic Species (NAS) database has mapped areas with the highest native aquatic gastropod species richness, as well as the areas of co-occurrence for several high-impact, established nonnative gastropod populations, including *Bithynia tentaculata, Cipangopaludina chinensis, Cipangopaludina japonica, Marisa cornuarietis, Melanoides tuberculata, Pomacea maculata, Pomacea canaliculata, Potamopyrgus antipodarum, Radix auricularia, Tarebia granifera, and Viviparus georgianus*. Using a heat map, these corresponding areas of overlap show the highest-risk locations for native species from the spread of nonnative gastropods. This map can serve as a broad guide for monitoring areas, designing early detection programs, and other prevention efforts for managers concerned for native gastropods. The main transportation vectors for nonnative gastropods in hot spot areas are also summarized to ensure that prevention efforts are most effective.

COLLABORATION IS THE KEY TO FISH LADDER PROPAGATION OF *EPIOBLASMA TRIQUETRA.*

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Understanding and protecting an aquatic ecosystem's biodiversity is the ultimate goal when it comes to combating the endangerment of species especially species like highly imperiled unionids. This growing list of declining unionid species includes the federally endangered Snuffbox (*Epioblasma triquetra).* Utilizing known standardized infestation methods, glochidia from multiple female Snuffbox were flushed from gravid gills and poured on the gills of their host fish Logperch (*Percina caprodes*). For the first 15 days the infested Logperch were kept in a mobile trailer with each fish in separate tanks under standard conditions. Logperch were monitored and fed daily. On day 15 cages, that are often used for mussel propagation, were set in a fish ladder on the Grand River, MI and Snuffbox infested Logperch were transferred to multiple cages. Challenges and successes of this process and the future expectations of this project to propagate Snuffbox for eventual release into the Grand River, MI will be highlighted. By employing these techniques in combination with further study fish ladder propagation may be an effective conservation strategy for endangered mussels. This was a large collaborative effort with additional challenges of COVID19; we will demonstrate how this was accomplished with suggestions for future fish ladder propagation.

COOPERATIVE PROPAGATION OF MUSSELS FOR RESTORATION IN VIRGINIA'S SOUTH RIVER.

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Following decades of industrial mercury contamination of the South River and South Fork of the Shenandoah River, private stakeholders and government agencies reached a landmark agreement in 2017 for restoration of the rivers, their riparian habitat, and their native fauna. A primary component of the restoration agreement is the propagation and release of freshwater mussels by the Virginia Fisheries and Aquatic Wildlife Center (VFAWC). VFAWC is a cooperative propagation facility operated jointly by the U.S. Fish and Wildlife Service and the Virginia Dept. of Wildlife Resources. The goals of the mussel propagation project include improvement of water quality, river substrate stabilization, and restoration of native mussel diversity. These goals have been made achievable by employing the personnel expertise and facilities of regional universities (Virginia Commonwealth Univ. and Virginia Tech) and natural resource agencies. Over the course of the project, individuals from eight species have been collected across three states for use as broodstock. Since 2018, 635,783 mussels have been propagated across eight species, with a total of 9,744 released into the target rivers and their tributaries. In 2020 alone, 400,076 juvenile mussels were produced across eight species. Of those eight species, four were successfully propagated using in vitro methods. In the near term, a greater proportion of effort will be devoted to the monitoring of past and future stocked mussels to evaluate the overall success of the project.

USE OF QUALITATIVE AND QUANTITATIVE SURVEYS TO DESCRIBE WESTERN PEARLSHELL MUSSEL DISTRIBUTION AND ABUNDANCE IN IDAHO

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We are investigating a two-phase approach to monitor the distribution and abundance of western pearlshell mussels (*Margaritifera falcata*) in intermountain west, clear water streams in Idaho. Phase 1 surveys were designed to maximize stream kilometers surveyed and gain qualitative mussel abundance information. Phase 2 quantitative surveys were designed to provide an accurate count of mussels within a stream reach utilizing 0.25m^2 quadrats in bank-to-bank transects systematically placed. Phase 1 surveys provided qualitative abundance information on 130 kilometers of stream in 31 distinct streams and seven different ecosections. Phase 2 quantitative surveys were more highly correlated with Phase 1 surveys in streams of seven meter wetted-width or less when one surveyor was used to perform the Phase 1 survey (R^2=0.37). Estimated variance from Phase 2 surveys did not trend with mussel density strata (low, medium, high) established from Phase 1 surveys. Phase 1 surveys may be useful for providing relative estimates of mussel abundance in addition to mussel presence. Further Phase 1 and Phase 2 survey work will be conducted in 2021 to complete the dataset for this analysis, including between-observer and seasonal variation.

STATE OF THE MUSSELS: BROAD SCALE POPULATION ASSESSMENTS OF NATIVE MUSSELS IN THE UPPER MISSISSIPPI RIVER.

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Despite a heightened global concern for native freshwater mussels, fundamental research on mussel ecology in large rivers is lacking. A common goal of state and federal resource managers in the upper Mississippi River (UMR) is to restore and sustain the native mussel community. Thus, we designed reach-wide systematic surveys to estimate the number of species, population size, abundance, and recruitment of mussels across six reaches (i.e., navigation pools) of the UMR. A total of 3460 live mussels were obtained in 1842-0.25 m^2 samples. Across all six reaches we documented 28 live species, with a given reach containing 16-23 live species. Across all reaches, *Amblema plicata*, *Obliquaria reflexa*, and *Utterbackia imbecillis* comprised 60% of the population. Across all reaches, about 25% of the species had an opportunistic life history strategy, 25% were periodic, and 50% were equilibrium. Population estimates varied almost 10-fold across reaches, ranging from 61-592 million mussels. Mean reach density varied about 2-fold across reaches and ranged from 2.9-5.4 mussels/m^2 (Global ANOSIM, p = 0.001). Evidence of strong recruitment by juveniles (defined as the species-specific age at sexual maturity) was observed; the percent of the population comprised of juveniles ranged from 14-57% across the six reaches and 61-78% of the species were found as juveniles. Interestingly, about 60% of the individuals were found in about 10% of the aquatic area. Collectively, these data indicate that the UMR, despite being regulated and impounded, contains a dense, diverse, and reproducing assemblage of native freshwater mussels. These

broad scale systematic data offer an unprecedented opportunity to ask a suite of questions regarding the ecology of native mussels in large rivers.

MOLECULAR AND PHYLOGENETIC ANALYSIS OF *TRYONIA DIABOLI* AND *TEXAPYRGUS LONGELYI*

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The purpose of this study is to conduct a molecular and phylogenetic analysis of *Tryonia diaboli* and *Texapyrgus longelyi* in order to aid in conversation efforts. *Tryonia diaboli* was named over a hundred years ago and since then has not been seen in the literature. Very little information is known about these species and what has been seen questions whether they are placed into the correct genus. *Tryonia diaboli* is described to be a surface dweller but has been found to be stygophilic. Both species are located near Devils River, Texas and were sampled for using mesh drift nets placed over water flow of the spring orifice. Next steps include detailed morphological description and DNA analysis will be performed using a strict PCR protocol. Snail shell and aperture height and width will be measured in micrometers using a stereoscopic microscope and Infinity Analyze and Capture Software using a set calibration protocol. The information gathered will aid in conservation efforts by informing policy makers of this critically imperiled species.

BUT FIRST, LET ME TAKE A 'SHELL-FIE': ASSESSING METAL TOXICITY IN SNAIL EMBRYOS USING TIME-LAPSED PHOTOGRAPHY.

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Despite being the most diverse class of the Molluscan phylum, gastropods and their development are not well studied compared with many model species in ecotoxicology. Embryonic development in freshwater gastropods has yet to be formally characterized and as a result, developmental milestones are not common ecotoxicological endpoints. Throughout embryonic development, numerous complex changes occur on timescales ranging from seconds to days and improvements in technology allow us to accurately measure these changes on increasingly finer scales. These developmental changes reveal important underlying evolutionary and ecological processes therefore, it is especially important now to improve our understanding of them in light of the unprecedented local and global change that many populations are experiencing. Using time-lapsed macrophotography and image processing techniques, we have characterized normal embryonic development in our test species under different incubation temperatures. From this standardized baseline of growth and developmental timing, we have now begun assessing the sensitivities of these novel endpoints to metals exposure. While tests are ongoing, our preliminary results demonstrate that metal interactions with the egg mass membrane play an important role in determining their toxicity to the embryo, resulting in very specific adverse outcomes for each metal. This specificity may be important to our ability to predict the adverse outcomes of specific contaminants to gastropod populations in the wild.

MONITORING SURVIVAL OF FEDERALLY ENDANGERED MUSSELS RELOCATED FROM PIPELINE CROSSING IN THE CLINCH RIVER, VIRGINIA

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In 2012, an approximately 525 square meter section of the Clinch River in southwest Virginia was dewatered using cofferdams so that a trench could be excavated for a water pipeline. The Biological Opinion for the project required a mussel relocation and subsequent monitoring of a subset of mussels using Passive Integrated Transponder (PIT) tags. We tagged 72 mussels—mostly Fluted Kidneyshells (*Ptychobranchus subtentus*)—and placed them in a grid in suitable habitat at a destination site 200 meters upstream of the project. An additional 20 *P. subtentus* already inhabiting the relocation destination were tagged and placed for comparison. Tagged mussels were periodically monitored over 7 years using a PIT sensor wand and portable reader. To better approximate survival with empirical uncertainty, we used 2 readily available model types in USGS Program MARK; Commack-Jolly-Seber (CJS) and Joint Live and Dead Encounters (Burnham 1993). Beyond the first month, monthly survival rates remained high over 7 years, from 94% to over 99%. Survival did not differ between relocated and resident *P. subtentus*. Despite modeling exercises and high detection rates, there was considerable uncertainty about the fate of undetected mussels. Models suggested undetected mussels were probably dead; however, tag loss may have confounded detection and survival estimates, and therefore affected model results. Our analysis demonstrated that relocation was an effective mitigation in this case. In all, we estimated that we were able to relocate 83% of the assemblage from a habitat that was completely destroyed in 2012. At that time, we relocated a total of 627 mussels upstream representing 17 species. Based on estimates from the most-supported CJS model, we estimated that 221 relocated mussels likely remained in the destination site 7 years later.

REDISCOVERY AND GENETIC CONFIRMATION OF THE THREERIDGE MUSSEL, *AMBLEMA PLICATA*, IN THE CHOCTAWHATCHEE RIVER, FLORIDA, USA.

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Recent freshwater mussel research and survey efforts have resulted in rediscovery of several species presumed extinct, and the discovery of many previously unrecognized species. Our objective was to conduct long-term monitoring of freshwater mussels in Florida's streams and rivers to provide ecologically significant findings to conservation managers. Here, we present the rediscovery of *Amblema plicata* (Say, 1817) from the Choctawhatchee River, Florida, USA, and provide genetic confirmation of our voucher identification. Prior to locating a live individual, the population in the Choctawhatchee River was thought to be extirpated. Based on museum records, *A. plicata* was previously collected from four sites in the Choctawhatchee River basin, FL, between October 1933 and November 1958. From 2014 to 2019, the FWC Freshwater Mussel Conservation Program surveyed 110 sites in this basin, collecting a total of 16,468 individual mussels representing 22 species. During these efforts, only one individual of *A. plicata* was found in 2019 during a survey using both quantitative and qualitative sampling procedures. Using a DNA barcoding approach, we verified our morphology-based identification with a 678-base pair fragment of the

CO1 gene and nucleotide BLAST search on GenBank. Several factors contribute to declines in freshwater mussel diversity, but most notable are habitat destruction, deterioration of water quality, lack of host fishes, and introduction of invasive species. Biodiverse mussel assemblages are integral functional components of freshwater ecosystems, warranting detailed status assessments that include distribution, abundance estimates, and habitat usage to provide a comparative baseline for future studies and monitoring community trends.

THE EXTREME CLIFFS NOTES FOR TRAINING NEW MUSSEL HEADS: 5 STEPS FOR DEVELOPING EFFECTIVE HANDS-ON TRAINING IN FRESHWATER MUSSEL CONSERVATION.

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The global decline of freshwater mussels is a complex and time-consuming problem to tackle. The more hands we have on deck to deal with species listing, toxicology testing, propagation technology, population monitoring, and taxonomic uncertainties the better. More hands-on-deck requires training more people in the basic skills of freshwater mussel conservation. This presentation will provide the extreme "Cliffs Notes" version of the training design process that I have used over the last 10 years. This 5-step process starts with clearly **Identifying the Skills** that are needed. In other words, what does a participant need to be able to "Do" when they get back to the job? Second, develop a **Skill Check** to help the instructor evaluate if the participant can "Do" the job when the training is complete. Third, develop a **Skill Practice** exercise that provides participants a chance to practice each skill before being evaluated on the Skill Check. Step 4 is to **Design the Content** of the training. The content should close the gap between where participants "ARE" in their skill level and where they need to "BE". There is always more content than time to teach it, so the key to Step #4 is selecting some content IN and other content OUT. The only content selected IN is content that is needed to practice the skill and complete the skill check (NEED TO KNOW). All other content is supplied as supplemental reading material (NICE TO KNOW). The final step is to combine the content, skill practices, and skill checks into **Training Modules**. Modules can vary in length but course content (think lectures) should take up a small percentage of the allotted time. The majority of the time should be spent "DOING", which includes instructors demonstrating the skill, participants practicing the skill, and participants demonstrating skill proficiency.

ARE PEAK STREAM FLOWS SHRINKING HABITAT FOR WESTERN PEARLSHELL MUSSELS IN THE STILLAGUAMISH WATERSHED?

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In 2020 the Stillaguamish Tribe prioritized freshwater mussel survey locations, and began reconnaissance surveys focused at or around Tribal owned properties along the Stillaguamish River and other tributaries. During these activities the only locations in the river and large streams where we observed mussels were in the slow moving water near banks and often within bank armoring or rip rap itself. Two year peak flows in the Stillaguamish have increased by around 50% or 7000cfs in the last ninety years and are projected to continue this trend. Consequently stream beds that are suitable for freshwater mussels in summer in terms of substrate and flow are subject to harmful water velocities and

bed load mobilization during the rainy season. We hypothesize that stream flows are eliminating stream beds as predicted habitat for western pearlshell mussels (*Margaritifera falcata*) in the Stillaguamish watershed, and that mussels will be further confined to banks and pools sheltered from these conditions.

POPULATION DENSITY AND REPRODUCTIVE SEASONALITY OF *TRYONIA CHEATUMI* (GASTROPODA; COCHLIOPIDAE), THE PHANTOM TRYONIA

Kathryn E. Perez[1], Nina Noreika[2,3], Chad Norris[4], Marty Kelly[5], Melissa Lopez[1], Christina Ortega[1], Salma Ruiz Sandoval[1], Samantha Gonzalez[1], and Weston Nowlin[2]. [1]University of Texas Rio Grande Valley, Edinburg, TX, 78542, USA; [2]Texas State University, San Marcos, TX 78666 USA; [3]Czech Technical University in Prague, Prague 16629 Czech Republic; [4] Guadalupe-Blanco River Authority, Seguin, TX 78155, USA; [5]Texas Parks and Wildlife Department, Austin, TX, 78744, USA.

We studied population density and reproductive seasonality of the Phantom Tryonia, *Tryonia cheatumi*, an endangered freshwater snail found in the San Solomon Spring system, an aridland freshwater spring system, in western Texas, USA. Seven populations were sampled seasonally using quantitative sampling methods (Lang benthic sampler) over a two-year period. There were large interannual differences in density (up to 25-fold) at all sites, but consistent seasonal patterns of density were not observed. San Solomon Pool had the largest population of *T. cheatumi* estimated at 57 million individuals (in 2017) with density up to 23,626 ± 39,030 m^{-2} in the spring season. In all populations, there appears to be some continuous recruitment but with the dominant reproductive season occurring at different times. At San Solomon Pool, Winter and Spring samples had the highest proportion of hatchlings but the Phantom Lake population had a higher proportion of hatchlings in Summer.

METHODS FOR MEASURING BIOENERGETIC PARAMETERS OF SMALL BIVALVES

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The invasive species *Corbicula fluminea*, may have detrimental effects on growth or survival of juvenile mussels. Bioenergetics models can help evaluate potential competitive interactions between these taxa. However, owing to the small size of *Corbicula* and juvenile mussels, estimating parameters required for bioenergetic modelling is challenging. We describe methods for performing energetic assays to estimate egestion, filtration, and respiration on small bivalves using *Corbicula*. For concurrent estimation of filtration and respiration, we tested 600 ml chambers containing sediment. Concurrent measurements require that experimental times be long enough to allow a measurable reduction in food particles but short enough that oxygen is not reduced below 80% saturation. Moreover, multiple small bivalves are required in each chamber to reach an adequate ratio of total wet mass (g) to chamber volume (ml) for respirometry. A ratio of 1:75 (g:ml) resulted in a 10% reduction in dissolved oxygen over two hours and a 32% reduction in suspended solids biomass. Feces and pseudofeces were collected from

the sediment surface with a micropipette, which allowed direct estimation of egestion rates. These early results are promising and suggest that it is possible to concurrently measure multiple energetic parameters for small bivalves. However, a tradeoff of these larger chambers is the inability to measure individual small bivalves (<1.5g). Therefore, to measure respiration rates in small (0.9-1.2 g) individuals, commercially-available 'mini-chambers' (6-10 ml) are being tested. The mini-chambers require specialized, non-submersible pumps and housing, which we fabricated using low-cost materials. When installed, the horizontal orientation of the mini-chambers require bivalves to lie on bare surfaces rather than orienting naturally in sediment. We successfully generated respiration data using the mini-chambers after an acclimation period of ~12 h. Future testing will include the use of a 45 ml vertical chamber design with or without sediment to reduce acclimation time.

LONG-TERM MONITORING OF FRESHWATER MUSSEL ASSEMBLAGES (BIVALVIA: UNIONIDAE) IN THE BUFFALO NATIONAL RIVER, AR.

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The Buffalo National River was established as the first National River in 1972 as a free-flowing Extraordinary Resource Water and Natural and Scenic Waterway. Multiple stream sections in this area are listed on the 303d list as impaired for nitrate, dissolved oxygen, and bacteria. Considering these impairments, the status of the Buffalo River freshwater mussels is of concern to the National Park Service. This project qualitatively reevaluated Buffalo River mussel resources over 153-river km and quantitatively re-sampled 12 long-term monitoring freshwater mussel sites established in 2005. Historically, 29 species have been recorded from the Buffalo River, and our inventory found 17 species. The goal of this study is to help inform conservation management decisions by evaluating mussel community dynamic changes and population trends. We found that all but one site has decreased in either species richness, diversity, or both. The most upstream mussel assemblage significantly decreased in total abundance while two far downstream sites significantly increased in total abundance. The most dominant species overall remains *Ptychobranchus occidentalis* (making up ~23% of all mussels found); however, *Villosa iris* is now the second most abundant (19%) replacing *Lampsilis reeveiana*. Shown by the lack of smaller class sizes, losses in juvenile recruitment were apparent for *P. occidentalis* and *L. reeveiana* along the river's length. Considering the national decline of freshwater mussels, documenting these local changes is essential to understanding their status and supporting the Buffalo National River's long-term watershed management goals.

PATTERNS OF U.S. FRESHWATER MUSSEL COLLECTING.

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Museum specimens and their associated metadata (identification, collection locality, collection date, etc.) serve as a primary data source for many aspects of freshwater mussel research and conservation. Understanding the spatial, temporal, and taxonomic distribution of museum data is important for identifying its strengths and weaknesses, and ultimately, how to use this data more effectively. Using over 200,000 publicly available U.S. freshwater mussel specimen records, we explore various spatial, temporal, and taxonomic patterns. Starting in the early aughts, we observed a steady decrease in the number of freshwater mussel records per year, which translates into an overall decrease in the number of species and watersheds sampled per year. Furthermore, these records are unevenly distributed across freshwater mussel biodiversity and the fresh waters in which they inhabit. In this paper we introduce the assembled dataset, summarize emergent patterns, and highlight some potential uses of this resource. We hope this research underscores the importance of strategic specimen collection and the careful use of museum data to better understand freshwater mussel ecology, evolution and conservation.

MOLECULAR PHYLOGENTICS OF INTERIOR HIGHLAND FUSCONAIA REVEALS EVIDENCE OF ANCIENT STREAM CAPTURE IN WESTERN OZARKS

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Pigtoe mussels (Unionidae: Pleurobemini: *Fusconaia* and *Pleurobema* spp.) are difficult to distinguish based on shell morphology alone. Recent molecular work has revealed cases of cryptic diversity within the group. One such case is the presence of a genetically distinct lineage formerly recognized as *Fusconaia flava* within the Ozark Highlands. This lineage has so far been identified from the Missouri and Arkansas river drainages. We used the CO1 mitochondrial gene to explore genetic variation and geometric morphometric techniques to analyze morphological variation in 92 specimens of *Fusconaia* and *Pleurobema* from the northern Ozarks. Analysis of the CO1 regions revealed that most specimens morphologically identified as *F. flava* collected from the Ozarks region represent the genetically distinct lineage, and that locally, *F. flava* may be more restricted in range than previously thought. Our results provide support for an ancient stream capture of the upper Arkansas River, formerly a tributary to the Missouri River drainage. Geometric morphometric analysis revealed some overlap in the shells from 3 *Fusconaia* species as well as the *P. rubrum/sintoxia* group. Taxonomic issues surrounding the unique *Fusconaia* lineage from the northern Ozarks will be discussed.

SURVIVAL AND GROWTH OF JUVENILE *LAMPSILIS RADIATA* DEPLOYED IN THE TIDAL ANACOSTIA RIVER WATERSHED.

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Beginning in June 2018, to support the goal of restoring mussel populations in the Anacostia River (AR, Washington, DC), we deployed juvenile hatchery-bred Eastern Lampmussel (*Lampsilis radiata*) for 10 weeks. The objective was to compare the survival and growth of mussels installed at various locations in the AR, a Potomac River (PR) location where gravid females were obtained (Bryan Point), and an upstream tributary (Beaverdam Creek). Water quality parameters and seston (quality and quantity) were measured at 3, 6, and 9 weeks post deployment. There were five silo locations, each with four replicates of 20 juveniles: Bryan Point (PR reference), Buzzard Point (AR), 11th St. (AR), and Beaverdam Creek 1 and 2. At four sites, floating baskets (8 replicates of 10 mussels) were deployed: Kenilworth Marsh (AR), Kingman Lake (AR), Capitol Standup (AR), and Kenilworth Aquatic Gardens (pond). Silo and basket data were analyzed separately. One silo site (11th St.) had significantly decreased survival (79%) vs. 94–100% at the others. For the sites with favorable survival, mussels increased from ~9 mm (Week 0) to ~30 mm (Week 10) at Buzzard Point and Bryan Point, with no increase at Beaverdam 1 and 2. Basket sites had 99% to 100% survival, and mussels increased from ~9 mm to 32-45 mm. There was a positive relationship of mussel growth with the percentage of bioavailable (i.e., non-refractory) material in seston samples (summed over the 3-, 6-, and 9-week collections). The study supports the use of hatchery-bred *L. radiata* for population restoration in the Anacostia and potentially, other east coast streams and rivers within the historic *L. radiata* range. A suitable strategy would be to place juveniles in baskets in areas protected from current, such as Kenilworth Marsh and Kingman Lake, for 3 to 6 months before release.

USING ENVIRONMENTAL DNA (eDNA) TO DETECT ENDANGERED *EPIOBLASMA TRIQUETRA* (SNUFFBOX).

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Epioblasma triquetra, the Snuffbox mussel, is a member of one of the freshwater mussel genera most at risk of extinction. In 2012, *E. triquetra* was the last species in the genus added to the U.S. endangered species list after status assessments reported a 60% reduction in its historic distribution. Traditional survey approaches for unionid mussels to estimate population boundaries and sizes can be logistically difficult and time consuming due to patchiness, cryptic burrowing patterns, and low densities. Environmental DNA (eDNA) has been used to detect species at low density and can be used to sample a more extensive area faster than traditional surveying. Using a species-specific real-time PCR assay, we sampled water from the largest remaining population of *E. triquetra* in Michigan, the Grand River watershed, during the

fall of 2020 and will again during the spring and summer of 2021. Collection sites were along the Grand River mainstem and three tributaries that include the Flat, Maple, and Thornapple rivers. We sampled sites known to have variable densities of live *E. triquetra* and sites where the status of *E. triquetra* is unknown. At a known high-density *E. triquetra* site on the Grand River differences in detection probability were tested by sampling surface water and water near the benthic/water interface. This study aims to determine if the species-specific assay for eDNA works for field-collected samples, determine if there is a difference in detectability between benthic zone and surface water eDNA samples, and observe if seasonality influences eDNA detection rate.

METABOLOMIC CHARACTERIZATION OF PHEASANTSHELL MUSSEL (*ACTINONAIAS PECTOROSA;* ORDER UNIONIDA) FROM A MORTALITY EVENT IN THE CLINCH RIVER, VA AND TN.

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As a part of the multi-year study to identify the role of infectious agents in recurring mortality of pheasantshell in the Clinch River, VA and TN, we looked at changes in metabolomic responses related to known viral loads. We compared the metabolites detected in the hemolymph of affected and unaffected pheasantshell from 2018 samples to correlate the metabolomic profile to field diagnosis of affected or unaffected and identify potential biochemical marker of disease. We used ultra-high-performance liquid chromatography combined with quadrupole time-of-flight mass spectroscopy (UHPLC-QTOF-MS) to detect both known and unidentified metabolites. We used volcano plots, dynamic partial least squares, and biological pathway analysis to identify relationships between viral infection and field diagnosis and to identify temporal changes between control animals collected during the three months of August, September, and October 2018. We found temporal changes (August to October) in 300 metabolites, some of which were associated with pathways for energy production (e.g., glycolysis and gluconeogenesis) and amino acid metabolism. We found 100 metabolites, that were correlated to field diagnosis of mussels. Pathway analysis of metabolites associated with field diagnosis is underway to determine whether indicators of disease can be identified. These results will be compared with metabolomic profiles of mussels from streams that are not having mussel die-offs.

THERMAL TOLERANCES OF *POPENAIAS POPEII* (TEXAS HORNSHELL) AND THEIR HOST FISH FROM THE RIO GRANDE BASIN, TEXAS: A RELATIONSHIP IN JEOPARDY.

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Riverine fauna in the American southwest are threatened by climate change and water withdrawal due to a rapidly increasing human population. Freshwater mussels are especially sensitive to changes in their hydrological regimes due to their unique life history and physiology. The Devils River harbors several regionally endemic fishes and the endangered freshwater mussel *Popenaias popeii*. To evaluate how reductions in flow and corresponding increases in water temperature may affect *P. popeii*, we tested the upper thermal tolerances (LT05 and LT50) of larvae (glochidia) and juveniles from two sites, Grass Patch and Ruthies, in the Devils River. Glochidia and newly transformed juveniles acclimated to 27°C were subjected to five experimental temperatures (20, 32, 34, 36, and 38°C) and a non-acclimated control (20°C) for either 24 hours (glochidia) or 96 hours (juveniles). Thermal thresholds were then related to *in situ* water temperature and discharge data using a uniform continuous above-threshold (UCAT) analysis. For glochidia, LT05 estimates were 27.9°C (Grass Patch) and 26.9°C (Ruthies), while LT50 estimates were 30.9°C (Grass Patch) and 31.6°C (Ruthies). For juveniles, LT05 and LT50 estimates were 27.4 and 32.7°C (Ruthies), respectively. Overlaying LT05 thresholds with *in situ* water temperature showed frequent exceedances, whereas LT50 thresholds were rarely exceeded. Additionally, we reviewed the upper thermal tolerances of *P. popeii*'s presumed host fish (*Cyprinella lutrensis*, *Carpiodes carpio*, and *Moxostoma congestum*) and their congeners, finding that lethal temperature tolerance (CLMax and LTmax) ranged from 33.3-41.1°C, which was rarely exceeded by *in situ* water temperature. Our results suggest that *P. popeii* and potentially its host fish may already be experiencing thermal stress, which will likely worsen due to groundwater pumping and climate change. These impacts threaten the long-term persistence of this species and highlight the urgent need for protection of instream flows in the Devils River.

UNDERSTANDING MUSSEL MICROBIOMES: RELATIONSHIPS BETWEEN VIRAL AND BACTERIAL COMMUNITIES FROM FRESHWATER MUSSEL MORTALITY EVENTS.

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Unusual mortality events (i.e., episodes of higher-than-normal mortality observed in wild and captive mussel populations) represent opportunities to understand the largely-unknown world of mussel microbial communities. The Clinch River in southwestern Virginia and northeastern Tennessee is home to 46 extant mussel species (20 of which are federally listed as endangered). A recurring mussel mortality event began in 2016 and has continued annually through 2020, leading to the losses of >80% in pheasantshell (*Actinonaias pectorosa*) populations of the lower river. We compared viral and bacterial communities from a multi-year study of the mass mortality event to assess potential pathogenic causes and understand their interactions. We analyzed samples from 58 pheasantshells (26 moribund "cases" and 32 healthy "controls" from 6 sites during 2017 and 2018. 16S rRNA gene revealed the presence of multiple bacteria associated with moribund mussels and at least one associated with healthy mussels. Quantitative PCR showed that in both cases and controls, overall bacterial microbiomes from hemolymph samples were present in very low abundances, suggesting that hemolymph is a relatively sterile environment in healthy animals. Simultaneous analysis of bacterial microbiomes, previously-described virology results, and case-control status showed a pattern of complex interactions with no single component completely explaining patterns of mortality.

PHYSIOLOGICAL CONDITION AND SPATIAL DISTRIBUTION OF UNIONIDS AND CORBICULIDS CO-OCCURING IN A LAURENTIAN GREAT LAKES WATERSHED, MI, USA.

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Aquatic ecosystems, especially in the Laurentian Great Lakes watershed, have been heavily influenced by many different aquatic invasive species, including multiple bivalve species. Corbiculids, bivalve clams in the genus *Corbicula,* are an invasive species in the Great Lakes however there is limited knowledge on corbiculid influence on Great Lakes' unionids. In 2018 and 2019, 191 sites were visited and 122 sites were surveyed throughout the main branch and tributaries of the Kalamazoo River, MI, USA. During the surveys 21 unionid species were found alive and benthic samples were collected to quantify the presence and densities of corbiculids. A subset of 25 sites were selected to

collect *Eurynia dilatata* (a common unionid species), corbiculids, and water quality; from these mollusks sampled, glycogen and fatty acid profiles were analyzed to determine potential diet overlap. We found that the invasion of corbiculids in the Kalamazoo River watershed may be limited or ongoing especially in the downstream (north-west) reaches. Also, while densities of unionids and corbiculids, when co-occurring, were correlated, unionid species richness decreased with increasing corbiculid density, illustrating a potential impact of corbiculids on native unionids species richness. However, glycogen levels in *E. dilatata* were not impacted by corbiculid densities, water temperature, or stream size gradient. Results from fatty acid analysis on both *E. dilatata* and corbiculids, illustrated no overlap in diet between *E. dilatata* and corbiculids. We will highlight the importance of watershed-wide data to help with conservation of unionids in a watershed with corbiculid invasion.

ASSESSMENT OF IMPACTS TO MUSSEL COMMUNITY STRUCTURE FROM A NEW INDUSTRIAL DISCHARGE IN THE UPPER SABINE RIVER, TEXAS.

Clinton R Robertson[1] & Adam Whisenant[2]. [1]Texas Parks and Wildlife Department - River Studies Program, San Marcos, TX; [2]Texas Parks and Wildlife Department – Water Quality Program, Tyler, TX.

Freshwater mussels are considered one of the most imperiled taxa in North America. Because freshwater mussels are long-lived, slow growing, sedentary organisms they are susceptible to many threats that have contributed to their decline, such as habitat alteration, water quality degradation, impoundments, and loss of host fish. Understanding the impact of these threats that could lead to declines in mussel diversity and abundance is critically important for the conservation of these species. Wastewater effluent has been documented as a point source pollutant of concern impacting freshwater mussels. Ammonia is a common pollutant from wastewater treatment facilities and one in which mussels are known to be highly sensitive compared to other taxa. This study's objective is to assess mussel community impacts from a recently permitted wastewater discharge in the upper Sabine River, Texas with ammonia limits almost double the 2013 Environmental Protection Agency 30-day chronic exposure criteria for mussels. Mussel community structure will be assessed through stratified-random timed search efforts, mussel demographic changes will be assessed by establishing mark-recapture sites and water quality will be assessed through surface and pore-water sampling from upstream control and downstream impacted reaches within the study area. As this effort is still underway, some preliminary results on community structure, mark-recapture, water quality monitoring, and future efforts will be presented.

SUMMARY OF THE PURPOSE AND ACTIVITIES OF THE FMCS GENETICS COMMITTEE

Kevin J. Roe[1], David Zanatta[2], (on behalf of the committee). [1]Iowa State University, Ames, IA.

The main duties of the Genetics Committee relate to educating the society on the value and uses of genetic techniques for the conservation of freshwater mollusks. The Genetics Committee also has as its purpose the dissemination of genetic information relating to systematics, population genetics, genomics, and aquaculture/captive propagation to the members of the society. The committee also serves as a source of expertise for guidance on genetics issues for government agencies and the society in general. The Genetics Committee has hosted and co-hosted several FMCS workshops, the most recent being on Species Status Assessment in San Antonio.

METAGENOMICS OF GILL TISSUE FROM TWO FRESHWATER MUSSEL SPECIES

Ieva Roznere[1], Heather Glon[1], and Marymegan Daly[1]. [1]Ohio State University, Columbus, OH.

High-throughput DNA sequencing has greatly improved our ability to study the roles of gene expression and microbiome composition in highly threatened yet understudied organisms such as freshwater mussels. Here we used metagenomic tools to explore the type of information that can be obtained from freshwater mussel RNA-Seq data sets. We characterized the gill microbiomes of two mussel species (*Pyganodon grandis* and *Amblema plicata*) in three different environments (pond, river, and captivity). Gill tissue was biopsied from *A. plicata* collected from the Muskingum River in Washington County, Ohio (n=3), *A. plicata* held in a propagation facility one year after translocation from the Muskingum River (n=4), and *P. grandis* collected from a pond in Marion County, Ohio (n=4). Extracted RNA was sequenced on the Illumina HiSeq platform. Kraken2 and Braken were used to taxonomically classify reads using the default Kraken protozoan database and the complete SILVA ribosomal RNA gene database, separately. The microbial communities of gill tissues were similar across the three groups. Mapping to the SILVA database showed that more than a quarter of the microbes classified were bacteria. Fungi were the most predominant group classified in *P. grandis* and the second most predominant group in *A. plicata*. Mapping to the Kraken protozoan database showed that the microbiomes of mussel gills in all locations were dominated by members of the phyla Apicomplexa (parasitic alveolates) and Bacillariophyta (diatoms). The gill microbiome of *P. grandis* was unique from that of *A. plicata* collected from either location in that a significant portion was comprised of Amoebozoa. Our findings reveal that comparing the microbial community between different species in different locations can provide foundational information as to which microorganisms are to be expected in a mussel's microbial fauna and which components may be influenced by a change in environment.

MODELING SURROGATE MUSSEL ABUNDANCE AND OCCUPANCY TO DETERMINE SUITABLE HABITAT FOR THE TRANSLOCATIONS OF TWO FEDERALLY ENDANGERED MUSSELS IN CENTRAL ILLINOIS.

Hugo Y. Ruellan[1], Kirk Stodola[1], Alison P. Stodola[1], Jeremy S. Tiemann[1]; [1]University of Illinois at Urbana-Champaign, Champaign, IL.

Federally endangered Clubshell (*Pleurobema clava*) and Northern Riffleshell (*Epioblasma rangiana*) were translocated to eight sites throughout the Middle Fork and Salt Fork Vermilion rivers (Wabash River drainage). However, the total amount of suitable habitat and the quality of the habitat in these rivers is unknown. We are investigating suitable habitat for *P. clava* and *E. rangiana*, making inferences using a suite of surrogate species. We surveyed 40 sites, 20 per river, in the summer of 2020 looking for surrogate species and total mussel abundance. We measured flow, depth, substrate composition, width, and macrophyte percentage at each site. We also determined slope, stream power, lateral channel stability, percentage of available water, persistent gravel bars, and surrounding land use using remotely sensed data. We fit occupancy and N-mixture models to determine the effects of these habitat variables on surrogate species presence/absence, abundance, and species richness. Increased agricultural land use, slope, stream power, and lateral channel stability all negatively affected surrogate species occupancy. Abundance of several surrogate species and total mussel abundance significantly increased with persistent gravel bars, while others were found to decrease with increased agricultural land use, slope, and channel stability. Persistent gravel beds may be indicative of suitable substrate for these mussels, and abundance and occupancy may decrease due to runoff from areas with increased levels of agricultural land use. Lateral channel stability and slope decreasing mussel abundance may be indicative of the rivers being channelized for urban or agricultural land use, or an artifact of stream size. Increases in slope may cause substrates to destabilize, reducing mussel habitat and possibly displacing mussels. These models will aid in determining suitable habitat for future translocations and conservation of *P. clava* and *E. rangiana* in central Illinois, and in determining suitable habitat for other endangered species outside of these rivers.

MITIGATING CONTAMINATION FOR IN-VITRO PROPAGATION OF DWARF WEDGEMUSSEL.

Jennifer E. Ryan[1], Allison H. Roy[2], Peter D. Hazelton[3], David L. Perkins[4] and Timothy M. Warren[4]. [1]Massachusetts Cooperative Fish and Wildlife Research Unit, Department of Environmental Conservation, University of Massachusetts Amherst, Amherst, Massachusetts; [2]U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst, Amherst, Massachusetts; [3]Daniel B. Warnell School of Forestry and Natural Resources, University of Georgia; [4]U.S. Fish and Wildlife Service, Richard Cronin Aquatic Resource Center, Sunderland, Massachusetts.

Comprehensive programs are needed to restore more than 70 federally endangered freshwater mussel species in the US, including the dwarf wedgemussel *(Alasmidonta heterodon*). Lab propagation is a critical component of many restoration plans; however, in small populations where broodstock are limited, more efficient methods of propagation are needed. Given that fungal contamination inhibits successful *in-vitro* propagation of dwarf wedgemussel, and a related species, the triangle floater (*Alasmidonta undulata)*, we assessed three methods of

contamination mitigation (media change frequency, concentration of the antifungal Amphotericin B, and method of antifungal replenishment). Across all experiments, higher levels of contamination reduced transformation success. Petri dishes that had media changes every other day (vs. those changed daily and every 3 days) had the highest contamination and the lowest glochidia transformation success, suggesting that minimizing opening of dishes may improve success. Treatments with the lowest (0 µg/mL) concentration of Amphotericin B and treatments with low-dose replenishment of Amphotericin B (versus frequent media changes) had the highest transformation success. Surprisingly, we found that contamination is not necessarily mitigated effectively by Amphotericin B and high levels of Amphotericin B may in fact inhibit transformation success. We identified the fungus as *Candida parapsilosis*, a common fungus found in aquatic and human environments, and suggest that future propagation efforts use mitigation methods that are specifically designed to target the fungal contaminant. This propagation is part of a multi-faceted restoration effort, including studies of population genetics, mussel habitat requirements, and fish populations at potential restoration sites, which are all vital for developing an effective species recovery plan.

PROPAGATION OF FRESHWATER MUSSELS AT VIRGINIA FISHERIES AND AQUATIC WILDFLIFE CENTER FOR RESORATION IN THE DAN RIVER.

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The Virginia Fisheries and Aquatic Wildlife Center (VFAWC) received a grant from the National Fish and Wildlife Foundation for the propagation of freshwater mussels in response to a coal ash spill in the Dan River. Targeted species for restoration include: Yellow Lampmussel (*Lampsilis cariosa*), Green Floater (*Lasmigona subviridis*), Notched Rainbow (*Villosa constricta*), Triangle Floater (*Alasmidonta undulata*), Atlantic Pigtoe (*Fusconaia masoni*), and James Spinymussel (*Parvaspina collina*). In addition and prior to propagation, a site suitability study was conducted by assessing growth and survival of Eastern Elliptio (*Elliptio complanata*) Since the beginning of the project 2017, VFAWC has released 41,158 mussels of four species among five sites in the Dan River and distributed 5,810 mussels to partnering agencies. Next year we intend to use *in vitro* propagation techniques that may prove necessary in the production of rare species such as Atlantic Pigtoe. Conditions in the Dan River have prohibited surveying to recapture propagated mussels. In 2021, we plan to conduct quantitative surveys of release sites for PIT and laser tagged mussels and to successfully propagate Atlantic Pigtoe.

RECRUITMENT IMPACTS OF CONTAMINANTS OF EMERGING CONCERN: SIMULATING POPULATION DYNAMICS BASED ON EMPIRICAL EXPOSURE STUDIES.

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Contaminants of emerging concern (CECs) are a broad range of contaminants such as pharmaceuticals, pesticides, or personal care products under ongoing assessment for their impact on aquatic life. The unique life cycle of unionids may increase vulnerability to chemical stress during essential periods such as metamorphosis. Tying an empirical study with population projections, we will highlight the potential for population level impacts of CEC exposure during unionid metamorphosis. Reductions in transformation were first indicated through exposure studies. *Lampsilis cardium* and host fish, *Micropterus salmoides,* were exposed to an agricultural or urban CEC mixture or controls for a long-term period (60 days) or a short-term period (12 days) in a controlled static renewal system. At the end of initial exposure, infestations were performed, and exposures resumed counting juveniles as they excised until the end of the long- (100 day) and short-term (40 day) exposures respectively. To accommodate data from both long- and short-term exposures, two models to determine juvenile transformation were assessed: a zero-inflated poisson model and dose response curves fit to a third order polynomial. Both models noted a shift to a later date for peak-day of juvenile excystment in agricultural and urban treatments ($p = 0.16$) and a reduced total number of juveniles ($p << 0.05$). Magnitudes of reduction determined by these models were applied to a Leftkovitch stage-based population model, and simulations were projected for thirty years. The Leftkovitch model included parameters from previous observational and empirical studies of stable populations though it must be noted that parameters were not obtained from a single population. Analysis reveals high sensitivity of glochidia transformation and indicates strong population declines are possible. This approach indicates that combining empirical studies with known observational data may allow for population projections to focus management attention on major sources of stress to vulnerable populations.

ONE SHELL SHAPE TO RULE THEM ALL? THE EFFECTS OF HYDRODYNAMIC FORCES ON THE SHAPE OF FRESHWATER MUSSELS.

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Unionid mussels are a diverse group that play a pivotal part in aquatic ecosystems by providing a number of ecosystem services such as the improvement of water quality through their suspension feeding. Water flow has a significant role in the morphology and physiology of freshwater mussels, particularly with their nutrition intake and reproductive practices. Unfortunately, excessive hydrodynamic forces can also be disruptive through the dislodgement of freshwater mussels from the benthos. This presentation focuses on how hydrodynamics affects the evolution and diversity of shell shapes of unionid mussels. Specifically, unionids have evolved in response to the hydrodynamic forces of

lift and drag as well as shear stress in the benthos while carrying out their feeding and reproductive activities. It is likely that unionid with elongated and circular shell shapes differ in response to the hydrodynamic forces they experience. It is predicted that mussels with elongated shell shapes will experience less hydrodynamic forces then non elongated shell shapes while accessing resources higher in the water column. These predictions are examined using computational fluid dynamic modeling, direct measurement in a flow chamber using force transducers and infer from measurements in the field in southwestern Ontario. Results will be discussed. This research will provide a broader understanding of the effects of hydrodynamic forces on organisms living in rivers, as well as the evolutionary history of unionids. In addition, further knowledge on past aquatic ecosystems can assist with developing conservation plans for endangered bivalves.

LONG-TERM MONITORING REVEALS ASYMMETRIC RESPONSES OF MUSSEL AND HOST FISH COMMUNITIES IN A BIODIVERSITY HOTSPOT

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Biodiversity hotspots can serve as protected areas that aid in species conservation. Long-term monitoring of multiple taxonomic groups within biodiversity hotspots can offer insight into factors influencing their dynamics. Mussels (Bivalvia: Unionidae) and fish are a highly diverse and imperiled group of organisms with contrasting life histories that should influence their response to ecological factors associated with global change. Here we use historical and contemporary fish and mussel survey data to assess fish and mussel community changes over a 33-year period (1986-2019) and relationships to host fish abundance in Bogue Chitto Creek, a tributary of the Alabama River and biodiversity hotspot. Mussel abundance declined by ~80% and community composition shifted with eight species previously recorded not found in 2019, and a single individual of the endangered *Pleurobema decisum*. Fish communities were not equally impacted and there was no apparent relationship between mussel declines and abundance of host fish. Variation in the proportion of life history traits composing mussel assemblages was also indicative of the disturbances specifically affecting the mussel community. However, changes and declines in mussel assemblages in Bogue Chitto Creek, cannot be firmly attributed to any specific factors or events because of gaps in historical data. Habitat degradation, recent droughts and invasive species could all be contributing factors that are especially impacting mussels because of their lack of mobility. Our work indicates that monitoring biodiversity hotspots using hydrological measurements, standardized survey methods and monitoring rates of species invasions would better identify the effects of multiple and interactive stressors the asymmetrically impact disparate taxonomic groups in freshwater ecosystems.

EMERGENT HYDRODYNAMICS AND INCREASED BED ROUGHNESS IN MUSSEL-COVERED BEDS.

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Freshwater mussels are ecosystem engineers and create biogenic habitat that provides surface area for benthic organisms to colonize and increases streambed complexity. Recent studies have also demonstrated that mussels can modify near-bed flows but have focused on individual or small clusters of mussels or have not examined the hydrodynamic effects of filter feeding. Here, we examined how mussel density, filter feeding, and average burrow position influence near-bed hydrodynamics and physical habitat. We conducted flume experiments over a bed of model mussels to quantify and characterize the turbulent flow field. Model mussels were constructed to mimic the exposed portion of a mussel protruding into the water column. Each mussel model was created with an opening to represent the exhalent aperture and equipped with a tube and flow-control valve connected to an external pump to mimic filter feeding. Particle image velocimetry was employed to quantify the flow characteristics that developed over the mussel-covered bed for a range of mussel densities and flow rates, and filtering and non-filtering scenarios. We also quantified and related burrow position, the amount of shell exposed at the sediment surface, and mussel density to bed roughness and near-bed flow in two northeastern US streams for several common mussel species. Our results show 1) a density-dependent effect where mussel shells alone increase bed roughness, reduce near-bed velocity and turbulence, displace the maximum shear stress off the bed and higher into the water column, and increase mixing lengths, 2) the process of filter feeding further amplifies these interactions, but mainly at lower bulk flows, and 3) the burrow position quantified in the field also demonstrates that mussels increase bed roughness and further alters near-bed flows. The results of this study help to better understand how mussels act as ecosystem engineers and modify the physical and hydraulic habitat of rivers.

LANDSCAPE SCALE ANALYSIS OF FRESHWATER MUSSEL DENSITIES IN THE UPPER MISSISSIPPI RIVER: VARIATION WITHIN AND AMONG NAVIGATION POOLS.

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Increased awareness of the importance of native freshwater mussels to the functioning of river ecosystems has led to a need for more research into mussel ecology. Resource managers in the upper Mississippi River are interested in how mussels are distributed so that habitat restoration projects can be designed to promote mussel assemblages. However, studies quantifying spatial patterns in mussel densities at landscape scales are lacking. Impoundment of the upper Mississippi River turned a free-flowing river into a series of navigation ‘pools’ (the reach of river between two consecutive locks and dams) that generally contain an upper riverine portion, a middle portion containing side channels and backwater lakes, and a lower impounded portion. Across the six navigation pools (3, 5, 6, 8, 13, and 18) that have been systematically sampled for mussels, we predicted that mussel densities would vary among pools and among pool thirds (upper, middle,

lower). We divided each pool longitudinally into thirds and used a negative binomial regression to compare densities across pools and across pool thirds. Pool-wide densities of mussels were similar across the six pools. Mussel densities were similar across the upper and middle thirds of the pools (within the same pool and among pools). However, mussel densities in the lower third of each pool were significantly greater than in the upper and middle thirds. Given this pattern was consistent across six pools, it indicates that similar spatial patterns may be evident in unsampled pools. Studies such as these are needed to gain a better understanding of spatial patterns and the environmental factors driving these dynamics. Resource managers can use these distribution patterns to implement viable restoration actions to protect this imperiled resource.

BRIDGING THE DATA GAP IN THE PENNSYLVANIA DEPARTMENT OF TRANSPORTATION PROGRAMMATIC AGREEMENT (PART II).

Ryan Schwegman[1], Dale Dunford[1], Phil Mathias[1], Becca Winterringer[1], Toni Zawisa[2], and Gregory Zimmerman[1]. [1]EnviroScience, Inc. Stow, OH. [2]Pennsylvania Department of Transportation Environmental Policy and Development Section, Clearfield, PA.

Western Pennsylvania has a large concentration of rare mussels including six federally threatened / endangered (T&E) species. Transportation improvement actions are a fundamental component of PennDOT's annual portfolio but inevitably encounter conflicts with T&E species. The Federal Highway Administration and PennDOT, in coordination with PFBC, FEMA, and the USACE, consulted with USFWS on a tiered programmatic biological assessment/biological opinion. Subsequent to issuance of the Tier 1 biological opinion, project specific, Tier 2 consultations have been completed. This approach has provided project streamlining benefits for PennDOT and the agencies at stake as well as conservation and recovery progress. A range of avoidance and minimization, conservation and recovery measures, identified in the Tier 1, are applied depending upon which of the five Management Units a project falls within. Based on existing survey data Management Unit 1 and 2 streams have high to moderate densities of T&E mussels, while Management Unit 3 (MU-3) streams are within the range of T&E mussels limited recent survey information exists to confirm the presence / absence of T&E species. PennDOT has provided funding to complete comprehensive surveys of these stream reaches as part of their Tier 1 commitment to research. In total, 12 streams accounting for 240 miles of surveyed stream are included in the project. Survey methods utilize a multi-phase approach with triggers for each phase, so that survey efforts are focused on stream reaches most likely to support T&E species. In 2018 and 2019 the survey work was completed and a total of 12,624 living mussels representing 25 species were detected during the survey efforts, although the presence of T&E species was limited. Data provided by these survey efforts was presented and provided to resources agencies to help better define those streams currently classified as Management Unit 3 in the Tier 1 programmatic.

VILLOSA FABALIS (RAYED BEAN), A DISCUSSION AND UPDATE OF RECENT RECORDS AND RANGE EXPANSION IN THE UPPER ALLEGHENY RIVER ABOVE KINZUA DAM IN PENNSYLVANIA, NEW YORK, AND THE SENECA NATION OF INDIANS.

Ryan J Schwegman[1], Dale P Dunford[1], Philip T Mathias[1]. [1]EnviroScience Inc., Stow, OH.

During the past several field seasons (2015 to 2020), malacologists from EnviroScience, Inc. has collected significant data on *Villosa fabalis* (Rayed Bean) in the Upper Allegheny River above Kinzua Dam in Northwestern Pennsylvania, New York, and Seneca Nation of Indians. Survey teams ranged in size and survey type from large crews dedicated to a mussel relocation at single location to small crews paddling long stretches of the Allegheny River systematically surveying quality habitat to provide species assemblages and detect threatened and endangered mussel species. Through these survey efforts, upstream range expansions for *V. fabalis* were detected in Pennsylvania in both the Allegheny River and Oswayo Creek. While the Rayed Bean Status Assessment recognizes the Allegheny River population as one of the most important remaining range wide today, it only describes the range "from downstream of Allegheny (Kinzua) Reservoir in Warren County to the pool of Lock and Dam 8 in northern Armstrong County". Preliminary data would suggest that populations upstream of Kinzua are substantial and may exceed those downstream on of Kinzua. From these survey efforts, much information can be inferred to enhance the recovery plan for the species, including density estimates and potential source population locations for future propagation efforts.

SEXUAL DIFFERENTIATION IN SOMATIC GROWTH WITHIN _LAMPSILIS CARDIUM_ (BIVALVIA: UNIONIDAE), AS A FUNCTION OF ENVIRONMENTAL IMPACTS.

Mariah Scott[1] and Rüdiger Bieler[2]. [1] University of Chicago, Chicago, IL; [2] Field Museum, Chicago, IL.

Females have to balance their survival and somatic growth with the fitness of their offspring. Somatic growth rate differences between females and males of a given species may provide insight into how costly reproduction is for females, in comparison to their male counterparts. Sexual dimorphism in shell shape is evident in *Lampsilis cardium*. Are there significant growth rate differences between females and males of *Lampsilis cardium*? If so, does the amount of sexual differentiation in somatic growth differ between habitats? This study plans to make comparisons between female and male *Lampsilis cardium,* from two watersheds to answer these questions. The comparisons of males and females will be limited to shells taken from a single collection event. Samples from each location will include the right shell valves of up to 30 females and 30 males of the species, utilizing existing museum collections. Optical 3-D scans of the specimens will be combined with cross-sections to determine the amount of length and external area added annually for each specimen. These measurements will allow specimens to be analyzed morphologically, with simulations of their growth rates over time. The growth of a specimen will be a model of the change in shell volume and shell cavity volume of females, compared to males, over successive years of growth.

COMPARISON OF LIVING COMMUNITY AND DEAD SHELL ASSEMBLAGES OF FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE) IN GREAT LAKES REGION TO BETTER UNDERSTAND ANTHROPOGENIC IMPACTS.

Mariah Scott[1] & Rüdiger Bieler[2]. [1] University of Chicago, Chicago, IL; [2] Field Museum, Chicago, IL.

Freshwater mussels in the family Unionidae have experienced numerous anthropogenic ecological changes in the Great Lakes region. One of the most notable is the impact of the invasive species, *Dreissena polymorpha* and *Dreissena bugensis*. Numerous studies from the expanding ranges of *Dreissena polymorpha* and *Dreissena bugensis* have found that these invasive species cause a dramatic decline in native unionid communities. Then, in numerous habitats, the two clades eventually begin coexisting. But, is the composition of the native unionid communities changed by the invasive species? This study will utilize data from the Unionid Refuge Project, comparing the discordance between living community and dead shell assemblages of freshwater mussels. The difference in species richness, composition, evenness, and abundance will be compared within each site. Over 200 half hectare sites throughout the Great Lakes region will be analyzed, representing a mixture of sites with no presence to high intensities of dreissenid invasion. This study will look for changes in species richness and community composition in these locations, to better understand how dramatically unionid communities are altered as a function of the intensity of dreissenid invasion.

NEAR REAL-TIME TRACKING OF MUSSEL FILTRATION AND CLEARANCE RATES: A REVIEW OF THE BENEFITS AND DOWNFALLS OF USING A BECKMAN-COULTER MULTISIZER

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Freshwater mussels can have a large impact on the concentration and composition of suspended particulate matter in the surrounding water column and may be an important tool in addressing water quality concerns. Assessing filtration rate (the number of particles removed) and clearance rate (the volume of water moved) of native mussels can inform a wide array of research goals, from generating a cost-benefit analysis of which mussel species and age group is best suited for an environmental biomanipulation project to providing an indicator of stress during a toxicity test. To expand current knowledge on the subject we designed a series of laboratory tests comparing mussel species (*Lampsilis radiata*, *L. fasciola*, and *Utterbackia imbecillis*), age group (juvenile, sub-adult, and adult), algae species (*Nannochloris sp.*, *Chlorella sorokiniana*, *Microcystis aeruginosa* [toxic] and *M. aeruginosa* [non-toxic]), and algal concentration (50,000, 100,000, 400,000 cells/mL). Using a Beckman-Coulter Multisizer 4e particle counter we were able to analyze samples in less than three minutes, monitoring algal concentration throughout the experiment in near real-time. However, during our experiments we encountered a variety of previously unreported complications involving sample storage method and duration, machine calibration and configuration, blockages caused by large particles or mussel excreta, and background particles obscuring algal counts. Some of these discoveries could have profound impacts on the accuracy of experimental data and highlight problems associated with this method of particle analysis. We suggest that standard operating

procedures and sample quality control methods be revisited and expanded upon to allow for fast, reliable, and replicable assessment of filtration and clearance rate during experiments.

CORBICULA EFFECTS ON SURVIVORSHIP, GROWTH, AND DRIFT OF JUVENILE *LAMPSILIS SILIQUOIDEA* IN LABORATORY EXPOSURES.

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The Asian clam, *Corbicula fluminea*, is an invasive species that is abundant and often co-occurs with native freshwater mussels. *Corbicula* is widely suspected of having negative effects on native mussels, but few studies have empirically tested this hypothesis. We used laboratory experiments to evaluate how adult *Corbicula* affected the survivorship, growth, and drift of juvenile *Lampsilis siliquoidea.* Growth and survival of newly metamorphosed mussels were tested in downwelling flow-through chambers with glass-bead substrates. Treatments were control (no clams), small clams (17 mm) at 900/m^2, or large clams (33 mm) at 500 clams/m^2. Mussel survival was lowered by about 4% (small clams) and 9% (large clams) relative to control and the effect was similar at 2, 3 and 4 weeks. Mussels doubled in length over 4 weeks and growth was unaffected by *Corbicula*. Tests on drift were carried out in small raceways with glass bead substrate. Flow speed across the substrate was approximately 0.7 cm/sec. Drifting behavior (wash-out) of 2-week (0.5 mm) and 6-week-old (1.5 mm) mussels was tested with *Corbicula* (23 mm) over 3 days. Mussel drift increased with clam density: 18%, 33% and 47% of 2-week-old mussels drifted at 0, 500 or 2000 clams/m^2, respectively. Drift of 6-week-old mussels was also significantly increased but only at the highest clam density. Interactions between *Corbicula* and juvenile native mussels could help explain why mussel populations continue to decline across the United States.

THE EXPANDING RANGE OF SOME MUSSELS IN MINNESOTA AND REVISION OF THE HISTORICAL MISSISSIPPI HEADWATERS FAUNA.

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Portions of three major watersheds originate within Minnesota's borders: Mississippi River, Hudson Bay, and St. Lawrence River. The Mississippi is further subdivided by St. Anthony Falls which was a significant faunal barrier to fishes and freshwater mussels. Fortunately, previous workers summarized mussel species within these watersheds providing a valuable distribution baseline. Individuals or populations of several species have since been found beyond their presumed historical range, most of which are in the Mississippi Headwaters above St. Anthony Falls. Two modes of expansion occurred. One set of species migrated upstream through locks, bypassing the falls, whereas the disjunct or limited distribution of other species suggests human mediated introductions as the likely avenue. The pre-European settlement Mississippi Headwaters fauna is revised to account for introduced species and recently recognized taxa.

HABITAT PREDICTS ABUNDANCE OF FIVE FRESHWATER MUSSEL SPECIES IN MASSACHUSETTS.

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Species-habitat relationships are critical for assessing population threats and informing conservation actions; however, habitat requirements for many freshwater mussels are unknown. We aimed to better understand habitat characteristics for five, stream-dwelling freshwater mussel species in Massachusetts: one state endangered species (*Alasmidonta varicosa*), one species of special concern (*Strophitus undulatus*) and three unlisted species (*Alasmidonta undulata*, *Elliptio complanata*, *Margartifiera margaritfera*) that are found in overlapping distributions in the state. We delineated the mesohabitat types (riffle, run, dammed pool, scour pool) within 25, 100-m river reaches in ten rivers. In longitudinal lanes, we collected species abundance (mussels/min^{-1}) via snorkeling and habitat variables (e.g. depth, emergent vegetation). Trends in mesohabitat use varied among species: *A. varicosa* and *M. margartifera* had highest abundances in dammed pools, *E. complanata* preferred dammed pools and runs to riffles and scour pools, and *A. undulata* and *S. undulatus* had equal abundances across mesohabitats (except for a low abundance of *A. undulata* in riffles). Despite these trends, mesohabitat type was not a strong predictor of species abundance and all habitat types were used proportional to their availability for each species, except for *E. complanata* which preferred different mesohabitat types in different rivers. The strongest habitat predictors of *A. varicosa* abundance were second order polynomial terms of maximum depth and pebble heterogeneity (D84/D16), and linear negative relationships to median particle size (D50) and large wood. Similarly, all species models (except *M. margartifera*) predicted negative relationships with D50 and both *A. undulata* and *E. complanata* had positive relationships with maximum depth. Habitat predictors of *M. margaritifera* were different than other species; negative relationships with algae and emergent vegetation were the strongest. This species-specific habitat modeling suggests that different habitat characteristics are critical to consider for determining management, including population restoration (e.g., where to reintroduce propagated mussels) and protection (e.g., land conservation).

USING MOLECULAR APPROACHES TO DELIMIT CONSERVATION UNITS FOR MULTIPLE SPECIES OF *POTAMILUS*.

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Freshwater mussels are among the most imperiled groups globally, resulting in legal protection and conservation actions to stem their decline. Unfortunately, recovery planning for many species may be stymied by the lack of conservation units (CUs) that are ecologically and evolutionarily discrete. We begin to address this issue by using multiple molecular approaches to establish CUs for three imperiled species in *Potamilus*: *P. amphichaenus*, *P. inflatus*, and *P. streckersoni*. *Potamilus inflatus* has been extirpated from much of its historical range and extant populations are restricted to limited stretches of the Mobile and Pontchartrain drainages. Delineating patterns of genetic diversity can be difficult when a taxon has been extirpated from a significant portion of its historical range, and in such cases, evaluations may benefit from the use of surrogate species as proxies. By characterizing genetic structure in co-distributed congeners using multi-locus sequence data, we resolve the hypothetical demographic history of *P. inflatus* and delineate two CUs corresponding to the Mobile and Pascagoula+Pearl+Pontchartrain provinces. For *P. amphichaenus* and *P. streckersoni*, we use genotype-by-sequencing and mitochondrial sequence data to define CUs. We then synthesize our molecular findings with field collections to elucidate distributional trends and contemporary status. Our methodology found defensible support for four CUs, each corresponding to an independent river basin. Survey data depicted an increase in species occurrence within each of the four CUs; however, increased occurrence was correlated with recent increases in sampling effort rather than evidence of population expansion. Our findings provide direction for natural resource managers in the development of conservation and recovery strategies for the three *Potamilus* species. Given the wide diversity of life history traits in freshwater mussels, it is an unrealistic expectation that other imperiled species will depict congruent phylogeographic patterns and there remains a critical need for robust molecular investigations to drive recovery planning.

PLANNING FOR THE CONTROLLED PROPAGATION AND REINTRODUCTION OF SPECTACLECASE (*CUMBERLANDIA MONODONTA*) USING IUCN GUIDELINES.

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Controlled propagation, augmentation, and reintroduction of endangered organisms is typically a priority action for their recovery, and in many cases is an urgent course of action to either restore or maintain existing population levels. Once wide-ranging and abundant, the Spectaclecase (*Cumberlandia monodonta*) was listed as Endangered under the Endangered Species Act on April 12, 2012 and reintroduction was identified as a strategy in the 2014 recovery outline. As a federally listed species, the U.S. Fish and Wildlife Service (Service) must comply with its' 2000 controlled propagation policy. As such, this plan is intended to explain the rationale for pursuing propagation and reintroduction, how it will be achieved with minimum risks and maximum likelihood for success, how the project will be evaluated and, if and when appropriate, terminated. The International Conservation of Nature (IUCN) guidelines were used to facilitate an assessment of ecological, social, and economic risks, and to aid development of collection, release, and monitoring strategies. Planning activities to minimize risks to extant populations and their habitats is imperative to avoid harm to existing populations of target and non-target species and to make efficient use of limited resources. The primary purpose of planned augmentations or reintroductions should be to establish free-ranging, self-sustaining wild populations of the species. The Service cooperated with state, federal, and local agencies, universities, and other partners to develop a propagation and reintroduction plan for Spectaclecase and will cooperate with those partners to implement this plan.

TEMPORAL DYNAMICS OF FRESHWATER MUSSEL LARVAE

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Native freshwater mussels often live in multispecies 'mussel beds' (e.g., 25 sp. in sites in the Sydenham River, Ontario) where many of the mussels have been reported to use the same fish species as hosts for their parasitic larvae. Given the coupling of mussels and host fishes, the purpose of this study is to gain a better understanding of the early life history of mussels to aid in their conservation. We are examining the temporal dynamics of glochidia in the water column and the potential for partitioning of their 'host' environment with the timing of glochidial release among species. We hypothesized that glochidia from different mussel species are released at different times to minimize potential competition for host fish. Glochidia were continuously sampled for 2-h discrete periods over ten 24-h sampling days (120 x 2-h samples) in the Sydenham River from late August to September. This is a period when a large number of mussel species are known to be gravid. Glochidia

abundance and identification to the species level was undertaken using morphometrics based on the known shapes and sizes of mussel species in the Sydenham River. The results will inform us when gravid females release their glochidia during the day and can be used to examine whether females try to match the diel activity of fish, increasing the chance of successful parasitism. Greater insight into the host-parasite relationship will be achieved, and potential threats and mechanisms leading to mussel declines can be revealed. This study will help improve our scientific understanding of mussel reproduction to supplement appropriate recovery, conservation and management plans.

OFFSPRING FROM A SINGLE FEMALE RETAINS POPULATION-LEVEL GENETIC VARIATION BUT ALTERS GENETIC STRUCTURE.

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Controlled propagation has become a common conservation practice for rare and endangered species to re-establish populations in their historic range and to augment extant populations. Such practice is often considered as a “last resort” to prevent species from extinction. While propagation programs became essential to increasing the number of individuals in the population, the genetic consequences, such as genetic erosion, genetic pollution, and artificial selection of certain traits, are largely undocumented. Using juveniles propagated from a single female of two common species (*Lampsilis cardium* and *L. siliquoidea*), we investigate the retention of genetic variation and genetic structure within the juveniles relative to the wild populations. Using microsatellite markers, we estimated genetic metrics (e.g., allelic richness and heterozygosity), population genetic structure, the presence of past bottlenecks, and multiple paternity within and between juveniles and wild populations. Propagated juveniles of two species retained the same amount of genetic variation as the wild population and showed no sign of population bottlenecks. However, the juveniles showed distinct allele frequency and population structure. The minimum number of sires contributing to each female ranged from 13 sires in *L. cardium* and 25 in *L. siliquoidea*. Such high numbers of sires likely maintain the amount of genetic variation within offspring from a single female. The consequences of altered allele frequency and genetic structure to the wild populations are currently unknown. This study showed that propagated juveniles likely retain population-level genetic variation; however, it is unknown whether small and declining populations of endangered species show similar patterns. Future studies need to investigate the genetic consequences of propagation in rare and endangered species.

EVALUATING WESTERN PEARLSHELL MUSSEL POPULATIONS FOR VIABILITY, REPRODUCTION AND HOST FISH GLOCHIDIA INFESTATIONS ACROSS FIVE WATERSHEDS IN WESTERN MONTANA.

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The western pearlshell (WEPE), *Margaritifera falcata* has experienced significant state-wide declines in Montana, and is now known from ~80 populations with only ~20 expected to be viable in 100 years. Hatchery propagation is being considered as a future prospect for recovering this species and understanding the reproductive timing and host fish requirements of their life-cycle is essential. This research evaluates three aspects of the WEPE's life-cycle critical for maintaining viable populations, by determining: 1) reproductive status and timing of WEPE gravidity across five watersheds with varying temperature regimes, 2) which salmonid host fish species WEPE are using successfully, by documenting the presence and timing of glochidia on gills, and 3) whether host fish densities or benthic habitat conditions are more of a determining factor for WEPE recruitment. We were successful at determining the reproductive status (gravidity) and timing of glochidia release by visiting 25 WEPE populations multiple times during their known spawning period. We electro-fished salmonids near the mussel beds to document the presence, abundance and timing of glochidia on salmonid gills. Earliest host fish infections were documented in the Kootenai watershed (June 26th) in 2019 and in the Big Hole (May 19th) in 2020. Latest infected fish gills were observed in Upper Rock Creek (August 26th, 2020). Host fish CPUE densities were positively correlated with viable WEPE populations (r^2=0.378), but this did not equate to higher percentages of glochidia on gills (r^2=0.128). Differential host-fish glochidia infection rates indicate that there are likely 2 types of species: 1) primary salmonid hosts (*Oncorhynchus spp.*) where rates of successful infestation and metamorphosis are high, and 2) marginal hosts (*Salmo, Salvelinus*) where success rates are low. Even though westslope cutthroat trout are WEPE's native host fish in Montana, pearlshell populations across multiple watersheds are recruiting by exclusively using brook trout.

DO MUSSELS BIOACCUMULATE THE FOREVER CHEMICAL, PFAS, DIFFERENTLY THAN OTHER AQUATIC ORGANISMS?

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In this study we investigated the bioaccumulation of per- and polyfluoroalkyl substances (PFAS) in the freshwater Eastern Pond mussel, *Ligumia subrostrata*. We focused on the freshwater mussel because there are very few studies reporting the uptake of PFAS in freshwater mussels and mussels are an important component of food webs where PFAS occur. The Eastern Pond mussel was selected because it is commonly found, and its range extends across North America. PFAS have been found to bind to proteins and colloids in surface water systems and, therefore, accumulation of PFAS is likely to differ based on organism feeding and behavior. In this study we determined the bioaccumulation kinetics of freshwater mussels in a controlled laboratory study. The laboratory study focused on deriving bioaccumulation kinetic parameters following exposure to PFHxS, PFOS, and PFDA at 10 µg/L and PFUnDA at 1 µg/L during a 14-day uptake exposure and a 7-

day elimination period. Bioconcentration factors (BCF), calculated as the ratio of PFAS in mussel tissue to water concentration, at day 7 were determined for PFHxS (0.24 ± 0.08), PFOS (7.73 ± 1.23), PFDA (4.80 ± 1.21), and PFUnDA (84.0 ± 14.4). Uptake and elimination rate constants as well as time to steady state were determined to provide input to food web models. In this study we found bioaccumulation of these four PFAS in Pond mussel is similar to uptake reported for fish and other aquatic invertebrates.

HABITAT SELECTION, HOST DETECTION, AND HYPOXIC RESPONSE IN THE SALAMANDER MUSSEL, *SIMPSONAIAS AMBIGUA*.

Eric Stegmann[1], Chris Barnhart[1], & Megan Bradley[2]. [1]Missouri State University, Springfield, MO; [2]Genoa National Fish Hatchery, Genoa, WI.

Two important threats to native mussels are loss of habitat and loss of access to the vertebrate hosts of the parasitic mussel larvae. The Salamander mussel, *Simpsonaias ambigua*, is a habitat specialist, living under flat rocks. It is often found in direct association with its only known host, the common mudpuppy, *Necturus maculosus*. This association could result from movement and habitat selection by the mussels themselves. Alternatively, it might result from the deposition of juveniles by a resident host. Habitat selection and host detection by *Simpsonaias* was examined using choice arenas and choice flumes. Variables tested in arenas included taxis with respect to flow, toward vertical edges, to positions beneath clear or opaque shelters, and aggregation with other individuals. Variables tested in choice flumes included movement toward host scent and dissolved oxygen. Significantly more *Simpsonaias* were found upstream, underneath shelters, beneath dark shelters, in contact with one another, and along the edge of the arena respectively. In choice flumes, mussels showed no preference for host salamander-scented water, fish-scented water, or control well water. Mussels showed no taxis with respect to dissolved oxygen at 15C, while at 20C mussels were found more often on the hypoxic side, perhaps because of inhibition of locomotion by hypoxia. Overall, the results show that *Simpsonaias* prefer and actively seek darkened shelter where they come into contact with solid surfaces and with each other. The results also suggest that construction of suitable shelters could be a useful conservation tool for this species.

FISH BEHAVIORAL RESPONSE TO LURES PRODUCED BY THE PLAIN POCKETBOOK MUSSEL (*LAMPSILIS CARDIUM*).

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Mussels species belonging to the Unionidae family are among the most threatened group of animals in North America, and part of the reason for this may be in part due to their complex life cycle. Many species in this family use lures to attract host fish for their glochia. *Lampsilis cardium* is one of the species that used a lure to attract host fish, and although laboratory tests identify which fish are capable of hosting mussels. Lab research cannot determine which fish will interact with the mussel lures. Fish species that are important to maintaining wild populations of mussels depends on both the physiology understood through laboratory tests and the way that fishes respond to mussel lures in their natural environment. Fish species that are physiologically suitable for parasitic glochidia must bite or strike the lure of a gravid female *L. cardium* in order for successful maturation of larvae. We conducted approximately 1 hour observations by using remote cameras to record fish behavior near *L. cardium* displaying their lures, mussels without lures and in areas of the river without mussels. While a large number of fishes have been observed in the river (roughly 50 species), only a few were observed in our videos of displaying *L. cardium*. Five of those

species exhibited interest in mussels, reflected by time spent near and oriented toward the mussels. *Fundulus notatus, Lepomis macrochirus*, and *Lepomis gibbosus* were observed striking the active lure of a displaying mussel. We compared the fish activity to laboratory reports of host suitability. At least the two sunfish were physiologically compatible with the mussels that we observed. In depth understanding of this critical life stage of Unionidae mussels is necessary for effective conservation efforts.

WASTEWATER TREATMENT OUTFALL AS A LIMITING FACTOR TO FRESHWATER MUSSEL REINTRODUCTION AND RECOLONIZATION.

Kristin A. Stockton. West Virginia University, Morgantown, WV.

In streams where freshwater mussels are declining or extirpated, propagation and reintroduction are attractive methods of supplementing or restoring populations. Prior to reintroduction, it is critical to determine if the stream can support mussels. Opequon Creek, our study stream, has been identified as a candidate for reintroduction. While Opequon Creek is impacted by suburban expansion and agricultural practices, streams with similar impacts still support mussels. Opequon Creek has a higher input from wastewater treatment plants (WWTPs) than other streams in the state. Many studies of the effects of WWTP effluent on mussels focus on adults and/or occur in a laboratory environment. Our goal was to determine the effects of exposure to WWTP outfall on juvenile mussel growth and survival in the field and to assess the water quality and environmental conditions of Opequon Creek for potential reintroduction. We placed juvenile *Lampsilis cardium* mussels in Barnhardt silos at eight sites throughout Opequon Creek and four sites in Back Creek (control). The sites were selected based on proximity to WWTP outfalls. Mussels were monitored monthly for growth and survival. Water quality data was collected bimonthly with a YSI unit and hourly with a temperature and conductivity logger. Samples were sent to a lab monthly for further analysis. Results indicate that WWTP outfall contributes to decreased survival of juvenile freshwater mussels. The data suggest that conductivity and temperature increased with proximity to outfall. These impacts were greater in the upper reaches of the stream where the outfall was less diluted. Our results suggest that total maximum daily loads may need to be further adjusted to adequately support freshwater mussels, especially in lower order streams and headwaters.

STEP BY STEP, BIT BY BIT, SHELL BY SHELL, THE MOLLUSKS WERE (MOSTLY) MOVED

Alison P. Stodola[1], Rachel M. Vinsel[1], Jeremy S. Tiemann[1], Sarah A. Douglass[1], and Kevin S. Cummings[1]. [1]Illinois Natural History Survey, Prairie Research Institute, University of Illinois.

The Illinois Natural History Survey is home to several significant biological collections, including a Mollusk Collection that houses nearly 100,000 lots of mollusks. We provide access to half a million specimens to the scientific community and general public, which facilitates research in morphology, systematics, and distributional changes in many molluscan fauna. An institutional initiative to relocate the INHS Mollusk Collection from its home in the historic Natural Resources Building on the University of Illinois campus to the Natural History Survey headquarters at U of I's research park began in 2017. Over the course of many months, the INHS Mollusk Collection move took shape and

came to fruition. We showcase images from the new space, highlight improvements in accessibility and safety, and provide pointers for anyone who may want to use biological collections in research. We also explain some of the complications with moving to a "new" building. Spoiler alert: we're not done yet! A myriad of complications arose when attempting to retrofit an office space into an ethanol storage facility, and the solution remains to be seen. Regardless, the new space provides improved visibility of the value of biological collections, better access, and a bright long-term home for the INHS Mollusk Collection.

INCLUSIVE AND EXCITING CHANGES TO THE FMCS WEBSITE

Nora RW Straquadine. FMCS Website Manager. Stony Brook University Southampton, School of Marine and Atmospheric Sciences, Southampton, NY 11968. nrstraquadine@gmail.com

To best accommodate our members and the public, some aspects of the FMCS website need to be reorganized. This includes making our existing web content more accessible, by ensuring it better aligns with the Web Content Accessibility Guidelines (WCAG) 2.1 recommendations. The WCAG is an internationally recognized authority for accessibility standards, and new content added to the website will be assessed for accessibility. The plan for key changes to the website includes reorganizing freshwater mollusk content for the general public, reorganizing for easier navigation for our society members, and making sure content is perceivable (through text alternatives like photo alt text and video transcripts, using distinguishable colors and contrasts), operable (keyboard accessible, easy to navigate), understandable, and robust (compatible with assistive technologies). The ultimate goal is being more inclusive to a wider range of people with disabilities. This topic is not just something for the society to consider but is important in our daily lives as scientists and professionals who communicate with the public. I hope this talk informs you of small changes you can make in your own presentations and content. I intend for this to be an ongoing discussion, so I encourage you to reach me at my email (nrstraquadine@gmail.com) to share your thoughts after the talk.

ABILITY OF ASIAN CLAMS (*CORBICULA FLUMINEA*) TO CLEAR AND DIFFERENTIATE BETWEEN TOXIC BLOOM-FORMING CYANOBACTERIA AND OTHER ALGAE.

Nora RW Straquadine & Christopher J Gobler. Stony Brook University Southampton, School of Marine and Atmospheric Sciences, Southampton, NY 11968

Cyanobacterial harmful algae blooms (cHABs) are increasingly disrupting freshwater ecosystems and introducing toxins into aquatic food webs. The invasive and edible Asian clam (*Corbicula fluminea*) can be found in waterways afflicted with cHABs. This study focuses on collecting preliminary data for how quickly *C. fluminea* could become a possible vector of cHAB toxins by investigating interactions with cHAB species. We conducted laboratory experiments exploring the clearance rates of, and particle selection by, *C. fluminea* using algal cultures (microcystin-producing *Microcystis aeruginosa* and the non-toxic green microalga *Raphidocelis subcapitata*). Our first aim was to investigate

clearance rates of each algae species at three concentrations mimicking typical dense bloom conditions and smaller blooms: 1 x 10^6 cells mL^{-1}, 5 x 10^5 cells mL^{-1}, and 2.5 x 10^5 cells mL^{-1}. The second aim was to explore particle selectivity with five ratios of *Microcystis* and *Raphidocelis* in the above cell concentrations. Clearance rates differed significantly ($p=<0.05$) between cell densities in the single species treatments but did not differ between the species, indicating that *C. fluminea* actively feeds on *Microcystis* and therefore, likely accumulates the hepatoxin, microcystin. In addition to the *Microcystis* experiments, we plan to conduct the same experiments using a cultured strain of *Dolichospermum circinale*, a filamentous cyanobacteria that produces saxitoxin. Understanding how quickly *C. fluminea* feeds on cyanobacterial blooms has implications for human health as well as bloom ecology and could be used for management decisions around harvesting this species.

THE FRESHWATER MUSSEL REARING FACILITY AT THE MILL OF KALBORN IN LUXEMBOURG, A GUIDED TOUR.

Frankie Thielen, Karin Michels, Sonja Heumann, Michel Frisch. all: natur & ëmwelt / Fondation Hëllef fir d'Natur, Kierchesstross 2, L-9753 Heinerscheid, Luxembourg,

Seven freshwater mussel species used to inhabit the stream, rivers and lakes of the small country Luxembourg in central Europe. All species have declined in their abundance during the last years. The two species of most concern are the thick shelled river mussel (*Unio crassus*) and the freshwater pearl mussel (*Margaritifera margaritifera*). Both species are meanwhile highly protected throughout Europe by national and EU-wide legislations. To support both species in the low mountain area of the Ardennes region in Belgium, Germany and Luxembourg a freshwater mussel rearing facility was installed at the mill of Kalborn in Luxembourg. Here we give a tour through our facility showing and explaining our culture procedure for both species. This starts with having the respective host fishes ready at the right time and collecting glochidia from both species to infest the host fishes. After the infestation, the host fish are transferred into our juvenile mussel collection installation. Once juveniles drop from the fish they are transferred into different rearing systems, like small static detritus boxes, sand aquaria and sand troughs. Later on, the small mussels are moved to an outdoor rearing channel. New trials, in 2020, using floating cages on a pond to grow out the mussels were very promising and will be presented. Having reached 5-10mm in size the mussels are tagged and released into their home streams. Some results on the recovery, growth and survival in the wild are presented. To check the possibility of reintroducing *Unio crassus* in two formerly populated rivers, we exposed juveniles in 2020 with mussel silos in these rivers. As growth and survival were encouraging we will continue these efforts in 2021. Beside the mussel culture our mill is also used to raise awareness on how important our freshwater ecosystems are. This by giving guided tours, but also by allowing children and students to explore the river and see its beauty.

DIFFERENTIAL VULNERABILITY OF NATIVE AND NON-NATIVE MOLLUSKS TO PREDATION BY JUVENILE BLACK CARP

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Black carp (*Mylopharyngodon piceus*), native to Pacific drainages of northern Vietnam, eastern China, and southeastern Russia, has become established in the Mississippi River basin in North America. The vulnerability of North American snails and bivalves to black carp predation remains unknown, especially as it relates to the juvenile life stage when these predators transition to mollusk prey. To address this knowledge gap, we conducted a series of laboratory feeding experiments to assess the relative vulnerability of different mollusk taxa to predation by juvenile (age-0 and age-1) black carp. Age-0 black carp were tested with North American native unionid *Hamiota perovalis*, native pleurocerid snail *Elimia livescens*, and a native snail in the family Physidae, whereas Age-1 black carp were tested with *Elimia*, the North American native unionid *Lampsilis cardium* and *Lampsilis cariosa*, a native clam in the family Sphaeriidae, and the non-native *Corbicula fluminea*. Juvenile black carp readily attacked and consumed shelled prey, but differences in vulnerability to being crushed or consumed were evident among prey taxa exposed to age-0 and age-1 black carp. Age-1 black carp displayed a wider range of feeding capabilities than age-0 black carp and easily consumed pleurocerid snails along with *Lampsilis* mussels and sphaeriid clams. The only prey taxon that age-1 black carp struggled to crush and consume was *Corbicula*, which had the thickest and widest shells relative to predator gape of all prey tested. Our experiment supports the contention that a wide range of small or juvenile mollusks are likely susceptible to predation by juvenile black carp but highlights variability in the relative vulnerability of different mollusks to predation by juvenile black carp. Prey-specific physical properties, such as shell strength and shell size, may drive differential predation pressure on mollusk populations as the invaded range of black carp expands.

NONINDIGENOUS AQUATIC MOLLUSKS IN ILLINOIS

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Nonindigenous aquatic species (NAS), commonly known as aquatic invasive species (AIS) or non-native aquatic species, are organisms that have become established beyond their native range. They often inhabit a variety of aquatic habitats and physicochemical conditions, reach high densities, and alter ecosystem function. Understanding the distribution of NAS is vital to protecting native biodiversity in invaded ecosystems. A search of museum collections, literature accounts, and field surveys conducted in recent years by biologists from the Illinois Natural History Survey, Illinois Department of Natural Resources, and other agencies revealed 11 NAS mollusk taxa have been reported in Illinois, and all but one (Big-ear Radix *Radix auricularia*) continue to have viable reproducing populations. The remaining ten includes six bivalves and four gastropods. Some taxa, like Zebra Mussel *Dreissena polymorpha*, Basket Clam species *Corbicula* spp., and Chinese Mystery

Snail *Cipangopaludina chinensis*, are widespread and abundant. However, others like Mottled Fingernail Clam *Eupera cubensis* or New Zealand Mud Snail *Potamopyrgus antipodarum*, are currently restricted to a particular location or drainage. Other NAS mollusks with the potential for becoming established in Illinois or boundary waters also will be discussed.

DIRECTING FIELD SURVEYS FOR CALIFORNIA FLOATER (*ANODONTA CALIFORNIENSIS/NUTTALLIANA* CLADE) AND WESTERN PEARLSHELL (*MARGARITIFERA FALCATA*) USING eDNA IN THE BEAR RIVER BASIN.

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Mussels are cryptic animals that are often difficult to study due to their biology and characteristics of the aquatic ecosystem. Environmental DNA (eDNA) can be a useful tool to direct field surveys by identifying areas with DNA fragments from the mussel species of interest. Mussels are ideal animals for eDNA surveys because they slough cells while filtering large volumes of water during feeding. We collected water samples for eDNA throughout the Bear River basin in Wyoming and analyzed samples for DNA from California Floater (*Anodonta californiensis/nuttalliana* clade) and Western Pearlshell (*Margaritifera falcata*) mussels. California Floater was present in Wyoming from north of Evanston to where the Bear River flows out of the state north of Cokeville, and the highest concentrations of DNA were in the northern portion of the basin. Western Pearlshell were present throughout the basin in Wyoming from the southern border of Wyoming to where the Bear River flows out of the state north of Cokeville, and concentrations were highest in the southern portion of the basin. Locations identified by eDNA provided potentially new locations for both mussel species and will direct future field efforts.

MUSSEL MEMORY: DIGITIZATION OF THE UNIONOIDA AT THE BUFFALO MUSEUM OF SCIENCE

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With historic roots dating back to the mid-1800's, the Buffalo Society of Natural Sciences (BSNS) has had an eventful and rich journey into the present scientific era. The Conchology Collection is of notable historic significance because it is the oldest section of the Museum's research collections. Not only does the collection extensively document the Niagara River Region, but it also holds representatives from other parts of the U.S. and from around the world. The most comprehensive publication of this collection is *The Mollusca of the Niagara Frontier Region and Adjacent Territory* published in 1948, by Imogene C. Strickler Robertson and Clifford L. Blakeslee. Shortly after the publication of this resource, conchology fell out of Buffalo's popular culture, and the collection has remained hidden. The recent resurgence of the city of Buffalo has prompted ecological efforts that can be directly enhanced by better access to this collection, especially because both endangered and extinct unionid species are well represented. Supported by IMLS Museums for America funding, the Buffalo Museum of Science aims to gain intellectual and physical control over the Conchology Collection, starting with the order Unionida, while increasing the current care and

management of this historic material. The collection holds 2,269 lots, containing 6,147 individual dry specimens of the order Unionida. Efforts are underway to re-curate, photograph, and digitize this collection to reflect advancements in archival practices and unionid taxonomy. This will produce a usable collection catalog accessible through aggregators such as iDigBio and GBIF. Improved accessibility to this collection will support current scientific inquiry pertaining to these important organisms. Additionally, the museum will also promote the conservation of our native mussels through the expansion of our 'Rethink Extinct' science studio that will highlight this updated collection.

GENETIC DIVERSITY MAINTAINED IN COMPARISON OF CAPTIVE-PROPAGATED AND WILD POPULATIONS OF *LAMPSILIS FASCIOLA* AND *PTYCHOBRANCHUS FASCIOLARIS* (BIVALVIA: UNIONIDAE).

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We compared the genetic diversity and structure between wild and captive-reared freshwater mussels at risk in Canada, *Lampsilis fasciola* (Wavy-rayed Lampmussel, WRL) and *Ptychobranchus fasciolaris* (Kidneyshell, KS), using 8 and 9 microsatellite-generated genotypes respectively. No significant differences were detected between wild and propagated WRL (from 12 mothers) or KS (from 7 mothers) based on genetic diversity metrics using Kruskal-Wallis tests. Effective population size (N_e) was estimated and there was considerable overlap in the estimated N_e between wild and captive populations of both species (WRL 37.6, 15.7-204.3; KS 49.9, 27.9-126). Pairwise F_{ST} and D_{est} values among wild WRL, captive-reared WRL juveniles, and across different time periods (2008 to 2018) were generally low (F_{ST} = 0.007-0.043, D_{est} = 0.005-0.282). Pairwise F_{ST} and D_{est} for KS were low and not significant (0.012, 0.017). When comparing captive-reared offspring with the wild population, STRUCTURE analysis revealed strong support for a single genetic population for both species. With at least 7 females contributing to brood stock, genetic diversity was maintained. To further elucidate the male contribution to each glochidial brood and the variability of genetic diversity in individual glochidial broods, using RAD-seq we generated single nucleotide polymorphisms (SNPs) for 7 female WRL and their respective broods. We expect to find trends in the genetic diversity and structure metrics similar to the microsatellite analyses. Using the SNP dataset, we also expect to find evidence of multiple-paternity and variability in the male contribution and expect this variation in male contribution to be reflected in the genetic diversity of the respective broods. These data will aid conservation of small populations in need of PTRA (propagation, reintroduction, translocation augmentation) strategies.

ASSESSING THE FEASIBILITY OF A FRESHWATER MUSSEL INTRODUCTION IN THE URBAN SAN ANTONIO RIVER USING A HOLISTIC STUDY DESIGN.

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The San Antonio River has seen an almost complete extirpation of freshwater mussels and an overall downward trend in biodiversity over the past several decades due to urbanization, most notably, habitat degradation driven by the growing need for flood conveyance. However, a nearly decade old ecosystem restoration of a nine-mile portion of this urban stretch of river has restored much of its ecological function. This restoration has already proven to be successful for establishing diverse avian and terrestrial vegetative populations and may potentially allow for renewed suitability for intolerant aquatic organisms such as freshwater mussels to once again take root. San Antonio River Authority biologists are exploring this opportunity through a series of studies to determine if a reintroduction of freshwater mussels is feasible in the future. The target species for research and reintroduction include the yellow sandshell (*Lampsilis teres*), pimpleback (*Cyclonaias pustulosa*), pistolgrip (*Tritogonia verrucosa*), and threeridge (*Amblema plicata*). Current and future studies include an adult growth and survival study, a juvenile stormwater toxicology study, host fish surveys, habitat suitability modeling, the development of propagation techniques for focal species, and the development of a genetic management plan. Preliminary data from the adult growth and survival study show promising results, however, results from the concurrent and future studies are necessary to inform any conclusions. The goal of this program is to make a decision in Spring 2021 based on data collected as well as input from outside experts.

SPECIES DELIMITATION IN THE DOMED CAVESNAIL (*PHREATODROBIA NUGAX*) USING INTEGRATIVE TAXONOMY.

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The domed cavesnails, *Phreatodrobia nugax*, is a minute (<2 mm maximum size) snail endemic to the Edwards-Trinity Aquifer System of Central Texas, USA. Several species of cavesnail that co-occur in samples from the aquifer are very challenging to distinguish from each other and from the domed cavesnail. Making this challenge more difficult is that the morphological variability in the domed cavesnail is extreme, including shells that are partially uncoiled, flat, tall, and everything in between. Previous molecular phylogenetic work supports the notion that what we are calling the domed cavesnail is polyphyletic, meaning that it is not clear what exactly is and is not considered *P. nugax* at the species level. This provokes conservation and regulatory concern because several species of cavesnail are considered endangered, but we might not be able to reliably distinguish them from the domed cavesnail. In my work, I attempt to distinguish the domed cavesnail from other closely related cavesnails using molecular phylogenetics and geometric morphometrics of *P. nugax* from different localities such as springs, seeps, and wells across its wide geographic range.

EVALUATION OF CHRONIC SENSITIVITY OF A FRESHWATER MUSSEL USING PARTIAL LIFE-CYCLE TOXICITY TEST AND LONG-TERM TOXICITY TEST.

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ASTM E2455 standard recommends a 4-wk duration for chronic toxicity tests using juvenile mussels with survival and growth endpoints; no standard test method to evaluate effects on mussel reproduction. Concerns have been expressed whether the responses of juvenile mussel survival and growth over a 4-wk exposure are adequate to assess long-term impacts. The objectives of this study were to evaluate the sensitivity of reproduction endpoints from a partial life-cycle test with fatmucket (*Lampsilis siliquoidea*) and survival and growth endpoints of juvenile mussels from a standard chronic 4-wk test and a longer-term 12-wk tests. Partial life-cycle tests were conducted by first exposing fatmucket brooding mature glochidia to six concentrations of potassium chloride (KCl) and nickel (Ni) for 6 wks. After the adult mussel exposure, subsamples of glochidia were isolated from adults to evaluate (1) glochidia viability, (2) the response of free glochidia in additional 24-h exposures, and (3) the success of glochidia metamorphosis. Chronic 4- and 12-wk KCl and Ni toxicity tests were conducted starting with 2-wk-old juvenile fatmucket. Preliminary results showed that 20% effect concentration (EC20) for glochidia viability after adult exposure to both toxicants did not change either with additional 24-h exposure with free glochidia or after the glochidia metamorphosis. EC20s for these reproduction endpoints were equal to or greater than EC20 for biomass (total dry weight of surviving mussels per replicate) from the 4-wk juvenile tests. Importantly, EC20s for the survival and biomass of juvenile mussels decreased >2-fold with extended exposure from 4 to 12 wks. Thus, the survival and growth of juvenile mussels in standard chronic 4-wk exposures may be representative to the reproductive endpoints from the partial life cycle study; however, the response of juveniles in a longer-term 12-wk exposure may reflect more accurate estimates of inherent sensitivity.

PHENOTYPIC PLASTICITY IN FRESHWATER GASTROPODS INFLUENCES SHELL SHAPE LESS THAN YOU THINK.

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Gastropod shells display a breathtaking amount of morphological diversity. Even with increased reliance on molecular data for taxonomic and conservation research, shells still form the basis of most gastropod taxonomy. However, intraspecific variation in shell morphology is common, and poor understanding of within-species vs. among-species variation complicates taxonomy and conservation of many gastropod groups. Nevertheless, within species conchological variation is often attributed to phenotypic plasticity, which is the phenomenon of a single genotype giving rise to multiple phenotypes. Here, I review the evidence of phenotypic plasticity as a causal mechanism of conchological variation across all freshwater snails. Phenotypic plasticity has been well documented in some Panpulmonata lineages (e.g., *Helisoma*), but experimental evidence on causes of within-species morphological variation is lacking for the majority of freshwater gastropod lineages.

Furthermore, phenotypic plasticity, when present, often has a small effect on shell shape. This should not be taken to mean that phenotypic plasticity is not selectively advantageous, but phenotypic plasticity rarely, if ever, causes the presence or absence of discrete shell features like spikes or shell ribs (i.e., plicae or carinae). Broadly, intraspecific shell shape variation in freshwater snails has been speculated to be caused by phenotypic plasticity more often than experimentally demonstrated. I argue that phenotypic plasticity should not be a null hypothesis to explain shell shape variation in freshwater snails. More common garden experimental studies are needed to understand if, and what, environmental cues influence shell shape.

ROLES AND ACTIVITIES OF THE GASTROPOD STATUS AND DISTRIBUTION COMMITTEE

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The role of the Gastropod Status and Distribution Committee is to provide expertise to the society on the conservation status and ranges of freshwater gastropods. Membership on the committee is open to any FMCS member that wishes to contribute expertise or learn more about freshwater gastropods. One of the first major projects of the committee was generating a comprehensive status and distribution report for all freshwater gastropods of the U.S. and Canada, which was published in *Fisheries* in 2013. Since then, the committee has worked to raise the profile of freshwater gastropods within the society and provide resources to researchers, on-the-ground managers, and the public. The committee is also tasked with periodic reviews of the conservation status of North American freshwater gastropods, and a names subcommittee was established in 2019 to provide an authoritative list of accepted common and scientific names of freshwater gastropods. For these efforts, the committee relies on engaged members from multiple career stages, including students, early-career researchers, and established professors/researchers. Looking forward, the gastropod committee will soon be merged with the mussel committee to form a Mollusk Status and Distribution Committee. In doing so, the goal is to build upon expertise of many society members that work on both mussels and snails, while at the same time continuing to advocate for the study and conservation of freshwater gastropods. We highly encourage anyone interested in freshwater gastropods, no matter your background or career stage, to attend the committee's meeting during this year's virtual symposium. We especially encourage graduate students to attend as we view the meeting as an exceptional networking opportunity, and many of the most active committee members started while students.

INSIGHTS INTO THE BIOLOGY, BIOGEOGRAPHY, CONSERVATION AND SYSTEMATICS OF PLEUROCERIDAE (GASTROPODA: CERITHIOIDEA) WITHIN A NEW PHYLOGENOMIC FRAMEWORK

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The systematics of Pleuroceridae has not been revised within a robust molecular framework owing to the unsuitability of traditional mitochondrial and nuclear markers for resolving species boundaries and the relationships among them. This has prevented the construction of a meaningful evolutionary framework for the family. We used an anchored hybrid enrichment approach and developed a novel probe set targeting hundreds of nuclear loci with the goal of constructing a backbone phylogeny for the family. The resulting topology reveals high levels of polyphyly at both the genus and species level among taxa currently considered valid. The lack of congruence with shell characters traditionally used in the diagnosis and circumscription of genera and species, will require a critical re-evaluation of conchological features and their utility. Conversely, external soft part morphology and life history traits, features traditionally overlooked, appear diagnostic for natural groups and are far less homoplastic than shell characters. The phylogeny supported many robust clades that will merit recognition at the genus level and supported the interpretation that at least some wide-ranging species comprise multiple small-range endemics possibly requiring conservation attention. Most clades are dominated by species from a single drainage, but repeated patterns of relationships between species from different drainages are indicative of historical or ongoing connectivity. Expanding the population and species sampling of this phylogenomic framework will allow recognition of meaningful species boundaries and management units, enabling the necessary sweeping systematic revisions and conservation assessments. Greater taxon sampling also should aid in understanding historical river connectivity in the eastern United States.

EFFECTS OF *CORBICULA FLUMINEA* ON JUVENILE MUSSEL SURVIVAL AND GROWTH IN LABORATORY EXPERIMENTS.

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We conducted a series of two- to three-week laboratory experiments to examine effects of *Corbicula* on survival and growth of hatchery-reared juvenile mussels and how these effects are modulated by various combinations of food abundance, temperature, and other factors. We conducted three different experiments with 60-day-old mussels and two different experiments with newly transformed mussels (<5 days old). For 60-day-old mussels, survival was 100% in all experiments. Growth generally was higher in higher food and warmer treatments, but, surprisingly, growth increased with increasing *Corbicula* abundance in two out of three experiments. Furthermore, effects of *Corbicula* and food interacted such that there was little or no effect of *Corbicula* at high food, but strong effects at low food. We hypothesized that juvenile

growth was facilitated by readily available food from *Corbicula* pseudofeces, but growth of 60-day-old juveniles did not differ between mussels isolated from or in physical contact with pseudofeces. In both experiments with newly transformed mussels, survival was significantly and up to 3 lower in *Corbicula* treatments. In contrast, survival in control treatments (no other bivalves) did not differ from treatments with adult native mussels at similar biomass to *Corbicula* treatments. In general, these effects were similar regardless of temperature or food. Growth also was significantly lower in *Corbicula* treatments in one of two experiments with newly transformed mussels. Potential artifacts of higher *Corbicula* abundance, higher food, and higher temperatures such as ammonia and dissolved oxygen were not related to juvenile mussel survival or growth in any experiment. Our results show that effects of *Corbicula* on mussels are complex and modulated by environmental conditions and mussel life stage, including potential facilitation of growth in some situations. However, the strong and consistent negative effects of *Corbicula* on newly transformed mussel survival suggests that *Corbicula* is an important factor in mussel declines.

GEOMETRIC MORPHOMETRIC ANALYSES AND DNA BARCODING DISTINGUISH AMONG VARIOUS GREAT LAKES FRESHWATER MUSSEL SPECIES (BIVALVIA: UNIONIDAE).

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Small differences in shell morphology of related and similarly-shaped mussel species have made it difficult to differentiate between certain species of unionids. Misidentification can have negative impacts on conservation efforts of endangered mussel species. We are presenting information from four different studies that used geometric morphometric analyses and DNA barcoding to help differentiate closely related, similar-looking mussel species in the Great Lakes region. The objectives of these studies were to: (1) determine how well morphometric models discriminated between/among similar species, (2) establish species identifications of specimens using DNA barcoding, and (3) determine the accuracy of field identifications compared to confirmed species identity. We used barcoding-confirmed morphometric models to differentiate among several different unionid species: 1) *Truncilla truncata* and *T. donaciformis*; 2) *Fusconaia flava* and *Pleurobema sintoxia*; 3) *Pyganodon grandis* and *P. lacustris*, and 4) *Lampsilis siliquoidea*, *L. fasciola*, *L. cardium*, and *Ortmanniana ligamentina*. In each study, specimens were collected from lakes and/or rivers in the Great Lakes region; at each site, a preliminary identification was made, shells were measured, a genetic sample was collected, and pictures were taken of the left shell valve onto which landmarks were digitized. After specimen collection, DNA was extracted from swabs or tissue biopsies and the COI mtDNA barcoding region was amplified and sequenced. COI sequences were then compared to sequences available on GenBank to confirm species identities. The results showed that the DNA-confirmed geometric morphometric models ranged from 85.9% to 99.2% accurate, depending on the species being examined. Combining geometric morphometric analyses and DNA barcoding can be a tool in distinguishing between and among morphologically similar unionid species and the creation of DNA-confirmed morphometric databases can aid freshwater malacologists across the Great Lakes region. Similar approaches could also be applied for differentiating among morphologically similar species in other regions.

A REVIEW OF OHIO PROTOCOL APPLICATION IN 2020 WITH A FOCUS ON SURVEYS OF ROUND HICKORYNUT (*OBOVARIA SUBROTUNDA*)

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The Ohio Mussel Survey Protocol was updated in 2020, and the most notable change was the drainage area criterion for survey need. In 2020, this trigger was reduced from streams greater than 10 square miles from points of impact to five square miles. Several streams that would not have previously warranted review for mussel resources were surveyed and indicated presence of live mussels. Additionally, since the October 2019 Species Status Assessment (SSA) of the Round Hickorynut was published, several locations within Ohio have been identified as harboring sustaining populations of the species that were not included in the original SSA. These locations were primarily identified through Ohio Department of Transportation funded roadway projects where the Protocol was used, and an unpublished report of a survey conducted in the late 1990s for the Wayne National Forest. The results of this review are beneficial to the utility and application of the Protocol in Ohio and updating location information of the Round Hickorynut in Ohio.

A HABITAT SUITABILITY MODEL FOR THE TENNESSEE HEELSPLITTER (*LASMIGONA HOLSTONIA*).

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Freshwater mussels are one of the most imperiled faunal groups, and approximately 70% of North American mussel species are endangered, threatened, or of special concern. Knowledge of what drives freshwater mussel establishment and persistence is critical for effective conservation. The Tennessee Heelsplitter (*Lasmigona holstonia)* is a rare, small-shelled Anodontine mussel restricted to the Tennessee and New River drainages. It is currently petitioned for listing by the U.S. Fish and Wildlife Service under the Endangered Species Act (ESA). We created a habitat suitability model for the Tennessee Heelsplitter using MaxEnt to describe potential distributional limitations. Presence records (total = 119) from museum databases and field surveys were used with GIS layers of baseflow, mean annual flow, stream order, stream gradient, groundwater table depth, and stream-adjacent soil characteristics, including pH, clay, sand, silt, and organic matter content. Modeled habitat suitability sufficiently overlapped known, occupied habitat based on the selected environmental covariates (Test AUC = 0.93, Standard Deviation = 0.02). Key variables corresponding with habitat suitability were mean annual flow, stream order, pH of soil, and stream gradient. Modeled suitable habitat for this species included areas of low to moderate flow, soil pH above 4, stream gradients below 210 dm/km, and all stream orders 1-6, with an increase in suitability in 3rd order streams. Our model identifies areas that may harbor unknown Tennessee Heelsplitter populations, especially in headwater streams where surveys are currently lacking. This project narrows the search scope for future surveys targeting this species and informs its listing decision under the ESA.

FIRST CONTEMPORARY OBSERVATION OF YELLOW LANCE (*ELLIPTIO LANCEOLATA*; LEA 1928) IN THE PATUXENT RIVER, MARYLAND, USA

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On 25 August, 2020, we collected one live specimen of the federally and state threatened Yellow Lance (*Elliptio lanceolata)* in the Patuxent River, providing the first evidence of this species from this river since four specimens were collected on 4 April, 1937. This locality is approximately 2.3 stream kilometers downstream of the confluence with the Hawlings River, which harbors the only known extant population of Yellow Lance in Maryland. Given Yellow Lance seemingly prefers sand substrate, which is susceptible to mobilization, this specimen does not definitively confirm the presence of an extant population in the Patuxent River. However, a relic population may have persisted undetected. Further mussel surveys are needed in this portion of the river, which lies between two water supply reservoirs, and further downstream of the lowermost dam to better understand the species' status and distributional extent.

RESULTS FROM RECENT SURVEYS AND CAPTURE-RECAPTURE MONITORING OF DWARF WEDGEMUSSEL IN NANJEMOY CREEK, MARYLAND.

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Freshwater mussels are among the most imperiled fauna in North America. The Dwarf Wedgemussel (*Alasmidonta heterodon*) is a federally and state endangered species that exists in just four watersheds in Maryland. Recovery objectives for this species include documenting viable populations and monitoring them over time to demonstrate stability in abundance and recruitment. Understanding population demographics like abundance, survival, and growth, requires tracking individuals through time. Nanjemoy Creek may have the largest Dwarf Wedgemussel population in the Chesapeake Bay drainage. A recent survey of 14 sites in Nanjemoy Creek encountered 161 Dwarf Wedgemussels, which were externally tagged with passive integrated transponders (PIT) to increase the probability of recovery in subsequent surveys. In response, we developed and initiated a capture-mark-recapture monitoring for this population that began at four sites two weeks later using a submersible PIT tag reader. The Robust Sampling Design was used with four secondary (closed) periods about two weeks apart within three primary (open) periods over nine months. Nearly all (91%) of the tagged Dwarf Wedgemussels were recaptured at least once during the first primary period. Recovery rate ranged during secondary periods from 60-90% and showed no clear pattern with changes in stream discharge and temperature. After the third primary sampling period, population modeling will be used to estimate apparent survival and detection probability. A second visual survey in 2021 will also be conducted at monitoring sites during which we will measure all recaptured mussels to determine growth rates and tag all unmarked mussels to estimate population size.

LINKING AGE DISTRIBUTION AND GROWTH RATES OF FRESHWATER MUSSELS TO ANTECEDENT FLOW CONDITIONS

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Flow regimes are altered by dam operations and the frequency and intensity of extreme low and high flows are predicted to increase with climate change. While dewatering can leave mussels stranded and increase their mortality, the impact of flooding is not well understood. Freshwater mussels are long-lived organisms and examining the impact of flow conditions on their performance is challenging. Thin-sectioning of their shells can be used to estimate the age distribution and growth rates of freshwater mussels, which can also be linked to antecedent flow conditions. The goal of this project is to examine growth and recruitment in relation to antecedent flow conditions and to compare two species with different life history strategies (opportunistic vs. equilibrium). Two common species, *Amblema plicata* (equilibrium species) and *Lampsilis teres* (opportunistic species) were sampled quantitatively with 25 quadrats per site at 6 sites in the Brazos, Colorado, and Guadalupe rivers in Texas. The analysis of the data is ongoing.

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The Freshwater Mollusk Conservation Society (FMCS) is an international scientific organization whose purpose is to conserve and advocate for freshwater mollusks. FMCS members and attendees of FMCS-sponsored symposia, workshops, meetings, or other FMCS activities (events) are expected to adhere to this Code of Conduct. FMCS is committed to providing a safe, productive, and welcoming environment for all participants and staff. All participants including, but not limited to, members, guests, attendees, speakers, volunteers, exhibitors, service providers, and others are expected to abide by this Code of Conduct. This Code of Conduct applies to in-person, electronic (text, email, social media), and written communications. The FMCS leadership encourages anyone to contact FMCS Executive Committee regarding ways in which the Society can improve inclusion and diversity and encourage a stimulating and supporting atmosphere.

Expected Behavior

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- Avoid personal attacks directed toward other attendees, participants, suppliers, or vendors.
- Be mindful of your surroundings and of your fellow participants.
- Speak up, intervene, or alert an FMCS board member if discriminatory or inappropriate behavior directed at others is observed or you notice a dangerous situation or someone in distress.
- Abide by the rules and policies of the event venue, hotels, FMCS-contracted facility, or any other venue.
- Request permission from speakers before recording or taking photographs during their presentations. Turn off any ringers or other disrupting devices during oral and poster sessions.

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It is important that our events be places where no attendee or staff is ever belittled, harassed, or made to feel unsafe. The following behaviors will not be tolerated:

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- Physical, written, or verbal abuse of any attendee, speaker, volunteer, exhibitor, service provider, or other event participant.

Examples of unacceptable behavior include, but are not limited to, unwelcomed physical contact; verbal comments related to gender, sexual orientation, disability, physical appearance, body size, race, religion, or national origin; inappropriate use of nudity and/or sexual images in public spaces or in presentations; and threatening or stalking any attendee, speaker, volunteer, exhibitor, service provider, or other event participant.

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Notification can occur by emailing, calling, or texting your concern to the FMCS President or the event services representative. After receiving a report of inappropriate behavior, the FMCS President, Executive Committee, and event services representative will assess the report and work with the complainant to determine the relevant facts, evidence, and most appropriate response.

Anyone filing a complaint concerning a suspected violation of the Code of Conduct must be acting in good faith and have reasonable grounds for believing the information disclosed indicated a violation of the Code of Conduct. Any allegation made with a malicious intent will be viewed as a Code of Conduct violation.

FMCS is committed to protecting the privacy of all individuals involved in the incident to the greatest extent practicable.

The FMCS Executive Committee reserves the right to take any lawful action deemed necessary in response to a violation of this Code of Conduct. This includes, but is not limited to, the immediate removal of the violator from the event without warning or refund. The FMCS Executive Committee may also elect to suspend the violator from future events. Repeated violations could result in loss of FMCS membership and a permanent ban on attendance at FMCS events.

Failure to adhere to the Code of Conduct is cause for removal from an event and/or suspension from membership in FMCS at the discretion of the Executive Committee. A Member may be suspended or removed from FMCS membership with cause by vote of two-thirds of the Board of Directors only after reasonable notice and an opportunity to be heard.