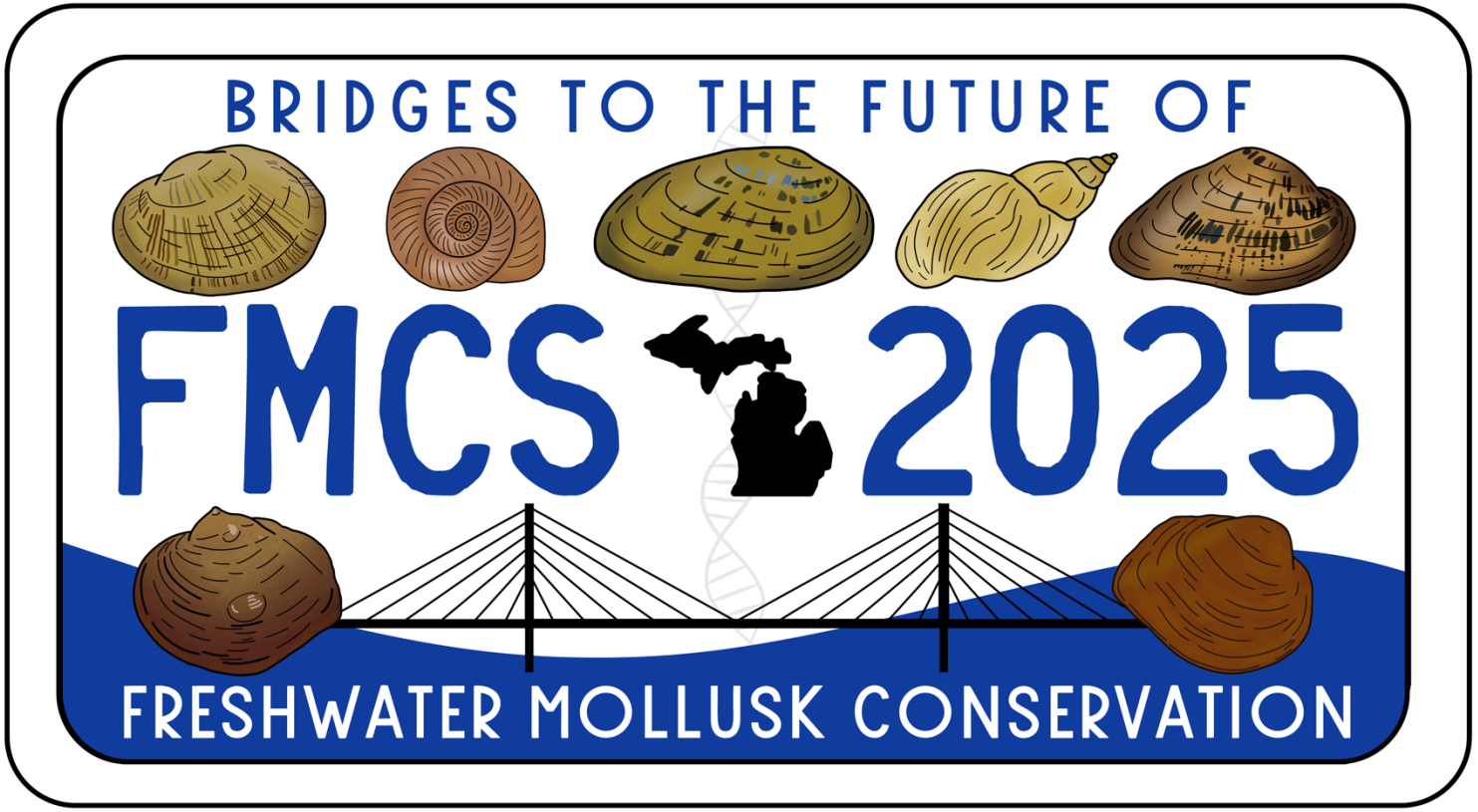


14th Biennial Symposium

Ann Arbor-Ypsilanti, Michigan

Monday, May 12, 2025 – Friday, May 16, 2025

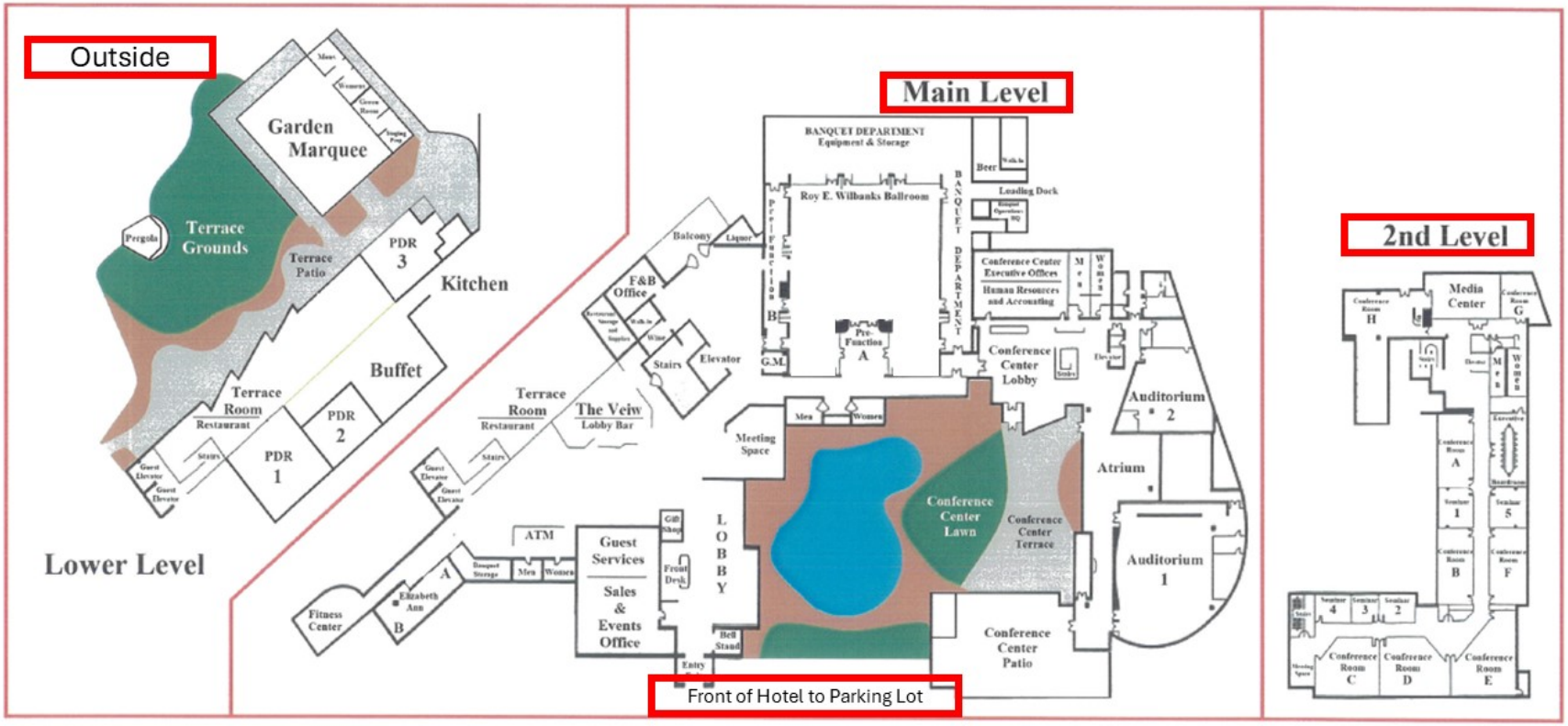
Symposium Planning Committee

Organizers: Amy Maynard, Dave Zanatta, Daelyn Woolnough
Local Planning: Dave Strayer, Joe Rathbun, Shay Keretz, Jesse McCarter, Renee Mulcrone, Eric Snyder, Jen Johnson, Kayla McRobb, Nathan Ring, Meghan Martinski, Grayson Kosak, Jocelynne Samu-Pittard, Bill Flanagan
Program Committee: Dave Strayer, Joe Rathbun, Shay Keretz, Jesse McCarter, Renee Mulcrone
Moderators: Joe Rathbun
A/V Communications: Alan Christian, Amy Maynard, Sophie Binder
Workshop: Nathanial Shoobs, Kathryn Holcolm, Russell Minton
Field Trips: Eric Snyder, Joe Rathbun, Scott LaValley, Trevor Hewitt, Taehwan Lee, Diarmaid Ó Foighil
Sponsorship: Kiara Cushway (lead)
Auction: Lisie Kitchel, Teresa Newton, Patricia Morrison, Renee Mulcrone, Becca Winterringer
Keynote Speaker: Jen Johnson
Student- Mentor Mixer: Dan Symonds, Madison Mueller
Registration: Alan Christian
Movie Night: Kayla McRobb
Acknowledgements: Julia Willsie (conference logo design)

FMCS Standing Officers

President: Megan Bradley
President Elect: Amy Maynard
Secretary: Sarah Veselka
Past President: Steve McMurray
Treasurer: Alan Christian

Meeting Space Layout



FMCS Code of Conduct.
During FMCS 2025 Executive Officers will be wearing YELLOW name tags.

This Code of Conduct was approved by the Board of Directors on 15 November 2018. It will appear in the Symposium Program and on the registration form for future symposia and workshops. Submitted by the Executive Committee.

Code of Conduct
The Freshwater Mollusk Conservation Society

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

- Communicate openly with respect and consideration for others, valuing a diversity of views and opinions.
- 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.

Unacceptable Behavior

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:

- Harassment, intimidation, or discrimination in any form.
- 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.

Reporting Unacceptable Behavior & Consequences

All members, event attendees, and event staff are expected to abide by the FMCS Code of Conduct. Anyone experiencing or witnessing behavior that constitutes an immediate or serious threat to public or personal safety should locate a house phone and ask for security. If a security officer is not available contact 911. Once the person is out of danger, contact an FMCS executive officer. Anyone requested to stop unacceptable behavior is expected to comply immediately. If you are the victim of unacceptable behavior or have witnessed any such behavior, please immediately notify an FMCS executive officer.

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.

The Freshwater Mollusk Conservation Society (FMCS) is dedicated to the conservation and advocacy of freshwater mollusks for public education and the conservation science of freshwater mollusks, North America's most imperiled fauna.

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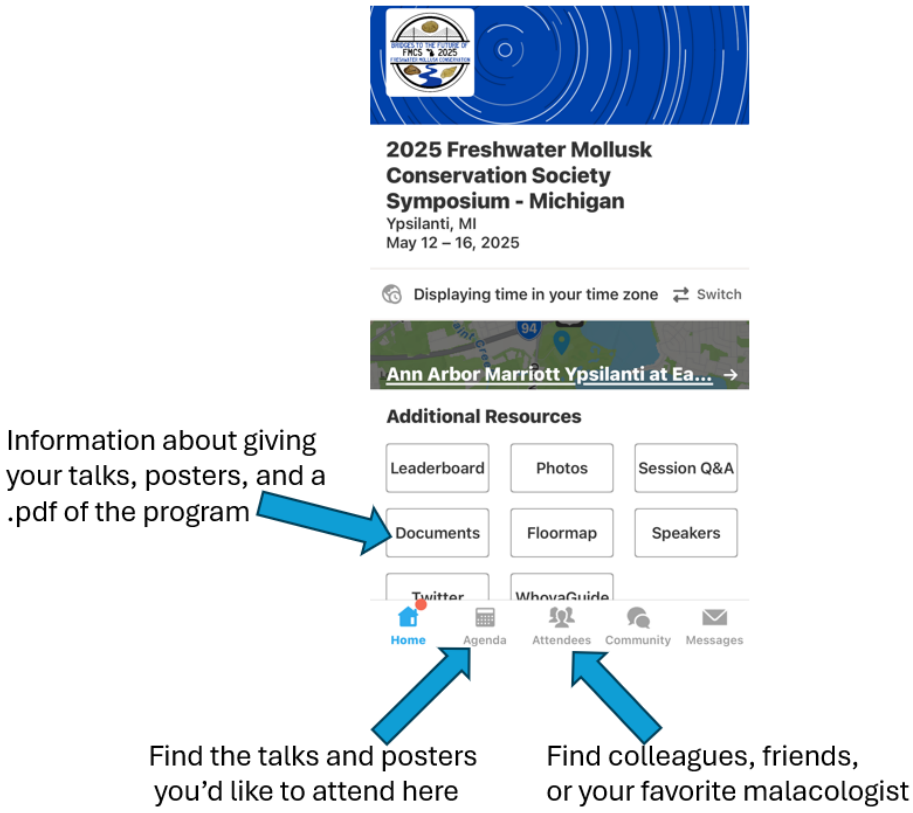
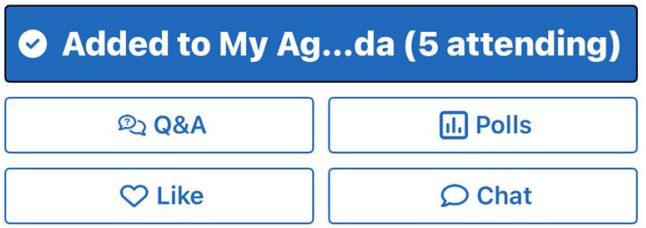
Whova

Whova is available as an app on a smartphone or whova.com Please use Whova for the most up to date schedule. Interact with our FMCS 2025 virtual attendees as well as people on-site by using the Q&A tab after talks.



Click on ANY talk title and it will bring you to the Q&A area to ask questions about the talk or poster.



Information on how to use Whova is online here: https://whova.com/portal/webapp/annua_202502/WhovaGuides/?type=Attendee

Workshop (preregistered only)- Monday 9am-2pm- lunch provided

A Practical Introduction to Freshwater Snail Identification, Collection, and Conservation

This 6-hour workshop provides participants with a general introduction to the biology and taxonomy of the native and invasive freshwater gastropods of the Midwest and Great Lakes, the most common techniques used to collect, preserve, and measure them, and the considerations that should be made when monitoring and managing their populations.

Participants will gain hands on experience in examining, identifying, and measuring specimens of native and invasive snails. Midwest and Great Lakes snails will be the taxonomic focus of this workshop, but the concepts learned will be applicable to freshwater snails across much of North America.

The workshop will be led by FMCS members Kate Holcomb (MN DNR), Nate Shoobs (Curator of Mollusks, The Ohio State University Museum of Biological Diversity), and Russ Minton (Professor, Gannon University).

After attending this workshop, participants should be able to:

- Recognize a freshwater snail and describe its anatomy/morphology in scientific terms (e.g. number of whorls, shell sculpture/ornamentation, shell shape)
- Identify freshwater snail specimens to family level based on anatomy and shell characters (within the Midwest and areas with similar faunas).
- Determine whether a particular snail specimen is invasive or native to an area, or whether the matter requires further investigation (e.g., needs genetic barcoding to confirm identification)
- Discuss / explain the basic biology/ecology of freshwater snails, and understand common threats to their population health.
- Recognize what makes a “good” and “bad” photo of a snail for the purposes of identification, and be able to take good photos.
- Take and record standard morphometric measurements of snails using vernier/dial calipers.
- Know the appropriate resources (publications, species databases, biodiversity aggregators, etc.) to consult to find reliable taxonomic information and species distribution records.

Tuesday FMCS Welcome Session- Tuesday 8am-10am- Wilbanks Ballroom

WELCOME SESSION

Tribal Welcome and Land Acknowledgment
Ms. Phyllis Davis
Match-E-Be-Nash-She-Wish Band of Pottawatomi (Gun Lake Tribe)

Ms. Davis is enrolled with the Match e Be Nash She Wish Band of Pottawatomi Indians of Michigan aka Gun Lake tribe from western Michigan. Ms. Davis has been an elected member of the Tribal council from 2008 until her recent retirement in October 2024. She has maintained a strong commitment and desire to advocate for all Tribes within the Great Lakes region to address the health and human disparities that are among the worst in all Indian country. Ms. Davis has worked for her tribe since 1998 as HHS Director to plan, develop and implement HHS programs for the citizens of her tribe. This commitment to advocate had prompted her to serve on numerous local, state, regional and national tribal workgroups to represent the Bemidji Area tribes through advocacy and education to Federal, State, and local agencies and partners to assist them in a better understanding of the alarming disproportion of available resources to American Indian and Alaskan Native Tribes.

Ms. Davis currently serves as the Chair for the Great Lakes Area Tribal Health Board for the Bemidji Area; this includes 34 Tribes and 8 Urban programs. Additionally, she has served as the regional representative to the National Indian Health Service National Tribal Budget Formulation Workgroup, IHS Special Diabetes Tribal Leaders Workgroup, Substance Abuse and Mental Health Services Administration Tribal Workgroup and the Secretary's Health and Human Services Workgroup. Ms. Davis's experience and knowledge regarding Tribal Consultation, Tribal sovereignty, Tribal programming, development and implementation provides insight from a grassroots perspective, in addition to the years of practical and applicable experience in working as an Elected Tribal Official. Ms. Davis continues to participate in many committees with her tribe.

Tuesday FMCS Welcome Session- Tuesday 8am-10am- Wilbanks Ballroom

Michigan's Great Aquatic Resources:

Michigan has fantastic aquatic resources including 3,288 miles of Great Lakes shoreline, over 11,000 inland lakes, and 36,000 miles of streams. These waters were shaped through glaciation, glacial retreat, and even the underlying geology formed by the glaciers. But the aquatic communities supported by these waters have changed over time due to threats like pollution, changes in land use (logging and agriculture) and Aquatic Invasive Species. We'll explore the spectrum of these great resources, highlighting a handful of notable habitats, species, and the work we do to keep them healthy.

Jim Francis

Lake Erie Basin Coordinator

Michigan Department of Natural Resources – Fisheries

Jim has worked his entire career in fisheries management in the Great Lakes. After completing his Master's thesis evaluating prey selectivity by walleye in Lake Erie, Jim took a position working on Lake Michigan, first with Indiana DNR and then Wisconsin DNR. And for the last 25 years, he has managed fisheries for Michigan DNR in the Lake Erie basin. In addition to Lake Erie, this includes inland lakes and streams and the St Clair – Detroit River System. Jim is an avid angler, hunter, and backpacker and lives in South Lyon with his wife Sharon and their pack of Bernese Mountain dogs.

Keynote Speaker- Thursday 8am- Wilbanks Ballroom

Unionids, People & Partnerships: Accelerating knowledge into action to advance freshwater mussel conservation in the Great Lakes

Dr. Catherine Febria- Healthy Headwaters Lab- University of Windsor, Ontario, Canada
(https://www.healthyheadwaterslab.ca/catherine-febria).

Dr. Febria is a Tier 2 Canada Research Chair in Freshwater Restoration Ecology and leads a dynamic lab that conducts research in Canada, USA, New Zealand on headwater ecosystems including drains, wetlands, streams, and the interfaces between surface and groundwater. Dr. Febria's talk will focus on the people and partnerships her lab has developed in the Sydenham River, which is a river that supports one of the greatest areas of species-diversity in Canada, and throughout her research program.

Photo credit: University of Windsor, Public Affairs & Communications

QUICK REFERENCE- TUESDAY	QUICK REFERENCE- WEDNESDAY
Welcome Session- 8:00-10AM- Wilbanks Ballroom- TUESDAY	Lightning Talks (Page 84) Wed May 14, 2025- 8:20 AM - 9:15 AM Auditorium 1
Special Session: Natural History and Conservation of Freshwater Mollusks in the Laurentian Great Lakes System Tue May 13, 2025- 10:20AM-12:00PM, 2-3:20PM- 3:40-5:40PM Auditorium 1	Contributed Session: Museums, Education, and Outreach Wed May 14, 2025- 8:20 AM - 10:00 AM Auditorium 2
Contributed Session: Morphometrics Tue May 13, 2025- 10:20 AM - 12:00 PM Auditorium 2	Contributed Session: Life History Wed May 14, 2025- 8:20 AM - 10:00 AM Conference Room E
Contributed Session: Propagation Tue May 13, 2025- 10:20 AM - 12:00 PM Conference Room E	Contributed session: Genetics, Genomics, and Systematics Wed May 14, 2025- 9:20- 10:00 AM, 10:20-12:00 PM, 2-3:20 PM Auditorium 1
Contributed Session: Habitat Studies Tue May 13, 2025- 2:00 PM - 3:20 PM, 3:40-5:20PM Auditorium 2	Special Session: Bridges to Recovery: Innovative Strategies to Advance Freshwater Mussel Restoration and Conservation Wed May 14, 2025- 10:20 AM - 12:00 PM, 2-3:20 PM, 3:40-5:20 PM Auditorium 2
Contributed Session: Contaminants and Ecotoxicology Tue May 13, 2025- 2:00 PM - 3:20 PM, 3:40-5:30PM Conference Room E	Contributed Session: Climate Change Wed May 14, 2025- 10:20 AM - 12:00 PM Conference Room E
POSTER SESSION- 6:00-8:30PM- Garden Maquee – TUESDAY (Page 88)	Contributed Session: Population Declines and Kills Wed May 14, 2025- 2:00 PM - 3:20 PM Conference Room E
FMCS "Movie Night"- 9PM-11:30PM- Auditorium 1- TUESDAY	Special Session: State of the science: environmental DNA for freshwater mussels Wed May 14, 2025- 3:40 PM - 5:20 PM Auditorium 1
	Contributed Session: Survey Methods and Designs Wed May 14, 2025- 3:40 PM - 5:20 PM Conference Room E
	BANQUET AND AUCTION- 6:30-10:30PM Wilbanks Ballroom- WEDNESDAY (Preview of Auction 5:30-6:30PM)

QUICK REFERENCE- THURSDAY
PLENARY SESSION- Dr. Catherine Febria- 8am Wilbanks Ballroom- THURSDAY
Special Session: Freshwater Mussel Data and Databases Thu May 15, 2025- 10:20 AM - 12:00 PM, 2-3 PM, 3-3:30 PM Auditorium 1
Contributed Session: Bridges to Recovery: Innovative Strategies to Advance Freshwater Mussel Restoration and Conservation Thu May 15, 2025- 10:20 AM - 11:00 AM Auditorium 2
Contributed Session: Conservation Planning Thu May 15, 2025- 10:20 AM - 12:00 PM Conference Room E
Contributed Session: Survey Methods and Designs Thu May 15, 2025- 11:00 AM - 12:00 PM Auditorium 2
FMCS BUSINESS LUNCH Noon-2 PM WILBANKS BALLROOM- ALL WELCOME!
Contributed Session: Monitoring Results and Status Thu May 15, 2025- 2:00 PM - 3:20 PM, 3:40-5:20 PM Auditorium 2
Contributed Session: Life History Thu May 15, 2025- 2:00 PM - 3:20 PM Conference Room E
Special Session: State of the science: environmental DNA for freshwater mussels Thu May 15, 2025- 3:40 PM - 5:20 PM Auditorium 1
Contributed Session: Population Declines and Kills Thu May 15, 2025- 3:40 PM - 5:20 PM Conference Room E

Special Session: Natural History and Conservation of Freshwater Mollusks in the Laurentian Great Lakes System Tue May 13, 2025- 10:20AM-12:00PM Auditorium 1 *Moderator: Dave Zanatta*		**Contributed Session: Morphometrics** Tue May 13, 2025- 10:40 AM - 12:00 PM Auditorium 2 *Moderator: Michael Hillary*		**Contributed Session: Propagation** Tue May 13, 2025- 10:20 AM - 12:00 PM Conference Room E *Moderator: Dan Hua*	
10:20-10:40	NATURAL HISTORY AND CONSERVATION OF FRESHWATER MOLLUSKS IN THE LAURENTIAN GREAT LAKES SYSTEM: INTRODUCTION TO THE SPECIAL SESSION- Strayer, Zanatta, Porto-Hannes (Page 24)	**10:20-10:40**	No Talk	**10:20-10:40**	VIRTUAL: ASSESSMENT OF LAMPSILID MUSSEL IN-VITRO TRANSFORMATION VARIABLES: MEDIA CHANGE FREQUENCY, DILUTION TIMING, AND GLOCHIDIA DENSITY- Kerney, Wayman (Page 28)
10:40-11	THE GENETIC STORY OF POST-GLACIAL COLONIZATION OF FRESHWATER MUSSELS INTO THE NORTH AMERICAN GREAT LAKES- Zanatta, Porto-Hannes, Inoue (Page 24)	**10:40-11**	PATTERNS OF SEXUAL DIMORPHISM IN THE CRITICALLY IMPERILED FRESHWATER MUSSEL GENUS EPIOBLASMA- Haugh, Zanatta, Pfeiffer (Page 26)	**10:40-11**	MUSSEL PRODUCTION FOR PENNSYLVANIA DEP AT WHITE SULPHUR SPRINGS NFH A 10-YEAR PROJECT- Phipps, Moore, Pickle, Spear (Page 29)
11-11:20	A CANADIAN PERSPECTIVE: CONSERVATION, PROTECTION, AND RECOVERY OF ONTARIO'S FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE)- Morris, Gibson, McNichols-O'Rourke (Page 25)	**11-11:20**	USING MORPHOLOGY TO IDENTIFY FRESHWATER MUSSEL GLOCHIDIA AND JUVENILES FROM WILD INFECTED HOSTS- Rollins, Robinson, Gregory, Hazelton, Wares (Page 27)	**11-11:20**	ADVANCES IN THE PROPAGATION AND CULTURE OF CRITICALLY ENDANGERED SPECIES OF FRESHWATER MUSSELS AT THE CUMBERLAND RIVER AQUATIC CENTER, TWRA.- Hua, Bajo-Walker, White, White, Kerns, Schroth (Page 29)
11:20-11:40	NATURAL HISTORY AND CONSERVATION OF FRESHWATER MUSSELS IN THE LAURENTIAN GREAT LAKES SYSTEM IN NEW YORK STATE- Porto-Hannes, Strayer (Page 25)	**11:20-11:40**	IDENTIFYING ENVIRONMENTAL DRIVERS OF SHELL SHAPE VARIATION IN THE FRESHWATER GASTROPOD CAMPELOMA DECISUM (SAY, 1817)- Western, Zanatta (Page 27)	**11:20-11:40**	No Talk
11:40-12	MUSSELS OF OHIO'S LAKE ERIE TRIBUTARIES, CHALLENGES TO CONSERVATION- Krebs, Lewis, Trimbath (Page 26)	**11:40-12**	ON THE FREQUENCY AND CORRELATES OF SINISTRALITY IN CAMPELOMA- Phelps, Shoobs (Page 28)	**11:40-12**	EVALUATING COMMERCIAL DIETS FOR THE PRODUCTION OF JUVENILE FRESHWATER PLAIN POCKETBOOK MUSSELS LAMPSILIS CARDIUM- Schardt, Miller, Watson, Rossi (Page 30)
LUNCH AND COMMITTEE MEETINGS (Grab Lunch at Wilbanks Ballroom then Proceed to Committee Meetings- POSTED) 12-12:50, 1-1:50 PM					

Special Session: Natural History and Conservation of Freshwater Mollusks in the Laurentian Great Lakes System Tue May 13, 2025, 2-3:20PM Auditorium 1 *Moderator: Dave Strayer*		**Contributed Session: Habitat Studies** Tue May 13, 2025- 2:00 PM - 3:20 PM Auditorium 2 *Moderator: Alison Stodola*		**Contributed Session: Contaminants and Ecotoxicology** Tue May 13, 2025- 2:00 PM - 3:20 PM Conference Room E *Moderator: Renee Mulcrone*	
2-2:20	UNIONID MUSSEL CONSERVATION IN MICHIGAN- Badra (Page 30)	**2-2:20**	ASSESSING PATTERNS OF FRESHWATER MUSSEL DISTRIBUTION UPSTREAM AND DOWNSTREAM OF TRIBUTARY CONFLUENCES IN THE LOWER GRAND RIVER, MICHIGAN- Kosak, Snyder, Flanagan (Page 32)	**2-2:20**	INVESTIGATING THE IMPACTS OF PARAFFIN DIPPING ON THE δ13C AND δ15N VALUES OF FRESHWATER MUSSEL PERIOSTRACUM- Balaji, Diefendorf, Miller (Page 34)
2:20-2:40	STATUS AND DISTRIBUTION OF UNIONIDAE IN THE LAURENTIAN GREAT LAKES WATERSHED: A COMPARATIVE ANALYSIS OF WISCONSIN AND MINNESOTA- Weinzinger, Sietman (Page 31)	**2:20-2:40**	MAPPING HABITAT SUITABILITY FOR NATIVE FRESHWATER MUSSELS ACROSS THE GREAT PLAINS- Crowley, Cheek, Pasbrig, Coulter (Page 32)	**2:20-2:40**	VIRTUAL: ASSESSING THE LETHAL EFFECTS OF GRANULAR BAYLUSCIDE ON THE EARLY LIFE STAGES OF A FRESHWATER MUSSEL- Kudla, Langlois, Coffield, MacDonald, Uju, Atkinson, Prosser (Page 34)
2:40-3:20	INVASION DYNAMICS AND IMPACT OF NON-NATIVE MOLLUSCS IN THE GREAT LAKES- Burlakova, Karayayev (Page 31)	**2:40-3**	EFFECTS OF HYDROLOGIC CONNECTIVITY AND LOCAL FACTORS ON FRESHWATER MUSSEL OCCUPANCY IN OFF-CHANNEL HABITATS- Shake, Hofmeier, Bruckerhoff (Page 33)	**2:40-3**	VIRTUAL: ADVERSE EFFECTS OF GRANULAR BAYLUSCIDE(R) EXPOSURE ON ADULT WASHBOARD MUSSELS (MEGALONAIAS NERVOSA)- Coffield, Kudla, Black, Uju, Prosser (Page 35)
		3-3:20	DISTRIBUTION AND ECOLOGICAL ASSOCIATIONS AMONG TWO SPECIES OF NATIVE MUSSELS (*GONIDEA ANGULATA* AND MARGARITIFERA FALCATA) AND ONE INVASIVE CLAM SPECIES (*CORBICULA FLUMINEA*) IN THE COLUMBIA RIVER BASIN- Neal, Bollens, Maine, Counihan, Rollwagen-Bollens (Page 33)	**3-3:20**	TAXONOMIC, SPATIAL, AND TEMPORAL VARIATION IN ELEMENTAL COMPOSITION OF FRESHWATER MUSSEL SHELLS AND EXTRAPALLIAL FLUID FROM THE UPPER OHIO RIVER WATERSHED, PENNSYLVANIA, USA- Dobra, Stewart (Page 35)
AFTERNOON BREAK **3:20-3:40 p.m.**					

Special Session: Natural History and Conservation of Freshwater Mollusks in the Laurentian Great Lakes System Tue May 13, 2025- 3:40-5:40PM Auditorium 1 *Moderator: Isa Porto-Hannes*		**Contributed Session: Habitat Studies** Tue May 13, 2025-3:40-5:20PM Auditorium 2 *Moderator: Kyle Sullivan*		**Contributed Session: Contaminants and Ecotoxicology** Tue May 13, 2025- 3:40-5:30PM Conference Room E *Moderator: Daelyn Woolnough*	
3:40-4	ASSESSING SHORT AND LONG-TERM REDISTRIBUTION PATTERNS OF UNIONIDAE POPULATIONS POST-TRANSLOCATION- Dampousse, Morris, Febria (Page 36)	**3:40-4**	UTILIZING 3D PRINTED SUBADULT MUSSELS IN COMPLEMENTARY FIELD AND FLUME STUDIES TO SUPPORT REINTRODUCTIONS IN AN URBAN RIVER- DiNicola, Lane (Page 38)	**3:40-4**	No Talk
4-4:20	RECRUITMENT AND HABITAT PREFERENCES OF FRESHWATER MUSSELS IN WESTERN NEW YORK STREAMS- Striedl, Fronk, Porto-Hannes, Krabbenhoft (Page 36)	**4-4:20**	MULTISCALE OCCUPANCY PATTERNS OF TEXAS FAWNSFOOT (*TRUNCILLA MACRODON*) POPULATIONS IN THE BRAZOS RIVER BASIN- Sullivan, Grimm, Littrell (Page 39)	**4-4:20**	FRESHWATER MUSSEL SURVEYS ON PENNSYLVANIA'S REDBANK CREEK SUGGEST ISSUES WITH AQUATIC CONNECTIVITY AND ACID MINE DRAINAGE ARE LIMITING RECOVERY- Raab (Page 41)
4:20-4:40	SURVEYS OF MID-MICHIGAN TRIBUTARIES CONSIDERING WATER BODY SIZE, HISTORIC DATA, AND RESURVEY INTERVALS- Vlasak, Woolnough (Page 37)	**4:20-4:40**	SPECIES DISTRIBUTION MODELING REVEALS SALINITY CONCENTRATION AS A MAJOR DRIVER OF PRESENCE FOR THE ESTUARINE BIVALVE *RANGIA CUNEATA* (ORDER VENERIDA)- Jimmerson, Schwalb, Zanatta (Page 39)	**4:20-4:40**	TESTING MUSSELS' EFFICIENCY AS A BIOREMEDIATION TOOL TO MITIGATE HEAVY METAL POLLUTION- Riccardi, Urbańska, Fontanella, Beone (Page 42)
4:40-5	USING INTERNS AND VOLUNTEERS TO SURVEY NATIVE MUSSELS ON THREE MILES OF THE HURON RIVER, PRIOR TO THE REMOVAL OF THE PENINSULAR DAM IN YPSILANTI, MICHIGAN- Mulcrone, Tolin, Martin, Steen, Pakey-Rodriguez (Page 37)	**4:40-5**	EXAMINING THE DISTRIBUTION OF MUSSELS IN POOLS AND RIFFLES OF THE SAN SABA RIVER- Greenfield, Schwalb (Page 40)	**4:40-5**	ASSESSMENT OF CONTAMINANT IMPACTS ON FRESHWATER MUSSELS IN THE CONASAUGA RIVER- Martin, Irwin, Hazelton, Bringolf, Escobar, Robinson, Kirsch, Stephens, Glassmeyer (Page 42)
5-5:20	STATUS OF FRESHWATER MUSSELS IN THE GRAND RIVER, MICHIGAN: ASSESSMENT OF THREATS AND OPPORTUNITIES FOR RESTORATION- Snyder, Kosak, Powers, Flanagan, Holtgren, Ogren, Rathbun (Page 38)	**5-5:20**	FRESHWATER MUSSELS OF THE HATCHIE RIVER: DISTRIBUTION, COMPOSITION, AND ABUNDANCE- Sallack, Key, Irwin-Womble, Rosenberger (Page 40)	**5-5:20**	PATTERNS IN CONTAMINANTS OF EMERGING CONCERN BASED ON UNIONID TISSUE, BIOFILM, WATER, AND SEDIMENTS IN A MIDWESTERN RIVER- Springer, Carrick, VanCuran, Woolnough (Page 43).
5:20-5:40	**PANEL DISCUSSION**		No Talk		No Talk
MIXER/POSTER SESSION (See page 90 for general poster topics and pages 91-112 for abstracts) **6:00-8:30 p.m. (poster set up 5:30-6:00 p.m.)**					

LIGHTNING TALKS + 2 contributed talks Wed May 14, 2025- 8:20 AM - 10:00 AM Auditorium 1 *Moderators: Nathan Ring and Meghan Martinski* *Moderator (contributed): Kentro Inoue*		**Contributed Session: Museums, Education, and Outreach** Wed May 14, 2025- 8:20 AM - 10:00 AM Auditorium 2 *Moderator: Stephanie Chance*		**Contributed Session: Life History** Wed May 14, 2025- 8:20 AM - 10:00 AM Conference Room E *Moderator: Jen Johnson*	
Lighting talks last 5 minutes (See Pages 86-89 for details)		**8:20-8:40**	THE MUSEUM OF FLUVIATILE MOLLUSKS AND HERBERT D. ATHEARN- Bogan, Smith, Bogan (Page 44)	**8:20-8:40**	No Talk
		8:40-9	SAVING MUSSELS FROM EXTINCTION: HOW AZA SAFE NORTH AMERICAN FRESHWATER MUSSEL WANTS TO STRENGTHEN THE ROLE OF ZOOS AND AQUARIUMS- Böhm, Harmon (Page 45)	**8:40-9**	VIRTUAL: GROWTH CHARACTERISTICS OF NATIVE FRESHWATER MUSSELS IN THE UPPER MISSISSIPPI RIVER SUPPORT VARIED RESILIENCE FOR SOME SPECIES- DuBose, Newton, Lipschultz (Page 47)
		9-9:20	A MULTI-FACETED APPROACH TO MOLLUSK CONSERVATION AT THE TENNESSEE AQUARIUM- Chance, George, Thayer (Page 45)	**9-9:20**	EVALUATING STRIPED BASS AS A HOST FOR YELLOW LAMPMUSSEL (*LAMPSILIS CARIOSA*)- Farrington, Cronin, Andersen, Gibbons, Perkins, Roy, Warren (Page 47)
9:20-9:40	SYSTEMATICS OF THE CRITICALLY IMPERILED PLEUROCERID GENUS *LITHASIA*- Donohoo, Tiemann, Whelan (Page 43)	**9:20-9:40**	WE LOVE BIODIVERSITY, BUT WHAT ABOUT DIVERSITY, EQUITY, & INCLUSION? RESULTS FROM DEMOGRAPHIC SURVEYS, 2022-2024- Craft (Page 46)	**9:20-9:40**	DETERMINATION OF FRESHWATER MUSSEL HOST USE THROUGH GENETIC BARCODING OF JUVENILE MUSSELS METAMORPHOSED ON NATURALLY INFESTED FISHES- Lanning, Patterson, Geda, Johnson (Page 48)
9:40-10	POPULATION STRUCTURE OF THE ENDEMIC AND FEDERALLY THREATENED PAINTED ROCKSNAIL, *LEPTOXIS COOSAENSIS*- Strasko, Garner, Johnson, Whelan (Page 44)	**9:40-10**	THE ART OF MUSSELS: PUBLIC ART AS A FORM OF SCIENTIFIC COMMUNICATION- Fedarick, Murphy, Record, Roy, Smith (Page 46)	**9:40-10**	INVESTIGATING THE ENVIRONMENTAL AND BIOLOGICAL PRESSURES ON TWO NATIVE WYOMING FRESHWATER MUSSELS: CALIFORNIA FLOATER AND WESTERN PEARLSHELL- Poratti, Tronstad, Cavalli, Gelwicks, Siddons (Page 48)
MORNING BREAK **10:00 AM-10:20 AM**					

Contributed session: Genetics, Genomics, and Systematics Wed May 14, 2025- 10:20-12:00 PM Auditorium 1 *Moderator: Gabrielle Sanfilippo*		**Special Session: Bridges to Recovery: Innovative Strategies to Advance Freshwater Mussel Restoration and Conservation** Wed May 14, 2025- 10:20 AM - 12:00 PM Auditorium 2 *Moderator: Pete Badra*		**Contributed Session: Climate Change** Wed May 14, 2025- 10:20 AM - 12:00 PM Conference Room E *Moderator: Chantelle Rondel*	
10:20-10:40	POPULATION GENOMICS OF THE TENNESSEE RIVER DRAINAGE ENDEMIC SMOOTH ROCKSNAIL, *LEPTOXIS VIRGATA* (GASTROPODA: CERITHIOIDEA: PLEUROCERIDAE)- Steed, Whelan (Page 49)	**10:20-10:40**	No Talk	**10:20-10:40**	HYPOXIA SENSITIVITY OF THE FEDERALLY THREATENED *PLEUROBEMA RIDDELLII* IN RELATION TO COMMON SPECIES- Blackwell, Adkins, Fogelman, Stoeckel (Page 52)
10:40-11	DEVELOPING A STANDARDIZED SNP PANEL FOR *ELLIPTIO LANCEOLATA* AND *PARVASPINA STEINSTANSANA* FOR GENETIC PARENTAGE-BASED TAGGING- Nissen, Cope, Evans (Page 49)	**10:40-11 (10:55)**	Introduction to Special Session- 10:55 (Badra)	**10:40-11**	THERMAL STRESS AND BIOENERGETICS: ESTIMATING SCOPE FOR GROWTH IN THE TEXAS FAWNSFOOT (*TRUNCILLA MACRODON*) ACROSS A RANGE OF TEMPERATURES- Adkins, Nunn, Stoeckel (Page 53)
11-11:20	A GENOMIC TOOL FOR THE LOW-COST MONITORING OF RELATEDNESS IN LAMPSILIS STRECKERI- Dunahoo, Kiss, Fluker, Berg (Page 50)	**11-11:20**	ARE WE MUSSEL- READY? ASSESSING WATER AND SEDIMENT QUALITY FOR THE POTENTIAL REINTRODUCTION OF FRESHWATER MUSSEL (FAMILY UNIONIDAE) IN NIAGARA RIVER- Porto-Hannes, Fronk, Striedl, Kunz, Krabbenhoft (Page 51)	**11-11:20**	CLIMATE SENSITIVITY IN MIDWEST MUSSELS VARIES WITH RANGE SIZE, TRAIT COMBINATIONS, AND LISTING STATUS- Skorupa, Douglass, Hopper, Schartel, Shoobs, Sietman, Bried (Page 53)
11:20-11:40	POPULATION GENOMICS AND PARENTAGE RELATIONSHIPS BETWEEN WILD AND CAPTIVE COHORTS OF THE FEDERALLY ENDANGERED ALABAMA LAMPMUSSEL, *LAMPSILIS VIRESCENS*- Krause, Johnson, Buntin, Whelan, Dinkins, Faust (Page 50)	**11:20-11:40**	NEW TOOLS FOR BUILDING HABITAT SUITABILITY MODELS AFTER OLD ONES FAIL- Lewis, Trimbath, Krebs (Page 52)	**11:20-11:40**	IMPACTS OF CLIMATE CHANGE ON FRESHWATER MUSSELS AND THEIR FISH HOSTS- Geist (Page 54)
11:40-12	GENETIC ASSESSMENTS OF ENDANGERED FRESHWATER MUSSELS AIM TO INFORM CONSERVATION MANAGEMENT IN THE MIDWESTERN U.S.- Waterhouse, Inoue, Bradley, Sietman (Page 51)	**11:40-12**	No Talk	**11:40-12**	WEATHERING THE STORM: A STATUS UPDATE OF APPALACHIAN ELKTOE (*ALASMIDONTA RAVENELIANA*) AND FUTURE PLANS FOLLOWING HURRICANE HELENE- Rondel, Etchison, Owensby (Page 54)
LUNCH AND COMMITTEE MEETINGS (Grab Lunch at Wilbanks Ballroom then Proceed to Committee Meetings- POSTED) 12-12:50, 1-1:50 PM					

Contributed session: Genetics, Genomics, and Systematics Wed May 14, 2025- 2-3:20 PM Auditorium 1 *Moderator: Sean Keogh*		**Special Session: Bridges to Recovery: Innovative Strategies to Advance Freshwater Mussel Restoration and Conservation** Wed May 14, 2025- 2-3:20 PM Auditorium 2 *Moderator: Pete Badra*		**Contributed Session: Population Declines and Kills** Wed May 14, 2025- 2:00 PM - 3:20 PM Conference Room E *Moderator: Jen Johnson*	
2-2:20	CONSERVATION GENOMICS OF *ANODONTA* FRESHWATER MUSSELS IN SWITZERLAND- Weber, Faust, Conrads, Feulner (Page 55)	**2-2:20**	"IT'S ALL NEW IN THE WEST!" A TRIBALLY MANAGED MUSSEL RESTORATION PROGRAM- Maine, O'Brien, Kunz, Seilo (Page 57)	**2-2:20**	ACCELERATED FRESHWATER MUSSEL DECLINES IN THE CHEHALIS BASIN, WA- Blevins, Tyson, Winkowski, Livingood-Schott, Hannam, Richard (Page 59)
2:20-2:40	SECONDARY CONTACT ERODES HISTORICAL DIVERSIFICATION IN THE WIDE-RANGING MAPLELEAF SPECIES COMPLEX- Keogh, Johnson, Smith, Sietman, Garner, Randklev, Simons (Page 55)	**2:20-2:40**	NATIVE UNIONID MUSSELS: IN VITRO PROPAGATION IN SUPPORT OF MUSSEL REINTRODUCTION PROGRAMS- Byappanahalli, Spoljaric, Przybyla-Kelly (Page 57)	**2:20-2:40**	INSIGHTS FROM THE PAST; USING AN ARCHAEOLOGICAL BIVALVE RECORD TO INFORM THE MANAGEMENT OF MODERN FRESHWATER MUSSELS- Hollander, Tronstad (Page 59)
2:40-3	SPAWNING AND MICROINJECTION OF QUAGGA MUSSEL EMBRYOS: METHODS TOWARDS CREATING AN IMMORTALIZED QUAGGA MUSSEL CELL LINE THROUGH GENETIC MODIFICATION- Hewitt, Sanfilippp, Senut, Suhr (Page 56)	**2:40-3**	SUSQUEHANNA (NY) BROOK FLOATER (*ALASMIDONTA VARICOSA*) POPULATION AND HABITAT ASSESSMENT POST DAM REMOVAL- Bulmer, Lord (Page 58)	**2:40-3**	A TOOL FOR STANDARDISED, RAPID MUSSEL HEALTH ASSESSMENT IN THE FIELD- Cossey, Rock, Signorini, Della Torre, Österling, Aldridge (Page 60)
3-3:20	VIRTUAL: REVIEW OF THE PHREATIC GASTROPODS IN THE EDWARDS-TRINITY AQUIFER SYSTEM OF TEXAS AND MEXICO WITH RECENT DISCOVERIES- Perez, Guerrero, Hutchins, Schwartz (Page 56)	**3-3:20**	DIRECT AND INDIRECT INFLUENCES OF DAM MODIFICATION AND FISH PASSAGE PROJECTS ON FRESHWATER MUSSEL COMMUNITIES- Martinski, Peake, Holem, Prentice (Page 58)	**3-3:20**	INVESTIGATING SCANDINAVIAN FRESHWATER PEARL MUSSEL (*MARGARITIFERA MARGARITIFERA*) MASS MORTALITY EVENTS- Cossey, Mageroy, Wengström, Kolmakova, Rock, Labecka, Österling, Erlandsson, Tanentzap, Richard, Aldridge (Page 60)
AFTERNOON BREAK **3:20 PM- 3:40 PM**					

Special Session: State of the science: environmental DNA for freshwater mussels Wed May 14, 2025- 3:40 PM - 5:20 PM Auditorium 1 *Moderator: Nate Marshall*		**Special Session: Bridges to Recovery: Innovative Strategies to Advance Freshwater Mussel Restoration and Conservation** Wed May 14, 2025 3:40-5:20 PM Auditorium 2 *Moderator: Matt Ashton*		**Contributed Session: Survey Methods and Designs** Wed May 14, 2025- 3:40 PM - 5:20 PM Conference Room E *Moderator: Erin McCombs*	
3:40-4	VIRTUAL: CHALLENGES AND OPPORTUNITIES IN USING eDNA METHODS FOR FRESHWATER MUSSEL DETECTION- Klymus, Ruiz-Ramos, Sansom, Volponi, Thompson, Jones, Barnhart, Erickson, Richter (Page 61).	**3:40-4**	VIRTUAL: SUBSTRATE STABILITY AS A METRIC TO ESTIMATE HABITAT FOR NATIVE FRESHWATER MUSSELS IN A LARGE RIVER AND IMPLICATIONS FOR CONSERVATION PRACTICES- Lipschultz, DuBose, Vaughan, Newton (Page 63)	**3:40-4**	QUANTIFYING THE BIAS ASSOCIATED WITH SPATIAL VS TEMPORAL REPLICATION IN SINGLE SEASON OCCUPANCY MODELS: AN APPLICATION FOR RARE FRESHWATER MUSSELS- Baker, Roy, Hazelton (Page 65)
4-4:20	USING ENVIRONMENTAL DNA (eDNA) TO IMPROVE MONITORING OF NATIVE MUSSELS IN RESTORATION PROGRAMS- Spoljaric , Przybyla-Kelly, Klymus, Aunins (Page 61)	**4-4:20**	REPATRIATING FRESHWATER MUSSELS INTO TOWN CREEK TO RESTORE SPECIES DIVERSITY AND COMMUNITY FUNCTION- Ashton, Kubala, McCann (Page 64)	**4-4:20**	BIOMARKER DISCOVERY FOR EVALUATION OF FRESHWATER MUSSEL (ORDER UNIONIDA) HEALTH AND IMMUNE STATUS- Mueller, Cope, LePrevost, McKenney, Yoder, Ben-Horin, Eads, Lutackas, Hayes, Zelko, Evans, Hoch, Fisk (Page 66)
4:20-4:40	DETECTING RARE FRESHWATER MUSSELS AND THEIR HOSTS: INTEGRATING EDNA AND CONVENTIONAL SURVEYS- Douglass, McCallus, Robinson, Ruellan, Schonken, Stodola, Vinsel, Sietman (Page 62)	**4:20-4:40**	No Talk	**4:20-4:40**	ASSESSMENT OF SPATIAL VARIATION IN POPULATION CONDITION OF THE ESA LISTED GUADALUPE ORB (*CYCLONAIAS NECKI)*, FALSE SPIKE (*FUSCONAIA MITCHELLI)*, AND GUADALUPE FATMUCKET (*LAMPSILIS BERGMANNI)* IN CENTRAL TEXAS- Gudgell, Littrell, Norris, Sullivan (Page 66)
4:40-5	USING eDNA FOR CONSERVATION ASSESSMENT OF THE POTENTIALLY EXTINCT WHITE CATSPAW AND OTHER RARE, THREATENED, AND ENDANGERED SPECIES IN NORTHWEST OHIO- Marshall, Fleece (Page 62)	**4:40-5**	THE HUNTERS STATION BRIDGE REPLACEMENT PROJECT, AN OPPORTUNITY FOR ENDANGERED SPECIES RECOVERY- Allison, Welte, Miller (Page 64)	**4:40-5**	APPLICATION OF THE MUSSEL ASSEMBLAGE HEALTH INDEX (MAHI) TO ADDRESS THE DECLINE OF FRESHWATER MUSSELS- McCombs, Haag, Burrow, DuBose, Price (Page 67).
5-5:20	VIRTUAL: A TARGETED eDNA MONITORING PROGRAM FOR SPECTACLECASE IN THE UPPER MISSISSIPPI RIVER- Spear, Tajjioui, Kelner, Waller, Cyphers, Jordan, Merkes, Moratz, Schreier, Sietman, Douglass (Page 63)	**5-5:20**	REINTRODUCING FRESHWATER MUSSELS INTO THE RESTORED MISSION REACH OF THE SAN ANTONIO RIVER- Magruder, Davis, Tucker, Arroyos, Marshall, Thompson (Page 65)	**5-5:20**	LEVERAGING PUBLICLY AVAILABLE STATE AND FEDERAL BIOASSESSMENT DATA WITH FRESHWATER MUSSEL SURVEYS- Holem, Martinski, Peake, Kogge (Page 67)
BANQUET AND AUCTION- WILBANKS BALL ROOM 6:30-10:30 PM					

Special Session: Freshwater Mussel Data and Databases Thu May 15, 2025- 10:20 AM - 12:00 PM Auditorium 1 *Moderator: Kayla McRobb*		**Contributed Session: Bridges to Recovery: Innovative Strategies to Advance Freshwater Mussel Restoration and Conservation + Contributed Session: Survey Methods and Designs** Thu May 15, 2025- 10:20 AM - 11:00 AM, 11 AM-Noon Auditorium 2 *Moderator: Joe Rathbun*		**Contributed Session: Conservation Planning** Thu May 15, 2025- 10:20 AM - 12:00 PM Conference Room E *Moderator: Jamie Bucholz*	
10:20-10:40	"STORIES FROM THE FIELD" AND THE NEED FOR A CENTRALIZED NATIVE MUSSEL DATA BASE IN MICHIGAN- Mulcrone, McRobb (Page 68)	**10:20-10:40**	LARGE-SCALE MUSSEL RELOCATION IN THE WISCONSIN RIVER - SUCCESSFULLY AVOIDING AND MINIMIZING TAKE OF LISTED SHEEPNOSE AND SALAMANDER MUSSELS- Gryga, Ostby, Englund, Holem, Kogge (Page 70)	**10:20-10:40**	INCIDENTAL TAKE PERMITS AND HABITAT CONSERVATION PLANS: DEVELOPMENT OF AN HCP FOR FRESHWATER MUSSELS AND AGRICULTURE IN THE SOUTHEASTERN U.S.- Rowe, Cowie, Golladay, Rowels, Sweeny, Walther (Page 72)
10:40-11	VIEWS FROM THE HIGHWAY: BUILDING A DATASET AND MUSSEL PROGRAM IN MICHIGAN- Grabarkiewicz, Alvarado (Page 68)	**10:40-11**	DEVELOPMENT OF AN INVENTORY AND PRACTITIONER NETWORK TO IMPROVE AQUATIC CONSERVATION TRANSLOCATIONS- Whelan, George, Apodoca, Chance, Drake, Foltz, Garrido, Hall, Lamonthe, Lance (Page 71)	**10:40-11**	VIRTUAL: AN AQUATIC SPECIES AT RISK THREAT ASSESSMENT AND PRIORITIZATION EXERCISE FOR THE LOWER THAMES VALLEY CONSERVATION AUTHORITY WATERSHED- McKay, Walton-Rabidaeu, Pothier, Nydam, Peacock, Singh (Page 73)
11-11:20	BEYOND PRESENCE/ABSENCE DATA – TRACKING FRESHWATER MUSSEL RELOCATIONS AND PROPAGATION RELEASES- Watson (Page 69)	**11-11:20**	IMPLEMENTATION OF THE WEST VIRGINIA MUSSEL SURVEY PROTOCOL ON A GROUP 4 SECTION OF THE OHIO RIVER: A CASE STUDY- Foltz, Benshoff, Jones, Jones, Ford, Symonds, Prewitt, Miller, Swecker, Spaeth (Page 71)	**11-11:20**	EDENVILLE DAM RESTORATION PROJECT HABITAT CONSERVATION PLAN FOR THE SNUFFBOX MUSSEL- Estrem, Sloan (Page 73)
11:20-11:40	IT TAKES A VILLAGE- BUILDING, MAINTAINING, AND IMPLEMENTING A STATEWIDE MOLLUSK DATA MANAGEMENT SYSTEM- Bajo-Walker (Page 69)	**11:20-11:40**	SAMPL: AN AGENT BASED MODEL TO EVALUATE SPATIAL SAMPLING STRATEGIES- Cushway, Foxfoot, Rosenberg, Schwalb, Swannack (Page 72)	**11:20-11:40**	THE FUTURE OF FRESHWATER MUSSEL PROPAGATION: BRIDGING THE GAP BETWEEN BASIC RESEARCH AND APPLIED ECOLOGICAL RESTORATION INITIATIVES- Bucholz, Maxwell-Doyle, Klein (Page 74)
11:40-12	DEVELOPMENT OF A FEDERALLY LISTED MUSSEL DATASET AND ANALYTICAL PIPELINE- Khadka, Olson, Che-Castaldo, Allstadt (Page 70)	**11:40-12**	DAMS AND CLAMS: RESERVOIR DRAWDOWNS AND FRESHWATER MUSSEL RELOCATIONS- Rathbun, Gulotty, O'Brien (Page 72)	**11:40-12**	COLLABORATIVE WILDLIFE PROTECTION AND RECOVERY INITIATIVE: ADVANCING FRESHWATER MUSSEL CONSERVATION THROUGH COMMUNITY COLLABORATION- Hu, Klymus, Newton (Page 74)
BUSINESS LUNCH AND STUDENT AWARDS 12 PM- 2 PM					

Special Session: Freshwater Mussel Data and Databases Thu May 15, 2025- 2-3:20 PM Auditorium 1 *Moderator: Kayla McRobb*		**Contributed Session: Monitoring Results and Status** Thu May 15, 2025- 2:00 PM - 3:20 PM Auditorium 2 *Moderator: David Dortman*		**Contributed Session: Life History** Thu May 15, 2025- 2:00 PM - 3:20 PM Conference Room E *Moderator: Trevor Hewitt*	
2-2:20	INVASIVE AND NON-LISTED MUSSEL SPECIES DATA COLLECTION AND HISTORIC DATA CONSOLIDATION- Hillary, Rogers, Badra, Nathan, Tonello, Harris, Johnson (Page 75)	**2-2:20**	A TALE OF TWO ISLANDS: MOLLUSK INVENTORY UPDATES AT OHIO RIVER ISLANDS NATIONAL WILDLIFE REFUGE- Barr, Katz (Page 76)	**2-2:20**	CONSEQUENCES OF LONG-TERM DECLINES IN FRESHWATER MUSSEL ABUNDANCE DEPEND ON LIFE HISTORY STRATEGIES- Lopez, Atkinson, Vaughn (Page 77)
2:20-2:40	MICHIGAN'S NATURAL HERITAGE DATABASE – HOW SNAILS AND MUSSELS ARE TRACKED IN MICHIGAN- Rogers (Page 75)	**2:20-2:40**	MUSSEL AND GASTROPOD DISTRIBUTIONS IN EL SALVADOR- Barraza, Inoue, Melara (Page 76)	**2:20-2:40**	POLYMORPHISM IN THE AGGRESSIVE MIMICRY LURE OF THE PARASITIC FRESHWATER MUSSEL *LAMPSILIS FASCIOLA*- Hewitt, Johnson, Buntin, Moore, Ó Foighil (Page 78)
2:40-3	MICHIGAN FRESHWATER MUSSEL DATABASE DEVELOPMENT PROJECT- Samu-Pittard (Page 75)	**2:40-3**	FRESHWATER MUSSELS OF CENTRAL ANND SOUTH AMERICA (UNIONIDAE, HYRIIDAE, MYCETOPODIDAE): DISTRIBUTIONAL PATTERNS AND OTHER COOL STUFF- Cummings, Graf (Page 77)	**2:40-3**	FIRST REPORT OF *PARAERGASILUS RYLOVI* IN FRESHWATER MUSSELS IN POLAND- Urbańska, Kaźmierczak, Skibińska, Lopes-Lima, Szpotkowski, Taskinen (Page 78)
3-3:20	**DATABASE ROUND TABLE DISCUSSION**	**3-3:20**	No Talk	**3-3:20**	PARASITES AFFECTS FRESHWATER MUSSELS' BEHAVIOR- Kaźmierczak, Skibińska, Riccardi, Rinaldi, Urbańska (Page 79)
AFTERNOON BREAK 3:20 PM – 3:40 PM					

Special Session: State of the science: environmental DNA for freshwater mussels Thu May 15, 2025- 3:40 PM - 5:20 PM Auditorium 1 *Moderator: Nate Marshall*		**Contributed Session: Monitoring Results and Status** Thu May 15, 2025- 3:40-5:20 PM Auditorium 2 *Moderator: Ericah Beason*		Contributed Session: Population Declines and Kills Thu May 15, 2025- 3:40 PM - 5:20 PM Conference Room E *Moderator: Alexander Karatayev*	
3:40-4	DEVELOPMENT AND VALIDATION OF ENVIRONMENTAL DNA ASSAYS FOR THE DETECTION OF FRESHWATER MUSSELS- Waits, Smith, Patnode, Clayton, McGregor, Fagin, Compton, Shoobs, Bergdale (Page 79)	**3:40-4**	HENS TEETH AND EBONYSHELLS: SEARCHING FOR ROUND EBONYSHELL (*REGINAIA ROTULATA*) IN THE CONECUH RIVER, ALABAMA, USA- Gangloff, Pugh, Thompson, Wells (Page 81)	**3:40-4**	MICROBIOME ANALYSIS HIGHLIGHTS INTERPLAY BETWEEN BACTERIA AND FRESHWATER MUSSELS- Evans, McCutcheon, Hoch (Page 84)
4-4:20	DEVELOPING A COORDINATED APPROACH TO EVALUATE FRESHWATER MUSSELS ACROSS OREGON AND WASHINGTON- Weaver, Winkowski, Blevins (Page 80)	**4-4:20**	RESULTS FROM A MULTI-PHASE STUDY IN THE KANKAKEE RIVER OF ILLINOIS AND INDIANA- Ford, Lewis (Page 82)	**4-4:20**	No Talk
4:20-4:40	FROM SPECIES DETECTION TO CONSERVATION ASSESSMENT AND PLANNING: AN eDNA PERSPECTIVE- Lopes-Lima (Page 80)	**4:20-4:40**	RESULTS OF MUSSEL SURVEYS FROM THE UPPER ROCK RIVER IN WISCONSIN AND ILLINOIS AND THE DISCOVERY OF LIVE CYCLONAIAS TUBERCULATA (*PURPLE WARTYBACK*)- Ford, Prewitt, Jones, Jones (Page 82)	**4:20-4:40**	MULTIPLE INVASIONS DECIMATE THE MOST IMPERILED FRESHWATER INVERTEBRATES- Karatayev, Burlakova, Karatayev, Cooper, Rudstam (Page 84)
4:40-5	ASSESSING THE POTENTIAL FOR ENVIRONMENTAL DNA TO PROVIDE THE BASIC INFORMATION NEEDED FOR REGULATORY DETERMINATIONS- Fleece, Marshall (Page 81)	**4:40-5**	LONG TERM CHANGES TO MUSSEL ASSEMBLAGES IN POOLS 2-10 OF THE UPPER MISSISSIPPI RIVER – A GLIMMER OF HOPE? Holcomb, Kelner, Secrist, Davis, Schroeder, Sietman, Holcomb (Page 83)	**4:40-5**	SILENT VICTIMS OF THE PYROCENE: FUNCTIONAL EXTIRPATION OF FRESHWATER MUSSELS FOLLOWING CATASTROPHIC WILDFIRE- Lawrence, Kupferberg, Bradley, Rypel, Hancock (Page 85)
5-5:20	**eDNA ROUND TABLE DISCUSSION**	**5-5:20**	OCCUPANCY AND DISTRIBUTION OF SWAP LISTED FRESHWATER MUSSEL SPECIES IN SOUTH CAROLINA- Beason, Kern (Page 83)	**5-5:20**	CHARACTERISTICS OF THE MICROBIOME OF JUVENILE FRESHWATER MUSSELS IN THE CONTEXT OF ENIGMATIC MUSSEL DECLINES IN THE EASTERN USA- Ford, Haag, Ibach, Price, McGregor, Sietman, Douglass, Stodola, Lane, Goldberg (Page 85)
END OF FMCS 2025 SYMPOSIUM					

NATURAL HISTORY AND CONSERVATION OF FRESHWATER MOLLUSKS IN THE LAURENTIAN GREAT LAKES SYSTEM: INTRODUCTION TO THE SPECIAL SESSION

David L. Strayer - Cary Institute of Ecosystem Studies, P.O. Box AB, Millbrook, NY 12545, USA; strayerd@caryinstitute.org. David T. Zanatta - Department of Biology and Institute for Great Lakes Research, Central Michigan University, Mount Pleasant, MI 48859, USA. Isabel Porto-Hannes - Department of Environment and Sustainability, University at Buffalo, Buffalo, NY 14260 USA.

The talks in this special session will: 1) describe our latest understanding of the natural history, origin, and diversity (species and genetic) of native mollusks in the Great Lakes basin; 2) review their conservation status and population trends; 3) highlight conservation actions for native mollusks underway in the Great Lakes region; and 4) identify gaps in knowledge for conserving and recovering freshwater mollusk diversity in the basin. Because the systematics, distribution, and current conservation status of gastropods and sphaeriids in the basin are so poorly known, this session will emphasize unionids. The entire Great Lakes basin was covered by glacial ice, so the fauna is of recent origin. The complicated postglacial history of the basin has strongly influenced the composition and distribution of its unionid fauna. Species colonized the basin from outside refuges via multiple natural connections or human introductions, resulting in a fauna that is a mixture of Interior Basin and Atlantic Slope species. Some species spread far from their points of origin, but others did not, and still live only near where they entered the basin. Many species entered the basin from multiple refuges, producing genetic differentiation within the basin. The unionid fauna of the Great Lakes basin includes 50-55 species, several of which are now extirpated from or very rare in the basin. Taxonomic uncertainties about some of these species, especially in *Pyganodon* and *Lampsilis*, hamper our understanding of their ecology and conservation. The waters and watersheds of the basin are heavily used, so impacts from multiple human activities (e.g., dams, pollution, land-use change, introductions of non-native species) have badly harmed unionid populations. Speakers in the session will provide details on faunas and conservation issues in each of the states and provinces in the basin. The session will close with a talk on non-native species in the basin and a panel discussion.

THE GENETIC STORY OF POST-GLACIAL COLONIZATION OF FRESHWATER MUSSELS INTO THE NORTH AMERICAN GREAT LAKES

David T. Zanatta - Department of Biology and Institute for Great Lakes Research, Central Michigan University, Mount Pleasant, MI 48859 USA.I sabel Porto-Hannes - Department of Environment and Sustainability, University at Buffalo, Buffalo, NY 14260 USA. Kentaro Inoue - Conservation Research Department, Shedd Aquarium, Chicago, IL 60605 USA.

The last three decades have seen rapid advances in genetic and genomic techniques for understanding patterns of distribution, colonization, diversity, and evolution of freshwater mollusks. Published studies have analyzed the phylogeography and population genetics of both common and rare/imperiled unionid species spanning the Pleistocene glacial maximum, from the Great Lakes region to unglaciated southern regions. These studies have used increasingly powerful approaches, including allozymes, mitochondrial DNA sequences, microsatellite genotypes, and, most recently, genome-derived single-nucleotide polymorphism (SNP) genotypes. Emerging patterns from these studies indicate that: 1) all species show considerable genetic diversity within and among the Great Lakes and their tributaries; 2) some species show evidence of recent reductions in genetic diversity due to genetic bottlenecks or founder effects in some isolated lakes and sub-watersheds; 3) some closely related species show evidence of hybridization at secondary contact zones following post-glacial colonization from geographically distinct glacial refugia; 4) many species show distinct population structuring by river drainage, possibly reflecting colonization from multiple glacial refugia; and 5) a minority of species show weak or no genetic structure even across broad geographic scales. These patterns likely linked to a species' life history, host fish use, host's dispersal abilities, or colonization from a single or multiple glacial refugia. The results of these studies are enhancing our understanding of genetic diversity and structure, offering new insight into the complex redistribution patterns of mussels into new habitats following the dramatic climactic shifts at the end of the Pleistocene. The revealed patterns are critical for guiding conservation and restoration strategies from watershed to global scales. We will conclude by identifying species and regions in the Great Lakes drainage in greatest need of future genomic study.

A CANADIAN PERSPECTIVE: CONSERVATION, PROTECTION AND RECOVERY OF ONTARIO'S FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE).

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The province of Ontario, Canada, is home to 41 species of freshwater mussels of the family Unionidae, all of which are known to occur within the Great Lakes and their watersheds. Knowledge of species distributions and status remained poor throughout the 19th and for most of the 20th centuries despite a small commercial fishery during the first half of the 20th century. An interest in understanding and conserving unionids grew following the arrival and establishment of invasive dreissenid mussels in the 1980s and the accompanying declines in native mussels. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed the first Ontario mussel in 1999 and to date, 16 Ontario species (39%) have been assessed at statuses ranging from Special Concern to Endangered. An additional four species (10%) remain as candidates. The Canadian *Species at Risk Act* (SARA) (2003) and the Ontario *Endangered Species Act* (ESA) (2007) provide protections and recovery directives for listed species while the federal Fisheries Act (1868) provides limited protections for non-listed species. In addition to the historical impacts associated with the commercial harvest and the arrival and establishment of dreissenid mussels, Ontario mussels continue to be threatened by deteriorating water quality related to intensive agricultural activities and urban development and expansion. Fisheries and Oceans Canada's Unionid Monitoring and Biodiversity Observation (UMBO) network now tracks populations of 33 species across seven Great Lakes subwatersheds where many species are showing positive signs of recovery. Four species have seen their status downlisted

NATURAL HISTORY AND CONSERVATION OF FRESHWATER MUSSELS IN THE LAURENTIAN GREAT LAKES SYSTEM IN NEW YORK STATE

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New York State is home to approximately 49 species of freshwater mussels in the family Unionidae, with about 38 of these species found in the waters of the lower Great Lakes and St. Lawrence River basins. Additionally, a single species from the family Margaritiferidae inhabits the basins. Despite their ecological importance, nearly 21% of unionid species in New York are presumed to be extirpated from the state, 35% are considered critically imperiled or imperiled, 23% are vulnerable and only18 % are secured or apparently secure. Besides the decline of various species in the state, which highlights their conservation importance, New York's fauna holds evolutionary and ecological significance. Following the last glaciation, species recolonized the lower Great Lakes from multiple glacial refugia, making the state a critical zone of secondary contact between previously isolated populations. This secondary contact has likely led to hybridization between multiple species, blurring the distinctions between closely related species. The construction of human-made canals across the lower Great Lakes have facilitated the expansion of some species' distribution ranges crossing drainage divides. In this talk we will: 1) describe our latest understanding of the natural history, origin, and diversity (species and genetic) of native mussels in New York State; 2) review their conservation status and population trends; 3) highlight several conservation actions that have been taken in New York to conserve freshwater mussels; and 4) identify gaps in knowledge for conserving and recovering freshwater mussel diversity.

MUSSELS OF OHIO'S LAKE ERIE TRIBUTARIES, CHALLENGES TO CONSERVATION

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The Lake Erie watershed composes a post glacial community of organisms that included some 43 species of unionid mussels based on Graf's historic review (2002), almost all of which can be considered in decline regionally. Poor water quality and habitat loss imposed the greatest impacts over time followed by invasive dreissenid and corbiculid mussels. A number (at least 8) are likely no longer present in the Ohio Lake Erie watershed, four others are federally endangered, and four more are state listed, possibly leaving 27 species not of concern, although less than half of them may really be considered safe. A growing problem is that no one knows. Reports of abundant mussels at some sites are ad hoc, derived when animals are relocated prior to construction repair along rivers and harbors. Following discovery, this habitat may be disrupted, adults are moved, and the fate of smaller individuals may vary. Long-term improvement to water quality predicts mussel recovery in many streams; fish recovery is documented. Removal of numerous small dams has also opened waterways, but there, recovery is prefaced by habitat change and often species loss. Furthermore, parks, tasked with beautifying and "improving" rivers, constantly reinforce embankments to limit erosion, and the great majority of Lake Erie's tributaries are owned by the public given that land laws extend ownership to under the water. Citizens commonly modify riparian zones for their use or aesthetic view. Raising juvenile mussels with the intent to introduce them appears to be occurring all over, and plans include the iconic Cuyahoga River, but determining what really is the right habitat and establishing access is key. Whether the rivers really are ready is the question.

PATTERNS OF SEXUAL DIMORPHISM IN THE CRITICALLY IMPERILED FRESHWATER MUSSEL GENUS EPIOBLASMA

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Members of the critically imperiled freshwater mussel genus Epioblasma are remarkable among the Unionoida with extreme sexual dimorphism related to the host trapping behavior of females. We aimed to quantify shell shape variation between sexes to reveal patterns of dimorphism within and among species in the genus. Shell shape variation was quantified using digital photographs of *Epioblasma* specimens (n = 1385) from natural history collections representing all 28 species and 5 subgenera. Two-dimensional shell shapes were estimated from the images of the interior the left valve via 3 Type I and 30 Type II Procrustes-transformed landmarks. A principal component analysis (PCA) was performed using all specimens, then the PC scores were used in a linear discriminant analysis (PCA-LDA) to examine patterns of sexual dimorphism. In addition to the PCA-LDA, thin-plate splines (TPS) were also used to visualize and quantify patterns of sexual dimorphism within and among species and subgenera. Our analyses showed that females were considerably more variable in shape than males in all species, but sexual dimorphism was much more pronounced in some species (e.g., *E. flexuosa*) and groups of species (e.g., subgenus *Torulosa*). We hypothesize that natural selection induced by host fish use is the major driver of female shell shape, whereas male shell shapes are more constrained by river hydrology and habitat. Furthermore, shell shape groupings formed by a cluster analysis when using female specimens were largely consistent with existing taxonomic classifications and available molecular phylogenies. A better understanding of the natural history of members of this critically imperiled genus is vital to the continued preservation and restoration of extant taxa.

USING MORPHOLOGY TO IDENTIFY FRESHWATER MUSSEL GLOCHIDIA AND JUVENILES FROM WILD INFECTED HOSTS

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Understanding ecological host relationships is increasingly recognized as a critical component in developing effective multi-species conservation strategies. Though multiple papers have evaluated differences in glochidia morphology across species, few have used this approach as a tool for host identification. This study aims to assess the utility of morphological characteristics in identifying mussel species by analyzing both DNA-barcoded reference samples and currently unidentified glochidia and juvenile specimens. By refining morphological identification techniques, we seek to enhance host determination methods and improve conservation efforts for imperiled freshwater mussels. We collected and photographed mussels from wild-caught host fish in the Flint River Basin (GA) throughout 2021 and 2022. Using ImageJ software, shell length, shell height, and hinge length of 494 individual glochidia and juvenile mussels were measured. DNA barcoding enabled the genetic identification of 169 specimens that served to establish a reference dataset. We used Discriminant Function Analysis (DFA) to categorize unknown specimens by their morphological traits and evaluated the classification accuracy through cross-validation techniques. Initial results demonstrate that morphological measurements yield species classification accuracy rates that match previous study findings between 72% and 79%. The study presents an effective species identification method, which is an alternative to genetic analysis and may provide essential support for mussel population monitoring and conservation initiatives.

IDENTIFYING ENVIRONMENTAL DRIVERS OF SHELL SHAPE VARIATION IN THE FRESHWATER GASTROPOD *CAMPELOMA DECISUM* (SAY, 1817)

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Campeloma decisum (family Viviparidae), Pointed Campeloma, is a common and widely distributed freshwater gastropod found across the eastern United States and southeastern Canada. Substantial conchological variation is known to be present in the species, but this variation and what it corresponds to has not been quantified. Our study sought to use geometric morphometric analyses to test which environmental factors may be driving shell shape variation in C. decisum. Campeloma decisum specimens (n = 458) and environmental data were collected from 22 sites in six lakes in central and northern Michigan. Specimens were photographed with apertures orthogonal to the camera lens and 26 landmarks were digitized onto each image to estimate shell and aperture shape. A Procrustes superimposition was performed to scale and rotate the shells to focus analyses solely on shape. A linear discriminant analysis of principal components (PCA-LDA) was run to quantify shape variation among the sites and lakes sampled. Correlations were tested for among environmental variables and PCA-LDA axes that defined shell shape. The PCA-LDA assigned 46.6% of snails to their site of origin and 86.9% to their lake of origin. Shell shapes of *C. decisum* were most strongly correlated with Secchi depth, ammonia concentration, pH, alkalinity, phosphate concentration, magnesium concentration, and percent sand substrate. Higher ammonia and phosphate concentrations often correlated with more elongate shapes (i.e., taller spire). The pH at sites and lakes appeared to be a strong driver of spire decollation with more acidic conditions likely breaking down calcium carbonate in shells. In contrast to a previous study on the often sympatric freshwater gastropod *Elimia livescens* (Menke, 1830) (family Pleuroceridae), our study did not find lake fetch (driving wave energy) to be major a driver of shell shape in *C. decisum*. However, to better test this, we recommend collecting additional *C. decisum* specimens from lakes with longer fetch to expand the dataset and further effects of lake morphometry on shell shape.

ON THE FREQUENCY AND CORRELATES OF SINISTRALITY IN *CAMPELOMA*

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The Ohio State University Museum of Biological Diversity (OSUM) maintains the largest collection of freshwater bivalves in the world, containing approximately 500,000 specimens in over 80,000 lots, mainly from North America. About one fifth (>19%) of the world's museum specimens of endangered or extinct freshwater mussels are housed at OSUM, more than any other single institution. Not captured in these numbers are those samples currently hidden within the collection's massive backlog, which is stored on 2,788 lineal feet of shelving in a series of ca. 1,900 bankers boxes. These boxes contain both of wet and dry specimens from historic orphaned collections, state surveys from across the country, and the collecting efforts of affiliated staff that simply remain unprocessed. Funding from the Missouri Department of Conservation has given us the opportunity to catalog backlog material from Missouri which had previously been a low priority in the collection. To date, we have processed 19 boxes, roughly 1% of the total collection backlog. In ~200 hours of effort, we have more than doubled the total number of wet-preserved lots of Missouri-endangered and federally listed mussel species from Missouri, and increased the total number of wet-preserved lots of Missouri unionoids available for scientific study in public collections by nearly 50%. We present our curatorial workflow, a descriptive summary of the material catalogued, and a discussion of our use of the recently-published MusselMapR dataset as a tool for strategic collection growth.

VIRTUAL: ASSESSMENT OF LAMPSILID MUSSEL IN-VITRO TRANSFORMATION VARIABLES: MEDIA CHANGE FREQUENCY, DILUTION TIMING, AND GLOCHIDIA DENSITY

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Metamorphosis from glochidium to juvenile is a crucial step in the life history of highly imperiled Unionidae, freshwater mussels. Most Unionid mussels begin as parasitic larvae, attaching to the gills of specific fish hosts before transitioning into juveniles and dropping off their hosts. Captive propagation is a powerful tool in freshwater mussel recovery; however, host specificity and unknown host species present a unique challenge. Using adapted cell culture methods to transform glochidia in vitro into juveniles allows propagators an alternative when culturing species with unknown hosts. We extracted glochidia from two *Villosa vibex* and two *Lampsilis straminea* captive females to assess media change frequency, dilution timing, and glochidia density effects on transformation rates. Lampsilis straminea transformation rates averaged 44.54 ± 1.72% and Villosa vibex averaged 66.69 ± 2.21%. In vitro transformation rates differed significantly between species, but not across media change frequency categories (five versus seven days a week). *Lampsilis straminea* transformation rates did not differ between dilution timing categories (22 versus 24 days) nor individual source females. *Villosa vibex* rates were significantly different between source females. Although a negative trend between transformation success and the number of glochidia per well was observed, only one of the four individual source females displayed a statistically significant correlation.

MUSSEL PRODUCTION FOR PENNSYLVANIA DEP AT WHITE SULPHUR SPRINGS NFH A 10-YEAR PROJECT

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In 2015 the Pennsylvania Department of Environmental Protection partnered with WSSNFH to produce several species of freshwater mussel. The project was funded by money from a sand and gravel dredging mitigation fund. Over the course of 10 years, we produced over 20,000 individuals of 7 species. This included several common species as well the rarer Pistolgrip, Round Hickorynut and Salamander Mussels. In all we produced over 1 million dollars' worth of animals, discovered new host animals, and developed new propagation techniques.

ADVANCES IN THE PROPAGATION AND CULTURE OF CRITICALLY ENDANGERED SPECIES OF FRESHWATER MUSSELS AT THE CUMBERLAND RIVER AQUATIC CENTER, TWRA

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To prevent the extinction of endangered freshwater mussel species, efforts have been undertaken at the Cumberland River Aquatic Center (C-RAC) of the Tennessee Wildlife Resources Agency. Among the critically endangered species, Hemistena lata, Epioblasma ahlstedti, Plethobasus cyphyus, Toxolasma cylindrellusand Pleurobema plenum have been propagated and released as part of restoration initiatives aimed at establishing viable populations. These efforts align with the recovery plans for these species through both fish host propagation and in-vitro culture methods. Cracking pearlymussels (H. lata) are particularly challenging to propagate and grow out, compared to other endangered freshwater mussel species, due to their sensitivity and vulnerability to environmental changes. Between 2019 and 2024, a total of 46,149 juvenile H. lata mussels were propagated, with 44,090 juveniles produced through in-vitro culture and 2,059 propagated using fish hosts. The success of in-vitro culture has greatly boosted juvenile production for this species. Notable progress in juvenile mussel culture has been made for H. lata since 2023, with improvements in the culture methodology. In the first two months of development, 136 H. lata juveniles surpassed 1 mm in length. Additionally, 48 juvenile H. lata mussels, ranging from 5.0 to 19.5 mm and aged 12 months, were successfully cultivated to a taggable size. These mussels were released into the Buffalo River, TN, marking a significant achievement in the species' restoration. This release is the first time H. lata has been propagated and restored since its listing as endangered in 1989. Post-release monitoring indicated that the juvenile H. lata mussels exhibited substantial growth within 40 days of their release. In addition, E. ahlstedti, P. cyphyus, T. cylindrellus and P. plenum have been grown out at C-RAC for restoration efforts over the past two years.

EVALUATING COMMERCIAL DIETS FOR THE PRODUCTION OF JUVENILE FRESHWATER PLAIN POCKETBOOK MUSSELS LAMPSILIS CARDIUM

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Freshwater mussels are invaluable for aquatic ecology and function as an indicator species in these environments. However, nutrition research is in the infancy of discovering how certain commercial feeds and additives may support growth and survival of hatchery raised freshwater mussels by providing essential nutrients and energy. This 14-week study evaluated various combinations of commercial algae and additives as dietary treatments. In a completely randomized arrangement, nine treatments were designed including: a negative control (NC; no feed), four treatments of paste algae, and four treatments of freeze-dried algae. Additives were included in the fed treatments (probiotic, worm casing, and commercial algae replacement). Groups of 20 mussels (initial weight(g) = 0.415 ± 0.04786) were stocked into 36, 9L tanks (n=4) in a static system with partial water exchanges (33%) occurring every 8 hours using an automated setup. The mussels were fed once a day and water quality parameters were tested weekly. Every two weeks mussels in each tank were sampled to assess length (in millimeters using Image-Pro Plus software), weight gain, and survival. Daily rations were adjusted after each sampling event according to tank mussel biomass. The results of the study revealed significant ($P \leq 0.05$) increases in length and weight when all additives were fed in combination with algae, whereas the mussels in the NC lost weight. Whole-body composition analysis including dry matter, protein, and energy showed varying results that require further investigation regarding feed combinations. This study provides new insights on the nutrition of freshwater mussels raised in captivity and may help in optimizing conservation/aquaculture endeavors.

UNIONID MUSSEL CONSERVATION IN MICHIGAN

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Michigan's rivers and lakes support diverse unionid mussel communities providing a range of ecological functions and ecosystem services, as well as intrinsic values. Scientific study of unionids in Michigan began with the early naturalists and museums, whose collections document historical status and range in the state. Ongoing surveys have revealed a unionid fauna that has undergone drastic decline for many of Michigan's 43 species. Currently, 17 are listed as state endangered or threatened and 13 are species of special concern. Seven are also federally listed and globally rare. Reasons for decline include direct habitat alteration from channelization, dredging, dams and impoundments; commercial harvest; cumulative impacts from conversion of natural landcover to urban and agricultural uses; and invasive species (Dreissenids). Growing awareness of unionid mussels within natural resource agencies, universities, and non-profits over the past 30+ years has led to them being increasingly accounted for in management decision making and conservation planning. Unionid conservation efforts include education, outreach, research, surveys, permitting, and regulation. While state and federal agencies primarily take on a management and regulation role, academia a research role, and natural heritage programs a data gathering and sharing role, coordination of these efforts is highly beneficial. Beginning in 2011, representatives from state and federal agencies, universities, consultants, and individuals were invited by agency staff to share information and collaborate on unionid conservation. The Michigan Mussel Workgroup meets annually and leads targeted conservation efforts, including the creation of standardized protocols for surveys and relocations associated with project permitting in rivers, lakes, and reservoirs; and a certification test for unionid species ID. A current collaboration has begun to build a comprehensive mussel occurrence database to facilitate data gathering and distribution, and provide information needed for conservation and management decision making.

STATUS AND DISTRIBUTION OF UNIONIDAE IN THE LAURENTIAN GREAT LAKES WATERSHED: A COMPARATIVE ANALYSIS OF WISCONSIN AND MINNESOTA

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The Unionidae family in the Laurentian Great Lakes watershed of Wisconsin and Minnesota has faced significant challenges due to invasive species and habitat degradation. However, recent statewide monitoring efforts have revealed encouraging findings, including surprisingly abundant and diverse mussel populations in the Apostle Islands National Lakeshore and stable mussel beds in lower Green Bay. Conservation efforts are underway, with mussel-focused reintroductions and restoration actions in EPA designated Areas of Concern, as well as barrier removals allowing host fish to transport mussels into previously inaccessible river reaches. Despite these positive developments, the status of rare species remains a concern. In Wisconsin, the federally endangered snuffbox mussel (*Epioblasma triquetra*) now occupies only about 17% of its historic range in the Wolf River basin, and a recent dam failure on the Little Wolf River in 2024 has threatened one of its remaining strongholds. This presentation will provide a comprehensive overview of the current state of Unionidae in Wisconsin and Minnesota, highlighting ongoing conservation and restoration efforts for these vital underwater ecosystems.

INVASION DYNAMICS AND IMPACT OF NON-NATIVE MOLLUSCS IN THE GREAT LAKES

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Currently, 16 non-native mollusc species are known in the Great Lakes, including 14 exotics (introduced from other continents) and two native transplants (relocated by humans from other regions of North America). These species account for 52% of the diversity of all free-living non-native benthic invertebrates in the lakes. At least four exotic molluscs (*Bithynia tentaculata, Pisidium moitessierianum, P. amnicum*, and *Valvata piscinalis*) were introduced in the 19th century, all via shipping with solid ballast. In contrast, more recent introductions, including *Dreissena polymorpha, D. rostriformis bugensis, and Potamopyrgus antipodarum*, were primarily transported through ballast water. Sixty-two percent of all exotic molluscs in the Great Lakes were introduced from Eurasia, 19% from Asia, and one species from New Zealand. The population sizes of non-native species vary dramatically, ranging from nearly undetectable (e.g., Corbicula fluminea and Radix auricularia) to extremely high, with *D. r. bugensis* accounting for 95% of the total wet biomass of all planktonic and benthic invertebrates in the four lower Great Lakes. Non-native species diversity was highest in the shallowest Lake Erie, and lowest in Lake Huron. The ecological impact of exotic species in the Great Lakes is proportional to their biomass, ranging from negligible (e.g., all sphaeriids, *C. fluminea*, and *Radix auricularia*) to strong, as seen with *D. r. bugensis*, which has transformed entire ecosystems in the four lower Great Lakes. Ongoing and projected temperature increases will create more favorable conditions for species currently restricted by low temperatures (e.g., *C. fluminea*) and facilitate the introduction and expansion of new exotic molluscs, particularly from warmer regions of Europe and Asia, further accelerating ecosystem transformations.

ASSESSING PATTERNS OF FRESHWATER MUSSEL DISTRIBUTION UPSTREAM AND DOWNSTREAM OF TRIBUTARY CONFLUENCES IN THE LOWER GRAND RIVER, MICHIGAN

Grayson Kosak, Eric Snyder, Bill Flanagan

Conservation of unionids necessitates further understanding of relationships with specific watershed features such as tributary confluences. We employed semi-quantitative and quantitative survey methods alongside environmental sampling to investigate unionid occupancy, distribution, and assemblage structure upstream and downstream of tributary-mainstem confluences in the lower Grand River, Michigan. Our results show unionid density, richness, and diversity were greater upstream of confluences. No significant distance-gradient effects were observed. Assemblage structure differed between upstream and downstream reaches with downstream assemblage structure being more predictable, though overall species composition was similar. Environmental modeling found water depth, benthic velocity, woody debris coverage, algae/macrophyte coverage, percent sand composition, temperature, dissolved oxygen, C. fluminea density, and soluble reactive phosphorus as important predictor variables of unionid distribution at confluences. Overall, tributary confluences represent complex and dynamic areas that are influenced by a variety of watershed and local level influences yet may support robust mussel assemblages where suitable conditions are present. Unionid distribution within tributary confluence effects is patchy and determined by localized habitat stability rather than longitudinal patterns. These findings underscore the importance of stable microhabitats and influences of local and watershed level characteristics on unionid assemblage success within the watershed.

MAPPING HABITAT SUITABILITY FOR NATIVE FRESHWATER MUSSELS ACROSS THE GREAT PLAINS

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Native freshwater mussels are cryptic and sedentary animals associated with beneficial ecosystem services but are experiencing unprecedented rates of decline due to environmental and anthropogenic factors. With the decline in populations and mussel diversity, identifying suitable habitats in Great Plains states is key to their recovery. State agencies must identify critical areas with high habitat suitability to look for existing populations and identify possible reintroduction locations. Conventional survey methods to detect mussel presence statewide are not ideal due to labor intensity and potential false negatives when mussels are buried. Habitat suitability models can help focus survey efforts and thus benefit to state agencies seeking to conserve mussels. Information on mussel distributions is limited in many Great Plains states and so mussel host fish are often used as surrogate indicators of habitat suitability. The objective of this study is to develop freshwater mussel habitat suitability models using host fish distribution data for rivers and streams in South Dakota. Models will be based on presence-only information, indicating the survivability and qualities of habitats for host fish. Model output is expected to identify waterbodies with high, moderate, and low habitat suitability based on the presence of fish hosts and landscape variables (temperature, flow, substrate, anthropogenic influence and others). Results of the habitat suitability models will be used to survey, propagate, and reintroduce native freshwater mussels while furthering foundational knowledge of Species of Greatest Conservation Need within this state. With the help of habitat suitability modeling, we intend to identify and direct limited resources to priority waterways for future surveying, monitoring, and reintroduction efforts in South Dakota and neighboring states.

EFFECTS OF HYDROLOGIC CONNECTIVITY AND LOCAL FACTORS ON FRESHWATER MUSSEL OCCUPANCY IN OFF-CHANNEL HABITATS

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Freshwater mussels are among the most imperiled aquatic taxa in North America, playing a critical role in ecosystem functioning. Freshwater mussel declines are primarily driven by anthropogenic alterations such as habitat degradation and stream fragmentation. Although much research has focused on the direct effects of riverine alterations on mussel populations, off-channel habitats like wetlands and floodplains, are also impacted by these changes. Lateral fragmentation of river systems can disconnect off-channel habitats, affecting mussel colonization and survival due to reduced connectivity, altered water quality, and disruptions to fish migration. The Great Plains region, characterized by its variable climate and extensive agricultural land use, faces significant hydrologic alterations, particularly disconnection of rivers to floodplain habitats, which threaten mussel populations in off-channel habitats. This study combines existing landscape data with field observations to quantify which habitat and landscape factors influence freshwater mussel occupancy in off-channel habitats including substrate type, water depth, land cover, and distance from river channels. We hypothesized a negative relationship between distance from the closest fifth order river and mussel occupancy and a positive relationship with habitat area. Preliminary data analysis supported our first hypothesis, but habitat area had no association with occupancy. Our findings will provide insights into the role of off channel habitats in mussel conservation and are a first step towards identifying management strategies to mitigate the impacts of habitat fragmentation and flow alteration.

DISTRIBUTION AND ECOLOGICAL ASSOCIATIONS AMONG TWO SPECIES OF NATIVE MUSSELS (*GONIDEA ANGULATA* AND *MARGARITIFERA FALCATA*) AND ONE INVASIVE CLAM SPECIES (*CORBICULA FLUMINEA*) IN THE COLUMBIA RIVER BASIN

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Native freshwater mussels are in decline globally. In the Columbia River Basin, USA, *Gonidea angulata* (western ridged mussel) are highly threatened and *Margaritifera falcata* (western pearlshell) are more common, as are the invasive clam *Corbicula fluminea* (Asian clam). Assessments of the distribution, abundance, and ecological associations of these bivalves are critical to native mussel conservation and invasive clam mitigation. We conducted 147 snorkel surveys and collected environmental data to populate a set of generalized linear mixed-effects models. Variation in G. angulata presence and/or abundance were best explained by impervious surface proportions and maximum annual air temperatures. *Margaritifera falcata* presence and/or abundance were best explained by host fish presence, dissolved oxygen, and elevation. *Corbicula fluminea* presence and/or abundance were best explained by substrate size and mean annual air temperatures. Microhabitat and landscape variables explained some variation in bivalve presence and abundance, but the inclusion of watershed as a random effect increased explanatory value. Consideration of species-specific habitat preferences and watershed-level variation could improve regional management in response to broad-scale native mussel declines and invasive clam expansion.

INVESTIGATING THE IMPACTS OF PARAFFIN DIPPING ON THE δ13C AND δ15N VALUES OF FRESHWATER MUSSEL PERIOSTRACUM

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Identifying historical and modern diets of freshwater mussels (Unionida) help protect food resources critical to imperiled populations. Unfortunately, direct observation of freshwater mussel feeding is challenging, resulting in limited dietary data for both modern and historical populations. Stable isotopes of shell periostracum are a useful proxy for reconstructing unionid diets and can provide information for recent and historically-collected museum specimens. However, some historical curatorial practices, such as coating shells in paraffin wax using a paraffin-xylene solution, may obscure a shell's original isotope values. Here, we investigated the isotopic impacts of paraffin wax dipping and removal on periostracum δ13C and δ15N values. We conducted three tests, each using five shells of both Lampsilis siliquoidea and *Obliquaria reflexa*. In all tests, we sampled periostracum from the 5th growth year, which is generally thick and easy to sample. The first two tests evaluated the isotopic impact of shell periostracum being dipped in solutions of either (1) paraffin-xylene or (2) xylene-only. In both cases, we dipped only half the shells, with the undipped halves serving as experimental controls. In the third test, we evaluated the efficacy of five repeated xylene rinses for removing paraffin and tested for impacts to δ13C and δ15N values of dipped vs. dipped-and-rinsed periostracum. We found that paraffin dipping had no significant impact on periostracum δ13C and δ15N values. However, we found small (but significant) changes in δ13C values of L. silquoidea and δ15N values of O. reflexa after dipping shells in xylene. Following paraffin-dipping, we also found that xylene-rises altered periostracum δ13C and δ15N values of O. reflexa, but not L. siliquoidea. Fortunately, in all cases that we found statistical shifts, the magnitude of these changes were smaller than previously reported intra-annual variation in periostracum δ13C and δ15N. Thus, paraffin-coated shells may still be useful for assessing meaningful dietary information from historical unionid specimens.

VIRTUAL: ASSESSING THE LETHAL EFFECTS OF GRANULAR BAYLUSCIDE ON THE EARLY LIFE STAGES OF A FRESHWATER MUSSEL

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Effective control of invasive sea lamprey (*Petromyzon marinus*) populations relies heavily on lampricides, but few studies have investigated the impacts of granular Bayluscide® (gB) on benthic dwelling organisms. Native freshwater mussels are present in many similar habitats that larval sea lamprey prefer, making them susceptible to non-target effects. The active ingredient of gB, niclosamide, was derived specifically as a molluscicide, therefore it is crucial to understand its impacts on a group of mollusks that have been imperiled due to many factors including the input of contaminants in the aquatic environment. Two early life stages of *Lampsilis siliquoidea* were tested in 7-day exposures to gB. Mortality was significant in both sub-adult and newly metamorphosed mussels. Tests with sub-adults generated an LC50 of 1.14% (0.72 – 1.57) of the suggested application rate after 7 days of exposure. Sub-adults were left to depurate in clean water, and the majority of mussels that survived exposure survived the depuration phase. Newly metamorphosed mussels were significantly more sensitive to gB applications, with effects seen at less than 1% of the suggested application rate. A significant decrease in mussel growth was seen at 0.78% of the suggested application rate, although no effect concentration could be generated. A 24-hour test was supplemented due to gB potency, revealing a similar LC50 of 0.67% (0.55 – 0.79) of the suggested gB application rate. This suggests that newly metamorphosed mortality occurs very quickly after gB exposure. Both early life stages of L. siliquoidea showed a sensitivity to gB. Although environmental conditions may have an influence on gB fate, the marked sensitivity of early life stages demonstrated in this study is crucial to understanding the effects of sustained gB application on the population dynamics of freshwater mussels.

VIRTUAL: ADVERSE EFFECTS OF GRANULAR BAYLUSCIDE(R) EXPOSURE ON ADULT WASHBOARD MUSSELS (*MEGALONAIAS NERVOSA*)

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The introduction of invasive sea lamprey (*Petromyzon marinus*) to the Laurentian Great Lakes has caused a variety of economic and ecological problems due to their parasitism of native fish species. Various control measures have been implemented to decrease the sea lamprey population in the Great Lakes, with the integration of lampricides in the late 1950's as one of the most effective methods. However, the lampricides could pose a risk to non-target organisms, such as native freshwater mussels, that reside in areas overlapping application sites. To determine the response of mussels to this chemical, adult washboard mussels (*Megalonaias nervosa*) were exposed to varying application rates of granular Bayluscide® (ranging from 6.25% to 200% of the application rate) for 7 days to determine an application rate that would cause 50% mortality (LC50). Although no mortalities were observed in the application rates of 6.25%, there were lethal effects in all other application rates. The LC50 determined from the experiment was 0.67 kg/hectare, which is below the suggested application rate of 5.6 kg/hectare. In addition, a scope for growth experiment was performed to measure physiological effects (oxygen consumption, clearance rate, and food absorption efficiency) following 24 hours of exposure equivalent to the application rate suggested for control of juvenile sea lamprey. There was no significant difference between the scope for growth of unexposed and exposed mussels, but behavioural changes were clearly observed in the mussels exposed to granular Bayluscide®. Our results suggest that adult washboard mussels may be adversely affected when exposed to granular Bayluscide® at application rates suggested for control of larval sea lamprey.

TAXONOMIC, SPATIAL, AND TEMPORAL VARIATION IN ELEMENTAL COMPOSITION OF FRESHWATER MUSSEL SHELLS AND EXTRAPALLIAL FLUID FROM THE UPPER OHIO RIVER WATERSHED, PENNSYLVANIA, USA

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Freshwater mussels are sedentary animals that continuously mineralize a carbonate shell, potentially preserving a multi-decadal chemical record of stream chemistry and mussel health. Shell production in freshwater mussels requires significant energy resources, and thus the chemistry of extrapallial fluid from which the shell is mineralized may also provide clues about mussel health and bioavailability of toxic metals. However, the relationships between stream chemistry, biological factors, and shell/extrapallial fluid composition are poorly understood, making interpretations difficult. Our objectives were to: 1) determine the extent to which species and stream location controlled the chemical composition of shells and extrapallial fluid; 2) assess patterns of elemental distribution in shells and extrapallial fluid, and 3) evaluate shell composition changes over time. We measured Ca, Ba, Sr, Mn, P, K, Na, Zn, Ni, Cd, Mg, Fe, and Pb in the shells and extrapallial fluid of 8 species (*P. alatus, A. ligamentina, A. plicata, L. recta, O. reflexa, F. flava, D. polymorpha, C. fluminea*), including river water and sediment porewater. Mussels represent 6 stream locations in the upper Ohio River watershed. To evaluate a range of typical stream environments, sites include locations considered 'unpolluted', as well as locations impacted by urban pollution, navigation dams, and flood control reservoirs. Additionally, we analyzed historical *A. ligamentina* shells from this watershed using museum collections, representing years 1880-2023. Preliminary results demonstrate that concentrations of most elements in both extrapallial fluid and shells vary significantly with species and location. *P. alatus*, for example, had significantly lower concentrations of both Cu and Zn in extrapallial fluid, potentially reflecting its occurrence in habitats of greater silt content and slower current. However, this variation was not observed in *P. alatus* shells. We also found that elevated shell Mn is restricted to the order Unionida, and is not universal in freshwater aragonite shells.

ASSESSING SHORT AND LONG-TERM REDISTRIBUTION PATTERNS OF UNIONIDAE POPULATIONS POST-TRANSLOCATION

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The translocation of native freshwater mussel (Unionidae) assemblages is widely used as a conservation mitigation strategy across North America. These conservation translocations involve relocating mussels from areas slated for in-water infrastructure projects to unaffected sites immediately upstream. This practice is particularly common in southern Ontario, Canada, where unionid diversity is the highest in the country. However, post-translocation monitoring largely focuses on the survival and recovery of relocated mussels at 1-month, 1-year, and 2-year intervals, leaving significant gaps in understanding of how sites recover, in either case when infrastructure activities proceed according to plan and when they do not. To address this knowledge gap, we revisited and quantitatively surveyed sites where translocations had occurred and conducted an experimental translocation to track redistribution patterns over time. Our goal was to assess community-level and species-specific unionid redistribution across sites and translocation context (survey vs. experimental). Preliminary findings suggest among sites where infrastructure activities did not occur, mussels returned to the excavated areas almost immediately. However, long-term restablishment was minimal or absent in sites where infrastructure activities took place, suggesting physical habitat alterations may inhibit recovery. These findings have important implications for conservation decision-making and ecosystem restoration. In cases where infrastructure projects are delayed or canceled, understanding redistribution patterns can inform whether translocations should be repeated or more closely timed with construction activities. Additionally, the lack of long-term reestablishment in impacted sites raises concerns about the ability for ecosystems to fully recover, particularly when these habitats are known to support species at risk of extinction. By providing insight into the natural recovery of impacted sites, this study strengthens freshwater mussel conservation policy and management strategies.

RECRUITMENT AND HABITAT PREFERENCES OF FRESHWATER MUSSELS IN WESTERN NEW YORK STREAMS

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Native freshwater mussels (Unionidae) are a diverse and imperiled group of organisms with significant conservation value. The Tonawanda Creek basin has one of the most diverse assemblages of unionids in western New York. Previous surveys have been conducted in Tonawanda Creek and its tributaries to characterize this ecologically significant assemblage. However, most of these surveys were qualitative and do not provide density estimates. They are also less likely to detect juvenile mussels (< 20 mm in length), which may be more sensitive to certain stressors. To better understand the recruitment statuses and habitat preferences of mussel populations in western New York, we conducted quantitative mussel surveys at stream locations with known mussel presence. Additionally, we assessed habitat quality, including substrate type and water chemistry, to better understand the conditions required for successful mussel recruitment. We surveyed six sites across three creeks (Tonawanda, Ellicott, and Ransom Creeks) and detected 16 live mussel species and an additional 3 species as spent shells. While Tonawanda Creek itself accounted for the majority of this diversity, three of the live species were exclusively found in Ellicott Creek. Mussel densities ranged from 0.4 to 16.27 mussels/m2, and sites with higher percent fine sediment (> 50 %) and higher water hardness (> 480 CaCO3) had the lowest mussel densities. We detected recent recruitment at all but one of six sites. Our surveys show that most of the largest mussel beds in Tonawanda Creek and its tributaries have retained the majority of their diversity and are actively recruiting. However, declines in catch per unit effort and species richness could indicate that these populations remain vulnerable. By assessing the habitat preferences and recruitment statuses within a speciose mussel assemblage, these surveys will facilitate the conservation of this highly imperiled group of animals.

SURVEYS OF MID-MICHIGAN TRIBUTARIES CONSIDERING WATER BODY SIZE, HISTORIC DATA, AND RESURVEY INTERVALS.

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Surveys are crucial for tracking assemblage shifts, monitoring imperiled species, and providing data for conservation efforts. Reducing resurvey time interval is important to track changes in assemblages effectively. Our research objectives are to determine the current diversity and density of unionids in tributaries of the Tittabawassee River, Michigan and to compare our data to the limited historical data. We surveyed 40 sites and compared these data to historical data by looking at shifts in abundance and assemblage changes. In total, we found >1000 live unionids representing 16 species. This study found many species that were not found 40 years ago as well as loss of species at numerous sites. The density of mussels changed at all but 3 sites (which were sites that only shells were previously found). Every species changed in density in at least one site, with the most variation observed in Pyganodon grandis with density changes in 16 sites. In the smallest tributaries, notable differences in assemblages were observed. One small site had twice as many Alasmidonta viridis compared to all other sites. Another small site was the only river site with live Utterbackia imbecillis. We are developing a standardized index to compare current data with historic survey data. We will identify variables that could help explain these changes to unionid assemblages over time including known risks to unionids (e.g., land use and invasive species). We want to address the time intervals between surveys and suggest approaches to optimize survey intervals. We hope to better understand the dynamics of these assemblages over time, how frequently data should be updated, and how surveying the entire watershed, including waterbodies of various sizes, may fill data gaps. Surveys performed on a time scale based on empirical data will provide managers with guidance for targeted conservation efforts such as presence and health of protected species, assemblage shifts, and risk mitigation.

USING INTERNS AND VOLUNTEERS TO SURVEY NATIVE MUSSELS ON THREE MILES OF THE HURON RIVER, PRIOR TO THE REMOVAL OF THE PENINSULAR DAM IN YPSILANTI, MICHIGAN

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The removal of the Peninsular Dam in Ypsilanti, Michigan will affect approximately 4.8km (3mi) of the Huron River. As the dam is dismantled, the area will be impacted by hydrological changes, water drawdowns, and/or sediment releases. Areas of the river above and below the Peninsular Dam are considered Category 3 by the USFWS, where the federally listed snuffbox, *Epioblasma triquetra* and rayed bean, *Paetulunio fabalis*, may be found. As a cost savings, the Huron River Watershed Council (HRWC) coordinated interns and volunteers to survey the 2.4km (1.5mi) of the wadeable portion of the river downstream of the dam. Oversight was conducted by ASTI-Environmental to identify mussels and assure proper semi-quantitative and quantitative methods were followed. Professional biologists from OHM-Associates surveyed the areas of the river over 1.1m (3.5ft) and used semi-quantitative and quantitative methods in the Category 3 area upstream. A reconnaissance survey was conducted by divers in the reservoir area (not flagged for any listed species) to document mussel occurrences for salvage efforts when water drawdown begins. No federally listed species were found in the entire survey area. However, recruitment was recorded downstream of Peninsular dam for the state threatened purple wartyback, *Cyclonaias tuberculata*, the wavy-rayed lampmussel, *Lampsilis fasciola*, and the black sandshell, *Ligumia recta*. Overall densities were estimated as 0.64 mussels/m2. Below Superior Dam and upstream of the reservoir, densities were estimated to be 0.03 mussels/m2, and only the plain pocketbook, Lampsilis cardium showed recruitment. Eighty-three percent of the mussels recorded in the main reservoir upstream were white heelsplitters, Lasmigona complanata. Four previous surveys and one reconnaissance survey on the Huron River in Washtenaw County were assessed to determine future relocation sites. Relocation efforts are still being determined as dam removal plans are finalized. Future work for relocation in wadeable areas may also involve interns and volunteers.

STATUS OF FRESHWATER MUSSELS IN THE GRAND RIVER, MICHIGAN: ASSESSMENT OF THREATS AND OPPORTUNITIES FOR RESTORATION.

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The Grand River is Michigan's longest river (400 km) with the 2nd-largest watershed. Agriculture dominates the watershed (57%), while 25% remains forested; wetlands have been reduced over 50%. The lower Grand River is confined to a glacial-outwash valley in the middle of which is a 3 km-long high gradient (1 m/km) reach located in the so-named city of Grand Rapids. Within this social/cultural backdrop, management and policy decisions are made. To inform this policy framework, recent semi-quantitative surveys of the freshwater mussel community in the lower Grand River indicate a robust community (26 species total; 1 federally listed, 5 state listed as threatened or endangered, 7 species of special concern). Four species, pink and white heelsplitter (Lasmigona complanata and Potamilis alatus), paper pondshell (Utterbackia imbecillis), and lilliput (Toxoplasma parvum), were newly detected compared to surveys conducted in 2002-2003. Additionally, we documented increased site-level detection and density compared to 2002-2003. Planning for a trial propagation facility is underway. Concomitant research into the state-listed lake sturgeon (Acipenser fulvescens) indicates successful spawning and juvenile recruitment and ongoing efforts with sonar technology will enable direct counts of adult spawner population size. Finally, efforts to revitalize the river corridor in downtown Grand Rapids, including the removal of several low head 'beautification' dams and reconstruction of historic rapids has the potential to improve ecosystem services and basic ecology in the urban river reach. This multifaceted research points to a resilient river community. Informed decision-making will bolster ecosystem recovery.

UTILIZING 3D PRINTED SUBADULT MUSSELS IN COMPLEMENTARY FIELD AND FLUME STUDIES TO SUPPORT REINTRODUCTIONS IN AN URBAN RIVER

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Freshwater mussels were once common in the southern and eastern United States, but habitat degradation and shifting climates have greatly reduced their numbers and in some cases extirpated them from these waterways. As a result, mussel habitat is very patchy across rivers, making it difficult to predict presence and estimate appropriate reintroduction locations. This is especially true for subadult mussels, which are small and hard to detect during routine surveys. To address this challenge, we have developed a framework for assessing subadult mussel habitat suitability that integrates flume experiments, an intensive field study, and 2D hydraulic modeling. For the field study, we imbedded 3-D printed mussels with PIT tags in the river and tracked their displacement over two field seasons. The printed mussels were also used in a flume study to determine subadult mussel displacement thresholds for different bed sediment and mussel sizes. These field and flume study results were then compared to 2D hydraulic model outputs to provide stakeholders with map-based habitat suitability assessments to inform reintroduction and restoration efforts. The framework is applied to an urban, restored reach in the San Antonio River, Texas, USA, where the local river authority is actively working towards reintroducing freshwater mussels into the river. The results from this study will provide river managers with tools to assess reintroduction locations and to inform future restoration projects with subadult freshwater mussel suitable habitat requirements in mind.

MULTISCALE OCCUPANCY PATTERNS OF TEXAS FAWNSFOOT (TRUNCILLA MACRODON) POPULATIONS IN THE BRAZOS RIVER BASIN

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Identifying key processes that regulate species distributions has been a difficult task for organisms within hierarchical systems, such as riverine unionids, because patterns can emerge from several processes operating at multiple scales. Further, data used for such tasks are seldom collected without error due to the imperfect detection of individuals during sampling, which can bias inferences about ecological relationships or true population states for species of interest. As part of a conservation agreement sponsored by the Brazos River Authority, we formulated hierarchical models that accounted for detectability to investigate patterns in multiscale occupancy for Texas Fawnsfoot populations in the Brazos River drainage of Texas. Mussel sampling was conducted from 2023–2024 in three sub-basins using a spatially nested design. In each sub-basin, we sampled multiple river segments with three to four sites per segment, three mesohabitats per site, and four spatially replicated transects per mesohabitat. We analyzed our models under a Bayesian framework to estimate site- and mesohabitat-occupancy as a function of covariates at broad and local scales, respectively. Our best supported model estimated a higher proportion of sites occupied within each sub-basin than portrayed by observed data alone. Site-occupancy was negatively associated with cumulative kilometers of stream length upstream and positively associated with 10-year minimum river discharge, suggesting segments that were lower in the river network or experienced more extreme low flows were less suitable for Texas Fawnsfoot. Mesohabitat occupancy illustrated a quadratic relationship with near-bed flow turbulence, maximized at an intermediate optimum, and was positively associated with percent cobble. This indicated a strong link to fluvial habitats with moderate near-bed turbulence and larger stabilizing substrates. In summary, our findings demonstrated the utility of integrating multiscale approaches with models that correct for detectability to better understand, monitor, and manage unionid populations.

SPECIES DISTRIBUTION MODELING REVEALS SALINITY CONCENTRATION AS A MAJOR DRIVER OF PRESENCE FOR THE ESTUARINE BIVALVE RANGIA CUNEATA (ORDER VENERIDA)

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Coastal estuaries are an important aquatic ecosystem, functioning as an ecotone between freshwater and marine regions. Estuaries are expected to face extreme pressure in the near future, as climate change and its effects continue to worsen. Saltwater intrusion describes a process in which the salinity gradients of an estuary are forcibly shifted inland, which can introduce many environmental stressors to sensitive species. Estuarine bivalves provide many ecosystem benefits, such as improving water clarity and enhancing nutrient cycling; however, their largely sedentary lifestyle also imposes greater vulnerability to such stressors. Rangia cuneata (Atlantic rangia), a bivalve native to the Gulf of Mexico, is adapted to low salinities – and is therefore distributed across the upper regions of estuaries where salinity remains low (including freshwater). R. cuneata relies heavily on these conditions for physiological functions, so quantifying the degree to which these parameters drive distribution patterns could be vital to building management strategies in the future. The goal of this study was to (1) examine distribution changes of R. cuneata over time in relation to five abiotic variables (salinity, temperature, depth, pH, and dissolved oxygen); and (2) to determine the species' potential vulnerability to imminent saltwater intrusion. Using a "presence" dataset of three Texas riverine estuaries (San Antonio/Guadalupe Bays and Sabine Lake) between 1990-2023. MaxEnt species distribution models (SDMs) were produced and compared across three decades. These models revealed that salinity was the best predictor for variation in presence of R. cuneata, the predictability based on salinity increased from 57 to 65% after 2000, while suitable habitat area diminished and shifted farther inland. This corroborates prior research demonstrating the necessity of low salinity regions for maintaining R. cuneata populations. Considering R. cuneata and other similar estuarine species, these models demonstrate their vulnerability and potential need for future conservation actions.

EXAMINING THE DISTRIBUTION OF MUSSELS IN POOLS AND RIFFLES OF THE SAN SABA RIVER

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Unionid mussels are known to have a patchy distribution, and a range of factors may affect their distribution such as shear stress and host fish range. Yet the relative importance of these factors at different spatial scales, mesohabitats (i.e., pools and riffles) and microhabitats (small scale differences (<1m) in velocity, depth, substrate, and aquatic vegetation coverage) are often not well understood. A previous study in the San Saba River (Texas, USA) found distinctive communities in the upper vs. the lower section of the river, and pools and riffles were found to have different community compositions. The goal of this study was to use a fine-scale approach to examine the distribution of mussels within and between mesohabitats in a one kilometer stretch in the lower and a 300-meter stretch in the Upper San Saba River. Preliminary results of timed searches every five to ten meters suggest that pools and riffles may not always have distinctive communities. Notably, typical riffle species tended to be abundant in the most upstream part of a pool immediately after a riffle. This could be due to the mussels being washed out during a flooding event or mussels crawling into the pools during drying events. Quantitative surveys will be conducted this summer to examine how environmental differences (shear stress, depth, etc.) may be linked to spatial distribution patterns of mussels. At the microhabitat scale, residency times of host fish in areas with high vs. low mussel abundances will be compared in collaboration with the Riverscape Ecology Lab (Texas A&M).

FRESHWATER MUSSELS OF THE HATCHIE RIVER: DISTRIBUTION, COMPOSITION, AND ABUNDANCE

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Freshwater mussels are amongst the most imperiled faunal groups, but significant data gaps exist regarding their distribution and habitat requirements. In particular, West Tennessee (WT) has few historic mussel records, making conservation and restoration efforts in the area difficult. Further, the region's unique hydrology and habitat conditions have largely been altered by land use changes, channelization, and water control structures such as culverts and impoundments. Efforts in recent decades have attempted to restore streams in WT to a more natural state, but this restoration has not targeted freshwater mussel conservation. The Hatchie River, a 238-mile tributary to the Mississippi River, remains one of the least degraded WT rivers, escaping impoundment and much of the channelization that has occurred in the area. Historically serving as a home to over 30 species of freshwater mussels, the Hatchie River provides a unique opportunity to study a relatively unimpacted mussel assemblage and to determine what habitats are associated with mussel aggregations in WT. In collaboration with the West Tennessee River Basin Authority, Tennessee Tech University surveyed the Hatchie River to update the freshwater mussel species composition and distribution. In addition, the physical habitat and landscape features were modeled to describe characteristics associated with large mussel aggregations. Information gathered during this research will guide future restoration efforts and identify locations and methods that would most benefit mussels in the WT region.

FRESHWATER MUSSEL SURVEYS ON PENNSYLVANIA'S REDBANK CREEK SUGGEST ISSUES WITH AQUATIC CONNECTIVITY AND ACID MINE DRAINAGE ARE LIMITING RECOVERY

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The freshwater mussel community of Redbank Creek (Jefferson, Armstrong, and Clarion counties, Pennsylvania) was surveyed from 2020-2024 to determine the level of recovery since its defaunation in the early 1900s. Eleven species were detected across 36 sample sites, including three species of greatest conservation need as outlined in Pennsylvania's state wildlife action plan; however, large descrepancies exist in the mussel communities upstream and downstream of the New Bethlehem Dam, despite the presence of many suitable host fishes. Seven of the ten species found downstream of the dam were not found upstream. Species richness averaged 4.45 species per site downstream but only 1.25 upstream of the dam. Differences in the mussel communities on either side of the dam are likely the result of nearly two centuries of poor host-fish passage. Further efforts are needed to determine the effectiveness of the fish passage facility at the New Bethlehem Dam and to find a solution for any problems that may exist. Fewer mussels were found downstream of tributaries impaired by acid mine drainage, particularly in the vicinity of Summerville where metal precipitate clogs interstitial spaces, cementing substrate components together. This "cementing" of substrates makes penetration difficult, likely hindering burying behaviors and limiting colonization by freshwater mussels. Results of this study highlight the need for remediation of mine related acidic discharges and the importance of maintaining aquatic connectivity in recovering systems.

TESTING MUSSELS' EFFICIENCY AS A BIOREMEDIATION TOOL TO MITIGATE HEAVY METAL POLLUTION

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Experiments were performed to evaluate freshwater mussels' potential use as tools to reduce pollution in the frame of Horizon SYMBIOREM Project (ID 101060361) aimed at developing integrated bioremediation solutions capable of removing multiple pollutants at the same time. FMs were chosen for their ability to filter large volumes of water, removing suspended particles (phytoplankton, bacteria, viruses) and contributing to the sequestration and/or transformation of pollutants (e.g., heavy metals, pesticides, microplastics, pharmaceuticals). Since FMs can be effective in promoting plant growth and nutrient absorption within 'Constructed Wetlands' (an ecological engineering solution for removing and transforming pollutants from wastewater) SYMBIOREM aims to develop a floating wetland system with symbiotic cultivation of FMs suspended in the submerged rhizosphere to more efficiently biodegrade or accumulate nutrients and pollutants. Estimation of mussels' bioaccumulation capacity was done by comparing heavy metals concentrations in soft tissues and shells of a common species (*Unio elongatulus*) with a Southern European distribution range. A very convenient situation for this study was provided by the recent translocation of mussels of this species from Lake Maggiore (with low levels of metal contamination) to Lake Orta (with high metal contamination dating back to the last century), both located in northern Italy. To seize the opportunity of this natural laboratory, metal concentrations were compared between three populations of mussels: the donor population, the one translocated six years ago and the one that spontaneously recolonized around 2000. At the same time, the microbiota of the mussels of the 3 sites was analysed. Here we present the comparison of bioaccumulation in the soft tissues and shells of the mussels of the 3 populations as related to heavy metals levels the sediments of the 3 sampling sites.

ASSESSMENT OF CONTAMINANT IMPACTS ON FRESHWATER MUSSELS IN THE CONASAUGA RIVER

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Freshwater mussels are some of the most imperiled taxa in the world. Threats to mussel populations have been attributed to habitat degradation or loss from dams, pollution, and invasive species. These disturbances can be correlatively associated with declines, yet research has often lacked rigorous methods of testing for causative factors of enigmatic loss. We are using a combination of field and laboratory exposure trials to assess the effects of multiple contaminant stressors on freshwater mussel survival and growth in the Conasauga River, GA. We conducted substrate-exposure studies in the laboratory using sediment collected from throughout the watershed following established sediment toxicity test conditions. During the summer of 2024, sediments were collected in the Conasauga River at 13 sites representing a gradient of expected municipal and agricultural contamination and varying land use practices. Sediment exposures were performed on juvenile mussels (average start length ~1.5 mm) at the UGA's ABEL. Average survival across all sites and the control was 96% for a 28-day duration. Average percent change in length was +72%. Average percent change in weight was +435%. Using simple linear models we found that nitrogen and magnesium had a significant effect on the change in length and weight, and total organic carbon had a significant effect on weight. We deployed juvenile mussels in silos from May to September to assess responses to waterborne contaminants in situ. Average percent survival was 92% for a five-month duration. Average percent change in length for this trial was +28%. Using simple linear models with a quadratic term on chlorophyll we found that the interaction between chlorophyll and temperature had a significant effect on the change in length and that chlorophyll had a non-linear effect. This study could inform reintroduction and conservation efforts for freshwater mussels in the Conasauga River. Additionally, data collected will further our understanding of the role sediment and waterborne contaminants play in the decline of freshwater mussels.

PATTERNS IN CONTAMINANTS OF EMERGING CONCERN BASED ON UNIONID TISSUE, BIOFILM, WATER, AND SEDIMENTS IN A MIDWESTERN RIVER

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Contaminants of emerging concern (CECs) constitute a group of anthropogenic chemicals that are broadly unregulated, and therefore often go undetected in waterways and can impact aquatic life. In North America, CECs have been increasingly detected in the Laurentian Great Lakes and their tributaries. Unionids interact with multiple media, including water and the benthos that expose them to CECs. This study in the Chippewa River, Michigan USA we considered water, unionids, and the collective benthic environment (sediment and living biofilms). This reach of river, although surrounded by agriculture, flows through the City of Mt. Pleasant within the Lands of the Saginaw Chippewa Indian Tribe. Using a collaborative approach 5 sites were selected for CEC, habitat, and biotic surveys. More than 200 CECs that included pharmaceuticals and personal care products (PPCP), multi-residue pesticides (MRES), per- and polyfluoroalkyl substances (PFAS), and hormones were tested for in all four media types. CECs were found in complex mixtures in all media types with > 100 CECs being detected in this study with a core of 13 CECs detected in all 4 media types across sites. PPCPs showed trends of increasing in detection at downstream sites, whereas MRES were found throughout the sampling sites. Unionid and biofilm assemblages were complex, but an assemblage shift toward more tolerant taxa was observed in both taxon groups downstream, while maintaining biomass, throughout the study reach. Surrounding land-use (e.g., road density, urbanization, and agriculture) were correlated with many of the results of the CEC signatures in this study. These data are the first of their kind for the region and provide a baseline for understanding CECs. Managers of the river can use these data to target detected CECs and known distribution of unionids and biofilms in management strategies for a healthier river.

SYSTEMATICS OF THE CRITICALLY IMPERILED PLEUROCERID GENUS LITHASIA

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Widespread anthropogenic stress in the southeastern United States, particularly in the Tennessee and Mobile River drainages, has severely declined aquatic species diversity. This decline coincides with an increased need to conserve remaining diversity. However, modern systematic reviews have not been done for many freshwater groups, which often hinders effective conservation planning because species boundaries are poorly defined. *Lithasia* is an imperiled freshwater pleurocerid snail genus composed of 15 currently recognized species distributed throughout the Ohio, Mississippi, Cumberland, and Tennessee River drainages. Taxonomic classifications of *Lithasia* have been predominantly based on shell morphology, which originally resulted in 30 nominal species. However, current species-level classification is based on vague shell characteristics and past research has indicated that at least two unrecognized species exist. Moreover, relationships among species are unclear. Our goal was to generate a robust phylogenetic framework for the genus *Lithasia* that can be used for taxonomic revisions and to re-evaluate the conversation status of each *Lithasia* species. Using the 3RAD restriction-site associated DNA sequencing approach, we generated genome-scale data and a molecular phylogeny of *Lithasia* with representatives of each currently recognized species of *Lithasia*. Samples from populations historically considered subspecies and potentially undescribed species were also collected to evaluate their taxonomic status. We inferred relationships among species using maximum likelihood, species tree inference, and network-based approaches. Our results show that under the current taxonomy, multiple recognized species were recovered as non-monophyletic. As such, several unrecognized lineages exist within the Cumberland and Tennessee River drainages. Species-level taxonomic revisions are needed within Lithasia. As a byproduct, the historical and current range of numerous species will be more restricted, which will require new conservation assessments for most *Lithasia* species.

POPULATION STRUCTURE OF THE ENDEMIC AND FEDERALLY THREATENED PAINTED ROCKSNAIL, LEPTOXIS COOSAENSIS

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Effective conservation requires population-level data so management actions can be planned and evaluated. Unfortunately, such data are lacking for most freshwater gastropods, including those in the highly imperiled Pleuroceridae. The Painted Rocksnail (*Leptoxis coosaensis*) is a federally listed pleurocerid that was historically found in many locations throughout the middle to upper Coosa River drainage in Alabama. Unfortunately, extensive construction of impoundments in the Coosa River caused a range reduction exceeding 97% loss. Currently, *L. coosaensis* is only found in small stretches of Choccolocco Creek, Buxahatchee Creek extending into Watson Creek, Ohatchee Creek, and in the Coosa River below Logan Martin Dam. To generate baseline genomic data and to model population dynamics, approximately 20 *L. coosaensis* individuals were collected from all remaining populations. Genomic data were generated utilizing a 2bRAD approach. Population genomic analyses revealed a unique genetic population at each of the four collection sites. High genetic diversity and negative inbreeding coefficients were also documented for each population. This suggests genetic diversity is being maintained in remaining *L. coosaensis* populations, despite a substantial range-wide decline. However, our results suggest that extirpated sites would have also held unique genetic populations, suggesting considerable evolutionary potential within *L. coosaensis* was lost. To ensure additional evolutionary potential is not lost, remaining populations must be protected. Captive propagation and reintroduction should also be considered, and our data should be used as a baseline metric for evaluating whether such programs are successful in generating captively reared cohorts with a suitable amount of genetic diversity. We recommend 1) management of *L. coosaensis* as four distinct units, 2) close monitoring of remaining populations to ensure more evolutionary potential is not lost, and 3) consideration of captive propagation and reintroduction to meet federal recovery objectives.

THE MUSEUM OF FLUVIATILE MOLLUSKS AND HERBERT D. ATHEARN

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“The Museum of Fluviatile Mollusks” was the name Herbert D. Athearn (1923-2011) used for his primarily freshwater mollusk collection. He was an avid student of freshwater mollusks. His private shell collection was meticulously organized and stored in cabinets built into his home, consisting of approximately 900 drawers containing the freshwater mussel collection, 138 shoeboxes containing the gastropod collection, 10 boxes containing the fingernail clam collection, and an additional 52 boxes of unprocessed collections. This collection was curated at current museum standards with detailed labels; all lots had catalog numbers; and all unionoid valves had catalog numbers written on the shells in India ink. Specimens were collected between 1850 and 2005, with 23,344 cataloged lots containing over 3,000 lots of imperiled and extinct taxa. Many lots contain growth series from the smallest juveniles to the largest specimens. He traded extensively with collectors worldwide, obtaining specimens from 84 countries. Specimens were collected from numerous waterways about to be inundated by a dam to create a reservoir, and from sites that today do not possess any molluscan species. It was donated in 2007 to the North Carolina Museum of Natural Sciences, Raleigh, North Carolina. Approximately 60 percent has been databased, totaling over 585,000 specimens. It largely consists of freshwater bivalves, primarily Unionidae, Margaritiferidae, and Sphaeriidae, and gastropods, represented by 20 freshwater families, with the greatest abundance representing the freshwater Pleuroceridae. The Athearn collection donation included his correspondence, library, field journals, and USGS topographic maps with marked field localities.

SAVING MUSSELS FROM EXTINCTION: HOW AZA SAFE NORTH AMERICAN FRESHWATER MUSSEL WANTS TO STRENGTHEN THE ROLE OF ZOOS AND AQUARIUMS

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On a global scale, North America is the major hotspot for freshwater mussel diversity, yet freshwater mussels – as elsewhere – are under threat. Of the around 300 species native to the US and Canada, 94 species are currently listed as endangered or threatened on the Endangered Species Act (ESA) and twelve species are listed as Endangered or Threatened via the Species at Risk Act in Canada. The IUCN Red List of Threatened Species currently lists 92 of 209 freshwater mussel species (44%) assessed on the IUCN Red List are threatened with extinction (Critically Endangered, Endangered or Vulnerable), with another 32 listed as Near Threatened.

Several Association of Zoos and Aquariums (AZA) organizations are actively involved in freshwater mussel conservation, from advocacy to propagation and field conservation and on to communication and outreach to the millions of visitors these institutions draw annually. AZA's Saving Animals From Extinction (SAFE) programs focus the collective expertise within AZA institutions and leverages their massive audiences to save species. A North American Freshwater Mussel SAFE program within AZA was established in 2023, to support ongoing conservation efforts of these imperiled yet vitally important freshwater organisms.

Here, we introduce our first three-year program plan, in the hope to connect the program to additional partners outside of AZA. Such partnerships and networks are vital in increasing capacity for freshwater mussel conservation across all sectors, for improving the messaging around freshwater mussels in zoos and aquariums, and increase advocacy for these often overlooked species.

A MULTI-FACETED APPROACH TO MOLLUSK CONSERVATION AT THE TENNESSEE AQUARIUM

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The Tennessee Aquarium (Aquarium) and the Tennessee Aquarium Conservation Institute (TNACI) are located along the banks of the Tennessee River in Chattanooga, Tennessee. TNACI is the research branch of the Aquarium and works to educate and inspire wonder of the natural world and to fulfill the Aquarium's mission to connect people with nature and empower them to make informed decisions about water and wildlife. The Aquarium and TNACI are utilizing multiple pathways to contribute to the conservation of freshwater mollusks including land management, host fish propagation, and education. TNACI staff work collaboratively to recover and prevent the extinction of the Laurel Dace and freshwater mollusks through a Regional Conservation Partnership Program through the U.S. Department of Agriculture to assist farmers and landowners in implementing conservation and best-management practices on their land. Early results demonstrate the program's potential to drive meaningful, on-the-ground conservation efforts in an area crucial to national freshwater mussel biodiversity. TNACI staff also propagate several fish hosts for rare mussel propagation and reintroduction programs. Additionally, Aquarium staff are working with the Association of Zoos and Aquariums on a collaborative North American Freshwater Mussel SAFE (Saving Animals From Extinction) program to target educational programs for the public. Current involvement includes a new exhibit in an Aquarium gallery, Ridges to Rivers, that highlights the importance of freshwater mussels.

WE LOVE BIODIVERSITY, BUT WHAT ABOUT DIVERSITY, EQUITY, & INCLUSION? RESULTS FROM DEMOGRAPHIC SURVEYS, 2022-2024

Sara Craft, Kentucky Division of Water

Inclusion and belonging of individuals from historically underrepresented groups is a goal of many professional societies, including FMCS. One responsibility of the FMCS Diversity, Equity, and Inclusion (DEI) committee is to monitor demographic trends and attitudes toward DEI initiatives through a survey distributed every two years. After a pilot survey in 2020, the Committee began distributing a standardized, repeated survey which has now collected responses during 2022 and 2024. The survey included 9 demographic questions, 14 questions regarding perceptions and experiences with FMCS, and one optional opportunity for comments. Survey results were summarized and compared between 2022 and 2024.

Response rate between the two surveys was similar, as were many results. As in 2022, survey participants were overwhelmingly white, highly educated, and well-established in their field. Some racial and ethnic groups were represented by survey participants in 2024 which were not identified in 2022. Overall, attitudes towards DEI content and perceptions of FMCS and the DEI committee remained largely similar between surveys. Most participants reported positive feelings towards DEI content and the overall culture of FMCS. However, when it came to a personal capacity for advancement within the society, awareness of existing code of conduct policies, and trust in leadership to handle issues related to discrimination at FMCS events, many participants were unsure. Notably, participants who reported experiencing or witnessing an instance of discrimination at an FMCS event rose from 3% in the 2022 survey to 9% in the 2024 survey. Numerous thoughtful comments in favor of and against DEI initiatives were received. The survey will continue to repeat every 2 years, and the DEI committee continues to work towards meeting the needs of all members.

THE ART OF MUSSELS: PUBLIC ART AS A FORM OF SCIENTIFIC COMMUNICATION

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Limited public awareness is the second biggest challenge faced by freshwater mussel managers, secondary only to limited funding. Increasing public awareness about the existence and value of freshwater mussels can foster support for their conservation. Public art installations may be an effective method of scientific communication because they reach a large audience of people through an emotional and personal lens, are not intellectually demanding to interface with, and are eye-catching. We are creating a mural depicting the ecosystem services provided by freshwater mussels to promote awareness of the freshwater mussels of Maine. This mural will be developed by art and ecology university students, high school students, and public volunteers who will learn about freshwater mussels and jointly create the socially-engaged art piece. This mural will be in a public park in Bangor, Maine and will have informational panels to provide detail on the intricate roles mussels play in our river ecosystems. We will discuss the potential benefits and challenges of art-science collaborations, the process of relationship building and co-learning in the creation of this mural, and best practices for using public art as a form of scientific communication. The mural, and the community's engagement with it, will showcase the power of public arts to communicate science and increase awareness of these imperiled and important taxa.

VIRTUAL: GROWTH CHARACTERISTICS OF NATIVE FRESHWATER MUSSELS IN THE UPPER MISSISSIPPI RIVER SUPPORT VARIED RESILIENCE FOR SOME SPECIES

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Growth characteristics such as size and age at maturity can influence population resiliency by increasing fecundity. In native freshwater mussels, size at maturity is variable, fecundity increases with size, and age at maturity decreases with the speed at which an individual reaches its asymptotic length (*K*). Thus, populations that reach larger body sizes faster could be more resilient. Our objective was to estimate asymptotic size (L_{inf}) and growth coefficient (*K*) to quantify variation in population growth characteristics in mussels that could influence fecundity. We used external age and length from 3230 individuals (17 species) systematically sampled from six navigation pools of the upper Mississippi River to estimate growth characteristics. Growth characteristics differed significantly across pools for *Amblema plicata*, *Fusconaia flava*, *Obliquaria reflexa*, and *Pustulosa pustulosa*. For example, an 80-mm *A. plicata* in Pool 18 reached larger sizes faster (median, 90th credible interval L_{inf} = 114 mm, 107-122 mm; *K* = 0.12 y^{-1}, 0.10-0.14 y^{-1}) than an 80-mm *A. plicata* in Pool 8 (L_{inf} = 99 mm, 95-105 mm; *K* = 0.09 y^{-1}, 0.08-0.11 y^{-1}). These age-at-length estimates indicate that the average *A. plicata* in Pool 18 likely matured sooner and reached 80% of its asymptotic size (when fecundity starts to plateau) 4.5 years earlier than the average *A. plicata* in Pool 8, which would be smaller and still growing, and its fecundity would not have yet plateaued. Growth characteristics were unrelated to the intensity of zebra mussel infestation but were related to density of other native mussels—Mussels reached a larger size more quickly in pools with higher densities of native mussels. Differences in asymptotic size and age at maturity (proxied by *K*) across pools indicate differences in a population's ability to respond to changing environmental conditions and could be informative when designing ecosystem restoration projects.

EVALUATING STRIPED BASS AS A HOST FOR YELLOW LAMPMUSSEL (LAMPSILIS CARIOSA)

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Host fishes are essential to understanding freshwater mussel distributions and suitable environments; they are the primary method of long-range dispersal for these sedentary animals and are required for reproduction. Only a few host fishes have been identified for the vulnerable Yellow Lampmussel (*Lampsilis cariosa*), and only two of these have been confirmed through both laboratory trials and examination of wild-caught fish: White Perch (*Morone americana*) and Yellow Perch (*Perca flavescens*). Striped Bass (*Morone saxatilis*) is an anadromous species that co-occurs with Yellow Lampmussel during the reproductive season and is a close relative to White Perch, suggesting it might be a suitable and ecologically-relevant host fish for this mussel. To evaluate Striped Bass as a host for Yellow Lampmussel, we 1) confirmed the ability of juvenile mussels to successfully metamorphose in laboratory experiments and 2) described the use of Striped Bass by mussels in native environments by extracting glochidia from wild-caught fish. For objective 1, we inoculated 205 Striped Bass with glochidia from three female Yellow Lampmussel, and counted juveniles produced over four weeks. In total, 282 juveniles were produced using Striped Bass, confirming successful metamorphosis. For objective 2, we collected glochidia from the gills and fins of 11 wild fish species in 2 rivers where Yellow Lampmussel were found. These glochidia were initially identified using morphometrics and then verified using DNA amplicon sequencing. Preliminary results suggest that Striped Bass are hosts for Yellow Lampmussel, although their ecological importance depends on spatial and temporal overlap of the species during glochidia availability. This study highlights the value of using both laboratory trials and wild fish examinations to determine potential host fishes for freshwater mussels. Our results suggest that Striped Bass may play a critical role in long-distance dispersal Yellow Lampmussel within and across drainages, which has important implications for conservation and management of both species.

DETERMINATION OF FRESHWATER MUSSEL HOST USE THROUGH GENETIC BARCODING OF JUVENILE MUSSELS METAMORPHOSED ON NATURALLY INFESTED FISHES

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Currently, host fishes are unknown for 43% of mussel species in Florida, including 25% of federally listed species despite host fish identification being a research priority in federal recovery plan documents. Traditional host trials, where fish are artificially inoculated with glochidia from a single mussel species, are labor-intensive and may be confounded by laboratory effects. A more pertinent and robust approach to determining host fish use in nature is assessing natural infestations on fish. Natural host infestation trials can help support inferences determined through traditional laboratory trials, while also helping to: further the understanding of host use in the wild, fill data gaps on concurrent infestation by multiple mussel species, and detect mussel species in areas where these species have not been observed through traditional mussel surveys or in localities where populations are presumed to be extirpated. To help evaluate ecologically significant host use in Florida, independent flow-through aquatic Z-HAB housing systems will be established at field laboratories across the state. Fish will be collected from targeted river basins, and each individual will be placed in a separate aquatic habitat which will have a filter cup placed at the outflow to collect any metamorphosed juvenile mussels. DNA will be extracted from collected mussels through a short incubation in lysis solution followed by a neutralizing buffer. DNA identifications will be determined through PCR amplification and bi-directional DNA sequencing of the Cytochrome Oxidase I (COI) mitochondrial gene. Raw sequence data will be validated and compared with an established USGS dataset of freshwater mussel reference sequences to identify each juvenile mussel. Genetically identifying juvenile mussels metamorphosed from naturally infested host fishes will help facilitate investigations into the coevolution of mussels and their hosts.

INVESTIGATING THE ENVIRONMENTAL AND BIOLOGICAL PRESSURES ON TWO NATIVE WYOMING FRESHWATER MUSSELS: CALIFORNIA FLOATER AND WESTERN PEARLSHELL

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Freshwater mussels are critical for healthy ecosystems, but the status of many species is unknown. Many mussel species are declining due to invading species, withdrawing water, rising water temperatures, and changing land-use practices, but threats are unknown for many species. Two species of freshwater mussels co-exist in the Bear River drainage in Wyoming and are of management concern: California floater (*Anodonta californiensis*) and Western pearlshell (*Margaritifera falcata*). Both species are in decline in other parts of their range. Our goal is to understand the life cycle and potential constraints on the California floater and Western pearlshell mussels in the Bear River. We assessed four stages of development to identify potential constraints for each species. We collected water samples to identify larval mussels, sampled fish to look for glochidia attached to their host, and conducted snorkel surveys to assess juveniles and adults in 2023 and 2024. We detected <20 glochidia from the water column, observed glochidia on the gills of 61 fish, discovered 14 potential juvenile mussels from sediment surveys, and detected 1,398 Western pearlshell and 180 California floater mussels during snorkel surveys. New host fish species the native mussels are using were identified, including bluehead sucker (*Catostomus discobolus*), mountain sucker (*Catostomus platyrhynchus*), and mountain whitefish (*Prosopium williamsoni*). Our project provides novel information on the distribution, abundance, reproduction, and potentially limiting factors for the California floater and Western pearlshell mussels within the Bear River watershed and will inform management decisions locally, regionally, and beyond.

POPULATION GENOMICS OF THE TENNESSEE RIVER DRAINAGE ENDEMIC SMOOTH ROCKSNAIL, *LEPTOXIS VIRGATA* (GASTROPODA: CERITHIOIDEA: PLEUROCERIDAE)

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The Tennessee River drainage is a hotspot of freshwater diversity. The Smooth Rocksnail, *Leptoxis virgata*, is a freshwater gastropod in the family Pleuroceridae with a historical range that encompasses approximately 700 km of the middle and upper Tennessee River drainage, including multiple tributaries. However, the species has suffered from range decline because of extensive impoundments in the system. Currently, *L. virgata* is a candidate for listing under the U.S. Endangered Species Act. However, a robust conservation assessment for *L. virgata* is hindered by outdated survey data and a complete absence of population genetic information. Using a 2b-RAD sequencing approach, we assessed the genetic diversity of remaining *L. virgata* populations in tributaries of the Tennessee River. We also examined population structure and connectivity. Despite current habitat fragmentation, populations have high relatively high levels of genetic diversity and low inbreeding. Genetic structure analyses indicated that each sampled site holds a unique genetic population, of *L. virgata*. We also observed higher genetic diversity in more downstream locations and a significant effect of isolation by distance, patterns seen in many other riverine species. Migration patterns among the different populations were downstream biased like what has been documented in other pleurocerid species. However, sampled populations are separated by six major dams, so inferred gene flow must predate dam construction. Population fragmentation could threaten the species in the future. Nevertheless, *L. virgata* is one of the most wide-ranging pleurocerids in the Tennessee River drainage, and persisting populations hold high levels of genetic diversity. Given population genomic data, particularly the number of populations with relatively high genetic diversity, *L. virgata* is likely not as high of a conservation priority as many other pleurocerids.

DEVELOPING A STANDARDIZED SNP PANEL FOR *ELLIPTIO LANCEOLATA* AND *PARVASPINA STEINSTANSANA* FOR GENETIC PARENTAGE-BASED TAGGING

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Freshwater mussels have important positive impacts on freshwater health through their myriad of ecosystem services. Due to pollution, habitat loss, introduction of invasive species, and declining water quality, around 50% of the 60 described freshwater mussel species found in North Carolina are imperiled. Two imperiled species distributed in Central North Carolina are the State and Federally Endangered Tar River Spinymussel (*Parvaspina steinstansana*) and the State and Federally Threatened Yellow Lance (*Elliptio lanceolata*). The objective of this study was to create a standardized SNP panel for these two species to be used for (1) monitoring the success of hatchery stockings through genetic parentage-based tagging (PBT), and (2) assessing population genetic metrics. A selection of several hundred SNPs were pulled from thousands of previously identified SNPs to create a panel that allows for high throughput, yet accurate detection of hatchery-bred individuals. The resulting SNP panel contained 201 SNPs for *E. lanceolata* and 139 SNPs for *P. steinstansana*. Subsequent parentage analysis using the SNP panel for *E. lanceolata* successfully identified parentage for 100% of positive controls. The SNP panel for *P. steinstansana* assigned parentage for 53 out of 57 (93%) positive controls. Unlike the positive controls for *E. lanceolata*, the positive controls for *P. steinstansana* spanned multiple cohorts ranging from 2013 to 2020. The wider range of cohorts resulted in an increase in brood that were not genotyped for at least 80% of loci, resulting in decreased power and assignment rate. Ensuring future broodstock are fully genotyped should overcome these obstacles and increase assignment rate. Both of these panels can be used to monitor the percent hatchery contribution through genetic PBT across populations, as augmentation and reintroduction efforts are implemented. The panel can also be used to monitor genetic diversity and population structure with ongoing stocking efforts.

A GENOMIC TOOL FOR THE LOW-COST MONITORING OF RELATEDNESS IN *LAMPSILIS STRECKERI*

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Poorly designed propagation, augmentation, and reintroduction (PAR) efforts can adversely affect the genetic variation of target populations. To address this challenge for the endangered speckled pocketbook mussel (*Lampsilis streckeri*), we developed a genomic tool to monitor relatedness of both captive broods and wild populations. Highly informative single nucleotide polymorphisms (SNPs) were identified from genomic sequencing and used to design a targeted genotyping panel. With this panel, we genotyped mothers used for propagation and their captively raised offspring. Fathers could not be genotyped because mothers were fertilized in the wild before capture. Parentage assignment was performed using a maximum-likelihood approach to assess the panel's accuracy and investigate patterns of relatedness within captive *L. streckeri* broods. Our panel of just 60 SNPs had 100% assignment accuracy for juveniles with known mothers, which validated the panel's ability to correctly assign parental relationships with a limited number of genetic markers. When applied to juveniles raised in "mixed" cages that contained offspring from multiple mothers, our panel showed that a few mothers produced the majority of genotyped juveniles. Unequal parental contributions can cause a loss of genetic variation due to incidental founder effects and should be mitigated during PAR. Our panel also identified multiple paternity in *L. streckeri*, with an average of 9.3, and a maximum of 18, putative fathers assigned to the offspring of each mother. Because of this high rate of multiple paternity, it is likely that using relatively few mothers for PAR will still maintain adequate genetic variation for *L. streckeri*, as long as females are fertilized in the wild. Our study identified unique patterns of relatedness in captive *L. streckeri* broods that will inform future PAR efforts, while demonstrating a simple and cost-effective workflow for developing similar genomic tools for other freshwater mollusk species.

POPULATION GENOMICS AND PARENTAGE RELATIONSHIPS BETWEEN WILD AND CAPTIVE COHORTS OF THE FEDERALLY ENDANGERED ALABAMA LAMPMUSSEL, *LAMPSILIS VIRESCENS*

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The Alabama Lampmussel, *Lampsilis virescens*, is a federally endangered freshwater mussel species that is restricted to small reaches of the Paint Rock River in Alabama and Emory River in Tennessee. Currently, captive propagation methods are being used to re-establish extirpated populations. However, little genetic information is available to guide broodstock selection and propagation procedures. We employed a 3RAD sequencing approach to generate genomic data on *L. virescens* for inferring demography, genetic structure, and population connectivity. We also characterized genetic diversity between three wild Paint Rock River females that were used as broodstock and five captively reared cohorts. Genetic structure analyses indicated that the Paint Rock and Emory River populations were genetically distinct. Observed and expected heterozygosity values for each population were about equal (Paint Rock River, H_{obs}: 0.25, H_{exp}: 0.28; Emory River, H_{obs}: 0.17, H_{exp}: 0.18). When looking at just Paint Rock River samples including wild-caught individuals, three broodstock females, and five captively reared cohorts, ADMIXTURE indicated that the data was best explained by five genetic clusters (K = 5), with most wild individuals having mixed ancestry in the Paint Rock River. The inbreeding coefficient (F_{is}) for wild Paint Rock River samples was also moderate (F_{is} = 0.12), a potential indicator of inbreeding due to consistent admixture observed in the wild population. Our data shows that captively reared cohorts had lower genetic diversity compared to wild populations, which could have implications for the genetic diversity and effective population sizes of reintroduced populations. With already limited broodstock available because of restricted population sizes, potential protocol changes for increasing genetic diversity of captively reared Alabama Lampmussel cohorts may be limited. Therefore, protocols currently in use by the Alabama Aquatic Biodiversity Center, like using new broodstock each year and ensuring multi-year releases for reintroduction efforts, should be continued.

GENETIC ASSESSMENTS OF ENDANGERED FRESHWATER MUSSELS AIM TO INFORM CONSERVATION MANAGEMENT IN THE MIDWESTERN U.S.

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North America is a global source for freshwater mussel biodiversity, home to around 300 species. In recent decades, mussel populations in the United States have experienced widespread decline resulting from anthropogenic changes to habitat and climate. The complex life histories of freshwater mussels further intensify this problem, as mussels are extremely sensitive to environmental stressors. In a bid to revitalize threatened populations, conservation groups have turned to captive breeding and reintroduction programs for many species of freshwater mussels. Despite their success in producing large numbers of progeny for release back into the environment, these programs often forgo genetic assessments to ensure that the natural genetic diversity of target populations is maintained. In partnership with state and federal agencies, we use ddRADseq and GT-seq methods to quantify genetic diversity and structure within propagated populations, including broodstock, glochidia and juveniles of multiple federally endangered species (Cumberlandia monodonta, Lampsilis higginsii, Epioblasma triquetra and Simpsonaias ambigua). By comparing these data with genotyped wild individuals from source populations, we evaluate the amount of natural genetic diversity retained during propagation. Furthermore, we sample wild individuals across each species range to gain a comprehensive understanding of total genetic diversity. This project enables us to develop genetic management guidelines for conservation agencies to optimize the success of recovery programs and safeguard the natural diversity of endangered mussels.

ARE WE MUSSEL- READY? ASSESSING WATER AND SEDIMENT QUALITY FOR THE POTENTIAL REINTRODUCTION OF FRESHWATER MUSSEL (FAMILY UNIONIDAE) IN NIAGARA RIVER

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Over the last century, the Niagara River basin has experienced substantial habitat and water quality degradation caused by industrial development and operations, shoreline and channel modification for navigation and electricity production, and introduction of invasive species (especially dreissenid mussels). Freshwater mussels of the family Unionidae, once very abundant in the basin, have suffered major declines: recent surveys indicate only 13 of the 32 historically recorded species are present. Despite years of collaborative efforts to restore and improve habitat quality, mussel diversity and abundance remain low. Because mussel populations recover slowly, large-scale propagation is a promising approach to accelerate their restoration. However, uncertainties remain regarding the suitability of current habitat conditions to support future mussel reintroduction, and this project aims to close this knowledge gap. To assess water and sediment quality, we propagated juvenile Fatmucket (*Lampsilis siliquoidea*) and placed them in mussel silos and sediment cages in the Niagara River as well as in tributaries known to sustain healthy mussel populations. Over three months, we monitored growth and survival. Results showed that juveniles in the Niagara River experienced higher mortality and slower growth than those in the tributaries. In particular, silt and sand substrates of the Niagara River led to 100% mortality of juveniles in sediment cages, whereas the gravel and cobble substrates of the tributaries supported both growth and survival. Water quality in the Niagara River was sufficient to sustain juveniles in silos, but juvenile growth remained lower than in the tributaries. We speculate that this disparity could be due to limited food availability, likely a result of competition with dreissenid mussels, flow rates, water temperature or a combination of these. The results of our study highlight sediment composition and food availability as critical factors influencing juvenile mussel growth and survival, providing essential insights for future restoration efforts.

NEW TOOLS FOR BUILDING HABITAT SUITABILITY MODELS AFTER OLD ONES FAIL

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Habitat Suitability Models (HSM) based on large-scale data, such as satellite imagery, digital elevation models (DEM) and stream gage systems often lead to unexpected misrepresentation of localized site conditions, as benthic conditions are not easily assessed from above. A traditional HSM devised from water depth and velocity, as well as substrates and the shear stresses present, was tested by introducing 80 PIT-tagged adult mussels spread in four sets across predicted good habitat. Despite a supporting model and early success during introduction, with only 1 loss, many mussels later died, and all were displaced from sites indicating shortcomings of the initial HSM and a need for localized measurements and a reconsideration of how riverbed stability will impact propagated juvenile mussels. Erosion is deemed a negative feature in most HSMs for rivers, but armoring banks for stability presents new unknowns. Therefore, a revised model focuses on riverbed stability after combining data from side scan sonar and an acoustic doppler current profiler (ADCP) to choose initial sites. Prior to any introductions, longitudinal ground truthing of depth, flow, water direction and sediment by classical analysis is planned. The ADCP enables measurement of variation in flow velocity, direction and bathymetry, which need to be contrasted between reaches protected by armoring and those free to widen into wetlands during high water events. Methods developed to tailor such an HSM may better predict introduction success of mussels at uninhabited sites, which is a critical challenge in rivers where historical populations were largely eliminated, restricting use of standard models built on presence and absence of mussels.

HYPOXIA SENSITIVITY OF THE FEDERALLY THREATENED *PLEUROBEMA RIDDELLII* IN RELATION TO COMMON SPECIES

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Freshwater mussels are threatened by a wide range of environmental stressors such as rising temperatures and hypoxia. Understanding how the sensitivity of rare species to stressors compares to that of more common species is critical to determining whether regulations are protective of mussel communities as a whole or need to be developed on a species-specific basis. In this study, we used respirometry techniques to compare hypoxia sensitivity among mussel species and to determine whether sensitivity increases with temperature. Species tested included the rare *Pleurobema riddellii* (Neches River, TX), sympatric, common *Cyclonaias pustulosa,* and allopatric, common *Lampsilis straminea* (Mobile Basin, AL). Using closed respirometry, we recorded respiration rates under conditions of progressive hypoxia at two temperatures (25 and 32°C). For each species and temperature combination we calculated the critical dissolved oxygen concentration (DO_{crit}: the dissolved oxygen threshold below which a mussel switches from aerobic to anaerobic respiration) and the regulation index (RI: the ability of an organism to maintain a constant respiration rate as DO declines). An increase in DO_{crit} and/or a decrease in RI indicate increased sensitivity to hypoxia. Analysis via ANCOVA showed no main effects of species or temperature on DO_{crit} and no significant interaction between species and temperature. There were no main effects of temperature on RI, but *P. riddellii* had a significantly lower RI than either *C. pustulosa* or *L. straminea*. There was no significant interaction between RI and temperature. Overall, we found evidence that *P. riddellii* was the most sensitive species to hypoxia in that RI was significantly lower in *P. riddellii* than the more common species, regardless of temperature. However, we found no evidence that sensitivity to hypoxia increased with temperature for any of the three species. Data from additional species tested under a similar protocol are currently being analyzed for inclusion in these comparisons.

THERMAL STRESS AND BIOENERGETICS: ESTIMATING SCOPE FOR GROWTH IN THE TEXAS FAWNSFOOT (*TRUNCILLA MACRODON*) ACROSS A RANGE OF TEMPERATURES

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Truncilla macrodon (the Texas fawnsfoot) is a federally Threatened species endemic to the Brazos and Colorado River basins of central Texas. The USFWS and Brazos River

Authority entered into a Candidate Conservation Agreement with Assurances that defined voluntary conservation measures including *ex-situ* studies to analyze physiological tolerances of *T. macrodon*. As part of this program, we investigated the sublethal effects of thermal stress and estimated the optimal temperatures for growth and reproduction in *T. macrodon* by estimating their scope for growth (SFG) over a range of temperatures. SFG is the net energy available for growth and reproduction after energy requirements associated with maintenance and feeding have been met. Because anecdotal evidence suggested *T. macrodon* actively burrow into the sediment where they are likely to experience relatively cool, stable conditions, we hypothesized that *T. macrodon* would be more sensitive to thermal stress than species that are typically found at the sediment surface. We estimated SFG by exposing mussels to 5 temperatures ranging from 18-30°C and measuring energy gains via feeding, and energetic costs via respiration. Mean energy absorbed by *T. macrodon* peaked at 26°C while mean energetic costs increased linearly with temperature. Mean estimated SFG in *T. macrodon* was positive from 19-26°C and negative above 26°C with a peak occurring at 22°C. Results suggest *T. macrodon* is a thermally sensitive species relative to other rare southwestern species such as *Popenaias popeii* whose SFG peaked at 28°C. Water temperatures in the Brazos River basin regularly exceed the optimal SFG temperature (22°C) for *T. macrodon* during 5-7 months of the year. These results highlight the importance of managing water and sediment temperatures for the conservation of this species, as well as the importance of determining the relationship between water and sediment temperatures within occupied habitat patches.

CLIMATE SENSITIVITY IN MIDWEST MUSSELS VARIES WITH RANGE SIZE, TRAIT COMBINATIONS, AND LISTING STATUS

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Mussel habitats are affected by extreme precipitation events, projected to increase with climate change in the central U.S. These events are forecasted to alter runoff patterns, potentially leading to increased flooding in winter and spring and flash droughts in summer. The Midwest's heightened exposure to extreme precipitation underscores the need to assess how mussels rank in their vulnerability to climate change. We evaluated mussel vulnerability by quantifying their (i) range size using area of occurrence (AOO), (ii) exposure to climatic variation, and (iii) adaptive capacity based on trait combinations. To calculate AOO, we compiled species occurrences in 13 Midwest states and assigned them to Hydrologic Unit Code-12 watersheds. We combined watershed area with the spatial variability in nine climate variables to calculate a standardized index that ranks the sensitivity of 90 mussel species, including 34 Regional Species of Greatest Conservation Need (RSGCN) identified by the Midwest Landscape Initiative. This approach recognized climate as a threat to select RSGCN (e.g., *Epioblasma rangiana*, *Lampsilis rafinesqueana*) and revealed unlisted climate-sensitive species (e.g., *Lampsilis hydiana*, *Ptychobranchus occidentalis*) with small range sizes in areas of variable climate exposure. To identify hotspots of species-rich trait clusters, we calculated a probability density function using kernel density estimation. Using a generalized additive model, we then mapped these hotspots to the climate sensitivity index. We found an association between climate tolerance and larger species, as well as those using low-energy environments characterized by slow currents and muddy substrates. By further combining occurrence records with index values, we identified watersheds with more vulnerable mussel species. This index facilitates the inclusion of data-limited species in conservation status assessments and highlights watersheds where climate change may pose a significant threat to mussel assemblages.

IMPACTS OF CLIMATE CHANGE ON FRESHWATER MUSSELS AND THEIR FISH HOSTS

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Climate change can have multiple impacts on freshwater mussels and their fish hosts. Some examples are highlighted in this presentation, based on a compilation of recent publications. Direct effects of climate change include changes of water temperatures and oxygen concentrations as well as adverse effects resulting from prolonged periods of drought and dewatering, often resulting in direct fish and mussel mortality. More subtle effects of climate change include changes of catchment-erosion and instream-sedimentation patterns, associated with changes of stream bed quality and nutrient input, which affect early life stages of both mussel and fish hosts. These effects are evident from both field exposures as well as defined flume mesocosm experiments in which synergistic effects of fine sediment, reduced flow and increased water temperatures on survival of critical early-life stages were evident for multiple species. In some cases, climate change also affects species interactions of mussels with their fish hosts as well as with predators. Examples include changes of attachment rates of glochidia larvae to fish hosts, and of larval metamorphosis success on the hosts which are both crucially dependent on water temperature. Other examples illustrated in this presentation include increased competition between invasive and native mussel species, and increased predation rates on mussels under changing temperature profiles. In conclusion, climate change results in multiple complex and, in part, synergistic effects on mussel and host fish habitats. Knowledge on these processes can at least help identify mitigation strategies such as flow regime management in regulated rivers, or riparian vegetation management.

WEATHERING THE STORM: A STATUS UPDATE OF APPALACHIAN ELKTOE (*ALASMIDONTA RAVENELIANA*) AND FUTURE PLANS FOLLOWING HURRICANE HELENE

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The Appalachian Elktoe, *Alasmidonta raveneliana*, is a federally endangered freshwater mussel endemic to the upper Tennessee River basin in western North Carolina and eastern Tennessee. The distribution of this species is currently limited to small patches of suitable habitat within the Little Tennessee and French Broad drainages in western North Carolina. However, it historically inhabited waters from the headwaters and tributaries to lower reaches of these river basins with little fragmentation. Direct threats to this species include pollution (chemical and thermal), altered flow conditions, dams, sedimentation, unstable or fragmented habitat, invasive species, and diseases. Biologists with the NC Wildlife Resources Commisson and US Fish and Wildlife Service have documented several declines following significant disturbances from tropical storms and hurricanes over the last 20 years. In September 2024, Hurricane Helene brought severe flooding to western North Carolina and east Tennessee. Many streams with extant Appalachian Elktoe populations were impacted by the storm. As biologists continue to evaluate the impacts of Helene, NCWRC biologists will conduct targeted Appalachian Elktoe surveys to assess their current distribution and abundance in the impacted watersheds. Mussel and habitat surveys will be conducted at long-term monitoring sites throughout the impact area. Survey results will help guide future management and conservation actions to aid in species recovery.

CONSERVATION GENOMICS OF *ANODONTA* FRESHWATER MUSSELS IN SWITZERLAND

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Freshwater mussels (Unionidae) are declining worldwide due to the combined effects of habitat degradation and destruction, climate change, pollution and invasive species. In Switzerland, there are three described species of the genus *Anodonta*: *A. anatina* and *A. cygnea* are widespread, while *A. exulcerata* is restricted to the southern part of the Alps. This study aimed to evaluate genetic diversity, genetic differentiation, inbreeding and effective population size of *Anodonta* populations in Switzerland using high-resolution genomic data. We generated reference genomes for *A. anatina* and *A. cygnea,* the first reference genomes of the *Anodonta*genus. We then collected non-lethally tissue samples of 423 *Anodonta* mussels (252 *A. anatina*, 153 *A. cygnea* and 18 *A. exulcerata*) from 32 populations occurring in lakes, ponds and rivers across Switzerland. Whole-genome resequencing data revealed the existence of a new undescribed *Anodonta* species south of the Alps, close to *A. anatina*. *A. anatina* metapopulation structure followed catchment area, with populations within catchment being more connected than populations among catchments. Genetic diversity was positively correlated with the water body size, highlighting that populations in small ponds are more vulnerable to environmental disturbances than populations in large lakes. Furthermore, we found very low levels of genetic diversity and heterozygosity in *A. cygnea* compared with *A. anatina* and *A. exulcerata*, which may be the result of selfing in this species. Finally, we found hybrids between *A. cygnea* and *A. exulcerata* in a sympatric population, highlighting that species limits are porous in this genus. Our study, informing about the vulnerability status of these species, is particularly relevant in the context of the ongoing update of the Swiss mollusc IUCN red list and has direct implications for management and conservation. Finally, our study provides important information on essential biodiversity variables, in line with the goals of the CBD to assess, maintain and safeguard genetic diversity.

SECONDARY CONTACT ERODES HISTORICAL DIVERSIFICATION IN THE WIDE-RANGING MAPLELEAF SPECIES COMPLEX

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The isolated river drainages of eastern North America serve as a natural laboratory to investigate the roles of allopatry and secondary contact in the evolutionary trajectories of recently diverged lineages. Drainage divides facilitate allopatric speciation, but due to their sensitivity to climatic and geomorphological changes, neighboring rivers frequently coalesce, creating recurrent opportunities of isolation and contact throughout the history of aquatic lineages. The Mapleleaf mussel, *Quadrula quadrula*, is widely distributed across isolated rivers of eastern North America and possesses high phenotypic and molecular variation across its range. This high intraspecific variation formerly represented three separate species: *Q. apiculata*, *Q. quadrula* sensu stricto, and *Q. rumphiana*. Previous research using mitochondrial markers found *Q. quadrula* sensu stricto paraphyletic with respect to *Q. apiculata* and *Q. rumphiana*, resulting in the collapse of the complex to a single taxon, *Q. quadrula*. In this talk, we integrate sequence data from three genomes, including female- and male-inherited mitochondrial markers and thousands of nuclear encoded SNPs, with morphology and geography to test the hypothesis that formerly recognized *Q. apiculata* and *Q. rumphiana* represent independent evolutionary lineages distinct from *Q. quadrula*. Across currently isolated river drainages, we found continuums of molecular and morphological variation, following a pattern of isolation by distance. In areas where multiple putative species were in contact, hybridization was frequent with no apparent fitness consequences, as advanced hybrids (i.e., > 1st generation) were common. Accordingly, we recognize *Q. quadrula* as a single cohesive species with subspecific variation (*Q. quadrula rumphiana*). Demographic modeling and divergence dating supported a divergence history characterized by allopatric vicariance followed by secondary contact, likely driven by river rearrangements and Pleistocene glacial cycles.

SPAWNING AND MICROINJECTION OF QUAGGA MUSSEL EMBRYOS: METHODS TOWARDS CREATING AN IMMORTALIZED QUAGGA MUSSEL CELL LINE THROUGH GENETIC MODIFICATION

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Mollusks comprise the second most diverse animal phylum yet are highly understudied at the cellular and molecular level. The lack of basic biological research is due, in part, to the lack of readily available molluscan cell lines. Despite the high biodiversity and overall ecological and economic importance of mollusks, only one molluscan cell line (Bge derived from *Biomphalaria galabrata*) has been made available to researchers.
Our group is working toward discovering methods to transform normal molluscan cells into immortalized cell lines that can then be mass produced, preserved, and shared among researchers. Such cells would be of great importance to conservation research, but could also prove invaluable in the development of control agents for invasive mollusks. One of the great challenges of developing molluscan cell lines is the tendency of mollusk cells to stop dividing when removed from their native tissue. Our strategy is to overcome this mitotic arrest (i.e. create cancer cells), through 1) the addition of oncogenes, and 2) the subtraction (or targeted mutation) of genes responsible for cell cycle control.We have not yet completed the establishment of efficient chemical methods for moving genes into mollusk tissues, so, at present, the most sure method of introducing foreign RNA/DNA is by microinjection. Microinjection requires mitotically active targets for stable introduction of foreign genetic material into the genome, so we have had to develop in-house methodologies for spawning, in vitro fertilization (IVF), and manipulation of zygotes to provide us with the necessary starting material. Over the past year, microinjection success rates of mRNAs and DNAs encoding reporter proteins have steadily increased from ≈ 0.5% to >10%. We now have several plasmid vectors carrying potent oncogenes and CRISPR/Cas9 reagents that we hope will induce stable transformation of embryonic quagga mussel cells in the coming year.

VIRTUAL: REVIEW OF THE PHREATIC GASTROPODS IN THE EDWARDS-TRINITY AQUIFER SYSTEM OF TEXAS AND MEXICO WITH RECENT DISCOVERIES

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The freshwater gastropod family Cochliopidae is a diverse component of the subterranean fauna in the karst and hyporheic habitats of the Edwards-Trinity Aquifer System (ETAS) of western Texas and northern Mexico, with 11 genera and 27 described species found in the region. The ETAS is a complex transboundary aquifer system extending across Texas, USA into the Mexican state of Coahuila. We recently used mitochondrial and nuclear DNA data, and examination of shell shape, shell sculpture and soft anatomy, to clarify relationships and names of phreatic cochliopids in the Western ETAS of Texas and Mexico. These new data were the basis for descriptions of three new species, synonymy of two species, and the reassignment of one species to a more appropriate genus. Ongoing sampling is being conducted to circumscribe the ranges of the phreatic snails in Texas and develop an NGS dataset to better understand the evolutionary history of this group.

"IT'S ALL NEW IN THE WEST!" A TRIBALLY MANAGED MUSSEL RESTORATION PROGRAM

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Recognizing the cultural and ecological importance of freshwater mussels, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) has been studying them since 2002. This work makes it the longest running freshwater mussel research project in the western United States and the only program focused on propagation of mussels for restoration. CTUIR is dedicated to restoring freshwater mussel populations in the Umatilla River and surrounding basins, as they are a vital "First Food". Sustainable harvest of freshwater mussels remains a treaty right, as tribal members seek to preserve their cultural and ecological importance.

After a 2005 mussel status survey revealed significant eradication of some mussel populations, restoration efforts were initiated. These efforts include status and distribution monitoring surveys, adult mussel trial translocations, and laboratory propagation. Since 2014, CTUIR has pioneered a propagation program for western mussel species, successfully propagating three genera: *Anodonta*, *Gonidea*, and *Margaritifera*. Current research focuses on refining propagation and rearing methods for western juvenile mussels while broadening the understanding of host fish relationships. The fact that freshwater mussels require a host fish to complete their life cycle means that conservation and restoration efforts are hampered by a lack of host fish knowledge.

The CTUIR Mussel Project prioritizes understanding current and future risks through research; protecting and monitoring existing mussel populations; and restoring impaired or extirpated populations and mussel habitat, along with adaptive management actions. CTUIR finalized a Supplementation Plan to guide the development and evaluation of mussel restoration strategies. Following this plan, the first pilot outplanting project of propagated western mussels was initiated July 2024 and monitoring continues for this cohort. The project's overall goal is to restore self-sustaining mussel populations to ceded areas, reconnecting cultural and ecological services provided by mussels.

NATIVE UNIONID MUSSELS: IN VITRO PROPAGATION IN SUPPORT OF MUSSEL REINTRODUCTION PROGRAMS

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Native unionid mussels are among the most threatened aquatic communities worldwide, including the Great Lakes basin. For instance, streams of Indiana Dunes National Park supported as many as 18 mussel species at one time; however, only two species [fatmucket (*Lampsilis siliquoidea*) and ellipse (*Venustaconcha ellipsiformis*)] exist now with limited occurrences. Mussels in their natural habitats have a complex life cycle that requires a host fish to produce juvenile mussels from glochidia (i.e., mussel larvae). While this parasitic relationship is temporary, only a small percentage of the larvae (~1%) will eventually develop into adult mussels. To overcome this barrier, mussel restoration programs are increasingly exploring alternate propagation methods, such as culturing mussel larvae under laboratory conditions (i.e., *in vitro* propagation), to improve survival and transformation of larvae to juvenile mussels with rates exceeding 90%. The objectives of this work (2022-current), a collaborative effort between U.S. Geological Survey (USGS) and National Park Service (NPS, Indiana Dunes National Park, INDU), are to: (1) develop and optimize *in vitro* propagation methods for select mussel species in support of ongoing restoration efforts at INDU; species of immediate interest include *Lampsilis siliquoidea* (Fatmucket), *Pyganodon grandis* (Giant Floater), *Lasmigona complanata* (White Heelsplitter), and *Venustaconcha ellipsiformis* (Ellipse) and (2) identify and characterize ecological factors (e.g., diet, interactions with microbes) to improve growth of juvenile mussels post transformation. Recent trials (2022-2024) for fatmucket produced over 10,000 juveniles (~52% transformation rate) despite methodological challenges. Similar *in vitro* culturing protocols will be evaluated for other mussel species during 2025.

SUSQUEHANNA (NY) BROOK FLOATER (*ALASMIDONTA VARICOSA*) POPULATION AND HABITAT ASSESSMENT POST DAM REMOVAL

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Previous freshwater pearly mussel surveys of Catatonk Creek identified an expanding population of Brook floaters. This New York State threatened freshwater pearly mussel is found as far north as Eastern Canada and as far south as Georgia along the East Coast. A low head spillway dam removal in 2020, immediately upstream of this population, was a cause for concern for the established Brook floaters in Catatonk Creek. Our 2024 survey of Catatonk Creek assessed the status of this population of Brook floaters four years post dam removal. In this survey, over 650 Brook floaters were identified and tagged. Because this population is constrained by habitat, there are concerns this location will approach, or already has reached, maximum capacity. We performed habitat assessments and collected data on physical stream characteristics and water quality, which will help to ascertain what makes this habitat favorable to this threatened species. Physical and chemical stream characteristics surveyed include water temperature, nutrients, conductivity, mesohabitat, benthic composition, pH, and suspended sediment. Results of habitat data analyzed over the past few months will be discussed. Assessing the habitat of these mussels and other local stream habitats will assist in developing a plan to conserve and, possibly, expand this imperiled population of Brook floaters.

DIRECT AND INDIRECT INFLUENCES OF DAM MODIFICATION AND FISH PASSAGE PROJECTS ON FRESHWATER MUSSEL COMMUNITIES

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Although the direct impacts of dam modification projects to freshwater systems may be conspicuous (i.e., changes to the flow regime, streambed agitation), recent research suggests that these projects may also have indirect impacts to the native freshwater mussel (Family Unionidae) communities upstream and downstream of the given infrastructure. Construction at Republic Dam in Republic, Michigan (Marquette County) was focused on modifying the existing dam to improve fish passage and reduce hazard risk along this segment of the Michigamme River. Construction included installing a series of boulder weirs, resulting in a direct impact to the streambed. Indirect impacts anticipated included flow alteration and potential sediment mobilization. Due to the documented presence of common and special concern mussel species in this stretch of the Michigamme River a mussel relocation was required by the Michigan Department of Natural Resources (MDNR) prior to construction. Low mussel abundance was expected at this site due to the swift current in the main channel and downstream of the dam. The mussel relocation efforts conducted at Republic Dam in 2024 documented generally unsuitable conditions for mussels in the main channel and immediately downstream of the dam, with flow velocities exceeding 5.5 feet/seccond and substrate dominated by concrete and boulder. These areas were generally devoid of mussels. However, lentic-like areas immediately upstream of the dam's secondary spillway yielded an unexpectedly high abundance (~2,000 live mussels) and low diversity, with all live specimens being Giant Floater (Pyganodon grandis). This presentation will discuss the design, methods, and results of the mussel relocation effort at the Republic Dam site and explore the implications of these results. Discussion will include exploring the potential benefits fish passage structures may have on the mussel community through the modification of the flow regime, habitat, and likely increase in fish presence and diversity.

ACCELERATED FRESHWATER MUSSEL DECLINES IN THE CHEHALIS BASIN, WA

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The Chehalis River Basin of southwestern Washington is home to three species of freshwater mussels native to the western U.S. Draining into the Pacific, the watershed encompasses 2,700 square miles and more than 3,400 miles of perennial streams. Although the basin once supported abundant freshwater mussel beds containing all three species in the mainstem river and tributaries, large scale declines in populations were first reported in 2015 and have continued at an accelerated pace over the last decade. Beginning in 2019, biologists from the Xerces Society, WDFW, USFWS, UW-Madison, and the Chehalis Tribe have collaborated on a broad effort to assess the distribution, status, and health of mussel populations in the basin. This collaborative effort has focused on 1) expanding and refining the known occurrence and status of mussels in the basin through eDNA sampling, distributional surveys, and long-term monitoring; 2) conducting targeted surveys to evaluate the extent of ongoing mass mortality events at mussel beds; and, 3) documenting potential factors contributing both to general mussel distribution and the mass mortality event, including sampling for pathogens, water quality analytes, and mussel condition. In total, more than 250 eDNA samples have been collected and are being analyzed to better understand where mussels have and continue to occur. Visual surveys for mussels have also been conducted annually, covering a total of 220 river miles, including repeat surveys at a subset of sites to document annual changes in mussel distribution. Monitoring has been conducted at 6 sites across the mainstem river and two tributaries annually, from which water samples were collected during two field seasons and more than 233 mussel samples were collected to assess condition and disease state. This presentation will discuss study results and the current status of mussel populations in the basin following a decade of accelerated decline.

INSIGHTS FROM THE PAST; USING AN ARCHAEOLOGICAL BIVALVE RECORD TO INFORM THE MANAGEMENT OF MODERN FRESHWATER MUSSELS

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Freshwater bivalves perform many ecosystem services, such as nutrient cycling, modifying habitat, and feeding animals and humans. Over 70% of North America's 300 freshwater mussel species are endangered, threatened, or of special concern. In addition to conservation concerns, this group is underrepresented in basic life history studies compared to less cryptic species (e.g. fish or mammals). Little is known about the historic distribution or population size of any of the 7 extant species of freshwater mussels in Wyoming, making it difficult to put modern population trends into context. The state of Wyoming houses thousands of bivalve shells in an archaeology record, which can be a valuable resource in assessing the historic distribution of freshwater mussel species in lieu of historic studies. Bivalve shells housed at the Frision Institute at the University of Wyoming were sorted to find identifiable shells. Shells with intact diagnostic features were identified, and, where possible, growth rates, age structures, and distributions were collected and compared to modern populations. Such comparisons allow us to assess long-term changes in population characteristics and assess the degree to which the growth of modern freshwater mussels differs from the pre-settlement. Are all extant species native to Wyoming's watersheds or were they introduced by human activity? We have thus far found 132 identifiable shells. The species we have identified were found at sites near the same watersheds where those species exist today. The presence of Western pearlshell (*Margaritifera falcata*) in Sweetwater and Sublette counties suggests that this species may be native to the Green River, which is a long-standing uncertainty. We have also discovered one specimen of Mapleleaf (*Quadrula quadrula*), a species currently found in Eastern South Dakota and Nebraska, which has never been observed in Wyoming. Comparing information from molluscs in archeology collections allow us to frame current distributions and place longer-term population trends into context to inform management plans.

A TOOL FOR STANDARDISED, RAPID MUSSEL HEALTH ASSESSMENT IN THE FIELD

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To address the precipitous declines of many freshwater mussel populations globally, it is necessary to apply informative tools for measuring mussel health, understand baseline measurements with these tools, and develop a systematic programme for monitoring populations to detect and take steps towards alleviating potential stressors. To do this, a suite of stress biomarkers has been applied to mussels; however, baseline measurements of these biomarkers are often not available, no framework exists for the translation of these methods from research into routine mussel health monitoring, and they are impractical for giving rapid health measurements in the field. We developed a standardised measure of valve closure strength and showed that it is correlated with well-established bioindicator assays for stress. Our method utilises a specially designed pair of tongs that can bend when opening a mussel to give a numerical reading of tong displacement. We have shown that this value loosely correlates with acetylcholinesterase activity, a common stress indicator. Our method takes only a few seconds per mussel so can be applied rapidly in the field. It provides a standardised reading that can be used to track changes in a mussel population's health status through time. We envision the wide application of this technique in rapid mussel health monitoring in the future.

INVESTIGATING SCANDINAVIAN FRESHWATER PEARL MUSSEL (*MARGARITIFERA MARGARITIFERA*) MASS MORTALITY EVENTS

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Unnaturally high levels of freshwater pearl mussel (*Margaritifera margaritifera*) mortality have been observed in four Norwegian rivers since 2022. Mussels from all four populations were used as broodstock in the Austevoll Cultivation Facility for the production of juvenile mussels to be used for restoration purposes. After the completion of breeding in summer 2021 the mussels were released in the upper sections of the respective rivers they were collected from. Since then, mortality rates of up to 99.9% have been observed downstream of the location where mussels were returned. Similarly devastating MMEs of pearl mussel populations are currently occurring in rivers in Sweden as well. Following the extraction of haemolymph samples from mussels, we have undertaken a metagenomic analysis to search for potential pathogens. We are also targeting a hypothesised gregarine parasite previously reported in Sweden with 18S sequencing. We are conducting histology to better characterise the pathology of the disease and search for potential etiological agents. By May we will have some of these results ready to discuss. Not only does this work investigate specific populations but it also begins to fill the general knowledge gap surrounding the drivers of mass mortality events of critically important freshwater mussel populations in Europe.

VIRTUAL: CHALLENGES AND OPPORTUNITIES IN USING eDNA METHODS FOR FRESHWATER MUSSEL DETECTION

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Improving our ability to detect and monitor freshwater mussel species is crucial to their continued conservation. Here we discuss multiple studies we have conducted to assess the ability of environmental DNA methods to detect freshwater mussels in riverine systems. We describe the development of multiple qPCR and metabarcoding assays and their use in a series of laboratory, field, and modeling studies. Our work demonstrates the ability to detect mussels, including federally endangered species such as the Spectaclecase (Cumberlandia monodonta) and the Oyster Mussel (Epioblasma capsaeformis), however, detections are often low and sporadic. Laboratory and modeling studies suggest that low eDNA shedding rates from mussels and hyporheic removal of DNA (likely through sediment absorption) could exacerbate low detection rates in riverine systems. Finally, we developed and demonstrated the use of male-mitotype and spawning-specific qPCR assays for the detection of male gamete release by freshwater mussels. Results of mesocosm and field studies indicate that a strong signal of gamete release occurs during the expected spawning period for the Spectaclecase, suggesting that these assays could be helpful to managers trying to understand the reproductive triggers of mussels in the wild or in captive rearing facilities. Our results will improve resource managers' understanding of how and when to use eDNA methods for freshwater mussel conservation needs.

USING ENVIRONMENTAL DNA (eDNA) TO IMPROVE MONITORING OF NATIVE MUSSELS IN RESTORATION PROGRAMS

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Environmental DNA (eDNA) has been increasingly applied to population assessment programs for biotic communities in aquatic and terrestrial ecosystems. An important benefit of this approach includes bypassing the need for collecting live specimens for identification that traditional surveys must rely on. Thus, eDNA is an invaluable and relatively cost-efficient tool for resource managers, especially for the detection of rare or cryptic species including freshwater mussels. While streams of the Indiana Dunes National Park (INDU) once supported 18 mussel species, all but two have been extirpated from the park's waterways due to habitat loss and related anthropogenic activities. To assist in a mussel monitoring program, we developed a new qPCR assay targeting *Lampsilis siliquoidea* – one of the species currently undergoing restoration efforts. For this purpose, a sample population of *L. siliquoidea* (*n* = 277) from the Iroquois River (a tributary of the Kankakee River) was transported to the National Park Service's (NPS) aquatic laboratory, then transferred to enclosures within a stream to let mussels adapt to the new environment. Finally, the mussels were moved to their permanent location within the eastern branch of the Little Calumet River of INDU. Water and sediment samples were collected for eDNA analysis from the mussel bed and at 20, 50, and 1200 meters downstream of the original bed over a period of 127 days (from August to December 2020). *L. siliquoidea* DNA was detected by droplet digital PCR consistently in eDNA samples from laboratory tanks and field enclosures, but detection rates dropped to 28% and 26% for water and sediment samples respectively in the Little Calumet River. DNA-based methods, such as the one developed and validated in this study, have potential to substantially complement traditional mussel surveys in population restoration programs and may be applied to mussel monitoring programs elsewhere in the Great Lakes basin.

DETECTING RARE FRESHWATER MUSSELS AND THEIR HOSTS: INTEGRATING EDNA AND CONVENTIONAL SURVEYS

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The Salamander Mussel (*Simpsonaias ambigua*) is a rare, small, thin-shelled freshwater mussel historically found in eastern and Midwest rivers of the United States and Ontario, Canada. It often occurs under slab rocks and bedrock ledges, where its host the Mudpuppy (*Necturus maculosus*) resides. Due to their small size, rarity, and the nocturnal, winter-active behavior of Mudpuppies, detecting and assessing Salamander Mussel and Mudpuppy populations is challenging. We conducted environmental DNA (eDNA) and conventional surveys for both species at historical sites in east-central Illinois rivers and eDNA surveys in Minnesota rivers. We detected Mudpuppy and Salamander Mussel eDNA at multiple locations in both states. In winter and spring 2025, we will follow the Mudpuppy sampling protocol established by Fisheries and Oceans Canada to conduct additional surveys in east-central Illinois, specifically assessing Mudpuppies for the potential presence of glochidia. Lastly, we developed and are validating an assay for the federally threatened Rabbitsfoot (*Theliderma cylindrica*) and surveying its distribution in the east-central Illinois rivers.

USING eDNA FOR CONSERVATION ASSESSMENT OF THE POTENTIALLY EXTINCT WHITE CATSPAW AND OTHER RARE, THREATENED, AND ENDANGERED SPECIES IN NORTHWEST OHIO

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Fish Creek in northwestern Ohio and northeastern Indiana supports a diverse assemblage of native freshwater mussels. This study used eDNA metabarcoding to assess community composition and spatial distribution of protected mussels throughout 18 river miles of Fish Creek. We used eDNA metabarcoding to (1) describe mussel community assemblages, (2) detect rare and federally listed species, and (3) provide estimates of relative mussel abundances. The eDNA sampling was also employed as a potential tool to detect the rare White Cat's Paw Pearly Mussel (*Epioblasma perobliqua*), with its last known living population occurring in Fish Creek. eDNA sampling matched visual tactile surveys throughout the region which included detection of three federally protected species (*Paetulunio fabalis, Pleurobema clava*, and *Theliderma cylindrica*). White Catspaw was not detected at any site within Fish Creek with either eDNA nor visual searches. However, while visual searches did not detect the proposed endangered Salamander Mussel (*Simpsonaias ambigua*), eDNA detected this species across several sites. From this work, Stantec, with the support of the Ohio Department of Transportation, conducted qPCR and metabarcoding eDNA surveys as a conservation assessment across several basins for *Simpsonaias ambigua* and its obligate host, the mudpuppy (*Necturus maculosus*). The development and validation of these eDNA protocols for the detection of entire mussel assemblages can increase survey efficiency, reduce field costs, and support conservation efforts for listing drainages of extant populations and monitoring conservation goals.

VIRTUAL: A TARGETED eDNA MONITORING PROGRAM FOR SPECTACLECASE IN THE UPPER MISSISSIPPI RIVER

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The Spectaclecase mussel (*Cumberlandia monodonta*) is an endangered freshwater species native to the Mississippi River basin. To support the conservation of Spectaclecase populations, the U.S. Army Corps of Engineers, Minnesota Department of Natural Resources, and Wisconsin Department of Natural Resources are implementing habitat restoration initiatives along the upper Mississippi River (UMR). However, there are few known populations of Spectaclecase in the UMR, and gathering more occurrence data is crucial to inform effective restoration efforts. Traditional diving methods are typically used for surveying Spectaclecase, but this species' preference for sheltered habitats, such as interstitial spaces and crevices, makes these methods risky, costly, and time-consuming. Environmental DNA (eDNA) presents a promising alternative for monitoring aquatic species, although freshwater mussels often yield low detection rates. A quantitative PCR (qPCR) assay for Spectaclecase has previously been developed. Our study aimed to build on this foundation by conducting eDNA surveys throughout the UMR to locate unknown populations. Between 2020 and 2024, we collected benthic eDNA samples from over 250 sites across 23 pools in the UMR. We also attempted dive surveys at new positive eDNA detection sites to confirm presence. Our findings indicate that eDNA can successfully identify previously unknown populations of Spectaclecase, although locations with documented populations of Spectaclecase sometimes failed to produce positive detections. Dive surveys revealed that even weak positive eDNA detections were sufficient to locate Spectaclecase mussels. In 2024, we expanded our efforts by testing out additional eDNA collection methods (filtering and plankton tow nets) and collecting samples to detect salamander mussel (*Simpsonaias ambigua*) and its obligate host species, mudpuppy (*Necturus maculosus*). This research highlights the effectiveness of eDNA as a monitoring tool while also addressing the challenges of detecting declining mussel populations in expansive river systems.

VIRTUAL: SUBSTRATE STABILITY AS A METRIC TO ESTIMATE HABITAT FOR NATIVE FRESHWATER MUSSELS IN A LARGE RIVER AND IMPLICATIONS FOR CONSERVATION PRACTICES

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Effective conservation practices depend on understanding what constitutes habitat for a given species. For native freshwater mussels, the lack of information on what defines quality physical habitat is limiting conservation and management decisions. Stability of river substrates can be used to predict the presence, density, and survival of mussels in the upper Mississippi River. A planned restoration project in a reach of the upper Mississippi River near Clinton, Iowa (Pool 13) will create islands and other structures that are designed to change current velocity and substrate stability. The objective of this study was to evaluate substrate stability in advance of the restoration project. Currently, information on substrate particle size, specifically particle size at the 50th percentile (D50), constrains the ability to estimate substrate stability accurately. In fall 2024, divers obtained surficial sediment (top ~10 cm) at 300 sites prior to quantitative sampling for native mussels. In the laboratory, sediments were homogenized, and a 200-g subsample was removed, dried, and sieved into eight discrete particle sizes using a sieve shaker. Of the 132 samples analyzed, the median D50 was 0.292 mm (range, 0.069–1.871), which corresponds to medium sand. D50 values will be used to compute the boundary Reynolds number and critical shear stress at each site. Those data, combined with data on bed shear stress derived from hydrodynamic models, should enable us to estimate substrate stability and its relationship with richness and density of native mussels. Information on substrate stability can be used by resource managers to design subsequent restoration projects that could enhance physical habitat for mussels and increase the diversity and density of mussels in the upper Mississippi River.

REPATRIATING FRESHWATER MUSSELS INTO TOWN CREEK TO RESTORE SPECIES DIVERSITY AND COMMUNITY FUNCTION

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Species augmentation or reintroduction (A/R) is a commonly used tool in freshwater mussel conservation. The practice has changed greatly over the past thirty years as knowledge on the ecological requirements to implement successful A/R projects, the potential benefits, and the evolutionary and ecological risks have been better studied. We applied a standard framework to evaluate the need for A/R in Town Creek, a tributary to the upper Potomac River in western Maryland. We assessed numerous qualitative and quantitative factors that could influence mussels and project success to draft a plan with narrative and numerical goals and methods to monitor actions. Over five years, we stocked 2,722 mussels of three species into 400 square meter plots at four sites via propagation (Brook Floater) and translocation (Atlantic Spike and Eastern Elliptio). Project implementation and monitoring was impacted by a flood of record that displaced habitat and mussels, which necessitated adaptive changes. Habitat recovered after flooding and was amenable to continued stocking by the next summer. PIT tag recovery data suggests high, but declining site fidelity over time. We have direct evidence that this is due to tag loss, mortality, and emigration. Growth and survival of sub-adult Brook Floater in in situ enclosures was high over two different time periods. Annual surveys observed increasing mussel bed density, but not concurrent with stocking rate. This disconnect may be due to species-specific differences in survival and low capture probability. The second phase of the study is being scoped based on multiple lines of evidence indicating the success, albeit variable, of the first phase. This calls for expanding populations around the four existing sites, stocking at four more sites, and beginning Creeper augmentation. Changes in species-specific stocking rates and shifting from translocation to propagation of Elliptio species are also being considered.

THE HUNTERS STATION BRIDGE REPLACEMENT PROJECT, AN OPPORTUNITY FOR ENDANGERED SPECIES RECOVERY

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Freshwater mussels are one of the most imperiled taxonomic groups in North America; of the 297 known species, 71% are considered endangered, threatened or of special concern. Their recovery has become a priority for many wildlife conservation organizations because of the benefits mussels provide to water quality and instream habitat. However, resource managers have had difficulties obtaining individuals for recovery purposes as husbandry techniques for many species are still in a nascent stage, production costs for species that have been studied are high, and/or donor populations capable of sustaining some levels of removal are not available. A bridge replacement project over the Allegheny River, a waterway in Forest County, Pennsylvania known to support the largest remaining populations of the endangered Northern Riffleshell and Clubshell mussels, presented us with an opportunity to study the effect stocking density, size, and sex ratio had on the retention, survival, and growth of translocated individuals. Study sites were founded at three locations on the Shenango River and two locations on Conewango Creek in Mercer and Warren Counties, Pennsylvania. During the summer of 2014, 90 Northern Riffleshell and 90 Clubshell mussels of varying lengths and sexes were PIT tagged and stocked within two grids, one for each species, containing twelve, 1 m^2 cells at each relocation site. Densities ranging from 0 to 15 individuals/m^2 were replicated in triplet within each grid using a complete randomized block design. A waterproof antenna and reader was used to recapture and or detect individuals one and two years post stocking to assess survival, retention, and growth at each site. Quantitative surveys of the relocation sites were completed 3 years post stocking to search for naturally reproduced juveniles resulting from the translocation efforts. The results of this study provide insight into stocking practices that maximize the benefit of translocated individuals during threatened and endangered species recovery efforts.

REINTRODUCING FRESHWATER MUSSELS INTO THE RESTORED MISSION REACH OF THE SAN ANTONIO RIVER

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Anthropogenic stressors have led to the rapid decline of freshwater species in a myriad of ways, most notably through habitat loss and decreased water quality and quantity. Freshwater mussels (Unionidae), one of the most affected groups, have experienced significant population reductions in the Upper San Antonio River (USAR) due to urbanization and the channelization of the river to facilitate flood conveyance, while populations downstream remain robust. Completed in 2013, the San Antonio River Improvements Project established the Mission Reach, a 13 km restored portion of the USAR providing complex instream habitat and extensive riparian buffers to enhance ecosystem resilience. In 2017, plans to reintroduce freshwater mussels to the Mission Reach were initiated to restore the freshwater mussel community and their associated ecosystem services to the USAR. Multiple feasibility studies have been conducted by the San Antonio River Authority and partners within the Mission Reach to assess mussel survivability, habitat suitability, and host fish populations, while developing propagation methodology to inform and eventually supply the ongoing reintroduction efforts. Four native species were selected for reintroduction including the Threeridge *Amblema plicata*, Yellow Sandshell *Lampsilis teres*, Pistolgrip *Tritogonia verrucosa*, and Pimpleback *Cyclonaias pustulosa*. The first cohorts of propagated freshwater mussels were reintroduced into the Mission Reach in 2024, marking a significant milestone in the reintroduction project and the continued restoration of the USAR. Our objectives are to reintroduce these species into the restored Mission Reach and employ a mark-recapture study to monitor their survival and growth, dispersal, and determine the influence of large- and small-scale abiotic factors on reintroduction success. In the long-term, we aim to evaluate mussel recruitment and establish quantitative measures of ecological uplift through the ecosystem services that reintroduced mussels provide for the Mission Reach.

QUANTIFYING THE BIAS ASSOCIATED WITH SPATIAL VS TEMPORAL REPLICATION IN SINGLE SEASON OCCUPANCY MODELS: AN APPLICATION FOR RARE FRESHWATER MUSSELS

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Occupancy sampling is used in wildlife studies to assess species' presence and distribution. This method traditionally involves visiting sites multiple times to account for imperfect detection and recording at each visit whether the species was observed. An alternative to repeat visits involves breaking sites up into spatial replicates for assessing detection, which is appealing to managers because it requires only one visit to each site. Depending on the system and species, however, this substitution can result in biased estimates of occupancy because it fundamentally changes the assumption of the statistical model (i.e., from constant occupancy status across temporal replicates to constant occupancy status across spatial replicates). The objective of this study is to use simulated data to compare the bias associated with using spatially replicated vs temporally replicated occupancy models across a variety of input parameters (true proportion occupied, abundance, number of replicates, and detection probability). Sites were constructed and populated in Program R and sampled using specified detection probabilities (0.05, 0.10, and 0.15) using spatial and temporal replication. Capture histories were fitted in an occupancy framework to determine the difference between estimated and true values of watershed level occupancy. The spatial replication method resulted in positive bias in the occupancy estimates, especially at low values of true occupancy. The temporal method, in contrast, generally resulted in unbiased estimates. Consequently, estimates of occupancy were almost always greater when using the spatial method compared to the temporal method. While the motivation for this study arose from research on freshwater mussels, the trends observed are not unique to this taxonomic group, and this approach could be adapted to better understand the sampling dynamics of other species. This study can inform sampling protocol designs and potentially retroactive adjustments to previously derived estimates that may be useful for scientists and managers.

BIOMARKER DISCOVERY FOR EVALUATION OF FRESHWATER MUSSEL (ORDER UNIONIDA) HEALTH AND IMMUNE STATUS

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Challenges of assessing the health of imperiled mussels persist despite urgent needs for tools and resources to combat widespread, enigmatic declines and mass mortality events. In semi-structured focus group discussions, experienced freshwater mussel propagation biologists emphasized the necessity for standardized, non-invasive health metrics to quantify mussel resilience that could be easily applied to propagation facilities and field settings. We optimized methods to measure multiple biomarkers of immune status in hemolymph and validated the Millipore Scepter (a portable, hand-held cell counter) that eliminates limitations imposed by expensive laboratory benchtop equipment (Beckman Coulter Multisizer 4e) and travel times from mussel collection sites. K_2EDTA microtainers held on ice for up to six hours were the most viable option for hemolymph preservation based on consistency in total hemocyte count and cell morphometrics. We found a highly significant agreement ($p < 0.01$) in total hemocyte count between the Multisizer 4e and the Millipore Scepter. The relevance of changes in hemocyte count and cell morphometrics was then evaluated and additional metabolic biomarkers were identified using stressor experiments. Mussels were starved and exposed to lipopolysaccharide (LPS), a compound that mimics exposure to gram-negative bacterium in healthy and susceptible mussels. Hemolymph was extracted for hemogram characterization and metabolomics. Starvation and LPS exposure each independently modulated immune function, assessed using the hemogram, with more pronounced effects elicited in animals exposed to both stressors consecutively. Metabolic profiles revealed that itaconic acid (itaconate) may be a robust biomarker of infection in susceptible mussels, even without visible signs of diminished health. These quantitative metrics complement established nonlethal procedures and reflect health and resilience rather than absence of disease. Future studies could benefit from early engagement with propagation biologists to better ensure adoption of research products and tools.

ASSESSMENT OF SPATIAL VARIATION IN POPULATION CONDITION OF THE ESA LISTED GUADALUPE ORB (*CYCLONAIAS NECKI*), FALSE SPIKE (*FUSCONAIA MITCHELLI)*, AND GUADALUPE FATMUCKET (*LAMPSILIS BERGMANNI)* IN CENTRAL TEXAS

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The Guadalupe-Blanco River Authority is developing a basin wide Habitat Conservation Plan (GRHCP) to conserve the endangered Guadalupe Orb (*Cyconias necki*), False Spike (*Fusconaia mitchelli*), and Guadalupe Fatmucket (*Lampsilis bergmanni*) mussels. During GRHCP development a critical need for occupied density information was identified to inform future conservation. A multiscale hierarchical survey framework was implemented to gather occupancy and density data. Experimental design employed 10-meter survey transects parallel to stream flow at representative locations in multiple mesohabitats. Randomly sample sites were identified in longitudinally distributed reaches from 4 sub-basins. Riffle and run mesohabitats were targeted for *C. necki* and *F. mitchelli*, with pool habitat for *L. bergmanni*, from known habitat associations. Each 10m^2 transect was assessed with visual/tactile surveys and 4,500 cm^3 substrate sieves. An 80-120 m^2 search area was evaluated at each site. 616 transects were monitored at 54 sampling sites in 16 representative reaches of 4 sub-basins. This approach allowed for a multi-tiered evaluation of species population condition at the basin, sub-basin, survey reach, sampling site, mesohabitat, and transect levels. Surveys resulted in collection of 3,082 mussels from 13 different species with detected occupancy of 93.8 ± 6.1% per reach and total occupied transect density of 1.36 ± 0.14 mussels/m^2. Kruskal-Wallis tests identified significant differences in occupied density of endangered species at the sub-basin ($\chi2$ = 9.9392 p = 0.02), reach ($\chi2$ = 42.23 p = <0.001), and sample site ($\chi2$ = 122.6, p = <0.001) geographic scales. Occupied transect density for endangered species was greatest in the lower Guadalupe (0.34± 0.06 mussels/m^2), followed by the San Marcos River (0.24± 0.07 mussels/m^2), upper Guadalupe (0.15± 0.02 mussels/m^2) and middle Guadalupe (0.14 ± 0.02 mussels/m^2) sub-basins. Results indicate that the employed methodology is suitable for discerning differences in endangered species population condition at a range of geographic scales.

APPLICATION OF THE MUSSEL ASSEMBLAGE HEALTH INDEX (MAHI) TO ADDRESS THE DECLINE OF FRESHWATER MUSSELS

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The causes of widespread mussel declines remain poorly understood, and few assessment methods quantify the extent of decline and overall assemblage health. These combined limitations pose challenges to policy and resource management efforts to protect this highly imperiled group. Most previous studies focused on specific streams, and none has critically evaluated potential causes of mussel declines across a large geographical area. Similarly, available assessment tools are specific to particular streams or regions and depend on untested assumptions or subjective assessments of species' tolerance to various factors. Therefore, we developed a broadly applicable, objective mussel assemblage health index (MAHI). MAHI includes 4 metrics representing fundamental aspects of assemblage or population health (species loss, recruitment, abundance, and population growth). Metrics are scaled from 0 to 10 (representing increasing health), and the composite score is the unweighted mean of the 4 metrics. MAHI effectively discriminated healthy (median score 8.3) and degraded (3.2) assemblages. The composite score is robust to missing values. Composite scores were similar to independent scores provided by experts, but MAHI eliminates variation due to differences in individual perception or experience. MAHI can be applied to streams across eastern North America using commonly collected mussel survey data, and it could be adapted to other regions. MAHI is free of untested assumptions or subjective assessments, and it accounts for expected differences in mussel assemblages due to stream size, biogeographic region, and other intrinsic factors. Importantly, MAHI does not correlate to other commonly used assessments like fish and aquatic insect index of biotic integrity (IBI) scores, which further highlights benefits for adoption of MAHI including capturing environmental stressors to enable early detection of mussel declines, better understanding the causes of declines, and evaluating the effectiveness of conservation strategies and management actions.

LEVERAGING PUBLICLY AVAILABLE STATE AND FEDERAL BIOASSESSMENT DATA WITH FRESHWATER MUSSEL SURVEYS

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The U.S. federal government and many U.S. states routinely conduct bioassessment surveys (hereafter "biosurveys") to evaluate and monitor the biological condition of wadeable rivers and streams. Examples of such programs include USEPA's National Rivers and Streams Assessment (NRSA) and Michigan's Qualitative Biological and Habitat Survey Protocol for Wadeable Streams and Rivers (Procedure 51). These programs characterize fish and benthic invertebrate communities, physical habitat, water chemistry, and sometimes other parameters such as contaminants in fish tissue and surface water. Biosurvey results are primarily used to document existing conditions of wadable streams, evaluate attainment of Clean Water Act (CWA) designated uses for water courses, and assess spatial and temporal trends in the health of biological communities. Agency-generated biosurvey data, including NRSA data, is publicly available and may provide insights related to freshwater mussel (Family Unionidae) communities and occurrence despite mussels not typically being included as a target organism in standardized biosurvey methodology. This presentation will discuss ways in which biosurvey data may be integrated into mussel survey planning and highlight other potential avenues to leverage biosurvey data to support interpretation of mussel survey results.

“STORIES FROM THE FIELD” AND THE NEED FOR A CENTRALIZED NATIVE MUSSEL DATA BASE IN MICHIGAN

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Native mussel studies in Michigan in the past 30 years have had overlapping activities at sites that are popular because of rare species occurrences or easy accessibility. Since 2017, construction permitting for waters in Michigan now includes required surveying and potentially relocating freshwater mussels when there are instream construction impacts. This has led to a substantial increase of mussel surveys around the state, particularly by consulting firms. Permitting and reporting for mussel surveys in Michigan are required at three levels: common species (including special concern species), state threatened and endangered species, and federally listed species. However, reporting formats for each of these levels are different. Survey sites where no mussels were found are often not reported, either. As a result, survey and relocation activities have not always been available in a timely manner to resource managers overseeing mussel survey plans (i.e., MDNR Watershed biologists and/or USFWS biologists). This may lead to a potential overlap in surveys, mussels being handled continuously by different groups at different times, or relocation sites not being flagged. In addition, researchers trying to study “natural” populations may not be aware of previous work. Universities or other organizations using sites for educational purposes may not be aware of surveys or relocations occurring at the sites. A central data base of activities available to resource managers would allow more accurate communication to researchers and consultants doing mussel work in Michigan. Different approaches to establishing a data base will be presented in this session.

VIEWS FROM THE HIGHWAY: BUILDING A DATASET AND MUSSEL PROGRAM IN MICHIGAN

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Over the past decade, new tools and procedures have been established to evaluate and mitigate construction impacts to freshwater mussels. Rewind to 2015, however, and the regulatory environment around mussels in Michigan was less developed and robust. During this period, the Michigan Department of Transportation (MDOT) began building an internal dataset to track and monitor mussels in state right-of-way (ROW). These data were drawn from consultant and in-house surveys at culverts, bridges, and streambank stabilization sites. To date, over 160 sites and 40,000 mussels have been added to our ArcGIS based system, which includes all rare and common species as well as "zero" sites. Approximately 34 ROW sites support state or federally listed mussels, with another 41 supporting special concern species. Tracking data over the past decade has helped inform project reviews, provided data for individual project biological assessments and programmatic agreements, identified stream crossings for our "protected areas" program, and reduced duplication of effort. This presentation traces back the last decade of data and protocol advances in Michigan, internal data management efforts by MDOT, and offers a positive outlook on how this momemtum could help support conservation and research in the future.

BEYOND PRESENCE/ABSENCE DATA – TRACKING FRESHWATER MUSSEL RELOCATIONS AND PROPAGATION RELEASES

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The Commonwealth of Virginia has a rich freshwater mussel fauna with upwards of 80 species, ranking the state around 6th in diversity nationwide. As such, the Virginia Department of Wildlife Resources (DWR), and other conservation partners, have long been active with various mussel conservation actions, generating copious amounts of information. DWR gathers this data from scientific collection permittees and maintains it in a centralized geodatabase, not unlike other state wildlife agencies. This geodatabase is relatively simple and set up to capture data primarily as presence/absence. Because of its relative simplicity, more complex data from sources like mussel relocations does not fit well within the database. However, maintaining this data is critical, so that DWR and other partners can potentially monitor these mussels over time to help document the viability of relocations as a minimization tool. Along with other mussel data, a more detailed, nongame aquatics database, which is managed by the state malacologist, is used to capture relocation data. A simple project-field identifier allows for this data to be easily queried. Similarly, Virginia has been one of the most active states in mussel propagation. Initially, this data was maintained through electronic release forms. While this was sufficient 15+ years ago when the mussels being released were small, untagged and not individually measured, this has changed with the ability to grow out and release larger mussels. The nongame aquatics database is insufficient to maintain this data, so a more specialized database was developed. This database allows us to quickly query data to answer questions such as how many mussels have been released of a particular species or over time, and spatially display the data. This data can also now be easily and readily shared with conservation partners.

IT TAKES A VILLAGE- BUILDING, MAINTAINING, AND IMPLEMENTING A STATEWIDE MOLLUSK DATA MANAGEMENT SYSTEM

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Mollusk data can take many shapes and forms and gets ever more complicated as our conservation programs grow, and as technology becomes more advanced. In the state of Tennessee, we have around 140 freshwater mussel species and nearly 100 species of freshwater snails, many of which are federally listed. Our mollusk program has been long established, which has resulted in a plethora of data ranging from relocations, survey results, and propagation releases from not only our own staff at Tennessee Wildlife Resources Agency (TWRA) but also our numerous partners including academics, consultants, and other government agencies. At this point in time, we are in the early phases of building a Mollusk Data Management System. This process is more than just building a presence/absence database. Simply put, this data management system will allow us to integrate multiple databases, streamline permit processes, and will provide us with powerful query capabilities leading to a better understanding of statewide mollusk health and population stability. While we have a challenging data journey ahead of us, we are excited to see the positive impacts it will have on our future mollusk conservation and management efforts.

DEVELOPMENT OF A FEDERALLY LISTED MUSSEL DATASET AND ANALYTICAL PIPELINE

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The U.S. Fish and Wildlife Service (USFWS) requires permit holders handling federally listed mussels to submit data collected during their activities . These data are critical for assessing species status, minimizing impacts, and informing recovery actions. Historically, these submissions have varied in format and structure, making data compilation challenging and limiting their overall utility. To address this issue, Region 3 of the USFWS has initiated an effort to standardize reporting requirements by identifying essential data needed to support recovery efforts. As part of this initiative, the US Geological Survey Wisconsin Wildlife Cooperative Research Unit are collaborating with USFWS to develop a reproducible analytical pipeline that streamlines data quality evaluation and compilation. These improvements have enabled us to create a mussel permit spatial dataset covering an 8-state region, 42 mussel species , 25 permit holders, and 771 surveys. Our data pipeline toolkit is robust as it incorporates normalized databases, version control, and reproducible error testing. In addition, our framework is also readily adaptable to other taxonomic groups and workflow modifications. Moving forward, we hope that this database will allow USFWS and other researchers to efficiently enter, track and analyze data, ultimately enhancing the utility of these permit data for freshwater mussel management and conservation.

LARGE-SCALE MUSSEL RELOCATION IN THE WISCONSIN RIVER - SUCCESSFULLY AVOIDING AND MINIMIZING TAKE OF LISTED SHEEPNOSE AND SALAMANDER MUSSELS

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In 2023 and 2024 GEI Consultants and Daguna Consulting collaborated in the planning and implementation of a large-scale mussel survey and relocation effort in south-central Wisconsin which was conducted prior to the rebuild and expansion of an existing interstate bridge spanning the Wisconsin River. Previous surveys had identified state and federally listed mussel species in this segment of the Wisconsin River, so an extensive relocation effort involving coordination with state and federal agencies was required. Mussels were cleared from >38,000m^2 using quantitative transect and meander search techniques. A series of survey blocks and transects were set up in primary and secondary zones of impact to ensure complete coverage. Detailed site characteristics data was collected in accordance with survey type, and mussels collected were identified and measured. Approximate age and sex were determined for a subset of specimens to provide insights into the population dynamics of this site. Searches resulted in the recovery and relocation of nearly 13,000 mussels across 23 species, including listed species such as Sheepnose (*P. cyphyus*) and Salamander Mussel (*S. ambigua*). The most dominant species across the site was Plain Pocketbook (*L. cardium*), representing approximately 26.2% of all individuals observed. Since Higgins Eye (*L. higginsii*) had previously been identified at this location in 2015, genetic testing was incorporated into the project to confirm whether it was currently present at the site or if observations were of the morphologically similar Hickorynut. A subset of mussels collected were tagged with a passive integrated responder (PIT) tag and nearly 3,000 individuals were marked with a shellfish tag or were Dremel marked. In this presentation the relocation techniques utilized, and survey results will be detailed. Post-relocation monitoring efforts will also be discussed, as well as prospective plans for on-going monitoring and mitigation, and how this work plays an important role in the species distribution and freshwater community in the Wisconsin River.

DEVELOPMENT OF AN INVENTORY AND PRACTITIONER NETWORK TO IMPROVE AQUATIC CONSERVATION TRANSLOCATIONS

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Freshwater animals globally face urgent threats that may require *ex situ* conservation actions. The IUCN defines conservation translocation as the deliberate movement of organisms from one site for release in another to yield a measurable conservation benefit beyond that to translocated individuals. These practices may include supplementation and reintroduction within a native range, as well as assisted colonization or niche replacement outside the native range. These approaches have been used in the southeastern United States for many nongame aquatic species in an effort to achieve species recovery, to prevent extinction, or to preclude listing. However, the multitude of organizations and agencies that participate in conservation translocation efforts has led to diverse and diffuse record-keeping. While the actual release or stocking of nongame aquatic species are reported to permitting agencies in different ways, there is not a regional or national standardized reporting form or database that tracks these reintroductions uniformly. To begin discussions on record-keeping needs for conservation translocations of nongame aquatic species, the Tennessee Aquarium hosted a two-day workshop for conservation practitioners across North America. Participants agreed that our fundamental goal is to improve aquatic conservation translocation outcomes. Our initial step is to develop an inventory of ongoing recently completed aquatic conservation translocations, with particular focus on the southeastern United States. To complement this inventory, we also seek to build a network of aquatic conservation translocation practitioners. Once these steps are completed, we can assess need and feasibility for scaling this effort both temporally and geographically.

IMPLEMENTATION OF THE WEST VIRGINIA MUSSEL SURVEY PROTOCOL ON A GROUP 4 SECTION OF THE OHIO RIVER: A CASE STUDY

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The West Virginia Mussel Survey Protocol (WVMSP) is viewed by many to be one of the most comprehensive methodology guidelines in the country. It was originally created as a joint venture between West Virginia Division of Natural Resources and the United States Fish & Wildlife West Virginia Field Office. Numerous other states have either adopted the protocol and the survey and salvage methodologies contained therein as valid methods within their state. In other cases, states have created their own protocol based off the WVMSP while adapting the protocol to better fit the specific needs of their state's mussel resources including differing methodologies for specific mussel fauna, survey conditions, and biogeography. Herein, we present a case study of the application of the WVMSP on a large river (Ohio) in an area known to contain federally and state listed mussels. We present a detailed walkthrough of the project from conception to field surveys and results, and how the WVMSP shapes these components of a survey. The project site on the Ohio River in Mason County, West Virginia involved over 15 acres of direct instream impacts spanning over 1.1 miles of shoreline. This project presents a unique application of the protocol on a spatial and temporal scale likely never seen before, in a situation with highly visible economic impacts. Preliminary survey efforts conducted across 34,240 meters of linear transects surveyed resulted in the collection of 13,007 mussels of 26 species with multiple fed and state listed species collected. Implementing the WVMSP on a project of this scale presented novel challenges, but displayed the flexibility and widespread applicability of the guidelines. We seek to communicate these challenges, highlighting pros and cons of the WVMSP, and further discussions about continual updates to these types of living documents.

SAMPL: AN AGENT BASED MODEL TO EVALUATE SPATIAL SAMPLING STRATEGIES

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Accurate and reliable information about populations is essential for informed conservation and management of threatened and endangered species like freshwater mussels. However, while many survey methods exist for assessing population characteristics, testing their efficacy in the field can be challenging given that characteristics of true populations are rarely known. We introduce Survey Analysis for Monitoring Populations (SAMPL), a novel agent-based model designed to simulate different population attributes and their implications for the performance of various field sampling techniques. In this iteration of SAMPL, we use freshwater mussels as our case study and simulate four common mussel sampling methods: simple random sampling, transect sampling, adaptive cluster sampling, and qualitative timed searches. SAMPL allows the user to experimentally manipulate both survey methodology (e.g., number and size of quadrats, transect spacing, number of initial samples) and mussel population metrics (e.g., density, spatial distribution, species' frequency and detectability) to assess the corresponding effects on survey performance. Here, we provide a brief introduction to SAMPL's key features and demonstrate its utility using a case study that assesses the effects of declining detectability on the performance of qualitative timed searches. We showcase how different sampling regimes and spatial distributions can influence population density estimates and describe the impacts those inferences can have on long term species management.

DAMS AND CLAMS: RESERVOIR DRAWDOWNS AND FRESHWATER MUSSEL RELOCATIONS

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Freshwater mussels are among the most imperiled group of animals in the world, and reservoirs can host large populations; 1 million or more in large reservoirs. Reservoir drawdowns (RRDs), for whatever purpose, and dam removals can seriously impact mussels in the reservoir and downstream of the dam sites. The State of Michigan has recently written a protocol for rescuing and relocating mussels in the course of RRDs. It discusses planning and executing a mussel rescue and relocation; search, rescue and handling techniques; relocation techniques; and post-RRD monitoring. Historical research on this topic and selected case studies will also be discussed.

INCIDENTAL TAKE PERMITS AND HABITAT CONSERVATION PLANS: DEVELOPMENT OF AN HCP FOR FRESHWATER MUSSELS AND AGRICULTURE IN THE SOUTHEASTERN U.S.

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One tool offered by the U.S. Fish and Wildlife Service for conservation of federally listed species is an Incidental Take Permit, which allows for limited "take" under the Endangered Species Act during otherwise lawful activities. Often the most difficult aspect of conserving aquatic species is competition over water with other consumers including agriculture and industry. This talk will provide an overview of the ongoing development of a freshwater mussel HCP in southwestern Georgia. It is designed to provide for agricultural and mussel needs during occasional periods of growing season water scarcity.

VIRTUAL: AN AQUATIC SPECIES AT RISK THREAT ASSESSMENT AND PRIORITIZATION EXERCISE FOR THE LOWER THAMES VALLEY CONSERVATION AUTHORITY WATERSHED

Vicki L. McKay – Lower Thames Valley Conservation Authority
Sarah E. Walton-Rabideau – Lower Thames Valley Conservation Authority
Neil Pothier – Lower Thames Valley Conservation Authority
Daniel Nydam – Lower Thames Valley Conservation Authority
Mark Peacock – Lower Thames Valley Conservation Authority
Sarbjit Singh – Lower Thames Valley Conservation Authority

The Lower Thames Valley Conservation Authority (LTVCA) undertook a two-year aquatic species at risk (SAR) threat assessment to better understand how a suite of environmental factors and stressors may impact 18 fish and 15 mussel SAR inhabiting the region's 58 subwatersheds and their critical habitats. Threats reviewed revolved around biology, soils, ecosystem modifications, climate change, water quantity, drainage and connectivity, groundwater, urban development and water quality. Threat information was assessed, using four different approaches, to rank 41 subwatersheds containing, or upstream of, one or more SAR. Threats selected for the prioritization exercise could be physically managed or mitigated through stewardship activities. These included soil erosion rates, turbidity levels, percent riparian shading, proportion of water quality samples exceeding provincial guidelines, calculated risk of water contamination and benthic indices. Eleven subwatersheds were identified as priorities for restoration and mitigation actions based on data availability. Those ranked based on sheer size indicated restoration efforts were needed in the western end of the watershed, while prioritization based on a per hectare basis shifted the focus to subwatersheds in the east. Focussing restoration efforts on these 11 priority subwatersheds allows the LTVCA to direct limited SAR funding to targeted projects in areas most likely to benefit aquatic SAR recovery. Virtual Talks will be available throughout Symposium.

EDENVILLE DAM RESTORATION PROJECT HABITAT CONSERVATION PLAN FOR THE SNUFFBOX MUSSEL

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The Edenville Dam Restoration Project Habitat Conservation Plan (HCP) for the Snuffbox Mussel (*Epioblasma triquetra*) is an application for an incidental take permit under Section 10 of the Endangered Species Act (ESA). The Edenville Dam impounds the Tobacco River and Tittabawassee River, forming Wixom Lake in Gladwin and Midland County, Michigan, approximately 1 mile upstream of the confluence of the two rivers. The dam was damaged during a storm event, causing the lake to drain. Following the draining of the lake, mussel surveys were conducted, and a small portion of the former lake was found to have suitable snuffbox habitat, one live snuffbox, and valves from several snuffbox. Restoration of the lake to its former elevation will flood this habitat and result in incidental take of the mussel and suitable habitat.

An HCP requires the creation of biological goals and objectives that offset the effects of the project and put the avoidance and minimization measures in the context of the species biology. It also requires a monitoring and adaptive management strategy that ensures the HCP goals and objectives are achieved. In exchange, the permittee receives a long permit term within which to achieve the HCP goals.

As more mussel species become federally listed per the ESA, there are likely to be increased opportunities for HCPs. Not only do HCPs provide for incidental take permits under the ESA, they also offer opportunities to do long-term, landscape-level conservation planning, and provide permit streamlining, regulatory certainty, and operational flexibility. Also, the Cooperative Endangered Species Conservation Fund Grant program allocates monies for data collection, planning, writing, and early implementation of HCPs. In this talk we provide a general overview of HCPs, using nationwide examples, and deliver a focused discussion on the Edenville Dam HCP.

THE FUTURE OF FRESHWATER MUSSEL PROPAGATION: BRIDGING THE GAP BETWEEN BASIC RESEARCH AND APPLIED ECOLOGICAL RESTORATION INITIATIVES

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Freshwater mussel propagation efforts continue to grow across North America, but the proximate and ultimate goals of these programs often vary across species and regions, along with the relative success of these initiatives. Applying the existing body of scientific literature on freshwater mussel species to approach conservation and restoration initiatives with careful consideration may lead to enhanced outcomes. The breadth of research on mussel ecosystem services, population genomics, phylogenomics, and ecology continues to expand, and harnessing these data to create species and community-centric management plans can help stakeholders and managers establish desired restoration outcomes. Examining data from existing literature, we consider how conservation managers can utilize peer-reviewed research to develop action plans for the propagation of at-risk mussel populations and communities. In addition, we discuss the Partnership for the Delaware Estuary's plan for building a state-of-the-art propagation facility in Philadelphia for the restoration of mid-Atlantic freshwater mussel species, and welcome feedback on our current initiatives.

COLLABORATIVE WILDLIFE PROTECTION AND RECOVERY INITIATIVE: ADVANCING FRESHWATER MUSSEL CONSERVATION THROUGH COMMUNITY COLLABORATION

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USGS Mussel Collaborative

The Collaborative Wildlife Protection and Recovery Initiative (CWPRI) is an informal partnership of federal and state agencies and non-governmental parties interested in recovering listed species and preventing new listings under the Endangered Species Act. In 2024, a Freshwater Mussel Workgroup was formed under CWPRI to unify and strengthen freshwater mussel conservation through multi-organization collaboration. Freshwater mussels are among the most imperiled faunal groups globally, yet they play a vital role in aquatic ecosystems by improving water quality and stabilizing habitats. Despite ongoing conservation efforts, progress is often slowed by gaps in research, fragmented strategies, regulatory challenges, and uncoordinated community engagement. This workgroup was created to bring mussel practitioners together under a shared framework to address these challenges. The workgroup is centered around four pillars: conservation (restoring habitat, improving water quality, and recovering species), research (filling knowledge gaps in mussel ecology, distribution, and propagation), regulatory efficiencies (streamlining permitting and agency coordination), and community engagement (connecting managers, researchers, students, and the public). Our kickoff meeting engaged about 60resource practitioners from 30 organizations. The first two steps initiated under this effort include summarizing information on current freshwater mussel working groups to ensure that CWPRIs efforts are not duplicating research already being addressed elsewhere. Second, synthesizing information on the species of greatest conservation need across states to develop a focal list of mussel species that could be addressed by this workgroup. We also hope to identify how this workgroup could align with and complement existing efforts, including those led by the Freshwater Mollusk Conservation Society. We hope to provide attendees examples of how they can engage with this workgroup based on their interests and expertise to build a stronger, more connected freshwater mussel conservation community.

INVASIVE AND NON-LISTED MUSSEL SPECIES DATA COLLECTION AND HISTORIC DATA CONSOLIDATION

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Currently, invasive and non-listed freshwater mussel data are spread across numerous independent sources including public reporting platforms such as the Midwest Invasive Species Network (MISIN) and USGS Nonindigenous Aquatic Species (NAS) for invasives, and Michigan Natural Features Inventory (MNFI) heritage database, university research and state/federal required reports for natives. Understanding the spatial extent of invasive and native mussel communities will aid in critical uncertainty preventing the development of effective managment strategies for native mussels. To address data gaps and "seed" the Michigan mussel database, the Michigan Department of Natural Resources (MDNR) and MNFI are collaborating in the consolidation of Michigan's invasive and native mussel data. MNFI have developed a backlog mussel database utilizing Survey123 for the entry of Michigan's past mussel data. This presentation will discuss the MDNR's role in data consolidation, MNFI's mussel backlog database, progress made and intended results.

MICHIGAN'S NATURAL HERITAGE DATABASE – HOW SNAILS AND MUSSELS ARE TRACKED IN MICHIGAN

Rebecca L. Rogers - Michigan Natural Features Inventory, Michigan State University Extension, Lansing, Michigan, USA, 48933.

Michigan Natural Features Inventory (MNFI) has maintained the Michigan's Natural Heritage Database for over 40 years and aims to be the state's most comprehensive source for biodiversity data. During this session you'll learn about MNFI, the NatureServe Network, heritage methodology and we will look at how snails and mussels are tracked in Michigan. We'll also introduce the MNFI team and walkthrough the web-based and mobile app to submit your own observations and talk about how MNFI shares data with partners.

MICHIGAN FRESHWATER MUSSEL DATABASE DEVELOPMENT PROJECT

Jocelynne Samu-Pittard, USFWS

Currently, no singular database for freshwater mussels exists for the state of Michigan, so the U.S. Fish and Wildlife Service (USFWS) is working with partners from across the state to develop one. The goal for this Michigan mussel database project is to develop a single location in which state mussel data for both native and invasive species is housed in an accessible, searchable, and mappable manner. The database and associated Survey123 form are intended to decrease data gaps while increasing access to state-wide mussel data to improve management decisions and research. Through this process, we have worked to navigate the federal data policies while addressing the needs of stakeholders. Though there is more work to be done and decisions to be made, this presentation will discuss intended results, progress made, lessons learned for what to avoid, and what has worked well.

A TALE OF TWO ISLANDS: MOLLUSK INVENTORY UPDATES AT OHIO RIVER ISLANDS NATIONAL WILDLIFE REFUGE

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The Ohio River Islands National Wildlife Refuge manages 24 islands in six pools of the Ohio River, covering over 350 river miles. The refuge is home to approximately 45 species of freshwater mussels, including 10 federally endangered or threatened species, and at least 4 species of freshwater snails. However, data on mussel and freshwater snail populations around the majority of refuge islands is minimal or over 20 years old. To assess if populations around islands are meeting refuge objectives for diversity, density, and recruitment, we began a novel mollusk inventory in 2022, and surveys are completed for two high priority islands. We are using a systematic sampling approach, with survey points distributed evenly around islands, and collect data on mussel and snail diversity and abundance along with depth and substrate composition. We found 170 live mussels from 15 species at Paden Island and 614 live mussels from 14 species at Upper Twin Island. Each island had two species that were not found at the other. Density at a point ranged from 0 – 3 mussels/m2 at Paden and 0 – 9 mussels/m2 at Upper Twin. We found uneven distribution of mussels and snails around each island and observed patterns tied to distance from the navigation channel or higher flows. These results have already served to guide mussel relocation and reintroduction projects, and we plan to continue island inventories moving forward.

MUSSEL AND GASTROPOD DISTRIBUTIONS IN EL SALVADOR

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Drastic declines in freshwater mollusk populations have raised global awareness of their conservation; however, information on their biology, species diversity, distribution remains limited in El Salvador. Between 2022 and 2024, surveys across rivers, lagoons, and lakes in El Salvador documented diverse mollusk species. We recorded four mussel species: *Nephronaias lempensis*, *N. goascoranensis*, *Mycetopoda siliquosa,* and the invasive *Sinanodonta pacifica*. *M. siliquosa* and *N. lempensis* occur in Ostúa, Lempa, and Grande de San Miguel Rivers as well as El Jocotal and Olomega Lagoons, while *N. goascoranensis* was restricted to the Goascorán River. Native mussels were often found with macroinvertebrates such as Platyhelminthes, annelids (Clitellata), and arthropods (Hexapoda: Diptera). High juvenile mortality events of N. lempensis were observed during the dry season due to reduced water levels in Rio Grande de San Miguel. The invasive *S. pacifica* was abundant in Lake Güija, with recent detections in Cerrón Grande Reservoir, while *Corbicula fluminea* was found in the estuarine portion of the Goascorán River. Sphaeriidae was associated with submerged plants and rocks in small rivers. Native bivalve species are included in the National List of Threatened Species of El Salvador. At least 10 freshwater gastropod species were recorded, including commercially important *Pomacea flagellata*, *Pachychilus chrysalis*, *P. largillierti*, and *P. subexaratus*. Other families included Ampullaridae, Ancylidae, Hydrobiidae, Physidae, and Planorbidae, with *Clypeolum latissimum* (Neritidae) reported from river rocks near the sea. The invasive *Melanoides tuberculata* and *Tarebria granifera* were abundant across diverse habitats. This study underscores the need for continued research and conservation of freshwater mollusks in El Salvador.

FRESHWATER MUSSELS OF CENTRAL ANND SOUTH AMERICA (UNIONIDAE, HYRIIDAE, MYCETOPODIDAE): DISTRIBUTIONAL PATTERNS AND OTHER COOL STUFF

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The recent freshwater mussels of the order Unionoida are represented by six families: Unionidae, Margaritiferidae, Hyriidae, Iridinidae, Mycetopodidae, and Etheriidae. Only the Unionidae, Hyriidae, and Mycetopodidae are represented in Central and South America. We will discuss patterns of distribution and endemism of mussels from the Río Grande south to Patagonia. The Central and South American mussel fauna is entirely distinct from that of North America and there are only four species of mussels sharded between Central and South America. Most of the species described by the early workers were short, vague, occasionally illustrated, and often based upon a single specimen. In addition, many of the the type localities were extremely vague consisting of a single river or country or in many cases completely unknown. As a result, the distribution and conservation status of freshwater mussels in Central and South America are still incompletely understood. Our designation of various species as valid or endemic are working hypotheses. Molecular phylogenetic analyses based on multiple mitochondrial and nuclear genes coupled with morphological and life history studies will result in some widespread taxa being broken up as cryptic species are discovered, and others lumped. It is our hope that providing a complete list of species described, distribution maps, photographs of type specimens, and georeferenced type locality data for all of the names applied to Central and South American freshwater mussels will encourage additional studies to better document species distributions and test hypotheses regarding the evolution and systematics of the rich and interesting freshwater mussel fauna in Central and South America.

CONSEQUENCES OF LONG-TERM DECLINES IN FRESHWATER MUSSEL ABUNDANCE DEPEND ON LIFE HISTORY STRATEGIES

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The causes and consequences of declining freshwater mussel biodiversity and biomass (defaunation) depend on species traits that regulate which species are vulnerable to particular stressors and the ecosystem-level consequences of declines. Areas with high levels of mussel species richness and endemism, such as the southeastern USA, are especially vulnerable. We used a >30-year long-term monitoring dataset and a trait-based framework to identify defaunation in multi-species freshwater mussel aggregations. Losses of mussel density were associated with biomass declines of 51–83%, and consequent losses of mussel-generated carbon and nutrient recycling and storage of 47–83%. Mussel aggregations became defaunated and lost function in rivers where drought conditions were more severe and/or frequent during the study. Unexpectedly, declines did not differ among thermal tolerance guilds—both thermally sensitive and thermally tolerant species declined in defaunated streams. Rather, the taxa driving the declines in density and ecosystem function were equilibrium strategists adapted for stable hydrologic conditions (low fecundity, long lifespans, late age at maturity). We suggest that the ecophysiological traits that impact individual survival may be more important in governing drought-induced defaunation at shorter time scales, while life history traits that govern population recovery may be more important at longer time scales. Given the significant role that river ecosystems play in global biogeochemical processes, defaunation of mussel aggregations may have major consequences if continued unchecked. These losses and their consequences may be especially significant in the southeastern USA, where freshwater biodiversity—and threats to that diversity—are high.

POLYMORPHISM IN THE AGGRESSIVE MIMICRY LURE OF THE PARASITIC FRESHWATER MUSSEL LAMPSILIS FASCIOLA

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Unionoid mussels (Bivalvia: Unionidae) are free-living apart from a brief, parasitic, larval stage that infects fish, and gravid female mussels have evolved a spectrum of strategies to infect fish hosts with their larvae. In many North American species, this involves displaying a mantle lure that acts as an aggressive mimic of a host fish prey, thereby eliciting a feeding response that results in host infection. The mantle lure of Lampsilis fasciola is of particular interest because it is apparently polymorphic, with two distinct primary lure phenotypes. One, described as “darter-like”, the other, described as “worm-like” and has an orange and black coloration. We investigated this phenomenon using genomics, captive rearing, biogeographic, and behavioral analyses. Within-brood lure variation and within-population phylogenomic (ddRAD-seq) analyses of individuals bearing different lures confirmed that this phenomenon is a true polymorphism. The relative abundance of the two morphs appears stable over ecological timeframes: the ratio of the two lure phenotypes in a River Raisin (MI) population in 2017 was consistent with that of museum samples collected at the same site six decades earlier. Within the River Raisin, four main “darter-like” lure motifs visually approximated four co-occurring darters, and the “worm-like” lure resembled a widespread common leech, Macrobdella decora. In situ field recordings of the L. fasciola “darter” and “leech” lure display behaviors, and the lure display of co-occurring congener L. cardium, were captured. Despite having putative models in distinct phyla, both L. fasciola lure morphs have largely similar display behaviors that differ significantly from that of sympatric L. cardium individuals. Discovery of discrete within-brood inheritance of the lure polymorphism implies potential control by a single genetic locus and identifies *L. fasciola* as a promising study system to identify regulatory genes controlling a key adaptive trait of freshwater mussels.

FIRST REPORT OF PARAERGASILUS RYLOVI IN FRESHWATER MUSSELS IN POLAND

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Ergasilids are ectoparasites of many freshwater fish species. *Paraergasilus rylovi* is the only ergasilid copepod known to infect freshwater mollusks. The most detailed ecological research on the species was done in Finland. It was described that adult females of *P. rylovi* parasitize mainly *Anodonta anatina* and *Pseudanodonta complanata* gills. Although the virulence of *P. rylovi* in mussels is not known, but the ergasilids of fish feed on gill tissues and blood. Ergasilids may cause deformation or necrosis of the gill filaments and sometimes high host mortality among fishes.

Finding bivalves infected with the same crustacean species in Poland gives an opportunity to provide new data on this parasite species and to deepen research. We had an opportunity to examine five species of Unionidae and *Dreisenna polymorpha*. The *P. rylovi* was inhabited the gills of *A. anatina*, *A. cygne*a, *U. tumidus*, and *D polymorpha*. We didn’t find the parasite inside *U. pictorum* and *P. complanata*. Due to uncertainties arising in the literature regarding the correct identification of the species, genetic analysis was carried out. Thanks to new imaging methods, we hope to record potential changes (damages) in the gills resulting from the presence of *Paraergasilus rylovi* and prove their parasitic nature and level of negative impact on the functioning of their host.

PARASITES AFFECTS FRESHWATER MUSSELS' BEHAVIOR

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Parasites' influence on hosts' behaviour is well known and described in several publications, however just a few concern bivalves. Most studies on parasitism on freshwater mussels concern about their mortality and physiology. The most common parasites of freshwater mussels include digenic flukes (like *Rhipidocotyle campanula* or *Rhipidocotyle fennica*) or aquatic mites. In our study we decided to test if the mussels' behavior is affected by the infection of castrating digenean trematode (genus *Rhipidocotyle*), by performing experiments (including Critical Thermal Maximum) on specimens of *Unio elongatulus* form Lake Maggiore (Italy). All behavioural responses where sampled with observations (camera recording and sampling of all occurrences of behaviour method) as well as with Hall sensors (gapping behaviour response). After experiments the animals were examined with two methods (non-invasive and invasive) in order to test if they were infected with parasites and how strong was the infection. Significant differences in behavior were found between parasite-infected and healthy individuals especially in Critical Thermal Maximum experiments. This may indicate that the trematode change the behavior of their hosts in favor of their own development.

DEVELOPMENT AND VALIDATION OF ENVIRONMENTAL DNA ASSAYS FOR THE DETECTION OF FRESHWATER MUSSELS

Eric Waits, Lucas Smith, Kathleen Patnode, Janet Clayton, Monte McGregor, Taylor Fagin, Michael Compton, Nathaniel Shoobs, and Amy Bergdale

Monitoring freshwater mussel occupancy can be challenging due to benthic life histories, limited abundance of many imperiled species, and habitat fragmentation. Environmental DNA (eDNA) monitoring offers a sensitive, efficient, and noninvasive approach to assist in the detection of mussels sight-unseen. Here we describe the development and validation of species-specific eDNA assays for the detection of species of conservation concern, as well as a metabarcoding assay aimed at detecting all freshwater mussel species. TaqMan assays were developed for the federally-endangered northern riffleshell (*Epioblasma rangiana*), snuffbox (*Epioblasma triquetra*), dwarf wedgemussel (*Alasmidonta heterodon*), and ring pink (*Obovaria retusa*), and the critically-imperiled brook floater (*Alasmidonta varicosa*). For species-specific assays, primer and probe sets were tested for specificity against DNA from 74 *Unionidae*, including co-occurring species. In vitro tests consistently detected focal species at environmentally relevant concentrations. No cross-amplifications were detected in non-target species for any of the eDNA assays, confirming species specificity. A novel metabarcoding assay designed to detect freshwater mussel species will also be presented. Currently, a database is being populated with the voucher DNA sequence information needed to assign species identities when cross-referencing metabarcoding data. The eDNA assays presented herein provide an efficient and non-invasive means to inventory and monitor freshwater mussel species and can be used complement traditional monitoring efforts.

DEVELOPING A COORDINATED APPROACH TO EVALUATE FRESHWATER MUSSELS ACROSS OREGON AND WASHINGTON

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Freshwater mussels are vital to the health of rivers and streams. Populations of freshwater mussel species in western states are experiencing range contractions and mass mortality events. Despite the conservation concerns, freshwater mussels frequently go unnoticed and there is limited quantitative data to support species management and conservation efforts across Oregon and Washington. Distribution information and tools that are needed to assess mussel population health and viability are lacking in this region. Both Oregon and Washington list freshwater mussels as species of greatest conservation need in their statewide action plans and one species, the western ridged mussel, is currently under consideration for federal ESA listing.

To help address data gaps, we developed a multi-agency effort combining environmental DNA (eDNA) collection with recently standardized visual survey methods. Using eDNA provides a cost-effective method for detecting presence. Combining eDNA with standardized visual surveys has advanced our understanding of population attributes for multiple freshwater mussel species across Oregon and Washington watersheds in ways not previously possible. Information collected in a coordinated manner across a large geographic scale provides the opportunity to develop techniques and standardize criteria for assessing mussel bed viability benefiting fish and wildlife management agencies of multiple states.

The overall objective of this project is to develop and coordinate a survey and assessment project for freshwater mussels in Oregon and Washington and is the first largescale coordinated effort of its kind. This work addresses basic data needs and establishes a baseline database of mussel bed viability against which species' population trends can be assessed into the future. We have completed two years of this four-year project. Partners have created a database, eDNA has been collected from over 100 locations, and standardized visual survey protocols have been implemented at over 75 different project sites.

FROM SPECIES DETECTION TO CONSERVATION ASSESSMENT AND PLANNING: AN eDNA PERSPECTIVE

Manuel Lopes-Lima - CIBIO/InBIO - Research Center in Biodiversity and Genetic Resources, University of PortoVincent Prié - SPYGEN, in Savoie Technolac, Le Bourget du Lac Cedex, in France

In this presentation I will give an overview of our team's work in the development and application of eDNA methods for freshwater bivalve conservation. I will begin with a summary of protocol development and validation, including the development of reference libraries and primers, and the estimation of species detectability. I will then present several case studies where we have sampled large rivers across several continents for all freshwater bivalves. From these case studies, I will discuss the use of eDNA for large-scale inventories of freshwater bivalves in remote areas, and the discovery of new and critically endangered species using eDNA. I will also present the results of a large-scale eDNA survey in France, where eDNA data have been used to detect novel invasive species, to improve conservation status assessments of the entire freshwater bivalve fauna, and even as a tool to improve systematic conservation plans and assist in the selection of protected areas for freshwater bivalves.

ASSESSING THE POTENTIAL FOR ENVIRONMENTAL DNA TO PROVIDE THE BASIC INFORMATION NEEDED FOR REGULATORY DETERMINATIONS

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Over the past three years, Stantec has conducted environmental DNA surveys as part of 10 different projects in 11 different basins throughout the Eastern United States for the purpose of assessing and characterizing freshwater mussel assemblages. Study objectives, survey design, sampling intensity, target species, and intended uses of the data varied considerably between studies. In five of the studies, visual tactile data were collected at coincident sites for the purpose of assessing the performance of the traditional versus molecular sampling methods. Review of the data produced by these studies revealed some shared attributes. Environmental DNA successfully 1) assessed unionid assemblage composition, 2) relative abundance, 3) detected rare taxa, and 4) detected taxa with listing designations. In addition, eDNA may generate value-added data (e.g., insight into reproductive behaviors, detection of cryptic species, simultaneous assessment of host species presence), that are not easily accomplished using widely practiced visual tactile survey methods. Despite this, eDNA is not acknowledged as a valid data source for most regulatory determinations due to uncertainties, real and perceived, regarding overall performance. This presentation will also review potential best management practices (e.g., surveyor credentials, sampling and analysis plans, state level survey protocols, etc.) adopted by other assessment methodologies (e.g., the Index of Biotic Integrity, mussel survey protocols, sediment sampling guidelines) for the purpose of ensuring data quality. This review is intended to prompt discussions among potential users of the data regarding appropriate best management practices for field methods, data quality, data interpretation, and limitations of eDNA.

HENS TEETH AND EBONYSHELLS: SEARCHING FOR ROUND EBONYSHELL (*REGINAIA ROTULATA*) IN THE CONECUH RIVER, ALABAMA, USA

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Freshwater mussel surveys in large streams are challenging because depth, fluctuating river levels and high turbidity may influence survey effectiveness and mussel detectability. As a result, the Conecuh-Escambia River System in northwestern Florida, is like many large coastal plain rivers, relatively under-surveyed. This drainage supports ~30 mussel taxa including 6 threatened or endangered species. Of these, the Round ebonyshell (*Reginaia rotulata*) is the least common with > 20 individuals detected in the last 2 decades. We conducted surveys low water conditions in late summer/autumn of 2022 and 2023 with the goal of assessing its range in Alabama. We found 2877 mussels (15 species) at 24 sites but 2231 (78%) were a single species, the Elephantear (*Elliptio crassidens*). Only one Round ebonyshell detected during this survey but because the Round ebonyshell was detected at its prior upstream limits in the Conecuh River, it seems likely that the reach extending from the Conecuh County boundary downstream to the Florida border remains occupied, albeit at very low densities. DNA data confirmed field identification and, together with Genbank sequences, revealed very low levels of divergence (~0.6%) between Round pearlshell and Ebonyshell (*Reginaia ebenus*). Stable gravel habitat appears to be a limiting factor for Round ebonyshell and other sensitive mussels in Alabama reaches of the Conecuh River. Future surveys may need to use side-scan or other sonar imagery to detect the apparently small and isolated habitat patches used by Round ebonyshell and other sensitive mussels and target surveys in these increasingly uncommon habitats. Additionally, more extensive genetic analyses are needed to assess whether the Round ebonyshell is a sister taxon to the Ebonyshell or whether it is simply a geographically and morphologically disjunct population of a much more widely distributed species.

RESULTS FROM A MULTI-PHASE STUDY IN THE KANKAKEE RIVER OF ILLINOIS AND INDIANA

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The Kankakee River is a key component of the freshwater mussel biodiversity of Illinois. Historically the basin supported approximately 40 species, is considered a "Biologically Significant Stream" in Illinois, and has been proposed as Critical Habitat for the federally endangered *Plethobasus cyphyus*. However, recent studies have documented a steady decline in species' occupancy, abundance, and distribution and only 27 species are thought to remain extant. Despite these declines, the basin retains many rare species, including several federal and state listed species. While broad historical information on the distribution and abundance of mussels is available for the basin, much is dated or lacking. As a result, inferences and safeguards regarding the status and health of mussels within the basin may be outdated or incorrect. To rectify this, a multi-phase study was initiated by the Illinois Department of Natural Resources to update mussel distributional and status data. Between 2023 and 2024 we surveyed at 54 sites across the basin using multiple sampling methods. This resulted in the collection of 34,700 live mussels of 33 species, including 55 *P. cyphyus*. The assemblage was dominated by *Actinonaias ligamentina*, *Cyclonaias tuberculata* and *Cyclonaias pustulosa*, and length frequencies indicated ongoing recruitment of multiple species. Several noteworthy species were documented, including two which have not been previously located in the basin. Generally, both abundance and species richness increased moving upstream from the confluence with the Des Plaines River until the Kankakee River Hydroelectric Power Station Dam, which appears to have negatively influenced assemblages above the dam. Upstream from the dam, both abundance and richness again continued to increase until near the Indiana border where the river is highly channelized and both metrics declined. Though the Kankakee River appears to contain a viable population of *P. cyphyus* along with several others, many additional species historically present continue to remain absent.

RESULTS OF MUSSEL SURVEYS FROM THE UPPER ROCK RIVER IN WISCONSIN AND ILLINOIS AND THE DISCOVERY OF LIVE CYCLONAIAS TUBERCULATA (*PURPLE WARTYBACK*)

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Aaron Prewitt - Edge Engineering and Science, LLC, Cincinnati, OH
Alyssa Jones - Edge Engineering and Science, LLC, Cincinnati, OH
Thomas Jones - Marshall University, Huntington, WV

The Rock River system was historically a stronghold for mussels in Illinois; However, studies have shown a decline over the last decade. Historical records indicated that the Rock River originally had a distribution of 45 mussel species. In July of 2021, Edge Engineering and Science surveyed six survey reaches using bank-to-bank transects to determine whether rare, threatened, or endangered species were still extant. In total 4,360 meters of transect was surveyed along the river bottom which yielded the collection of 2,506 individuals of 19 species. The assemblage was dominated by *Potamilus ohiensis* (Pink Papershell, n=1,138) and *Cyclonaias pustulosa* (Pimpleback, n=856) which together accounted for nearly 80% of the total mussels collected. Additionally, approximately half of the assemblage found consisted of juvenile individuals. During surveys *Cyclonaias nodulata* (Wartyback, n=1)*, Cyclonaias tuberculata* (Purple Wartyback, n=4), and *Truncilla donaciformis* (Fawnsfoot, n=12) were collected, all of which are Illinois or Wisconsin state listed species. The collection of the Purple Wartybacks marked the first live individuals recorded in the Rock River since the late 1980s and was presumed to be extirpated from the river system. Furthermore, the numerous juvenile mussels collected during survey efforts indicates successful reproduction and continued recruitment for 10 different species. Despite the loss in species richness over the last few decades the upper Rock River appears to represent a relatively healthy mussel stream and could benefit from more studies in the future.

LONG TERM CHANGES TO MUSSEL ASSEMBLAGES IN POOLS 2-10 OF THE UPPER MISSISSIPPI RIVER – A GLIMMER OF HOPE?

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Mussels in the upper Mississippi River (UMR) have experienced myriad threats ranging from alterations from commercial navigation, commercial harvest for buttons, invasive species like zebra mussels, and changing climatic conditions. Many species have experienced declines in abundance and distribution. To document assemblage changes, the Minnesota DNR and the U.S. Army Corps of Engineers periodically monitor a number of sites in the UMR. Eleven sites were selected with consistent and comparable data sampled periodically (2-12 times) from to 2009-2024, spanning UMR Navigation Pools 2-10 from the Twin Cities, MN to Guttenberg, IA. The same area at each site was surveyed on each occasion using whole substrate excavation of 0.252 quadrats and species, age (external annuli), and length for each mussel is collected. Data were pooled and split into two timeframes, 2009-2016 (n=28) and 2017-2024 (n=27) as this coincided with a natural break in the sampling period and ensured each site had at least one sample in both periods. Despite moderate declines at two sites, two-sample T-Tests revealed significant increases in overall species richness (from 13-17 species), density (from 7.8 to 17.5 mussels/m2), and recruitment in the 2017-2024 time period. Much of the overall assemblage density increase is attributable to recruitment as density of mussels from ages 0-3 and 4-6 increased 255 and 230 percent, respectively, while mussels from ages 7-10 and >10 did not change significantly (109 and 97.6 percent, respectively). Significant increases in density of equilibrium (177%), periodic (252%), and opportunistic (400%) life history strategists occurred in 2017-2024. Assemblage data at 9/11 monitoring sites indicate conditions favoring successful recruitment have been present for the last decade. Density increases in all life history strategies were observed but were most apparent in opportunistic species. While UMR complete mussel assemblage recovery remains distant, current trends are encouraging.

OCCUPANCY AND DISTRIBUTION OF SWAP LISTED FRESHWATER MUSSEL SPECIES IN SOUTH CAROLINA

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Morgan Kern - Freshwater Mussel Program, South Carolina Department of Natural Resources, West Columbia, South Carolina, USA, 29172

Freshwater mussels from the order Unionida are unique organisms that live discreetly in the substrate of rivers and lakes and serve as a crucial trophic link between the water column and the benthos (Vaughn and Hakenkamp, 2001). Unfortunately, freshwater mussels throughout North America have continued to decline in diversity, abundance, and range. The causes of these declines are complex, but anthropogenic at their source. In 2022, South Carolina was home to 26 SWAP listed mussel species, 13 of which were highest priority species of greatest conservation need (SGCN) and there is a need for the South Carolina Department of Natural Resources to effectively manage and conserve freshwater mussel populations to continue to meet the expectations of the public as well as maintain the viability of the freshwater mussels within the State. The purpose of this project was to provide updated distribution data on SWAP listed species to update the Natural Heritage Database and inform management decisions. This project was accomplished, in part, by completing 45 catch per unit effort (CPUE) field survey sites for freshwater mussels. Individual mussels were collected through visual and tactile searches. All data was recorded and submitted to the Natural Heritage Database for statewide management. Surveying efforts across 45 field sites yielded a total of 5,667 individual mussels representing 15 different species across 8 different basins. Observations at sites across the state show habitat degradation due to urbanization and agriculture. Streams in these areas are incised, dominated by loose sand substrate, and have steep banks. Additionally, several streams were noted as having no riparian buffer and allowing livestock to enter streams. Although only 10 individuals of highest priority SGCN were collected, we were able to collect updated general habitat condition parameters and occupancy data that can be used to aid in conservation and management efforts of freshwater mussel across the state.

MICROBIOME ANALYSIS HIGHLIGHTS INTERPLAY BETWEEN BACTERIA AND FRESHWATER MUSSELS

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Madelyn G. McCutcheon - South Oldham Science Department, Crestwood, Kentucky, USA, 40014
Rachael A. Hoch - North Carolina Wildlife Resources Commission, Raleigh, North Carolina, USA, 27606

The Federally Endangered Tar River Spinymussel (Parvaspina steinstansana), endemic to the Tar and Neuse River basins in North Carolina, has restricted distribution with little evidence of natural recruitment. Since 2008, wild recruited individuals detected during surveys have been brought to the Conservation Aquaculture Center (CAC) in Marion, NC, for use as brood in propagation. In Fall of 2020, multiple Tar River Spinymussels at the CAC experienced a sudden mortality event, providing a rare opportunity to evaluate and characterize microbiota in healthy and unhealthy (characterized by lack of siphoning, gaping, and not burrowing) individuals of the same mussel species. The 16S gene was used to characterize the bacterial microbiomes for healthy propagated, unhealthy propagated, healthy wild, and unhealthy wild populations. Beta-diversity and ANCOM analyses demonstrated that all four groups exhibited unique microbiome profiles, despite wild-born samples having been housed at the hatchery for many years. Ten unique sequences (amplicon sequence variants or ASVs) were found to be differentially abundant between the healthy and unhealthy samples, with five prevalent in healthy individuals and five prevalent in unhealthy individuals. Our results indicate that birth environment creates a bacterial imprint that persists for years, if not a lifetime, in a mussel. Additionally, while some bacterial species may be pathogenic, other bacterial species may be protective. Results of this and future studies that seek to voucher identified ASVs and examine their presence in other taxa and natural systems would be valuable in helping hatchery managers maintain healthy brood for imperiled freshwater mussel species and in identifying possible biomarkers with which to monitor freshwater systems.

MULTIPLE INVASIONS DECIMATE THE MOST IMPERILED FRESHWATER INVERTEBRATES

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Invaders can have devastating impacts on freshwater ecosystems, but these impacts can subside over time as ecosystems “adapt” to the invasion of new species. We analyzed changes in species composition and density of molluscs in Oneida Lake (New York, USA), one of the best studied North American lakes based on detailed surveys conducted in 1915-17, 1967-68, 1992-95, 2012, and 2022-23, and on annual benthic surveys from 2009 through 2023. Eutrophication and habitat alteration after 1920 resulted in a 25% decline in species richness and a 95% decline in the density of native gastropods by 1967, while species richness of unionids did not change. The arrival of zebra mussels in 1991 and quagga mussels in 2005 was associated with an increase in species richness and density of native gastropods and an extirpation of unionids by 1995. However, an invasion by the round goby in 2013 led to a significant decline across all gastropod families, disproportionately impacting soft-shelled and shallow-dwelling species, while other species, including invasive dreissenids, partially recovered 3 to 7 years after the goby invasion. This mollusc recovery was depth-related and was limited to deeper areas. Altogether, molluscan communities were sensitive to ecosystem change and invasives species, with some invaders offsetting the impacts of eutrophication and habitat alterations. While individual stressors have taxon-specific and sometimes positive impacts, eutrophication and species invasions have collectively decimated the native mollusc community over the past century.

SILENT VICTIMS OF THE PYROCENE: FUNCTIONAL EXTIRPATION OF FRESHWATER MUSSELS FOLLOWING CATASTROPHIC WILDFIRE

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Sarah J. Kupferberg - Independent Researcher, Berkeley, California, USA, 94707.
Rebecca L. Bradley - Center for Environmental Management of Military Lands, Colorado State University, Fort Collins, Colorado, USA, 80524.
Andrew L. Rypel - Department of Wildlife, Fish & Conservation Biology and Center for Watershed Sciences, University of California, Davis, Davis, California, USA, 95616. Jacquelyn J. Hancock – U.S. Army Garrison Fort Hunter Liggett, U.S. Army, Fort Hunter Liggett, California, USA, 93928.

In the western United States, where many historically pyrodiverse landscapes have become homogenized due to changes in resource use, climate, and fire suppression, the extent and severity of wildfires have intensified. So-called “megafires” can dramatically alter aquatic ecosystems via wildfire byproduct runoff, yet their long-term effects on wild freshwater mussel populations remain poorly documented. In 2020, a major wildfire and subsequent atmospheric river caused substantial sedimentation in areas of high mussel abundance, raising concerns about population persistence. In 2024, we conducted visual and environmental DNA (eDNA) surveys to assess the status of California floaters (Anodonta californiensis) along approximately 46 km of the San Antonio River in Monterey County, California. We did not detect live mussels during visual surveys and had only one positive eDNA detection in the lower river reach. Pre-wildfire, mussels were already sparse in the downstream reaches near San Antonio Dam and Lake, suggesting that this area offers marginal habitat and may not support natural recolonization of more suitable upstream reaches. Post-wildfire changes in habitat structure, fish assemblages, and water permanence—particularly due to sedimentation—provide strong evidence that California floaters face long-term extirpation from the study area.

CHARACTERISTICS OF THE MICROBIOME OF JUVENILE FRESHWATER MUSSELS IN THE CONTEXT OF ENIGMATIC MUSSEL DECLINES IN THE EASTERN USA

Charlotte E. Ford – Department of Pathobiological Sciences, University of Wisconsin-Madison, Madison, WI, USA
Wendell R. Haag – US Forest Service, Southern Research Station, Center for Bottomland Hardwoods Research, Frankfort, KY, United States
Andrew Ibach - University of Kentucky, Lexington, KY, USA
Steven J. Price - University of Kentucky, Lexington, KY, USA
Monte A. McGregor – Kentucky Department of Fish and Wildlife Resources, Frankfort, KY, USA
Bernard Sietman - Minnesota Department of Natural Resources, Lake City, MN, USA
Sarah Douglass - Illinois Natural History Survey, Champaign, IL, USA
Alison Stodola - Illinois Natural History Survey, Champaign, IL, USA
Tim Lane - Virginia Department of Wildlife Resources, Marion, VA, USA
Tony L. Goldberg – Department of Pathobiological Sciences, University of Wisconsin-Madison, Madison, WI, USA

Enigmatic mussel declines with no apparent cause have occurred in streams throughout the USA and elsewhere since the 1960s. We investigated associations between the microbiome of juvenile mussels and mussel assemblage health in 91 streams in 13 eastern US states from 2021 to 2023. In each stream, we placed 3-month-old hatchery-reared juvenile mussels in silos in June and retrieved them in September (59 to 120-day exposure period). Study species were *Lampsilis cardium* (56 streams), *L. fasciola* (9), *L. ovata* (10), *L. ornata* (5), *L. reeviana* (3), and *Venustaconcha constricta* (8). Mussel assemblages in study streams ranged from healthy to highly degraded. We also collected wild individuals of the invasive *Corbicula fluminea* from each stream when present. We used 16S rRNA sequencing to characterize bacterial communities in stream-exposed juvenile mussels, *C. fluminea*, and juvenile mussels from the hatchery prior to exposure in streams. Across all samples, we detected 11502 bacterial taxa from 23 phyla. Bacterial species richness and composition differed between stream-exposed and hatchery juveniles, between stream-exposed mussels and *C. fluminea*, and between *C. fluminea* from healthy and degraded streams. Species richness and composition did not differ between juveniles from healthy and degraded streams, but some bacterial species were more abundant in healthy or degraded streams. Our results show that the mussel microbiome changes rapidly to reflect characteristics of streams, but their microbiome differs from that of resident *C. fluminea*. Differences in bacterial abundance between juveniles from healthy and degraded streams suggest that the microbiome plays a role in enigmatic mussel declines or is affected by the same factors that cause them.

LIGHTNING TALKS Wed May 14, 2025-8:20 AM – 9:15 AM Auditorium 1 *Moderators: Nathan Ring and Meghan Martinski*	
8:20-8:25	EXPLORATION OF A NOVEL TECHNIQUE FOR AGING SHELLS OF TAR RIVER SPINYMUSSEL (PARVASPINA STEINSTANSANA) UTILIZING X-RAY MICRO-COMPUTED TOMOGRAPHY- Amber Olson, Fisk, Walter, Rimmer, Baby, Cope (Page 87)
8:25-8:30	MUSSELS SUSPENDED IN MACROPHYTES- Rathbun, Strayer (Page 87)
8:35-8:40	CAPTIVE PROPAGATION EFFORTS FOR A FEDERALLY LISTED AQUATIC SNAIL IN IDAHO- Bangs (Page 87)
8:45-8:50	IMPACTS OF COMPOSTED COW MANURE ON JUVENILE *E. TRIQUETRA* MUSSELS IN A PULSED FLOW REARING SYSTEM- Ohlman, *Boyce*, Cremers.(Page 88)
8:50-8:55	COMPARISON OF M199 AND L-15 MEDIA FOR IN VITRO PROPAGATION OF *LAMPSILIS SILIQUOIDEA*- Ellis, Phelps, Roznere (Page 88)
8:55-9:00	OUTREACH AND IDENTIFICATION RESOURCES FOR MINNESOTA FRESHWATER MUSSELS- Holcomb, Boyce, Sietman, Schroeder, Secrist, Holcomb, Ohlman (Page 88)
9:00-9:05	UNEARTHING HISTORY: 'ORPHANED' COLLECTION FROM SAGINAW VALLEY STATE UNIVERSITY ILLUSTRATES COMMUNITY CHANGES IN MICHIGAN RIVERS SINCE THE DREISSENID INVASION- VanScoyoc, Samu-Pittard, Rathbun (Page 89)
9:05-9:10	MULTIPLE EXTINCT MUSSEL SPECIES IN THE "ORPHAN" GRAND RAPIDS PUBLIC MUSEUM SHELL COLLECTION- Rathbun, Redman, Sayles (Page 89)
9:10-9:15	*VIRTUAL:* DETERMINING SPECIES BOUNDARIES IN THE SPRINGSNAIL *PYRGULOPSIS* (MOLLUSCA, GASTROPODA, HYDROBIIDAE)- Perez, Meadows, Lundskog, Miskow (Page 89)

EXPLORATION OF A NOVEL TECHNIQUE FOR AGING SHELLS OF TAR RIVER SPINYMUSSEL (PARVASPINA STEINSTANSANA) UTILIZING X-RAY MICRO-COMPUTED TOMOGRAPHY

Amber Olson[1], Michael Fisk[1], Michael Walter[1], Langston Rimmer[1], Ruksana Baby[2], and Gregory Cope[2] – [1]North Carolina Wildlife Resources Commission, Mebane, North Carolina, USA, 27302; [2]North Carolina State University, Raleigh, North Carolina, USA, 27695.

Age and growth data are essential components in the understanding of the life history of freshwater mussels and help to inform both conservation and management decisions of rare and endangered species. Traditional aging methods for freshwater mussels involve taking a thin section of the shell where annuli corresponding to annual growth can then be observed and counted. While often considered the most accurate method to age mussels, this process destroys the shell and prohibits additional analysis of the whole shell. This can be especially problematic when studying rare species, as the number of shells is usually extremely limited and irreplaceable. The Tar River Spinymussel (*Parvaspina steinstansana*) is a federally endangered mussel endemic to the Tar-Pamlico and Neuse River basins of North Carolina and is found in extremely low numbers, with only 15 individuals found within the past 10 years. Augmentation efforts for the species were initiated in 2010 and while wild captured broodstock have survived over 12 years in captivity, the natural lifespan of the mussel is unknown. To attempt to avoid the problem of sacrificing shells to obtain age-data, we decided to investigate a novel approach utilizing x-ray tomography. Though there is limited research into the applicability of x-ray tomography for aging hard structures, it has been used extensively as a non-invasive method to analyze the internal components of specimens without damage. North Carolina State University possesses a Zeiss Xradia 50 Versa 3D X-Ray Tomography System which was utilized to scan known-age propagated Tar River Spinymussels to validate annuli. If successful, this method may prove to be an invaluable alternative method in conducting age and growth studies of rare mussels in which sacrificing vouchered shells is not ideal.

MUSSELS SUSPENDED IN MACROPHYTES

Joe Rathbun[1] and David L. Strayer[2] – [1]retired aquatic biologist, Lansing, Michigan, USA, 48910; [2]Cary Institute of Ecosystem Studies, P.O. Box AB, Millbrook, NY 12545, USA.

Dozens of floater mussels (*Pyganodon* spp.) were found suspended in thick growths of bladderwort (*Utricularia* sp.) in ponds in Michigan's Upper Peninsula, within 1 meter of the water surface and well above the pond bottom. The seasonal persistence of these mussels in the water column, suspended in macrophytes, deserves further investigation.

CAPTIVE PROPAGATION EFFORTS FOR A FEDERALLY LISTED AQUATIC SNAIL IN IDAHO

Alyssa N. Bangs – U.S. Fish and Wildlife Service, Boise, Idaho, USA, 83709.

The Bliss Rapids snail (Taylorconcha serpenticola) is a small aquatic snail found only in the Thousand Springs area of southern Idaho and limited to Eastern Snake River Plain Aquifer springs and spring-influenced waters. Since late 2023, the USFWS has partnered with the University of Idaho to develop a system to maintain Bliss Rapids snails in a captive setting, with the goal of short-term survival (for cases where populations may be exposed to short-term stressors, like treatment for quagga mussel) and long-term captive propagation.

IMPACTS OF COMPOSTED COW MANURE ON JUVENILE *E. TRIQUETRA* MUSSELS IN A PULSED FLOW REARING SYSTEM

Lindsay M. Ohlman, Isabel R. Boyce, and Keyshawn T. Cremers – Minnesota Department of Natural Resources, Lake City, Minnesota, USA, 55041.

The Minnesota Department of Natural Resources has been working to propagate Snuffbox (Epioblasma triquetra; federally endangered) since 2016, with limited success. In 2024, we conducted a 12-week laboratory experiment to test the effects of different substrates in a pulsed flow culture system. Our results showed that Black Kow® composted cow manure and Saint Croix River sediment significantly improved survival compared to the control sediment. These results demonstrate that Black Kow® composted cow manure is a viable alternative to naturally sourced sediments, which can often be difficult to obtain.

COMPARISON OF M199 AND L-15 MEDIA FOR IN VITRO PROPAGATION OF *LAMPSILIS SILIQUOIDEA*

Chase Ellis, Alexandra Phelps, and Ieva Roznere – Department of Evolution, Ecology, and Organismal Biology, The Ohio State University, Columbus, Ohio, USA, 43212.

We compared the transformation rates of in vitro propagated Lampsilis siliquoidea (Fatmucket) using M199 culture media, L-15 culture media, and M199 supplemented with lipid concentrate. Mussels in M199 had significantly higher transformation rates (75%) than mussels in L-15 (53%) but the addition of lipid supplements did not result in significant differences.

OUTREACH AND IDENTIFICATION RESOURCES FOR MINNESOTA FRESHWATER MUSSELS

Kathryn Holcomb, Isabel Boyce, Bernard Sietman, Zoe Schroeder, Zeb Secrist, Jordan Holcomb, and Lindsay Ohlman – Center for Aquatic Mollusk Programs, Minnesota Department of Natural Resources, Lake City, Minnesota, USA, 55041.

Awareness about freshwater mussels has increased greatly in the last 25 years, but the need to educate the public on their value remains to gain support for their conservation. Public outreach is an important part of the Minnesota Department of Natural Resources (MnDNR) Center for Aquatic Mollusk Programs (CAMP) annual conservation activities. Recently, CAMP has focused on two outreach projects involving freshwater mussel identification resources: an updated field guide and an app to facilitate identification. These resources will be distributed at outreach events, tours of the CAMP propagation facility, and to interested individuals encountered while in the field. The updated Field Guide to the Freshwater Mussels of Minnesota is a long-anticipated update of the previous field guide from 2003 and includes more descriptive species accounts, new photos of freshwater mussels, and updated distribution maps. The new app (named the Clam App) will be available on the Google and Apple stores and will allow the public to identify and report on freshwater mussels they find. This app will ultimately be used by the MnDNR to improve our understanding of species distributions across the state of MN and will be used by the public to learn about the status of mussels and how to identify mussels in Minnesota.

UNEARTHING HISTORY: 'ORPHANED' COLLECTION FROM SAGINAW VALLEY STATE UNIVERSITY ILLUSTRATES COMMUNITY CHANGES IN MICHIGAN RIVERS SINCE THE DREISSENID INVASION.

Haley VanScoyoc[1], Jocelynne Samu-Pittard[1], and Joseph Rathbun[2] – [1]U.S. Fish and Wildlife; [2]Retired Aquatic Biologist

From 1979-1992, researchers conducted mussel surveys in major river systems and tributaries of the Laurentian Great Lakes. Although the associated collection has been long forgotten, it contains thousands of valves of many at-risk, threatened, and endangered species collected prior to the freshwater mussel crash correlated with the invasion of dreissenids in the late 1980s. This invaluable collection can be used to assess community changes in many of these systems over the past 45 years.

MULTIPLE EXTINCT MUSSEL SPECIES IN THE "ORPHAN" GRAND RAPIDS PUBLIC MUSEUM SHELL COLLECTION.

Joe Rathbun[1], Cory Redman[2], Brenda Sayles[1], [1]retired aquatic biologist, Lansing, Michigan, USA, 48910; [2]Grand Rapids Public Museum, Grand Rapids, Michigan, USA, 49504.

An old and long-ignored collection of freshwater and marine mollusk shells at the Grand Rapids Public Museum (Michigan, USA) contains specimens of several extinct freshwater mussel species: *Epioblasma flexuosa* (leafshhell; 117 shells), *Epioblasma propinqua* (Tennessee riffleshell), *Epioblasma torulosa* (tubercled blossom), *Pleurobema fibuloides* (highnut) and *Pleurobema perovatum* (ovate clubshell). These specimens may be of interest to researchers working on these species.

VIRTUAL: **DETERMINING SPECIES BOUNDARIES IN THE SPRINGSNAIL *PYRGULOPSIS* (MOLLUSCA, GASTROPODA, HYDROBIIDAE)**

Kathryn E. Perez[1], Trenton Meadows[1], Chanté Lundskog[2], Eric Miskow[3] - [1]School of Integrative Biological & Chemical Sciences, University of Texas Rio Grande Valley, Edinburg, TX, 78569; [2]Utah Department of Natural Resources, Division of Wildlife Resources, Salt Lake City, UT 84116, USA; [3]Nevada Division of Natural Heritage, Department of Conservation and Natural Resources, Carson City, NV 89701.

In desert environments, unique communities of animals, plants, and microbes depend on groundwater at springs and cienegas. There is a diverse radiation of small (<5 mm) snails found across the desert southwest in North America, thought to mostly consist of single-site endemics, confined to single springs. As such, nearly all springsnail species are considered critically imperiled with their existence depending on maintenance of spring-flows in regions of declining water availability. Taxonomic work primarily based on mitochondrial sequences or penial morphology of species assumed to be single-site endemics delineated many species and unnamed lineages that are the subject of the current investigation. In these studies, we are applying DNA data (mitochondrial and nuclear) and several morphological features (shell shape, radula tooth shape/size, penial morphology) to the taxonomy of *Pyrgulopsis*. We have re-examined the validity of several named species and determined whether unnamed mitochondrial lineages should be formally described. To date, we have proposed the synonymy of *P. nonaria* and *P. transversa* with *P. pilsbryana*. In another clade, we have supported the species-level status of very closely related but distinct *P. serrata* and *P. marcida* and propose that a lineage referred to in the literature as "Lineage C" should be formally described. We have found a mix of over and under-splitting, that we attribute in part, to overreliance on the assumption that springsnails are single-site endemics, and therefore disregarding potential geographic variation in DNA and morphology.

POSTER GENRAL TOPICS- Poster Session 6:00-8:30 PM- Garden Marqueee (Set up Tuesday in the Garden Marquee 5:30-6:00)	
Poster #s	**Topic**
1-6	Conservation and Recovery
7-9	Propagation
12-14	Life History
15-16	Morphometrics
17-19	Museum, education, outreach
22-31	Survey and monitoring: results
32-39	Survey and monitoring: methods
40-41	Contaminants and ecotoxicology
42-45	Genetics, genomics, and systematics
46-47	Habitat
49-51	Climate change
52-54	Conservation planning

ABTRACTS ON FOLLOWING PAGES IN POSTER NUMBER ORDER

POSTER SESSION ABSTRACTS (Note: Due to changes in schedule not all numbers are consecutive to aid Student Judges)	
Tuesday May 13, 2025 – 6:00 – 8:30 p.m. – Garden Marquee	
Poster 1	**LINKING HABITAT PARAMETERS TO UNIONID ASSEMBLAGES AT THE LENTIC-LOTIC TRANSITION OF LAKE MICHIGAN AND ITS TRIBUTARIES.** Masaki Hara, David T. Zanatta, Daelyn A. Woolnough - Department of Biology and Institute for Great Lakes Research, Central Michigan University, Mount Pleasant, Michigan, USA, 48859.
	Although freshwater mussels (Unionidae) are considered ecologically crucial in Great Lakes tributaries and many of the 43 species in Michigan are considered imperiled, no comprehensive or standardized surveys of the lower reaches of Lake Michigan tributaries have been conducted. Among many known threats to unionids, non-native bivalves (dreissenids and *Corbicula*) have invaded the region. This study is examining the relationships among environmental factors and unionid and invasive bivalve distributions and diversity. The areas surveyed are in the lower reaches of Lake Michigan tributaries that are transitional zones between Lake Michigan and inland waterbodies and may provide habitats for both unionids and invasive bivalves. Watersheds surveyed were randomly selected based on the proportion of the watershed area represented in the entire Lake Michigan drainage. We conducted standardized timed-search unionid surveys (SCUBA and snorkeling) to detect the presence of unionids and used PONAR methods to sample for invasive bivalves. Habitat parameters were recorded during each survey. In the summer of 2024 (year 1 of 3), 80 sites in 36 watersheds of the lower peninsula of Michigan were surveyed. Of these, 14 watersheds had live unionids consisting of 1238 live individuals representing 17 species including six species considered imperiled in Michigan. Zebra Mussels and Quagga Mussels were detected in 67% and 45% of all sites surveyed, respectively. Ordinations were used to determine how habitat parameters were related to unionid presence, relative density, and diversity. This study is attempting to clarify the relationship between the distribution patterns of unionids, habitat parameters, and threats to unionids and habitats in these transitional zones. Understanding distribution patterns and potential drivers of the patterns will support constructing habitat models for species assemblages. Project years 2 and 3 will focus on Lake Michigan tributaries in the upper peninsula of Michigan and Wisconsin, respectively.
Poster 2	**COMPARISON OF SEDIMENT DYNAMICS AND MUSSEL RESPONSE IN TWO OZARK RIVERS.** Justin K. Higa and Brandon J. Sansom - U.S. Geological Survey, Columbia Environmental Research Center.
	Freshwater mussels are often found in dense, multispecies and multigenerational aggregations, known as mussel beds. The persistence of mussel beds has been linked to localized hydraulic parameters relating to sediment stability such as shear stress. However, past studies indicate that river systems experience channel-forming flows every 1-2 years and despite the relatively frequent recurrence of channel-forming flows that would mobilize the sediment occupied by mussels, mussel beds remain in the same location for decades. Direct observations of sediment and mussel movement within mussel beds remain limited, further clouding the mechanics of sediment dynamics and mussel persistence within mussel beds. In this study, we evaluated sediment and mussel movement dynamics using Radio Frequency Identification (RFID) and accelerometer technology in the Osage and Gasconade rivers in central Missouri. We affixed tracers to mussels, sediment particles, and surrogate mussels to track differences between sediment properties and mussel morphometrics and behavior. Several repeat RFID surveys were conducted over a 2-year period in each river to relocate tagged tracers. In general, movement dynamics differed across tracer type and river. For example, In the Osage River, the majority (97%) of mussels remained at their initial deployment location throughout the 2-year survey, whereas 52% of sham mussels and 70% of rocks were displaced downstream. In the Gasconade River, all tracer types had high rates of downstream displacement: 85% of live mussels, 100% of sham mussels, and 93% of rocks experienced downstream movement. Further analysis is underway to examine tracer movement as a response to peaks in discharge, which may provide insights into mussel bed persistence in the face of changing flow regimes.

Poster 3	**USE OF CONTINUOUS SEDIMENT-WATER INTERFACE MONITORING TO EVALUATE FRESHWATER MUSSEL HABITAT CONDITIONS.** Allison N. Sieja, Eric L. Brunson, James L. Kunz, Brittany G. Perrotta, Brandon J. Sansom, Maximilian K. Schelich, Jeffery A. Steevens – U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO, USA 65201
	The mussel silo is a portable cage used to house juvenile freshwater mussels, which utilizes the Bernoulli effect to create an upwelling flow through the chamber that houses the mussels. In addition to being employed to evaluate in situ exposures to contaminants, silo usage has expanded to assist in the habitat quality determination of potential reintroduction sites for restoration and remediation projects. We deployed sensor silos concurrent with an in situ mussel exposure for a restoration project in the Clinton watershed near Detroit, Michigan, which historically had high levels of anthropogenic activities and varying water quality issues. Many of the historical issues have been addressed, making the Clinton River potentially suitable for mussel augmentation. We integrated dissolved oxygen, temperature, light, and conductivity sensors into the silo design so that the sensors would record measurements from within the chamber and provide continuous water quality data at 5-minute intervals. A pressure sensor was also integrated to record continuous water level data, also at 5-minute intervals, at each deployment location. Four silos with integrated sensors were deployed for 78 days, and sensor data was compared to water quality data taken from surface-level water obtained at two-week intervals. Generally, sensor data was similar to surface-level water grab samples. We also used the water quality data from the sensor silos to parameterize a stream metabolism model that can directly link primary productivity with freshwater mussel growth and overall stream status, which acts as an additional tool to characterize the habitat conditions of a potential restoration or augmentation site. Similarly, we deployed additional sensor silos in 2024 to examine the water quality of streams remediated from coal mining discharges in Pennsylvania, and in 2025 we plan to deploy sensor silos in streams affected by metal mining in Oklahoma as well as mountainous streams of Oregon.
Poster 5	**REINTRODUCTION OF TENNESSEE BEAN (*VENUSTCONCHA TRABALIS*) TO THE UPPER NORTH FORK HOLSTON RIVER, VIRGINIA.** Sarah L. Colletti, Tim W. Lane, Tiffany C. Leach – Aquatic Wildlife Conservation Center, Virginia Department of Wildlife Resources, Marion, Virginia, USA 24354. Rose E. Agbalog – US Fish and Wildlife Service, Lacey, Washington, USA 98503.
	Tennessee Bean, *Venustacocha trabalis* (Conrad, 1834), is a critically endangered species limited to seven disjunct populations across the Tennessee River Basin. To recover the species, the USFWS recommends reestablishing a viable population in the North Fork Holston River (NFHR) where it was extirpated. Direct anthropogenic impacts to the NFHR include the collapse of an alkaline industrial waste muck dam in 1924, and continued toxic mercury contamination from a Superfund site in the town of Saltville, VA. A site plan was developed to reintroduce animals above the impacted reach and approval for the action was granted by USFWS, Virginia DWR, and local Smyth County, VA administrators in 2021. In July 2022, 600 Tennessee Bean produced using broodstock from a tributary of the Holston River, were released at two restoration sites. Three hundred of these animals were affixed with Passive Integrated Transponder (PIT) tags and placed in two grids at each site (four total grids). Active PIT-tag surveys were conducted in the summers of 2023 and 2024, and moving forward will continue at least once a year, to allow for a long-term dataset and population performance modeling. The naïve survival among grids from 2022-2023 was 64% and mortality was 5%. Survival improved to 82% from 2023-2024 while mortality was similar at 7%. Survival from release to 2024 was 52% and total mortality averaged 10%. Partial gravidity was documented in females as of 2024, a good sign for future recruitment. After two years, the high survival implies the habitat conditions are suitable for the species. To achieve our goal of a self-sustaining population in the NFHR, additional cohorts will need to be released. This should ensure both the presence of multiple age classes and the promotion of genetic integrity. At present, too few sampling events have occurred to accurately model survival and detection parameters for the newly established populations. However, after 2-3 additional sampling events, we anticipate detection, and survival can be accurately measured using Program Mark.

Poster 6	**FRESHWATER MUSSEL SALVAGE AREA COLLECTION AND RELOCATION MONITORING RESULTS FOR A CHEMUNG RIVER, NEW YORK PUBLIC WORKS PROJECT.** Nicholas Firman[1], Matthew Frackelton[1], Jeremy Henson[2], and Alan D. Christian[3,4]. [1:] ARCADIS, One Lincoln Center, Syracuse, New York, 13202; [2:] ARCADIS (Headquarters), Highlands Ranch, Colorado, 80129, USA; [3:] Ursinus College, Environment and Sustainability Department, Collegeville, Pennsylvania, 19426, U.S.A; [4:] ADC Education and Environmental Services, Collegeville, Pennsylvania 19426 U.S.A.
	The Chemung County Sewer District Wastewater Treatment Plant (WWTP) consolidation project was necessary to facilitate upgrades to the county's wastewater treatment and conveyance systems to meet applicable water quality regulations, promote water quality improvements, and ensure future resiliency. The public works project includes installing a new 48-inch diameter gravity sewer pipeline across the Chemung River to the Regional WWTP. The Chemung River is listed as a Class C(T) stream under the New York State Department of Environmental Conservation (NYSDEC) Protection of Waters Regulatory Program, indicating it is a protected waterway that supports fish and shellfish propagation and is suitable for primary and secondary recreation. According to the NYSDEC Natural Explorer Database, there were two state-threatened mussel species of potential occurrence in Chemung County, New York, including the brook floater (*Alasmidonta varicosa*) and the green floater (*Lasmigona subviridis*). As part of the NYSDEC permit requirements, an initial project area mussel survey was conducted in 2021 and confirmed the presence of the green floater within the project salvage area. This triggered a salvage area removal and relocation of freshwater mussels using NYSEC-approved protocols This presentation will report on and discuss 1) the physical habitat and water quality variables of both the salvage and relocation areas, 2) the collection, redundancy marking of target species, and relocation of all live mussels collected in the salvage area to the relocation area, and 3) the dedicated monitoring of marked target species' survival at one-month and twelve-month intervals.
Poster 6B	**STRONG PARTNERSHIPS: THE KEY TO MUSSEL RESTORATION AND WORKING TOWARD GREEN INFRASTRUCTURE.** Mandy Annis, Jessica Pruden – U.S. Fish and Wildlife Service, Michigan Ecological Services Field Office, East Lansing, MI, USA 48823; Megan Bradley- U.S. Fish and Wildlife Service, Genoa National Fish Hatchery, Genoa, WI, 54632; Jeffery Steevens, Allison Sieja, James Kunz, Brandon Samson- U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO, 65201; Pete Badra – Michigan Natural Features Inventory, Michigan State University, East Lansing, MI, 48823
	Freshwater mussels are in sharp decline worldwide. Such declines have not only led diversity loss but to the loss of the ecosystem services they provide. Re-establishing native mussel assemblages are key to making ecosystems & the communities they inhabit whole. Native mussel green infrastructure benefits communities through ecosystem services: improved water quality by reducing nutrients, bacteria & contaminants, increasing stream bed stabilization, provision of habitat for benthic organisms, & nutrient processing which forms the basis of food webs. Often biodiversity is the focus of management, & while important to overall ecosystem health, does not relay the importance of native mussels to people who benefit from the green infrastructure services they provide. Our approach illustrates the value of using that message to engage community support & build partnerships. We deliver a message about the potential of mussel restoration to improve water quality, recreation, fisheries, & overall health of the Clinton River watershed Metro Detroit, Michigan. We built upon established partnerships & develope new ones at all levels of the community. We worked with our state agency partners, county agencies, townships, private property owners, non-governmental organizations, & federal agency partners to build this pilot project that focuses on assessing native mussel habitat needs, assessing reintroduction success, & quantifying ecosystem uplift associated with mussel restoration, building the framework for more efficient & cost-effective restoration efforts. We highlight how partners supply important ongoing data collection, monitoring & outreach for the project. Our efforts will provide a scientifically rigorous assessment of green infrastructure services & will be shared with communities at the restoration sites & more broadly to show why mussels are important to community health as well as functionally restored ecosystems. This contributes towards building community support for additional restoration efforts throughout the Great Lakes & beyond.

Poster 7	**MORE MUSSELS WITH THE MOORE DOWNWELLER.** John S. Moore and Andrew T Phipps – USFWS White Sulphur Springs National Fish Hatchery.
	Most mussel production facilities experience similar limiting factors in maximizing the total number of mussels produced each year; limited staffing leading to time constraints, the physical aquaculture system space necessary, and the cost of developing new methodologies. Thus, it is important to create mussel culture systems that reduce the amount of time and effort necessary to maintain them and house a large number of animals in the smallest footprint possible. Downwelling systems can be made very easily to help alleviate the amount of time and effort necessary to culture 0.8-15mm mussels, take up a relatively small footprint for the number of animals they can hold, and can likely be built with the common materials already present at existing mussel production facilities. Downwelling systems allow mussels under culture to be examined regularly with minimal effort, potentially leading to faster recognition and response to changing animal needs and improved juvenile mussel survival.
Poster 8	**A VISUAL GUIDE TO THE GROWTH AND DEVELOPMENT OF JUVENILE FRESHWATER MUSSELS (*ANODONTA*, *GONIDEA*, AND *MARGARITIFERA*) IN WESTERN NORTH AMERICA.** Zach Seilo[1], Alexa Maine[1], Christine O'Brien[2], and Donna Nez[1] – 1 Confederated Tribes of the Umatilla Indian Reservation, 2 Browns River Consultants
	North America has the most diverse and abundant assemblage of freshwater mussels in the world, with over 300 species recognized across the continent. Unfortunately, freshwater mussels are one of the most imperiled taxonomic groups in North America prompting the IUNC (2002) to identify over 30% of the mussel species as requiring conservation status. West of the continental divide there are currently three genera of freshwater mussels, and they are among the most understudied freshwater mussels in North America. The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) include freshwater mussels among their traditional subsistence foods, also known as First Foods, and the CTUIR has established a program aimed at researching and restoring freshwater mussels to their historic range throughout CTUIR historic territory. The CTUIR Freshwater Mussel Project operates a research lab at Walla Walla Community College in Walla Walla, Washington where the three mussel genera (*Anodonta*, *Gonidea*, and *Margaritifera*) are artificially propagated, and the incremental development of each life history stage is studied for each species. This poster provides a visual guide to the development (from egg to mussel) of freshwater mussels produced and observed in the CTUIR Freshwater Mussel Artificial Propagation Lab.

Poster 9	**THE EFFECTS OF CULTURING DENSITY AND SAMPLING FREQUENCY ON GROWTH AND SURVIVAL OF JUVENILE MOUNTAIN CREEKSHELL (*LEAUNIO VANUXEMENSIS*).** Tiffany C. Leach, Tim W. Lane, and Sarah L. Colletti - Aquatic Wildlife Conservation Center, Virginia Department of Wildlife Resources, Marion, Virginia, USA 24354.
	Effective culturing techniques for hatchery-reared freshwater mussels are critical to the success of species recovery programs and are frequently refined for individual facilities. At the DWR Aquatic Wildlife Conservation Center, culturing juvenile mussels from newly metamorphosed to 12 weeks of age remains challenging. This experiment investigated the impact of two treatments, sampling frequency and culturing density, on the growth and survival of 0-12-week-old Mountain Creekshell (*Leaunio vanuxemensis*). The primary objectives were to determine the ideal sampling intervals to maximize growth and survival and to evaluate how levels of crowding might be influencing those same outcomes. Juveniles were separated into nine sediment tanks per sampling interval with three replicates for each density treatment. Sampling frequencies were set to 1-week, 2-week, and 4-week checks and density treatments were set to 50, 250, and 500 juveniles per tank. Temperature, food mix, per mussel (0.015 mL) and sediment size were kept constant throughout the experiment. For the 1-week sample, there was a significant positive effect (p <0.001) in survival and growth per tank compared to 2-week and 4-week samples by the end of the study. The average survival across density treatments was 0-35.6% and the average total growth was 0.38-3.88 mm. This indicates that weekly sampling is a necessary protocol to ensure improved quantity and quality of progeny at our facility. Juvenile survival and growth on the 250 and 500 tanks were not significantly different at the conclusion of the 3-month study but each significantly outperformed the 50 tanks, suggesting crowding is not a limiting factor at our facility up to 500 per tank. Future experimentation will look at survival and growth of juveniles fed at least double the feeding rate chosen for this study, as we suspect the 50 tanks incurred higher than expected mortality over the first two weeks of the study due to malnourishment.
Poster 12	**A CONSERVATION CHALLENGE: UNDERSTANDING THE RELATIONSHIP BETWEEN NATIVE FRESHWATER MUSSELS AND INVASIVE CARP.** Samantha Poratti[1], Lusha Tronstad[1], and Brianna Freeman[2] – [1] Wyoming Natural Diversity Database and Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82071, [2] Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82071
	Freshwater mussels are one of the most imperiled animal groups in North America, with 30-40% of species extinct or listed as vulnerable in the last 100 years. Their decline is driven by drought, warmer water temperatures, pollution, and exotic species. The loss of native freshwater mussels (NFM) reduces nutrient recycling, habitat for aquatic organisms, food sources for animals, and water quality. The ramifications of introducing non-native fish, such as common carp (*Cyprinus carpio*), are well-studied. Almost nothing is known about the extent to which common carp, one of the eight most invasive fish species worldwide, disrupt the life cycle of NFM. To address this gap, we examined to what degree common carp consumed two NFM, the California floater (*Anodonta californiensis*, CF) and Western pearlshell (*Margaritifera falcata*), in the Bear River, Wyoming. In 2023, we collected stomach contents from 102 carp between 300 and 900 mm total length. Thirty-one percent contained freshwater mussels, predominately CF. This is the first documentation that common carp consume NFM, and the information has the potential to conserve native mussels by limiting direct consumption and improving abiotic conditions for these species. We suggest further investigating how native mussels can be conserved by managing common carp.

Poster 13	**BROOK FLOATER RANGEWIDE CONSERVATION AND RESTORATION INITIATIVE.** Chris B. Eads[1], Michael J. Walter[2], Loretta M. Lutackas[1], W Gregory Cope[3], and Jay F. Levine[4] – [`1]Yates Mill Aquatic Conservation Center, NC State University, Raleigh, NC 27603; [2]North Carolina Wildlife Resources Commission, Mebane, NC 27302; [3]Department of Applied Ecology, NC State University, Raleigh, NC 27695; [4]Department of Marine, Earth, and Atmospheric Sciences, NC State University, Raleigh, NC 27695.
	Bluehead chubs (*Nocomis leptocephalus*) and their congeners serve as ecosystem engineers and keystone species by constructing gravel spawning mounds that support diverse Cyprinid assemblages. Both the chubs and their nest associates serve as hosts for certain freshwater mussel species. Of the six federally listed mussel species on North Carolina's Atlantic Slope, laboratory trials indicate that five of them depend either on these chubs or their nest associates as primary hosts: *Parvaspina collina* (endangered), *Parvaspina steinstansana* (endangered), *Lasmigona decorata* (endangered), *Elliptio lanceolata* (threatened), and *Fusconaia masoni* (threatened). Beyond North Carolina, species in the *Fusconaia, Pleurobema,* and related genera often exclusively use Cyprinids as hosts, including *Nocomis* nest associates, and these mussel species are frequently among the most imperiled. Despite their ecological significance, *Nocomis* chubs often receive little direct survey effort, but their populations are essential for persistence of these rare mussels. Mussel conservation efforts should connect to host fish distribution, abundance and niche overlap. Observations on the frequency and location of chub mounds may serve as a helpful indicator of potentially suitable habitat for the mussels that rely on them.
Poster 14	**WHEN YOUR HOST FISHES GET COLD FEET: MUSSEL GLOCHIDIA AREN'T SURE WHEN THEY WANT TO METAMORPHOSIZE.** Brian Hefferon[1,2], Andrew Gascho Landis[1], Paul H. Lord[2], and Daniel Stich[2] – [1]Department of Fisheries, Wildlife, and Environmental Science, State University of New York, Cobleskill, NY 12043; [2]Biology Department, State University of New York, Oneonta, NY 13820
	Many freshwater mussel–host fish associations remain unknown. Furthermore, for effective conservation and propagation, it is important to understand how host fish traits drive the metamorphosis process. The goal of this study was to assess the influence of host fish effectiveness and thermal preference on the timing of juvenile drop-off. Twenty-two potential host species were tested in the lab by infesting them with yellow lampmussel (*Lampsilis cariosa*) glochidium. Counts of glochidia and juveniles occurred every other day to determine host fish effectiveness and the timing of metamorphosis. We calculated accumulated thermal units for each trial and used published thermal preference for each host fish to use in generalized linear models. Variation in the timing of metamorphosis was observed among the fishes tested. When grouped as "viable" (>5% metamorphosis) and "less viable" (<5% metamorphosis) host fish, the glochidia metamorphosed sooner on "viable" fish. When investigating the possible influence of the fishes' thermal preference on the timing of metamorphosis, glochidia metamorphosed sooner on coldwater fish compared to warmwater fish. Our study is the first to demonstrate that metabolic rate, as it relates to the temperature preference of fish, influences metamorphosis timing of yellow lampmussel.

Poster 15	**CORRELATIONS BETWEEN SHELL MORPHOLOGY AND HABITAT OF *PYGANODON* MUSSELS IN NORTHERN MICHIGAN INLAND LAKES.** Alec Smith[1], Michael Hillary[2], and David T. Zanatta[3] – [1]Biology Department, Central Michigan University, Mount Pleasant, MI USA, 48859; [2]Michigan Department of Natural Resources, Cadillac Customer Service Center, Cadillac, MI USA 49601; [3]Biology Department and Institute for Great Lakes Research, Central Michigan University, Mount Pleasant, MI USA, 48859.
	Unionid mussels are known to demonstrate considerable intraspecific variation in shell shapes that respond to environmental factors. Most published studies on shell shape variation focus on rivers, and on river-specific environmental variables such as velocity, discharge, and watershed slope. However, unionids also inhabit (and for some species, prefer) the benthos of lacustrine systems, thus the importance of developing an understanding of what factors influence shell morphology in the absence of riverine flow regimes. Our study uses data gathered in summer 2024 mussel surveys of inland lakes in Michigan. We tested for correlations between shell shapes among populations of *Pyganodon grandis* (Giant Floater) and *P. lacustris* (Lake Floater) and a variety of environmental conditions. The 2D shape of the shells was quantified on a digital image of the left valve from 259 specimens by placing 2 Type I landmarks to anchor 20 additional (Type II) landmarks around the shell edge. A Procrustes transformation was implemented to accounted for specimen size differences. A shell inflation index was calculated as a ratio of width to length for each specimen. An LDA of the PC scores of the Procrustes-transformed landmarks and a previous dataset of *Pyganodon* specimens identified using COI barcodes were used to identify the 2024-collected specimens as either *P. grandis* or *P. lacustris*. We found that *P. lacustris* (130 of 259 total specimens) appears to be more widespread in Michigan than previously known. Correlations were tested for between mean PCA-LDA axis scores (as an index of shell shape) and inflation ratios for both *Pyganodon* species, lakes, and sites with environmental features. For both *P. grandis* and *P. lacustris*, siltier substrates appear related to more elongate shell shapes, higher *D. polymorpha* densities appear related to less elongate shapes, and rocky shoreline appears related to very slightly concave shapes and more inflated shells. This study identifies some potential drivers of shape variation in lake-dwelling unionids.
Poster 16	**MORPHOLOGICAL ANALYSIS OF LANCE MUSSELS USING 2D MORPHOMETRIC ANALYSIS.** Quinn Astin, Marco Guadagno, Rudra Mehta, and Curt Elderkin – The College of New Jersey, Department of Biology, Ewing, NJ USA
	The genus *Elliptio* is a diverse, geographically widespread lineage that includes several species of lanceolate mussels that are endemic to the Atlantic Slope fauna. In North American drainages species boundaries and specimen identification in *Elliptio spp.* is complicated by numerous factors including high intraspecific variation, low interspecific variation and incomplete lineage sorting. Pennsylvania has currently one lance mussel in the Potomac drainage *E. fisheriana*, and Virginia recognizes four *Elliptio* lance mussels *E. lanceolata*, *E. fisheriana* and *E. producta* and *E. augustata*. We will use 2D shell morphometric analysis to investigate the morphological diversity of these lance mussels and determine how unique shell morphology is and is not, among species. Currently our analysis only includes valves from the mollusk collection at Philadelphia Academy of Natural Sciences, however future analysis will include valves from other collections such as the Smithsonian National Museum of Natural History and the North Carolina Museum of Natural Sciences. Results for this study are currently in progress and in the future we hope to add barcoding analysis using mitochondrial DNA from the COI gene from specimens collected from Atlantic Slope drainages in Virginia and Pennsylvania.

Poster 17	**STREAMING CONSERVATION: USING VIRTUAL TOURS TO SHOWCASE PROPAGATION AND RESEARCH AT THE YATES MILL AQUATIC CONSERVATION CENTER.** Loretta M. Lutackas[1], Chris B. Eads[1], D. Craig Lawson[1], and W. Gregory Cope[2] – [1]Yates Mill Aquatic Conservation Center, North Carolina State University, Raleigh, North Carolina, USA, 27603; [2]Department of Applied Ecology, North Carolina State University, Raleigh, North Carolina, USA, 27695.
	The Yates Mill Aquatic Conservation Center (YMACC) at North Carolina State University is dedicated to the conservation of imperiled freshwater species of North Carolina through propagation, research, education, and public outreach. To document our facility, share methodologies with fellow researchers, and promote public engagement, we are developing a comprehensive and interactive video tour. The tour will showcase our specialized systems and highlight the species they support. Highlighted on the virtual tour will be our 4,400 sq ft facility's key features, including our advanced filtration system processing approximately 400 GPM from Yates Mill Pond, specialized holding and rearing systems, and dedicated laboratory spaces. While in-person tours are limited by staff availability and time of year, our virtual tour will enable us to reach substantially more stakeholders, researchers, and community members, bringing aquatic conservation to audiences who may not have the opportunity to visit. In 2024, our inaugural year of operation, we propagated seven species of unionid mussels and raised over 12,000 individuals, with some reaching lengths of up to 32 mm in one growing season. We plan to track the video's implementation across various audiences and outlets, including our website, social media pages, and facility lobby to assess its effectiveness as an educational tool. This poster combines our initial propagation outcomes with our virtual tour to demonstrate how digital access can enhance both conservation success and public engagement in aquatic species recovery efforts.
Poster 18	**THE FMCS MOLLUSK CERTIFICATION PROGRAM.** Nathan Click (co-chair), Heidi Dunn, David A. Foltz II, Alexa Maine, Dan Symonds, and Becca Winterringer (co-chair). – FMCS Professional Development Committee.
	FMCS member? Check. Published in peer reviewed journal? Check. Presenting mollusk research at the Symposium? Check. What's the standard of education and experience to be recognized as a mollusk professional? The Professional Development Committee has the answer. If you are a member of the Freshwater Mollusk Conservation Society (FMCS), you might consider applying to receive recognition as a mollusk professional. The mollusk professional certification has been a topic of FMCS conversation for nearly a quarter of a century. After much information gathering, in late 2016 the FMCS Board approved establishing the Professional Certification Ad-hoc Committee to explore a certification for mollusk professionals. The Professional Development Committee was formally recognized as a functional committee of the Society at the 2019 Symposium in San Antonio. Since then, the Committee has been working to fine tune guidelines and procedures of the mollusk certification program, adjust the certification tiers based on a volunteer pool of over 50 applicants, and develop an implementation strategy that includes committee and certification procedures and rules. The mollusk professional certification specifically addresses the National Strategy for the Conservation of Freshwater Mollusks Issue 8. The goals of the program are: 1) establish standards for key skills and competencies for mollusk conservation professionals and 2) recognize achievements of mollusk professionals. This presentation describes how the Professional Certification Program was developed and how it will be implemented.

Poster 19	**WHAT WILL IT TAKE TO CATALOG THE OSU MUSEUM BACKLOG, AND IS IT WORTH IT? MAKING THE CASE WITH MISSOURI MUSSELS.** Alexandra R. Phelps and Nathaniel F. Shoobs - Department of Evolution, Ecology, and Organismal Biology, The Ohio State University Museum of Biological Diversity, Columbus, Ohio, 43212.
	The Ohio State University Museum of Biological Diversity (OSUM) maintains the largest collection of freshwater bivalves in the world, containing approximately 500,000 specimens in over 80,000 lots, mainly from North America. About one fifth (>19%) of the world's museum specimens of endangered or extinct freshwater mussels are housed at OSUM, more than any other single institution. Not captured in these numbers are those samples currently hidden within the collection's massive backlog, which is stored on 2,788 lineal feet of shelving in a series of ca. 1,900 bankers boxes. These boxes contain both of wet and dry specimens from historic orphaned collections, state surveys from across the country, and the collecting efforts of affiliated staff that simply remain unprocessed. Funding from the Missouri Department of Conservation has given us the opportunity to catalog backlog material from Missouri which had previously been a low priority in the collection. To date, we have processed 19 boxes, roughly 1% of the total collection backlog. In ~200 hours of effort, we have more than doubled the total number of wet-preserved lots of Missouri-endangered and federally listed mussel species from Missouri, and increased the total number of wet-preserved lots of Missouri unionoids available for scientific study in public collections by nearly 50%. We present our curatorial workflow, a descriptive summary of the material catalogued, and a discussion of our use of the recently-published MusselMapR dataset as a tool for strategic collection growth.
Poster 22	**RE-DISCOVERY AND STATUS OF A POPULATION OF YELLOW LANCE IN MARYLAND.** Megan E. Kubala, Sally Ehlers, Matthew J. Ashton - Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Division, 580 Taylor Ave. C-2, Annapolis, MD 21401.
	Nearly two-thirds of North America's freshwater mussel species are endangered, extinct, or imperiled. Maryland is no exception: 14 of the state's 16 mussel species are rare, threatened, or endangered. Some species have experienced such severe declines in distribution and abundance that populations are isolated to one or a few streams and face extirpation. Yellow Lance (*Elliptio lanceloata*) was listed as federally threatened in 2018 after six of the eight extant populations were found to have low resiliency and lacked evidence of recruitment. Its extant status in the Patuxent River basin of Maryland was clarified during the listing process by a re-examination of natural history voucher specimens, discovery of additional, valid specimens, and the serendipitous collection of a live individual in the Hawlings River during a fish community survey. Over a six-year-period, the Maryland Department of Natural Resources and partners surveyed streams with historical and contemporary records of Yellow Lance to: 1) determine their occupancy, 2) compare recent and current patterns in their distribution and abundance, and 3) collect survey data in a manner that can account for imperfect detection. A total of 1,809 mussels of seven species were observed at 63 sites, primarily in the Hawlings and Patuxent River. A total of 35 Yellow Lance were observed across all years, although 65% of these were detected in the 2018 survey. The abundance of Yellow Lance and mussels in general appears to be declining in the Hawlings River. Their occupancy in the Patuxent River was limited to a single site near the confluence with the Hawlings River. They were not detected at other localities with historical records of Yellow Lance even though mussels were abundant at some. Surveying at regular intervals, implementation of eDNA sampling, and a comprehensive watershed management plan to conserve the species are high priorities.

Poster 23	**ASSESSING HABITAT CONNECTIVITY AND MUSSEL DISTRIBUTIONS IN THE BAYOU PIERRE WATERSHED, LOUISIANA, USA.** Julia N. Morin, Garrett W. Hopper, and Michael D. Kaller - School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, Louisiana, USA, 70808.
	Freshwater mussels (Order Unionida) are a diverse group with over 800 species worldwide, 300 of which live in the United States. Mussels provide essential ecosystem services including water filtration and nutrient cycling yet are some of the most imperiled organisms on Earth, largely explained by stream habitat fragmentation and loss. The southern United States has significant mussel diversity; however, distribution and abundance are widely unknown in Louisiana compared to nearby states. Bayou Pierre, a tributary to the Red River in northwestern LA is estimated to have 21 species of freshwater mussels, four of which are species of greatest conservation need (SGCN) according to Louisiana's State Wildlife Action Plan. Available records for Bayou Pierre are over a decade old and may not reflect current assemblages as this watershed has been fragmented by culverts, bridges and other structures. This study aims to address these knowledge gaps through three approaches: road-stream crossing assessments, qualitative mussel surveys with rapid habitat assessments, and follow-up habitat and quantitative surveys. Road-stream crossing assessments inform barriers to host fish passage and will be conducted according to protocol developed by the Southeast Aquatic Resource Partnership at 300 sites identified in the National Aquatic Barrier Inventory and Prioritization Tool. We intend to use an occupancy modeling approach to estimate the presence of SGCN mussels along the length of Bayou Pierre. We plan to perform additional habitat assessments at a subset of sites that examine stream substrate conditions and conduct quantitative mussel surveys to determine density, biomass, and species composition. Results will provide important baseline information on habitat connectivity for host-fishes and updated mussel distributions and abundances that will aid in informing state conservation actions.
Poster 24	**FRESHWATER GASTROPOD ASSEMBLY IN STATE-MANAGED SEASONAL WETLANDS THROUGHOUT ILLINOIS.** Ashleigh R. McCallum, Alison P. Stodola, Kirk W. Stodola, and Rachel M. Vinsel – Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, Champaign, Illinois, 61820.
	Seasonal and semi-permanent wetlands are ecologically significant due to their role in indicating ecosystem health, storing surface water, exchanging groundwater, and providing habitat for wildlife. Despite their importance, these wetlands remain understudied, and factors influencing aquatic gastropod populations within them are largely unknown. Gastropods were collected as part of a broader study assessing the ecological health of state-managed wetlands using unbaited minnow traps and macroinvertebrate dip-netting. Minnow trap deployment was scaled to wetland size, with one trap per 25 m^2, ranging from a minimum of 4 to a maximum of 15 traps per wetland. Dip-netting was conducted using a 250 µm D-framed multifilament dip net, with one 1-meter sweep per 100 m^2, ranging from a minimum of four to a maximum of 40 sweeps per wetland. Gastropods collected were preserved in 70% ethanol jars for subsequent identification and analysis. Mollusks were sorted by site, collection date, and sampling type (minnow trap versus D-net) and identified to the lowest taxonomic level possible. We built Poisson regression models to estimate species richness at each pond using habitat covariates: area, canopy cover, fish presence, land use, and shoreline slope. These models were tested for multicollinearity with Variance Inflation Factor (VIF) and ranked based on Akaike's Information Criterion (AICc). Similarly, we built linear regression models to estimate total abundance and Shannon diversity, with the same testing and ranking approach. Additionally, we used logistic regression to model the presence of each family group, also using habitat covariates and ranking the models with AICc. All gastropods collected were pulmonate snails (i.e., lung-breathing), with three families and 12 species across 97 sites. Estimates of gastropod richness and abundance varied with landscape features. Our findings help explain how seasonal and semi-permanent wetlands in Illinois provide habitat for largely understudied aquatic gastropod populations.

Poster 26	**DIVERSITY AND DISTRIBUTION OF THE MUSSEL FAUNA OF ABRAMS CREEK.** Caleb Moses[1], Augustin Engman[1], Gerry Dinkins[2], Matt Kulp[3], and Luke Etchison[4] – [1]School of Natural Resources, University of Tennessee, Knoxville, Tennessee, USA, 37996; [2]Curator of the Malacological Collection of the McClung Museum, University of Tennessee, Knoxville, Tennessee, USA, 37996; [3]Great Smoky Mountains National Park, Gatlinburg, Tennessee, 37738; [4]North Carolina Wildlife, Raleigh, NC, 27606.
	Abrams Creek is a protected, forested watershed nearly entirely contained in the boundaries of the Great Smoky Mountains National Park. This stream maintains a high level of biodiversity due to portions of its watershed being underlain by limestone. In 1957 a rotenone treatment was conducted to establish a trophy trout fishery here, which extirpated 31 of the 63 fishes native to Abrams Creek. Due to the duration of this treatment and the loss of their host species, it is likely that several mussel species were also extirpated by this event. Since the 1957 treatment some natural fish recolonization has occurred and has been aided by species reintroductions, but this system has remained disconnected from the Little Tennessee river due to the Chilhowee impoundment. Several of the fish species extirpated have been successfully restored, so the National Park Service is considering taking action to expand the diversity of mussel species as well. The extant mussel fauna of Abrams Creek has never been fully characterized, with only select reaches having been surveyed prior to 2023. This study fully characterized the current mussel assemblage and species distributions over the entire length of viable mussel habitat in Abrams Creek using a standardized snorkel timed search protocol. One person-hour snorkel searches were conducted at thirty-two sites over 26.5 river kilometers. All observed mussels were identified, measured, sexed and alphanumerically tagged. Several hotspots of mussel abundance and the upper limit of mussel occurrence were identified in this system. Evaluating this data indicates negative relationships between both species richness and relative abundance with increasing distance from the impoundment, but the environmental drivers of this relationship have not yet been identified. During this study five species were observed, with a sixth - *Pleuronaia barnesiana*- being observed in 1918 by A. E. Ortmann; however when comparing this stream to nearby systems that regularly sustain 10-20 species, it seems likely that mussel diversity was reduced.
Poster 27	**CHARACTERIZING THE AQUATIC SNAIL ASSEMBLAGE OF BAYOU BARTHOLOMEW, LOUISIANA.** Caleb Moses[1], Augustin Engman[1], and Gerry Dinkins[2] – [1]School of Natural Resources, University of Tennessee, Knoxville, Tennessee, USA, 37996; [2]Curator of the Malacological Collection of the McClung Museum, University of Tennessee, Knoxville, Tennessee, USA, 37996.
	Bayou Bartholomew is a river that flows 364 miles from Arkansas through Louisiana to its confluence with the Ouachita River. While much of the fish and freshwater mussel diversity of the Bayou is known, the aquatic snail fauna has never been surveyed. Ten survey sites have been completed within the Louisiana section with a timed search survey being completed at every site and a quantitative grid survey conducted at a subset of these sites. All snails collected were identified and batch weighed, and a subset of each species collected were retained for further identification. We plan to return to Bayou Bartholomew later in 2025 to conduct 12 additional sites to complete the characterization of the aquatic snail assemblage present here.

Poster 28	**WORKING TOWARD THE RECOVERY OF THE PALE LILLIPUT (*TOXOLASMA CYLINDRELLUS*).** Kristin I. Womble, Amanda E. Rosenberger, and Robert T. Paine – Tennessee Cooperative Research Unit, Tennessee Tech University, Cookeville, Tennessee, USA, 38505.
	The Pale Lilliput (*Toxolasma cylindrellus*) is a federally endangered freshwater mussel that is restricted to two natural populations in the Tennessee River drainage. Historical surveys of the Pale Lilliput were conducted without current understanding of its short-term brooding life history or burrowing behaviors, and these surveys likely under-sampled areas where the species would be attracting its Fundulus hosts (i.e., shallow stream margins). Propagation has resulted in reintroductions of the species in several locations; however, targeted surveys to discover new Pale Lilliput populations in the species' historical range have not occurred on a large scale. The objective of this project was to use combined methods of habitat modeling, targeted field surveys, and environmental DNA to assess the current status and distribution of the Pale Lilliput to inform recovery. Our MaxEnt model (Test AUC=0.92, Omission rate=0.17) identified areas with higher forest cover extent, low mean annual flows, moderate stream gradients, low nitrogen fertilizer application rates and road densities, and higher mean summer stream temperatures as suitable for the Pale Lilliput. We used our model results to select sites for targeted field surveys and sampled 22 sites throughout 14 streams in 2023 and 2024. While we did not observe Pale Lilliputs in the field, we identified Crow Creek and Richland Creek as potential reintroduction sites for the species. Since the Pale Lilliput is often difficult to detect in field surveys, we selected six sites for eDNA sample collection, focusing on sites most likely to harbor the species. We will create Pale Lilliput reference sequences and generate eDNA assays in winter of 2025, and will collect water samples during spring and summer of 2025. This study assists the recovery of the Pale Lilliput by informing efforts to establish an additional viable population and assesses the utility of combining habitat modeling, targeted field surveys, and eDNA for rare species conservation.
Poster 29	**REDISCOVERING GUATEMALA'S FRESHWATER MUSSELS.** Josué García-Pérez[1], José Vásquez[1], Abril Cardona[1], Keyla Ruiz[1], Lindsay Tecún[1], Daniel Bautista[1], Kentaro Inoue[2], Yasmín Quintana[2], and Manuel Barrios-Izás[3] - [1]Centro de Estudios del Mar y Acuicultura, Universidad de San Carlos de Guatemala; [2]Conservation Research Department, John G. Shedd Aquarium, 1200 South Lake Shore Drive, Chicago, Illinois 60605, USA; [3]Research Institute, Centro Universitario de Zacapa, Universidad de San Carlos de Guatemala.
	Guatemala is a hotspot for freshwater mussels, hosting unique Unionidae and Mycetopodidae species, including endemics. However, the lack of recent field surveys has hindered efforts to assess their diversity, distribution, and conservation status. Current knowledge relies mainly on historical records, some nearly a century old. Historically, 25 freshwater mussel species were reported, but many identifications were based on shell morphology, making records uncertain. Several species have not been observed for decades, highlighting the urgent need for systematic research to validate species identities and reassess their conservation status. Since 2024, surveys have reevaluated Guatemala's freshwater mussel diversity, focusing on historical sites and unexplored habitats in rivers, lakes, and lagoons. To date, 60 locations have been surveyed, covering 50% of historical sites and adding 30 new ones. Preliminary findings reveal a complex biogeographic scenario. Some sites contain only native species, others host both native and invasive mussels, while certain areas have only invasive species. In the most concerning cases, no mussels were detected, suggesting possible displacement or local extirpation of native species due to habitat degradation, declining water levels, and pollution. Based on shell morphology and initial DNA analyses, identified native species include *Nephronaias championi, N. ortmanni, N. yzabalensis, Delphinonaias largillierti, Psoronaias semigranosa,* and *Mytilopsis sallei.* Additionally, the invasive species *Sinanodonta pacifica* and *Corbicula fluminea* were recorded. These findings provide crucial insights into Guatemala's freshwater mussels, revealing high shell morphological plasticity and suggesting lower species diversity than historically reported. The study underscores the need for continued monitoring, integrative taxonomy, and conservation efforts to clarify species identities and protect this ecologically significant group.

Poster 31	**INSIGHTS INTO MUSSEL POPULATION RESPONSE TO TRANSPORTATION INFRASTRUCTURE IMPROVEMENTS IN ILLINOIS.** Alison P. Stodola, Rachel M. Vinsel, and Kirk W. Stodola – Illinois Natural History Survey, Prairie Research Institute, University of Illinois, Champaign, Illinois, 61801
	Assessing population response is essential for understanding ecological impacts, particularly for at-risk species. We have collected mussel survey data from over 700 sites at Illinois Department of Transportation infrastructure improvement projects. However, many surveys lack standardized methods, which limit our ability to detect population changes. We investigated typical mussel densities in Illinois, predicted mussel abundance within a site, and examined short-term population response following bridge construction. Our dataset relied on multiple-pass transect surveys at 15 sites in Illinois. Mussel density varied widely, with an average site density of 0.34 mussels/m^2 (range 0.0004 – 5.2). Pre- and post-construction response also varied widely, though we did observe a population increase at one site within only two years of construction. To predict mussel abundance at areas within a site (upstream, downstream, and under the bridge), we fit generalized linear mixed effect models while accounting for site variability. Our models revealed significant differences between areas—mussels were more abundant beneath and upstream of bridges. This study provides a critical baseline for comparing pre- and post-disturbance conditions, as well as a general framework for understanding typical mussel distributions in Illinois streams. Standardized, quantitative survey methods improve our ability to detect ecological trends, guide conservation efforts, and inform mitigation strategies to minimize impact on mussel population.
Poster 32	**USING ZERO-INFLATED MODELING OF TRANSECT SAMPLING TO OPTIMIZE POPULATION MONITORING OF FRESHWATER MUSSELS.** Gabriel T Inoshita[1], Alfredo A Ascanio[1], Daniel A Trujillo[2], Nathan Thompson[2], Kentaro Inoue[3], and David J Berg[4] – [1]Department of Biology, Miami University, Oxford, Ohio; [2]New Mexico Department of Game and Fish, Santa Fe, NM; [3]Daniel P. Haerther Center for Conservation and Research, John G. Shedd Aquarium, Chicago, IL; [4]Department of Biology, Miami University, Hamilton, Ohio.
	Human-induced climate change is impacting ecosystems around the world. This makes maintaining populations of sensitive species important. Freshwater mussels are one of the taxonomic groups most sensitive to climatic changes, leading to declines in many species of mussels. For agencies charged with protecting imperiled taxa, maintaining accurate estimates of abundance is important for monitoring and recovery of populations. At the same time, sampling resources are limited. For over 25 years, the New Mexico Department of Game and Fish has used transect sampling to monitor the Black River population of the Texas Hornshell (*Popenaias popeii)*. We sought to improve population abundance monitoring through modeling and estimating the effects of reducing sampling effort on precision and sampling cost. Due to large numbers of zero transects (>40%) encountered, we decided to use a zero-inflated model that incorporates habitat differences to estimate abundance. In 2023-2024, we repeated a population census using methods that were also used in 2011-2012 and 2017-2018 censuses. Combining the results of the three censuses, we generated a zero-inflated Poisson model to predict abundance within the river. This approach improved estimate precision by 80% compared to previous methods. We found that estimated model error doubles every 5 years we project the model into the future and that reduced sampling designs can produce good estimates with limited decrease in precision. We investigated changes in demographic parameters through a 27-year mark-and-recapture study, discovering that the total population is decreasing by about 1.67% per year. A reduced sampling scheme, which reduces costs, implemented with the zero-inflated Poisson model, which increases precision, will allow for periodic complete surveys. This approach can be applied for many types of surveys where zero inflated data is encountered.

Poster 33	**A BASELINE ASSESSMENT OF THE SPRINGS OF THE CAHABA RIVER WATERSHED: DEVELOPMENT OF A SPRING INVENTORY.** Nathaniel D. Sturm[1], Rebecca A. Bearden[1], Gregory M. Guthrie[2], and Gary A. Hastert[2] – [1]Geological Survey of Alabama, Ecosystems Investigations Program, Tuscaloosa, Alabama, USA, 35401; [2]Geological Survey of Alabama, Groundwater Assessment Program, Tuscaloosa, Alabama, USA, 35401.
	The Cahaba River is a primary tributary of the Alabama River in the Mobile River basin. It is the longest free-flowing river in Alabama and is known to have the greatest stream fish diversity of any similarly sized river in the country. It also has one of the most diverse mussel and snail faunas remaining in North America. While the fish and mussel faunas of flowing streams in the Cahaba River watershed are better known, there has never been a comprehensive assessment of the watershed's springs or their respective faunas. Springs are unique habitats where groundwater-surface water interactions provide relatively stable temperatures throughout the year. Several snail species inhabit springs, such as the Cockle Elimia (*Elimia cochliaris*) and the Princess Elimia (*Elimia bellacrenata*), which are endemic to the Cahaba watershed and currently under review for listing under the Endangered Species Act. The Geological Survey of Alabama (GSA) has been tasked with developing a baseline assessment of the springs in the Cahaba River watershed through creation of a spring inventory. While the Cockle Elimia and Princess Elimia are currently only known from a limited number of springs, identification of additional spring habitats may reveal new populations or areas suitable for species reintroduction. To accomplish this task, GSA personnel has implemented multiple methods for locating and identifying springs, including compiling information from topographic maps, agency reports, and various geographic databases, interviewing local landowners, utilizing LIDAR and digital elevation models (DEM) to identify potential spring pools, and conducting field surveys with thermal cameras. Potential spring sites on the initial inventory list were subject to ground truthing efforts to confirm the presence of a spring and assess habitat characteristics, quality, threats, and snail presence. It is intended that the resulting spring inventory will provide a valuable tool to researchers and responsible resource stewards to inform future sampling, restoration, and reintroduction opportunities.
Poster 34	**USING ARCGIS ONLINE TO AGGREGATE DATABASE RECORDS INTO A USER-FRIENDLY INTERACTIVE MAP OF OHIO'S FRESHWATER MUSSELS.** Lauren M. Lagemann[1], Alex B. Dunahoo[2], Nathaniel F. Shoobs[3], and David J. Berg[1] – [1]Department of Biology, Miami University, Hamilton, Ohio, USA, 45011; [2]Department of Biology, Miami University, Oxford, Ohio, USA, 45056; [3]Department of Evolution, Ecology, and Organismal Biology, The Ohio State University Museum of Biological Diversity, Columbus, Ohio, 43212.
	Georeferenced biodiversity records are essential for the conservation and management of biological resources but are often scattered across multiple databases with varying levels of accessibility. While museum data have recently become more accessible, data managed by agencies, especially concerning species of conservation concern, remain largely inaccessible to most resource managers. To address these issues, we are developing an interactive mapping application using ArcGIS Online that summarizes Ohio's freshwater mussel distributions, while obscuring point data for protected species. Records are being compiled from iNaturalist, the Ohio Department of Natural Resources, the Ohio Department of Transportation, The Ohio State University Museum of Biological Diversity, and a synthesis of museum collections. Future records added to compatible sources will be automatically imported using Application Programming Interfaces (APIs). Users will initially view a map of Ohio overlaid by togglable watershed or county boundaries, with widgets that filter records based on collection year, data source, and mussel condition. Users can select specific watersheds or counties to generate a list of species that have records within the selected area. Alternatively, users can select species of interest to generate a list of the watersheds or counties that contain records for those species. The lists can then be downloaded as a CSV file, which will include the most recent collection year of each species within each county or watershed. This project develops an important resource for monitoring species distributions over time, which will support future research and conservation efforts. In addition, we discuss the spatial, taxonomic, and temporal biases that are present within each data source. For example, after 2010, *Pyganodon grandis* had the most iNaturalist records of Ohio unionids, but was ranked sixth in the synthesis of museum records. While this project focuses on Ohio's freshwater mussels, our analytical framework can easily be transferred to other locations and taxa.

Poster 36	**POTENTIAL DESCRIPTION OF FRESHWATER MUSSEL (BIVALVIA: UNIONIDAE) SPAWNING USING ENVIRONMENTAL DNA.** Daniel Symonds[1], Cody Fleece[2], and Nathaniel Marshall[3] – [1]Edge Engineering and Science, Columbus, OH, USA, 43146; [2]Stantec Consulting Services, Cincinnati, Ohio, USA, 45242; [3]Stantec Consulting Services, Topsham, Maine, USA, 04086.
	Freshwater mussels reproduce through spermcasting, where males discharge spermatozeugmata sperm masses consisting of thousands of spermatozoa. Females then capture sperm from the water column and brood their glochidia until they mature, with this brooding time varying between species. Freshwater mussels exhibit doubly uniparental inheritance, in which a maternal and a paternal mitochondrial genome is transmitted uniparentally, with these two genomes displaying greater than 30% genetic divergence. This unique trait provides an opportunity to use environmental DNA (eDNA – traces of shed genetic material found in the environment) as a tool to track mussel spawning events, as an increase in male mitochondrial DNA may signal an increase in spermatozeugmata in the water column. Changes in eDNA concentrations temporally can help elucidate spawning periods for these species. The nature of sampling for eDNA (water samples) allows for sampling during periods when/where traditional surveys are not feasible (e.g. cold water temperatures). This study analyzed eDNA samples collected from four waterbodies between 2021-2023. DNA extraction and metabarcoding for the mitochondrial 16S gene was used to amplify both female and male mitotypes for freshwater mussel. The ten species that had both mitotypes present were assessed to compare sequence read abundances. Multiple species were shown to have a large bias in samples towards the male mitotype (>85%), indicating the potential detection of a spawning event. A combination of long-term sampling and monitoring of abiotic factors may allow conservation biologists to obtain species-specific and drainage-specific spawning criteria (e.g. time of year, water temperature cues, etc.).
Poster 38	**LEVERAGING NEW TECHNOLOGY TO IMPROVE MUSSEL SEARCH METHODOLOGY IN RESERVOIRS.** Kayla McRobb, Renee Mulcrone, Seth McRobb, Melissa Meszaros, John Barbatano, Laura Gallagher, Liam Conlan, Jacob Harrison, Valerie Novaes, Mary Trzeciak and Debbie Gibson – OHM Advisors, Livonia, Michigan, USA, 48150.
	OHM Advisors were contracted to survey for mussels throughout the Peninsular Dam impoundment in Ypsilanti, MI, to support anticipated removal of the dam. Much of the impoundment is too deep to survey without use of SCUBA diving equipment. The Michigan Freshwater Mussel Protocols maintained by the Michigan Freshwater Mussel Working Group currently do not allow for reconnaissance surveys in waters deep enough to require use of SCUBA diving equipment; deep waters for which there is no historical data or which may be devoid of mussels must nevertheless be searched using a semi-quantitative methodology. Current reservoir semi-quantitative search methodology requires setting transects perpendicular to impoundment shorelines every 25 meters. This creates gaps in the search pattern and wastes expensive dive time while staff retrieve and move lines and anchors. OHM Advisors devised a new method for reconnaissance surveys of deep impoundments or unlisted streams to reduce unproductive dive time and minimize gaps in the search pattern, which MDNR approved for use in the Peninsular Dam reservoir. Waterproof GPS devices were used to track divers' meander search paths while divers took detailed, time-stamped notes on substrate changes and mussel locations. Mussels were identified to species and processed as usual by qualified personnel. Time-stamped mussel data and substrate notes were associated with georeferenced meander paths to geolocate mussels and delineate regions of the impoundment by substrate. This alternative survey methodology provided finer detail and accuracy than current methods while reducing unproductive dive time and associated costs. Traditional survey methods for reservoirs would have covered about 6,300 meters of transect over approximately 25 working days, while the same size team covered 19,400 meters of meander survey in just five working days utilizing this new technique.

Poster 39	**ASSESSING AND RECOVERING NATIVE FRESHWATER MUSSELS IN THE GREAT PLAINS USING EDNA APPROACH.** Emily M. Zavacki and Omera B. Matoo – Department of Biology, University of South Dakota, Vermillion, South Dakota, USA, 57069
	Described as one of the most imperiled fauna in the United States, freshwater mussels are experiencing drastic population declines with extinction rates projected up to 50% by the end of the century. In the Great Plains states (including South Dakota and Nebraska), river warming, agricultural runoff, and recurring droughts have accelerated mussel population declines by 53%. Yet, conservation efforts to identify source populations for maintaining genetic diversity in state hatcheries, pinpoint suitable waterways for reintroduction, and assess the decline of historically common species are hindered due to the limited understanding of mussel distribution in these states. However, conventional field surveys are time-consuming, disruptive, and require taxonomic expertise. To overcome these limitations, we are using a comprehensive environmental DNA (eDNA) metabarcoding approach across 200 sites in watersheds of these two states. eDNA metabarcoding is a molecular systematics approach that will allow simultaneous detection of multiple mussel species, via analyses of water samples, using high-throughput DNA sequencing with two widely used phylogenetic taxonomic markers - cytochrome c oxidase subunit I (COI) and NADH dehydrogenase subunit 1 (ND1). These results, when complemented with tactile surveys, will inform (1) mussel biodiversity across large spatial scales, (2) presence of rare and federally listed species; (3) out-of-range and/or invasive species; and (4) estimates of relative mussel community abundances. Overall, this study generates critical insights for evolutionary potential, long-term sustainability, and policymaking for freshwater mussels.
Poster 40	**ACUTE TOXICITY OF THREE MINING-RELATED CONTAMINANTS TO FOUR PLEUROCERID SNAIL SPECIES.** Allison N. Sieja[1], David J. Soucek[1], Paul D. Johnson[2], and Jennifer P. Grunewald[3] – [1]U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO, USA, 65201; [2]Alabama Department of Conservation and Natural Resources, Alabama Aquatic Biodiversity Center, Marion, AL, USA 36756; [3]U.S. Fish and Wildlife Service, Alabama Ecological Services Field Office, Tuscaloosa, AL, USA, 35486.
	Freshwater mollusks are some of the most imperiled fauna groups globally. Previous studies demonstrated freshwater mussels are highly sensitive to contaminants, including major ions, ammonia, and metals. Like freshwater mussels, freshwater gastropods are also highly diverse and exhibit high endemism throughout North America. However, gastropod toxicity data are limited, particularly for gilled species that represent the bulk of species diversity. The objective of this study was to determine the sensitivity of four Pleuroceridae species: Gladiator Elimia (*Elimia hydeii*), Black Mudalia (*E. melanoides*), both of which are endemic to the Locust Fork watershed of Alabama, Sharp-Crest Elimia (*E. carinifera*), restricted to small sections of three Mobile Basin tributaries, and Liver Elimia (*E. livescens),* common through the Midwest, to coal mining-related contaminants. We conducted 96-h acute toxicity tests with sodium sulfate, a mixture of calcium sulfate and magnesium sulfate, and manganese. For the sodium sulfate and manganese tests, juvenile *E. livescens* and adult *E. hydeii*, *E. carifinera*, and *E. melanoides*were exposed to five concentrations of each chemical (50% serial dilution) plus a control under static conditions at 23°C. Mortality was assessed at 48 and 96-h. Control survival in all tests was above 90%. Initial testing with the full dilution series for *E. livescens* indicated no toxicity to the calcium and magnesium sulfate mixture. The other three species were tested only with the highest concentration and did not indicate sensitivity. The median lethal concentrations (LC50) for sodium sulfate for each of the four snail species were more sensitive when compared to lunged snails but fell within the range observed for freshwater mussels in previously published reports. The LC50 for *E. livescens* for manganese was similar to that of another gilled snail in the family Thiaridae and fell in the range observed for other freshwater mollusks. We plan to conduct chronic toxicity testing with juvenile Mobile River Basin gastropods in the second year of the study.

Poster 41	**A REGULATORY FRAMEWORK FOR OIL SPILL RESPONSE ACTIVITIES AFFECTING MOLLUSKS: A DEMONSTRATION OF A LARGE-SCALE PROGRAMMATIC ACTION.** Becca Winterringer[1], Jerome Popiel[2], and Michael deMoulpied[1] – [1]EnviroScience, Stow, Ohio 44224; [2]Ninth Coast Guard District, AJC Federal Building - Room 2083J, 1240 E. 9th Street, Cleveland, OH 44199
	Biological evaluations (BE) were developed to assess the potential for adverse effects on species and designated critical habitats protected under the Endangered Species Act (ESA) resulting from response actions used in the implementation of the National Oil and Hazardous Substances Pollution Contingency Plan. BE's, similar to biological assessments as programmatic federal actions, provide the framework for the development of future action(s) that are authorized, funded, or carried out at a later time. BE's focus on the potential effects of oil spill response actions within the Action Areas. The effects evaluated were those associated with specific spill response actions used to minimize the risks from the spilled material during an emergency response, and not the material itself. This poster demonstrates the regulatory framework for two Action Areas (9 states in total), which examined 91 species, including 11 proposed or designated critical habitats. Of the 91 species reviewed, 22 were mollusks. Through a stepwise process, the BE first assessed the likelihood of exposure to spill response actions within a defined environment, leading to an analysis of the effects of these actions on ESA-listed species and critical habitats. Environments defined in the context of the BE were: Shorelines; Coastal Zones; Ports, Canals, and Industrial Areas; Rivers and Streams; Bays and Estuaries; Ponds and Lakes; Wetlands; and Uplands. The risk of injury or death from exposure to activities was evaluated for each species within each occupied habitat type using species distribution data and traits to determine potential ranges. An illustration of the regulatory framework and processes informing spill response actions and their subsequent effects on mollusks, addressed in the BE, will be presented.
Poster 42	**CONSIDERATIONS FOR SWAB CHOICE IN MUSSEL CONSERVATION GENETIC STUDIES.** Edie G. Nissen[1], Loretta M. Lutackas[1], W. Gregory Cope[1], and Heather K. Evans[2] – [1]North Carolina State University, Raleigh, North Carolina, 27695; [2]North Carolina Wildlife Resources Commission, Raleigh, North Carolina, 27606.
	A reliable sampling method is crucial for conservation genetic studies with imperiled species of freshwater mussels. Large sample sizes are often needed to generate robust estimates for population genetic studies, and non-invasive techniques are desired to minimize stress on sampled organisms. Conversely, non-invasive collection methods often lead to decreased quantity or quality of extracted DNA. The purpose of this study was to identify the most optimal swabbing method for use in freshwater mussel conservation genetic research. We evaluated five different swab types and three different storage methods to determine whether there was a relationship between swab type, adequate DNA yield, and sequencing success. The results revealed that the more absorbent the swab (Puritan Hydraflock), the greater the DNA yield, but the poorer the sequencing success. In contrast, less absorbent swabs (Puritan Cotton Swab) resulted in lower DNA yield, but higher sequencing success. Our findings demonstrated that DNA yield alone is not an adequate indicator of high-quality DNA needed for sequencing success and subsequent conservation genetic analysis. In addition, we found that storing the swab in a liquid fixing solution was not necessary for sequencing success, as long as swabs were stored cold after collection. Although cost and ease of use are common factors that determine the type of swabs employed in mussel genetic sampling, we have demonstrated that swab choice may influence the outcome and that standardization to a common swab among future studies may be beneficial.

Poster 43	**ASSESSMENT OF THE POPULATION GENETIC DIVERSITY AND STRUCTURE OF *SIMPSONAIAS AMBIGUA*.** Kentaro Inoue[1], Claire Waterhouse[1], Sarah A. Douglass[2], and Bernard E. Sietman[3] – [1]Conservation Research Department, Shedd Aquarium, Chicago, IL, USA, 60605; [2]Illinois Natural History Survey, University of Illinois at Urbana-Champaign, Champaign, IL, USA, 61820; [3]Center for Aquatic Mollusk Programs, Minnesota Department of Natural Resources, Lake City, MN, USA, 55041.
	Simpsonaias ambigua, the Salamander Mussel, is one of the most unique unionid species in North America. While nearly all unionids use fish as their hosts, *S. ambigua* exclusively relies on the Mudpuppy (*Necturus maculosus*). This species is also a habitat specialist, residing under large boulders that align with Mudpuppy habitats. In August 2024, *S. ambigua* was proposed for listing as Endangered under the Endangered Species Act. To facilitate its recovery, an assessment of its current population genetic status is essential. In collaboration with multiple stakeholders, we collected genetic samples from 13 populations across its range, from Minnesota to Pennsylvania and south to Kentucky. We genotyped the mitochondrial *cox1*gene and SNPs derived from ddRADseq to assess various population genetic metrics, including diversity, structure, and connectivity. These results will inform conservation strategies, including captive propagation and reintroduction programs, to support species recovery.
Poster 44	**MOLLICUTES AND MOLLUSKS: EVIDENCE OF CODIVERSIFICATION.** Russell L. Minton – Department of Biology, Gannon University, 109 University Square, Erie, Pennsylvania, USA, 16541
	Endosymbiont codiversification with their hosts is known from multiple taxa. Codiversification suggests parallel evolution of symbionts and hosts leading to congruent phylogenies in each group. Mollicutes, the smallest known bacteria capable of self-replication, may codiversify with their hosts. Many bacterial endosymbionts, including Mollicutes, are known from mollusks. Mollicutes are present in marine, freshwater, and terrestrial mollusks, and are especially abundant in digestive tissues. In this study I described two aspects of Mollicutes and mollusk interactions. First, I explored the phylogenetic and taxonomic diversities of Mollicutes found in molluscan samples, focused specifically on freshwater snails. Second, I asked whether evidence of codiversification existed between Mollicutes and their molluscan hosts. Strong signals of cophylogeny were identified between molluscan and Mollicutes phylogenies using event-based and distance-based analyses. Event-based solutions were significantly shorter than those generated by random host-bacterial tip associations. Distance-based analysis also provided significant evidence of codiversification through phylogeny convergence. My results provide the first preliminary data suggesting codiversification of Mollicutes with their mollusk hosts. My data also show significant correspondence between mollusk and Mollicutes phylogenies. It is unclear what function, if any, Mollicutes serve in their mollusk hosts and how that function may explain patterns of codiversification. Determining the function of Mollicutes in mollusks along with comprehensive host and symbiont phylogenies are needed to determine whether the associations represent cophylogeny, coevolution, or just correlation.

Poster 45	**EXPLORATION OF CELL DIVISION IN INVASIVE MOLLUSKS: TOWARDS IMMORTALIZED CELL LINES.** Gabrielle E. Sanfilippo, Trevor Hewitt, Steve Suhr, and Marie-Claude Senut – Biomilab LLC, 4209 S Pennsylvania Ave., Lansing MI, 48190.
	Invasive mollusks, including quagga (*Dreissena bugensis*) and zebra mussels (*Dreissena polymorpha*), endanger native ecosystems and biodiversity, infrastructure, and recreational and commercial fisheries. The development of biocontrol strategies to limit the damage of these species requires detailed understanding at the cellular level that is not currently available because immortalized cell lines for the study of most molluskan species have not been created. Our group is working to produce cell lines that will provide a platform from which to better understand mollusk biology, develop new approaches to protect the health of native species, and devise control strategies for invasive mollusks. Our laboratory uses dreissenid mussels, New Zealand mud snail (*Potamopyrgyus antipodarum*), and Asiatic golden clam (*Corbicula fluminea*) as model organisms to analyze cell division (mitosis). While dreissenid embryos display numerous dividing cells by several measures, a different result is observed in adult animals. DNA replication detection assays and immunofluorescence techniques reveal that adult dreissenids have significantly lower levels of endogenous cell proliferation than *Potamopyrgus* or *Corbicula*. Furthermore, following soft tissue injury expected to induce a regenerative response, mitosis and regeneration was consistently observed in *Potamopyrgus,* but was completely absent in the bivalves. *In vitro*, after passive or enzymatic dissociation and plating of either embryonic or adult cells under different conditions, none of the mollusk species tested produced dividing, mitotic cells. Despite the complete absence of mitosis, cells from each species could be maintained alive for >2 months. These data provide us with baseline information regarding the natural mitotic processes of these species and will guide future experiments aimed at inducing permanent immortalization and conversion to transformed cell lines.
Poster 47	**COMPARING MUSSEL COMMUNITY STRUCTURE, GROWTH, AND SURVIVAL IN DIFFERENT HABITAT TYPES OF THE LOWER NECHES RIVER.** Emily K. Pody and Astrid N. Schwalb – Department of Biology, Texas State University, San Marcos, Texas, USA 78666.
	The intensity and frequency of droughts and floods have been increasing with climatic changes. Backwater habitats in lowland, meandering rivers may provide crucial refuge habitat for some species of freshwater mussels during such climatic events. Habitats that are adjacent to backwaters such as the mainstem river or sidearms can have distinct environmental conditions, e.g., in terms of food availability, substrate, and habitat stability during flooding, which may shape mussel community structure and growth. The goal of this study was to compare community structure, growth, and survival between backwater habitats and adjacent habitats in 10 different sections of the lower Neches River in East Texas. A combination of semi-quantitative timed searches and quantitative searches using random, stratified quadrats will be used to examine the distribution and community composition of mussels in the different habitats. A mark-recapture study will assess mussel survival and growth. Environmental factors such as bed shear stress, water velocity, and food availability will be measured to examine which factors may be driving potential differences in mussel performance in the different habitats. The study will improve our understanding of factors underlying the community structure and dynamics of freshwater mussels, which will be useful to improve conservation strategies for these imperiled species.

Poster 49	**IDENTIFYING AT-RISK SPECIES OF PYRGULOPSIS SPRINGSNAILS.** Megan M. Norcom[1] and David J. Berg[2] –[1]Department of Biology, Miami University, Oxford, OH, USA; [2] Department of Biology, Miami University, Hamilton, OH, USA.
	Springsnails of the genus *Pyrgulopsis* are widely distributed in freshwater habitats throughout western North America. Many of these species are limited to single springs or spring systems. Such species are of conservation concern due to the threat of habitat loss brought on by climate change and groundwater usage. For this reason, our goal is to identify the members of the genus which are most at risk when threatened by these factors. We used COI sequences obtained from GenBank for 129 of the 170 described species to produce a phylogenetic tree which showed that species located in Nevada, Utah, Texas, California, Montana, and Mexico form clades. We will perform character state reconstructions based on temperature, precipitation, salinity, and groundwater availability. We will use climate models to examine environmental change into the future. This will allow us to determine which species are less likely to be able to adapt to habitat conditions brought on by climate change. Using current and historical groundwater data, we will predict which species may face habitat loss due to increased groundwater usage. The results of this research will produce a list of *Pyrgulopsis* species we predict to be most at-risk due to climate change and groundwater usage. This list will serve as a resource for managers attempting to prioritize springsnail conservation and recovery in the arid West.
Poster 50	**UPPER THERMAL TOLERANCE OF THE WESTERN RIDGED MUSSEL (*GONIDEA ANGULATA*), WESTERN PEARLSHELL (*MARGARITIFERA FALCATA*), AND WESTERN SCULPIN SPECIES (*COTTUS* SPP.).** Rachael Valeria[1], Alexa Maine[2], Christine Parent[1], and James Nagler[1] – [1]Department of Biological Sciences, University of Idaho, Moscow, Idaho, USA; [2]Department of Natural Resources, Confederated Tribes of the Umatilla Indian Reservation, Walla Walla, Washington, USA.
	Freshwater mussels are ecologically and culturally important and globally have the highest extinction and imperilment rates of any animal. The Western Ridged Mussel (*Gonidea angulata*) and the Western Pearlshell (*Margaritifera falcata*) are experiencing die-offs across their native ranges and increasing water temperature is a possible factor. To undergo metamorphosis to the juvenile life stage, *G. angulata* use the gills of sculpins (*Cottus* spp.) and *M. falcata* use the gills of salmonids (*Oncorhynchus* spp.) to host their larval life stage. The purpose of this laboratory study was to determine the upper thermal tolerances of *G. angulata* and *M. falcata*, and of two sculpin species, Margined Sculpin (*Cottus marginatus*) and Paiute Sculpin (*Cottus beldingi*). Upper thermal tolerance was determined using sublethal acute and chronic tests. The acute test consisted of increasing the water temperature until critical thermal maximum (CTmax) behaviors were observed. The mean CTmax temperature was 34.1°C for *G. angulata* and 33.2°C for *M. falcata,* and the mean for the two *Cottus* spp. was 28.9°C. The chronic test gradually increased the water temperature surrounding the test organism to 2°C below the CTmax determined in the acute test for each species and maintained that temperature for seven days. Survival was recorded over the 7-day period. In the chronic test, no mussels of either species survived until the end of the 7-day test period, while 58.3% of the sculpins survived. Based on the acute test results, *G. angulata* and *M. falcata* have a higher CTmax than their host fish, but based on the chronic test, *C. marginatus* and *C. beldingi* have a higher upper thermal tolerance than the mussels. These differences in thermal tolerance could create a thermal separation between mussel and host fish, thus limiting mussel reproduction as climate change leads to warming surface waters.

Poster 51	**IMPACTS ON FRESHWATER MUSSELS FROM BEWLEY SHOALS ON THE NOLICHUCKY RIVER FOLLOWING THE FLOODWATERS FROM HURRICANE HELENE.** David Foltz II, et al. – Edge Engineering and Science, 4270 Ivy Pointe Blvd., Suite 110, Cincinnati, Ohio, 45245
	Hurricane Helene was a devastating tropical cyclone that struck the southeastern United States in late September of 2024. It is one of the deadliest and most destructive natural disasters in recent history within the United States with over 210 fatalities and damages estimated upwards of 75 billion dollars. The storm caused catastrophic rainfall in TN and NC resulting in widescale flooding. This was particularly felt in the French Broad and Nolichucky Rivers. The Nolichucky River at Lowlands, TN crested on September 28, 2024 at over 35 feet with its median daily height at 7 feet. The flooding exceeded the gaging station readings for discharge and broke at above 60,000 cubic feet per second, though it likely exceeded that by more than 40-50 times when extrapolating the logarithmic discharge from gage height. Damage to the surrounding area was catastrophic. Effects were well documented in local and national news and across social media; however, effects to local wildlife have been difficult to gage. As floodwaters receded, Eastern Hellbenders and freshwater mussels were stranded hundreds of meters from local streams. In fact, the flooding was considered so devastating to the Eastern Hellbender populations within the affected streams that the species was proposed to be listed under the Endangered Species Act as the streams affected were considered strongholds for the species prior to the flooding. Effects on mussels were lesser known and little has been documented across the region, but effects on Bewley Shoals on the Nolichucky River was monitored for a period of months following the flooding. Herein, we present findings from these monitoring events documenting changes on the local landscape including the dewatering of Bewley Shoals and noted impacts of local mussel fauna to aid state and federal agencies in management of these mussel resources following catastrophic natural events like Hurricane Helene.
Poster 52	**RESTORATION PLANNING FOR FRESHWATER MUSSEL POPULATIONS IN THE UPPER POTOMAC RIVER, MARYLAND.** Megan E. Kubala, Sally Ehlers, and Matthew J. Ashton - Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Division, 580 Taylor Ave. C-2, Annapolis, MD 21401.
	Freshwater mussels are one of the most imperiled faunal groups in North America. Their reduced abundance and diversity have been attributed to habitat alteration, water quality degradation, and host fish deficiency. While water and habitat quality have improved in some areas, many populations have become reduced to the point that natural resource agencies must propagate mussels in hatcheries to recover their natural populations. In the upper Potomac River, mussel restoration via augmentation or reintroduction can be an important tool to help restore species diversity and ecosystem function upstream of Dam No. 5 where conditions are again suitable to support mussel populations. Together with partners, we propose a multi-year plan to restore ecologically functional and viable populations of multiple mussel species found in the upper Potomac River. The three main phases of the restoration plan include 1) identifying reaches of suitable habitat, 2) conducting a silo study with juvenile mussels, and 3) implementing small-scale stocking of monitoring plots within five sections of the upper Potomac River. To date, we have evaluated 85 river kilometers and have identified approximately 2.87 km2 of suitable mussel habitat. To inform restoration planning, we performed a quantitative survey of a reference mussel bed to estimate stocking goals and tested semi-quantitative survey methods to evaluate stocking success. If stocked at a similar density to the reference bed, this project has the potential to augment 4 million mussels across all areas of suitable habitat. Despite the mitigation of historical water quality impacts, without active management, it is unlikely that mussels will naturally recolonize the upper Potomac River due to a lack of source populations. Following this action plan has the potential to not only aid in population expansion, but also prevent species uplisting.

Poster 53	**VIRGINIA DEPARTMENT OF WILDLIFE RESOURCES FRESHWATER MUSSEL CONSERVATION PLAN.** Kayla Howard and Kim Morgan – Virginia Department of Wildlife Resources, Forest, Virginia, USA, 24551
	The Virginia Department of Wildlife Resources' Freshwater Mussel Conservation Plan draft was recently completed in December of 2024. Virginia boasts a diverse freshwater mussel fauna, with 78 species currently recognized in the state. However, over 80% of these species maintain a regulatory status or are designated as a Species of Greatest Conservation Need. With so many species at risk, a conservation plan was developed to highlight gaps in knowledge and to guide future conservation and restoration efforts. This plan takes a species-based approach, identifying a goal and necessary actions for each species known to Virginia. However, we also provide a broad statewide strategy, identifying needs in various areas such as surveys and data management, host fish management, research and propagation, outreach, and habitat restoration. Next tasks include an internal review of the plan, coordinating with partners to ensure all priority conservation actions are included in the plan, and final review by these partners and DWR. The final plan is anticipated to be completed during the summer of 2025.
Poster 54	**RESTORING OUR RIVERS: SCOPING CANADA'S FIRST UNIONID MUSSEL REINTRODUCTION.** Kelly A. McNichols-O'Rourke[1], Mandy P. Gibson[1], Christopher G. Wilson[2], Lauren Damphousse[3], Todd J. Morris[1] - [1]Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, Ontario, Canada, L7S 1A1; [2]Fish Culture Section, Ministry of Natural Resources, Peterborough, Ontario, Canada, K9J 8M5; [3]Healthy Headwaters Lab, University of Windsor, Ontario, Canada, N0R 1K0.
	Ptychobranchus fasciolaris (Kidneyshell) was assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2003, having experienced a 70% decline from its historical range due to the dreissenid invasion, habitat loss, and pollution. The species was then listed under Canada's Species at Risk Act in 2005, where a Recovery Strategy was developed with a long-term goal of maintaining current subpopulations and re-establishing others in historically occupied habitats. Currently, this species is extant and reproducing in only two of the original nine waterbodies it historically occupied in Canada – the East Sydenham River and the Ausable River. The populations in these systems are reproducing with abundances considered stable to increasing. In 2023, Fisheries and Oceans Canada (DFO) developed a decision support framework for assessing the feasibility of conservation translocations that weighs the likelihood of achieving recovery objectives against the likelihood and magnitude of unintended consequences to both target and donor populations and habitats. Ontario's Ministry of Natural Resources (MNR) successfully propagated P. fasciolaris in 2015 as part of an unrelated research project and nearly 800 of these individuals, now almost 10 years old, are available for use in a recovery action. Using available survey and habitat data we explore the application of DFO's decision support framework to a proposed reintroduction of Kidneyshell into the Thames River to restore its extirpated population.

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From the 2025 Biennial Symposium Planning Committee:

Thank you for making the 2025 Symposium a Success!