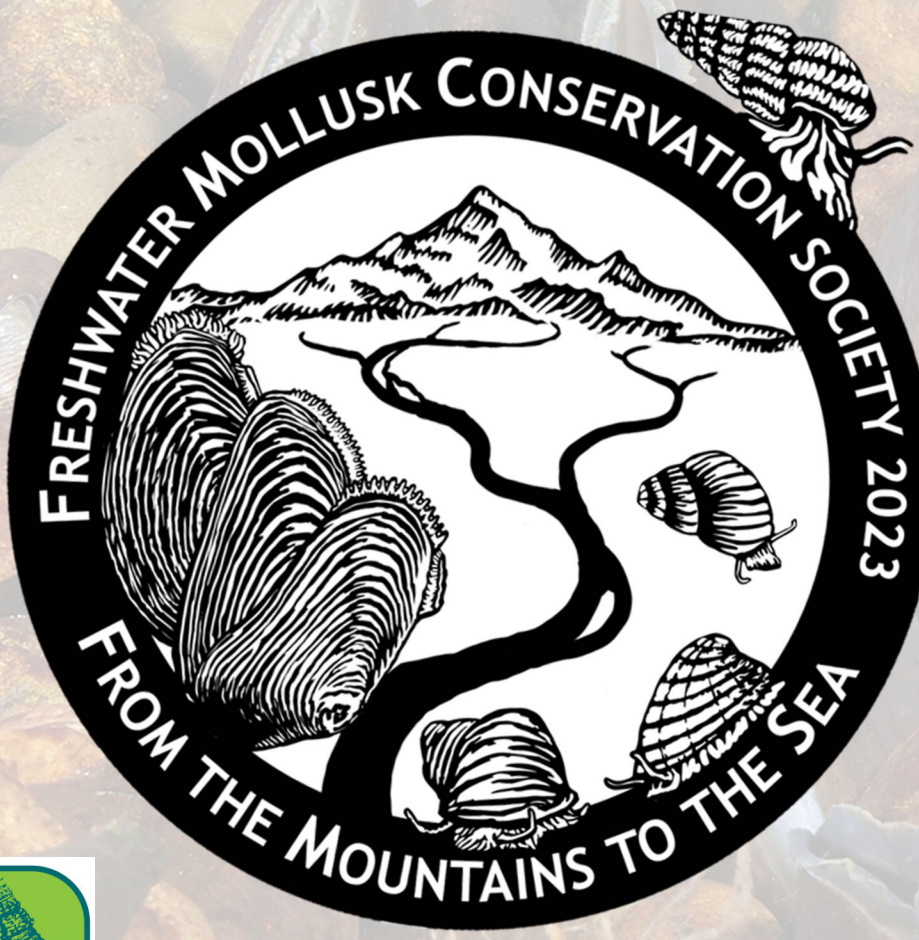
13th Biennial Freshwater Mollusk Conservation Society Symposium

Portland, OR

April 10-14th, 2023



Double Tree by Hilton Hotel

1000 NE Multnomah St, Portland, OR 97232

Thank you Sponsors!!

River: >$2,000

Cayuse - Walla Walla - Umatilla Confederated Tribes of the Umatilla Indian Reservation Treaty of 1855

EnviroScience™ Excellence In Any Environment

EDGE ENGINEERING & SCIENCE

Stream: $1,000 - $1,999

DAGUNA CONSULTING

U.S. FISH & WILDLIFE SERVICE — Department of the Interior

OREGON Fish & Wildlife

VIRGINIA DWR — CONSERVE. CONNECT. PROTECT.

Private donations from **Former Clammer** and in honor of **Tom Watters,** for his contributions to FMCS

Eddy: $500 - $999

Washington Department of FISH & WILDLIFE

XERCES SOCIETY for Invertebrate Conservation

RDG RIVER DESIGN GROUP

Mussel: $100 - $499

Montana Biological Survey — Aquatic Ecology Fisheries Taxonomy Assessments

EcoAnalysts, Inc.

FLOY TAG—Seattle, WA

L E C — Lewis Environmental Consulting, LLC

2023 Symposium Organizers

Emilie Blevins
Xerces Society for Invertebrate Conservation

Megan Bradley
U.S. Fish and Wildlife Service

Alan Christian
Ursinus College

Alexa Maine
Confederated Tribes of the Umatilla Indian Reservation

Patty Morrison
U.S. Fish and Wildlife Service, Retired

Michele Weaver
Oregon Department of Fish and Wildlife

Symposium Planning Committee

Auction: Ron Constable, Lisie Kitchel

AV/Communications: Sophie Binder, Alan Christian, Amy Maynard, Sarah Veselka

Awards: Curt Elderkin, David Hayes, Susan Oetker

Diversity, Equity, and Inclusion: Tam Smith, Daelyn Woolnough

Field Trips: Emilie Blevins, Michele Weaver, Travis Williams, Monica Blanchard

Keynote Speakers: Eric Quaempts, Janine Castro, Laura Taylor

Local Arrangements: Kevin Aitkin, Emilie Blevins, Alexa Maine, Patty Morrison, Nate Neal, Courtney Newlon, Christina Wang, Michele Weaver

Program: Emilie Blevins, Patty Morrison, Alexa Maine, Monica Blanchard, Derek Wilson

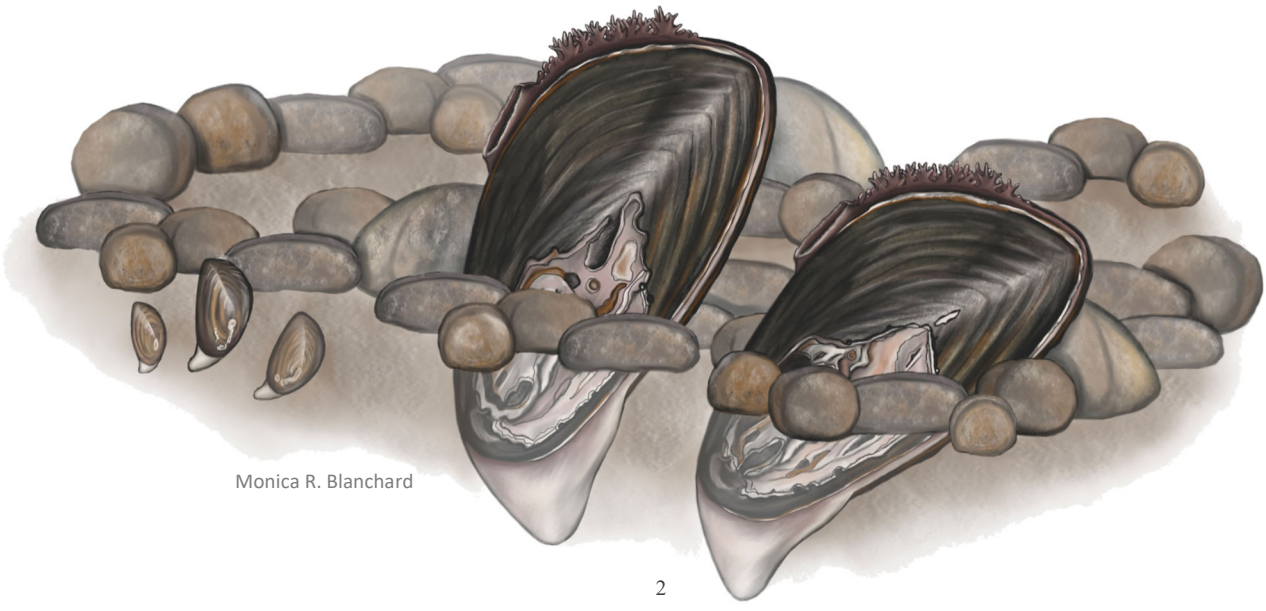
Socials: Emilie Blevins, Lisie Kitchel, Nate Neal, Amy Maynard, Dan Symonds, Michele Weaver, Derek Wilson

Sponsorship and Vendors: Ron Constable, Courtney Newlon, Marie Winkowski, Edge Engineering & Science, Little Pond Nature Prints

Virtual Platform: Alan Christian

Workshop: Emilie Blevins

Acknowledgements: Patrick Norton Illustrations (conference logo design), Roger Tabor (USFWS, cover photo)



Monica R. Blanchard

FMCS Standing Officers

President: Steve McMurray
President Elect: Megan Bradley
Secretary: Sarah Veselka
Past President: Jeremy Tiemann
Treasurer: Alan Christian

FMCS Functional Committees and Chairs:

Awards:
Chair: Curt Elderkin - The College of New Jersey - (elderkin@tcnj.edu)
Co-Chairs: David Hayes - Eastern Kentucky University - (david.hayes@eku.edu)
Susan Oetker - U.S. Fish and Wildlife Service - (susan_oetker@fws.gov)

Chapters:
Chair: Emilie Blevins - The Xerces Society (emilie.blevins@xerces.org)
Co-Chair: Manuel Lopes-Lima (manuelpmlopeslima@gmail.com)

Diversity, Equity, and Inclusion:
Chair: Tamara Smith - U.S. Fish and Wildlife Service - (tamara_smith@fws.gov)

Elections:
Chair: Wesley Daniel - U.S. Geological Society (wdaniel@usgs.gov)

Finance: Vacant

National Strategy: Vacant

Outreach:
Chair: Amy Maynard - U.S. Fish and Wildlife Service - (amy_maynard@fws.gov)
Co-Chair: Dan Symonds - (DESymonds@edge-es.com)

Professional Development Committee:
Chairs: Becca Winterringer - The Nature Conservancy (b.winterringer@tnc.org)

Amanda Rosenberger - U.S. Geological Survey Tennessee Cooperative Fisheries Research Unit (arosenberger@tntech.edu)

Publications:
Chair: Wendell Haag - U.S. Forest Service (Wendell.haag@usda.gov)

Symposium:
Megan Bradley - U.S. Fish and Wildlife Service - (megan_bradley@fws.gov)

FMCS Technical Committees and Chairs:

Conservation and Restoration:
Chair: Maddie Platta - Minnesota Dept. of Natural Resources (madeline.pletta@state.mn.us)
Tyler Hern - U.S. Fish and Wildlife Service (tyler_hern@fws.gov)
Jesse Weinzinger - Wisconsin Department of Natural Resources (jesse.weinzinger@wisconsin.gov)

Environmental Quality and Advocacy:
Chairs: Mickey Matthews - Arkansas State Highway and Transportation Department - (mickey.matthews@ardot.gov)
Braven Beaty - The Nature Conservancy - (bbeaty@tnc.org)

Field Studies and Ecosystems:
Chair: Lisie Kitchel - Wisconsin Dept. of Natural Resources (lisie.kitchel@wi.gov)
Co-Chair: Carla Atkinson (carlalatkinson@gmail.com)

Genetics:
Chair: Nathan Johnson - U.S. Geological Society (najohnson@usgs.gov)

Mollusk Status and Distributions:
Chairs: Jason Wisniewski - Tennessee Wildlife Resources Agency (Jason.wisniewski@tn.gov)
Wesley Daniel - U.S. Geological Survey (wdaniel@usgs.gov)

FMCS Code of Conduct and Meeting Expectations

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.

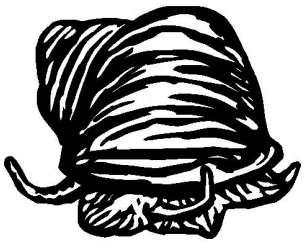
The FMCS Executive Committee reserves the right to take any lawful action deemed necessary in response to a violation of this Code of Conduct. This includes, but is not limited to, the immediate removal of the violator from the event without warning or refund. The FMCS Executive Committee may also elect 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.

Accessibility

Lactation Room: A lactation room is available for all who would like to use it at any time during the conference. It will be an explicitly dedicated standard single queen room with a small refrigerator, and you are welcome to store supplies in there as well. If you need access, ask at the front desk for the room key. You will be asked to leave an ID at the front desk while you access the room.

Childcare: Below is a list of local childcare options. Please note this list is for general informational purposes and is provided in good faith. However, FMCS and its representatives make no representation or warranty of any kind, express or implied, regarding the accuracy, adequacy, validity, or reliability of the information provided. As such, FMCS and its representatives shall not be subject to any liability for loss or damage of any kind incurred as a result of the use of this list or reliance on any information provided by this list:



Wevillage
971-302-6187
https://www.wevillage.com/ne-portland

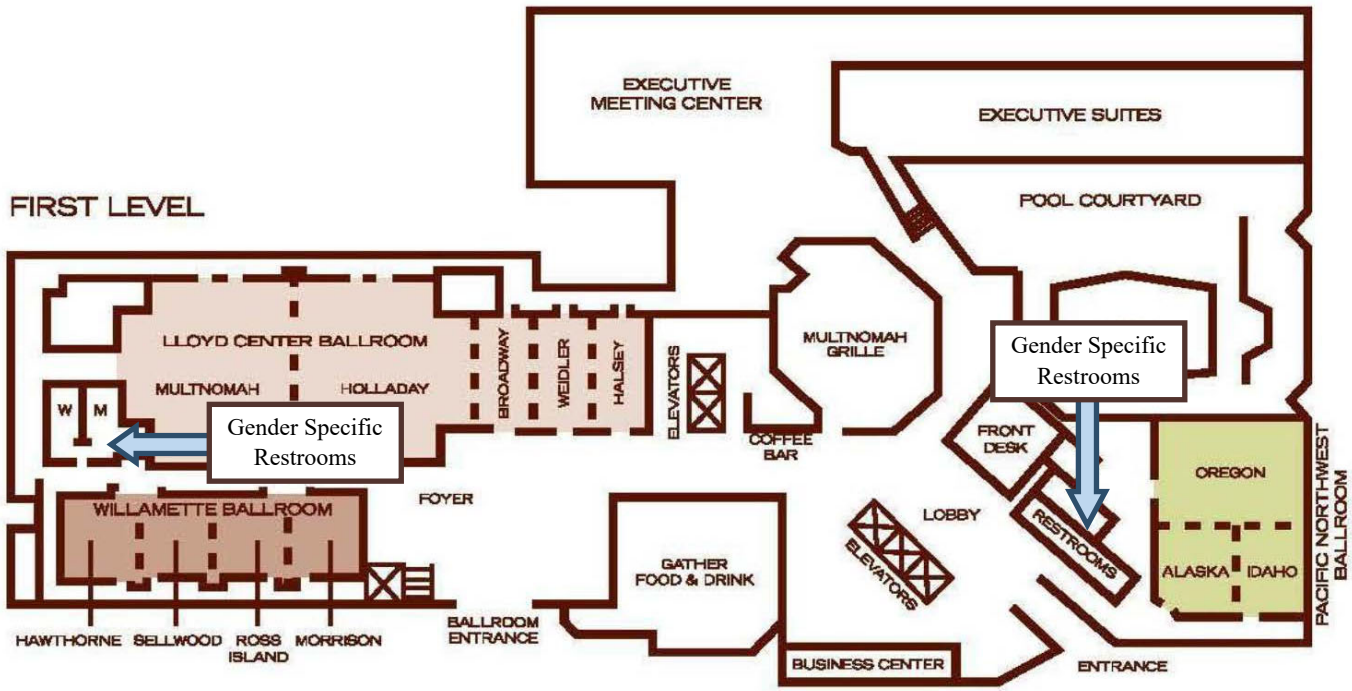
Grandma's Place
503-281-6800
http://www.gpelc.net/

MetroKids Child Development Center
(503) 797-1702

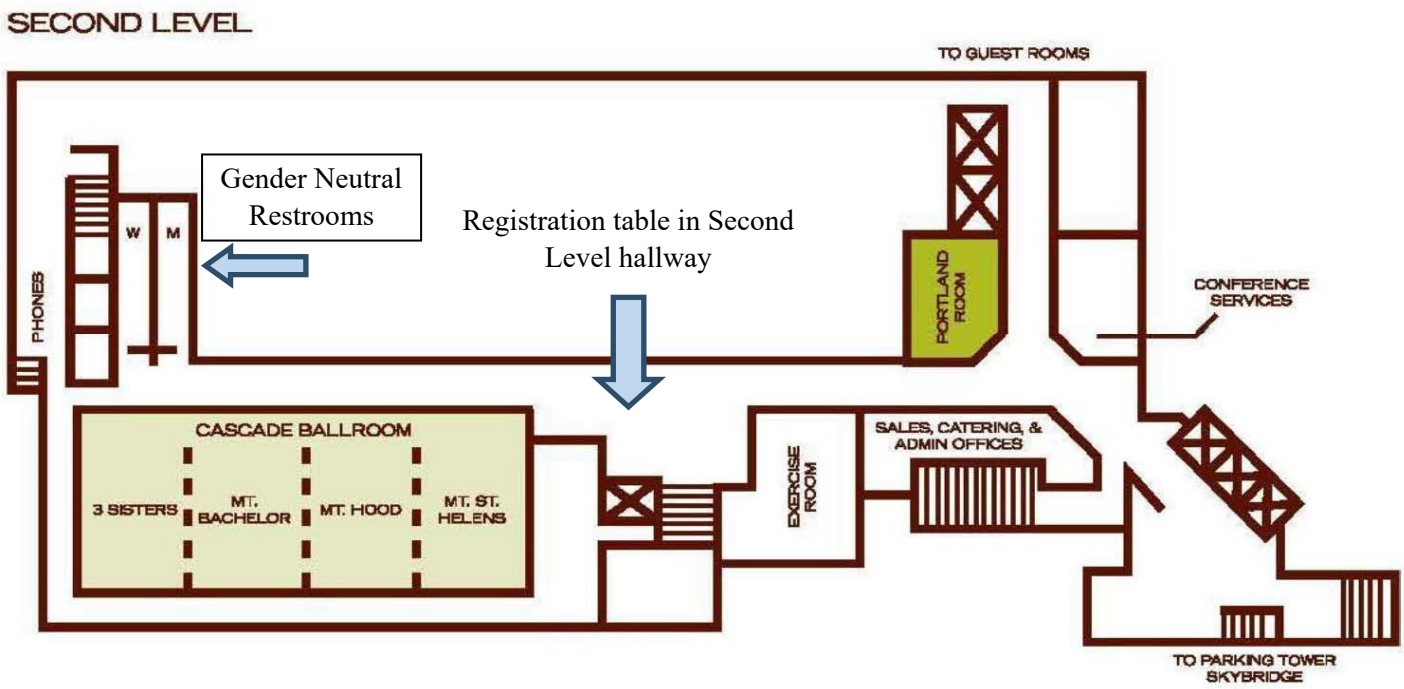
ShalaKids Drop-in Daycare
(503) 963-9642

NWNannies LLC
(503) 245-5288
info@nwnannies.net
https://nwnannies.net/

Double Tree Conference Center Floor Map



Mixers, socials, meals, and poster sessions will be held in the Pacific Northwest and Lloyd Center Ballrooms.



Plenary presentations, platform sessions, and committee meetings will be held in the Cascade Ballrooms: Mt. Hood, Mt. Bachelor, and 3 Sisters rooms. Presentation loading and networking breaks will take place in the Mt. St. Helens room.

Virtual Symposium Whova App and Website Platforms

Download the **Whova App** at the Apple App Store or Google Play and connect to the FMCS 2023 Symposium by searching for **FMCS**

OR

https://whova.com/portal/webapp/inter_202304/

Use the Whova App to see the agenda, read abstracts, plan your personal schedule, and connect with other attendees

Visit the meeting website: →

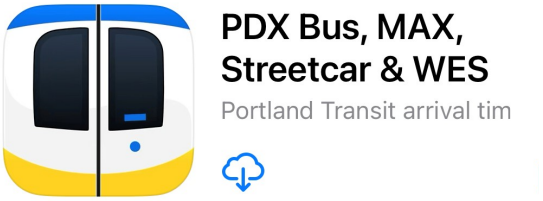
https://www.molluskconservation.org/EVENTS/2023SYMPOSIUM/2023_FMCS-SYMPOSIUM.html

Transportation Around Portland

Get to and from the Airport on the Max Light Rail Red Line, exit at the Lloyd Center/11NE Ave stop for the Double Tree by Hilton Hotel

Use the TriMet online scheduling map or the TriMet App (search TriMet or PDX Bus, MAX, Streetcar & WES) to plan routes on the city buses, light rail, and streetcar:

https://trimet.org/home/

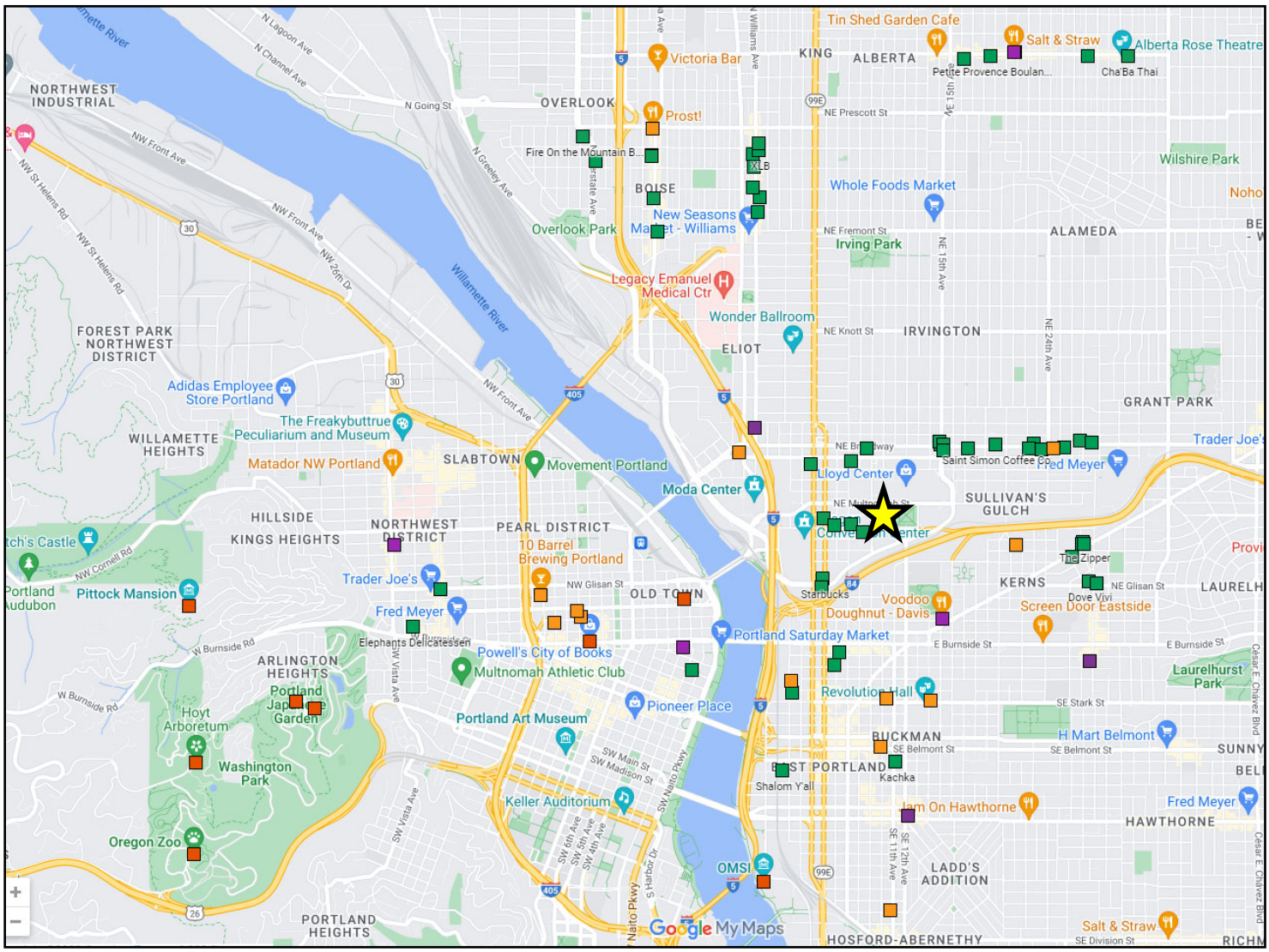


The Doubletree by Hilton Portland has an on-site parking structure. The discounted rates negotiated for symposium attendees are $22 for overnight parking with in-and-out privileges and $20 per day for daily parking.

Additional trip planning information can be found here:

https://www.travelportland.com/plan/

Exploring the nearby Neighborhoods and Portland



Explore Portland with this interactive Google Map that can be found using this QR Code

The local planning committee packed this map with information about the neighborhood around the Double Tree Hotel as well as the broader Portland area. Use this list of Portland staples to help you find nearby restaurants, food carts, breweries, Portland area activities, and more.

Workshop: Monday April 10th, 2023

Underwater Photography and Filmography

Instructors: Jeremy Monroe, Freshwaters Illustrated

(freshwatersillustrated.org)

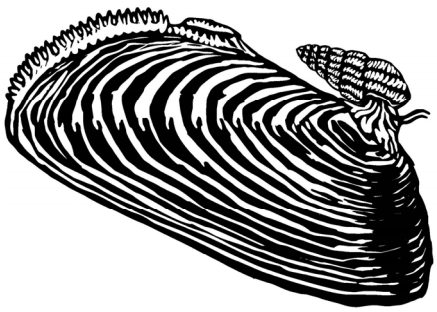
Laura Tesler, Oregon Department of Fish and Wildlife (laurateslerphotography.com)

Tim Akimoff, Oregon Department of Fish and Wildlife

(Instagram.com/MyODFW, Facebook.com/MyODFW, Twitter.com/MyODFW)

A picture is worth a thousand words, especially in today's visually driven world of social media. Are you interested in improving your underwater filmography or photography skills to better capture and communicate the importance of freshwater mussels and snails? Join us for a workshop led by experts in the fields of nature photography and filmography, as well as science communication. You'll receive information and training regarding equipment and technique and learn more about using digital media for conservation.

Laura Tesler Photography



Field Trips: Friday April 14th, 2023

All trips meet in the Double Tree Lobby at the designated start time

TRIP 1: WATERFALLS, STURGEONS and DAMS, 9am-3pm

This field trip will take participants along the Columbia River corridor in Oregon, stopping at Multnomah Falls (https:// www.travelportland.com/region/multnomahfalls/) then traversing on to Bonneville Dam (https:// www.travelportland.com/region/bonneville-dam/). Attendees can take a tour of the dam, see the fish ladder, visit Herman the Sturgeon (https://myodfw.com/articles her-man-sturgeon) and take a short self-guided hike to nearby Wahlclella Falls. The trip is less than an hour's drive from the hotel and will allow time for participants to enjoy some of the highlights of the Oregon side of the Columbia River.

TRIP 2: CONSERVATION and RESTORATION SUCCESSES of the LOWER COLUMBIA in WASHINGTON, 9am-3pm

This field trip will take participants along the Columbia River corridor in Washington, first heading to Steigerwald Lake National Wildlife Refuge (https:// www.fws.gov/refuge/steigerwald-lake), following a 2- year closure and $31 million floodplain habitat restoration project. The site is home to native freshwater mussels, salmon and steelhead, and a variety of bird life. Following a tour hosted by USFWS staff, the field trip will continue on to Cape Horn for stunning views of the Columbia Gorge and a presentation by staff from the Friends of the Columbia Gorge (https:// gorgefriends.org/). The trip also is less than an hour's drive from the hotel and will allow time for participants to enjoy some of the highlights of the Washington side of the Columbia River.

TRIP 3: ASTORIA and the OREGON COAST, 8am-4pm

A trip to Oregon is never complete without a visit to the Pacific coast. This field trip will take participants to Fort Stevens State Park on the Oregon coast (https://stateparks.oregon.gov/index.cfm?do=park. profile&parkId=129), followed by lunch in Astoria (https://traveloregon.com/places-to-go/cities/ astoria/). Attractions include a historic shipwreck, the Astoria Column (https://astoriacolumn.org/), and the Columbia River Maritime Museum (cost is $16, to be paid by attendee; https:// www.crmm.org/). The travel time is approximately 2 hours (one way from the hotel), with about a half hour additional driving between the coast and Astoria.

TRIP 4: WILLAMETTE RIVER FIELD TRIP, 9am-3pm

This field trip will take participants on an urban canoe trip around Ross Island in the Willamette River. This is a great opportunity to see the river up close, and view the City of Portland from a different perspective. Learn about restoration efforts on Ross Island, mussel work that is occurring upstream, and some of the ongoing riverine issues in the City of Portland. Bring a waterproof shell and insulating layers. The trip will take about three hours depending on water levels. Please note that, depending on conditions, cancellation is possible.

Keynote and Plenary Session Speakers

Eric Quaempts, *Director of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) Natural Resource Dept.*

Eric has served in his current role since 2004, where he implemented the First Foods management approach. Previously, Eric spent eight years as a Wildlife Biologist in the CTUIR DNR and eight years with the Umatilla National Forest. Eric's primary professional interest is in relating the culture of the CTUIR to the ecology of the Columbia Basin, and in so doing promote understanding of the Tribe's culture, natural resource restoration goals, and Treaty Rights. As an enrolled member of the Yakama Indian Nation, Eric has spent most of his life living on the Umatilla Indian Reservation, and his professional career has been focused in working on the reservation and in the Ceded Lands of the CTUIR. **Eric will be speaking on Tuesday (4/11) at 8:20am about "First Foods Management Promotes Reciprocity and Restoration of Diverse Aquatic Communities."**

Janine Castro, *Project Leader for the Columbia River Fish and Wildlife Conservation Office (CRFWCO), U.S. Fish and Wildlife Service*

Janine has been in Federal service for over 30 years. She spent almost 10 years with the Natural Resources Conservation Service as a geomorphologist working on rivers throughout the western US before joining the US Fish and Wildlife Service. Janine worked for 17 years at the Oregon Fish and Wildlife Office in Portland as a river scientist where she was involved in all aspects of aquatic habitat restoration. In 2017, Janine joined CRFWCO as the Project Leader. Janine provides national and international training on stream restoration, river science, and public speaking for scientists. **Janine will be speaking on Tuesday (4/11) at 9:10am about "The Landscapes and Rivers of the Pacific Northwest."**

Laura Taylor, *West Multnomah Soil & Water Conservation District*

Laura helps woodland owners grow healthy resilient forests by developing forest stewardship plans, providing technical assistance, and managing forest health projects for their properties. She also manages field monitoring and data collection efforts for the District's rural conservation projects and provides expertise on plants and pollinators. **Laura will be talking on Thursday (4/13) from 8:00-8:40am about "Weaving equity and inclusion into your organization's operations."**

FMCS 2023 Symposium Schedule Summary

Date/Start Time	End Time	Function	Room
Monday, 4/10			
9:00 AM	5:00 PM	Registration	Cascade Foyer
9:00 AM	10:00 AM	Coffee	St. Helens
9:00 AM	5:00 PM	Vendor/Tradeshow/Breaks	St. Helens
9:00 AM	10:00 PM	AV Loading	St. Helens
10:00 AM	3:00 PM	Workshop - Underwater Filmography	Mt. Hood
4:30 PM	6:30 PM	Board/ExCom Meeting	Mt. Hood
2:30 PM	4:30 PM	Bivalve Names Subcommittee	Mt. Bachelor
3:00 PM	5:00 PM	Gastropod Names Subcommittee	3 Sisters
3:20 PM	3:40 PM	Break	St. Helens
6:30 PM	7:30 PM	Student Mentor	PNW Ballroom - Oregon
7:00 PM	10:00 PM	Welcome Social	PNW Ballroom - Alaska & Idaho
Tuesday, 4/11			
7:00 AM	5:00 PM	Registration	Cascade Foyer
7:00 AM	8:00 AM	Coffee	St. Helens
7:00 AM	5:00 PM	Vendor/Tradeshow/Breaks	St. Helens
8:00 AM	10:00 AM	Plenary/General Session	Cascade Ballroom
10:00 AM	10:20 AM	Break	St. Helens
10:20 AM	5:00 PM	Session A	Mt. Hood
10:20 AM	5:00 PM	Session B	Mt. Bachelor
10:20 AM	5:00 PM	Session C	3 Sisters
12:00 PM	2:00 PM	Committee Meetings	Mt. Hood, Mt Bachelor, 3 Sisters
3:20 PM	3:40 PM	Break	St. Helens
5:30 PM	9:00 PM	Poster Session	PNW Ballroom
8:30 PM	10:00 PM	Movie Night - Hidden Rivers by Freshwaters Illustrated	Mt. Hood
Wednesday, 4/12			
7:00 AM	5:00 PM	Registration	Cascade Foyer
7:00 AM	8:00 AM	Coffee	St. Helens
7:00 AM	5:00 PM	Vendor/Tradeshow/Breaks	St. Helens
8:00 AM	5:00 PM	Session A	Mt. Hood
8:00 AM	5:00 PM	Session B	Mt. Bachelor
8:00 AM	5:00 PM	Session C	3 Sisters
10:00 AM	10:20 AM	Break	St. Helens
12:00 PM	2:00 PM	Committee Meetings	Mt. Hood, Mt Bachelor, 3 Sisters
3:20 PM	3:40 PM	Break	St. Helens
5:30 PM	10:30 PM	Tuesday Reception, Banquet, Raffle/Auction	Lloyd Center Ballroom
Thursday, 4/13			
7:00 AM	5:00 PM	Registration	Cascade Foyer
7:00 AM	8:00 AM	Coffee	St. Helens
7:00 AM	5:00 PM	Vendor/Tradeshow/Breaks	St. Helens
8:00 AM	10:00 AM	DEI Presentation and Lightning Talks	Cascade Ballroom
10:00 AM	10:20 AM	Break	St. Helens
10:20 AM	5:00 PM	Session A	Mt. Hood
10:20 AM	5:00 PM	Session B	Mt. Hood
10:20 AM	5:00 PM	Session C	3 Sisters
12:00 PM	2:00 PM	Business Lunch	PNW Ballroom
3:20 PM	3:40 PM	Break	St. Helens
Friday, 4/14			
		Field Trips	DoubleTree Lobby

FMCS 2023 Symposium Overview Schedule

2023 FMCS Symposium General Schedule At A Glance					
Sunday 4/09	Monday 4/10	Tuesday 4/11	Wednesday 4/12	Thursday 4/13	Friday 4/14
and NOTES					
	Registration 9:00 am - 6:00 pm	Registration 7:00 am - 5:00 pm	Registration 7:00 am - 5:00 pm	Registration 7:00 am - 10:00 am	
		Breakfast on our own	Breakfast on our own	Breakfast on our own	
** Rooms are available at the Group Rate	Workshop 10:00 am - 3:00 pm Underwater Photography and Filmography (lunch provided)	Welcome, Announcements, and Plenaries 8:00 am - 10:00 am	3 Concurrent Sessions 8:00 am - 10:00 am	DEI Presentation 8:00 am - 8:40 am Lightning Talks 8:40 am - 10:00 am	
		Break 10:00 am to 10:20 am	Break 10:00 am to 10:20 am	Break 10:00 am to 10:20 am	
		3 Concurrent Sessions 10:20 am - 12:00 pm	3 Concurrent Sessions 10:20 am - 12:00 pm	3 Concurrent Sessions 10:20 am - 12:00 pm	
Items in BLUE are those which we will offer virtual access		Lunch break and box lunches for Committee Meetings 12:00 pm to 2:00 pm 12:00 pm - 1:00 pm Mollusk Status and Distribution Publications DEI special meeting on Names 1:00 pm - 2:00 pm Professional Development Field Studies and Eco Services Genetics	Lunch break and box lunches for Committee Meetings 12:00 pm to 2:00 pm 12:00 - 1:00 pm Diversity, Equity, Inclusion Outreach Guidelines and Techniques	FMCS All Members' Luncheon and Business Meeting 12:00 pm to 2:00 pm	Field Trips and Explore Portland option for those who are interested.
	2:30 pm - 4:30 pm Bivalve Names Sub-Committee meeting 3:00 pm - 5:00 pm Gastropod Names Sub-Committee meeting	3 Concurrent Sessions 2:00 pm - 3:20 pm	3 Concurrent Sessions 2:00 pm - 3:20 pm	3 Concurrent Sessions 2:00 pm - 3:20 pm	
		Break 3:20 pm - 3:40 pm	Break 3:20 pm - 3:40 pm	Break 3:20 pm - 3:40 pm	
	FMCS Board Meeting 4:30 pm - 6:30 pm (refreshments provided)	3 Concurrent Sessions 3:40 pm - 5:00 pm	3 Concurrent Sessions 3:40 pm - 5:00 pm	3 Concurrent Sessions 3:40 pm - 5:00 pm	
	Student-Mentor Mixer 6:30 pm - 7:30 pm	Poster Set-Up 5:30 pm - 6:00 pm	Preview Auction Items, Dinner and Auction 5:30 - 10:30 pm, (Dinner served at 6:30 pm)	Dinner On Your Own and Explore Portland	
	Welcome Reception with food and drink 7:00 pm - 10:00 pm	Poster Session and Mixer with food and drinks 6:00 pm - 8:30 pm (Posters to be available online, with links to the authors for questions later)			
		Movie presentation 8:30-9:45 pm			

Committee Meeting Times and Location

Committee	Day	Time	Room
Bivalve Names Subcommittee	Monday 4/10	2:30 - 4:30	Mt. Bachelor
Gastropod Names Subcommittee	Monday 4/10	3:00-5:00	3 Sisters
Mollusk Status and Distribution	Tuesday 4/11	12:00-1:00	Mt. Hood
Publications	Tuesday 4/11	12:00-1:00	Mt. Bachelor
DEI Committee Special Discussion Topic: Mollusk Common Names	Tuesday 4/11	12:00-1:00	3 Sisters
Professional Development	Tuesday 4/11	1:00-2:00	Mt. Hood
Field Studies and Ecoservices	Tuesday 4/11	1:00-2:00	Mt. Bachelor
Genetics	Tuesday 4/11	1:00-2:00	3 Sisters
Diversity, Equity, and Inclusion	Wednesday 4/12	12:00-1:00	Mt Hood
Outreach	Wednesday 4/12	12:00-1:00	Mt. Bachelor
Guidelines and Techniques	Wednesday 4/12	12:00-1:00	3 Sisters

Tuesday 4/11 Platform Session Schedule - Abstracts start on page 23

Platform Session 1A: Status and Distribution of Mollusks 1 Tuesday (4/11) 10:20am - 12:00pm - Mt. Hood *Moderator: Steve McMurray; Missouri Department of Conservation, Columbia, MO*		Platform Session 1B: Invasive Species Impacts Tuesday (4/11) 10:20am - 12:00pm - Mt. Bachelor *Moderator: Jeremy Tiemann; Illinois Natural History Survey, Champaign, IL*		Platform Session 1C: Mollusk Health and Die-Offs Tuesday (4/11) 10:20am - 12:00pm - 3 Sisters *Moderator: Jordan Richard; U.S. Fish and Wildlife Service, Southwestern VA Field*	
PL 01 10:20-10:40	**MUSSELS OF THE WOLF RIVER, TN: A RESURVEY OF UNIONIDS IN AN INUNDATED CUMBERLAND TRIBUTARY.** J. G. Fetters, A. E. Rosenberger, and A. Ford	PL 06 10:20-10:40	**DIFFERENTIAL VULNERABILITY OF NATIVE AND NON-NATIVE MOLLUSKS TO PREDATION BY JUVENILE BLACK CARP.** J. S. Tiemann, A. P. Porreca, A. Runyon, S. E. Butler, and J. J. Parkos III	PL 11 10:20-10:40	**A STUDY TO EVALUATE CAUSES OF MUSSEL DECLINES ACROSS THE EASTERN U.S.** W. R. Haag, C. L. Atkinson, A. K. Darracq, T. P. Dubose, K. J. Fogelman, T. L. Goldberg, A. J. Ibach, S. Knowles, C. Martin, E. S. McCombs, S. J. Price, C. G. Smith, J. A. Stoeckel, D. L. Waller, and M. N. Waters
PL 02 10:40-11:00	**USING HYDROACOUSTIC IMAGING TO PREDICT YELLOW LAMPMUSSEL DISTRIBUTION AND HABITAT USE IN THE CONNECTICUT RIVER WATERSHED.** S. J. Farrington, D. Perkins, A. H. Roy, and T. Warren	PL 07 10:40-11:00	**INTERACTION BETWEEN TWO INVASIVE SPECIES, DREISSENA POLYMORPHA AND HYDRILLA VERTICILLATA.** E. A. Lorkovic and A. N. Schwalb	PL 12 10:40-11:00	**AN INTERDISCIPLINARY APPROACH TO ASSESSING DRIVERS OF UNIONID MUSSEL DIE-OFFS.** J. Da Silva Neto, M. Dennis, G. Dinkins, R. Hardman, A. Engman
PL 03 11:00-11:20	**DRIVERS OF BROOK FLOATER (ALASMIDONTA VARICOSA) OCCUPANCY AND ABUNDANCE: A WATERSHED ANALYSIS ACROSS THEIR HISTORIC RANGE.** A. M. Hershberger, A. H. Roy, J. R. Carmignani, and P. D. Hazelton	PL 08 11:00-11:20	**ECOSYSTEM SERVICES PROVIDED BY THE EXOTIC BIVALVES DREISSENA POLYMORPHA, D. ROSTRIFORMIS BUGENSIS, AND LIMNOPERNA FORTUNEI.** L. E. Burlakova, A. Y. Karatayev, D. Boltovskoy, and N. M. Correa	PL 13 11:00-11:20	**VIRUSES IN HEALTHY AND MORIBUND WESTERN PEARLSHELL (MARGARITIFERA FALCATA) DURING A MASS MORTALITY EVENT.** T. L. Goldberg, E. Blevins, E. M. Leis, I. F. Standish, J. C. Richard, C. D. Dunn & D. Waller
PL 04 11:20-11:40	**THEN, NOW, AND THE SHELLS INBETWEEN: UNDERSTANDING CHANGES IN THE COMMUNITY COMPOSITION OF FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE) IN GREAT LAKES REGION THROUGH COMPARISON OF HISTORIC DATA, LIVING COMMUNITY, AND DEAD SHELL ASSEMBLAGES.** M. Scott	PL 09 11:20-11:40	**DREISSENA IN THE GREAT LAKES: WHAT HAVE WE LEARNED IN 35 YEARS OF INVASION.** A. Y. Karatayev and L. E. Burlakova	PL 14 11:20-11:40	**IS IT CLIMATE CHANGE, POLLUTION, OR AN UNKNOWN DISEASE? FRESHWATER MUSSELS DIE OFF ON THE EUROPEAN SCALE.** M. Urbańska, Aldrige D., Atasaral S., Bylyna L., Collas F., Cossey D.A., Dobler A., Douda K., Hernández J., Geist J., Halabowski D., Henn T., Hoos P., Ilarri M., Labedzka A., Lajtner J., Lima M.L., Magerøy H.J., Moorkens E., Morales J., Motte G., Nakamura K. Nogueira J., Ondina P., Österling M., Ożgo M., Riccardi N., Shevchuk L., Shumka S., Son M., Sousa R., Teixeira A., Thielen F., Tomović T., Varandas S.
PL 05 11:40-12:00	**ASSESSING THE FRESHWATER MUSSEL ASSEMBLAGE OF THE ROBERT C. BYRD POOL, OHIO RIVER.** E. H. Bellamy , T. G. Jones, A. R. Jones and N. S. Wheeler	PL 10 11:40-12:00	**HAWAII'S FRESHWATER GASTROPOD INVASIONS: EXASPERATING CRYPTIC SPECIES COMPLEXES AND NEW INTRODUCTIONS.** N. W. Yeung, J. R. Kim, and K. A. Hayes	PL 15 11:40-12:00	**INVESTIGATING MUSSEL MORTALITY EVENTS IN THE EASTERN UNITED STATES: RESULTS FROM MORTALITY EVENTS, SENTINEL ANIMAL STUDIES, AND EXPERIMENTAL INFECTION TRIALS.** J. C. Richard, E. Leis, D. L. Waller, S. Knowles, and T. L. Goldberg

Platform Session 2A: Genetics and Phylogeny 1 Tuesday (4/11) 2:00-3:20pm - Mt. Hood *Moderator: David Berg; Miami University, Oxford, OH*		Platform Session 2B: Community Ecology and Ecosystems 1 Tuesday(4/11) 2:00-3:20 pm - Mt. Bachelor *Moderator: Astrid Schwalb; Texas State University, San Marcos, TX*		Platform Session 2C: Propagation, Restoration, and Reintroduction 1 Tuesday(4/11) 2:00-3:20 pm - 3 Sisters *Moderator: Heidi Dunn; EcoAnalysts, Inc., O'Fallon, MO (Retired)*	
PL 16 2:00-2:20	**GENOMICS AND THE THREE RS OF CONSERVATION.** D. J. Berg and S. R. Hein	PL 20 2:00-2:20	**GAINING INSIGHTS ON RESPONSES OF FRESHWATER MUSSELS TO ENVIRONMENTAL HETEROGENEITY AND ON THEIR DISTRIBUTION.** A. N. Schwalb, K. C. Cushway, Z. Mitchell, M. E. Martinski, K. Hayes, K. Cottenie, J. S. Perkin, M. Perez Rocha	PL 24 2:00-2:20	**MUSSEL RESTORATION AT THE GUTTENBERG, IOWA TRAIN DERAILMENT SITE, MISSISSIPPI RIVER.** H. L. Dunn, M. Bradley, and A. Kenny
PL 17 2:20-2:40	**PHYLOGENETIC AND MORPHOLOGICAL ANALYSES OF TWO FRESHWATER MUSSEL SPECIES IN THE CUMBERLAND AND GREEN RIVER DRAINAGES.** K. Ortiz, J. Jones, M. Compton, and E. Hallerman	PL 21 2:20-2:40	**CHOOSING SIDES: UNIONIDS EXHIBIT SUBSTRATE "PREFERENCE" AND VARYING ACTIVITY LEVELS IN A BEHAVIORAL CHOICE EXPERIMENT.** M. E. Martinski and A. N. Schwalb	PL 25 2:20-2:40	**DOES IN VITRO MEDIA COMPOSITION MATTER? A GENE EXPRESSION EXPERIMENT IN LAMPSILIS SILIQUOIDEA.** K. Ulin, I. Roznere, and M. Daly
PL 18 2:40-3:00	**PACBIO HI-FI GENOME ASSEMBLY OF THE IBERIAN DOLPHIN FRESHWATER MUSSEL UNIO DELPHINUS SPENGLER, 1793.** A. Gomes-dos-Santos, M. Lopes-Lima, A. M. Machado, A. Teixeira, L. F. C. Castro, E. Froufe	PL 22 2:40-3:00	**MACROINVERTEBRATE-MEDIATED LEAF DECOMPOSITION RATES ARE LOWER IN THE PRESENCE OF MUSSELS IN A SMALL BOREAL FOREST STREAM.** R. Gal, L. Greenberg, B. McKie, and M. Österling	PL 26 2:40-3:00	**PHYSIOLOGICAL PLASTICITY AND RESPONSE TO FOOD AVAILABILITY OF UTTERBACKIANA IMPLICATA AND SAGITTUNIO NASUTUS.** M. J. Gentry and D. A. Kreeger
PL 19 3:00-3:20	**POPULATION GENOMICS OF AN ENDANGERED FRESHWATER MUSSEL, ARCIDENS WHEELERI, IN LITTLE RIVER, ARKANSAS.** M. C. Adcock, K. R. Moles, N. L. Garrison, and N. V. Whelan	PL 23 3:00-3:20	**HOLDING THEIR GROUND: IMPACTS OF HIGH AND LOW FLOW CONDITIONS ON FRESHWATER MUSSEL DISTRIBUTION AND COMMUNITY COMPOSITION.** K. C. Cushway, A. E. Harris, C. D. Piercy, Z. A. Mitchell, and A. N. Schwalb	PL 27 3:00-3:20	**THE LOST AND FORGOTTEN: MUSSELS OF WEST TENNESSEE.** K. N. Key and D. Blackwood

Platform Session 3A: Genetics and Phylogeny 2 Tuesday (4/11) 3:40-5:00pm - Mt. Hood *Moderator: Nathan Whelan; US Fish and Wildlife Service, Auburn, AL*		Platform Session 3B: Community Ecology and Ecosystems 2 Tuesday(4/11) 3:40-5:00 pm - Mt. Bachelor *Moderator: Garrett Hopper; University of Alabama, Tuscaloosa, AL*		Platform Session 3C: Conservation Strategies 1 Tuesday(4/11) 3:40-5:00 pm - 3 Sisters *Moderator: Alexa Maine; Confederated Tribes of the Umatilla Indian Reservation, Walla*	
PL 28 3:40-4:00	**SYSTEMATICS, TAXONOMY, AND MOLECULAR ECOLOGY OF BLACK MUDALIA, ELIMIA MELANOIDES (GASTROPODA: PLEUROCERIDAE).** N. V. Whelan, A. Baldwin, P. D. Johnson, J. T. Garner, E. E. Strong	PL 32 3:40-4:00	**EVALUATING THE PACE OF TEMPORAL CHANGE FOR FRESHWATER MUSSEL COMMUNITIES.** G. W. Hopper, E. J. Miller, W. R. Haag, C. C. Vaughn, D. J. Hornbach, J. W. Jones, and C. L. Atkinson	PL 36 3:40-4:00	**WESTERN FRESHWATER MUSSEL MASTER PLAN: PRIORITIES, STRATEGIES, AND A PLAN FOR THE FUTURE.** A. N. Maine, C. O'Brien, D. Nez, B McIlraith, and Z. Seilo
PL 29 4:00-4:20	**GENOME SKIMMING AND MICRO-CT SCANNING ELUCIDATE SPECIES BOUNDARIES IN PROBLEMATIC PLEUROBEMINES.** A. J. Franzen, J. M. Pfeiffer, S. M Keogh, and C. C. Vaughn	PL 33 4:00-4:20	**HIERARCHICAL STRUCTURING OF GENOMIC DIFFERENTIATION AND BETA DIVERSITY WITHIN FRESHWATER MUSSEL COMMUNITIES.** J. Bucholz, I. Sánchez González, G. W. Hopper, C. L. Atkinson, and J. D. Lozier	PL 37 4:00-4:20	**SYNTHESIS OF NATURAL HISTORY COLLECTIONS DATA REVEALS PATTERNS OF US FRESHWATER MUSSEL DIVERSITY AND DECLINE.** J. Pfeiffer, T. Dubose, S. Keogh
PL 30 4:20-4:40	**SPRINGS AS ISLANDS: ISLAND BIOGEOGRAPHY AND CONSERVATION GENOMICS OF TWO NARROW-RANGE ENDEMIC PLEUROCERID SNAILS.** S. A. Donohoo, P. Johnson, N. V. Whelan	PL 34 4:20-4:40	**SIBLING FRESHWATER MUSSELS REARED IN LAKE-STREAM GARDENS REVEAL PHENOTYPIC PLASTICITY AS MECHANISM OF ECOPHENOTYPY.** S. M. Keogh, B. J. Minerich, L. M. Ohlman, M. E. Pletta, A. E Scheunemann, Z. A. Secrist, A. J. Franzen, B. E. Sietman, and A. M. Simons	PL 38 4:20-4:40	**HARMONIZING DATASETS TO EXPAND DISTRIBUTIONS OF FRESHWATER MUSSEL SPECIES AT RISK IN THE SYDENHAM RIVER WATERSHED.** J. A. Willsie, and C. M. Febria
PL 31 4:40-5:00	**POPULATION GENETICS OF THE INVASIVE JAPANESE MYSTERY SNAIL, Heterogen japonica AND ITS FIRST GENETICALLY CONFIRMED REPORT FROM CALIFORNIA.** W.A.N.U Abeyrathna, S. H. Sanders, A. Barreto , A. A. Davinack	PL 35 4:40-5:00	**PHENOTYPIC RESPONSES TO ENVIRONMENTAL GRADIENTS: A THREE-DIMENSIONAL QUANTITATIVE APPROACH TO ASSESS MUSSEL SHELL PLASTICITY.** I. Sánchez González, J. Bucholz, G. W. Hopper, J. D. Lozier, and C. L. Atkinson	PL 39 4:40-5:00	**PRIORITIZING STREAM REACHES FOR CONSERVATION OF FRESHWATER MUSSELS.** A. H. Kiser, C. A. Craig, T. H. Bonner, B. Littrell, C. H. Smith, C. R. Robertson, H.-H. Wang, W. E. Grant, M. S. Johnson, R. Lopez, and C. R. Randklev

Student presentation

Virtual presentation

Wednesday 4/12 Platform Session Schedule - Abstracts start on page 44

Platform Session 4A: Contaminants and Ecotoxicology Wednesday (4/12) 8:00-10:00 am - Mt. Hood *Moderator: Teresa Newton; USGS, Upper Midwest Environmental Sciences Center, LaCrosse, WI*		Platform Session 4B: Life History and Ecology 1 Wednesday (4/12) 8:00-10:00 am - Mt. Bachelor *Moderator: Art Bogan, NC Museum of Natural Sciences, Raleigh, NC*		Platform Session 4C: Human Impacts and Climate Change 1 Wednesday (4/12) 8:00-10:00 am - 3 Sisters *Moderator: Kaelyn Fogelman; Auburn University, Auburn, AL*	
PL 40 8:00-8:20	**BEHAVIORAL AND REPRODUCTIVE EFFECTS OF THE LAMPRICIDES TFM AND TFM:1% NICLOSAMIDE ON NATIVE FRESHWATER MUSSELS.** T. Newton, M. Boogaard, N. Schloesser, C. Kirkeeng, J. Schueller, and S. Toribio	PL 46 8:00-8:20	**TOO HOT TO HANDLE: THERMAL TOLERANCE OF POPENAIAS POPEII (TEXAS HORNSHELL) IN THE BLACK RIVER, NEW MEXICO.** X.L. Rangaswami, A.H. Kiser, M. Ramey, R.R. Lopez, and C.R. Randklev	PL 52 8:00-8:20	**A REVIEW OF TEMPERATURE AND HYPOXIA STRESSORS TO FRESHWATER MUSSELS.** K. J. Fogelman, K. Coffman, J.Archambault, E. Irwin, M. Walsh, S. Brewer, and James A. Stoeckel
PL 41 8:20-8:40	**PRIORITIZING CONTAMINANTS OF EMERGING CONCERN BASED ON THEIR EFFECTS ON FRESHWATER MUSSELS.** I. Roznere, V. An, T. Robinson, J. A. Banda, and G. T. Watters	PL 47 8:20-8:40	**EFFICACY OF CALCEIN AS A VALIDATION TOOL FOR ANNULUS FORMATION IN FRESHWATER MUSSELS.** A. Eismont, M. deMoulpied, C. Robertson, R. Lopez, and C. Randklev	PL 53 8:20-8:40	**THE MOLECULAR AND PHYSIOLOGICAL RESPONSES TO THERMAL STRESS OF FOUR UNIONID SPECIES.** J. D. Millwood P. D. Johnson, and M. J. Jenny
PL 42 8:40-9:00	**ACUTE AND CHRONIC EFFECTS OF TWO PERFLUOROALKYL SUBSTANCES ON DIFFERENT LIFE STAGES OF FRESHWATER MUSSELS: COMPARISON TO OTHER INVERTEBRATE TAXA.** D. J. Soucek, R. A. Dorman, E. L. Pulster, J. L. Kunz, N. Wang, and J. A. Steevens	PL 48 8:40-9:00	**DENSITY AND SURVIVORSHIP OF TWO MICRO-ENDEMIC SPRINGSNAILS.** M. P. Jones, D. A. Trujillo, D. H. Long, and D. J. Berg	PL 54 8:40-9:00	**LINKING PHYSIOLOGY, BEHAVIOR, AND THERMAL TOLERANCE IN FRESHWATER MUSSELS.** H. M. Adkins, K. J. Fogelman, E. B. Pieper, J. A. Radich, J. M. Miller, B. S. Helms and J A. Stoeckel
PL 43 9:00-9:20	**INGESTION AND DEPURATION OF POLYSTYRENE SPHERES BY A JUVENILE FRESHWATER MUSSEL FOUD IN SOUTHERN ONTARIO.** Y. Kudla, P. L. Gillis, K. A. Kidd, and R. S. Prosser	PL 49 9:00-9:20	**FORM AND FUNCTION: IS GILL MORPHOLOGY PREDICTIVE OF RESOURCE ASSIMILATION IN FRESHWATER MUSSELS?** M. B. Lodato, B. van Ee, and C. L. Atkinson	PL 55 9:00-9:20	**EFFECTS OF RISING TEMPERATURES ON SCOPE FOR GROWTH OF POPENAIAS POPEII (TEXAS HORNSHELL).** E. Pieper, J. Radich and J. Stoeckel
PL 44 9:20-9:40	**ASSESSING AMMONIA TOXICITY OF TEXAS UNIONID MUSSELS.** E. D. Beason, S. J Swarm, L. J. Gudgell, T. L. Lanzer, C. Robertson and A. N. Schwalb	PL 50 9:20-9:40	**CRACKING THE CODE: ASSESSMENT OF COMMUNITY RELATIONSHIPS OF FRESHWATER MUSSELS AND FISH HOSTS USING GENETIC BARCODING.** H. Robinson, P. Hazelton, J. Wares, G. Cowie, B. Scott, and S. Williams	PL 56 9:20-9:40	**ACUTE AND CHRONIC EFFECTS OF SEA SALT TO FRESHWATER MUSSELS: IMPLICATIONS FOR CLIMATE-INDUCED SEA LEVEL RISE IN COASTAL RIVERS.** J. K McIver II, W. G. Cope, N. J. Hostetter, R. Boyles, T. J. Kwak, T. Ben-Horin, F. Weber, J. Nelson, A. Maynard, A. Glen, B. Watson, M. Fisk
PL 45 9:40-10:00	**DEVELOPING A REPRODUCTIVE TOXICITY TEST METHOD FOR FRESHWATER MUSSELS.** A. N. Sieja, M. C. Barnhart, J. L. Kunz, D. Cleveland, B. E. Sietman, D. K. Hardesty, E. L. Brunson, J. A. Steevens, and N. Wang	PL 51 9:40-10:00	**USING STABLE OXYGEN, CARBON, AND CLUMPED ISOTOPES TO CONFIRM ANNUAL BANDING AND CALCULATE HIGH RESOLUTION GROWTH RATES IN AMBLEMA PLICATA FROM THE BRAZOS RIVER, TX.** M. A. Brewer, E. L. Grossman, and C. R. Randklev	PL 57 9:40-10:00	**THERMAL TOLERANCES OF THE FRESHWATER MUSSELS CYCLONAIAS PUSTULOSA AND FUSCONAIA ASKEWI, FROM THE SABINE RIVER, TEXAS** D. Mildenberger, R. Lopez, and C. R. Randklev
Platform Session 5A: Status and Distribution of Mollusks 2 Wednesday (4/12) 10:20am-12:00 pm - Mt. Hood *Moderator: Daelyn Woolnough, Central Michigan University, Mount Pleasant, MI*		**Platform Session 5B: Surveys and Monitoring 1 Wednesday (4/12) 10:20am-12:00 pm - Mt. Bachelor** *Moderator: Ron Constable; Oregon Department of Fish and Wildlife, Eugene, OR*		**Platform Session 5C: Community Ecology and Ecosystems 3 Wednesday (4/12) 10:20am-12:00 pm - 3 Sisters** *Moderator: Carla Atkinson; University of Alabama, Tuscaloosa, AL*	
PL 58 10:20-10:40	**HIGHLY VARIABLE POPULATIONS OF ENDANGERED SNUFFBOX ACROSS MICHIGAN.** D. A Woolnough and S. M LaValley	PL 63 10:20-10:40	**OREGON DEPARTMENT OF FISH AND WILDLIFE SNORKEL SURVEYS GET SOME MUSSELS.** K. Scully-Engelmeyer, E. F. Granek, E. Blevins, and R. Constable	PL 68 10:20-10:40	**SECONDARY PRODUCTION AND NUTRIENT FLOWS AS MEDIATED BY FRESHWATER MUSSEL COMMUNITIES OVER TIME.** C. L. Atkinson, A. K. Burrow, G.W. Hopper, J. W. Lopez, and W. Haag
PL 59 10:40-11:00	**FEDERAL LISTING AND RECOVERY PROGRESS FOR THE YELLOW LANCE (ELLIPTIO LANCEOLATA) AND ATLANTIC PIGTOE (FUSCONAIA MASONI).** J. M. Archambault	PL 64 10:40-11:00	**COMMUNITY CHANGES IN A FRESHWATER MUSSEL BED FROM 2005 TO 2021 IN THE GREEN RIVER, KENTUCKY.** J. M. Jacobs, M. A. McGregor, A. C. Shepard, T. J. Bailey, M. A. King, T. Williams	PL 69 10:40-11:00	**A MULTIVARIATE ASSESSMENT OF WEST VIRGINIA MUSSEL COMMUNITIES.** K. Eliason, M. Everhart, and J. Clayton
PL 60 11:00-11:20	**CURRENT DISTRIBUTION OF WESTERN RIDGED MUSSEL (GONIDEA ANGULATA) IN IDAHO.** L. Snoddy and J. Sauder	PL 65 11:00-11:20	**A COMPARISON OF SUBSTRATE COMPOSITION ASSESSMENT TECHNIQUES FOR THE GREENUP POOL OF THE OHIO RIVER.** T. Jones, A. Jones, M. Kriege, J. Miller, H. Bellamy, T. Annario, and M. Bruening	PL 70 11:00-11:20	**FRESHWATER MUSSEL-GENERATED SECONDARY PRODUCTION IS MEDIATED BY WATERSHED POSITION AND LIFE HISTORY STRATEGIES.** J.W. Lopez, C. L. Atkinson, A. K. Burrow, G. W. Hopper, and W. R. Haag
PL 61 11:20-11:40	**MUSSEL MOVEMENT: THEY LIKE TO MOVE IT, MOVE IT?** S. A. Douglass, E. J. Kessler, J. S. Tiemann, A. P. Stodola, and M. J. Dreslik	PL 66 11:20-11:40	**COMPARISON OF POPULATION DEMOGRAPHIC DATA FROM FOUR POPULATIONS OF THE FEDERALLY ENDANGERED RAYED BEAN, PAETULUNIO FABALIS (MOLLUSCA: UNIONIDAE).** D. Foltz, D. F. Ford, J. Grabarkiewicz, A. Benshoff, M. Kriege, and J. Spaeth	PL 71 11:20-11:40	**DECLINE OF SUSPENDED PARTICULATES ALONG A DENSE MUSSEL ASSEMBLAGE IN A SMALL MINNESOTA STREAM.** J. Fedarick, and B. Sietman
PL 62 11:40-12:00	**FLORIDA'S FRESHWATER MUSSEL CONSERVATION PROGRAM: INSIGHTS FROM CONSTRUCTING A BASELINE OF DISTRIBUTIONAL AND PHENOLOGICAL DATA.** S. R. Geda, L. N. Patterson, A. N. Olson, and J. S. Lanning	PL 67 11:40-12:00	**HISTORICAL CHANGES TO MUSSEL COMMUNITIES IN UPPER SECTIONS OF OHIO RIVER NAVIGATIONAL POOLS WITH NOTES FROM RECENT SURVEYS BELOW NEW CUMBERLAND AND PIKE ISLAND LOCKS AND DAMS.** M. Kriege	PL 72 11:40-12:00	**MACROINVERTEBRATE ASSEMBLAGE ASSESSMENTS AS A MEASURE OF SITE QUALITY FOR FEDERALLY LISTED FRESHWATER MUSSEL SPECIES.** S. B Benfield, J. M. Fisk
Platform Session 6A: Status and Distribution of Mollusks 3 Wednesday (4/12) 2:00-3:20 pm - Mt. Hood *Moderator: Zee Searles-Mazzacano; CASM Environmental, Portland, OR*		**Platform Session 6B: Conservation Strategies 2 Wednesday (4/12) 2:00-3:20 pm - Mt. Bachelor** *Moderator: Allison Roy; U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife*		**Platform Session 6C: Community Ecology and Ecosystems 4 Wednesday (4/12) 2:00-3:20 pm - 3 Sisters** *Moderator: Danielle Kreeger; Partnership for the Delaware Estuary, Wilmington, DE*	
PL 73 2:00-2:20	**ASSESSING FRESHWATER MUSSEL POPULATIONS IN OREGON'S WILLAMETTE RIVER BASIN: STATUS, DISTRIBUTION, AND UTILITY OF eDNA SURVEYS.** Z. Searles Mazzacano, T. Williams, and L. McMullen	PL 77 2:00-2:20	**USING REGIONAL WORKING GROUPS FOR MUSSEL SPECIES CONSERVATION.** A. H Roy, J. R Carmignani, P. D Hazelton, A. J Skorupa, S. C Sterrett, N. Whelan, and the Brook Floater Working Group	PL 81 2:00-2:20	**INCIDENCE AND RESTORATION PRIORITIZATION OF RARE AND COMMON SPECIES OF FRESHWATER MUSSELS IN THE TIDAL DELAWARE RIVER, USA.** D. Kreeger, K. Cheng, R. Thomas, L. Butler, M. Gentry, and L. Morgan
PL 74 2:20-2:40	**PHASE I SURVEY RESULTS FROM A MULTI-PHASE STUDY IN THE LOWER WABASH RIVER, ILLINOIS AND INDIANA.** D. F. Ford	PL 78 2:20-2:40	**DAM REMOVAL AND FRESHWATER MUSSELS: GUIDANCE FOR RESTORATION, CASE STUDIES, AND GAPS IN KNOWLEDGE.** E. S. McCombs	PL 82 2:20-2:40	**THE IMPORTANCE OF CLEAN WATER: AN EMPRICAL ANALYSIS OF MUSSEL ABUNDANCE AND POLLUTANT ABATEMENT IN MINNESOTA RIVERS.** B. Bakshi, R. W. Bouchard, Jr., D. Hornbach, B. Sietman, and D. Wasley
PL 75 2:40-3:00	**STATUS AND DISTRIBUTION OF FRESHWATER MUSSELS IN THE LOUISIANA SECTION OF BAYOU BARTHOLOMEW.** G. R. Dinkins, A. C. Engman, B. Bajo-Walker, Z. W. Clark, J. Wolbert, K. Hecke, and J. B. Alford	PL 79 2:40-3:00	**FRESHWATER PEARL MUSSEL (MARGARITIFERA MARGARITIFERA) IN FINLAND – STATUS OF THE POPULATIONS AND CONSERVATION.** Oulasvirta, P., and Syväranta, J	PL 83 2:40-3:00	**PREDICTING THE EFFECT OF RESTORATION ACTIONS ON MUSSEL ASSEMBLAGE HABITAT: A DECISION TOOL TO AID PRACTIONERS.** A. J. Skorupa, S. Doran, C. E. Dumoulin, A. H. Roy, and D. R. Smith
PL 76 3:00-3:20	**AN ANALYSIS OF CYPROGENIA ABERTI (WESTERN FANSHELL) ASSEMBLAGE DYNAMICS IN THE BLACK RIVER, MO.** K. Schmidt, R. Kegerries, H. Dunn, G. Bowman, and C. Knerr	PL 80 3:00-3:20	**CONFREMUS – BUILDING A NETWORK OF EXCELLENCE FOR THE CONSERVATION OF EUROPEAN FRESHWATER MUSSELS.** M. Lopes-Lima	PL 84 3:00-3:20	**SPATIAL VARIATION IN MUSSEL COMMUNITY COMPOSITION AND RICHNESS RESULTS IN DISTINCT STOICHIOMETRIC HOTSPOTS IN RIVERS ACROSS A BIOGEOGRAPHIC REGION.** C. C. Vaughn and C. L. Atkinson
Platform Session 7A: Genetics and Phylogeny 3 Wednesday (4/12) 3:40-5:00 pm - Mt. Hood *Moderator: Ellen Strong; Smithsonian Institution, Washington, DC*		**Platform Session 7B: Conservation Strategies 3 Wednesday (4/12) 3:40-5:00 pm - Mt. Bachelor** *Moderator: David Hu; USGS, Reston, VA*		**Platform Session 7C: Propagation, Restoration, and Reintroduction 2 Wednesday (4/12) 3:40-5:00 pm - 3 Sisters** *Moderator: Kevin Roe; Iowa State University, Ames, IA*	
PL 85 3:40-4:00	**A NEW SYSTEMATIC FRAMEWORK FOR JUGA (GASTROPODA, CERITHIOIDEA): LINGERING QUESTIONS AND FUTURE DIRECTIONS.** E. E Strong, J. T. Garner, P. D. Johnson, and N. V. Whelan	PL 89 3:40-4:00	**USGS STRATEGIC SCIENCE VISION FOR NATIVE FRESHWATER MUSSELS IN THE UNITED STATES.** D. Hu, T. Newton, and N. Johnson	PL 93 3:40-4:00	**EVALUATING RESTORED MUSSEL POPULATION GENETICS AND SURVIVORSHIP IN THE CEDAR RIVER WATERSHED.** K. J. Roe and Katelyn Miller
PL 86 4:00-4:20	**RE-VISITING HOW WE DEFINE SPECIES OF THE "PYRGULOPSIS KOLOBENSIS" COMPLEX (CAENOGASTROPODA: HYDROBIIDAE) IN THE WESTERN US.** K. E. Perez, M. Solis, E. Miskow, C. Lundskog, J. Sorensen	PL 90 4:00-4:20	**A COMPREHENSIVE FRESHWATER MUSSEL DATABASE FOR THE DUCK RIVER DRAINAGE, TENNESSEE: THE HISTORY OF MUSSELS IN A PRIORITY WATERSHED.** K. I Womble and A. E. Rosenberger	PL 94 4:00-4:20	**USING FOOD DYE TO BATCH-TAG FRESHWATER MUSSELS.** J. S. Moore, A. T Phipps, and E. Falk
PL 87 4:20-4:40	**MOLECULAR PHYLOGENETICS UNEARTHS HIDDEN BIODIVERSITY WITHIN ALASMIDONTA VIRIDIS (RAFINESQUE, 1820) SPECIES COMPLEX IN THE MIDWESTERN US.** K. Inoue, M. Compton, S. Faiman, B. Fisher, J. Harris, T. Lane, A. Pieri, G. Sanfilippo, B. Sietman, A. Stodola, and D. Zanatta	PL 91 4:20-4:40	**THE SUSTAINABLE RIVERS PROGRAM: MOLLUSK RESOURCES AS INDICATORS IN ADAPTIVE MANAGEMENT OF USACE INFRASTRUCTURE.** B. Winterringer	PL 95 4:20-4:40	**IDENTIFICATION OF PRODUCTION HOST SPECIES FOR THE SALAMANDER MUSSEL (*Simpsonaias ambigua*).** A. T. Phipps, J.S. Moore, and Aerin Doughty
PL 88 4:40-5:00	**MOLECULAR ECOLOGY OF THE FEDERALLY ENDANGERED FRESHWATER MUSSEL CUMBERLANDIA MONODONTA.** A. P. Hannah, K. Inoue, D. J. Berg, K. Moles, T. Lane, and N. V. Whelan	PL 92 4:40-5:00	**HABITAT SUITABILITY ASSESSMENT OF LOGGERS CREEK, BOISE, IDAHO.** D. MacCoy	PL 96 4:40-5:00	**SUCCESSFUL IN VITRO TRANSFORMATION OF UNATTACHED ALASMIDONTA HETERODON GLOCHIDIA FOLLOWING EXPOSURE TO HOST FISH.** C. B. Eads, L. M. Lutackas, and J. F. Levine

Student presentation
Virtual presentation

Thursday 4/13 Platform Session Schedule - Abstracts start on page 74

Platform Session 8A-1: Outreach, Education, and Inclusion Thursday (4/13) 10:20am-11:00pm - Mt. Hood *Moderators: Sara Craft; Kentucky Division of Water, KY and Kelly McNichols-O'Rourke; Great Lakes*		Platform Session 8B: Human Impacts and Climate Change 2 Thursday (4/13) 10:20am-12:00pm - Mt. Bachelor *Moderator: Becca Winterringer; EnviroScience, Stow, OH*		Platform Session 8C: Propagation, Restoration, and Reintroduction 3 Thursday (4/13) 10:20am-12:00pm - 3 Sisters *Moderator: Monte McGregor; Kentucky Dept of Fish and Wildlife Resources, Frankfort, KY*	
PL 97 10:20-10:40	**CONTINUED ASSESSMENT OF SOCIETY DEMOGRAPHICS AND ATTITUDES TOWARDS DIVERSITY, EQUITY, AND INCLUSION.** S. R Craft, and J. P. Chong	PL 102 10:20-10:40	**FRESHWATER MUSSELS AS A FLOOD EARLY WARNING SYSTEM.** N. Riccardi, V. Modesto, D. Manca, S. Kazmierczkzack, L. Tosato, A. Pilbala, S. Piccolroaz, L. Fraccarollo, N. Benistati, D. Termini L. Di Micco, D. Viero, C. Saltalippi, G. Cicioni, F. Alimenti, R. V. Gatti, F. Bahmanpouri, S. Barbetta, T Moramarco	PL 107 10:20-10:40	**OBSERVATIONS OF WILD RECRUITMENT IN AUGMENTED POPULATIONS OF THE FEDERALLY ENDANGERED TAR RIVER SPINYMUSSEL (PARVASPINA STEINSTANSANA).** M. Walter, R. Hoch, C. Eads, M. Fisk, H. Evans, and M. McCutcheon
PL 98 10:40-11:00	**CITIZEN SCIENCE IN ACTION.** D. Haake, B. Colravy, H.-B. Griffis, and S. Douglass	PL 103 10:40-11:00	**EFFECTS ANALYSIS OF OIL SPILL RESPONSE ACTIVITIES ON MOLLUSKS: A DEMONSTRATION OF A LARGE-SCALE PROGRAMMATIC ACTION.** B. Winterringer and J. Popiel	PL 108 10:40-11:00	**RECOVERY OF THE PALE LILLIPUT, TOXOLASMA CYLINDRELLUS: A FEDERALLY ENDANGERED FRESHWATER MUSSEL IN ALABAMA AND TENNESSEE.** P. Johnson, M. Buntin, T. Fobian, J. Wisniewski, D. Hua, D. Hubbs, J. Holifield, and J. Garner
Platform Session 8A-2: Surveys and Monitoring 2 Thursday (4/13) 11:00am-12:00pm - Mt. Hood					
PL 99 11:00-11:20	**THE UPS AND DOWNS OF BIG RIVER DIVING: MINNESOTA DEPARTMENT OF NATURAL RESOURCES DIVING GUIDE.** Z. Secrist	PL 104 11:00-11:20	**IMPACTS OF SUSPENDED SEDIMENT ON JUVENILE FRESHWATER MUSSELS.** W. Zhu, C. Barnhart, H. Brown, J. Kunz, S. McMurray, A. Roberts, J. Steevens, K. Trauth, B. Wang, B. Deng	PL 109 11:00-11:20	**PREDICTING SUITABLE HABITAT FOR CRITICALLY IMPERILED FRESHWATER MUSSELS TO AID FUTURE TRANSLOCATIONS IN EAST-CENTRAL ILLINOIS.** H. Y Ruellan, K. W Stodola, A. P Stodola, and J. S Tiemann
PL 100 11:20-11:40	**ASSESSMENT OF SPATIAL VARIATION AND POPULATION CONDITION OF THE ESA PROPOSED GUADALUPE ORB (CYCLONAIAS NECKI) AND FALSE SPIKE (FUSCONAIA MITCHELLI) IN DATA LIMITED PORTIONS OF A CENTRAL TEXAS RIVER BASIN.** B. Littrell, K. Sullivan, and L. J Gudgell	PL 105 11:20-11:40	**MUSSEL POPULATION SHIFTS OVER A CENTURY IN AN URBANIZING WATERSHED.** A. P. Stodola, J. Weinzinger, L. Kitchel, H. Y. Ruellan, S. A. Douglass, and J. S. Tiemann	PL 110 11:20-11:40	**IN VITRO CULTURE AND PROPAGATION OF FOUR ENDANGERED MUSSELS, THREE EPIOBLASMA SPECIES AND ONE ALASMIDONTA, USING A COMBINATION OF SERUM MIXTURES IN A PHYSIOLOGICAL NUTRIENT SOLUTION.** M. A. McGregor, J. M. Jacobs, M. A. King, A. C. Shepard, T. J. Bailey, and T. Williams
PL 101 11:40-12:00	**AN OVERVIEW OF THE UNIONID MONITORING AND BIODIVERSITY OBSERVATION NETWORK (UMBO) – ONTARIO'S LONG-TERM MUSSEL MONITORING PROGRAM.** K. A. McNichols-O'Rourke, M. Goguen, M. P. Gibson, and T. J. Morris	PL 106 11:40-12:00	**THE EFFECT OF AN INDUSTRIAL EFFLUENT HIGH IN MAJOR IONS ON POPULATIONS OF FRESHWATER MUSSELS.** P. L. Gillis, E. E. Hayward, C. J. Bennett, R. S. Prosser, J. Salerno, T. Liang, S. Robertson, and C. D. Metcalfe	PL 111 11:40-12:00	**RESTORING FRESHWATER MUSSELS TO THE CLINCH AND POWELL RIVERS: MONITORING AND EVALUATION OF THE CERTUS, INC. AND LONE MOUNTAIN PROCESSING, INC. NATURAL RESOURCE DAMAGE ASSESSMENT CASES IN VIRGINIA and TENESSEE, U.S.A.** J. M. Hyde, J. W. Jones, W. Henley, T. Lane, and B. Watson

Platform Session 9A: Surveys and Monitoring 3 Thursday (4/13) 2:00-3:20 pm - Mt. Hood *Moderator: Adam Benshoff; EDGE Engineering and Science, Kent, OH*		Platform Session 9B: Status and Distribution of Mollusks 4 Thursday (4/13) 2:00-3:20 pm - Mt. Bachelor *Moderator: Cody Fleece; Stantec, Cinncinati, OH*		Platform Session 9C: Propagation, Restoration, and Reintroduction 4 Thursday (4/13) 2:00-3:20 pm - 3 Sisters *Moderator: Phil Mathias; EnviroScience, Stow, OH*	
PL 112 2:00-2:20	**HISTORICAL IMPACTS CAUSING THE DECLINE OF FRESHWATER MUSSELS AND CURRENT EFFORTS TO DELINEATE REMAINING POPULATIONS – UPPER NIAGARA RIVER, ERIE AND NIAGARA COUNTIES, NEW YORK, UNITED STATES.** A. K. Benshoff	PL 116 2:00-2:20	**AN UNUSUAL FINDING OF THE SALAMANDER MUSSEL (SIMPSONAIAS AMBIGUA): IMPLICATIONS FOR DETECTABILITY AND CONSERVATION STATUS.** W. C. Fleece, N. Berg, E. Johnson, L. Kitchel, J. Weinzinger, and G. Brecka	PL 120 2:00-2:20	**IMPLEMENTATION OF A REGIONAL "MUSSELS FOR CLEAN WATER INITIATIVE" FOR THE UPPER MID-ATLANTIC REGION.** L. Morgan, D. Kreeger, K. M. Cheng, M. Gentry
PL 113 2:20-2:40	**ENVIRONMENTAL DNA TOOLS FOR THE CONSERVATION OF FRESHWATER MUSSELS.** K. E. Klymus, D. V. Ruiz- Ramos, N. L. Thompson, Z. Taylor, K. Ortiz, J. W. Jones, M. C. Barnhart, C. A. Richter	PL 117 2:20-2:40	**PAUL HUGHES PRESERVE MUSSEL INVENTORY SURVEYS.** A. Prewitt and C. Swecker	PL 121 2:20-2:40	**MAKING CONNECTIONS: PENNDOT'S HUNTER STATION PROJECT REINTRODUCED FRESHWATER MOLLUSKS TO THEIR HISTORIC RANGES AND CREATED NEW CONNECTIONS BETWEEN THE RIVER'S COLLECTIVE STAKEHOLDERS.** P. T. Mathias, S. Titus, and G. F. Zimmerman
PL 114 2:40-3:00	**DESIGN OF MALE SPECIFIC qPCR ASSAYS FOR THE DETECTION OF FRESH WATER MUSSEL SPAWNING EVENTS.** D. V. Ruiz-Ramos, K. E. Klymus, N. L. Thompson, M. Voshage, J. W. Jones, M. C. Barnhart, C. A. Richter	PL 118 2:40-3:00	**CONSERVATION STATUS OF HAWAII'S FRESHWATER LYMNAEIDAE.** K. A. Hayes, K. M. Bustamente, D. R. Sischo, N. W. Yeung	PL 122 2:40-3:00	**HIGGINS EYE REINTRODUCTION TO THE CHIPPEWA RIVER: A SURVEY SUGGESTS SUCCESS.** M. Bradley, E. Glidewell
PL 115 3:00-3:20	**INVESTIGATING FRESHWATER MUSSEL DISTRIBUTIONS IN THE ALTAMAHA RIVER SYSTEM IN SUPPORT OF A CANDIDATE CONSERVATION AGREEMENT (CCA).** M. T Rowe	PL 119 3:00-3:20	**AN UPDATE ON THE FRESHWATER MUSSELS (BIVALVIA: UNIONOIDEA) OF VIETNAM.** A. E. Bogan and V. T. Do	PL 123 3:00-3:20	**PROPAGATION AND CULTURE OF ENDANGERED FRESHWATER MUSSELS FOR RESTORATION & SERUM SELECTION IN IN-VITRO CULTURE OF GLOCHIDIA.** D. Hua, P. L. Hildreth, K. L. White, L. M. Huffman, A. Sims, J. Campbell and C. Simpson

Platform Session 10A: Conservation Strategies 5 Thursday (4/13) 3:40-5:00 pm - Mt. Hood *Moderator: Austin Davis; San Antonio River Authority, San Antonio, TX*		Platform Session 10B: Status and Distribution of Mollusks 5 Thursday (4/13) 3:40-5:00 pm - Mt. Bachelor *Moderator: Alyssa Bangs; US Fish and Wildlife Service, Boise, ID*		Platform Session 10C: Life History and Ecology 2 Thursday (4/13) 3:40-5:00 pm - 3 Sisters *Moderator: Jess Jones; US Fish and Wildlife Service, Blacksburg, VA*	
PL 124 3:40-4:00	**RECENT RECOVERY EFFORTS FOR THE CRITICALLY IMPERILED FRESHWATER MUSSEL THELIDERMA SPARSA: A CASE STUDY TO INSPIRE THOSE MANAGING SPECIES ON THE BRINK.** T. Lane, T. Leach, S. Colletti, J. Ferraro, R. Agbalog, C. Carey, and J. Jones	PL 127 3:40-4:00	**BARTRAM'S MISSISSIPPI SPINY MUSSEL.** N. F. Shoobs and A. R. Kabat	PL 131 3:40-4:00	**SPAWNING TIME MITIGATES ITERATIVE SEASONAL TRADE-OFFS BETWEEN REPRODUCTION AND MORTALITY IN THREATENED FRESHWATER MUSSEL.** T. A. Zajac and K. Zając
PL 125 4:00-4:20	**USING VOLUNTARY CONSERVATION AGREEMENTS FOR FRESHWATER MUSSEL CONSERVATION IN THE AMERICAN SOUTHWEST.** M. Johnson, E. Orsak, and C. Hayes	PL 128 4:00-4:20	**FRESHWATER MUSSEL INVESTIGATIONS IN MÉXICO (2017-2022).** K. S. Cummings and J. S. Tiemann	PL 132 4:00-4:20	**CHARACTERIZATION OF SPECTACLECASE HOST FISH, HIODON SPP., MOVEMENT PATTERNS IN THE ST. CROIX NATIONAL SCENIC RIVERWAY.** M. Meulemans, M. Bartsch, D. Waller, B. Sietman, Z. Secrist, J. Strias, and M. Shaffer
PL 126 4:20-4:40	**ASSESSING THE FEASIBILITY OF A MUSSEL REINTRODUCTION INTO THE MISSION REACH OF THE SAN ANTONIO RIVER, SAN ANTONIO, TEXAS.** A. Davis, C. Vaughn, S. Donovan, B. Lane and M. Conley	PL 129 4:20-4:40	**USING OCCUPANCY MODELING TO ASSESS APPALACHIAN ELKTOE (ALASMIDONTA RAVENELIANA) DISTRIBUTION IN A MONTANE STREAM.** C. Rondel, Z. Farris, J. Mays, and M. Gangloff	PL 133 4:20-4:40	**DO PARASITIC FRESHWATER MUSSELS MANIPULATE HOST BEHAVIOR? EARLY EVIDENCE OF EXTENDED PHENOTYPE FROM THE MARGARITIFERA MARGARITIFERA – SALMO TRUTTA INTERACTION.** S. L. Rock, J. Watz, P. A. Nilsson, O. Calles, and M. E. Österling
		PL 130 4:40-5:00	**WHAT IS A SPECIES STATUS ASSESSMENT? INFORMING LISTING DECISIONS UNDER THE ENDANGERED SPECIES ACT.** A. Bangs	PL 134 4:40-5:00	**DESCRIPTION OF THE MANTLE LURE AND NOVEL MIMICRY OF THE ENDANGERED CUMBERLANDIAN COMBSHELL (EPIOBLASMA BREVIDENS) IN THE CLINCH RIVER, EASTERN U.S.A.** J. W. Jones, Z. Taylor, and T. Lane

Virtual presentation

Lightning Talks Scheduled

Thursday 4/13 - 8:40-10:00 am

PROPAGATION EFFORTS WITH BANBURY SPRINGS LIMPET IN IDAHO. Alyssa Bangs, U. S. Fish and Wildlife Service, Boise, ID.

Virtual. PROPAGATION OF SPECTACLECASE (*CUMBERLANDIA MONODONTA*) AND RAISING TO RELEASABLE SIZE. Lindsay Ohlman, Minnesota Department of Natural Resources.

UPDATE ON THE NATURAL RECRUITMENT AND DISPERSION OF *LAMPSILIS HIGGINSII* POPULATIONS IN THE MISSISSIPPI RIVER IN MINNESOTA. Mike Davis, Minnesota Department of Natural Resources.

DOES THE PRESENCE OF ADULT MUSSELS IN CULTURE ENVIRONMENTS BENEFIT JUVENILE MUSSELS? Ben Minerich, Minnesota Zoo.

SUBSTRATE EFFECTS ON JUVENILE *L. TERES* SURVIVAL IN A PULSE FLOW REARING SYSTEMS. Thomas Funk, U. S. Fish and Wildlife Service, Inks Dam National Fish Hatchery.

A NOVEL APPROACH TO MOLLUSK INVENTORY ON OHIO RIVER ISLANDS NWR. Elaine Barr, U. S. Fish and Wildlife Service.

NOVEL FIELD METHODS FOR GROWING PROPAGATED JUVENILE MUSSELS IN THE DELAWARE ESTUARY. Kurt Cheng, Partnership for the Delaware Estuary.

TWO YEAR REVIEW OF THE OHIO MUSSEL SURVEY PROTOCOL REQUIREMENTS FOR SMALLER STREAMS. Megan Michael, Ohio Department of Transportation, Office of Environmental Services.

AN UPDATE ON THE GUIDE TO THE LARVAE OF NORTH AMERICAN FRESHWATER MUSSELS. Monte McGregor, KY Dept. Fish and Wildlife Resources, Center for Mollusk Conservation.

A DECADE OF MONITORING SURVIVAL OF FEDERALLY ENDANGERED MUSSELS RELOCATED FROM A PIPELINE CROSSING IN THE CLINCH RIVER, VIRGINIA. Brett Otsby, Daguna Consulting, LLC.

WESTERN FRESHWATER MUSSELS AS A FIRST FOOD: RESEARCH AND RESTORATION. Alexa Maine, Confederated Tribes of the Umatilla Indian Reservation, Department of Natural Resources.

THE FRESHWATER SNAILS OF MONTSERRAT, LESSER ANTILLES. Nate Shoobs, Curator of Mollusks, Ohio State University Museum of Biological Diversity.

UPDATES FROM THE OHIO STATE MUSEUM MOLLUSK DIVISION. Nate Shoobs, Curator of Mollusks, Ohio State University Museum of Biological Diversity.

Blue Background Designates Student Poster

Poster Session

Abstracts start on page 95

Tuesday, April 11 6:30 - 8:30 pm - Pacific Northwest Ballroom

Poster #	
Life History and Ecology	
PO 01	FRESHWATER GASTROPOD 101 EDUCATIONAL POSTER. Sarah Douglass and Nora Straquadine.
PO 02	WESTERN PEARLSHELL REPRODUCTION, AS OBSERVED AND PHOTOGRAPHED IN THE NORTH UMPQUA RIVER, OREGON. John C. Ratliff.
PO 03	APPLYING NOVEL METAL ISOTOPES IN FRESHWATER BIVALVE SHELLS AS ENVIRONMENTAL TRACERS IN RIVERINE SYSTEMS. Kristi S. Dobra, Brian W. Stewart, and Rosemary C. Capo.
PO 04	HOST FISHES OF THE YELLOW LAMPMUSSEL (*LAMPSILIS CARIOSA*). Brian Hefferon, Dr. Andrew Gascho Landis & Paul H. Lord.
PO 05	INVESTIGATING THE ROLE OF RIVER HERRING AS HOSTS FOR FRESHWATER MUSSELS IN THE CONNECTICUT RIVER WATERSHED. Jacqueline Stephens, Allison H. Roy, Adrian Jordaan, David Perkins & Kenneth Sprankle.
Status and Distribution of Mollusks	
PO 06	RANGE EXTENSION AND CO-OCCURRENCE OF *PYRGULOPSIS* SPECIES ACROSS NORTHERN NEVADA. Almeta Helmig, Eric Miskow, Delaney Martin.
PO 07	PRELIMINARY RESULTS FROM A STUDY ON THE POPULATION DEMOGRAPHICS OF THE DWARF WEDGEMUSSEL (*ALASMIDONTA HETERODON*) IN NANJEMOY CREEK, MARYLAND. Matt Ashton and James McCann.
PO 08	STATUS AND DISTRIBUTION OF *CUMBERLANDIA MONODONTA* IN MISSOURI, INCLUDING RECENT (2019 AND 2022) RANGE EXTENSIONS IN OSAGE RIVER TRIBUTARIES Scott Faiman, Bryan Simmons, Andy Roberts, Pablo Oleiro, Steve McMurray.
PO 09	UPPER BLACK RIVER MISSOURI UNIONID ASSEMBLAGES Rachel M Fox, Ronald Kegerries, Heidi Dun[1], Georganne Bowman and Caleb Knerr.
PO 10	A SPECIES STATUS ASSESSMENT FOR THREE FRESHWATER MUSSELS FROM THE TENNESSEE AND CUMBERLAND RIVER BASINS. Daniel B. Fitzgerald, Andrew R. Henderson & David R. Smith.
PO 11	THE FRESHWATER MUSSELS OF CENTRAL AMERICA: EL SALVADOR (MYCETOPODIDAE & UNIONIDAE). Kentaro Inoue, Veronica Melara, José Enrique Barraza Sandoval.
PO 12	UNIONID ASSEMBLAGE AND HABITAT ASSESSMENT AFTER MAJOR DAM FAILURES IN MID-MICHIGAN. Nicole M Vellequette, Ava M Laszlo, David T Zanatta, & Daelyn A Woolnough.
Surveys and Monitoring	
PO 13	DEVELOPMENT OF A FLEXIBLE MID-SIZED RIVER MUSSEL SAMPLING PROTOCOL AND INVESTIGATION OF STATEWIDE MULTI-SCALE MUSSEL HABITAT RELATIONSHIPS. Ava M. Laszlo, Stephen McMurray and Jacob T. Westhoff.

PO 14	USING CAPTURE-RECAPTURE TO ASSESS THE SURVIVORSHIP OF RELOCATED MUSSELS IN THE LOWER SULPHUR RIVER. Rachel Lancaster, Dr. Joshua Banta, Jared Dickson, Dr. Matthew Greenwold, and Dr. Lance Williams.
PO 15	DEVELOPING AN EFFICIENT MUSSEL ABUNDANCE ESTIMATION PROCEDURE. Gabriel T Inoshita, Daniel Trujilio, Kentaro Inoue, Steve Hein, and David Berg.
PO 16	DEVELOPING A MODELING FRAMEWORK TO UNDERSTAND DOWNSTREAM TRANSPORT OF FRESHWATER MUSSEL ENVIRONMENTAL DNA. Brandon J. Sansom, Dannise V. Ruiz-Ramos, Nathan L. Thompson, Maura O. Roberts, Zachary Taylor, Katie Ortiz, Jess W. Jones, Catherine A. Richte[1], Katy E. Klymus.
PO 17	FRESHWATER MUSSELS UPSTREAM OF A MANMADE WATERWAY: A CASE STUDY OF A TRIBUTARY TO THE TENNESSEE-TOMBIGBEE WATERWAY IN THE SOUTHEASTERN USA. Ashley Seagroves Ruppel.
PO 18	LONG-TERM MUSSEL MONITORING ON THE OHIO RIVER FOR THE WILLOW ISLAND HYDROELECTRIC PROJECT, WILLOW ISLAND LOCKS AND DAM (ORM 162), PLEASANTS COUNTY, WEST VIRGINIA. Katie Jackson, Mike Powell, Marty Sneen
PO 19	TARGETED SURVEYS OF TOXOLASMA PARVUM (LILLIPUT) IN CANADA. Mandy P. Gibson, Kelly A. McNichols-O'Rourke, and Todd J. Morris.
PO 20	MONITORING AND CONSERVING WESTERN PEARLSHELL MUSSELS IN THE LOWER BOISE RIVER. Colin Custer
PO 21	EFFORTS TOWARD DEVELOPMENT OF A STANDARDIZED VISUAL SURVEY PROTOCOL FOR WESTERN NORTH AMERICAN FRESHWATER MUSSELS. Emilie Blevins, Bryce Frank, Emily Johnson, Scott Miller, Jeff Moss, Anna Smith, Alexa Maine, John Erhardt, Doug Nemet[4], Courtney Newlon, & Barbara Adams.
PO 22	COMPARISONS OF TWELVE FRESHWATER MUSSEL BED ASSEMBLAGES QUANTITATIVELY SAMPLED AT A 15-YR INTERVAL IN THE BUFFALO NATIONAL RIVER, ARKANSAS. Anna M. Pieri, John L. Harris, Mickey W. Matthews, Shawn W. Hodges, Ashley R. Rodman, Jennifer L. Bouldin, and Alan D. Christian
Propagation, Restoration and Re-Introductions	
PO 23	GROWTH AND SURVIVAL OF FATMUCKET (LAMPSILIS SILIQUOIDEA) IN THE CUYAHOGA RIVER. Megan Herbruck, Samantha Knapp, Robert Krebs, Eric Soehnlen, Doug Kapusinski, Adam Benshoff, Andrew Hannes, Celia Schwart[1], and Ryan Trimbath.
PO 24	RECOVERY EFFORTS FOR SPECIES OF FRESHWATER MUSSELS WITHIN THE SUPERFUND SITE IN THE LOWER GRASSE RIVER IN MASSENA, NY. Colby Bowman, Jessica L. Jock, & Jay Wilkins.
PO 25	IMPACTS OF DIETARY SUPPLEMENTATION OF WORM CASTINGS ON GROWTH AND SURVIVAL OF CULTIVATED ALASMIDONTA VARICOSA (BROOK FLOATER) AND LAMPSILIS CARDIUM (PLAIN POCKETBOOK). Marilyn Can, Jace Nelson, David Janetski, Rachel Mair, & Brian Watson.
PO 26	EXAMINATION AND RECLASSIFICATION OF MUSEUM SPECIMENS TO IMPROVE RANGE EXTENT OF CANARY KINGSHELL, *LAMPSILIS SIETMANI* . Kathryn E Conatser, Rachel M Vinsel, & Alison P Stodola.
PO 27	AN UPDATE ON MUSSEL CULTURE AND MUSSEL-ADJACENT WORK AT GENOA NATIONAL FISH HATCHERY. Elizabeth Glidewell, Megan Bradley, Doug Aloisi.

PO 28	USING ANALYTES IN FISH HEMOLYPH TO DETERMINE HOST SPECIFICITY. Jacqualyn Halmbacher, Thomas Funk, Bailey Gaines
PO 29	RAPID COLONIZATION BY FRESHWATER MUSSELS IN A RESTORED RIVER REACH. Daniel Kelner, Bernard Sietman, Mike Davis, David Potter, Zebulin Secrist, Jillian Fedarick, Alexie Horner, Hunter Poffinbarger, Zoe Schroeder.
PO 30	MUSSEL PROPAGATION AND CONSERVATION RESEARCH AT THE USGS COLUMBIA ENVIRONMENTAL RESEARCH CENTER. James L Kunz, Ning Wang, Jeff Steevens
PO 31	SUCCESSFUL CULTURE OF JUVENILE WESTERN PEARLSHELL (*MARGARITIFERA FALCATA*) IN A PULSE FLOW THROUGH AUTO FEEDING SYSTEM. James Kunz, Alexa Maine, Jeff Steevens, Ning Wang, James Barron.
PO 32	FRESHWATER MUSSEL PROPAGATION AT NEOSHO NATIONAL FISH HATCHERY. Amy Maynard and Nathan Eckert.
PO 33	HERE FISHY FISHY, WHERE HAVE YOU BEAN? CONFIRMATION OF HOST FISHES FOR THE FEDERALLY ENDANGERED CHOCTAW BEAN, *OBOVARIA CHOCTAWENSIS* (BIVALVIA: UNIONIDAE). Lauren N Patterson, Susan R Geda & Nathan A Johnson.
PO 34	EFFECTS OF PARASITIC FRESHWATER MUSSELS ON THEIR HOST FISHES: A REVIEW. Sebastian L. Rock, Johan Watz, P. Anders Nilsson, Martin E. Österling.
PO 35	GROWTH AND SURVIVORSHIP OF POST-LARVAL JUVENILE MUSSELS RELEASED DIRECTLY INTO BASKETS AT GREEN LANE RESERVOIR. Roger L. Thomas, Alexis Wysocki, Kurt Cheng, Lance Butler, Danielle Kreeger, and Malcolm Newman.
PO 36	COMBATTING MICROBIAL CONTAMINATION DURING *IN VITRO* PROPAGATION OF *ELLIPTIO COMPLANATA* . Raquel Wetzell, Rachel Mai[2], Jennifer Ryan, & Rima Franklin.
	Ecosystems and Community Ecology
PO 37	HYDRAULICS AND STABILITY OF MUSSEL HABITAT IN A DYNAMIC FLOW REGIME. Maura O. Roberts, Brandon J. Sansom, Robert B. Jacobson.
	Genetics and Phylogeny
PO 38	EVALUATING THE TAXONOMIC VALIDITY OF ROUGH RABBITSFOOT (*THELIDERMA CYLINDRICA STRIGILLATA*) AS A SUBSPECIES AND REEXAMINING PHYLOGENETIC RELATIONSHIPS WITHIN THE GENUS *THELIDERMA.* Caitlin Carey, Jess Jones, Eric Hallerman, Rose Agbalog, Andrew Henderson, Mark Ford.
PO 39	MOLECULAR AND MORPHOLOGICAL ANALYSIS OF *LAMPSILIS* SPECIES IN THE POTOMAC RIVER USING 2D MORPHOMETRIC ANALYSIS AND DNA BARCODING. David Zanatta, Alec Smith, Curt L. Elderkin ,Emily Allison, Shenney Lin, John Pfeiffer, and Matt Ashton.
PO 40	DESIGN OF A SNP PANEL FOR LOW-COST MONITORING OF RELATEDNESS OF A FRESHWATER UNIONID. Alex B. Dunahoo, Andor J. Kiss, Brook L. Fluker, David J. Berg.
	Human Impacts and Climate Change
PO 41	HYPOXIA TOLERANCE OF *PLEUROBEMA RIDDELLII* (LOUISIANA PIGTOE) Emalyn Blackwell, Hannah Adkins, Kaelyn Fogelman, Evelyn Pieper, & James Stoeckel.
	Contaminants and Ecotoxicology
PO 42	THE INFLUENCE OF WATER HARDNESS ON THE SALT-SENSITIVITY OF EARLY LIFE STAGE FRESHWATER MUSSELS. Patricia L. Gillis, Karen Lemon, C. James Bennett, Joseph Salerno, Ryan S. Prosser.

PO 43	AN EVALUATION OF ACUTE AND CHRONIC TOXICITY OF AMMONIA AND NITRATE TO A NATIVE FRESHWATER MUSSEL (ARKANSAS BROKENRAY, *LAMPSILIS REEVEIANA*) FROM THE BUFFALO NATIONAL RIVER, ARKANSAS. James L Kunz, Ning Wang, Jeff Steevens, Anna Pieri, Jennifer Bouldin.
PO 44	INFLUENCE OF INCREASING WATER TEMPERATURE ON THE THERMAL TOLERANCE OF *GONIDEA ANGULATA* AND ITS HOST FISH, *COTTUS* SPP. Rachael Valeria, Alexa Maine, James Nagler.
PO 45	EVALUATION OF THE SENSITIVITY OF A FEDERALLY ENDANGERED MUSSEL (TENNESSEE BEAN, *VENUSTACONCHA TRABALIS*) TO SELECTED CHEMICALS. Ning Wang[1], Chris Ivey[1], Danielle Cleveland[1], James Kunz[1], Rebecca Schapansky[2], Timothy Lane[3].
Invasive Species Impacts	
PO 46	POPULATION DENSITIES AND DISTRIBUTIONS OF NATIVE MUSSEL SPECIES AND RUSTY CRAYFISH IN SCHOHARIE CREEK, NY. Baileigh Behan, Brian Hefferon, Jessica Furlong, Andrew Gascho Landis.
PO 47	ADDRESSING IF INTERSPECIFIC COMPETITION OCCURS BETWEEN INVASIVE FRESHWATER CLAMS AND NATIVE JUVENILE MUSSELS. Taylor E. Kelley; Garrett W. Hopper; Carla L. Atkinson; Arial J. Shogren.
Conservation Strategies	
PO 48	THE YATES MILL AQUATIC CONSERVATION CENTER: A NEW AQUATIC SPECIES PROPAGATION FACILITY AT NORTH CAROLINA STATE UNIVERSITY. Chris B. Eads, Loretta M. Lutackas, and W. Gregory Cope.
PO 49	UNIONIDS RESTORATION ACTIVITIES AND THEIR EFFECTIVENESS WITHIN WEST VIRGINIA. Michael E. Everhart.
PO 50	SHELD, A TRAIT DATABASE FOR FRESHWATER MUSSELS OF THE UNITED STATES OF AMERICA Garrett W. Hopper, Jamie R. Bucholz, Traci P. Dubose, Kaelyn J. Fogelman, Sean M. Keogh, Megan E. Kubala, Matthew B. Lodato, David H. Nichols, Irene Sánchez González, John M. Pfeiffer, James A. Stoeckel, Jeffery D. Lozier, Carla L. Atkinson.
PO 51	CURRENT ACTIVITIES TO SUPPORT FRESHWATER MUSSEL RESTORATION IN THE SUSQUEHANNA RIVER BASIN. Zachary Taylor, Matthew Ashton, and Tony Prochaska.
Mussel Health Assessment and Die-Offs	
PO 52	BIOMARKERS OF HEALTH AND IMMUNOCOMPETENCE IN FRESHWATER MUSSELS: AN ASSESSMENT OF APPLICABILITY TO WILD AND HATCHERY POPULATIONS. Madison E. Polera, W. Gregory Cope, Erin McKenney, Catherine E. LePrevost, Jeffrey A. Yoder,Tal Ben-Horin, Chris B. Eads, Heather Evans, Rachael Hoch, J. Michael Fisk II, Michael J. Walter.

Gray title denotes student presentation

Platform Session 1A: Status and Distribution of Mollusks 1

Tuesday (4/11) 10:20am - 12:00pm - Mt. Hood

PL 01 10:20-10:40	**MUSSELS OF THE WOLF RIVER, TN: A RESURVEY OF UNIONIDS IN AN INUNDATED CUMBERLAND TRIBUTARY**
	Jack G. Fetters[1], A. E. Rosenberger [1, 2,] A. Ford [3] [1]Tennessee Technological University, Cookeville, TN; [2]U.S. Geological Survey, Tennessee Cooperative Fishery Research Unit, Cookeville, TN; [3]U.S. Fish and Wildlife Service, Tennessee Ecological Services Field Office, Cookeville, TN.
	The Cumberland River drainage in Tennessee and Kentucky has one of the most diverse assemblages of freshwater mussels in the world, including several species that are federally listed as endangered. Many of its moderately sized streams, such as the Wolf River, a tributary to the Obey River, are understudied and infrequently monitored. The Wolf River is a stronghold of the Cumberland River mussel fauna, playing particularly important role in the persistence of the federally endangered fluted kidneyshell *Ptychobranchus subtentus* . In this study, we revisited multiple sites from a previous survey to assess any changes in the distribution or abundance of mussels in this system. A broad survey approach was used to determine if chronic stressors, habitat variables, and food availability either correspond with their current status or portend future changes in the system. Using qualitative and quantitative sampling methods paired with remotely sensed habitat data, we performed multivariate canonical correspondence analysis to determine habitat associations with freshwater mussel abundances in the Wolf River. Our results indicate mussel abundances and richness contrast between the upstream (low) and downstream (high) sections. These differences are associated with high conductivity, alkalinity, mean temperatures, and higher % forest cover with in the watershed. Mussel populations, including fluted kidneyshell, persist in this system and show signs of recruitment throughout occupied reaches; however, low abundances upstream and limited recruitment indicate careful monitoring may be warranted. Management actions that improve water quality conditions for mussel growth may be favorable for this continued persistence. These results give insight on mussel declines in low productive areas and provide management guidelines for freshwater mussel reintroduction and habitat restoration with in Wolf River.
PL 02 10:40-11:00	**USING HYDROACOUSTIC IMAGING TO PREDICT YELLOW LAMPMUSSEL DISTRIBUTION AND HABITAT USE IN THE CONNECTICUT RIVER WATERSHED**
	Stefanie J. Farrington [1,2] , David Perkins [2] , Allison H. Roy [3,] and Timothy Warren [2] 1Massachusetts Cooperative Fish and Wildlife Research Unit, Organismic and Evolutionary Biology Program, University of Massachusetts, Amherst, MA 01003; 2U.S. Fish and Wildlife Service, Richard Cronin Aquatic Resource Center, Sunderland, MA 01375; 3U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, Department of Environmental Conservation, University of Massachusetts, Amherst, MA 01003.
	Yellow Lampmussel, *Lampsilis cariosa,* is a vulnerable freshwater mussel species that is declining throughout its range (Georgia, USA to Nova Scotia, Canada). This species is endangered in Massachusetts and Connecticut, where it is found only in the Connecticut River. Microhabitat features and their association with Yellow Lampmussel within this sixth order river have not been examined; mapping these fine-scale habitat features could illuminate this relationship. Furthermore, the distribution of Yellow Lampmussel in the Connecticut River has not been formally assessed; recent surveys are limited and not standardized. Therefore, the goal of this project was to describe habitat where Yellow Lampmussel are known to occur and identify additional potentially suitable habitat within the Connecticut River mainstem where this species has not been documented. We used side-scan sonar and drop-camera videos deployed from a boat to collect habitat information, including substrate type and water depth, from a 100 km stretch of river. We used ArcGIS spatial analysis tools to characterize, digitize, and map habitat types. Using Yellow Lampmussel occurrence data, we mapped the species distribution and habitat use in the Connecticut River. The species distribution map will be used to conduct additional snorkel and SCUBA surveys in habitats identified as suitable where no extant Yellow Lampmussel population has been documented. The results of this study may also be useful for identifying candidate areas for release of propagated or relocated individuals, as well as identifying habitats associated with occurrence of other species of interest such as river herring and endangered shortnose sturgeon.

PL 03 11:00-11:20	**DRIVERS OF BROOK FLOATER (*ALASMIDONTA VARICOSA*) OCCUPANCY AND ABUNDANCE: A WATERSHED ANALYSIS ACROSS THEIR HISTORIC RANGE**
	Alexa M Hershberger [1] , Allison H Roy [2] , Jason R Carmignani [3] , and Peter D Hazelton [4] . 1 Organismic and Evolutionary Biology Program, University of Massachusetts, Amherst, MA 01003; 2 U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, Department of Environmental Conservation, University of Massachusetts, Amherst, MA 01003; 3 The Natural Heritage & Endangered Species Program, Division of Fisheries and Wildlife, MassWildlife, Westborough, MA 01581; 4 Warnell School of Forestry & Natural Resources, University of Georgia, Athens, GA 30602.
	Brook Floater (*Alasmidonta varicosa*) is an Atlantic slope unionid species of high conservation concern. This species is listed as critically imperiled (9 states), imperiled (3), vulnerable (3), and extirpated (2) across their historic range from Georgia to Nova Scotia. Over 50% of the historic populations have been extirpated, yielding a few scattered viable populations. In 2017, researchers investigated Brook Floater species distribution across their historic range in the United States with a nonparametric decision tree, which estimated correlations between mussel presence and environmental variables at the watershed (HUC12) and stream scales. Climate and land cover variables were strong positive predictors of Brook Floater absence within stream reaches; however, the ability to predict watershed-scale occupancy was limited by the lack of standardized mussel and habitat sampling and the inability to assess detection. In 2018, the Brook Floater Working Group addressed these limitations by developing a standardized rapid assessment sampling protocol. Here, we identified drivers of occupancy and abundance with the standardized sampling data in six states (13 watersheds) from 2016 to 2019. We collected physical habitat measurements for each longitudinal search lane (e.g., bed texture, vegetation) and stream reach (e.g., canopy cover, mesohabitat type). Preliminary results suggest occupancy may be positively associated with substrate type (e.g., sand) and mesohabitat type (e.g., runs) but is variable across watersheds. Low detection probability of this rare species may limit our ability to make inferences about habitat relationships. The findings from this study will produce an adaptable regional analysis model that can help managers identify reach-scale habitat preferences for protection and suitable habitat for reintroduction.
PL 04 11:20-11:40	**THEN, NOW, AND THE SHELLS INBETWEEN: UNDERSTANDING CHANGES IN THE COMMUNITY COMPOSITION OF FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE) IN GREAT LAKES REGION THROUGH COMPARISON OF HISTORIC DATA, LIVING COMMUNITY, AND DEAD SHELL ASSEMBLAGES**
	Mariah Scott; University of Chicago, Chicago, IL
	Freshwater mussels of the family Unionidae have experienced numerous anthropogenic ecological changes in the Great Lakes region. The types of anthropogenic changes have shifted over time and include, but are certainly not limited to, habitat disturbance, pollution, direct harvest for the historic button industry, and introductions of invasive mussels. Past studies revealed which species have been found in the Great Lakes region over time, and began to compare changes in community composition. This study works to expand on past efforts, using more sources of data and additional measures of changes in community composition. Survey-like museum collections, formal historical surveys, and recent surveys (2011-2012) with both live-observed animals and dead shell assemblage data were compared. Four study areas were targeted to look at large areas with high levels of human stressors (Lake St. Clair and Western Lake Erie), a smaller region with a high level of human stressors (Presque Isle Bay), and a small region with limited sources of human stressors (Douglas Lake, Northern Michigan). These study areas allow for qualitative comparisons based on size of region and amount and type of human impact. The various sources of data, representing over 9,000 occurrence records of unionids, allow for detailed temporal comparisons of community composition. The difference in species richness, evenness, and community composition (Jaccard Chao, Spearman Rho, and Non-metric Multi-dimensional Scaling) were compared within each study area. Dead shell assemblage data were compared to other data types to learn more about the ecosystem and timing of changes, providing information in areas of inconsistent temporal sampling. Observed patterns revealed consistent decreases in species richness and evenness, as well as changes in species composition over time. There were also some exceptions to these overall patterns worth discussing. This information will help us better understand when and how unionid communities have been altered.

PL 05 11:40-12:00	**ASSESSING THE FRESHWATER MUSSEL ASSEMBLAGE OF THE ROBERT C. BYRD POOL, OHIO RIVER**
	E Hunter Bellamy [1] , Thomas G Jones [1] , Alyssa R Jones [1] & Nicholas S Wheeler [1] . 1 Marshall University, Huntington, WV
	Freshwater mussels are the most imperiled taxa in the United States and are vastly understudied. This study aims to better understand mussel populations in a large navigable river and to identify factors affecting their diversity and abundance. Objectives include: 1) describe the mussel assemblage within the study area; 2) analyze potential factors that may be impacting mussel assemblage; 3) compare results to similar data collected from the Greenup Pool to assess factors driving the different pools freshwater mussel assemblages. The study area encompasses the 41.7 mile reach of the Robert C. Byrd (RCB) pool of the Ohio River. The sites were selected from the 2019 ORSANCO RCB pool assessment which utilized random site selection across the pool. Surveys were conducted using SCUBA and data are collected on mussel abundance, reproduction, and diversity. Light, depth, and substrate composition were recorded and analyzed as factors. This study is innovative as mussel surveys are not typically conducted on such a large-scale or by using randomized sampling sites. A larger, pool-wide scale will be more representative of the current mussel assemblage and the data collected could serve as a baseline to site – specific surveys. The Robert C. Byrd pool was hypothesized to be in better condition than the Greenup pool due to lower urbanization. Preliminary results do not support the hypothesis. Of three sites collected during the 2021 season, only 189 live individuals were collected. Similar site locations within the Greenup pool average 332 live individuals. Results from 2022 season also do not seem to support the hypothesis. Fifteen more sites were sampled across the pool. The lower two thirds of the pool are virtually devoid of any mussel presence, dead or alive.

Gray title denotes student presentation

Platform Session 1B: Invasive Species Impacts

Tuesday (4/11) 10:20am - 12:00pm - Mt. Bachelor

PL 06 10:20-10:40	**DIFFERENTIAL VULNERABILITY OF NATIVE AND NON-NATIVE MOLLUSKS TO PREDATION BY JUVENILE BLACK CARP**
	Jeremy S. Tiemann [1] , Anthony P. Porreca [2] , Andrew Runyon [2] , Steven E. Butler [2] , and Joseph J. Parkos III [2] . [1] Illinois Natural History Survey, Prairie Research Institute at the University of Illinois, 1816 South Oak Street, Champaign, Illinois 61820 USA [2] Kaskaskia Biological Station, Illinois Natural History Survey, Prairie Research Institute at the University of Illinois, 1235 CR 1000 N, Sullivan, IL, 61951 USA
	The Black Carp (*Mylopharyngodon piceus*), a molluscivorous xenocypridin native to east Asia, has become established in the Mississippi River basin. However, the vulnerability of North American snails and bivalves to Black Carp predation remains unknown, especially as it relates to the juvenile life stage when these predators transition to mollusk prey. To address this knowledge gap, we conducted a series of feeding experiments to assess the vulnerability of native and non-native mollusks to predation by age-0 and age-1 Black Carp. In the first experiment, age-0 Black Carp were tested with native unionid *Hamiota perovalis* , native pleurocerid *Elimia livescens* , and native physid *Physella* sp., while Age-1 Black Carp were tested with *Elimia* , native unionids *Lampsilis cardium* and *Lampsilis cariosa* , native sphaeriid *Sphaerium* sp., and non-native cyrenid *Corbicula fluminea* . Juvenile Black Carp readily attacked and consumed shelled prey. Age-1 Black Carp displayed a wider range of feeding capabilities than age-0, easily consuming *Elimia* along with *Lampsilis* and *Sphaerium* sp. The only prey taxon that age-1 Black Carp struggled to crush and consume was *Corbicula* , which had the thickest and widest shells relative to predator gape of all prey tested. In the second experiment, we quantified size-specific vulnerability of native (*Physella* sp., *Elimia livescens* , and *Sphaerium* sp.) and non-native (*Dreissena polymorpha* , *Corbicula fluminea* , and *Cipangopaludina chinensis*) mollusks to predation by juvenile Black Carp. Results from this experiment showed that *Physella* sp. was vulnerable across all tested sizes, byssal thread attachment by *Dreissena* reduced vulnerability, and interspecific differences in size-specific vulnerability were associated with shell thickness and shape. Our experiments support the contention that small mollusks are susceptible to predation by juvenile Black Carp but highlights how prey-specific physical properties, such as shell size and strength, could drive differential predation pressure on mollusk populations as the invaded range of Black Carp expands.
PL 07 10:40-11:00	**INTERACTION BETWEEN TWO INVASIVE SPECIES, *DREISSENA POLYMORPHA* AND *HYDRILLA VERTICILLATA***
	Emily A. Lorkovic and Astrid N. Schwalb. Texas State University, San Marcos, Texas.
	Zebra mussels (*Dreissena* polymorpha) are infamous invaders of aquatic ecosystems. Facilitation of macrophytes by dreissenid mussels associated with increased water clarity and declines in phytoplankton has been documented by several studies. Yet, interactions with *Hydrilla verticulata* , a submerged aquatic plant native to Southeast Asia have not been investigated yet. The objectives of this study were to examine (1) how substrate composition affects the distribution of zebra mussels and Hydrilla in Canyon Lake, Texas; (2) how size distribution of zebra mussels on rocky substrate differ to those attached on Hydrilla; and (3) use experiments to determine if (a) hydrilla affects the biomass of zebra mussels and (b) zebra mussels affect the growth of Hydrilla. Dive surveys in June and September 2022 showed higher densities of Hydrilla in softer substrate. Zebra mussel densities, however, did not differ significantly between softer and rocky substrate, because smaller zebra mussels were able to attach to Hydrilla tissue in large numbers, although the number of attached zebra mussels declined in September. Both lab and field experiments did not show any indication of facilitation between zebra mussels and Hydrilla. There was some indication of potential negative impacts of hydrilla on zebra mussels, but this remains to be studied further.

PL 08 11:00-11:20	**ECOSYSTEM SERVICES PROVIDED BY THE EXOTIC BIVALVES *DREISSENA POLYMORPHA, D. ROSTRIFORMIS BUGENSIS* , AND *LIMNOPERNA FORTUNEI***
	*Lyubov E Burlakova [1] *, Alexander Y Karatayev [1] , Demetrio Boltovskoy [2] & Nancy M Correa [3] . [1] Great Lakes Center, SUNY Buffalo State University, Buffalo, NY, USA; [2] Universidad de Buenos Aires, Argentina; [3] Servicio de Hidrografía Naval & Sede Educativa Universitaria, Buenos Aires, Argentina.*
	The ecosystem services approach to conservation is becoming central to environmental policy decision making. While multiple negative biological invasion-driven impacts on ecosystem structure and functioning have been identified, much less was done to evaluate their ecosystem services. In this presentation we focus on the often-overlooked ecosystem services provided by three notable exotic ecosystem engineering bivalves, the zebra mussel, the quagga mussel, and the golden mussel. One of the most significant benefits of invasive bivalves is water filtration, which results in water purification and changes rates of nutrient cycling, thus mitigating the effects of eutrophication. Mussels are widely used as sentinel organisms for the assessment and biomonitoring of contaminants and pathogens and are consumed by many fishes and birds. Benefits of invasive bivalves are particularly relevant in human-modified ecosystems. We summarize the multiple ecosystem services provided by invasive bivalves and recommend including the economically quantifiable services in the assessments of their economic impacts. We also highlight important ecosystem disservices by exotic bivalves, identify data limitations, and future research directions. This assessment should not be interpreted as a rejection of the fact that invasive mussels have negative impacts, but as an attempt to provide additional information for scientists, managers and policymakers.
PL 9 11:20-11:40	**DREISSENA IN THE GREAT LAKES: WHAT HAVE WE LEARNED IN 35 YEARS OF INVASION**
	Alexander Y Karatayev [1] & Lyubov E Burlakova. Great Lakes Center, Buffalo State College, 1300 Elmwood Ave, Buffalo, NY 14222
	We summarized over 35 years of research on zebra and quagga mussels in the Laurentian Great Lakes. Invasion dynamics, growth, and reproduction of dreissenids in the Great Lakes are governed by lake morphometry. In shallow polymictic lakes, lakes basins, and embayments quagga mussels became dominant 4 – 12 years after coexistence but did not fully replace zebra mussels even after 30 years of coexistence. In contrast, in deep Great Lakes quagga mussels became dominant faster at greater depths, form much higher density, and drive zebra mussels to virtual extirpation. At <30 m mussels overshot their carrying capacity and declined within 13 – 15 years after first detection. At 30 – 90 m their densities increased more slowly and declined to a lesser extent, while at >90 m populations continue to increase even after 35 years of invasion. After the proliferation of quagga mussels, benthic wet biomass (including molluscs shells) increased about two orders of magnitude and currently exceeds zooplankton biomass >40-fold. Strong benthic/pelagic coupling redirects food and energy from the water column to the bottom causing an increase in Secchi depth, decline in phosphorus, chlorophyll, phytoplankton and zooplankton biomass. The abundance of commercially important fishes declined as a result of the dramatic decrease in their main food deep water amphipods *Diporeia* , which has been outcompeted by exotic mussels. However, the introduction of round goby into the Great Lakes in the 1990s provided an important link between dreissenids and commercially and recreationally valuable fish species, increasing their productivity.

PL 10 11:40-12:00	**HAWAII'S FRESHWATER GASTROPOD INVASIONS: EXASPERATING CRYPTIC SPECIES COMPLEXES AND NEW INTRODUCTIONS**
	Norine W. Yeung [1] , Jaynee R. Kim [1] , Kenneth A. Hayes [1] . Bernice Pauahi Bishop Museum, Honolulu, HI.
	Invasive species are a threat to natural resources, agriculture and human health. Knowing which species are present and where they occur provides conservation and resource managers with critical data for evaluating impacts, prioritizing control and mitigation activities and developing management policies. Currently, there are 73 established non-native, non-marine mollusc species in Hawaii, 15 of which are freshwater species from six families (Ampullariidae, Cochliopidae, Lymnaeidae, Physidae, Planorbidae, Thiaridae). Hawaii has at least two cryptic species complexes (i.e. *Melanoides tuberculata, Planorbella trivolvis*) and several unknown species (e.g. *Tryonia* sp., *Physa/Physella* sp.). Several established species are known agricultural pests (e.g. *Pomacea canaliculata*) and vectors (e.g. *Tarebia granifera* , *Mieniplotia scabra*) of zoonotic diseases. Over the last decade, surveys conducted across the main islands have recovered four newly established invasive freshwater molluscs on a single island, so far. Effective biosecurity policies and actions require accurate identification and an understanding of the potential impacts of introduced species, and ongoing surveys ensure early detection that are critical to control and eradication. Without such survey efforts, and the support from agencies charged with managing resources, many more species will continue to establish and spread, threatening native ecosystems, agricultural resources, and public health.

Gray title denotes student presentation

Platform Session 1C: Mollusk Health and Die-Offs

Tuesday (4/11) 10:20am - 12:00pm - 3 Sisters

PL 11 10:20-10:40	**A STUDY TO EVALUATE CAUSES OF MUSSEL DECLINES ACROSS THE EASTERN U.S**
	Wendell R. Haag [1], Carla L Atkinson [2], Andrea K Darracq [3], Traci P Dubose [4], Kaelyn J Fogelman [5], Tony L Goldberg [6], Andrew J Ibach [7], Susan Knowles [8], Charlotte Martin [6], Erin S McCombs [9], Steven J Price [7], Carl G Smith [1], James A Stoeckel [5], Diane L Waller [11], and Matt N Waters [5]. [1] U.S. Forest Service, Frankfort, KY; [2] University of Alabama, Tuscaloosa; [3] Murray State University, Murray, KY; [4] ORISE Post-doctoral Scholar, US Forest Service, Frankfort, KY; [5] Auburn University, Auburn, AL; [6] University of Wisconsin, Madison; [7] University of Kentucky, Lexington; [8] U.S. Geological Survey National Wildlife Health Center, Madison, WI; [9] American Rivers, Asheville, NC; [11] U.S. Geological Survey, Upper Midwest Science Center, La Crosse, WI.
	The causes of widespread mussel declines remain poorly understood. Most previous studies focused on specific streams, and none have critically evaluated potential causes of mussel declines across a large geographical area. In 2020, we initiated a study across up to 13 states in >75 streams. Study streams represent a continuum of those having highly degraded to high-quality mussel assemblages. For each stream, we are compiling data on or directly measuring a wide variety of potential causes of mussel declines (independent variables), including water quality, land use, stream connectivity, mussel food availability and quality, sediment characteristics, invasive bivalve abundance, and broad-spectrum pathogen diagnostics. Our response variables are mussel assemblage health and individual mussel health and performance. We developed an index of mussel assemblage health that scores assemblages on a continuous scale from 0–10 and is applicable across the study area. We are assessing individual mussel health based on survival, growth, physiological condition, and histological examination of juvenile mussels exposed in silos to ambient stream conditions for three months. Our overarching goal is to examine whether any of the potential causal factors are consistently associated with mussel assemblage health or individual mussel health. We describe the study goals and approaches and discuss preliminary findings. The project depends on a broad, collaborative network of partners from over 34 institutions, agencies, and organizations, including dozens of personnel and substantial in-kind contributions.
PL 12 10:40-11:00	**AN INTERDICIPLINARY APPROACH TO ASSESSING DRIVERS OF UNIONID MUSSEL DIE-OFFS**
	Jeronimo Da Silva Neto [1,3], Michelle Dennis [1], Gerald Dinkins [3], Rebbeca Hardman [4], Augustin Engman [2. 1] College of Veterinary Medicine, The University of Tennessee, Knoxville, TN; [2] School of Natural Resources, The University of Tennessee, Knoxville, TN; [3] McClung Museum of Natural History and Culture, Knoxville, TN; [4] Florida Wildlife Commission, St. Petersburg, FL
	Annual unionid mussel die-offs have occurred since 2016 in the Clinch River, a freshwater biodiversity hotspot flowing across southwest Virginia into east Tennessee. Although many researchers have investigated these events, a single causative factor or mechanism has not been identified. We aim to determine the likely causes of mussel mortality at two die-off sites in the Clinch River. Our approach longitudinally compares hemolymph indices, tissue histopathology, and bacterial microbiome of moribund free-living Actinonaias pectorosa (i.e., individuals showing advanced clinical signs of disease) with in-situ population of hatchery-reared (i.e., apparently healthy) A. pectorosa maintained in silos at the same sites. We sampled 29 wild moribund mussels and 68 silo mussels in 2021 and 2022. Although a die-off event occurred at both sites from August – November 2021 and 2022, no silo mussels presented clinical signs of disease or significant gross or microscopic lesions. However, moribund mussels consistently had multisystemic and multifocal infiltrative hemocytosis with necrosis and intracellular rod-shaped bacteria (bacilli), consistent with sepsis. Microbiome analysis identified Aeromonas spp., Salmonella spp., and Yokenella spp., as the main operational taxonomic units present in digestive glands of moribund mussels, which is congruent with previous studies assessing bacterial communities of moribund mussels in the Clinch River. While bacterial infection appears to play a role in seasonal mussel mortality, it is presently unclear whether bacteria represent opportunists or primary pathogens. These results, in combination with spatiotemporal environmental data (e.g., temperature and stream discharge), will be used to explore the role of disease and environmental stressors in die-off events.

PL 13 11:00-11:20	**VIRUSES IN HEALTHY AND MORIBUND WESTERN PEARLSHELL (MARGARITIFERA FALCATA) DURING A MASS MORTALITY EVENT**
	Tony L. Goldberg [1] , Emilie Blevins [2] , Eric M. Leis [3] , Isaac F. Standish [3] , Jordan C. Richard [1,4] , Christopher D. Dunn [1] & Diane Waller [5] . [1] University of Wisconsin-Madison, Madison, WI; [2] Xerces Society for Invertebrate Conservation, Portland, OR; [3] U.S. Fish and Wildlife Service, La Crosse Fish Health Center, Midwest Fisheries Center, Onalaska, WI; [4] U.S. Fish and Wildlife Service, Southwestern Virginia Field Office, Abingdon, VA; [5] U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI
	Freshwater mussels (Unionida) are declining precipitously worldwide due to a litany of known and unknown environmental stressors. Among these, disease has been arguably the least studied, although evidence from unionids and other bivalves suggests that infection can cause rapid and dramatic population declines. In 2018 and 2020, we sampled 50 Western Pearlshell (Margaritifera falcata) non-lethally for hemolymph during mass mortality events. We chose approximately equal numbers of moribund mussels (cases) and apparently healthy mussels (controls) from the same sites in the Chehalis and Skookumchuck Rivers in the state of Washington, USA. We then used broad-spectrum metagenomic methods in the laboratory and bioinformatic computational analyses to characterize viral communities in each mussel, with the goal of identifying viruses associated with ill health. We have thus far identified over 200 distinct taxa representing viruses with DNA genomes (single-stranded and double-stranded), RNA genomes (positive and negative sense), linear genomes, and circular genomes. Among these, approximately 50% are currently unclassified taxa, and many others are highly divergent variants of known viruses. Notably, several are familial relatives of viruses known to cause disease in invertebrates and invertebrates, including in other bivalves and anadromous fishes, respectively. Communities of viruses differed markedly among individuals, with the distribution of the number of co-infecting viruses per mussel following a right-skewed distribution (i.e. some individuals hosting zero or few viruses and others hosting over 20 viruses). Apparently healthy mussels had, on average, lower intensities of infection than did moribund mussels, although this trend was not strongly driven by any one virus. Our findings do not indicate a "smoking gun" viral cause of mortality in Western Pearlshell, but rather that viruses in this system either reflect compromised mussel physiology or cause disease indirectly or non-specifically, or both. Our results have implications for future assessments of mussel mass mortality events in the wild and for captive propagation.
PL 14 11:20-11:40	**IS IT CLIMATE CHANGE, POLLUTION, OR AN UNKNOWN DISEASE? FRESHWATER MUSSELS DIE OFF ON THE EUROPEAN SCALE**
	Maria Urbańska [1] , Aldrige D. [2] , Atasaral S. [3] , Bylyna L. [4] , Collas F. [5] , Cossey D.A. [2] , Dobler A. [6] , Douda K. [7] , Hernández J. [16] , Geist J. [6] , Halabowski D. [8] , Henn T. [9] , Hoos P. [6] , Ilarri M. [10] , Labedzka A. [11] , Lajtner J. [12] , Lima M.L. [10] , Magerøy H.J. [13] , Moorkens E. [14] , Morales J. [16] , Motte G. [15] , Nakamura K. [16] , Nogueira J. [10] , Ondina P. [17] , Österling M. [18] , Ożgo M. [19] , Riccardi N. [20] , Shevchuk L. [4] , Shumka S. [21] , Son M. [22] , Sousa R. [23] , Teixeira A. [24] , Thielen F. [25] , Tomović T. [26] , Varandas S. [24] . [1] Poznań University of Life Sciences, PL; [2] University of Cambridge, UK; [3] Karadeniz Technical University, TR, [4] Zhytomyr State University UA; [5] Radboud Unversity, NL; [6] Technische Universität München, DE; [7] Czech University of Life Sciences Prague, CZE; [8] University of Lodz, PL; [9] Estonian University of Life Sciences, EE; [10] University of Porto, PT; [11] Jagiellonian University, PL; [12] University of Zagreb, HR; [13] ; Norwegian Institute for Water Research, NO; [14] Trinity College Dublin, IE; [15] CRNFB, BE; [16] University of Valencia Cavanilles, ES; [17] University of Santiago de Compostela, ES; [18] Karlstad University, SE; [19] Kazimierz Wielki University, Bydgoszcz, PL [20] ; CNR ISE - Institute of Ecosystem Study, IT; [21] Agricultural University of Tirana, ALB; [22] Institute of Marine Biology, Odessa, UA; [23] University of Minho, Braga, PT; [24] Instituto Politécnico de Bragança, Bragança, PT; [25] Natur & Ëmwelt/Fondation Hëllef fir d'Natur, LU; [26] University of Belgrade, SRB;

	The European Cooperation in Science and Technology Program (COST) funds the creation of research networks called COST Actions. This network facilitates collaboration among researchers from across Europe (and beyond) and thus provides a stimulus for research development. In 2019, funding was allocated for the project "Conservation of freshwater mussels: a pan-European approach" (CONFREMU) (CA 18239). This has allowed undertaking mussel research and data collection on a European scale. One of the projects conducted under CONFREMU aims at collecting data on known mass mortality cases of freshwater mussels. We searched articles, newspapers and social media describing the causes of local extirpation, assessing the quality of the evidence and dividing by the causes of sudden mortality. Conservation of biodiversity requires reliable evidence of the causes of extirpation. It is expected that by analyzing collected documentation about mass mortality events, it will be possible to establish correct management with protection/recovery protocols defined and to understand better the causes of these phenomena to remediate them.
PL 15 11:40-12:00	**INVESTIGATING MUSSEL MORTALITY EVENTS IN THE EASTERN UNITED STATES: RESULTS FROM MORTALITY EVENTS, SENTINEL ANIMAL STUDIES, AND EXPERIMENTAL INFECTION TRIALS**
	Jordan C. Richard [1,2], Eric Leis [3], Diane L. Waller [4], Susan Knowles [5], and Tony L. Goldberg [6,7 1] U.S. Fish and Wildlife Service, Southwestern Virginia Field Office, 330 Cummings Street, Abingdon, VA, 24210, [2] Department of Freshwater and Marine Science, University of Wisconsin-Madison, [3] La Crosse Fish Health Center, Midwest Fisheries Center, U.S. Fish and Wildlife Service, 555 Lester Ave, Onalaska, WI, 54650. [4] U.S. Geological Survey, Upper Midwest Environmental Sciences Center, 2630 Fanta Reed Rd, La Crosse WI, 54603, [5] U.S. Geological Survey, National Wildlife Health Center, 6006 Schroeder Rd, Madison, WI 53711. 6Department of Pathobiological Sciences, University of Wisconsin-Madison, 1656 Linden Drive, Madison WI 53706, 7Global Health Institute, University of Wisconsin-Madison, 1300 University Avenue, Madison WI 53706
	Beginning with a mass mortality event in the Clinch River in 2016, the freshwater mussel health investigation team has conducted a series of epidemiologic investigations of unusual mortality events (i.e., episodes of higher-than-normal mortality observed in wild and captive mussel populations) in Northeast, Southeast, and Midwest Regions. Here, we give a brief overview of active investigations, which includes mortality events 9 states, including MN, WI, IL, IA, MI, OH, VA, NC, and TN. Events vary in their scope, duration and timing, with some appearing to be isolated incidents, while others show patterns of seasonal recurrence. In some cases mortality appears to affect a limited number of species, while other cases include mortality of all mussels. However, in all cases investigated, there were no associated fish kills or mortality of other taxa observed. Investigations have utilized a variety of epidemiologic methods, including case-control studies, sentinel animal studies, and experimental infection trials. To date, over 1,000 novel viruses have been identified in mussels from wild study sites. Mussel viromes show distinct patterns that differ markedly between hatchery settings and wild populations. Results for each mortality event vary, but elevated viral richness and viral load appears to be a common element in many instances. Experimental infection trials remain difficult – particularly for viruses – as no viable mollusk cell lines are available to aid with the isolation and culture of viruses identified from mortality events.

Gray title denotes student presentation

Platform Session 2A: Genetics and Phylogeny 1

Tuesday (4/11) 2:00-3:20pm - Mt. Hood

PL 16 2:00-2:20	**GENOMICS AND THE THREE RS OF CONSERVATION**
	David J. Berg [1] & Steven R. Hein [2, 3] . 1Miami University, Hamilton, OH; 2Miami University, Oxford, OH; 3National Oceanic and Atmospheric Administration, Silver Spring, MD.
	Species status assessments (SSAs) and species recovery plans (SRPs) utilize the life history and ecology of a target species, and the current conditions of the species to predict the probability of persistence into the future. The foundations of these are the 3 Rs of conservation biology: resiliency, redundancy, and representation. We consider how population genomics can inform understanding of the 3 Rs in creating SSAs and SRPs. Resiliency measures population health, with highly resilient populations exhibiting positive demographic factors, high genetic variation, and large population size. Within populations, genetic factors contributing to resiliency include inbreeding and assortative mating, and genetic drift. Estimating resiliency can be done using within-population metrics such as the number of private alleles, nucleotide diversity, and genetically effective population size (Ne). Management activities increasing resiliency include actions that decrease mortality and increase recruitment, and population augmentation from captive or wild sources. Redundancy is primarily concerned with maintaining multiple populations. As such, the focus is on among-population genetic variation and gene flow connecting populations at various spatial scales. Redundancy can be evaluated using measures of population divergence such as FST, population inference, and estimates of migration rates. Management activities that can increase redundancy include population re-establishment and assisted migration. Representation focuses on the responses of a species to changing environments by estimating adaptive potential at loci that are likely to be under selection. Preservation of variation at such loci is the primary management activity for maintaining adaptive potential. We illustrate the application of population genomics to determining the 3 Rs using Popenaias popeii, a federally endangered species from the Rio Grande basin.
PL 17 2:20-2:40	**PHYLOGENETIC AND MORPHOLOGICAL ANALYSES OF TWO FRESHWATER MUSSEL SPECIES IN THE CUMBERLAND AND GREEN RIVER DRAINAGES**
	Katlyn Ortiz [1] , Jess Jones [1,2] , Mike Compton [3] , Eric Hallerman [1] . [1] Virginia Polytechnic Institute and State University, Blacksburg, VA; [2] United States Fish and Wildlife Service, Blacksburg, VA; [3] Kentucky State Nature Preserves Commission, Frankfort, KY.
	The Kentucky Creekshell, Leaunio ortmanni, is currently under review to be designated as a federally listed species. The distribution of the species was historically considered endemic to the Green River drainage of central Kentucky and northern Tennessee, U.S.A. Recent molecular genetic studies have suggested that the populations of the Mountain Creekshell, L. vanuxemensis, in the lower Cumberland River drainage (Red River system) were synonymous with the populations of L. ortmanni in the Green River drainage, suggesting the distribution of L. ortmanni extends beyond the Green River drainage. To clarify the status, distribution, and phylogenetic relationship of the two species in these drainages, we tested the synonymy of the two taxa by utilizing molecular and morphological characters. Tissue samples were collected from L. ortmanni at 11 localities throughout the Green River drainage, from L. vanuxemensis at 6 localities in the Cumberland River drainage, and 5 localities in the upper Tennessee River Basin, and from Cambarunio iris at 14 localities in the upper Tennessee River Basin. We used the ND1 mitochondrial DNA gene, sequenced 150 individuals, and obtained 13 sequences from GenBank (L. ortmanni N=13, L. vanuxemensis N=78, C. iris N=72). We analyzed variation at 10 nuclear DNA microsatellites and successfully genotyped 186 individuals (L. ortmanni N=101, L. vanuxemensis N=85). We documented shell morphological characteristics from 195 individuals (L. ortmanni N=65, L. vanuxemensis N=130) to conduct the taxonomic assessment. We observed two divergent mtDNA lineages that were not concordant with the geography of the nominal taxa (i.e., both lineages occurred in each basin) and surprisingly, haplotype sharing and minimal divergence occurred among all three taxa. Hence, the ND1 gene did not differentiate Leaunio ortmanni and L. vanuxemensis from each other, and many of the C. iris haplotypes from the upper Tennessee River basin were intermingled within the clades containing these two taxa.

	However, phylogenetic analysis utilizing nuclear DNA microsatellites clearly divided L. ortmanni from the Green River and L. vanuxemensis from the Cumberland drainages into two well-diverged and distinct clades. An assignment test-based algorithm implemented in program STRUCTURE also supported K=2 across the Green and Cumberland River drainage divide. Morphological characteristics have been measured and are pending analysis, but considerable phenotypic variation within and among populations has been observed. Our early analyses suggest that L. ortmanni and L. vanuxemensis should be kept as separate species and retain their historical distributions until further analyses are completed.
PL 18 2:40-3:00	**PACBIO HI-FI GENOME ASSEMBLY OF THE IBERIAN DOLPHIN FRESHWATER MUSSEL UNIO DELPHINUS SPENGLER, 1793**
	Gomes-dos-Santos André [1,2] , Lopes-Lima Manuel [3,4] , Machado M. André [1,2] , Teixeira Amílcar [5] , C. Castro L. Filipe [1.2] , Froufe Elsa [1] . [1.] CIIMAR/CIMAR — Interdisciplinary Centre of Marine and Environmental Research, University of Porto; [2.] Department of Biology, Faculty of Sciences, University of Porto; [3.] CIBIO/InBIO - Research Center in Biodiversity and Genetic Resources, Universidade do Porto; [4.] IUCN SSC Mollusc Specialist Group, c/o IUCN; [5.] Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança.
	Mussels of order Unionida are the most diverse group of strictly freshwater bivalves, with nearly 1,000 described species, widely dispersed across world freshwater ecosystems. They are highly threatened and show the highest record of extinction within all faunal taxa. Conservation is particularly concerning in species occurring in the Mediterranean biodiversity hotspot that is exposed to multiple anthropogenic threats, possibly acting in synergy. That is the case of the dolphin freshwater mussel Unio delphinus Spengler, 1793, endemic to the western Iberian Peninsula, which has experienced recent accentuated population declines. To date, only four genome assemblies are available for the order Unionida and only one European species. Here, we present the first genome assembly of Unio delphinus. We used the long-read sequencing technology PacBio HiFi to generate a highly contiguous genome assembly. The assembly is 2.5 Gb long, possessing 1254 contigs with a contig N50 length of 10 Mbp. This is the most contiguous freshwater mussel genome assembly to date and is an essential resource for investigating the species' biology and evolutionary history that ultimately will help to support conservation strategies.
PL 19 3:00-3:20	**POPULATION GENOMICS OF AN ENDANGERED FRESHWATER MUSSEL, ARCIDENS WHEELERI, IN LITTLE RIVER, ARKANSAS**
	Mia C Adcock [1] , Kendall R. Moles [2] ,Nicole L. Garrison [3] & Nathan V. Whelan [1,4] . [1] School of Fisheries, Aquaculture, and Aquatic Sciences, Auburn University, Auburn, AL; [2] Arkansas Game and Fish Commission, Benton, AR; [3] Department of Biological Sciences, West Liberty University, West Liberty, West VA; [4] Southeast Conservation Genetics Laboratory, United States Fish and Wildlife Service, Auburn, AL.
	North America is a hotspot of freshwater mussel diversity. However, over the last century many anthropogenic stressors have led to substantial declines of freshwater mussels in North America. Conserving the remaining mussel fauna is a priority, as they play an integral role in freshwater ecosystems. The Little River in Arkansas is home to one of the last standing populations of the federally endangered freshwater mussel, Arcidens wheeleri (Ouachita Rock Pocketbook). Population dynamic information is lacking for A. wheeleri, and no population genetic study has been conducted on this species. A greater understanding of the genetic diversity within a population can serve as a benchmark for developing an effective management plan. We sampled A. wheeleri from three locations in the Little River: upstream, midstream and downstream. Genomic data were generated with single-enzyme restriction-site associated DNA sequencing (RADseq) approach to assess genetic diversity and structure of A. wheeleri in the Little River. ADMIXTURE analyses indicated one genetic cluster among the three locations, with no structure or sub-populations. Observed heterozygosity values were significantly lower than expected heterozygosity values, with Ho = 0.13 and He = 0.26. Captive propagation is an increasingly common conservation tool for freshwater mussels. Based on our results, A. wheeleri is genetically similar across the Little River, and would be an appropriate broodstock source for captive propagation and reintroduction efforts. Our results provide important genetic information for A. wheeleri that should be used to inform and guide conservation efforts.

Gray title denotes student presentation

Platform Session 2B: Community Ecology and Ecosystems 1

Tuesday(4/11) 2:00-3:20 pm - Mt. Bachelor

PL 20 2:00-2:20	**GAINING INSIGHTS ON RESPONSES OF FRESHWATER MUSSELS TO ENVIRONMENTAL HETEROGENEITY AND ON THEIR DISTRIBUTION**
	Astrid N. Schwalb [1], Kiara C. Cushway [1], Zachary Mitchell [2], Meghan E. Martinski [1], Kayla Hayes [1], Karl Cottenie [3], Joshua S. Perkin [4], Mariana Perez Rocha [1]. 1 Texas State University, Texas, USA. 2 Eastern New Mexico University, Portales, NM, USA. 3 University of Guelph, ON, Canada. 4 Texas A&M University, College Station, TX, USA.
	Understanding the factors driving the distribution of unionid mussels is fundamental for conservation plans, evaluation of threats, and predicting the impact of climate change. This presentation synthesizes research on mussel distribution in the upper Colorado River basin, Texas over the past five years. The river system is characterized by flash floods and depauperate mussel communities, with extreme droughts and groundwater extraction posing major threats. Sampling of mussels and fish at 100 pool/riffle sites by the Texas Research Institute for Aquatic and Groundwater Ecology (TRIAGE) showed that differences between rivers were associated with differences in fish, but also spatially structured environmental factors. Fine-scale distribution data collected in spatially extensive surveys (three 20km segments) of the San Saba River indicated that environmental heterogeneity (between segments and pools vs. riffles) structured the distribution of mussels at the tributary scale. This was most noticeable with a trait-based approach. Deeper perennial pools in the intermittent middle segment may serve as important refuges for mussels to avoid desiccation and lethal high temperatures. Using a HEC-RAS model for the upper segment, site occupancy in the upper segment could be predicted with 67-79 % accuracy based on hydrodynamic conditions at high and low flows. Translocation experiments between and within segments of the San Saba River revealed strong limitation by local habitat condition for the opportunistic species (Utterbackia imbecillis), while other factors, which may affect earlier life stages may limit the distribution of Cyclonaias. Substrate choice experiments in the laboratory suggested that species can be classified along a gradient of substrate preference, which tended to be associated with mobility and may affect their responses to environmental heterogeneity. This synthesis shows that several processes at different spatial scales need to be considered to disentangle the factors underlying the complex patterns of the distribution and abundance of freshwater mussels.
PL 21 2:20-2:40	**CHOOSING SIDES: UNIONIDS EXHIBIT SUBSTRATE "PREFERENCE" AND VARYING ACTIVITY LEVELS IN A BEHAVIORAL CHOICE EXPERIMENT**
	Meghan E. Martinski [1] and Astrid N. Schwalb [1 1] Biology Department, Texas State University, San Marcos, TX
	Evidence of habitat preference in unionids is mostly anecdotal and based on field observations, but few studies have tested this experimentally. The objective of this study was to use pair-wise substrate choice experiments to examine whether unionid species with different anecdotal habitat preferences and life history strategies would differ in (1) substrate preference and (2) horizontal movement and burrowing. We compared behavioral responses of 10 unionid species of central and east Texas over a 72-hour period, using 10 to 54 individuals per species. Behavioral responses varied widely between species. Opportunistic species and periodic Lampsilis species were the most mobile (L. teres moving up to 1.91 m in 72 hours) and most showed preferences for finer substrate. Most species tested burrowed, either partially or completely, 80 to 100% of the time. In contrast, more than 66% of the time Plectomerus dombeyanus neither moved nor burrowed. Two of the ten species (Lampsilis teres and Lampsilis satura) showed a strong substrate preference, where a specific substrate was consistently chosen. Four species tended to move towards a specific substrate, yet less consistently, and the remaining four species showed no preference. Preferred substrate in the experiments matched field observations of dominant substrate (at collection sites) for all the species that showed at least some substrate preference (6 of the 10 species). For example, Fusconaia askewi and Truncilla truncata were most often found in gravel beds during sampling and showed a preference for gravel in our experiments. Our results are in accordance with previous studies that showed equilibrium species (long-lived; thick-shelled) to be the least mobile life history group. In addition, our results suggest that species can be classified along a gradient from strong substrate preference (i.e., specialists) to broad substrate tolerance (i.e., generalists), which tends to be associated with mobility, but not consistently.

PL 22 2:40-3:00	**MACROINVERTEBRATE-MEDIATED LEAF DECOMPOSITION RATES ARE LOWER IN THE PRESENCE OF MUSSELS IN A SMALL BOREAL FOREST STREAM**
	Raviv Gal [1], Larry Greenberg [1], Brendan McKie [2], Martin Österling [1]. 1Karlstad University, Karlstad, Sweden; 2Swedish University of Agricultural Sciences, Uppsala, Sweden.
	Where it occurs, seasonal leaf shedding results in a large and almost sudden addition of coarse particulate organic matter to inland waters. Leaves are then decomposed over time by fungi, bacteria and benthic invertebrates, gradually releasing nutrients bound in the leaves. The indirect effects of freshwater bivalves on leaf decomposition rates have recently begun to be explored. Margaritifera margaritifera, like many other freshwater bivalves, was an abundant and potentially keystone species, with potential effects on ecosystem functioning in many streams, but has subsequently experienced substantial losses in numbers and reproduction capacity and is currently endangered. We conducted an in-situ manipulative experiment in a Swedish stream with a non-reproducing population, in which 30 enclosures measuring 30 x 30 cm containing coarse gravel and mesh bags with birch (Betula) leaves were placed in the stream and stocked with 0, 3, 6, 12 or 24 mussels. Decomposition occurred for 3 months between November and January, at temperatures averaging 2.2 °C. Unexpectedly, the presence of mussels was associated with decomposition rates that were lower than those in control enclosures without mussels. The results of this study suggest that nutrients bound in leaves may in some contexts be released more slowly and thus be available to organisms over longer timeframes in systems with intact mussel populations.
PL 23 3:00-3:20	**HOLDING THEIR GROUND: IMPACTS OF HIGH AND LOW FLOW CONDITIONS ON FRESHWATER MUSSEL DISTRIBUTION AND COMMUNITY COMPOSITION**
	Kiara C. Cushway [a], Aubrey E. Harris [b], Candice D. Piercy [b], Zachary A. Mitchell [a,c], and Astrid N. Schwalb [a a] Biology Department, Texas State University, San Marcos, Texas, U.S.A. [b] United States Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi, U.S.A. [c] Eastern New Mexico University, Portales, New Mexico, U.S.A.
	The patchy distribution of freshwater mussels has been widely acknowledged in scientific literature and habitat stability and adequate hydrodynamic conditions during extreme flows are often cited as important factors controlling where mussels may persist. Yet, most research on the impact of hydrodynamic conditions on mussel distribution has focused on smaller scales (<1 m–1 km). Hence, the objective of this study was to use a 2-D HEC-RAS model to simulate hydrodynamic conditions during extreme flows in a 20 km segment in the San Saba River, Texas in combination with survey data for mussels collected every 100 m (200 sites total) to: 1) examine whether flow conditions at (extreme) high (approx. 10-600 x median daily flows) and baseline low (approx. 0.7 x median daily flows) flows differ between hotspots of mussel richness and diversity and other sites, and 2) examine how well site occupancy can be predicted based on hydrodynamic conditions occurring at high and low flows. We found that hotspots of richness and diversity occurred in areas with lower shear stress, stream power, and Froude number during high flows, and at greater depths during low flows. Site occupancy could be predicted with 67-79 % accuracy based on hydrodynamic conditions at tested flows. Our results confirm findings of previous studies that hydrodynamic conditions are an important factor for distribution of mussels and show that mussel presence at a segment scale can be relatively well predicted based on hydrodynamic factors alone, although the importance of other factors remain to be studied. Understanding hydrodynamic conditions that occur at extreme flows is important given that the frequency and magnitude of extreme flow events are increasing in response to climate change, which could impact available mussel habitat.

Gray title denotes student presentation

Platform Session 2C: Propagation, Restoration, and Reintroduction 1

Tuesday(4/11) 2:00-3:20 pm - 3 Sisters

PL 24 2:00-2:20	**MUSSEL RESTORATION AT THE GUTTENBERG, IOWA TRAIN DERAILMENT SITE, MISSISSIPPI RIVER**
	[1] Heidi L. Dunn, [2] Megan Bradley, and [3] Aleshia Kenny. 1 EcoAnalysts, Inc., O'Fallon, MO; 2 USFWS, Genoa National Fish Hatchery, Genoa, WI; 3 USFWS, Moline, Illinois Ecological Services Office, Moline, Il.
	In July 2008, a large rock fell onto the railroad tracks near Mississippi River mile 610 within Bluff Slough causing a train derailment, resulting in train cars submerged in the Mississippi River. Diesel fuel and other petroleum products leaked into the river and settled to the river bottom. The large rock was blasted off the tracks and fell into the river. Subsequent mussel investigations revealed a species rich unionid mussel bed extending from approximately 500 m upstream of the derailment to the downstream end of Bluff Slough. Impacts from the derailment included loss of unionid mussels under a work pad that was needed to facilitate removal of the train cars and pooling of petroleum products primarily at the downstream end of the work pad. One dead mud puppy, Necturus maculosus, was also recovered at the downstream end of the slough covered in oil. A shell of a salamander mussel, Simpsonaias ambigua, was also recovered. USFWS and Iowa DNR received damage settlements under CERCLA, Oil Pollution Act, Clean Water Act, and NRDAR regulations. Recovery efforts included monitoring unionid community recovery in the work pad area in 2009, 2013, and 2021; stocking propagated unionids; monitoring the N. maculosus population; and developing a stocking plan for S. ambigua. Damage to the unionid community was limited to near the work pad area. Although some petroleum remains in the substrate near the large rock and unionids have not colonized within that area, the area within and around the work pad area has recolonized. Necturus maculosus occur in the project area but are not as abundant as in other areas of Pool 11. Genoa Fish Hatchery is working with the state of Iowa on establishing a population of Salamander Mussel in Bluff Slough.
PL 25 2:20-2:40	**DOES IN VITRO MEDIA COMPOSITION MATTER? A GENE EXPRESSION EXPERIMENT IN LAMPSILIS SILIQUOIDEA**
	Kaitlin Ulin [1], Ieva Roznere [1], & Meg Daly [1]. 1The Ohio State University, Columbus, OH.
	Artificial propagation, called in vitro, has been commonly used to transform juvenile freshwater mussels without the need of a fish host, making it a useful tool for conservation biology. To improve our success of in vitro propagation, we must first expand our current limited knowledge of the larval development of mussels. The key to this is understanding what nutrients are needed for the successful development and propagation of healthy juvenile mussels. In this study, we compare media of various compositions to assess the growth of larval mussels. Growth is evaluated via analysis of the transcriptome, which can reveal internal processes happening within an organism. Glochidia were extracted from adult Lampsilis siliquoidea mussels, pooled, and separated into three media groups: Leibovitz's L-15 Medium (L-15), Medium 199 with Hank's balanced salts (M199), and M199 with Hank's balanced salts and 50 µL of lipids from concentrate. Glochidia developed in an incubator until signs of metamorphosis were present. Juveniles were collected from each dish, rinsed with sterile ultrapure water, and snap frozen in liquid nitrogen. RNA was extracted from the samples and sequenced on the Illumina NovaSeq 6000 sequencer with output as 100-base-pair paired-end reads. Assembly of the de novo transcriptome was performed and differentially expressed transcripts between the three groups were identified. This study combines the accessibility of in vitro propagation with gene expression analysis of larval growth between growth media of different compositions with the goal of improving in vitro juvenile mussel propagation. Exploring the differences in gene expression between the media types will allow us to better understand larval response to the culture media and provides foundational knowledge that is needed to improve the conservation of the highly imperiled and ecologically important freshwater mussels.

PL 26 2:40-3:00	**PHYSIOLOGICAL PLASTICITY AND RESPONSE TO FOOD AVAILABILITY OF UTTERBACKIANA IMPLICATA AND SAGITTUNIO NASUTUS**
	Matthew J Gentry & Danielle A Kreeger. Partnership for the Delaware Estuary, 110 South Poplar St. Ste. 202 Wilmington, DE 19801
	Hatchery propagation and pond grow-out are essential tools for freshwater mussel restoration. The relocation of hatchery-sourced mussels from high-productivity grow-out ponds to restoration sites may present a nutritional challenge if seston composition differs between sites. Within sites, mussels adjust their physiological processing to compensate for gradual changes in concentration of particulate matter (PM), particulate organic matter (POM) and the organic fraction of particulate matter (PPOM). However, when relocated between sites, mussels may be exposed to rapid changes. The physiological plasticity of mussels responding to seston change was assessed by reciprocally transplanting hatchery-produced mussels from the Delaware River Basin (Utterbackiana implicata, N = 60; Sagittunio nasutus, N = 60) between a stream (PM = 3.71 mg/l, PPOM = 59%) and hydrologically-linked pond (PM = 11.95 mg/l, PPOM = 35%). Four physiological experiments were conducted post-transplantation to measure feeding responses, and growth and survival was monitored for 134 days post-transplantation. A complimentary laboratory study was conducted using S. nasutus (N = 24) transplanted from the pond site into four treatments of lab diets ranging from low quantity and high quality (PM = 0.98 mg/l, PPOM = 67%) to high quantity and low quality (PM = 21.87 mg/l, PPOM = 38%). Mussels were held in the lab for 15 days during which three physiological experiments were conducted. Results suggest that high PPOM (i.e., food quality) is associated with greater mussel growth even at significantly lower POM concentrations. Both species adjusted feeding processes to the new environmental conditions quickly, but growth rates lagged in transplanted mussels until condition indices stabilized to match those of the non-transplanted mussels. Understanding physiological responses to changes in environmental condition will guide best practices for transplantation, set expectations for the growth and survival of mussels post-transplantation, and provide tools for accurately assessing ecosystem services provided by freshwater mussels.
PL 27 3:00-3:20	**THE LOST AND FORGOTTEN: MUSSELS OF WEST TENNESSEE**
	Kayla N. Key [1] and David Blackwood [1] [1] West Tennessee River Basin Authority, Tennessee Department of Environment and Conservation, Humboldt, TN.
	Despite efforts, streams in west TN faces a paucity of freshwater mussel records, particularly those in the Mississippi drainage. Further, hydrological and habitat conditions of these western-flowing rivers contrast from their Eastern counterparts limiting the utility of transferring knowledge to direct management or restoration action to conserve these mussel species. Traditionally, these streams have been treated as aquatic biodiversity deserts due to the past channelization and deforestation of the region; However, historical data suggests these streams once had a surprisingly high mussel species richness compared to watersheds in other states that are considered diverse. Within recent decades, restoration efforts in the region have been successful in restoring stream and floodplain function to a more natural state and provide functional lift to many stream systems, generally focus on increasing sinuosity and floodplain connectivity in channelized streams. These restored streams have been remediated to the point where mussel populations could again be sustained. However, blockages to fish passage and the long-life span of mussels limits their ability to naturally disperse and colonize these habitats. Therefore, some areas such as west TN, may require assisted recolonization to directly augment and expedite recovery since the natural dispersal of native populations can be slow or not possible. We discuss our ongoing efforts to collaborate with other state agencies on a Freshwater Mussel Recovery Program for west TN.

Gray title denotes student presentation

Platform Session 3A: Genetics and Phylogeny 2

Tuesday (4/11) 3:40-5:00pm - Mt. Hood

PL 28 3:40-4:00	**SYSTEMATICS, TAXONOMY, AND MOLECULAR ECOLOGY OF BLACK MUDALIA, ELIMIA MELANOIDES (GASTROPODA: PLEUROCERIDAE)**
	Nathan V. Whelan [1,2] , Annika Baldwin [3] , Paul D. Johnson [4] , Jeffrey T. Garner [5] , Ellen E. Strong [6] . 1United States Fish and Wildlife Service, Auburn, AL; 2Auburn University, Auburn, AL; Amherst College, Amherst, MA; 4Alabama Department of Conservation and Natural Resources, Marion, AL; 5Alabama Department of Conservation and Natural Resources, Florence, AL; 6National Museum of Natural History, Washington, DC.
	Freshwater gastropods have faced huge declines in North America. For example, nearly 30% of pleurocerids originally found in the Mobile River basin are presumed extinct, and 79% of species in the family Pleuroceridae are imperiled. Given the importance of pleurocerids to many freshwater ecosystems in eastern North America, their decline risks the health of freshwater resources. One Pleurocerid species that was previously considered lost from over 70% of its range is Elimia melanoides. This species was considered for protection under the Endangered Species Act, but taxonomic uncertainty precluded a listing decision. Little is known about the molecular ecology of E. melanoides, and our current taxonomic concept of the species may not reflect true levels of species diversity. Using 3-RAD library prep and Illumina sequencing, we assessed landscape genetic patterns and the systematics of the species to determine the number of species within what has historically been identified as Elimia melanoides. Our data suggest the current concept of Elimia melanoides requires revision. Elimia melanoides is geographically constrained to four tributaries in the Locust Fork of the Black Warrior River. Furthermore, multiple populations previously considered to be E. melanoides are, in reality, a smooth, upstream clinal variant of E. hydeii. Within E. melanoides, we found high population structure and limited admixture, indicating that the loss of any one population would result in the loss of unique evolutionary potential. Our data also indicate extreme convergence in shell morphology among E. melanoides and upstream populations of E. hydeii, and shells are not reliable for distinguishing the two species.
PL 29 4:00-4:20	**GENOME SKIMMING AND MICRO-CT SCANNING ELUCIDATE SPECIES BOUNDARIES IN PROBLEMATIC PLEUROBEMINES**
	Alex J Franzen [1,2] , John M Pfeiffer [3] , Sean M Keogh [4] , and Caryn C Vaughn [1,2] 1 Oklahoma Biological Survey, Norman, OK 2 University of Oklahoma Ecology and Evolutionary Biology Graduate Program, Norman, OK 3 Smithsonian National Museum of Natural History, Washington, DC 4 University of Minnesota, Bell Museum of Natural History, St. Paul, MN
	Taxonomic hypotheses are the basis for understanding freshwater mussel biodiversity, but often species boundaries largely rely on subjectively comparing morphological characters, especially shell-based traits. Species delimitation in the unionid tribe Pleurobemini has perpetually puzzled malacologists because both high intraspecific and low interspecific conchological variation is emblematic of the group, with the former leading to taxonomic over splitting and the latter leading to taxonomic lumping. Recent multilocus phylogenetic studies of the genus Fusconaia have rejected many aspects of traditional classification and presumably uncovered multiple instances of cryptic species diversity, but a purely molecular approach is often insufficient to formally revise species boundaries. To clarify Fusconaia species boundaries, we set about generating integrative datasets that would maximize geographic, character, and taxon sampling using next-generation methods. Using a combination of museum collections and our own collecting efforts, we sampled specimens across the geographic distribution of the Wabash Pigtoe (Fusconaia flava), a common species that is widespread throughout the Mississippi River drainage basin that likely contains cryptic diversity. We used a relatively new and cost-effective high-throughput sequencing approach called genome skimming to reconstruct complete mitochondrial genomes, capture ribosomal DNA, and uncover conserved orthologous loci. Additionally, we generated 3D reconstructions of shells using micro-CT scanning for more nuanced morphometric analyses of shell traits to test for corresponding differences. Our phylogenetic analyses suggest that F. flava contains at least four distinct and geographically restricted species. Though frustrating to identify, pleurobemines are an ecologically important group of mussels containing endangered species and cryptic diversity that offer a unique opportunity to examine the relative influences that ecology, phylogeny, and biogeography have on the diversity and evolution of shell morphology.

PL 30 4:20-4:40	**SPRINGS AS ISLANDS: ISLAND BIOGEOGRAPHY AND CONSERVATION GENOMICS OF TWO NARROW-RANGE ENDEMIC PLEUROCERID SNAILS**
	Samantha A. Donohoo [1] , Paul Johnson [2] , Nathan V. Whelan [1,3] . [1] School of Fisheries, Aquaculture, and Aquatic Sciences, Auburn University, Auburn, AL; [2] Alabama Aquatic Biodiversity Center, Alabama Division of Conservation and Natural Resources, Marion, AL; [3] Southeast Conservation Genetics Laboratory, United States Fish and Wildlife Service, Auburn, AL.
	Mussels of order Unionida are the most diverse group of strictly freshwater bivalves, with nearly 1,000 described species, widely dispersed across world freshwater ecosystems. They are highly threatened and show the highest record of extinction within all faunal taxa. Conservation is particularly concerning in species occurring in the Mediterranean biodiversity hotspot that is exposed to multiple anthropogenic threats, possibly acting in synergy. That is the case of the dolphin freshwater mussel Unio delphinus Spengler, 1793, endemic to the western Iberian Peninsula, which has experienced recent accentuated population declines. To date, only four genome assemblies are available for the order Unionida and only one European species. Here, we present the first genome assembly of Unio delphinus. We used the long-read sequencing technology PacBio HiFi to generate a highly contiguous genome assembly. The assembly is 2.5 Gb long, possessing 1254 contigs with a contig N50 length of 10 Mbp. This is the most contiguous freshwater mussel genome assembly to date and is an essential resource for investigating the species' biology and evolutionary history that ultimately will help to support conservation strategies.
PL 31 4:40-5:00	**POPULATION GENETICS OF THE INVASIVE JAPANESE MYSTERY SNAIL, Heterogen japonica, AND ITS FIRST GENETICALLY CONFIRMED REPORT FROM CALIFORNIA**
	W.A.N.U Abeyrathna [1] , Shawn H Sanders [2] , Ashley Barreto [3] , Andrew A. Davinack [3] . [1] Department of Biology, Clarkson University, Potsdam, New York 13699, USA; [2] U.S. Fish and Wildlife Survey, Fish and Aquatic Conservation, Sacramento, California 95825, [3] Department of Biology, Wheaton College, Norton, Massachusetts 02766, USA
	The so-called Japanese mystery snail Heterogen japonica (Martens, 1861), is a notorious invader which was first introduced to the United States through the Asian food markets in California in late 1800s. Curiously, H. japonica has never been reported from California since then, but Cipangopaludina chinensis (Gray, 1834) has repeatedly been reported. In this study we sampled mystery snail specimens from a section of Sacramento River in California during an annual drawdown operation. We utilized the mitochondrial barcoding gene, cytochrome c oxidase 1 (CO1), as both a DNA barcoding and population genetic marker. DNA barcoding results confirmed that the mystery snails we sampled during the drawdown operations were H. japonica and thus our result is the first genetic confirmation of H. japonica from California more than a century later of its first introduction in the US. The global population genetic structure of H. japonica in the indigenous and non-indigenous range exhibited marked structure across the populations indicating low connectivity levels. The genetic diversity of H. japonica populations in the indigenous range was also higher than the H. japonica populations from the non-indigenous range. Heterogen japonica is now being genetically confirmed from a wide range in its non-indigenous range and our results indicate that the cosmopolitan distribution of H. japonica reflects its broad physiological tolerance and wide variety of vectors which aids its dispersal.

Gray title denotes student presentation

Platform Session 3B: Community Ecology and Ecosystems 2

Tuesday(4/11) 3:40-5:00 pm - Mt. Bachelor

PL 32 3:40-4:00	**EVALUATING THE PACE OF TEMPORAL CHANGE FOR FRESHWATER MUSSEL COMMUNITIES**
	Garrett W. Hopper [1], Edwin J. Miller [2], Wendell R. Haag [3], Caryn C. Vaughn [4], Daniel J. Hornbach [5], Jess W. Jones [6], Carla L. Atkinson [1]. [1] Department of Biological Sciences, University of Alabama, Tuscaloosa, AL, USA; [2] Kansas Department of Wildlife and Parks, Independence, KS, USA; [3] US Forest Service, Southern Research Station, Center for Bottomland Hardwoods Research, KY, USA; [4] Oklahoma Biological Survey and Department of Biology, University of Oklahoma, Norman, OK, USA; [5] Department of Biology and Department of Environmental Studies, Macalester College, St. Paul, MN, US; [6] U.S. Fish and Wildlife Service, Department of Fish and Wildlife Conservation and Virginia Polytechnic Institute and State University, Blacksburg VA, USA.
	The loose-equilibrium concept (LEC) has support from studies of multiple taxonomic groups and predicts communities diverge transiently but return toward an earlier or average structure. The LEC framework can help determine whether systems are changing expectedly or are permanently altered. Long-lived, slow-growing animals are sensitive to sources of mortality and typically recover slowly. Community change may transpire over decadal timescales, which exceed most studies. Unionid mussels are long-lived animals and occur in dense, species-rich assemblages that are heterogeneously distributed in rivers. Aggregations can persist for decades despite disturbances that differentially affect species and may produce variable trajectories for different aggregations in the same river. We propose mussels are valuable models to study the community dynamics of long-lived animals. We leveraged existing long-term datasets from seven rivers (Clinch [30 years], Powell [30 years], Kiamichi [30 years], Verdigris [30 years], St. Croix [20 years], Sipsey [20 years], and Little Tallahatchie rivers [10 years]) in the eastern USA. We provide a novel perspective on community ecology by asking whether mussel assemblages exist in a non-equilibrium state. Our synthesis demonstrates that 12 of 31 mussel aggregations had trajectories consistent with the LEC, with at least one LEC trajectory per river, illustrating that local conditions can mediate temporal stability. Trajectory directionality was primarily driven by the balanced appearances and disappearances of rare species, and to a lesser extent by the dynamics of common species. Dynamics for some of the most intact mussel communities in North America reflect non-equilibrium states. We conclude that communities of long-lived animals can tend toward deterministic regulation consistent with the LEC, however, LEC trajectories may reflect a community state. LEC was not universal and directionally changing systems may be trending toward irreversible conditions. Conservation approaches acknowledging the reality of rapid environmental change are needed to manage communities of long-lived animals.
PL 33 4:00-4:20	**HIERARCHICAL STRUCTURING OF GENOMIC DIFFERENTIATION AND BETA DIVERSITY WITHIN FRESHWATER MUSSEL COMMUNITIES**
	Jamie Bucholz [1], Irene Sánchez González [1], Garrett W. Hopper [1], Carla L. Atkinson [1], Jeffrey D. Lozier [1]. [1] University of Alabama, Tuscaloosa, AL
	Elucidating patterns in species and genomic differentiation between and among communities can unveil the drivers of diversity across scales. Freshwater mussels often exist in species-rich assemblages in stream systems and can enhance ecological function. More diverse, species-rich communities may provide a greater suite of ecosystem services than species-poor communities, therefore understanding the patterns and potential drivers of diversity within mussel communities is pertinent to their conservation. Using quantitative surveys and genomic sequencing, we examined taxonomic and genetic differentiation in mussel communities from seven rivers in the Mobile and Tennessee River Basins of the Southeastern USA. We sequenced 17 species from 5 phylogenetic Tribes, including 361 pairwise population comparisons (743 individuals). Preliminary patterns suggest that patterns of taxonomic beta diversity and genetic differentiation (FST) largely mirror each other, with low genetic structure observed within rivers, weak to moderate genetic structure observed within basin between rivers, and strong genetic structure observed between rivers in different basins. Mantel tests reveal strong patterns of isolation by distance for most species. These data suggest that the same processes may govern patterns of differentiation at both the taxonomic and genomic scale.

PL 34 4:20-4:40	**SIBLING FRESHWATER MUSSELS REARED IN LAKE-STREAM GARDENS REVEAL PHENOTYPIC PLASTICITY AS MECHANISM OF ECOPHENOTYPY**
	Sean M Keogh [1] , Ben J Minerich [2] , Lindsay M Ohlman [3] , Madeline E Pletta [3] , Anna E Scheunemann [3] , Zebulin A Secrist [3] , Alex J Franzen [4] , Bernard E Sietman [3] , & Andrew M Simons [1] . 1University of Minnesota, Bell Museum of Natural History, St. Paul, MN; 2Minnesota Zoo, Apple Valley, MN; 3Minnesota Department of Natural Resources, Center for Aquatic Mollusk Programs, Lake City, MN; 4University of Oklahoma, Norman, OK.
	Identifying the mechanisms that produce phenotypic variation is fundamental to understanding how organisms adapt to their environments. One mechanism capable of within-species phenotypic variation is phenotypic plasticity, where a single genotype can produce multiple phenotypes dependent on environmental conditions. Many freshwater mussel species possess morphological variation that varies predictably with the environment, called ecophenotypy (e.g. Ortmann's Law of stream position). These ecophenotypic trends are frequently assumed to be the result of phenotypic plasticity or 'ecophenotypic plasticity' but the experimental means to differentiate genetic versus environmental (phenotypic plasticity) effects is lacking. We released thousands of marked Pyganodon grandis siblings from a single broodstock into ten sites (nine field, one enclosure) and two habitat types (lake and stream) when they were three months old (15-25mm). We allowed them to grow for two years before recapture. We recaptured 70 individuals from four field sites including both lake and stream habitats and 305 from the artificial enclosure. We found dramatic phenotypic differences in size relative shell height and width (inflation) between siblings reared in lake and stream habitats. The morphology of recaptured individuals generally matched the wild population at each site, showing that the environment and phenotypic plasticity, rather than genetic differences, are the primary driver of morphological variation in P. grandis.
PL 35 4:40-5:00	**PHENOTYPIC RESPONSES TO ENVIRONMENTAL GRADIENTS: A THREE-DIMENSIONAL QUANTITATIVE APPROACH TO ASSESS MUSSEL SHELL PLASTICITY**
	Irene Sánchez González [1] , Jamie Bucholz [1] , Garrett W. Hopper [1] , Jeffrey D. Lozier [1] , Carla L. Atkinson [1] . [1] University of Alabama, Tuscaloosa, AL.
	Phenotypic variability is an important response of organisms to environments. Although shell variation is a well-known phenomenon among freshwater mussel populations, studies examining these differences across several rivers and drainages are uncommon and the degree and factors causing variation are not always well quantified. We combined a novel three-dimensional (3D) geometric morphometric approach and ordination techniques to identify spatial patterns of natural shape variation across four rivers in the Mobile and Tennessee River basins. We scanned individuals from seven species spanning four phylogenetic tribes to understand if phenotypic responses were specific to species, tribe or morphological structure. Our methodology involves 3D surface scanning both valves jointly to quantify variation in inflation and depth of the shell. These scans provide a high-resolution image which creates a mesh with over 500 points per individual that allows for accurate intraspecific comparisons. Our preliminary findings suggest a strong relationship between distance from headwaters and shell variation, especially in sculptured species where downstream populations were significantly more inflated. We plan to continue examining the specific environmental variables related to these differences. Phenotypic responses along the river longitudinal gradient were also substantially stronger in the tribe Quadrulini in comparison to Lampsilini, however, more work to increase our sample size and species representation from these and other tribes is needed to fully reach a conclusion. Exploring shape variability and uncovering the underlying causes is essential to understanding diversity and further explore the ecological relationships between form and function.

Gray title denotes student presentation

Platform Session 3C: Conservation Strategies 1

Tuesday(4/11) 3:40-5:00 pm - 3 Sisters

PL 36 3:40-4:00	**WESTERN FRESHWATER MUSSEL MASTER PLAN: PRIORITIES, STRATEGIES, AND A PLAN FOR THE FUTURE**
	Alexa Maine [1] ; Christine O'Brien [2] ; Donna Nez [3] ; Brian McIlraith [4] ; Zach Seilo [1] . [1] Confederated Tribes of the Umatilla Indian Reservation, Department of Natural Resources, Fisheries Program, Freshwater Mussel Research and Restoration Project, Walla Walla, WA; [2] Browns River Consultants, LLC, Waynesville, NC; [3] Confederated Tribes of the Umatilla Indian Reservation, Department of Natural Resources, Fisheries Program, Freshwater Mussel Project, Pendleton, OR 97801. [4] HDR Engineering, Inc., Portland, OR.
	Freshwater mussels are a vital component of intact river systems and are culturally important to Native Americans like the members of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). As a First Food of significant cultural and ecological importance, freshwater mussels have been studied by the CTUIR since 2002, which makes it the longest running freshwater mussel research project in the western United States. Beginning in 2014, the CTUIR embarked on the first pilot propagation program for western mussel species. The CTUIR has now successfully propagated three genera of mussels (Anodonta, Gonidea, and Margaritifera) and has reared Margaritifera falcata, Western Pearlshell for two years in captivity, in coordination with USGS-Columbia Environmental Research Center (Columbia, MO). CTUIR's Freshwater Mussel Research and Restoration Project (Mussel Project) identified three priority areas that organize laboratory and field work: 1) understanding current and future risks through research; 2) conservation, protection, and monitoring of existing mussel populations; and, 3) restoration of impaired or extirpated populations and mussel habitat, and the development of adaptive management actions. The CTUIR Mussel Project conducts research under seven components, and recently initiated investigations into restoration of freshwater mussel habitat and populations. In 2021, the CTUIR completed a Master Supplementation Plan to guide the development, testing, and evaluation of strategies for freshwater mussel restoration. This plan outlines four phases of strategic progress, including laboratory methods, field testing, synthesis of preliminary results, and regional application of restoration actions. A research phase will follow existing CTUIR Mussel Project components and provide technical information necessary to transition from phase to phase in the Master Supplementation Plan. The CTUIR Mussel Project's overall goal is to restore self-sustaining mussel populations to CTUIR ceded areas to reconnect cultural and ecological services provided by mussels.
PL 37 4:00-4:20	**SYNTHESIS OF NATURAL HISTORY COLLECTIONS DATA REVEALS PATTERNS OF US FRESHWATER MUSSEL DIVERSITY AND DECLINE**
	John Pfeiffer [1] , Traci Dubose [2] , Sean Keogh [3] . 1 Smithsonian Institution, National Museum of Natural History, Washington, DC; 2Department of Biological Sciences, Virginia Tech, Blacksburg, VA; 3University of Minnesota, Bell Museum of Natural History, St. Paul, MN.
	Natural history collections are uniquely positioned to chronicle biodiversity changes across time and space and are a fundamental data source in taxon-based research and conservation. With over 90 species listed under the Endangered Species Act, freshwater mussels are one of the most imperiled animal assemblages in the United States and are the focus of considerable conservation efforts (e.g., species status assessments, listing decisions, and recovery plans). Unfortunately, natural history collections data are often underleveraged in such efforts, in part, because much of the data are decentralized and nonstandard, and thus, difficult to access and analyze. Our objective herein is to synthesize, standardize, and enrich digitized US freshwater mussel collections data to better suit the needs of conservation stakeholders. We aggregated specimen records from 45 US natural history collections and enriched these records by programmatically standardizing taxonomic information, flagging potentially problematic records, and joining records with freshwater-specific spatial frameworks (e.g., hydrological units and stream segments) and their associated metadata. The assembled dataset includes 410,665 records, 302 species, and 1,494 hydrological units (8 digit-level). Using these enriched records, we estimated ecological attributes for over 280 freshwater mussel species including aspects of range size (i.e., area of occupancy and change in area of occupancy) and habitat preferences (i.e., stream order size, discharge, slope, and velocity). Listed species had significantly fewer occurrences and smaller area of occupancy in comparison to non-listed species. Listed species also tended to have a higher stream order preference and discharge preference than non-listed species. Finer quantification of these ecological attributes can be used to make more data-driven ecological and conservation inferences.

PL 38 4:20-4:40	**HARMONIZING DATASETS TO EXPAND DISTRIBUTIONS OF FRESHWATER MUSSEL SPECIES AT RISK IN THE SYDENHAM RIVER WATERSHED**
	Julia A. Willsie [1], Catherine M. Febria [1,2]. 1Great Lakes Institute for Environmental Research, University of Windsor, Traditional Territory of the Three Fires Confederacy of First Nations, Windsor, ON, Canada; 2Department of Integrative Biology, University of Windsor, Windsor, ON, Canada.
	The Sydenham River watershed covers nearly 3,000 km2 and is widely known for its high level of biodiversity. With 34 species of freshwater mussels, 15 of which are federally listed species at risk, the Sydenham is officially the most biodiverse in Canada for mussel species. Mussel species continue to be largely underexplored in terms of distribution, population size, life history traits, and co-existence with host fish, making conservation and restoration efforts a challenge. To advance the conservation of freshwater mussel species at risk, and accelerate restoration efforts on the ground, this project aims to harmonize existing freshwater mussel species at risk distribution data together with other forms of knowledge. As more mussel species continue to be listed as at-risk, there is a growing, urgent need to harness existing datasets and work collaboratively across organizations to simultaneously conserve species at risk and restore their critical habitats. Currently, there is a knowledge gap regarding mussel and host fish relationships; many host fish are unknown and threats to relationships are vague. Stronger collaborations, including amongst fish and mussel biologists, could help identify shared research directions. Here I present findings from an interdisciplinary project using the Sydenham River watershed as a case study. I engaged multiple research methods, including a robust literature synthesis to compile available host fish data, a synthesis of local, federal and community science datasets to inform and amplify my own empirical field survey, and explored their spatial overlaps in the watershed using geographic information systems. These data were visualized using ArcGIS Pro and reveal areas of overlap as well as informing where future efforts should be focused. This research approach can apply to mussel efforts elsewhere to prioritize and coordinate multiple management decisions needed to support a greater number of species including at-risk fauna and critical interactions across a watershed.
PL 39 4:40-5:00	**PRIORITIZING STREAM REACHES FOR CONSERVATION OF FRESHWATER MUSSELS**
	Alexander H. Kiser [1], Cody A. Craig [2], Timothy H. Bonner [2], Brad Littrell [3], Chase H. Smith [4], Clinton R. Robertson [5], Hsiao-Hsuan Wang [6], William E. Grant [6], Matthew S. Johnson [7], Roel Lopez [8], Charles R. Randklev [1,8] 1 Texas A&M Natural Resources Institute, Texas A&M AgriLife Research Center at Dallas, Dallas, TX, USA. [2] Department of Biology/Aquatic Station, Texas State University, San Marcos, TX, USA. [3] Bio-West, Inc. Austin, TX, USA. [4] Department of Integrative Biology, University of Texas, Austin, Texas, USA. [5] Texas Parks & Wildlife Department, Inland Fisheries Division, Management and Conservation Branch, San Marcos, TX, USA. [6] Ecological Systems Laboratory, Department of Ecology and Conservation Biology, Texas A&M University, College Station, TX, USA. [7] U.S. Fish & Wildlife Service, Austin Ecological Services Field Office, Austin, TX, USA. [8] Natural Resources Institute Texas A&M University, College Station, TX, USA.*
	Human impacts to aquatic ecosystems have resulted in systemic declines of global freshwater species abundance and richness. Conservation and governmental groups worldwide have designated protected areas to preserve the remaining diversity. The biodiversity hotspot approach, which designates areas based on high levels of species richness, has been useful for identifying areas to protect both terrestrial and aquatic species. However, for freshwater species, additional approaches are warranted to identify specific stream reaches for protection and/or restoration. To address this issue, we present methodology to create a Gridded River Identification System (GRIS) for river segments based on 30-second arc grids (~0.9km) combined with the USGS National Hydrography High Resolution Dataset. To demonstrate the utility of this approach, we obtained occurrence data for six imperiled freshwater mussel species in Texas and created ensemble species distribution models (ESDM) based on climate and topographical variables. Predicted occupancies were overlaid onto the GRIS in Texas and rank ordered from 1 to 5, with 1 being lowest probability of occupancy and 5 being the greatest. The rank ordered segments were then used to identify priority reaches for conservation and restoration activities. Our approach is widely applicable to other freshwater species so long as distribution information is available. The GRIS can also be easily developed for stream systems outside of the current study area. Future studies could build upon our framework by incorporating additional taxa data and projected changes in climate and land use to assess distribution stability.

Gray title denotes student presentation

Platform Session 4A: Contaminants and Ecotoxicology

Wednesday (4/12) 8:00-10:00 am - Mt. Hood

PL 40 8:00-8:20	**BEHAVIORAL AND REPRODUCTIVE EFFECTS OF THE LAMPRICIDES TFM AND TFM:1% NICLOSAMIDE ON NATIVE FRESHWATER MUSSELS**
	Teresa Newton [1], Michael Boogaard [1], Nicholas Schloesser [1], Courtney Kirkeeng [1], Justin Schueller [1], and Sherwin Toribio [2]. [1] U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI; [2] University of Wisconsin La Crosse, La Crosse, WI.
	The lampricides TFM (3-trifluoromethyl-4'-nitrophenol) and Niclosamide (NIC, 2', 5-dichloro-4'-nitrosalicylanilide) are used to control sea lamprey populations in the Great Lakes and associated tributaries. Niclosamide is often used as an additive to TFM to reduce the amount of TFM required to control sea lamprey. Concern is growing over the risk that lampricide treatments pose to native freshwater mussels residing in streams. Our objectives were to determine the acute toxicity of TFM and TFM:NIC to free glochidia (removed from the marsupial gills), compare the relative toxicity of TFM and TFM:NIC between free glochidia and brooded glochidia (within the marsupial gills), determine if glochidia age influences toxicity, and assess if exposure of gravid mussels to TFM and TFM:NIC alters behavior and reproduction. Three acute toxicity tests (2:TFM, 1:TFM+NIC) were conducted with glochidia and adults of the plain pocketbook mussel (Lampsilis cardium). In tests with glochidia, viability did not differ across TFM and TFM+NIC concentrations that encompassed typical stream treatments. Glochidia age influenced toxicity as glochidia obtained later in the brooding season were less viable than glochidia obtained earlier in the brooding season. Exposure of adults to elevated concentrations of lampricides often resulted in behavioral effects, but rarely affected reproductive endpoints. Because mussels are long-lived (30-100 y), even intermittent and short duration exposures may cumulatively affect mussels over their lifetime. The risks posed by lampricide treatments in the Great Lakes would be further informed by research on the sublethal effects of lampricides, particularly effects on non-target organisms such as mussels.
PL 41 8:20-8:40	**PRIORITIZING CONTAMINANTS OF EMERGING CONCERN BASED ON THEIR EFFECTS ON FRESHWATER MUSSELS**
	Ieva Roznere [1], Viktoriya An [2], Timothy Robinson [2], Jo Ann Banda [3], G. Thomas Watters [1]. [1] Ohio State University, Columbus, OH. [2] University of Wyoming, Laramie, WY. [3] U.S. Fish and Wildlife Service, Gloucester, VA.
	Contaminants of emerging concern pose a serious hazard to aquatic wildlife, especially freshwater mussels. The growing number of contaminants in aquatic systems requires scientists and managers to prioritize contaminants that are most likely to elicit a biological response for further monitoring and toxicological testing. The objectives of this study were to identify a sub-category of contaminants most likely to affect Pyganodon grandis and to describe alterations in metabolites and gene expression between various sites. Mussels were deployed in cages for two weeks at four sites along the Maumee River Basin, Ohio, USA. Water samples were analyzed for the presence of 220 contaminants. Hemolymph samples were collected for metabolomics and analyzed using mass spectrometry. Contaminants that significantly covaried with metabolites were identified using partial least-squares (PLS) regression. Tissue samples were collected for transcriptomics, RNA was sequenced using an Illumina HiSeq 2500, and differential expression analysis was performed on assembled transcripts. Of the 220 targeted contaminants, 69 were detected in at least one water sample. Of the 186 metabolites detected in mussel hemolymph, 43 showed significant differences between the four sites. The PLS model identified 44 contaminants that significantly covaried with changes in metabolites. A total of 296 transcripts were differentially expressed between two or more sites, 107 received BLAST hits, and 52 were annotated and assigned to one or more Gene Ontology domains. Our analyses reveal the contaminants that significantly covaried with changes in metabolites and are most likely to negatively impact freshwater mussel health and contribute to ongoing population declines in this group of highly endangered animals. Our integration of “omics” technologies provides a broad and in-depth assessment of the short-term effects of contaminants on organismal physiology. Our findings highlight which contaminants are most likely to be causing these changes and should be prioritized for more extensive toxicological testing.

PL 42 8:40-9:00	**ACUTE AND CHRONIC EFFECTS OF TWO PERFLUOROALKYL SUBSTANCES ON DIFFERENT LIFE STAGES OF FRESHWATER MUSSELS: COMPARISON TO OTHER INVERTEBRATE TAXA**
	David J. Soucek, Rebecca A. Dorman, Erin L. Pulster, James L. Kunz, Ning Wang, Jeffery A. Steevens. U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO
	The increasing diversity, quantity, and potential toxicity of synthetic chemicals in the environment present significant risks to aquatic ecosystems. Recently per- and poly-fluoroalkyl substances (PFAS) have been the focus in scientific and regulatory communities, and public media. The literature available on effects of PFAS on aquatic species thus far suggests that invertebrates may be particularly sensitive to some of these compounds. Our objective was to compare the responses of freshwater mussels and mayflies to two PFAS to determine the relative risks to these taxa. We evaluated the responses of the mussel Lampsilis siliquoidea glochidia and juveniles to acute and chronic (juveniles only) exposure to two compounds: perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), and we compared their responses to effect levels observed with a laboratory cultured mayfly, Neocloeon triangulifer. In acute tests, glochidia were more sensitive to both compounds than juvenile mussels, with PFOS being approximately an order of magnitude more toxic than PFOA. However, glochidia were 365- and 44-fold less sensitive than the mayfly in acute exposures. The relative chronic effects of PFOS were disparate as well, with the mussel demonstrating no effects on survival, growth, or biomass at up to 2 mg PFOS/L, and the mayfly exhibiting reduced growth at less than 1 µg PFOS/L. Responses to PFOA were more similar between taxa, with the mussel having reduced growth and biomass at 20 mg PFOA/L, and the mayfly having no lethal or sublethal effects at up to 3 mg PFOA/L. Comparing effect levels to observed surface water concentrations of these compounds suggests that PFOS may present an environmentally realistic risk for mayflies, but not mussels. PFOA effect levels for both taxa are sufficiently high to not be predictive of environmental risk. More research is needed to determine potential risks of PFAS with different chain lengths and functional groups.
PL 43 9:00-9:20	**INGESTION AND DEPURATION OF POLYSTYRENE SPHERES BY A JUVENILE FRESHWATER MUSSEL FOUND IN SOUTHERN ONTARIO**
	Yaryna Kudla [1], Patricia L. Gillis [2], Karen A. Kidd [3], & Ryan S. Prosser [1]. 1 School of Environmental Sciences, University of Guelph, Guelph, ON; 2 Aquatic Contaminants Research Division, Environment and Climate Change Canada, Burlington, ON; 3 Department of Biology & School of Earth, Environment & Society, McMaster University, Hamilton, ON.
	Plastic debris polluting our waterways has been a concern for decades. Recently increased attention has been placed on microplastics (MPs) in aquatic ecosystems. These small plastic particles (<5 mm) have been observed in marine and freshwater ecosystems globally. To date, freshwater studies have focused on the presence and/or concentration of MPs in surface waters. To assess their risk, there is a need to compare environmental concentrations of MPs to concentrations that cause adverse effects. Freshwater mussels are a group of filter-feeding organisms that have experienced a decline due to habitat destruction and poor water quality, and they are under-represented in MPs research. A sub-chronic 28-day exposure test followed by a 7-day depuration period was conducted with ~2 cm juvenile Lampsilis siliquoidea (fatmucket mussel). Tests were performed with polystyrene spheres, a common MP used in toxicity studies and a typical polymer found in environmental samples such as wastewater effluent. Algal food stocks were spiked with microplastics, with treatment concentrations ranging from 100 – 300,000 MP/L. Mortality was monitored throughout the entire test, and burial assays were run every 7 days following full static water changes. Ingestion of MPs was determined by whole tissue digestion of individual mussels. Tissues from the depuration stage were compared to non-depurated mussels to assess whether juveniles have the potential to eliminate MPs within a 7-day period. Less than 10% mortality observed, and burial ability was not affected as the concentration of MPs increased within treatments. Mussels were found to efficiently depurate microplastics ingested after 7 days, especially at the highest concentrations tested. Such findings will inform the risk assessment of MPs to freshwater biota, specifically mollusks which can be sensitive to certain contaminants.

PL 44
9:20-9:40

ASSESSING AMMONIA TOXICITY OF TEXAS UNIONID MUSSELS

Ericah D Beason [1] , Somerley J Swarm [2] , Lee J Gudgell [3] , Tara L Lanzer [1] , Clint Robertson [4] & Astrid N. Schwalb [1] . 1-Texas State University, San Marcos, TX; 2-San Marcos Aquatic Resource Center U.S. Fish and Wildlife Service, San Marcos, TX; 3-Guadalupe-Blanco River Authority, Seguin, TX; 4-Texas Parks and Wildlife Department, San Marcos, TX.

Degradation to water quality poses a threat to freshwater mussels, including non-point source nutrient pollution from agriculture, and permitted point sources such as wastewater discharges. Early life history stages of unionid mussels are known to be highly sensitive to ammonia, yet the Texas Commission on Environmental Quality (TCEQ) wastewater effluent limits on ammonia follow pre-2013 EPA ammonia guidelines that are known to be lethal to freshwater mussels. Data on ammonia toxicity for freshwater mussels in Texas should help inform revision to TCEQ's wastewater discharge criteria for ammonia and the development of the Guadalupe River Habitat Conservation Plan to limit impacts to freshwater mussels. Hence, the objective of this study was to determine median lethal concentrations (LC50s) for ammonia with glochidia (24 – 48 hours) and newly released juveniles (96 hours exposure) of state-listed mussel species in Texas, including species proposed to be listed under the Endangered Species Act, following the ASTM Standard Guide for Conducting Laboratory Toxicity Tests with Freshwater Mussels. Brooding mussels were collected in the Sabine and Guadalupe River. The LC50s for glochidia of Lampsilis teres, L. bergmanni, Fusconaia askewi, L. satura, Potamilus purpuratus and F. mitchelli ranged between 27 and 79 mg/L of TAN (at ph7). Trials with juvenile mussels are ongoing. Extracting glochidia from short-term brooders with conglutinates was challenging and it was extremely difficult to extract a sufficient number of glochidia with high viability from different females. Consequently, during further testing for this project we will hold short-term brooding mussels until they naturally release their conglutinates and conduct toxicity tests with one individual at a time.

PL 45
9:40-10:00

DEVELOPING A REPRODUCTIVE TOXICITY TEST METHOD FOR FRESHWATER MUSSELS

Allison N Sieja [1] , M Christopher Barnhart [2] , James L Kunz [1] , Danielle Cleveland [1] , Bernard E Sietman [3] , Doug K Hardesty [1] , Eric L Brunson [1] , Jeffery A Steevens [1] & Ning Wang [1] . 1 US Geological Survey Columbia Environmental Research Center, Columbia, MO; 2 Missouri State University, Springfield, MO; 3 Minnesota Dept. of Natural Resources Center for Aquatic Mollusk Programs, Lake City, MN

Current ASTM standard methods for toxicity testing with freshwater mussels only use survival and growth endpoints. The objective of this study aimed to develop a method for evaluating contaminant effects on mussel reproduction, specifically on the spawning process, fertilization, embryonic development of glochidia, and parasitism success, using a short-term brooder (Deertoe, Truncilla truncata) and a reference toxicant, potassium chloride (KCl). Field-collected adult male and female Deertoe were held separately in two flow-through diluters. The diluters supplied 6 KCl concentrations (50% serial dilution). Mussels were exposed individually in each of 4 replicate chambers per test concentration at 10°C for 2 weeks. Thereafter, temperature was raised to 15°C to trigger spawning. Male spawning was monitored through video cameras. Fertilization was performed by exposing females to a milt mixture from untreated males 3 times a day for 3 days. Following spawning, females were exposed to KCl for an additional 6 weeks during embryonic development. Afterwards, glochidia were collected to inoculate the host fish (Freshwater drum, Aplodinotus grunniens). All males spawned, mostly within 10 hours of the temperature increase. The onset of male spawning, spawning duration, and dry mass of milt were not significantly different between the control and any treatments. Although 90% of females spawned, only 22% had viable glochidia at the end of the exposure. Many females released immature glochidia throughout the embryonic development period, and the quantity of brood varied greatly among females. Glochidia viability, at the end of adult exposures and in a 24-hour continuous exposure, as well as parasitism success were not significantly different between the control and any treatments. The results indicate that the reproductive toxicity test was successfully completed with male Deertoe but not with females. We will refine our methods in the second year of the study to improve fertilization and embryonic development under control conditions.

Gray title denotes student presentation

Platform Session 4B: Life History and Ecology 1

Wednesday (4/12) 8:00-10:00 am - Mt. Bachelor

PL 46 8:00-8:20	**TOO HOT TO HANDLE: THERMAL TOLERANCE OF *POPENAIAS POPEII* (TEXAS HORNSHELL) IN THE BLACK RIVER, NEW MEXICO**
	Xenia L. Rangaswami [1], Alexander H. Kiser [1], Matthew Ramey [2], Roel R. Lopez [1], & Charles R. Randklev [1]. [1] Texas A&M Natural Resources Institute, Texas A&M AgriLife Research Center at Dallas, Dallas, TX; [2] CEHMM, Carlsbad, NM
	Freshwater mussels are globally imperiled due to their sensitivity to changes in hydrology such as streamflow and temperature. The Black River in southeastern New Mexico hosts a stronghold population of the federally endangered unionid Popenaias popeii (Texas hornshell) and several regionally endemic fishes. The species has experienced population decline, attributed in part to declining discharge; however, the role of changing stream temperatures in its decline has not been investigated. We evaluated the upper thermal tolerances (LT05 and LT50) of larvae (glochidia) and newly transformed juveniles from the Black River. Individuals were acclimated to 27°C, and then immersed at five experimental temperatures (28, 30, 32, 24, and 36°C) and non-acclimated control for 12-h and 24-h (glochidia) or 96-h (juveniles). Thermal tolerances of P. popeii and its presumed host fish were superimposed on in situ water temperature and discharge data to determine exceedances. Temperature was hind-casted to 2007 to temporally expand the dataset. For glochidia, LT05 was exceeded frequently and LT50 was exceeded occasionally, while juvenile thresholds were never exceeded. We demonstrate how laboratory derived physiological thresholds can be used in conjunction with environmental data to evaluate the hydrologic needs of aquatic organisms, which is useful for environmental management.
PL 47 8:20-8:40	**EFFICACY OF CALCEIN AS A VALIDATION TOOL FOR ANNULUS FORMATION IN FRESHWATER MUSSELS**
	Anna Eismont [1], Michael deMoulpied [1], Clint Robertson [2], Roel Lopez [1], Charles Randklev [1]. [1] Texas A&M Natural Resources Institute, Texas A&M AgriLife Research Center at Dallas, Dallas, TX, USA. [2] Texas Parks & Wildlife Department, Inland Fisheries Division, Management and Conservation Branch, San Marcos, TX, USA.
	Unionid mussels deposit growth rings (annuli) within the shell, analogous to fish otoliths and growth rings in woody plants. These rings have been used to generalize growth, age, and longevity for multiple mussel species and populations, informing how a species may respond to change. The primary method for evaluating annuli has been to create thin sections by cutting vouchered shell into 1.0-1.5 mm cross sections through the umbo to the dorsal margin using a low-speed saw. These thin sections are mounted on unfrosted microscope slides and sanded for increased annuli visibility. This technique has seen limited application within Texas due to concerns that winter stream temperatures are too warm to regulate growth. If correct, annuli produced during winter months could be mistaken for yearly growth and confound age and growth estimates, producing ineffective management. To address these concerns researchers have started examining the utility of fluorescent stains to mark shells. Fluorescent stains chelate calcium in the growing shell, causing a permanent mark that fluoresces under ultraviolet light. For unionids, preliminary research suggests this technique is viable, especially in juveniles, though its utility in adults remains in question. To begin addressing whether thin-sectioning is useful for mussels in warmwater streams, we first used the fluorochrome calcein to validate annulus formation by marking two species, one fast and another slow growing, and evaluating any mark and additional growth after a period of time. Second, we evaluated two calcein concentrations (125 mgL -1 and 250 mgL -1) at three exposures (12, 24, and 48 hours) to determine the combination that produces high quality marks with low mortality for both species. Both experiments are ongoing but preliminary results indicate that faster growing species produce clearer marks than slower growing populations and mortality is low, indicating this technique could be applied to threatened species.

PL 48 8:40-9:00	**DENSITY AND SURVIVORSHIP OF TWO MICRO-ENDEMIC SPRINGSNAILS**
	Mary P. Jones [1], Daniel A. Trujillo [2], Dustin H. Long [3], David J. Berg [4]. [1] Miami University, Oxford, OH; [2] New Mexico Department of Game & Fish, Albuquerque, NM; [3] Turner Endangered Species Fund, NM; [4] Miami University, Hamilton, OH.
	Few demographic and life history studies have been conducted on hydrobiid snails found in aridland springs throughout the western USA. These snails are typically tiny (1-4 mm) and often narrowly endemic to isolated spring systems. Two such species are the federally endangered Chupadera Springsnail, Pyrgulopsis chupaderae, and the federal candidate Pecos Springsnail, Pygrulopsis pecosensis. Each species is endemic to a single spring system in south-central and southeastern New Mexico respectively. We sought to develop an efficient and sustainable means of monitoring the population structure of these springsnails by employing multiple methods for population assessment including placing tiles in the spring to measure relative densities, deploying in situ enclosures to monitor the same snails over time, and using field macro-photography to record shell length as a measure of age structure. Sites were visited at least once a month for a year. Both relative density and demographic structure varied by season for each species. These trends were similar between the species, including a likely peak in reproduction during the fall. Both species showed a maximum lifespan greater than one year and exhibited Type III survivorship (high mortality at younger ages), although the Chupadera Springsnail survivorship is higher in the very young age classes. We were also successful in observing recruitment of P. chupaderae through our in situ enclosures. This represents the first known observation of egg capsules for this species and confirms that individuals lay egg capsules containing a single embryo. We did not observe recruitment for P. pecosensis. These results provide useful demographic information that is applicable to the conservation and management of these species. The methods tested during this study can be employed to gather further information on other narrow-endemic invertebrates as well.
PL 49 9:00-9:20	**FORM AND FUNCTION: IS GILL MORPHOLOGY PREDICTIVE OF RESOURCE ASSIMILATION IN FRESHWATER MUSSELS?**
	Matthew B. Lodato [1], Brian van Ee [1], Carla L. Atkinson [1]. 1. University of Alabama
	Resource partitioning has been long recognized to promote species coexistence, but the relationship between resource use and morphology among functionally similar species remains unclear. Freshwater mussels (family: Unionidae) are benthic filter-feeders that use ciliary action to siphon and consume suspended materials. As mussels often occur in dense and speciose aggregations, there is high potential for resource overlap and consequential partitioning among co-occurring species. We asked whether gill cirri density (CD) is predictive of resource assimilation among co-occurring mussel species. To evaluate patterns of resource assimilation, we measured stable isotopic signatures and estimated isotopic niche area (INA) of 13 mussel species across eight sites in the Sipsey River, Alabama. For a subset of the same individuals, we determined CD using scanning electron microscopy for five mussel species(Cyclonaias kieneriana, Fusconaia cerina, Lampsilis ornata, Pleurobema decisum, Tritogonia verrucosa) across four of the eight sites. We predicted wider INA to be associated with species with lower CD because a broader range of size classes would be captured and assimilated. We also expected species-specific differences in INA and CD across sites. Overall, there was no relationship between INA and CD across sites, indicating morphology may not influence dietary plasticity of mussel species. Across sites, we observed variation in INA within and among species. Within each site, we measured little interspecific INA overlap indicating species were likely partitioning resources. We found significant species-specific differences in CD across sites suggesting that environmental differences may drive gill plasticity that, in turn, influence resource use within and among species. Understanding mussel feeding ecology is important because habitat modifications may affect food resource availability and consequently, species-specific influences on ecosystem processes.

PL 50 9:20-9:40	**CRACKING THE CODE: ASSESSMENT OF COMMUNITY RELATIONSHIPS OF FRESHWATER MUSSELS AND FISH HOSTS USING GENETIC BARCODING**
	Hayley Robinson [1], Peter Hazelton [1], John Wares [1], Gail Cowie [2], Ben Scott [3], Shayla Williams [4] *[1] University of Georgia, Athens, GA; [2] Georgia Water Planning and Policy Center, Albany, GA; [3] Flint RiverQuarium, Albany, GA; [4] Albany State University, Albany, GA.*
	Unionid host selectivity is often species specific, and identification of host fish is a critical step in conservation planning for individual mussel species. The Flint River harbors approximately 23% of the freshwater mussel (Order Unionida) diversity in the state of Georgia. Nine species in the basin are state or federally listed, and local diversity is threatened by shifting hydrologic conditions, increasing habitat loss, and sedimentation. Currently, knowledge on host species is lacking for nearly 40% of mussel species in the Flint. In this study, we surveyed host use for mussels in the lower Flint River and its tributaries, specifically evaluating naturally encysted mussels on wild caught fish. Wild infected fish were collected in 2021 and 2022 and held in laboratory conditions such that glochidia and juvenile mussels were collected as they excised from their live hosts. Mussel samples were then identified using genetic barcoding of the cytochrome oxidase c subunit I (COI) locus where 38 unique mussel-host relationships were identified. Of these, 33 relationships are considered novel when cross referenced to the Illinois Natural History Survey mussel-host database. Additionally, numbers of mussels collected from dissections of preserved fish from field sampling were combined with totals collected from live trials to evaluate overall fish infection rates across our nine study sites. Environmental and community predictors such as mussel abundance, fish species richness and evenness, and watershed characteristics were assessed for potential influence on observed infection rates and host utilization. Future directions of this study will include comparison of a mussel-specific mitochondrial locus (female open reading frame, or FORF) performance compared to COI in mussel species identification.
PL 51 9:40-10:00	**USING STABLE OXYGEN, CARBON, AND CLUMPED ISOTOPES TO CONFIRM ANNUAL BANDING AND CALCULATE HIGH RESOLUTION GROWTH RATES IN AMBLEMA PLICATA FROM THE BRAZOS RIVER, TX**
	Melanie A. Brewer [1], Ethan L. Grossman [1], and Charles R. Randklev [2]. 1 Department of Geology and Geophysics, Texas A&M University, College Station, TX; 2 Texas A&M Natural Resources Institute, Dallas, TX.
	Annual banding in freshwater mussels has been accepted and widely used to age and roughly interpret environmental conditions, however external disruption may lead to false annuli, or disturbance bands. Using annual bands and isotope and trace-element chemistry, we studied juvenile growth in modern and historic specimens collected in 2013 and 1900 from the Brazos River, TX to (1) reconstruct temperature (using “clumped” isotopes; 13C-18O bonds) and oxygen isotope compositions (18O/16O) of the river water (δ18Owater), seasonality, and molluscan growth rates; (2) determine causes of disturbance banding; and (3) explore new trace element proxies that might reveal relationships between primary productivity and growth rate. Intervals showing annual banding correspond to the lowest clumped isotope temperatures (~15°C), while intervals with false annuli yielded higher temperatures (20-25°C). Monthly chronologies were established assuming maximum and minimum seasonal temperature in July and January, respectively. Growth ranged from 0.4 to 2.3 mm per month with the fastest rates corresponding to late spring and early summer in the historic shell. In contrast, preliminary analyses of the modern shell suggest faster growth in late fall. Reconstructed δ18Owater were within modern measured values, -5.2 to 0.4‰, and covaried with temperature reflecting seasonal patterns in meteoric water. Carbon isotopes (13C/12C) also covaried with temperature and δ18Owater with lower δ13C during peak productivity periods. These data demonstrate the utility of clumped isotopes to uniquely determine seasonal growth in mussel shells and, combined with other isotopic and chemical proxies, provide promising results for interpreting factors influencing mussel growth including seasonality, drought, and extreme temperature. Such information can aid in mediating the impact of climate change and human impact on freshwater mussel environments.

Gray title denotes student presentation

Platform Session 4C: Human Impacts and Climate Change 1

Wednesday (4/12) 8:00-10:00 am - 3 Sisters

PL 52 8:00-8:20	**A REVIEW OF TEMPERATURE AND HYPOXIA STRESSORS TO FRESHWATER MUSSELS**
	Kaelyn J. Fogelman [1], Kristie Coffman [1], Jennifer Archambault [2], Elise Irwin [3], Maureen Walsh [4], Shannon Brewer [1,3], and James A. Stoeckel [1]. [1] School of Fisheries, Aquaculture, and Aquatic Sciences, Auburn University, Auburn, Alabama 36849, USA; [2] Eastern North Carolina Ecological Services, U.S. Fish and Wildlife Service, Raleigh, North Carolina 27606, USA; [3] U.S. Geological Survey, Alabama Cooperative Fish and Wildlife Research Unit, Auburn University, Auburn, Alabama 36849, USA; [4] Ecological Services, U.S. Fish and Wildlife Service, Panama City, Florida 32405, USA
	Freshwater mussels of the order Unionoida are currently one of the most imperiled groups of organisms in North America. Accurate risk assessments and development of effective management strategies for remaining populations requires knowledge of the effects of water quality stressors on species' viability. We conducted a systematic literature review to (1) summarize existing lethal and sublethal effects of temperature and hypoxia on unionids by life stage and taxonomy, (2) discuss ecological and climate change implications of existing water quality stressor data (3) identify needs for future research and methodological standardization. Our literature review has identified lethal thermal tolerance estimates for only 28 of 302 (9%) of species in the families Unionidae and Margaratiferidae. The 90th percentile of acute median lethal temperatures was 31.7°C for glochidia (19 species), 36.5 °C for juveniles (13 species), and 37.8°C for adults (4 species). An ongoing review of sublethal thermal tolerance has revealed wide range of sublethal effects including, but not limited, to altered ecosystem services, energetics, physiological processes, horizontal and vertical movement, reproductive activities, and glochidia success. The review of hypoxia tolerance is ongoing, but a preliminary synthesis has revealed that low DO concentrations affect mussel's ability to regulate oxygen consumption rates and affect behaviors such as movement, mantle and siphon extension, gaping, glochidia release, and increased respiration rates following re-exposure to normoxic conditions. The survival of species during emersion events is dependent upon habitat preference and behaviors of the species and life stage. Lethal and sublethal tolerance data for additional species, combined with a comprehensive database of stream temperatures and dissolved oxygen concentrations would be of great use in modeling the frequency and duration of sublethal stress ranges and lethal limit exceedance in North American systems and which taxa and populations are currently living at or near their upper lethal limits.
PL 53 8:20-8:40	**THE MOLECULAR AND PHYSIOLOGICAL RESPONSES TO THERMAL STRESS OF FOUR UNIONID SPECIES**
	Joshua D. Millwood [1], Paul D. Johnson [2], and Matthew J. Jenny [1]. [1] University of Alabama, Tuscaloosa, AL; [2] Alabama Aquatic Biodiversity Center, Alabama Department of Conservation & Natural Resources, Marion, AL.
	As global temperatures continue to rise most groups of organisms, terrestrial and aquatic, are being affected. Impacts on these organisms include drought, flooding, thermal stress, etc. Unionid mussels, being sessile organisms, are certainly not immune from these environmental changes and how they may respond is not well known. To better understand how various species of mussel may react to elevated temperatures we performed a mesocosm study utilizing adult mussels. We investigated species with various habitat ranges and various brood strategies to gain a better understanding of how distribution and life history may influence thermal stress response. Individuals of Fusconaia cerina, F. escambia, Cambarunio nebulosus, and Leaunio lienosus were placed into one of three temperature treatments (low: 22°C, mid: 25°C, and high: 28°C) for approximately 6 weeks. This experimental design was utilized to produce a sub-lethal response to collect molecular (differential gene expression) and physiological (respiratory, metabolic, and enzymatic) response data. Data from this experiment is still being analyzed, but preliminary results show a potential correlation between extent of thermal stress response and brood strategy. Gaining a better understanding of the physiological response, and molecular underpinning of those responses, to thermal stress could be instrumental in protecting this important and highly impacted group of organisms.

PL 54 8:40-9:00	**LINKING PHYSIOLOGY, BEHAVIOR, AND THERMAL TOLERANCE IN FRESHWATER MUSSELS**
	Hannah M. Adkins [1] , Kaelyn J. Fogelman [1] , Evelyn B. Pieper [1] , Jessica A. Radich [1] , Jonathan M. Miller [2] , Brian S. Helms [2] & James A. Stoeckel [1] . 1Auburn University, Auburn, Alabama; 2Troy University, Troy, Alabama.
	As climate change and anthropogenic activities alter surface water temperatures, knowledge of thermal tolerances and a framework for describing thermal guilds are essential for conserving unionid diversity. However, estimates of thermal tolerance in adult unionids exist for <10% of North American species. We evaluated a combination of sublethal physiological (respiration), behavioral (foot extension, gaping), and lethal (mantle retraction, lack of response) endpoints to acute thermal stress (+2°C/h starting at 25°C) to better understand the sequential relationships among endpoints, differences in sublethal endpoints within sympatric and/or among allopatric populations, and whether these endpoints were predictive of differences in lethal endpoints among populations and species. We examined three sympatric species (Elliptio pullata, Leaunio lienosus and Lampsilis straminea), three allopatric species (Pleurobema riddelli, Popenaias popeii, and Pyganodon grandis) and two allopatric subpopulations within the same species (L. straminea). Species showed some variation in the relative order of response to acute thermal stress: foot extension could occur either before or after a sudden decrease in metabolic rate (MDt), which was always followed by gaping, then mantle retraction and lack of response to probing (CTM). Significant variation in MDt occurred among sympatric species. Furthermore, some species showed evidence of adaptive temperature-insensitive metabolism, a thermal response known to occur in some littoral and intertidal marine mollusks, but not previously described for freshwater unionids. Behavioral endpoints did not differ among sympatric species, nor did the lethal endpoint. L. straminea from a pond population showed a reduced metabolic rate and higher CTM compared to those from a spring-fed river. Increased understanding of linkages between sublethal and lethal thermal endpoints, and variance among species and populations will be of great use in further identifying thermal guilds of freshwater unionids.
PL 55 9:00-9:20	**EFFECTS OF RISING TEMPERATURES ON SCOPE FOR GROWTH OF POPENAIAS POPEII (TEXAS HORNSHELL)**
	Evelyn Pieper[1], Jessica Radich[1] & James Stoeckel[1]. [1]Auburn University, Auburn, AL
	Texas Hornshell (P. popeii) is a federally endangered mussel with a historic range limited to parts of Texas, New Mexico, and Mexico. We are currently working with a collaborative team to investigate effects of rising temperatures on scope for growth (SFG): the net energy balance available to Texas Hornshell for reproduction and growth. SFG is calculated as the difference between energy intake (i.e. clearance and assimilation rates) and energetic costs (respiration, egestion, excretion). Mussels were collected from the Black River, New Mexico and acclimated for two weeks to one of five temperatures (16, 20, 24, 28, 32°C) within a range frequently observed in their occupied habitat. Following acclimation, we measured respiration rate, clearance rate, and absorption efficiency for 6 mussels per temperature. All mussels were fed Reed Mariculture LPBTM Frozen Shellfish Diet ® at a concentration of ~30,000 cells/mL during experimental assays. Clearance and respiration rates increased exponentially with temperature, whereas absorption efficiency increased until 24°C and then decreased. Thus mussels were filtering more food particles out of the water column, but eventually getting less energy from that food, while metabolic costs continued to increase. Estimated SFG increased from 16 to 28°C, followed by a decline in SFG as temperature increased further. Gage data from the Black River show that temperatures regularly exceed 28°C during the hot summer months and these high temperatures are likely to impede energetic investment in growth and reproduction, particularly under low flow. Information from this study will be used to help develop flow regulations protective of Texas Hornshell populations in the Black River. With increasing water demand, prevalence of seasonal droughts, and climate warming, the likelihood of P. popeii continuing to experience stressful temperatures and decreased energetic capacity in the foreseeable future is high.

PL 56 9:20-9:40	**ACUTE AND CHRONIC EFFECTS OF SEA SALT TO FRESHWATER MUSSELS: IMPLICATIONS FOR CLIMATE-INDUCED SEA LEVEL RISE IN COASTAL RIVERS**
	Joseph K McIver II [1], W. Gregory Cope [1], Nathan J. Hostetter [2], Ryan Boyles [3] Thomas J. Kwak [2,a], Tal Ben-Horin [1], Frank Weber [4], Jace Nelson [5], Amy Maynard [6], Andrew Glen [7], Brian Watson [8], Michael Fisk [9]. [1] NC State University, Raleigh, NC; [2] USGS, NC Cooperative Fish and Wildlife Research Unit, NC State University, Raleigh, NC; [3] USGS, Southeast Climate Adaptation Science Center, NC State University, Raleigh, NC; [4] RTI International, RTP, NC; [5] Virginia Department of Wildlife Resources, Charles City, VA; [6] US Fish and Wildlife Service, Neosho, MO; [7] Missouri Department of Conservation, Cape Girardeau, MO; [8] Virginia Department of Wildlife Resources, Forest, VA; [9] North Carolina Wildlife Resources Commission, Mebane, NC.
	Freshwater mussels can be negatively impacted by water salinization associated with climate-induced sea level rise. Sea salt is largely made up of sodium chloride. However, sea salt contains other ions such as potassium, sulfate, and calcium. The collective impact of these ions on freshwater mussel fitness and organ tissues is not clearly understood. Therefore, we conducted acute toxicity tests on glochidia and juveniles of 3 freshwater mussel species, and chronic toxicity tests on 2 species of sub-adult freshwater mussels, all of which inhabit Atlantic Slope drainages. Glochidia and juveniles of each species were exposed to 7 concentrations of Instant Ocean® Sea Salt (IOSS), a synthetic sea salt. These concentrations ranged from 0 to 34 parts per thousand (ppt). Glochidia underwent 48-hour acute toxicity tests, where viability was assessed at hour 24 and 48. Juveniles underwent 96-hour acute toxicity tests, where viability was assessed at hour 48 and 96. We calculated the median lethal concentration (LC50) for each acute toxicity test and found that glochidia were more sensitive to IOSS than juveniles. LC50s for glochidia at hour 24 ranged from 0.45 to 3.95 ppt, whereas LC50s for juveniles ranged from 5.04 to 10.44 ppt at hour 96. Sub-adult mussels were exposed to 4 concentrations of IOSS for 28 days and sampled for ion chemistry and histopathological analyses at day 0 (baseline), 7, 14, and 28. Chronic toxicity tests were conducted with standard reconstituted water and natural waters to obtain environmentally relevant results. Extensive mortality and notable damage to digestive diverticula was observed by day four for one mussel species. Mean ion concentrations in body tissues varied significantly from baseline levels in numerous treatments. This information can be used to enhance freshwater mussel conservation strategies in regions that are, or will be impacted by freshwater salinization associated with climate-induced sea level rise.
PL 57 9:40-10:00	**THERMAL TOLERANCES OF THE FRESHWATER MUSSELS CYCLONAIAS PUSTULOSA AND FUSCONAIA ASKEWI, FROM THE SABINE RIVER, TEXAS**
	Dorothea Mildenberger [1], Roel Lopez [1], & Charles R. Randklev [1] 1Texas A&M Natural Resources Institute, Texas A&M AgriLife Research Center at Dallas, Dallas, TX.
	Thermal regimes of aquatic systems are changing due to human-mediated impacts to water quantity such as excessive groundwater pumping, river impoundment and insufficient regulatory oversight to protect baseflows. Changes in water temperature negatively impacts aquatic species through exceedances of biological thresholds that, in turn, impacts population performance (i.e., growth, survivorship, and reproduction). Unionid mussels exemplify sensitivity to changing thermal regimes because they are sessile, reliant on host fish for dispersal and reproduction, and dependent on ambient temperature to regulate growth and reproduction. Despite the role water temperature plays in mussel population performance, thermal tolerance estimates exist for only a fraction of unionid mussels. This is concerning given that unionid mussels as a group are highly imperiled and thermal stress has been linked to their decline. To address this issue, we tested the upper thermal limits (LT 05 and 50) of one common and widely distributed mussel, Cyclonaias pustulosa, and one species that is presently considered threatened, Fusconaia askewi, from the Sabine River, located in East Texas. Mussels were acclimated to 27°C then tested at four experimental temperatures (30, 33, 36, 39°C) and a non-acclimated control (20°C) for 10 days (240-hr). Preliminary results indicate LT50 and LT05 estimates similar to those of congeners. Relating water temperature to our laboratory derived thresholds indicates some exceedances, though additional temperature data is needed to validate this finding. Future work will focus on comparing thermal tolerance across multiple populations of both species to help conservationists better understand how thermal tolerance varies within a given species and to help guide efforts focused on protecting and restoring instream flows.

Gray title denotes student presentation

Platform Session 5A: Status and Distribution of Mollusks 2

Wednesday (4/12) 10:20am-12:00 pm - Mt. Hood

PL 58 10:20-10:40	**HIGHLY VARIABLE POPULATIONS OF ENDANGERED SNUFFBOX ACROSS MICHIGAN**
	Daelyn A Woolnough [1] & Scott M LaValley [1,2]. [1] Central Michigan University, Biology Department and Institute for Great Lakes Research, Mt. Pleasant, MI; [2] Virginia Tech, Blacksburg, VA.
	Snuffbox (Epioblasma triquetra) is a globally rare unionid species that is federally endangered in the United States and Canada. Snuffbox, compared to historic records, has experienced a 60% range compaction and currently inhabits the Great Lakes, Appalachia, and parts of the Mississippi River drainages. In Michigan, Snuffbox were documented in 12 rivers prior to this study; 10 in the USFWS Rule and 2 new populations documented since 2018. This study sought to collect comparable demographic data, surrounding unionid species assemblage, and microhabitat (abiotic and biotic) characteristics that may influence Snuffbox populations. 253 live Snuffbox were found in 180 person hours with targeted, but standardized, surveys. We found a highly variable Snuffbox catch per unit effort (live Snuffbox per person hour; CPUE) that varied from 0.09 to 9.57 at the survey sites. Snuffbox sex ratios, CPUE, lengths, and ages in the Huron River watershed, St. Clair River watershed, and the Tobacco River suggest these populations are at-risk of decline or are declining while other Snuffbox populations across Michigan are potentially stable and many are showing signs of reproduction. Unionid community was compared among survey sites and we highlight potential sites for Snuffbox reintroductions or augmentations. Snuffbox habitat includes low turbidity, substrate composition of 50-65% sand and 30% gravel, along with abundant logperch (Percina caprodes) that are known Snuffbox host fish. GIS analyses of land use, surficial geology, dams, and inland lakes determined how the variability of the area upstream of Snuffbox populations may influence CPUE. A wide variety of land use and surficial geology and some demographic data poorly explained Snuffbox presence and CPUE and indicated some populations may be facing pressures from highly localized sources such as pollutants, invasive species competition, or predation. We found assessing threats at multiple scales is likely important to the conservation of Snuffbox.
PL 59 10:40-11:00	**FEDERAL LISTING AND RECOVERY PROGRESS FOR THE YELLOW LANCE (ELLIPTIO LANCEOLATA) AND ATLANTIC PIGTOE (FUSCONAIA MASONI)**
	Jennifer M. Archambault, Ph.D. US Fish and Wildlife Service, Eastern North Carolina Ecological Services Field Office, Raleigh, NC.
	In November 2022, the USFWS released a draft Recovery Plan for the Yellow Lance (Elliptio lanceolata), a freshwater mussel listed as threatened in 2018 under the Endangered Species Act and that received designated critical habitat in 2021. The Recovery Plan describes recovery criteria for determining when the Yellow Lance should be considered for removal from the List of Endangered and Threatened Wildlife (50 CFR 17.11), specific actions that will be necessary to meet those criteria, and estimates the time and costs for implementing recovery actions. The USFWS is also developing a Recovery Implementation Strategy of activities that will support the broader recovery actions, and is seeking input from conservation partners about specific activities needed for the recovery of the Yellow Lance. The plan estimates that recovery of the Yellow Lance will take about 50 years at a cost of $98.8 million. The USFWS anticipates releasing a final Recovery Plan and a Recovery Implementation Strategy for the Yellow Lance by September 2023. In December 2021, the USFWS listed the Atlantic Pigtoe (Fusconaia masoni) as threatened and designated critical habitat for the species. The agency released a recovery outline to guide recovery until a Recovery Plan is available, and currently is working on a draft. Conservation partners are encouraged to provide input that will inform recovery criteria and actions needed to support recovery. This presentation will include discussion of the recovery criteria for the Yellow Lance and the rationale for each; recovery actions needed to support the species' recovery (e.g., surveys and monitoring, habitat protection, and captive propagation); and examples of activities that comprise several of the actions. It will also include an overview of the listing, critical habitat designation, and recovery planning progress for the Atlantic Pigtoe.

PL 60 11:00-11:20	**CURRENT DISTRIBUTION OF WESTERN RIDGED MUSSEL (GONIDEA ANGULATA) IN IDAHO**
	Lyn Snoddy [1] & Joel Sauder [2] . 1Idaho Department of Fish and Game, Jerome, ID; 2Idaho Department of Fish and Game, Lewiston, ID.
	The western ridged mussel (Gonidea angulata) was petitioned for listing under the Endangered Species Act in August 2020, primarily due to purported declines in distribution and sudden, enigmatic die-offs. Occurrence records in Idaho are limited in number and geographic extent, with few targeted surveys in recent years. In 2021 and 2022, the Idaho Department of Fish and Game visited 259 potentially occupied sites, conducted 243 visual encounter surveys, collected 181 eDNA samples, and re-processed 236 previously-collected eDNA samples. Visual encounter survey methods and survey site selection varied by waterbody type. For larger rivers accessible by boat, we attempted to detect mussels at 2-3-mile intervals with a series of informal spot checks (i.e., brief aquascope/snorkel surveys) or formal surveys that were both time and area constrained. For smaller rivers and streams, we focused on surveying sites with historical observations, previous eDNA detections, or potentially suitable habitat. For formal surveys, we recorded lengths of the first 100 mussels encountered and documented habitat and general site characteristics. Live western ridged mussels were detected at 112 visual encounter survey locations. Mussel densities and size classes varied widely across river drainages. eDNA sampling resulted in 73 positive detections. These data confirm the presence of Western Ridged Mussels across a significant portion of Idaho; including, but not limited to: the Clearwater, Salmon, middle and lower Snake, Payette, Owyhee, Bruneau, and Weiser rivers. Future survey work should expand on our efforts to document the presence of this species and look for opportunities to estimate changes in abundance and distribution across the state.
PL 61 11:20-11:40	**MUSSEL MOVEMENT: THEY LIKE TO MOVE IT, MOVE IT?**
	[1] Sarah A. Douglass , [1] Ethan J. Kessler, [1] Jeremy S. Tiemann, [1] Alison P. Stodola, & [1] Michael J. Dreslik. [1] Illinois Natural History Survey, University of Illinois Urbana-Champaign, Champaign, IL.
	Freshwater mussels are often considered sedentary, but little information exists on horizontal movements and the mechanisms driving them. Current research suggests low water levels, temperature, day length, and reproductive cues influence some species' movements. It is a common conservation practice to move mussels from the impact zone of bridge construction or repairs to salvage listed species and highly speciose or dense beds. Additional information is necessary to help determine best practices for moving mussels. In 2013, the Illinois State Toll Highway Authority concluded a lane expansion project on the I-90 Toll Road from Chicago to Rockford, Illinois. During the last several years, we have conducted a capture-mark-recapture study to evaluate the mussel community and possible long-term effects resulting from construction practices in the Kishwaukee River at I-90 and an adjacent highway. For one study objective, we recorded the location (latitude and longitude) of PIT-tagged individuals from 2015-2018 during August, September, and October. We modeled species' upstream and downstream movement and used species, size, year, gage height, and flow rate as covariates. Movements were calculated by measuring the distance and direction between successive mussel locations. Mussels exhibited unidirectional movement downstream each winter season. Unidirectionality was also found from September to October, but the direction was perpendicular to streamflow in 2016 and upstream in 2017. Understanding mussel movement and displacement can aid resource managers in identifying species-appropriate management decisions and guide future research efforts.

PL 62 11:40-12:00	**FLORIDA'S FRESHWATER MUSSEL CONSERVATION PROGRAM: INSIGHTS FROM CONSTRUCTING A BASELINE OF DISTRIBUTIONAL AND PHENOLOGICAL DATA.**
	Susan R. Geda [1], Lauren N. Patterson [1], Amber N. Olson [2], and Jacob S. Lanning [2]. 1Florida Fish and Wildlife Conservation Commission, Garcon Point Aquatic Research Center, 1600 Garcon Point Rd. Milton, FL 32583. 2Florida Fish and Wildlife Conservation Commission, Freshwater Fisheries Research, 7386 N.W. 71st St. Gainesville, FL 32653.
	The Freshwater Mussel Conservation Program of the Florida Fish and Wildlife Conservation Commission aims to establish baseline mussel assemblage data for Florida's major river basins by characterizing taxonomic composition, abundance distributions, and habitat requirements. The program focuses on federally listed species and those designated as species of greatest conservation concern, while also monitoring stable populations of common species. Research opportunities that contribute to our understanding of freshwater mussel ecology are also pursued by program biologists. Here we summarize our methods and the insights these efforts have provided to past and recent publications, including: the rediscovery of species and populations thought to be extinct or extirpated, the creation and maintenance of a platform for referencing updated temporal gravidity data, and investigations into host-mussel relationships. Monitoring efforts are becoming increasingly important as aquatic habitats face unprecedented threats. Providing a comparative baseline for future studies will help researchers track changes in mussel communities over time. Similarly, documenting phenological trends creates a comparative dataset, helps to identify data gaps and interspecific patterns, and contributes to the study of complex reproductive processes and the mechanisms behind them. Ultimately, these monitoring and research endeavors inform decision making regarding the conservation and management of freshwater mussel species in the Greater Floridan Region.

Gray title denotes student presentation

Platform Session 5B: Surveys and Monitoring 1

Wednesday (4/12) 10:20am-12:00 pm - Mt. Bachelor

PL 63 10:20-10:40	**OREGON DEPARTMENT OF FISH AND WILDLIFE SNORKEL SURVEYS GET SOME MUSSEL**
	Kaegan Scully-Engelmeyer [1], Elise F. Granek [1], Emilie Blevins [2], & Ron Constable [3]. 1Portland State University (Environmental Science and Management), Portland, OR, USA; 2Xerces Society for Invertebrate Conservation, Portland, OR, USA; 3Oregon Department of Fish and Wildlife, Salem, OR, USA.
	As part of a long-term conservation effort, the Oregon Department of Fish and Wildlife (ODFW) monitors juvenile salmonids (Oncorhynchus ssp.) and their habitat in Western Oregon. Monitoring is accomplished by snorkel surveys in randomly selected stream reaches. In 2010, ODFW partnered with Xerces Society to collect data on freshwater mussels as part of this effort. The partnership resulted in the verification of mussels in waterbodies where status was unknown and an analysis of mussels in the Coast Range, a large ecoregion within Western Oregon. Only one species, Margaritifera falcata, was observed in the coastal watersheds of this ecoregion, though Anodonta were observed elsewhere in Western Oregon. Naïve occupancy of M. falcata was 12.4% in the Coast Range, with a detection probability of 45%. Observations were typically more frequent in the southern Coast Range than in the north. Occupancy correlated with stream reach variables: the relationship was positive with boulder counts and coho salmon (O. kitsutch) abundance, and negative with stream gradient and percent secondary channel. Results informed the conservation status of mussels in Western Oregon and may focus additional surveys. Our partnership leveraged resources of an established monitoring program and increased its conservation value at negligible costs. It is illustrative of the benefits and limitations of 'piggy-backing" to collect data on lesser-known species and has exposed dozens of fisheries professionals to the fascinating world of freshwater mussels.
PL 64 10:40-11:00	**COMMUNITY CHANGES IN A FRESHWATER MUSSEL BED FROM 2005 TO 2021 IN THE GREEN RIVER, KENTUCKY**
	Julieann M. Jacobs, Monte A. McGregor, Adam C. Shepard, Travis J. Bailey, Michelle A. King, Travis Williams. Kentucky Department of Fish and Wildlife Resources, Center for Mollusk Conservation, Frankfort Kentucky, 40601.
	The Green River is a large tributary of the Ohio River located in south central and western Kentucky and portions of Tennessee. It has historically supported 71 species of freshwater mussels and is considered one of the most biologically rich branches remaining of the Ohio River system. We assessed the mussel population at one mussel bed in a 1,000 m2 area with the use of 1m2 quadrats in the summer 2005, 2010, 2016, and 2021. We determined species presence, abundance, and distribution patterns for all species. We collected 35 species (3,894 individuals) for all four events. The most dominant species in three of the four events was the mucket, Actinonaias ligamentina (29% to 49% relative abundance). Mucket densities ranged from 3.95 (2005), 3.62 (2010), 4.47 (2016) to 3.15/m2 (2021). Other abundant species were the spike, Elliptio dilatata (4.7 - 32%), purple wartyback, Cyclonaias tuberculata (5.8-6.8%), threeridge, Amblema plicata (0.8-10%), round pigtoe, Pleurobema sintoxia (1.4-4.7%), and the longsolid, Fusconaia subrotunda (2.9-4.1%), collectively 75-80% of the individuals. Mean densities by species ranged from 0.01 to 4.47/m2. Fifteen species were rare in 2005 (2 T&E), 14 in 2010 (1 T&E), 16 in 2016 (3 T&E), and 14 in 2021 (3 T&E). Mussels were considered rare if densities were less than 0.1/m2. In 2005 only 1 species was present at densities >0.5/m2, compared to 4 species in 2010, 6 in 2016, and 3 in 2021. Average mussel density for all years ranged from 8.04 to 14.10/m2 with maximum densities/m2 ranging from 30 to 53/m2. Three endangered species, the fanshell, Cyprogenia stegaria, sheepnose, Plethobasus cyphyus, and rough pigtoe, Pleurobema plenum, were detected at densities from 0.2-0.6/m2 (fanshell) and 0.0-0.03/m2 (sheepnose and rough pigtoe). From 2016 to 2019, we released 450 stockable size endangered pink muckets, Lampsilis abrupta, into this site. Nineteen individuals were found in 8 m2 grids during the 2021 quantitative sampling at a total density of 0.26/m2 (2.5% relative abundance), showing that sampling effort was sufficient to detect rare and stocked individuals, even at low densities.

PL 65 11:00-11:20	**A COMPARISON OF SUBSTRATE COMPOSITION ASSESSMENT TECHNIQUES FOR THE GREENUP POOL OF THE OHIO RIVER**
	Thomas Jones [1], Alyssa Jones [2], Mitchell Kriege [2], Jacob Miller [2], Hunter Bellamy [1], Tyler Annario [1], & Michael Bruening [2]; 1 Marshall University, Huntington, WV; 2 Edge Engineering & Science, Cincinnati, OH.
	The Ohio River Sanitation Commission (ORSANCO) has regulatory authority over the mainstem Ohio River. Since the mid-1980's they have developed a biomonitoring protocol which includes electrofishing, deployment of hester-dendy multiplates, water quality sampling and habitat assessment. When the in-river sampling began, technology was limited for sediment assessment. ORSANCO developed and still utilizes an ingenious sediment mapping technique using a 20 ft. copper pole with an endcap. The copper pole is bounced along the substrate and with the combination of vibration and sound a skilled biologist can determine dominant sediment composition and depth. The resultant data are used to classify dominant sediment types throughout the river. We have used ORSANCO randomized sites for the collection of mussel data for several years. We have assessed the 40 most recent sites used in the Greenup Pool. We compared the copper pole data and % sediment composition at each site. We used ArcMap spatial analysis to create sediment maps from both sources. The individual site and entire pool comparisons found copper pole data to greatly underestimate the presence of fines. Overabundance of fine sediments are thought to negatively impact many species of mussels. Simple correlations of both fish index scores and benthic invertebrate's richness were negatively correlated to mussel richness/abundance. Our findings suggest copper pole data greatly underestimate fine coverage and that fish/benthic invertebrate data appear to monitor different environmental drivers than Unionids.
PL 66 11:20-11:40	**COMPARISON OF POPULATION DEMOGRAPHIC DATA FROM FOUR POPULATIONS OF THE FEDERALLY ENDANGERED RAYED BEAN, PAETULUNIO FABALIS (MOLLUSCA: UNIONIDAE)**
	David Foltz [1], David F. Ford [1], Jeff Grabarkiewicz [2], Adam Benshoff [1], Mitchell Kriege [1], and John Spaeth [1.1] Edge Engineering and Science, 16285 Park Ten Place #400, Houston, TX 77084 [2] Ecological Survey and Design, LLC, 410 Taylor Lane, Chelsea, MI 48118*
	Paetulunio fabalis is a rare North American unionid, currently listed as endangered by the USFWS. Life history and population demographic data are critical information necessary to determine an accurate status of a species and ensure that effective conservation measures are being implemented, however, life history and demographic data are sparsely available for P. fabalis. Here we present and compare population demographic and assemblage association results from four geographically disparate populations occupying the Lake Erie and Ohio River drainages. At each site we measured and sexed all P. fabalis for morphometric and sex ratio comparisons within and between survey sites. Lengths were significantly different between almost all survey sites, and between males and females at each site individually. In addition, we compared lengths by survey method (qualitative vs quantitative) at the Cassadaga Creek Site, and lengths were significantly different between survey methodologies. Quantitative sampling methods primarily resulted in the collection of more individuals with a smaller mean and size range at this site. Finally, we ran non-metric multidimensional scaling analysis at all survey sites to examine species associations with P. fabalis. The NMDS analysis indicated that P. fabalis was primarily associated with Eurynia dilatata, Amblema plicata, and Ptychobranchus fasciolaris at the Cassadaga Creek Site, Fusconaia flava at the Tymochtee Creek Site, E. dilatata, Lampsilis siliquoidea and P. fasciolaris at the Blanchard River Site, and with E. dilatata or alone at the Swan Creek Site. This study presents some of the first population demographic data for this rare species, which is vital to understanding its current sustainability, the conservation needs of the species, and ensuring protective measures are adequate. Additionally, this study presents a novel (Cassadaga Creek Site), reproducing population of P. fabalis which warrants continued protections and further studies.

PL 67 11:40-12:00	**HISTORICAL CHANGES TO MUSSEL COMMUNITIES IN UPPER SECTIONS OF OHIO RIVER NAVIGATIONAL POOLS WITH NOTES FROM RECENT SURVEYS BELOW NEW CUMBERLAND AND PIKE ISLAND LOCKS AND DAMS**
	Mitchell Kriege , Edge Engineering and Science, 16285 Park Ten Place #400, Houston, TX 77084.
	The upper Ohio River mainstem has undergone intense industrial and municipal pollution throughout the 19th and early 20th centuries that depleted its historical freshwater mussel fauna. However, following passage of the Clean Water Act in 1972, conditions steadily improved and many sensitive unionids have begun to recolonize the river. Our team surveyed two sites below Ohio River Navigational Locks and Dams, Pike Island and New Cumberland. Findings revealed differing mussel bed densities and species richness (Pike Island: n = 1,274, S = 16, New Cumberland: n = 292, S = 12). Comparing modern survey results to historic mussel bed conditions suggests improvement of these habitats, while differences between the two sites suggest additional factors outside of water quality have influenced mussel community recovery. The site below Pike Island Locks and Dams is of particular note as the site contains a high density and diversity of mussels including sensitive unionid species, suggesting an increased chance that this area may contain federally listed unionid species. Additionally, substrate quality at the site was high, consisting of stable, clean swept gravel. This site may allow for recolonization via propagation/reintroduction efforts for federally listed unionid species.

Gray title denotes student presentation

Platform Session 5C: Community Ecology and Ecosystems 3

Wednesday (4/12) 10:20am-12:00 pm - 3 Sisters

PL 68 10:20-10:40	**SECONDARY PRODUCTION AND NUTRIENT FLOWS AS MEDIATED BY FRESHWATER MUSSEL COMMUNITIES OVER TIME**
	Carla L. Atkinson [1], Angela K. Burrow [2], Garrett W. Hopper [1], Jonathan W. Lopez [1], Wendell Haag [3]. [1] University of Alabama, Department of Biological Sciences, Tuscaloosa, Alabama 35487 USA; [2] ORISE Postdoctoral Research Fellow, United States Forest Service and University of Kentucky, Department of Natural Resources, Lexington, Kentucky 40506 USA; [3] United States Forest Service, Southern Research Station, Frankfort, Kentucky 40601 USA
	Studies assessing primary production and net ecosystem production comprising the base of stream food webs have increased with the broad usage of continuous oxygen sensors and stream metabolism models. Secondary production (SP), however, has been assessed less frequently and represents the formation of heterotrophic biomass (B) through time (g m-2 y). SP is an important ecosystem metric that allows for assessment of ecosystem retentiveness and energy flow. SP comprehensively integrates population density, biomass, growth rates, and survivorship into a single metric linking population- to ecosystem-level metrics. To date, SP analyses in streams have generally been limited to aquatic insects while few studies have assessed freshwater mussel (Family: Unionidae) population- and community-level secondary production. Here, we describe a method for estimating SP of a multi-species mussel community that combines quantitative mussel surveys, species-specific length-biomass relationships, and von Bertalanffy growth functions. We show the utility of this method and pair our SP estimates with species-specific soft and shell tissue data (carbon [C], nitrogen [N], and phosphorus [P]) to estimate nutrient storage rates in two species-rich freshwater mussel communities in the Sipsey River, Alabama over space and time. Overall, SP of the two mussel communities rivals that of aquatic insects in this system, but SP:B ratios are lower. Further, within these mussel communities, long-lived, slow-growing species (i.e., equilibrium species) comprise most of the nutrient sequestration as they are dominant and species-specific nutrient stoichiometry mediates these rates. Our results highlight the importance of freshwater mussels to energy flows and nutrient cycling and storage in river ecosystems.
PL 69 10:40-11:00	**A MULTIVARIATE ASSESSMENT OF WEST VIRGINIA MUSSEL COMMUNITIES**
	Kevin Eliason [1], Michael Everhart [1], and Janet Clayton [2]. 1West Virginia Division of Natural Resources, Elkins WV; 2West Virginia Division of Natural Resources (Retired).
	As a state agency the West Virginia Division of Natural Resources (WVDNR) is tasked with monitoring and tracking the status of all mussel species in the state. While populations and individual sites have been assessed at length, a multivariate analysis of our mussel communities had not been completed. West Virginia has 65 extant mussel species spanning across 3 drainage basins (the Ohio River, the Potomac River, and the James River). The WVDNR has established 35 long-term monitoring sites across WV with the first beginning in 2003 and the latest being created in 2020. After creation, these sites are revisited on a five-year rotation with differing methods being used to monitor the populations at each site. With the use of R statistical software and the vegan package, a non-metric multidimensional scaling (NMDS) analysis was performed. We make comparisons between sites, mussel communities and potential environmental factors. I will give an overview of NMDS, discussing possible pitfalls and utilities of the method when comparing mussel communities across space and time.

PL 70 11:00-11:20	**FRESHWATER MUSSEL-GENERATED SECONDARY PRODUCTION IS MEDIATED BY WATERSHED POSITION AND LIFE HISTORY STRATEGIES**
	Jonathan W. Lopez1 [1], Carla L. Atkinson [1], Angela K. Burrow [2], Garrett W. Hopper [1], Wendell R. Haag [3]. [1] University of Alabama, Department of Biological Sciences, Tuscaloosa, Alabama 35487 USA; [2] ORISE Postdoctoral Research Fellow, United States Forest Service and University of Kentucky, Department of Natural Resources, Lexington, Kentucky 40506 USA; [3] United States Forest Service, Southern Research Station, Frankfort, Kentucky 40601 USA.
	Unionid mussel aggregations can fundamentally alter stream ecosystem functions such as nutrient and energy flows. However, spatial variation in mussel assemblage composition drives differences in their functional effects. Mussel-driven impacts on primary production and ecosystem metabolism are well-documented, but there is no thorough understanding of mussel-generated secondary production (SP)—the formation of heterotrophic biomass over time—in streams. This is in part due to a lack of long-term, quantitative survey data in most locations and a lack of species-specific growth rates. Here, we used production-to-biomass ratios that were calculated using a >20-year quantitative mussel survey dataset and species-specific length-biomass regressions to estimate spatial variation in SP across a series of mussel beds in the Sipsey River, AL, USA. Mussel-generated SP was mediated by the taxonomic composition of mussel assemblages and associated variation in the dominant life history strategies within those assemblages. Areal SP was greater at sites lower in the watershed. This increase in mussel-generated SP corresponded to a shift in the life history strategies of species generating production. At upper-watershed sites, SP was generated primarily by fast-growing, short-lived opportunistic species and invasive clams (Corbicula fluminea). Slow-growing, longer-lived equilibrium species generated most of the SP lower in the watershed. This supports the hypothesis that opportunistic strategists contribute more to ecosystem function in less stable habitats that are prone to disturbance (e.g., drying, thermal stress), while equilibrium strategists are more important in generating ecosystem function in stable habitats. Taxa with high productivity values were often, but not always, the dominant components of assemblage biomass. This underscores the utility that SP has over metrics of biomass and abundance when quantifying mussel-generated ecosystem function. SP provides a time-integrated metric of mussels' contributions to ecosystem function and allows more accurate spatial and temporal scaling of processes such as nutrient and carbon cycling and storage.
PL 71 11:20-11:40	**DECLINE OF SUSPENDED PARTICULATES ALONG A DENSE MUSSEL ASSEMBLAGE IN A SMALL MINNESOTA STREAM**
	Jillian Fedarick [1], Bernard Sietman [2]. 1Northeastern University, Boston, MA; 2Minnesota Department of Natural Resources, Lake City, MN
	Water filtration by freshwater mussels is a valuable ecosystem service; however, it has not been well studied in natural settings. We measured particulate concentrations along a naturally occurring multi-species assemblage (Mussel Site) and a stream reach with no mussels (Reference Site) to examine the potential effect of mussels on suspended particulates. We predicted that E. coli, chlorophyll-a, and total suspended solids would decline along the Mussel Site and not the Reference Site because of mussel filtration. We collected 3 replicate water samples at upstream, midstream, and downstream stations along both reaches in August, September, and October 2022 to determine concentration values. In accordance with our predictions, concentrations of particulates declined from upstream to downstream at the Mussel Site but not at the Reference Site. Linear mixed-effect modeling determined that the interaction between mussel presence (Mussel Site, Reference Site) and sample location (upstream, midstream, downstream) best explained these patterns. There was lower support for the total suspended solids interactive model (AIC weight = 0.45) compared to the other two particulates (AIC weight > 0.95). Because mussels can selectively filter out some size categories of total suspended solids over others, this particulate may not be an accurate measure of filtration. Future studies could use stream mesocosms and flow cytometry techniques to directly measure mussel filtration of suspended particulates. Our results suggest that mussels can appreciably reduce suspended particulate concentrations including harmful bacteria. This study provides a useful example of the ecosystem services mussels provide and why their conservation is needed.

PL 72 11:40-12:00	**MACROINVERTEBRATE ASSEMBLAGE ASSESSMENTS AS A MEASURE OF SITE QUALITY FOR FEDERALLY LISTED FRESHWATER MUSSEL SPECIES**
	Sierra B Benfield [1] , J Michael Fisk [2] . 1 North Carolina Wildlife Resources Commission, Inland Fisheries Division, Marion, NC; 2 North Carolina Wildlife Resources Commission, Inland Fisheries Division, Mebane, NC.
	Unionid mussels are among the most imperiled groups of organisms in the world. Understanding predictors of imperiled mussel presence is essential in locating wild populations and areas that are capable of supporting them. Episodic degraded water quality events can impact sensitive species and can go undetected, resulting in reaches with quality physical habitat but poor mussel diversity. Typical water quality measurements taken in the field are only a snapshot of current conditions and do not reflect long-term conditions. Biological assessments could provide a more complete measure, acting as a predictor of suitable habitat that may support wild or reintroduced populations of imperiled mussels. Mussels are active members of the benthic community, yet their interactions and associations with other members of the benthos are not fully understood and warrant further research. The objectives of this study are to 1) describe macroinvertebrate assemblages in sites that support rare mussels and sites that do not, and 2) determine if any association between groups of insects (feeding or taxonomic) and rare mussels exists. Benthic macroinvertebrate assemblages were assessed at twelve sites: seven contemporary sites where Tar River Spinymussel, Parvaspina steinstansana, are known to occur, and five sites that have good physical habitat but P. steinstansana no longer occur. Collections were taken with a Surber sampler, with ten samples from the best mussel habitat and ten from the best macroinvertebrate habitat, as well as a sample taken directly from the valves of live mussels. Sites were compared based on calculated biotic indices and diversity measures, and significant differences were detected. These measures may be used to determine threshold values that could indicate a site capable of supporting P. steinstansana. This research provides a better understanding of the associations between macroinvertebrates and rare mussels, and helps make more informed decisions on future augmentations and surveys.

Gray title denotes student presentation

Platform Session 6A: Status and Distribution of Mollusks 3

Wednesday (4/12) 2:00-3:20 pm - Mt. Hood

PL 73 2:00-2:20	**ASSESSING FRESHWATER MUSSEL POPULATIONS IN OREGON'S WILLAMETTE RIVER BASIN: STATUS, DISTRIBUTION, AND UTILITY OF eDNA SURVEYS**
	Zee Searles Mazzacano [1]; Travis Williams [2]; & Laura McMullen [3]. 1CASM Environmental and ICF, Portland, OR; 2Willamette Riverkeeper, Oregon City, OR; 3ICF, Portland, OR.
	Freshwater mussels in the western US are under-studied compared to their eastern cousins, and no western species currently receive federal protection. Mussel distribution throughout Oregon's rivers is poorly documented, with limited historical records to inform the degrees of population decline. The Willamette River flows 187 miles north through the Willamette Valley to the Columbia River and is the largest watershed entirely in Oregon. The majority of Oregon's population lives in the Willamette Valley, which increases urban and agricultural stressors on mussels and their habitats. We launched a long-term project in 2016 to characterize freshwater mussel populations throughout the Willamette basin. Scouting trips followed by longitudinal boat and snorkel surveys were conducted in the mainstem Willamette River and selected tributaries over four years. Detailed surveys were conducted where large mussel populations were previously noted, including qualitative transect surveys of beds and quantitative randomized quadrat surveys. To facilitate detection of juveniles without undue substrate disturbance, a subset of quadrats was double-sampled with excavation. The dense western pearlshell (Margaritifera falcata) populations varied greatly in length class structure, density, substrate burial factor, and number of juveniles among sites. Substrate and flow characteristics also differed among sites, with many dense beds found in what would not be considered "typical" pearlshell habitat. Some sites also contained small numbers of floaters (Anodonta) and a single western ridged mussel (Gonidea angulata) was found in a highly urbanized reach. Outreach and training was also conducted for local partners including tribal entities and watershed councils to increase mussel conservation awareness. Continuing work includes eDNA sampling for mussels paired with detailed snorkel surveys to generate more baseline data on the current status of freshwater mussel populations in the Willamette River basin.
PL 74 2:20-2:40	**PHASE I SURVEY RESULTS FROM A MULTI-PHASE STUDY IN THE LOWER WABASH RIVER, ILLINOIS AND INDIANA**
	David F. Ford [1], [1] Edge Engineering and Science, LLC, Houston, TX.
	The Wabash River is a major tributary of the Ohio River Basin, marks part of the border between Illinois and Indiana, and is an important component of the natural resources of both states, including freshwater mussels. Historically the Wabash River Basin supported approximately 75 species of freshwater mussels; however, only about 30 species are still known to be extant within the mainstem. Though survey efforts within this basin have historically been fairly substantial, they have primarily focused upon the upper portions of the basin, where most of the rare and listed species are known to historically occur, and survey efforts within the lower basin have been less frequent. To fulfill a multi-objective study the Illinois Department of Natural Resources contracted Edge Engineering and Science to complete a multi-phase study within the lower Wabash River. Phase I survey goals were to determine locations where federally listed mussel species and other rare species remained, to find mussel concentrations, and determine the species assemblages of these concentrations. Phase I survey efforts were completed in 2021. A total of 219 person hours were expended surveying at 45 sites throughout the lower Wabash River during the Phase I effort. This resulted in the collection of 887 live individuals of 23 species, including 137 federally endangered Potamilus capax. The lower Wabash River appears to remain a stronghold for P. capax and many other mussel species. Potamilus capax is exhibiting active recruitment with multiple size classes and elevated abundances, and pending no major environmental changes or adverse events, the basin is expected to continue harboring populations of this rare, federally endangered species. Given the evidence of recruitment for this rare species and the presence of many other mussel species, including state-listed species, further studies and preservation of the lower Wabash River is warranted.

PL 75 2:40-3:00	**STATUS AND DISTRIBUTION OF FRESHWATER MUSSELS IN THE LOUISIANA SECTION OF BAYOU BARTHOLOMEW**
	Gerald R. Dinkins [1], Augustin C. Engman [1], Brittany Bajo-Walker [2], Z. Winston Clark [1], Justin Wolbert [3], Kyler Hecke [4], and J. Brian Alford [5]. 1University of Tennessee, Knoxville, TN, 3Virginia Department of Wildlife Resources, Forest, VA, 3Tennessee Valley Authority, Norris, TN, 4Arkansas Tech University, Russellville, AR, 5The Ohio State University, Put-in-Bay, OH.
	As a major tributary to the species-rich Ouachita River, Bayou Bartholomew is a key ecosystem for the freshwater mussel diversity of southeast Arkansas and northeast Louisiana. The mussel assemblage of the Louisiana section of Bayou Bartholomew has not been assessed since the early 2000s. In 2021, we sampled over 100 river km on the main channel of Bayou Bartholomew and four tributaries from just downstream of the Louisiana/Arkansas border to the confluence with the Ouachita River using a novel two-phase timed-search protocol. A suite of relevant habitat variables and site attributes were quantified or qualitatively noted and one site was selected for sampling using a grid survey to determine quantitative estimates of mussel density. Our survey confirmed the presence of 35 species including 12 species of greatest conservation need (SGCN). In total, 3,295 live mussels representing 33 species were collected in the main channel, 234 live mussels representing 18 species were found in a quantitative grid, and four species were found in tributaries. Two additional species were only found in tributaries as dead shells. Length frequencies of all common and abundant species indicated ongoing annual recruitment. Patterns of ubiquity in the main channel of Bayou Bartholomew varied by species, and mussels were rare in the tributaries. Generalized linear modelling and non-metric multidimensional scaling analyses identified relationships between mussel assemblage composition and the distance from the confluence with the Ouachita River and habitat variables including substrates, depth, and mesohabitat types. A comparison with previous studies did not provide any evidence of major changes in overall mussel species distributions or occurrence in Bayou Bartholomew in Louisiana. We attribute the apparent stability in the mussel assemblage to the fact that major anthropogenic alterations such as channelization, impoundments, and watershed urbanization have been minimal since the earlier studies.
PL 76 3:00-3:20	**AN ANALYSIS OF CYPROGENIA ABERTI (WESTERN FANSHELL) ASSEMBLAGE DYNAMICS IN THE BLACK RIVER, MO**
	Kristin Schmidt [1], Ronald Kegerries [1], Heidi Dunn [1], Georganne Bowman [2], and Caleb Knerr [2]. 1EcoAnalysts, Inc. O'Fallon, MO; 2Missouri Department of Transportation, Jefferson City, MO.
	The western fanshell (Cyprogenia aberti) is known to occur in 20 streams in AR, KS, and MO and is proposed for listing as threatened under the Endangered Species Act. The species is locally abundant in the Black River of MO, which is considered a stronghold. EcoAnalysts and their partners conducted a relocation beneath the BU 60 bridge in Poplar Bluff, MO in June 2022 and collected over 6,000 C. aberti, 500 of which were aged based on external annuli and measured for length, width, and height. This data was analyzed, along with data from other recent Black River projects, to examine age, size, and habitat metrics. Our analysis of these data will provide a more nuanced understanding of the biotic and abiotic factors influencing C. aberti and an updated overview of the distribution of this species within the Black River. Our hope is that dissemination of this data will better inform project and land managers and help guide future conservation efforts within the Black River drainage.

Gray title denotes student presentation

Platform Session 6B: Conservation Strategies 2

Wednesday (4/12) 2:00-3:20 pm - Mt. Bachelor

PL 77 2:00-2:20	**USING REGIONAL WORKING GROUPS FOR MUSSEL SPECIES CONSERVATION**
	Allison H Roy [1], Jason R Carmignani [2], Peter D Hazelton [3], Ayla J Skorupa [4], Sean C Sterrett [5], Nathan Whelan [6], and the Brook Floater Working Group. [1] U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, Department of Environmental Conservation, University of Massachusetts, Amherst, MA; [2] Massachusetts Division of Fisheries and Wildlife, Westborough, MA; [3] Warnell School of Forestry & Natural Resources, University of Georgia, Athens, GA; [4] Massachusetts Cooperative Fish and Wildlife Research Unit, Department of Environmental Conservation, University of Massachusetts, Amherst, MA; [5] Monmouth University, Department of Biology, West Long Branch, NJ; [6] U.S. Fish and Wildlife Service, Southeast Conservation Genetics Lab, Auburn University, Auburn, AL
	Species conservation is inherently regional in scope. While specific management and conservation efforts may largely be completed by state agencies, coordination of monitoring and restoration is critical to understand species' status and threats, identify best restoration strategies, and maximize efficiency of resources. In 2016, we established the Brook Floater Working Group (BFWG), a partner-driven group of managers and scientists throughout the brook floater range (Atlantic Slope of United States and Canada) to guide research and monitoring toward rangewide conservation of this at-risk freshwater mussel species. Creation of the BFWG was spurred by a U.S. Fish and Wildlife Service Competitive State Wildlife Grant (C-SWG), although initial participants included many partners from state and federal agencies and academic institutions in addition to the 4 funded states. While the leadership team included academic participants, buy-in and regular participation by the state partners was critical for establishing trust. In the first five years, we developed standardized field sampling protocols, sampled streams throughout the range, propagated and stocked mussels, and developed conservation plans and outreach materials. Monthly partner meetings provided opportunities to share experiences with sampling and propagation, discuss challenges and opportunities for restoration, and identify research needs. The discussions led to a second C-SWG grant that started in 2022 and includes population genetic work, plus additional sampling, data analysis, protocol development, and propagation. Leveraged resources in many states and Canada are providing additional opportunities for advancing brook floater conservation. Despite turn-over in state managers over the last 7 years, participation of nearly all states and provinces has remained and the group continues to grow. This regional working group serves as a model for coordinated conservation for other species and regions.
PL 78 2:20-2:40	**DAM REMOVAL AND FRESHWATER MUSSELS: GUIDANCE FOR RESTORATION, CASE STUDIES, AND GAPS IN KNOWLEDGE.**
	Erin Singer McCombs, American Rivers, 29 N. Market St., Ste 603A, Asheville, NC 28801, emccombs@americanrivers.org.
	Dam removal is gaining momentum as a restoration tool to increase aquatic connectivity, public safety, and recreational opportunities especially with the funding from the Bipartisan Infrastructure Law. With thousands of small and medium sized dams to prioritize for removal in unique habitats, information to guide the process is needed. Freshwater mussels are an imperiled group of aquatic organisms across the country frequently found below small dams in high richness and density. This talk will provide guidance to resource and project managers on the best practices for prioritizing and removing dams where freshwater mussels are present and offer case studies from completed projects across the country. The first step when approaching a dam for removal is to determine if the project will achieve effective restoration, ideally eliminating the root cause of stream impairment. While large information gaps in understanding dam removal effects on freshwater mussel populations exist, case studies have shown that adverse short-term impacts to freshwater mussels can be reduced with proper planning, timing, and removal techniques. Management options to address the presence of freshwater mussels at a dam removal may include sediment management, mussel relocation, and equipment location management. Additionally, a need remains for collaboration between resource managers and academics to get a better grasp of the complex ecological impacts of dam removal.

PL 79 2:40-3:00	**FRESHWATER PEARL MUSSEL (MARGARITIFERA MARGARITIFERA) IN FINLAND – STATUS OF THE POPULATIONS AND CONSERVATION**
	Oulasvirta, P. [1] *and Syväranta, J.* [1] *1Alleco Ltd., Veneentekijäntie 4, FIN-00210 Helsinki, Finland.*
	Freshwater pearl mussel (FPM) is listed as an Annex II and V species under the EU Habitats Directive. In Finland FPM is protected according to the Nature Conservation Act as a strictly protected species. In Europe, FPM is red-listed as critically endangered (CR). A Strategy and Action plan for the protection of FPM in Finland was completed in 2021 by the Finnish Ministry of the Environment. One part of the action plan is to assess the status of FPM populations. The status of populations is classified into six categories which are viable, maybe-viable, non-viable/partly- viable, dying-out, almost-extinct and extinct. The main criteria for judging the viability of the population are the population size and the proportion of juvenile mussels. The population size is based on data obtained from the mussel counts conducted in random transects. At present, the number of rivers known to contain FPM in Finland is 151. The population status assessment has been carried out in 76 rivers. From these studied rivers, the status of the population is viable in 10.5 %, maybe-viable in 7.9 %, non-viable/partly-viable in 60.5 %, dying-out in 9.2 % and almost- extinct in 11.8 % of the rivers. The number of known extinct populations is at least 30. The real number of extinct populations is, however, much higher, since only part of the past populations is known. According to the Action plan, the population status assessments continue in the yet un-studied populations. The results of the surveys will serve as a basis for the conservation measures and a monitoring program to be drawn up in the future. As part of the outreach by researchers, university students in the United States created artworks that visualize the project data, in an ongoing collaboration across art and science conservation.
PL 80 3:00-3:20	**CONFREMUS – BUILDING A NETWORK OF EXCELLENCE FOR THE CONSERVATION OF EUROPEAN FRESHWATER MUSSELS**
	Manuel Lopes-Lima. BIOPOLIS/CIBIO, University of Porto, Portugal.
	COST (European Cooperation in Science and Technology) is a funding agency for research and innovation networks. COST Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. In 2019, COST approved the CA18239 - Conservation of freshwater mussels: a pan-European approach (CONFREMU) to develop and coordinate research activities on the biodiversity and ecological role of freshwater mussels on a pan-European scale to establish a network of researchers developing new approaches to sustaining ecological functions and biodiversity of European freshwaters.Its main aims are to: i) increase the knowledge about European Mussels' biodiversity: compiling genetic diversity data, distribution, and abundance data to identify spatial diversity patterns, evolutionarily significant units, biodiversity hotspots, and populations needing urgent conservation actions; ii) collect data on the mussels' biological features, juxtaposed with features of their environment to reveal the main drivers of mussels' decline. Develop and implement effective monitoring schemes for freshwater ecosystems and their catchments based on freshwater mussels. iii) build a Strategic Agenda for mussels and freshwater management on a European scale. iv) raise awareness of the important ecological role of mussels to European stakeholders. Through this research network, more than 70 researchers from 32 countries have been working together interchanging knowledge through meetings, short missions, training schools, and student interchange, producing multiple distinct outputs such as research papers, metanalyses and reviews, books, maps, and outreach materials and advancing the knowledge on European freshwater mussels and their functions. The present lecture aims to present the network to an international audience together with its main achievements and scientific results.

Gray title denotes student presentation

Platform Session 6C: Community Ecology and Ecosystems 4

Wednesday (4/12) 2:00-3:20 pm - 3 Sisters

PL 81 2:00-2:20	**INCIDENCE AND RESTORATION PRIORITIZATION OF RARE AND COMMON SPECIES OF FRESHWATER MUSSELS IN THE TIDAL DELAWARE RIVER, USA**
	Danielle Kreeger [1], Kurt Cheng [1], Roger Thomas [2], Lance Butler [3], Matt Gentry [1], and Leah Morgan [1]. *[1] Partnership for the Delaware Estuary, 110 S Poplar St, Suite 202, Wilmington, DE; [2] The Academy of Natural Sciences of Drexel University, Patrick Center for Environmental Research, Philadelphia, PA; [3] Philadelphia Water Department, Philadelphia, PA.*
	Freshwater mussel assemblages have been in steep decline as measured by decreasing biodiversity, range and abundance. Most restoration attention has centered on rare species, despite the implications of losing whole mussel assemblages for critical ecosystem processes such as their positive contributions to water and habitat quality. There is emerging interest in restoring both common and rare species in natural systems to help sustain vital ecosystem services. In addition to traditional restoration, mussel communities could be added or enhanced in created or heavily altered aquatic systems, such as stormwater ponds, living shoreline projects, and reengineered canals. However, including common species in mussel recovery plans has elicited concern based on the premise that augmenting common species could undermine rare species recovery due to competition or other ecological factors. To inform restoration, quantitative mussel surveys were performed between 2012- 2014 in the tidal freshwater zone of the Delaware Estuary. Random 1 m2 quadrats (n=264) were excavated in shallow subtidal areas at 9 sites. Mussel percent occurrence, numerical density, and biomass were dominated by Elliptio complanata and Utterbackiana implicata, and subordinate species included Atlanticoncha ochracea, Sagittunio nasutus and Lampsilis cariosa. The two dominants were found by themselves in > 38% of the quadrats, whereas A. ochracea, S. nasutus and L. cariosa were found by themselves in 3.8%, 0% and 0% of quadrats, respectively. The greatest occurrence of subordinates was in quadrats with >10 mussels. No evidence of negative species interactions was detected, and the occurrence of rarer species may in fact depend on habitat modifications from more abundant foundational species. Efforts to promote mussel-mediated ecosystem services in eutrophic, impacted systems such as the urban Delaware River should adopt a phased approach to first establish mussel beds using foundational species, and then augment with rarer species to eventually mimic natural assemblages at nearby reference sites.
PL 82 2:20-2:40	**THE IMPORTANCE OF CLEAN WATER: AN EMPRICAL ANALYSIS OF MUSSEL ABUNDANCE AND POLLUTANT ABATEMENT IN MINNESOTA RIVERS**
	Baishali Bakshi [1], R. William Bouchard, Jr. [2], Daniel Hornbach [3], Bernard Sietman [4], and Dennis Wasley [5]. *Economic policy analyst, Environmental Analysis and Outcomes Division, Minnesota Pollution Control Agency, Saint Paul, MN; [2] Research Scientist, Environmental Analysis and Outcomes Division, Minnesota Pollution Control Agency, Saint Paul, MN; [3] Professor, Macalester College, Saint Paul, MN; [4] Malacologist, Center for Aquatic Mollusk Programs, Minnesota Department of Natural Resources, Lake City, MN; [5] Limnologist, Environmental Analysis and Outcomes Division, Minnesota Pollution Control Agency, Saint Paul, MN.*
	Freshwater mussels provide valuable ecosystem services such as water filtration, nutrient cycling, stream bed stabilization, habitat for aquatic organisms, and have an important role in food webs. However, they are one of the most sensitive and imperiled aquatic taxa and are threatened by water pollution, habitat loss, and altered hydrology. Regulating pollution through National Pollutant Discharge Elimination System (NPDES) permits has a variety of benefits but also entail costs in terms of wastewater treatment technology as well as resources and time needed to implement water quality standards. To understand better the association between regulation, improvements in water quality, and conservation of freshwater mussels in Minnesota, we propose to link data on mussel abundance and extirpation rates to the temporal change in key pollutants such as sediment, nutrients, and chloride, as well as other factors including flow alteration, habitat features, fish diversity, and human population at the watershed level. These data will be analyzed using a generalized mixed effects regression model to generate findings on the relationship of mussel health with improvements in water quality. We will look at these relationships for different freshwater mussel life history strategies, such as equilibrium, periodic, and opportunistic to gain more insight into their effective conservation. The goal of this project is to inform and develop more effective strategies for mussel conservation.

PL 83 2:40-3:00	**PREDICTING THE EFFECT OF RESTORATION ACTIONS ON MUSSEL ASSEMBLAGE HABITAT: A DECISION TOOL TO AID PRACTITIONERS**
	Ayla J. Skorupa [1], Sandra Doran [2], Christine E. Dumoulin [3], Allison H. Roy [4], and David R. Smith [3]. 1Massachusetts Cooperative Fish and Wildlife Research Unit, Department of Environmental Conservation, University of Massachusetts, Amherst, MA; 2U.S. Fish and Wildlife Service, New York Ecological Services Field Office, Cortland, NY; 3U.S. Geological Survey, Eastern Ecological Science Center, Kearneysville, WV; 4U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, Department of Environmental Conservation, University of Massachusetts, Amherst, MA
	The allocation of restoration efforts to benefit freshwater mussel conservation is often hampered by a lack of information on species' habitat. The Delaware River Basin (hereafter basin) is the largest free-flowing mainstem river in the eastern (Atlantic Slope) U.S. and supports 13 freshwater mussel species of varying imperilment levels. The basin is also the source of water for approximately 13.3 million people. Thus, to offset anthropogenic influences and consider ecological integrity, programs have focused on funding restoration actions (e.g., barrier removal, riparian restoration) to benefit aquatic species. However, it is unknown how the effect of such management/restoration actions on mussel habitat may vary across the basin which lends a need to prioritize among actions given limited funding. We used mussel presence/absence data, landscape-scale environmental covariates and mussel traits to predict the probability of suitable habitat for the 13 mussel species within U.S. Environmental Protection Agency's StreamCat catchments. Variance partitioning among landscape covariates indicate that either nitrate or road stream crossing density were most important in explaining habitat suitability for 11 mussel species. Relationships between mussel traits and habitat covariates also explain the probability of suitable habitat. For example, mussel host specialists were positively related to base flow index within a catchment. We predicted habitat suitability for each mussel species for varying restoration actions and found species' habitat within catchments was differentially affected. However, when considering the mussel assemblage as a group, and across the basin, the predicted probability of suitable habitat was positively related to a manipulated increase in restored riparian area. This modeling approach allows practitioners to evaluate restoration actions on single species as well as mussel assemblages. While our work focuses on the Delaware River Basin, this approach may be beneficial in assessing tradeoffs among restoration actions in other U.S. watersheds.
PL 84 3:00-3:20	**SPATIAL VARIATION IN MUSSEL COMMUNITY COMPOSITION AND RICHNESS RESULTS IN DISTINCT STOICHIOMETRIC HOTSPOTS IN RIVERS ACROSS A BIOGEOGRAPHIC REGION**
	Caryn C. Vaughn [1] and Carla L. Atkinson [2]. [1] Department of Biology and Oklahoma Biological Survey, University of Oklahoma, Norman, OK: [2] Department of Biological Sciences, University of Alabama, Tuscaloosa, AL.
	Freshwater mussels make important contributions to nutrient cycling and storage in rivers, but the overall magnitude of these contributions varies with mussel abundance, community composition, and species traits. We used an extensive dataset on mussel communities, their life history traits, and functional effect traits across eight rivers from a single biogeographic region, the Ouachita Mountains of the US Interior Highlands, to examine how differences in mussel communities and their functional traits affected overall functional diversity and dispersion and nutrient storage (carbon [C], nitrogen [N] and phosphorus [P]) and nutrient excretion rates (N and P). Our preliminary analyses indicate that there is high variation in richness, biomass, and consequently excretion rates, nutrient storage, and overall stoichiometry. In general, larger stream reaches tended to harbor mussel beds with more species, greater community biomass, and subsequently higher excretion rates and overall storage. Most striking was how assemblage composition impacted overall excretion and nutrient storage stoichiometry. In particular storage N:P was negatively related to excretion N:P by the mussel communities. This general pattern was related to assemblage composition where communities with a greater proportion of lampsilines had higher excretion N:P and lower storage N:P. Our work highlights the diversity of traits within a single family of aquatic organisms and how that can result in high spatial variation in nutrient storage and cycling.

Gray title denotes student presentation

Platform Session 7A: Genetics and Phylogeny 3

Wednesday (4/12) 3:40-5:00 pm - Mt. Hood

PL 85 3:40-4:00	**A NEW SYSTEMATIC FRAMEWORK FOR JUGA (GASTROPODA, CERITHIOIDEA): LINGERING QUESTIONS AND FUTURE DIRECTIONS**
	Ellen E Strong [1] , Jeffrey T Garner [2] , Paul D Johnson [3] & Nathan V Whelan [4,5] . 1National Museum of Natural History, Smithsonian Institution, Washington, DC; 2Alabama Department of Conservation and Natural Resources, Florence, AL; 3Alabama Aquatic Biodiversity Center, Alabama Department of Conservation and Natural Resources, Marion, AL; 4,5 United States Fish and Wildlife Service, and Auburn University, Auburn, AL.
	Juga is a genus of freshwater snails native to the Pacific Northwest. Their highly variable shells, combined with a propensity for morphologically distinct forms to occupy discrete geographic areas, have contributed to a proliferation of species-group names and recognized OTUs. A recent molecular phylogeny with dense population sampling has enabled a comprehensive revision and demonstrated that diversity of Juga is lower than previously thought. Nearly all species previously considered valid were shown to be para- or polyphyletic grades of organization in shell ornament. Homoplasy in shell morphology is common and almost all valid species contain weakly ornamented forms that, in the absence of locality information or sequence data, often cannot be reliably identified. Conversely, most species also include highly distinctive morphs that cannot be mistaken. Despite clarifying the circumscription of extant species, the new systematic framework has exacerbated existing knowledge shortfalls as it has redrawn species boundaries to cut across almost all species as previously defined. Thus, much of the scant conventional knowledge on life histories, distributions, population size and structure, ecological tolerances, and habitat preferences will require reassessment. While the molecular analyses clarified the diversity of Juga species, they did not resolve the relationships among them. Additional sequencing effort is needed to clarify these relationships and confirm the identities of Sierra Nevada populations for which no sequences are yet available. The identity and status of several isolated records in the eastern Columbia Gorge are also in need of further scrutiny. Many populations have not been reevaluated in decades and some are already known to have fallen victim to drought or human-mediated impacts. These impacts on groundwater-dependent species like Juga can be expected to worsen in a warming climate. The ranges of some species have contracted markedly, and one newly described, narrow-range endemic may warrant immediate protection.
PL 86 4:00-4:20	**RE-VISITING HOW WE DEFINE SPECIES OF THE "PYRGULOPSIS KOLOBENSIS" COMPLEX (CAENOGASTROPODA: HYDROBIIDAE) IN THE WESTERN US**
	Kathryn E. Perez [1] , Megan Solis [1] , Eric Miskow [2] , Chanté Lundskog [3] , Jeffrey Sorensen [4] . [1] Biology Department, University of Texas Rio Grande Valley, Edinburg, TX; [2] Nevada Division of Natural Heritage, Carson City, NV; [3] Utah Department of Natural Resources, Salt Lake City, UT; [4] Arizona Department of Game & Fish, Phoenix, AZ
	Until 2017, Pyrgulopsis kolobensis (Taylor, 1987) was treated as a widespread species or species complex with a range including the Great Basin, Snake River Basin, and Colorado River Basin (NV, UT, ID). Hershler et al. (2017) named several new species and restricted P. kolobensis to Toquerville Springs, which left many lineages formerly known as P. kolobensis with uncertain status. As a consequence, natural resource managers have to deal with hundreds of spring-snail populations in limbo without ready means to ascertain their conservation status. Toquerville Springs is now dry, leaving "real" P. kolobensis extirpated from its only known population. Several Pyrgulopsis species and mitochondrial lineages have been petitioned for federal listing and natural resource management agencies in AZ, UT, NV are trying to get a handle on diversity and distributions of these taxa. For example, P. transversa, P. pilsbryana, and P. nonaria were named on the basis of distinct penial morphology, however mitochondrial data finds a single shallow (0.7% COI genetic distance) clade, "Lineage A". Conversely, "Lineage C" contains several deeply divergent mitochondrial lineages (>10% COI genetic distance) without names available. We are examining some of these lineages using congruence among numerous datasets (mt DNA, nuclear DNA, radula morphology, male and female reproductive anatomy, and shell morphometrics) to inform species descriptions and/or synonymies. It is an open question whether some springs which contain deeply divergent mitochondrial lineages harbor multiple distinct species and whether we must re-assess the utility of some morphological features that were heavily relied upon in previous work.

PL 87 4:20-4:40	**MOLECULAR PHYLOGENETICS UNEARTHS HIDDEN BIODIVERSITY WITHIN ALASMIDONTA VIRIDIS (RAFINESQUE, 1820) SPECIES COMPLEX IN THE MIDWESTERN US**
	Kentaro Inoue [1], Michael Compton [2], Scott Faiman [3], Brant Fisher [4], John Harris [5], Tim Lane [6], Anna Pieri [5], Gabrielle Sanfilippo [7], Bernard Sietman [8], Alison Stodola [9], David Zanatta [7]. [1] Shedd Aquarium, Chicago, IL; [2] Office of Kentucky Nature Preserves, Frankfort, KY; [3] Missouri Department of Conservation, Jefferson City, MO; [4] Indiana Department of Natural Resources, Edinburgh, IN; [5] Arkansas State University, Jonesboro, AR; [6] Virgina Department of Wildlife Resources, Marion, VA; [7] Central Michigan University, Mt. Pleasant, MI; [8] Minnesota Department of Natural Resources, Lake City, MN; [9] Illinois Natural History Survey, Champaign, IL.
	As freshwater mussels are one of the most endangered groups of animals, developing effective conservation strategies require better understanding of taxonomic status and ecology of imperiled species. Current efforts using molecular techniques have uncovered hidden diversity in many freshwater mussels and led to taxonomic revisions and descriptions of new species. Alasmidonta viridis (Rafinesque, 1820), Slippershell Mussel, inhabits small headwater streams throughout the Midwestern US including tributaries of the Upper Mississippi River, Ohio River, and Great Lakes and streams of the Interior Highlands. Although A. viridis currently has no federal protection, many states list it as threatened, endangered, or species of greatest conservation need due to declining populations and vulnerability to environmental changes. Despite this, the taxonomic status and genetic diversity of A. viridis have never been assessed. In this study, we collected genetic samples from over 40 sites across the distributional range and assessed phylogenetic structure to evaluate the taxonomy and systematics of A. viridis. Phylogenetic analyses using mitochondrial and nuclear gene sequences revealed that A. viridis was comprised of multiple genetically distinct lineages and possible unrecognized species within the species complex. Furthermore, the genus Alasmidonta was polyphyletic, and generic revisions are warranted. The results will be used to aid future research and conservation efforts including population genomics, controlled propagation, and population restoration.
PL 88 4:40-5:00	**MOLECULAR ECOLOGY OF THE FEDERALLY ENDANGERED FRESHWATER MUSSEL CUMBERLANDIA MONODONTA**
	Austin P. Hannah [1], Kentaro Inoue [2], David J. Berg [3], Kendall Moles [4], Tim Lane [5], Nathan V. Whelan [1]. [1] Southeastern Conservation Genetics Lab, U.S. Fish and Wildlife Service, Auburn University, Auburn AL. [2] John G. Shedd Aquarium, Chicago, IL. [3] Miami University, Oxford, OH. [4] Arkansas Game and Fish Commission, Benton, AR [5] Virginia Department of Wildlife Resources, Marion, VA.
	Freshwater mussels are among the most globally imperiled organisms. Yet, how anthropogenic river modifications have influenced the landscape genetics of most natural mussel populations is very much in its infancy. Cumberlandia monodonta (Unionoidea: Margaritiferidae) was once broadly distributed throughout the Mississippi River drainage. However, anthropogenic river modifications have caused widespread extirpation and have reduced contemporary populations to approximately 20 disjunct streams. Despite extensive fragmentation, past microsatellite research showed a striking lack of genetic structure across the range of C. monodonta. We generated a dataset of thousands of single nucleotide polymorphisms (SNPs) for collection sites across the contemporary range of C. monodonta and hypothesized that genome-scale data would provide higher resolution and reveal patterns of genetic structure not seen in microsatellite-based analyses. Even with thousands of nuclear loci, little genetic structure was found across the range of C. monodonta. We found that the only unique genetic cluster formed from individuals collected in the Ouachita River drainage in Arkansas. Furthermore, we observed no genetic patterns indicating contemporary habitat fragmentation. The effects of fragmentation are likely obscured or simply delayed by the long life cycle of C. monodonta (i.e., 80+ years), whereas the absence of genetic structure is most likely mediated by a highly vagile fish host during the parasitic stage of the life cycle. Our results also provide evidence that genomic data will not always result in inferences of finer-scale genetic structure than microsatellites. From a conservation standpoint, C. monodonta in Arkansas should be treated as a distinct management unit.

Gray title denotes student presentation

Platform Session 7B: Conservation Strategies 3

Wednesday (4/12) 3:40-5:00 pm - Mt. Bachelor

PL 89 3:40-4:00	**USGS STRATEGIC SCIENCE VISION FOR NATIVE FRESHWATER MUSSELS IN THE UNITED STATES**
	David Hu [1], Teresa Newton [2], Nathan Johnson [3]. [1] U.S. Geological Survey, Ecosystems Mission Area, Reston, VA. [2] U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI; [3] U.S. Geological Survey, Wetland and Aquatic Research Center, Gainesville, FL.
	North America is a global center for native freshwater mussel diversity. Mussels are among the most imperiled fauna on the planet. Reasons for local and widespread declines in mussels are largely unknown, although threats can include habitat loss, disease, contaminants, altered flow regimes, invasive species, and climate change. Over the past three decades, there has been substantial research on mussels, however, there are still substantial information gaps that are limiting conservation and management efforts. We developed a U.S. Geological Survey (USGS) science vision for native freshwater mussels to synthesize the existing science gaps that are relevant to the USGS mission and to identify opportunities where the USGS can address these gaps based on the agency's capabilities and expertise. Our intent was to identify focal research themes that are urgently needed to inform conservation and management decisions while making efficient use of available resources. We spoke with resource partners across local, regional, and national organizations and assessed the capabilities of the USGS workforce and identified three focal research themes. Research on biodiversity seeks to enhance the diversity of mussel species and populations to support healthy aquatic ecosystems. Research on emerging stressors seeks to improve the understanding of how mussel species, populations, and communities respond to emerging stressors, including environmental contaminants and climate change. Research on conservation seeks to enhance the recovery of species and populations and to identify data gaps limiting the conservation of mussels and their habitats Given the breadth and scope of the issues facing mussels across the U.S., the themes outlined in this strategic vision can only be accomplished through extensive collaborations between USGS and the full spectrum of natural resource partners, including other federal agencies, state agencies, tribal organizations, universities, industry, non-governmental organizations, and the public.
PL 90 4:00-4:20	**A COMPREHENSIVE FRESHWATER MUSSEL DATABASE FOR THE DUCK RIVER DRAINAGE, TENNESSEE: THE HISTORY OF MUSSELS IN A PRIORITY WATERSHED**
	Kristin I Womble [1] and Amanda E. Rosenberger [2]. [1] Tennessee Cooperative Fishery Research Unit, Tennessee Technological University, Box 5114, Cookeville, TN 38505; [2] U.S. Geological Survey, Tennessee Cooperative Research Unit, Tennessee Technological University, Box 5114, Cookeville TN, 38505
	The Duck River is one of the most biologically diverse rivers in North America, with approximately 60 extant species of freshwater mussels, 15 of which are federally listed. The drainage has been thoroughly surveyed historically and is currently the focus of multiple conservation and reintroduction efforts. An investigation of historical changes in the distribution and abundance of the systems' freshwater mussels would provide important and foundational information for these efforts. However, Tennessee lacks a comprehensive freshwater mussel database, requiring entities to outsource data requests to multiple agencies. This is arduous and time-consuming, inhibiting efficiency in the beginning stages of projects. Therefore, we used the Duck River as an opportune and relevant starting point for a proposed statewide freshwater mussel database. We compiled mussel records from federal, state, and academic entities, as well as museums and published literature, and built a spatially-explicit Microsoft Access database with attributes relevant for freshwater mussel data (e.g. sampling type, sampling effort, shell condition). All records were compiled into a geographic information system in ArcGIS Pro for spatial visualization of species distribution, richness, and abundance. The database includes over 6,500 individual freshwater mussel records of 80 species from the 1800s to 2022, enabling us to describe long-term trends in mussel diversity and abundance in the drainage. This project identifies historical and current core areas of diversity throughout the Duck River drainage and highlights stream reaches that lack recent sampling efforts. The database directly benefits agencies and stakeholders tasked with the management and conservation of the state's biota, improves efficiency of their efforts, and can serve as the basis for multiple future research and conservation initiatives in the Duck River. Additionally, this database serves as a template for a state-wide database and is ready to be expanded into other river drainages in Tennessee.

PL 91 4:20-4:40	**THE SUSTAINABLE RIVERS PROGRAM: MOLLUSK RESOURCES AS INDICATORS IN ADAPTIVE MANAGEMENT OF USACE INFRASTRUCTURE**
	Becca Winterringer[1]. The Nature Conservancy, Worldwide Office, 4245 N. Fairfax Drive, Suite 100, Arlington, Virginia 22203
	The Sustainable Rivers Program (SRP) is a national partnership between the U.S. Army Corps of Engineers (USACE) and The Nature Conservancy (TNC). The mission of SRP is to improve the health and life of rivers by changing dam operations to restore and protect ecosystems, while maintaining or enhancing authorized uses and other project benefits. Now in its 20th year, SRP has grown from seven rivers in 2002 to 46 locations across the continental United States; SRP is the largest scale and most comprehensive program for implementing environmental flows at USACE facilities. Programmatic work focuses on providing opportunities for more environmental benefits from water resources infrastructure. Opportunities are realized in location-based work through adoption of adaptive management strategies that increase environmental benefits of USACE regulated reservoirs, locks and dams, dry dams, and other special projects. Environmental indicators are vast and robust for SRP Projects, and freshwater mussels, specifically, have a significant footprint within the SRP. Flow regimes and how to manage and improve flows for mussels and their hosts have been identified across several SRP project locations. This presentation will highlight the SRP footprint within the Pacific Northwest and present case studies of SRP sites that have integrated mussel diversity, habitat, and life strategy components in associated flow modeling and adaptive management plans at USACE facilities.
PL 92 4:40-5:00	**HABITAT SUITABILITY ASSESSMENT OF LOGGERS CREEK, BOISE, IDAHO**
	Dorene MacCoy. City of Boise, ID.
	Loggers Creek is a multi-use urban side channel of the Lower Boise River, located in Southeast Boise. Historically, the creek was used for lumber transportation, but currently it delivers irrigation water to public users and neighborhoods in southeast Boise. The creek is known to support rainbow trout, brown trout, mountain whitefish, and western pearlshell mussels. Additionally, it offers unique habitat for birds, fish, and other aquatic organisms in an otherwise urban environment. The City of Boise is looking for opportunities to improve habitat conditions as part of the City's water quality program and initiatives to enhance the river and has identified Loggers Creek as a potential habitat enhancement location. The City of Boise and HDR Engineering worked together to update a 2D model originally developed by the Corps of Engineers to describe existing hydraulic conditions in the Lower Boise River Watershed. The model is referred to as the Boise River Management Tool (BRMT). The BRMT was also updated to include existing habitat suitability index (HSI) models developed by Washington Department of Ecology for different life stages of fish. The BRMT uses depth and velocity to identify critical fish spawning and rearing habitat as well as adult life stages. The BRMT has worked well in the mainstem Lower Boise River but lacked resolution to identify critical habitat in smaller tributaries and side channels. The City of Boise conducted a habitat (width, depth, velocity, substrate, fish cover, and fish passage barriers), and mussel field surveys in Loggers Creek at a 50 meter transect resolution to document existing conditions. The model and habitat suitability of Loggers Creek was updated using the field observation. The model does not include measures of fish cover and substrate size which is critical for identifying suitable fish habitat. Both modeled and field surveys were used to identify restoration and habitat improvement projects in Loggers Creek. This study indicated the need for both a modeled analysis of habitat suitability and field observations to make informed decisions on the complexity for Loggers Creek. We are in the process of updating the HIS models specific to the Lower Boise River and include models for freshwater mussels. This effort also provides a study design that could be replicated for other side channels in the Lower Boise River Watershed.

Gray title denotes student presentation

Platform Session 7C: Propagation, Restoration, and Reintroduction 2

Wednesday (4/12) 3:40-5:00 pm - 3 Sisters

PL 93 3:40-4:00	**EVALUATING RESTORED MUSSEL POPULATION GENETICS AND SURVIVORSHIP IN THE CEDAR RIVER WATERSHED**
	Kevin J. Roe and Katelyn Miller. Department of Natural Resource Ecology and Management, Iowa State University, Ames, Iowa 50011
	Three gravid female Threeridge mussels (Amblema plicata) were collected from a population in the Upper Cedar River Watershed in Minnesota and used to propagate a population of juveniles for introduction into the lower Cedar River. Genetic samples were taken from a) the source population, b) the juvenile mussels directly after transformation from glochidia (larvae), and c) the juveniles after a year of growth in the hatchery. Samples were genotyped at 10 microsatellite loci. All three sample sets were significantly differentiated from the source population. Multiple paternity was detected, with the three different maternal broods, increasing genetic variability in the cohort. After a year in the hatchery, extensive mortality was found to have reduced genetic variation, with 94% of the surviving juveniles having been produced from only one dam. The use of three females for broodstock and the contribution of alleles from upstream males initially produced a juvenile population that were as diverse as the source population, but not genetically representative of the source population. Non-random mortality in the hatchery resulted in a biased population of juveniles that were further reduced in genetic variation. Surviving juvenile mussels were placed at four different sites in the Cedar River Watershed in mussel silos (enclosures). Juvenile growth was measured biweekly along with physical environmental conditions, water chemistry, and measures of organic matter availability over two open-water seasons. Juvenile growth was found to be strongly positively influenced by daily minimum water temperature and turbidity, which was the most explanatory food-indicating variable in this experiment. Chlorophyll a and total nitrogen were found to have the strongest negative impacts on growth. Juvenile mussels were tagged with uniquely numbered shellfish tags and passive integrated transponders, released into substrate in one site on the Cedar River in Iowa, and their growth and survival will continue to be monitored.
PL 94 4:00-4:20	**USING FOOD DYE TO BATCH-TAG FRESHWATER MUSSELS**
	John S. Moore [1], Andrew T Phipps [1], Erin Falk [1]. 1 USFWS White Sulphur Springs National Fish Hatchery.
	The need to distinguish between hatchery propagated and wild freshwater mussels is critical to proper conservation and restoration practices as well as assessing overall success of restoration efforts. Current tagging practices involve gluing plastic tags or etching the shell of each animal individually which require a large time investment. With this new tagging method we have designed, dye is added to the water while the mussels are under culture and the subsequent shell growth of the mussels retains the color of the dye, effectively tagging the animals. This new technique of batch-tagging animals with dye drastically reduces the amount of time needed to tag a large group of animals when individual identification is not necessary. While the exact process of how this occurs is currently unknown, only a change in color in the periostracum and the hinge ligament has been observed thus far. After dyeing of the water has stopped, subsequent shell growth returns to normal coloration, leaving a band of color on the shell which can be used to identify batches of animals. So far, early studies do not show a difference in survival or growth rates of animals tagged with dye when compared to control groups. Since the technique is new, studies of the retention of the tag over time are currently ongoing to determine whether the tagging technique will be a viable option for mussel propagation in the future.

PL 95 4:20-4:40	**IDENTIFICATION OF PRODUCTION HOST SPECIES FOR THE SALAMANDER MUSSEL (Simpsonaias ambigua)**
	Andrew T Phipps [1], John S. Moore [1], Aerin Doughty [1]. 1 USFWS White Sulphur Springs National Fish Hatchery.
	Salamander mussel (Simpsonaias ambigua) is a state endangered species in Pennsylvania and listed as critically impaired in West Virginia. The natural host species for the S. ambigua is common mudpuppy (Necturus maculosus). Unfortunately, difficulty of collection and concerns about common mudpuppy populations have stifled salamander mussel propagation efforts in West Virginia. In order to find more sustainable and available host species, two species of salamanders, axolotls (Ambystoma mexicanum) and tiger salamanders (Ambystoma tigrinum), were tested for host suitability for S. ambigua. The natural host N. maculosus was included as a control. Host suitability was determined by two criteria: 1) collecting live transformed juveniles from the potential host, and 2) if collected juveniles were alive and growing after one week. Both salamander species tested proved to be viable host for S. ambigua. The discovery of these new host species will expand the abilities of propagation facilities to produce S. ambigua.
PL 96 4:40-5:00	**SUCCESSFUL IN VITRO TRANSFORMATION OF UNATTACHED ALASMIDONTA HETERODON GLOCHIDIA FOLLOWING EXPOSURE TO HOST FISH**
	Chris B. Eads, Loretta M. Lutackas, and Jay F. Levine. North Carolina State University, Raleigh, NC
	Traditional propagation of freshwater mussels is often done by suspending glochidia in a small volume of water with their host fish until sufficient larval attachment occurs. Afterwards, the majority that do not attach are usually either disposed of or preserved in ethanol. We attempted to salvage unattached Alasmidonta heterodon glochidia following exposure to their host (Etheostoma nigrum) and transform them using in vitro methods. Glochidia from 5 female A. heterodon were extracted and placed in 7 liters of water with 101 Johnny Darters for 30 minutes. Afterwards, fish were removed to separate aquaria, and the remaining glochidia were collected by sieve and thoroughly rinsed with filter-sterilized water. A separate group of glochidia from the same broods exposed only to lab water but not fish for a similar length of time were processed in a similar way. All glochidia were thoroughly rinsed again with sterile Dulbecco's Modified Eagle's Medium, sieved, and processed to remove debris, non-viable glochidia, and those closed on their neighbor. Remaining glochidia were then transferred to cell culture flasks with 5 ml of media containing M199, a mammalian serum mixture, gentamicin, rifampicin, and amphotericin B and incubated at 23°C with 3% CO2. Survival of fish-exposed glochidia was 88.1% after 2 days and 40.9% after 5 days. Glochidia exposed only to water were all dead within three days. After these assessments, as many dead glochidia as feasibly possible were pipetted out using a dissecting scope, and live mussels were carefully transferred to new media flasks. Mortality then slowed significantly, and approximately 2,000 individuals (28.5% survival) fully metamorphosed between days 17-21. Successful grow-out to adulthood and spawning in 18 months using traditional laboratory and wild water methods yielded an increase of 10% in production over use of host fish alone. Further refinement of this technique could yield even greater results.

Gray title denotes student presentation

Platform Session 8A-1: Outreach, Education, and Inclusion

Thursday (4/13) 10:20am-11:00pm - Mt. Hood

PL 97 10:20-10:40	**CONTINUED ASSESSMENT OF SOCIETY DEMOGRAPHICS AND ATTITUDES TOWARDS DIVERSITY, EQUITY, AND INCLUSION**
	Sara R Craft [1], Jer Pin Chong [2]. [1] Kentucky Division of Water, Frankfort, KY; [2] University of Illinois at Chicago, Chicago, IL
	Increased inclusion and support of individuals from historically underrepresented groups continues to be 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. A pilot survey was distributed in 2020 and was updated and distributed a second time in 2022. The 2022 survey included 9 demographic questions, 14 questions regarding perceptions and experiences with FMCS, and one optional opportunity for comments. The survey was distributed to 854 members and recent attendees of FMCS events, and 162 responses were received. While gender and LGBTQ+ status were represented well among participants, race and ethnicity were heavily biased toward individuals identifying as white. Participants age 30 or younger were underrepresented, as were participants without a graduate degree. Most participants reported having worked in their current field for 10+ years. Most participants felt that increasing coverage of DEI topics and initiatives would be a positive step for FMCS, although many participants felt that this goal had not yet been effectively met. Most participants felt that they had an equal opportunity to advance in the society, and were comfortable sharing their identity within FMCS. When asked what activities participants would like to see FMCS focus on in the future, creating a welcoming environment and increasing outreach opportunities to underrepresented groups were among the most popular choices. The DEI committee will continue to distribute this survey every other year and track changes in the demographics and attitudes of FMCS members over time. This survey helps to evaluate the reception of committee initiatives and gauge interest from the larger Society in developing outreach programs that will promote diversity, equity, and inclusion in our community.
PL 98 10:40-11:00	**CITIZEN SCIENCE IN ACTION**
	Danelle Haake [1], Bruce Colravy [2], Hannah-Beth Griffis [1], & Sarah Douglass [3]. 1Illinois RiverWatch, National Great Rivers Research and Education Center, Alton, IL; 2Upper Sangamon River Conservancy, Mahomet, IL; 3Illinois Natural History Survey, University of Illinois Urbana-Champaign, Champaign, IL
	A volunteer led effort to monitor freshwater mussels long-term in a central Illinois river was initiated in 2021. This work is a collaboration between citizen scientists in the Illinois RiverWatch Network and Upper Sangamon River Conservancy (USRC) and partners in research and education representing the National Great Rivers Research & Education Center, Illinois Natural History Survey, Missouri Botanical Garden, and Saint Louis Zoo. With support from the research and education team, experienced citizen scientists with RiverWatch and the USRC implemented a capture-mark-recapture study at 8 sites across the upper Sangamon River that will continue for 10 years. Results from the first two years include marking hundreds of mussels, capturing ~20 species, and recording one live individual of the state endangered Spike Eurynia dilatata. Until 2022, live Spike had not been recorded in the basin in decades. Additionally, this project has produced a short film, mussel story map, and seminars for community events. The ability of this work to impact the long-term conservation of freshwater mussels will be enhanced by bringing the local community into the scientific process and engaging them as partners throughout our project.

Gray title denotes student presentation

Platform Session 8A-2: Surveys and Monitoring 2

Thursday (4/13) 11:00am-12:00pm - Mt. Hood

PL 99 11:00-11:20	**THE UPS AND DOWNS OF BIG RIVER DIVING: MINNESOTA DEPARTMENT OF NATURAL RESOURCES DIVING GUIDE**
	Zeb Secrist , Minnesota Department of Natural Resources, Lake City, MN.
	Self-Contained Underwater Breathing Apparatus (SCUBA) diving is routinely used to conduct freshwater mussel surveys. However, this activity can be dangerous, especially in large rivers where challenges include high flow, limited visibility, underwater obstacles, and other boaters. Traditional safety protocols, such as the buddy system, are not always applicable for this type of scientific diving. Therefore, the Minnesota DNR Center for Aquatic Mollusk Programs has developed and adopted protocols that are best suited for this unique diving setting. I will provide an overview of our sampling procedures, discuss the hazards of big-river diving, and explain the safety protocols we implement that prepare our divers and crew for the unexpected.
PL 100 11:20-11:40	**ASSESSMENT OF SPATIAL VARIATION AND POPULATION CONDITION OF THE ESA PROPOSED GUADALUPE ORB (CYCLONAIAS NECKI) AND FALSE SPIKE (FUSCONAIA MITCHELLI) IN DATA LIMITED PORTIONS OF A CENTRAL TEXAS RIVER BASIN**
	Brad Littrell [1] , Kyle Sullivan [1] , & Lee J Gudgell [2] . 1-BIO-WEST INC., San Marcos, TX; 2-Guadalupe-Blanco River Authority, Seguin, TX
	Three mussel species endemic to the Guadalupe River basin in central Texas were proposed to receive endangered status protections by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act (ESA) in August of 2021: 1) Guadalupe Orb (Cyclonaias necki); 2) False Spike (Fusconaia mitchelli); and 3) Guadalupe Fatmucket (Lampsilis bergmanni). A review of previous survey activity identified large portions of the river basin that fell within the historical reach of these species where surveys have not occurred. Additional data was needed to inform the development of the Guadalupe River Habitat Conservation Plan (GRHCP) to properly determine the effects of covered activities on ESA proposed species. Mussel surveys were conducted on a hydrologically stratified section of the Guadalupe River and San Marcos River tributary to assess the current population condition of ESA proposed species in these data limited areas as well as spatial variation of all mussel assemblages within the study reach. A total of 13,015 mussels represented by 12 species were observed during approximately 218 p-h of sampling effort across 60 sites in five river study segments. Results from Kruskal-Wallis tests failed to detect meaningful differences in species richness ($\chi2 = 5.66$, $p = 0.13$), diversity ($\chi2 = 6.98$, $p = 0.07$), and species evenness ($\chi2 = 2.94$, $p = 0.40$) among study segments. Despite the lack of statistical differences in these community metrics, several notable trends were observed. Diversity and species evenness were generally higher in the San Marcos River as compared to the Guadalupe River segments. A permutational MANOVA analysis also revealed meaningful differences in assemblage structure among study segments ($SS = 4.84$, $F = 11.64$, $p < 0.001$). The results of this study extended the known distributional range of C. necki and F. mitchelli and revealed significant differences in ESA proposed species abundance and recruitment among study segments, with significantly higher recruitment rates in the San Marcos River (7.99%) as compared to the Guadalupe River segments (3.57%-4.35%). Results indicate that populations of C. necki in the San Marcos and Guadalupe rivers are healthier than previously documented and additional monitoring is needed to accurately describe their current distribution and population condition throughout the basin.
PL 101 11:40-12:00	**AN OVERVIEW OF THE UNIONID MONITORING AND BIODIVERSITY OBSERVATION NETWORK (UMBO) – ONTARIO'S LONG-TERM MUSSEL MONITORING PROGRAM**
	Kelly A. McNichols-O'Rourke , Meg Goguen, Mandy P. Gibson, , and Todd J. Morris. Fisheries and Oceans Canada, Burlington, Ontario, L7S 1A1.

	Canada is home to 55 species of unionid mussels and 41 of those are found in Ontario. Of these 41, 15 are considered species at risk (SAR). Shortly after unionid mussel surveys began in earnest in Ontario, it was quickly recognized that a long-term, quantitative monitoring program should be developed with the purpose of collecting baseline information and tracking these important species through time. In 1999, the monitoring program started with 15 sites selected in the Sydenham River – Canada's most speciose mussel river. The sampling protocol delineates a 375 m2 area, where a systematic sampling approach is employed by dividing the area into 25 blocks, each 3 m x 5 m in size. Within each block, three randomly selected quadrats are chosen for complete excavation. Since its inception, the monitoring program, now dubbed the Unionid Monitoring and Biodiversity Observation Network (UMBO), includes over 50 sites across six watersheds. Some of these sites have now been sampled three times, with 5-12 years between each sampling event. Baseline data such as species density and richness have been collected for over 25 species including 11 mussel SAR. To date, results indicate that the unionid assemblages at these sites are either stable or increasing in density and species richness over time. The long-term information collected through UMBO is being used to monitor and support unionid conservation efforts in Ontario.

Platform Session 8B: Human Impacts and Climate Change 2

Thursday (4/13) 10:20am-12:00pm - Mt. Bachelor

PL 102 10:20-10:40	**FRESHWATER MUSSELS AS A FLOOD EARLY WARNING SYSTEM**
	N. Riccardi [1], V. Modesto [1], D. Manca [1], S. Kazmierckzack [1], L. Tosato [2], A. Pilbala [2], S. Piccolroaz [2], L. Fraccarollo [2], N. Benistati [3], D. Termini [3], L. Di Micco [4], D. Viero [4], C. Saltalippi [5], G. Cicioni [6], F. Alimenti [6], R. V. Gatti [6], F. Bahmanpouri [7], S. Barbetta [7], T. Moramarco [7] 1 Water Research Institute (IRSA), The National Research Council (CNR), Largo Tonolli 50, 28922 Verbania, Italy; [2] Department of Civil, Environmental and Mechanical Engineering, University of Trento, Via Mesiano 77, 38123 Trento, Italy; [3] Department of Engineering, University of Palermo, Viale delle Scienze, 90128 Palermo, Italy; [4] Department of Civil, Environmental, and Architectural Engineering, University of Padova, Via Marzolo 9, 35131 Padova, Italy; [5] Department of Civil and Environmental Engineering, University of Perugia, Via Goffredo Duranti 93, 06125 Perugia Italy; [6] Department of Engineering, University of Perugia, Via Goffredo Duranti 93, 06125 Perugia, Italy; [7] Research Institute for Geo Hydrological Protection (IRPI), The National Research Council (CNR), Via Madonna Alta 126, 06128 Perugia, Italy.
	Since future climatic scenarios predict an increase in frequency and intensity of extreme events, understanding how flood conditions affect freshwater organisms are crucial for their conservation. Freshwater mussels' (FM) behavioural responses are increasingly used as an early indicator of environmental disturbances. To date FMs' behavioural responses to physical and chemical stressors were evaluated, particularly temperature and chemical pollutants, but no study evaluated if and how mussels react to hydrological stressors. The first aim of this work was to perform laboratory experiments in artificial flumes to evaluate the eligibility of mussels' behaviour as a biomonitoring tool used in real-time remote systems. To this end, we used the valvometric technique (that exploits the Hall sensor) to measure the mussels' valve gaping behaviour when subjected to different hydrological and sediment transport conditions mimicking the onset of floods. Freshwater mussels promptly reacted to extreme discharge conditions with sediment transport by increasing valve gaping frequencies. The second objective was to test FMs valvometric behaviour in the field to improve the reliability of the data and standardize the use of this methodology for its practical application. For this purpose, experiments were performed to compare sticked and free mussels' responses in rivers. The preliminary results of this field work confirmed that mussels sharply increase their valve gaping in response to extreme conditions promoted by natural floods. Both laboratory and field experiments suggest that mussels' behaviour is a suitable indicator of the change of hydrological conditions and can be used as biomonitoring tool in biological early warning system (BEWS).
PL 103 10:40-11:00	**EFFECTS ANALYSIS OF OIL SPILL RESPONSE ACTIVITIES ON MOLLUSKS: A DEMONSTRATION OF A LARGE-SCALE PROGRAMMATIC ACTION**
	Becca Winterringer [1] and Jerome Popiel [2]. [1] Enviroscience, Stow, Ohio 44224; [2] Ninth Coast Guard District , AJC Federal Building - Room 2083J, 1240 E. 9th Street, Cleveland, OH 44199
	A biological evaluation (BE) to assess the potential for adverse effects on species and critical habitats resulting from oil spill response actions was undertaken by the U.S. Coast Guard between 2020 and 2022. The BE, similar to a biological assessment as a programmatic federal action, provided the framework for the development of future action(s) that are authorized, funded, or carried out at a later time. The BE focused on the potential effects of oil spill response actions within the Action Area (inland and coastal zones of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin, including tribal territories). The effects evaluated were those associated with the specific spill response actions used to minimize the risks from the spilled material during an emergency response, and not the material itself. A total of 90 species, including 10 proposed or designated critical habitats, were considered in the BE. Of the 90 species reviewed, 22 were mollusks. The BE, through a stepwise process by first assessing the likelihood of exposure to spill response actions used within a defined environment, resulted in an analysis of the effects of those spill response actions on ESA-listed species and critical habitat. Environments defined in the context of the BE were: Shorelines; 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 were considered for each species within each habitat type. Information on each species' known range and characteristics was used to determine where each species could occur. A demonstration of the effects pathways for which the effects analysis were derived for mollusks addressed in the BE will be presented.

PL 104 11:00-11:20	**IMPACTS OF SUSPENDED SEDIMENT ON JUVENILE FRESHWATER MUSSELS**
	*Wenyu Zhu [1], Chris Barnhart [2], Henry Brown [1], James Kunz [3], Stephen McMurray [4], Andy Roberts [5], Jeff Steevens [3], Kathleen Trauth [1], Binbin Wang [1], Baolin Deng [1] *. [1] University of Missouri, Columbia, MO; [2] Missouri State University, Springfield, MO; [3] Columbia Environmental Research Center, US Geological Survey, Columbia, MO; [4] Missouri Department of Conservation, Columbia; [5] U.S. Fish and Wildlife Service, Missouri Ecological Services Field Office, Columbia, MO.*
	Stream bed erosion and siltation are major factors impacting benthic organisms, including freshwater mussels. Notably, construction activities, including road and bridge construction, may lead to increased suspended solids and sedimentation in rivers and streams and subsequently affect mussels and their habitat. The effects of elevated suspended solids from construction activities on mussels, especially sensitive juveniles, remains mostly unknown. Here, we investigated the effects of acute exposure (96 h) to suspended sediments on juveniles of three species: Fatmucket (Lampsilis siliquoidea), Arkansas Brokenray (Lampsilis reeveiana), and Washboard (Megalonaias nervosa). We studied two age groups for each species (1 to 2-week-old and 2-month-old) and three sediment types (river sediment from native mussel habitat in the Spring River, Missouri, a terrestrial soil from the Ozark Highlands region with high clay content, and a quarried limestone). Furthermore, a chronic 28-day exposure study was carried out with 2-month-old Fatmucket. Fatmucket was selected as a model because it is a widespread native species and is commonly used for toxicity testing. A concentration series of total suspended solids (TSS) up to ~5000 mg/L was applied. Exposure results showed no lethal effect from either acute or chronic tests with any of the three sediments. However, the chronic study revealed that sediment type and TSS can affect the growth of juveniles. Spring River sediment and Osage clay soil promoted mussel growth at lower concentrations, while all three sediments inhibited juvenile growth at higher TSS levels. Thus, the negative impacts of TSS on juveniles may be limited to long-term and high-level exposures. Ongoing studies also address the effects of sediment deposition and burial of juveniles, and planned studies will investigate sediment effects on adults.
PL 105 11:20-11:40	**MUSSEL POPULATION SHIFTS OVER A CENTURY IN AN URBANIZING WATERSHED**
	Alison P. Stodola [1], Jesse Weinzinger [2], Lisie Kitchel [2], Hugo Y. Ruellan [1], Sarah A. Douglass [1], and Jeremy S. Tiemann [1]. [1] Illinois Natural History Survey, Prairie Research Institute, University of Illinois, Champaign, IL. [2] Wisconsin Department of Natural Resources.
	Urban, agricultural, and industrial development is increasing in many parts of the central and eastern United States and these changes can lead to population shifts in long-lived, sessile species like freshwater mussels. We examined over 150 years of freshwater mussel data from the Fox River watershed to determine whether community assemblages are shifting with land-use change. The Fox River flows from southeastern Wisconsin into north-central Illinois and over 30 species of freshwater mussels have been recorded from this basin. Most early survey and conservation efforts were focused on the mainstem Fox River, which has been dammed and industrialized over the past century. We compiled species richness data, identified areas with unique assemblages, and located habitat or existing locales of rare, endangered species. We sampled ~75 sites in 2020-2022, and confirmed presence of 24 live species in the watershed. Rare or imperiled species such as Snuffbox (Epioblasma triquetra) and Purple Wartyback (Cyclonaias tuberculata) remain extirpated, but we documented diverse, abundant mussel populations in many major tributaries. These data will be used to update the focus of conservation efforts in the watershed, which includes augmentation of state-endangered Rainbow (Cambarunio iris) in Wisconsin. Documenting comprehensive changes in freshwater mussel communities is necessary to understand species shifts and adaptations in a changing environment.
PL 106 11:40-12:00	**THE EFFECT OF AN INDUSTRIAL EFFLUENT HIGH IN MAJOR IONS ON POPULATIONS OF FRESHWATER MUSSELS**
	Patricia L. Gillis [1], Erin E. Hayward [2], C. James Bennett [1], Ryan S. Prosser [3], Joseph Salerno [1], Tanner Liang [2], Shelby Robertson [1], Chris D. Metcalfe [2]. [1] Aquatic Contaminants Research Division, Water Science and Technology Directorate, Environment and Climate Change Canada, [2] The School of the Environment, Trent University, [3] School of Environmental Science, University of Guelph

	The Grand River watershed in a densely populated region of Ontario supports one of the richest assemblages of freshwater mussels in Canada. However, water quality in this watershed is influenced by urban development, agriculture, and industry. Mussel populations and water chemistry in the lower Grand River and its tributary Boston Creek were evaluated to determine whether point sources of pollution such as discharges of domestic wastewater and industrial effluent, and non-point sources of pollution are affecting freshwater mussel populations. Semi-quantitative population surveys (timed visual searches) conducted at nine study sites identified 20 freshwater mussel species, including three (Canadian) Species at Risk. Mussel abundance (34–160 mussels/search hour) and species richness indicated that mussel populations in the lower Grand River watershed are continuing to recover from historical lows reported in the 1970s. However, changes in mussel populations at some sites were consistent with altered water chemistry. Most notable was that mussels downstream of a gypsum plant discharge were significantly smaller in length than those same species upstream of it. The downstream water chemistry was characterized by elevated conductivity (~2000 µS/cm) and calcium (~500 mg/L), as well as concentrations of sulfate (~1000 mg/L) previously shown to be toxic to freshwater mussels. In the Grand River downstream of the confluence with the Boston Creek tributary, there tended to be ($p > 0.05$) fewer mussels (mean 34 ± 20/h) compared to upstream (mean 67 ± 15/h) and this corresponded to altered water chemistry, including elevated sulfate (239 mg/L) downstream of the confluence relative to upstream (58 mg/L). These data indicate that chronic exposure to high levels of major ions is likely driving changes to mussel population structure. In addition, the discharges from an industrial plant may be impacting sensitive biota well beyond the immediate tributary receiving environment.

Platform Session 8C: Propagation, Restoration, and Reintroduction 3

Thursday (4/13) 10:20am-12:00pm - 3 Sisters

PL 107 10:20-10:40	**OBSERVATIONS OF WILD RECRUITMENT IN AUGMENTED POPULATIONS OF THE FEDERALLY ENDANGERED TAR RIVER SPINYMUSSEL (PARVASPINA STEINSTANSANA)**
	Michael Walter [1], Rachael Hoch [1], Chris Eads [2], Michael Fisk [1], Heather Evans [1] and Madelyn McCutcheon [1]. 1North Carolina Wildlife Resources Commission, Raleigh, NC; 2North Carolina State University, Raleigh, NC.
	The Tar River Spinymussel (Parvaspina steinstansana) is a federally endangered freshwater mussel endemic to the Tar-Pamlico and Neuse River basins of North Carolina. Following several seasons of low detection and observing decreasing fertilization rates in wild populations, university researchers and state and federal resource managers began efforts to develop and implement captive propagation techniques for the Tar River Spinymussel in 2008. To date, this work has resulted in the release of nearly 40,000 propagated Tar River Spinymussels across 25 reaches in the Tar-Pamlico and Neuse River basins. Continuous monitoring of augmented populations has confirmed the survival and growth of stocked individuals and, in 2018, gravidity in propagated Tar River Spinymussels was documented for the first time. In April and June of 2022, WRC staff in collaboration with North Carolina State University (NCSU) began the collection of known Tar River Spinymussel host fish species at 2 augmented sites in Little Fishing Creek (Tar-Pamlico basin). Targeted host fish species included Bluehead Chubs (Nocomis leptocephalus), Pinewoods Shiners (Lythrurus matutinus), Swallowtail Shiners (Notropis procne) and White Shiners (Luxilus albeolus). Fish were euthanized and their gills were examined for encysted glochidia. Encysted glochidia were found on 10 of 209 examined fish, 2 of which were visually identified by NCSU staff as Tar River Spinymussels. To confirm identification of the glochidia, WRC geneticists conducted genetic barcoding of individual glochidia using cytochrome c oxidase I (COI) and confirmed the presence of Tar River Spinymussel glochidia on wild host fish gills indicating successful infestation of wild host fish in augmented populations. Additionally, in 2022, a small, untagged Tar River Spinymussel was found in an augmented reach during monitoring surveys. This individual is believed to be the first observation of successful recruitment of propagated Tar River Spinymussels in the wild.
PL 108 10:40-11:00	**RECOVERY OF THE PALE LILLIPUT, TOXOLASMA CYLINDRELLUS: A FEDERALLY ENDANGERED FRESHWATER MUSSEL IN ALABAMA AND TENNESSE**
	Paul Johnson [1], Michael Buntin [1], Todd Fobian [1], Jason Wisniewski [2], Dan Hua [3], Don Hubbs [4], Jesse Holifield [1], and Jeffrey Garner [5]. [1] Alabama Department of Conservation and Natural Resources (ADCNR), Alabama Aquatic Biodiversity Center (AABC), Marion, Alabama; [2] Tennessee Wildlife Resources Agency (TWRA), Nashville, Tennessee; [3] TWRA, Cumberland River Aquatic Center (C-RAC), Gallatin, Tennessee; [4] DLH Environmental LLC, Camden, Tennessee, [5] ADCNR, Florence, Alabama. paul.johnson@dcnr.alabama.gov
	Toxolasma cylindrellus (Pale Lilliput) has been listed as Endangered under the ESA since 1976. Its range was restricted to Estill Fork of Paint Rock River and Hurricane Creek in northeast Alabama until a few specimens were discovered in Lick Creek (Duck River basin) in 2015. Multi-state recovery efforts have focused on establishing new populations with hatchery-reared juveniles. Toxolasma cylindrellus have relatively low fecundity (x = 11,663 glochidia / ♀), yet juveniles have been repeatedly produced by traditional and, recently, in vitro culture techniques. Regional recovery planning identified the Duck River as a priority reintroduction stream for T. cylindrellus and ADCNR donated 802 juveniles to TWRA for the first stocking in September 2014. Seventeen subsequent stockings at seven Duck River basin localities have released an additional 3,402 mussels in the basin. Ten ADCNR stockings in the Paint Rock River have introduced 4,413 individuals at two sites. Three ADCNR stockings at a single site in Bear Creek have released 1,160 additional animals. Finally, TWRA has stocked 563 juveniles into the Elk River at a single site for a total of 11,323 T. cylindrellus released back into their historic range. Monitoring efforts in Alabama and Tennessee repeatedly recovered tagged adults indicating good growth and survivorship. Additionally, TWRA has located young untagged T. cylindrellus near three Duck River Basin stocking localities, and ADCNR verified multiple new recruits at both Paint Rock River reintroduction localities. Targeted survey efforts by ADCNR in 2021 in the upper Paint Rock watershed identified another 12 T. cylindrellus occurrences, including the first live individuals observed in the Larkin and Lick Forks since 1964. Expansion of upper Paint Rock populations and successful reintroduction efforts demonstrates the value of the many habitat improvement projects implemented by TVA and TNC across the species range. In combination, these efforts are meeting stated species recovery goals under the Endangered Species Act and could eventually lead to downlisting.

PL 109 11:00-11:20	**PREDICTING SUITABLE HABITAT FOR CRITICALLY IMPERILED FRESHWATER MUSSELS TO AID FUTURE TRANSLOCATIONS IN EAST-CENTRAL ILLINOIS**
	Hugo Y Ruellan [1] , Kirk W Stodola [1] , Alison P Stodola [1] , & Jeremy S Tiemann [1] . [1] Illinois Natural History Survey, Prairie Research Institute, University of Illinois, Champaign, IL.
	Freshwater mussels are the most imperiled freshwater taxa and translocation of these endangered species is one option for conservation. However, the long-term success of translocations is difficult to determine, in part because the amount of suitable habitat for a translocated species is often not known. The federally-endangered Northern Riffleshell (Epioblasma rangiana) and Clubshell (Pleurobema clava) were recently translocated to the Middle Fork and Salt Fork Vermilion rivers in east-central Illinois, however the total amount of suitable habitat in both rivers remains unknown. To identify suitable habitat for these mussels in the Middle Fork and Salt Fork Vermilion rivers, we sampled 79 sites for surrogate mussel species of E. rangiana and P. clava, along with their host fishes. We investigated habitat suitability by modeling presence/absence and abundance of surrogate mussel species to create a habitat suitability index. We then validated our model predictions using timed searches in year two of our study. Our results indicate there is more suitable habitat than previously believed throughout both rivers and that these rivers should be able to support large populations of these mussels. Our approach also demonstrates how landscape metrics can be used to successfully identify potential sites for future translocations.
PL 110 11:20-11:40	**IN VITRO CULTURE AND PROPAGATION OF FOUR ENDANGERED MUSSELS, THREE EPIOBLASMA SPECIES AND ONE ALASMIDONTA, USING A COMBINATION OF SERUM MIXTURES IN A PHYSIOLOGICAL NUTRIENT SOLUTION**
	Monte A. McGregor , Julieann M. Jacobs, Michelle A. King, Adam C. Shepard, Travis J. Bailey, and Travis Williams. Kentucky Department of Fish and Wildlife Resources, Center for Mollusk Conservation, Frankfort, KY.
	In vitro culture is a process by which glochidia are removed from the adult mussels, placed in nutrient solutions in incubators, and allowed to metamorphose to the juvenile stage. We tested the method with three Epioblasma species, E. brevidens, E. triquetra, and E. obliquata, and Alasmidonta atropurpurea using a mixture of serum types from paddlefish (P) and rabbit (R). We tested mixtures of R only, RP (2:1), and P only for E. brevidens and isolated a few thousand larvae from 2 females in three 100mm petri dishes with 10.23 ml of M199 media, serum mixture (ratio of 2:1), and antibiotics. Dishes were incubated in CO2 (1%) temperature-controlled incubators at 24°. The P only formula had 93% of larvae (5,481) transform, while the R:P and R only mixture had 42% (2,080 juveniles) and 52% (2,822 juveniles) transformation, respectively. In other trials, the R only formula performed poorly for E. triquetra (32-35%), but did work for E. obliquata (43-87%) and A. atropurpurea (57-96%). Due to the poor R only success, we used the P only formula to transform E. triquetra and increased success to 43-91% transformation. Juveniles were placed in 8 L trays with 1,000 to 3,000 juveniles/tray and fed daily 1-2 ml of a mixed diet of cultured freshwater algae and commercially available marine algae (Reed Mariculture) with 53% freshwater to 47% marine by volume, and a trace of probiotic. After four months, survival ranged from 4-19% for E. brevidens (10%), E. triquetra (4%), E. obliquata (15%), and A. atropurpurea (19%). Epioblasma brevidens, E. triquetra, E. obliquata, and A. atropurpurea grew to an average of 4.3 mm, 5.4 mm, 6.0 mm, and 5.3 mm, respectively, in this period. Juveniles were taken to a second rearing hatchery in Lake Cumberland, KY and stocked into floating cages and baskets, where they grew to an average of 13.4 mm, 16.6 mm, 8.1 mm, and 13.51 mm, respectively, for the remainder of the 2022 growing season.

PL 111 11:40-12:00	**RESTORING FRESHWATER MUSSELS TO THE CLINCH AND POWELL RIVERS: MONITORING AND EVALUATION OF THE CERTUS, INC. AND LONE MOUNTAIN PROCESSING, INC. NATURAL RESOURCE DAMAGE ASSESSMENT CASES IN VIRGINIA and TENESSEE, U.S.A.**
	J. Murray Hyde [1], Jess W. Jones [2], William Henley [1], Timothy Lane [3], and Brian Watson [4] [1] Freshwater Mollusk Conservation Center, Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA 24060; [2] United States Fish and Wildlife Service, Virginia Field Office, Department of Fish and Wildlife, Conservation, Virginia Tech, Blacksburg, VA 24060; [3] Aquatic Wildlife Conservation Center, Virginia Department of Wildlife Resources, Marion, Virginia 24354; [4] Virginia Department of Wildlife Resources, Forest, Virginia 24551
	There have been several Natural Resource Damage Assessment and Restoration (NRDAR) cases involving freshwater mussels in recent decades, but none have analyzed whether mussel restoration was successful. This study represents the first evaluation of restoration of freshwater mussels in a NRDAR context. The purpose of this study was to determine whether, and to what extent, mussel restoration was successful for two large-scale, multi-year (>10 years) NRDAR cases in the upper Tennessee River basin of Virginia and Tennessee, the Certus, Inc. and Lone Mountain Processing, Inc. NRDAR cases. We used mussel release data from 2004 – 2017 and a Leslie matrix model to estimate the expected abundance of mussels at nine restoration and monitoring sites in the Clinch and Powell rivers. These expected abundances were compared to estimated abundances from quadrat surveys in 2015 – 2017, and either in 2020 or 2021 at the same sites. Estimated abundance from quadrat surveys was 57% – 85% lower than expected based on Leslie matrix modeling results. While the presence of a stable mussel population was not demonstrated given the limited time frame of this study, there was evidence of successful restoration, such as released mussels reaching breeding ages, presence of mussels at low-to-medium densities at restoration sites, and confirmation of limited recruitment from two species. However, lower-than-expected abundance suggests that mussels are either settling or recruiting outside of restoration sites or that survival and recruitment of released mussels are lower than expected relative to the rates modeled in the Leslie matrix. Further study is needed to determine to what extent each of these factors contribute to lower-than-expected abundance to better estimate the scope of restoration required in future NRDAR cases (e.g., sampling farther downstream to quantify dispersal and recovery of alive or dead mussels to more accurately characterize survival).

Platform Session 9A: Surveys and Monitoring 3

Thursday (4/13) 2:00-3:20 pm - Mt. Hood

PL 112 2:00-2:20	**HISTORICAL IMPACTS CAUSING THE DECLINE OF FRESHWATER MUSSELS AND CURRENT EFFORTS TO DELINEATE REMAINING POPULATIONS – UPPER NIAGARA RIVER, ERIE AND NIAGARA COUNTIES, NEW YORK, UNITED STATES**
	Adam K. Benshoff , Senior Malacologist; EDGE Engineering and Science, Kent, Ohio, U.S.
	The Niagara River is an important binational waterway that connects Lake Erie to Lake Ontario. At the beginning of the 20th century, various chemical and steel industries began to the alter the shoreline landscape of the river. After several years of coordination and development, the U.S. Niagara River Area of Concern (AOC) Habitat Restoration Plan was finalized in 2019. The U.S. Fish and Wildlife Service (USFWS) and New York State Department of Environmental Conservation (NYSDEC) began discussions to conduct assessments and potential restoration efforts within the Niagara River aquatic ecosystem in support of the U.S. Remedial Action Plan (RAP) for the Niagara River AOC. Based on historical museum records, the Upper Niagara River once boasted a diverse mussel assemblage, however, only 22 sites had been assessed for freshwater mussels. Previous survey efforts have occurred in near shore habitats due to pre-construction surveys associated with near-shore project installations. Offshore riverine habitats have been largely excluded from surveys and inherently exhibit a knowledge gap in the extant mussel distribution within the Upper Niagara River. Efforts began in 2020 to develop standardized methods that could be followed to determine occurrence, abundance, distribution, and assemblage characteristics of extant mussel resources in near-shore locations where live mussels were collected as well as offshore habitats. Spanning the 2021 and 2022 survey seasons those methods were field tested using qualitative searches (n=25) and linear transects (n=16) placed perpendicular to river flow with a focal emphasis on offshore habitats. Surveys resulted in the collection of seven live species and 12 additional species collected as deadshell only, including federally endangered Snuffbox (Epioblasma triquetra).
PL 113 2:20-2:40	**ENVIRONMENTAL DNA TOOLS FOR THE CONSERVATION OF FRESHWATER MUSSELS**
	Katy E. Klymus [1] , Dannise V. Ruiz- Ramos [1] , Nathan L. Thompson [1] , Zachary Taylor [2] , Katie Ortiz [2] , Jess W. Jones [3] , M. Christopher Barnhart [4] , Catherine A. Richter [1] 1U.S. Geological Survey, Columbia, MO; 2Virginia Tech, Blacksburg, VA; 3U.S. Fish and Wildlife Service, Blacksburg, VA ; Missouri State University, Springfield, MO
	Freshwater mussels of the Unionida order are greatly imperiled; therefore, improving our ability to detect and monitor these species is crucial to their continued conservation. Environmental DNA (eDNA) analysis is a non-invasive tool that identifies species-specific DNA that is shed into the environment. Here we discuss ongoing projects in our lab to develop eDNA tools that will aid freshwater mussel management. We explain the two major types of eDNA methods (species-specific qPCR assays and community-wide, metabarcoding assays), discuss the types of questions that each can answer and provide examples from our lab. We developed and tested two eDNA metabarcoding assays that are group specific to Unionid mussels, and species-specific qPCR assays that detect markers for two federally endangered mussel species, the oyster mussel (Epioblasma capsaeformis) and the spectaclecase (Margaritifera monodonta). First, we found that species diversity in the Clinch River measured by our metabarcoding analyses reflected species diversity assayed in traditional mussel surveys. Second, we collected spatial and temporal replicate eDNA samples from two rivers, the Clinch River in Virginia and Tennessee and the Big Piney River in Missouri. We used species-specific markers for oyster mussel in the Clinch River and spectaclecase in the Big Piney River to better understand movement of eDNA. We found that detections were highly variable across time and among sampling locations. We discuss how species' natural history and biology, along with population densities may influence eDNA detections. Finally, we discuss future research to improve the utility of eDNA tools for freshwater mussel surveys.

PL 114 2:40-3:00	**DESIGN OF MALE SPECIFIC qPCR ASSAYS FOR THE DETECTION OF FRESH WATER MUSSEL SPAWNING EVENTS**
	Dannise V. Ruiz-Ramos [1], Katy E. Klymus [1], Nathan L. Thompson [1], Megan Voshage [1], Jess W. Jones [2], M. Christopher Barnhart [3], Catherine A. Richter [1]. 1USGS Columbia Environmental Research Center, Columbia, MO. 2Virginia Tech, Blacksburg, VA. 3Missouri State University, Springfield, MO.
	North American freshwater mussels are of special concern due to their ecological and cultural importance, high endemism, and high imperilment. Monitoring mussel populations is difficult because of their burrowing habit and patchy distribution. Environmental DNA (eDNA) analysis could aid in detecting mussel beds, endangered species, and spawning events. For many species of freshwater mussels, the timing and duration of gamete production and release are unknown. Here, we use eDNA to detect spawning in two mussel species, the mucket (Actinonaias ligamentina) and the spectaclecase (Margaritifera monodonta), taking advantage of a unique trait of bivalve biology. Mussels from the Order Unionida inherit mitochondrial genomes from both parents, with the two genomes evolving independently. This trait is known as Doubly Uniparental Inheritance (DUI) and was first observed in marine bivalves. Female mussels inherit female-transmitted mitochondrial genomes, and male mussels inherit the mitochondrial genomes from both parents. While maternal-inherited mitochondria are found in female gonads and somatic tissues of both sexes, the paternal-inherited mitochondria are found in the gametes and gonadal tissue of the male. We developed male-specific eDNA assays that could be used to detect sperm released into the water. We designed species-specific qPCR assays from available male mitochondrial genomes and tested the assays for species and sex specificity. We performed pilot studies to detect spawning activity in experimental ponds. Our results will help inform the design of eDNA monitoring studies and interpretation of eDNA results for managers guiding freshwater mussel conservation efforts.
PL 115 3:00-3:20	**INVESTIGATING FRESHWATER MUSSEL DISTRIBUTIONS IN THE ALTAMAHA RIVER SYSTEM IN SUPPORT OF A CANDIDATE CONSERVATION AGREEMENT (CCA)**
	Matthew T Rowe [1] Georgia Department of Natural Resources; Social Circle, GA
	The Altamaha River System contains a diverse freshwater mollusk assemblage including five endemic mussels, one of which is federally Endangered, and other rare mollusk species. In 2018, the Georgia Department of Natural Resources entered a Candidate Conservation Agreement with Georgia Power and the US Fish and Wildlife Service to evaluate and monitor populations of rare mollusks in the Altamaha Basin with a focus on Georgia Power generating facilities. In the first four years of the project, four reservoirs and portions of the associated Ocmulgee and Altamaha River were sampled to establish distributions and relative abundances for target species. Timed surveys were conducted using a variety of sampling methods including snorkeling, surface supplied air, and SCUBA diving. To date, the project has observed over 15,000 individual mussels from 15 different species. Both natural and manmade features were found to dictate mussel distribution patterns. One of the rarest species, the Altamaha Spinymussel has not been detected despite surveys at sites where the species was historically present.

Platform Session 9B: Status and Distribution of Mollusks 4

Thursday (4/13) 2:00-3:20 pm - Mt. Bachelor

PL 116 2:00-2:20	**AN UNUSUAL FINDING OF THE SALAMANDER MUSSEL (SIMPSONAIAS AMBIGUA): IMPLICATIONS FOR DETECTABILITY AND CONSERVATION STATUS**
	William C. Fleece [1], Noah Berg [1], Elizabeth Johnson [1], Lisie Kitchel [2], Jesse Weinzinger [2], and Gregory Brecka [3]. 1. Stantec Consulting, Cincinnati, Ohio; 2. Wisconsin Department of Natural Resources, Madison, Wisconsin; 3. Wisconsin Department of Transportation, Madison, Wisconsin.
	In the summer of 2022, a large population of Salamander Mussels (Simpsonaias ambigua) was collected at the tributary junction of the Wisconsin River and Long Lake in Richland County, Wisconsin. The survey was commissioned by the Wisconsin Department of Transportation (WisDOT) as part an effort to replace the existing State Trunk Highway (STH) 130 Crossing of the Wisconsin River. A total of 1,648 live mussels from 21 species were relocated from the salvage area. Salamander Mussels (n = 711) were the most abundant species collected. A population of this size is highly unusual and a review of prior collecting data in the State of Wisconsin revealed that the 2nd highest total for this species was 30 individuals. In September of 2011, the U.S. Fish and Wildlife Service initiated a status review for Salamander Mussels based on a preliminary finding that listing may be warranted. The primary habitat occupied by the Salamander Mussels was one hundred percent bedrock which is atypical for unionid mussels. Most of the animals were found deep in the voids of shallow overlapping sandstone layers. This habitat type could be inaccessible or easily overlooked during traditional unionid surveys. Few other unionid mussels were found in this habitat type suggesting a high degree of specialization. This study has important implications for Salamander Mussel detectability and conservation status, perhaps pointing out the need for a more focused study of this specific geologic feature. Further, it may be possible to replicate these habitat features for population augmentation, if warranted, for future conservation of this species.
PL 117 2:20-2:40	**PAUL HUGHES PRESERVE MUSSEL INVENTORY SURVEYS**
	Aaron Prewitt and Casey Swecker, Edge Engineering and Science, LLC. (4005 Ponder Drive, Cincinnati Oh, 45244)
	The Paul Hughes Preserve is a newly formed nature preserve in Monroe County, West Virginia. The preserve contains approximately 4,035 feet (1,230 meters) of Southfork Potts Creek and Potts Creek. South Fork Potts Creek is known to support populations of the federally endangered James Spinymussel (Parvaspina collina – formerly Pleurobema collina). Stream restoration efforts included mussel inventory surveys to better understand the resident community. Survey conditions were optimal with clear water, visibility greater than one-meter, minimal recent rainfall, and direct overhead sunlight. Surveys covered 1,230 meters of stream and over 54 person hours of search time. Surveys yielded 22 live James Spinymussel and 2 Creeper (Strophitus undulatus) from Southfork Potts Creek. Within the mainstem Potts Creek portion of the survey (downstream of the confluence of Southfork Potts Creek and Potts Creek), fish and macro invertebrates were abundant; however, no live mussels or deadshell material were observed. This may be due to cold mountain spring water inputs from North Fork Potts Creek. The results of the survey confirm the status of a reproductive population of federally endangered James Spinymussel within the Paul Hughes Preserve and facilitate future restoration efforts.
PL 118 2:40-3:00	**CONSERVATION STATUS OF HAWAII'S FRESHWATER LYMNAEIDAE**
	Kenneth A. Hayes [1], Keahi M. Bustamente [2], David R. Sischo [2], Norine W. Yeung [1]. 1 Bernice P. Bishop Museum, Honolulu, HI; 2Hawaii State Department of Land and Natural Resources, Honolulu, HI

	Freshwater ecosystems are among the most critically imperiled systems in the world, with nearly one in three species threatened with extinction. Accurate data regarding species identities, distributions, abundances, and range contractions are all critical for developing best practices to manage aquatic resources and stem the tide of extinction. Native Hawaii freshwater snails belong to Neritidae, comprising three species, and the Lymnaeidae with four recognized species. Unfortunately, their dull brown coloration and often inconspicuous nature has brought the Hawaiian lymnaeids less attention than the land snails, yet the potential for extinctions of freshwater species is considerably higher. The taxonomic framework for the Hawaiian Lymnaeidae is more than 70 years old, and except for Erinna newcombi, which is protected under the US Endangered Species Act, no conservation assessments of lymnaeids in Hawaii have been done in the last century. Hubendick recognized five species of native lymnaeids in Lymnaea, and considered all widespread on multiple islands, except for L. (Erinna) newcombi. Others recognized two species of Erinna and two in Lymnaea. To update the taxonomic framework necessary for effective conservation we have been completing surveys across the main Hawaiian Islands and analyzing historical and recently sampled collections in an integrative framework. Phylogenetic analysis of snails from the main Hawaiian Islands indicates that there are at least a dozen endemic species, and possibly as many as twenty, including the only two species of sinistral lymnaeids in the world. Species in this small radiation of lymnaeids are geographically restricted to drainages, and in some cases consist of only a handful of individuals in a single population. Most are found in highly ephemeral 'vertical wetlands' associated with waterfalls and seeps. Negative impacts from habitat modification, climate change, and invasive species are likely to extirpate these populations, resulting in extinction a diverse fauna that remains poorly understood.
PL 119 3:00-3:20	**AN UPDATE ON THE FRESHWATER MUSSELS (BIVALVIA: UNIONOIDEA) OF VIETNAM**
	Arthur E. Bogan [1] and Van T. Do [2] . [1] North Carolina Museum of Natural Sciences, Raleigh NC, USA. Arthur.bogan@naturalsciences.org ; [2] Institute of Ecology and Biological Resources (IEBR), Vietnam Academy of Science and Technology (VAST), Ha Noi, Viet Nam.
	Vietnam has a high diversity of freshwater mussels in the Indo-Burma area. Fifty-nine freshwater mussel species of Unionoida have been reported from Vietnam. However, over the past six years there has been a tremendous increase in integrative work on the phylogeny of the freshwater mussels of Asia. Reviewing this work, we have updated the taxonomy of the Unionoid fauna of Vietnam. This has resulted in the recognition of 5 new tribes, 6 new genera, 16 species transferred to different genera, 1 genus synonymized, 2 new species described, and another discovered, described, and submitted, and 4 species moved into synonymy. The revised list of the Unionoidea of Vietnam contains 2 families, 4 subfamilies, 12 tribes, 29 genera, 58 species. Total freshwater mussel species recognized in Vietnam has decreased by two species but reflects a better understanding of the relationships of the Vietnamese fauna. During the past six years the IUCN Red List of Threatened Species has updated six assessments for Unionoidea from Vietnam. This resulted in two changes from Data Deficient to Least Concern. The taxonomic change of one species changed its conservation status from Not Examined to Endangered. Conservation status and basic biological information on these freshwater mussels is still under researched and information on host fish is lacking. Based on these new results it is clear more focused field work is required to better understand this fauna. These data are critical to the conservation of these species.

Platform Session 9C: Propagation, Restoration, and Reintroduction 4

Thursday (4/13) 2:00-3:20 pm - 3 Sisters

PL 120 2:00-2:20	**IMPLEMENTATION OF A REGIONAL "MUSSELS FOR CLEAN WATER INITIATIVE" FOR THE UPPER MID-ATLANTIC REGION**
	Leah Morgan , Danielle Kreeger, Kurt M. Cheng, Matt Gentry. Partnership for the Delaware Estuary, 110 S Poplar St, Suite 202, Wilmington DE, 19801.
	Both currently and historically, freshwater mussel restoration work has focused on biodiversity conservation goals. However, natural mussel assemblages are often dominated by more common species that are also in decline, evidenced by dwindling abundance, limited recruitment, and shrinking distributions. Depletion of entire assemblages results in reduced ecosystem services, such as their biofiltration and transformation of polluting particles (e.g., suspended solids, nutrients, pathogens), undermining management efforts to sustain water quality. The Mussels for Clean Water Initiative (MuCWI) was launched in 2019 to promote cleaner water in freshwater systems in the upper mid-Atlantic region, especially the Delaware and Susquehanna River Basins. One focus is projects to reestablish assemblages in natural systems, where viable. In urban areas with impaired water quality, genetically-appropriate mussels are also being introduced into man-made systems (e.g., stormwater ponds) and augmented in living shoreline projects that improve mussel carrying capacity via habitat improvement. To furnish mussels for restoration, research, monitoring, and outreach, a new hatchery is being designed in Philadelphia, Pennsylvania, along with regional mussel rearing centers having suitable ponds for grow-out. The annual propagation goal is 500,000 taggable-sized (>20 mm) mussels. Initially, MuCWI will focus on producing "foundational" species needed to establish mussel beds, thereby improving habitat suitability for rarer species that can be added later. Ideally, the final relative species abundance will mimic that of natural assemblages at nearby reference sites. Pilot projects to restore mussels in streams, enhance mussels along shorelines, and introduce mussels into reservoirs and stormwater ponds have shown very promising growth and survival using hatchery-produced mussels. This initiative expands the toolkit of nature-based tactics that can help sustain vital ecosystem services, which may be especially useful in watershed areas having impaired water quality and a history of environmental injustice.
PL 121 2:20-2:40	**MAKING CONNECTIONS: PENNDOT'S HUNTER STATION PROJECT REINTRODUCED FRESHWATER MOLLUSKS TO THEIR HISTORIC RANGES AND CREATED NEW CONNECTIONS BETWEEN THE RIVER'S COLLECTIVE STAKEHOLDERS**
	Philip T. Mathias [1] , Shane Titus [2] , and Gregory F. Zimmerman. [1] Enviroscience, Stow, Ohio 44224; [2] Seneca Nation of Indians 90 Ohi:yo' Way Salamanca, NY 14779
	The Hunter Station Bridge Replacement Project over the Allegheny River has been recognized as a unique and significant endangered freshwater mussel project due to the size and geographic scale of the effort. The project was funded by the Pennsylvania Department of Transportation (PennDOT) and Federal Highway Administration (FHWA). EnviroScience, the project teaming partners and stakeholders completed the salvage, relocation, and monitoring of federally and state endangered as well as non-listed mussels. Federally listed mussel species were relocated to suitable habitats to re-establish or augment existing populations throughout their historic ranges in PA, OH, NY, WV, KY, IN, IL, IA, and the Seneca Nation of Indians. The Allegheny Territory of the Seneca Nation of Indians (Seneca Nation) includes the upper Allegheny River from the Pennsylvania Border upstream to Vandalia, New York. A total of 680 Clubshell (Pleurobema clava) and 503 Northern Riffleshell (Epioblasma rangiana) were relocated to the Seneca Nation in an effort to reestablish these mussels above the Kinzua Dam. Mussels on the Seneca Nation's lands were monitored for their growth and survivorship and through these efforts spawned additional research, collaborations, and field surveys. The Seneca Nation example was not unique as this multi-jurisdictional and agency effort continues to promote collaboration between many stakeholders across the 600+ mile relocation area. This talk will further discuss the cultural and landscape-level success of this collaboration, results of the mussel reestablishment on Seneca Nation lands, the partnership between PennDOT and the Seneca Nation, and the continued mussel efforts put forth by the Seneca Nation.

PL 122 2:40-3:00	**HIGGINS EYE REINTRODUCTION TO THE CHIPPEWA RIVER: A SURVEY SUGGESTS SUCCESS**
	Megan Bradley , Elizabeth Glidewell. USFWS, Genoa National Fish Hatchery, Genoa, WI.
	The Higgins Eye Pearlymussel (Lampsilis higginsii) was listed as endangered under the Endangered Species Act in 1976. Since listing, the known range has expanded, and there have been increased monitoring efforts, improvements in sampling and propagation techniques, reintroductions, and greater emphasis on research. The population objective for range-wide recovery of the Higgins eye is at least five EHAs that contain reproducing, self-sustaining populations that are not threatened by zebra mussels, and that are sufficiently secure to assure long-term viability of the species. The ability to propagate and reintroduce L. higginsii into habitats that it occupied historically has facilitated its path towards recovery. The Chippewa River in Wisconsin has been considered as a potential reintroduction location for L. higginsii since the early 2000's. It contains high quality mussel habitat and is likely part of its historical range. The first reintroduction site was selected based on 2016 surveys due to a diverse mussel assemblage, including the presence of another endangered mussel, the Sheepnose (Plethobasus cyphyus), and the previous reintroduction 177 Winged Mapleleaf (Quadrula fragosa). The Recovery Plan down-listing criteria were used, along with the surveyed mussel community densities and conservative 5- and 10-year survival rates for the subadult Higgins Eye, to calculate that 3,000 subadults were needed to maintain the reintroduced population for at least 20 years. Genoa National Fish Hatchery has been involved in the propagation, augmentation, and survey of Higgins Eye since 2000. Hatchery staff reared, and with partners, tagged and placed 2,997 Higgins Eye at the Chippewa site in 2017. A monitoring survey in 2021 found a survival rate of approximately 100%. No more than a dozen shells have been collected during interim qualitative assessments, and active luring has been observed in early autumn. This interim survey, along with the observed reproductive behavior, suggests that there is the possibility of the successful persistence of this reintroduced population.
PL 123 3:00-3:20	**PROPAGATION AND CULTURE OF ENDANGERED FRESHWATER MUSSELS FOR RESTORATION & SERUM SELECTION IN IN-VITRO CULTURE OF GLOCHIDIA**
	Dan Hua [1], Parker L. Hildreth [1], Kellie L. White [1], Lacy M. Huffman [1], Ashttan Sims [1], Josh Campbell [2] & Chris Simpson [2]. 1Cumberland River Aquatic Center, Tennessee Wildlife Resources Agency, Gallatin, TN; 2Biodiversity Division, Tennessee Wildlife Resources Agency, Nashville, TN.
	Propagation of freshwater mussels for restoration has achieved remarkable progress in US and has become a primary strategy to recover populations of endangered species. However, juvenile mussel production of those critically endangered species is still at a very limited scale. The Cumberland River Aquatic Center (C-RAC) of Tennessee Wildlife Resources Agency was established to work with partners to propagate and produce endangered aquatic wildlife; and to conserve, protect and restore their jeopardized population and ecosystems. Fourteen federally listed endangered species have been produced at C-RAC since 2016. A total of 56,142 juvenile mussels including 10 federally listed endangered species were propagated in 2022. Of those, Hemistena lata, Epioblasma ahlstedti, Plethobasus cyphyus and Pleurobema plenum are critically endangered and very difficult to be propagated in great quantity. With the massive selection of serum, the productions of these species were highly increased through in-vitro culture. And 36,265 juvenile mussels including 9 endangered species of freshwater mussels were produced through in-vitro culture at C-RAC in 2022. Five critically endangered species including Hemistena lata, Epioblasma ahlstedti, Plethobasus cyphyus, Pleurobema plenum and Pleuronaia gibber were produced through in-vitro culture for the first time. Our results revealed that in-vitro culture media, serum or fish plasma are species specific. Glochidia of Hemistena lata preferred Media M199 associated with horse serum while glochidia of Plethobasus cyphyus achieved the highest transformation rates into juveniles in horse serum compared with those in rabbit serum and rainbow trout plasma. Glochidia of Pleurobema plenum reached similar transformation rates in horse serum and rabbit serum. Addition to above, recruitments of Toxolasma cylindrellus, Epioblasma brevidens and Epioblasma capsaeformis were detected at our restoration sites in Duck River and Powell River that implied the primary success in recovery of those endangered species through propagation and restoration efforts.

Platform Session 10A: Conservation Strategies 5

Thursday (4/13) 3:40-5:00 pm - Mt. Hood

PL 124 3:40-4:00	**RECENT RECOVERY EFFORTS FOR THE CRITICALLY IMPERILED FRESHWATER MUSSEL THELIDERMA SPARSA: A CASE STUDY TO INSPIRE THOSE MANAGING SPECIES ON THE BRINK**
	Tim Lane [1], Tiffany Leach [1], Sarah Colletti [1], Joseph Ferraro [2], Rose Agbalog [3], Caitlin Carey [4], and Jess Jones [5] [1] Virginia Department of Wildlife Resources, Marion, VA. [2] Virginia Department of Wildlife Resources, Marion, VA (retired). [3] U.S. Fish & Wildlife Service, Abingdon, VA [4] Conse Management Institute, Virginia Tech Polytechnic Institute and State University, Blacksburg, VA. [5] U Fish & Wildlife Service, Blacksburg, VA
	Theliderma sparsa is one of the most critically imperiled North American unionids. Since listed endangered (1976), few objectives identified in the recovery plan have been achieved. A single isolated population of unknown viability remains, spanning a 20-mile reach of the Powell River, TN/VA. From this reach, 5 female and 3 male mussels were collected to start a captive breeding population between 2019–2021, requiring extensive inter-agency planning, permitting, funding, and hundreds of hours of search effort. To overcome obstacles inhibiting successful captive propagation in the past (propensity to abort unfertilized eggs and embryos when handled), a novel long-term holding technique was developed in 2019 using flow-through aquaculture pans with natural food and temperature regimes, allowing behavior to be closely monitored and viable glochidia to be collected in a controlled and predictable manor. Ultimately, 4 females became gravid and released viable-glochidia while unexpectedly demonstrating multiple brooding in a season. Host-fish identification efforts compounded challenges to metamorphose juveniles, until Erimystax insignis was identified as a highly suitable host in 2020. In 2021, a cohort of 858 juveniles was successfully collected from 24 E. insignis. With advancements in culture techniques and diets, 165 (19%) juveniles survived to 16 months and grew to 15–20 mm in length. Of these, 125 were successfully released into the upper Clinch River, VA in fall 2022 to augment a recently extirpated population, while 40 remain in culture to facilitate future captive-breeding attempts. Additionally, preliminary evaluations of within population (broodstock) genetic diversity, using mtDNA, have revealed unique haplotypes for each individual; however, nucleotide diversity was low. These efforts aim to increase redundancy of T. sparsa and reduce the risk of extinction posed by acute and chronic anthropogenic impacts to a single population. Maintaining robust wild-populations of identified hosts will be essential for the persistence of this host-specialist mussel.
PL 125 4:00-4:20	**USING VOLUNTARY CONSERVATION AGREEMENTS FOR FRESHWATER MUSSEL CONSERVATION IN THE AMERICAN SOUTHWEST**
	Matthew Johnson [1], Erik Orsak [2] & Charles Hayes [3]. [1] U.S. Fish and Wildlife Service Austin Ecological Service Field Office, Austin, Texas, [2] U.S. Fish and Wildlife Service Arlington Ecological Service Field Office, Arlington, Texas, [3] U.S. Fish and Wildlife Service Albuquerque Ecological Service Field Office, Albuquerque, New Mexico
	Texas and New Mexico are home to more than 50 species of freshwater mussels, many of them state or basin-level endemics. A dozen of these species are currently in various stages of review by the U.S. Fish and Wildlife Service for potential listing under the Endangered Species Act (ESA), and one other mussel species (Texas Hornshell) has already been listed as endangered. In a region as large and diverse as the U.S Southwest, the Service strongly believes that partners will be key contributors to the conservation and recovery of freshwater mussels. The existence of 14 River Authorities in Texas, self-supported public agencies that manage surface water resources, creates unique opportunities to achieve these conservation goals. Currently, the Service is working with several of these organizations, as well as industry partners in New Mexico, to develop voluntary conservation agreements, Candidate Conservation Agreements with Assurances and Habitat Conservation Plans. In some cases, these agreements have the potential to preclude the need to list a species under the ESA, when proactively implemented early enough and with sufficient conservation. In the event of a mussel species being listed under the ESA, the permits associated with these agreements will allow the participants to continue covered operations while still leveraging their standing in their respective basins to pursue conservation goals. The Service will discuss the freshwater mussel conservation opportunities and challenges provided by these voluntary agreements and unique state-level entities.

PL 126 4:20-4:40	**ASSESSING THE FEASIBILITY OF A MUSSEL REINTRODUCTION INTO THE MISSION REACH OF THE SAN ANTONIO RIVER, SAN ANTONIO, TEXAS**
	Austin Davis [1], Christopher Vaughn [1], Shaun Donovan [1], Belize Lane [2] & Megan Conley [2]. 1San Antonio River Authority, San Antonio, Texas; 2Utah State University, Logan, Utah.
	Freshwater mussels historically inhabited the Upper San Antonio River, however, due to urbanization over the past several decades, a near extirpation has occurred within the urban segments despite thriving populations downstream. In 2013, a previously channelized eight-mile portion of the Upper San Antonio River, the Mission Reach, was rehabilitated by increasing instream cover and improving resiliency. The San Antonio River Authority has begun assessing the feasibility of reintroducing freshwater mussels in the Mission Reach to increase connectivity with downstream populations and incorporate new ecosystem services into the urban reach. The four most abundant species identified within the San Antonio River basin were chosen for reintroduction: Amblema plicata, Cylconaias pustulosa, Lampsilis teres, and Tritogonia verrucosa. Feasibility of reintroduction was assessed through three major tasks: survivability and growth, habitat suitability, and propagation. Adult mussels were sourced from healthy populations in Lower San Antonio River and placed in cages, two experimental sites within the Mission Reach and one control site in Goliad County, Texas. Growth and survival were measured over the course of two years. Results from this study indicated that the observed mussel growth and survival within the Mission Reach were comparable to, and in some cases exceeded, that of the control site. The modeling of potential suitable habitat is an ongoing effort in partnership with outside government agencies and universities that is anticipated to be completed in 2023. Inks Dam National Fish Hatchery is working on propagation techniques with the goal of introducing propagated mussels into the Upper San Antonio River in the Spring of 2024. The reintroduction of native freshwater mussels is essential for a more complete ecological restoration and reintroduction of the ecosystem services that native mussels provide.

Platform Session 10B: Status and Distribution of Mollusks 5

Thursday (4/13) 3:40-5:00 pm - Mt. Bachelor

PL 127 3:40-4:00	**BARTRAM'S MISSISSIPPI SPINY MUSSEL**
	Nathaniel F. Shoobs [1] & Alan R. Kabat [2] 1Museum of Biological Diversity, The Ohio State University, Columbus, OH; 2Museum of Comparative Zoology, Harvard University, Cambridge, MA
	"Spiny mussels"—freshwater mussels with spiny projections on their shells—are extremely rare. Of the 850 extant species in this highly speciose, cosmopolitan family of freshwater bivalves, only three are known to produce spines. These three species of spiny mussels are restricted range endemics of the east coast of North America, specifically the South Atlantic Slope region (southern Virginia to Georgia, U.S.A.). Here, we discuss a credible historical record from 1775 of a possible fourth species of "spiny mussel" from the lower Mississippi River in central Louisiana, and its implications for the biogeography of spiny mussels.
PL 128 4:00-4:20	**FRESHWATER MUSSEL INVESTIGATIONS IN MÉXICO (2017-2022)**
	Kevin S. Cummings & Jeremy S. Tiemann. Illinois Natural History Survey, Prairie Research Institute, University of Illinois, Urbana-Champaign, IL.
	The Recent freshwater mussels of the Order Unionoida are represented by six families: Unionidae Rafinesque, 1820, Margaritiferidae Henderson, 1929, Hyriidae Swainson, 1840, Iridinidae Swainson, 1840, Mycetopodidae Gray, 1840, and Etheriidae Deshayes, 1830. The Unionidae and Mycetopodidae are represented in Central America but the fauna is poorly known and is badly in need of revision. Historically, the freshwater mussels of Central America have been associated with Nearctic lineages. However, the Central American assemblage is distinct from that of North America and endemic to the American tropics. Field surveys over the past five years were conducted in four major basins that drain to the Gulf of México – from north to south: the Conchos, a Río Grande tributary in Chihuahua (2018); the Pánuco in San Luis Potosi (2017, 2018); the Papaloapan in Veracruz (2022); and the Usumacinta in Chiapas and Tabasco along the Guatemalan border (2019). In general, the streams we investigated in the Pánuco and Usumacinta were of high quality with a largely intact and abundant mussel fauna. Streams in the Conchos were devoid of native bivalves and invasive Asian clams (Corbicula) were widespread and abundant. Sampling conditions in the Papaloapan were not ideal because of recent rains but it was clear that the rivers there have been degraded to a large extent. Some, like the Río San Juan, still harbor mussels. As with the Conchos, non-native mollusks were widespread and abundant in the Papaloapan. Melanoides tuberculata (Müller, 1774) and Corbicula fluminea (Müller, 1774) were present at nearly all sites. Cummings et al. (In preparation) are preparing a monograph on the freshwater mussels of Central America to be published later this year or in early 2024. Freshwater mussel distribution maps have been prepared based on data from thousands of museum specimens and field surveys in select rivers in México.
PL 129 4:20-4:40	**USING OCCUPANCY MODELING TO ASSESS APPALACHIAN ELKTOE (ALASMIDONTA RAVENELIANA) DISTRIBUTION IN A MONTANE STREAM**
	Chantelle Rondel [1], Zachary Farris [2], Jason Mays [3], and Michael Gangloff [2]. 1North Carolina Wildlife Resources Commission, Waynesville, NC; 2Appalachian State University, Boone, NC; 3United States Fish and Wildlife Service, Asheville, NC.

	Freshwater mussels, including some of the most endangered and difficult to detect taxa, can be challenging to sample for many reasons. Understanding factors influencing detectability of endangered species allows for better estimates of site occupancy and distribution, both critical components of managing at-risk species. However, few studies have attempted to incorporate detectability into estimates of freshwater mussel occupancy rates. We sampled 23 sites within the South Toe River for Appalachian elktoe (Alasmidonta raveneliana), a state and federally endangered freshwater mussel, to determine its distribution throughout the river and used a pseudo-occupancy approach to model how abiotic factors contribute to mussel detectability as well as how imperfect detection influences occupancy estimates. We found that 17 of the 23 sites surveyed were occupied by Appalachian elktoe, with the most densely-populated sites occurring within a relatively short span of the South Toe River. Model results suggest that the probability of occupancy was influenced by site characteristics and that detectability was influenced by site characteristics and survey conditions. The results of this study suggest that the abundance and distribution of Appalachian elktoe in the South Toe River is larger than previously believed based on data from historical monitoring sites. Results of occupancy modeling suggest that sampling conditions, substrate composition, and the experience level of searchers may all influence detectability of freshwater mussels. Presence/absence data may be obtained relatively quickly during snorkel surveys and a pseudo-occupancy approach allows for searchers to only visit a site one time, making occupancy modeling an effective tool for monitoring mussel populations using limited resources or in difficult-to-access or seldom-surveyed reaches. However, it is also important to select and measure site co-variates at scales that are both relevant to mussel ecology and survey methodology.
PL 130 4:40-5:00	**WHAT IS A SPECIES STATUS ASSESSMENT? INFORMING LISTING DECISIONS UNDER THE ENDANGERED SPECIES ACT**
	Alyssa Bangs . U.S. Fish and Wildlife Service.
	In 2020, the U.S. Fish and Wildlife Service (USFWS) was petitioned to federally list the western ridged mussel (Gonidea angulata) under the Endangered Species Act (ESA). The western ridged mussel is a freshwater mussel restricted to northwestern North America and is the only species within the genus Gonidea. It occurs in California, Oregon, Washington, Idaho, Nevada, and British Columbia, although its distribution has decreased compared to its historical range. The USFWS determined that the petition presented substantial information indicating that listing may be warranted; the USFWS is now reviewing the species to determine if listing under the ESA is warranted. This review process includes using the best available science to complete a Species Status Assessment, a rigorous and repeatable evaluation of species' biology and factors influencing the species, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain long-term species viability. The result is a single report which can then be used to inform all ESA decisions, including listing status, research needs, recovery actions, and how public or private actions may affect the species.

Platform Session 10C: Life History and Ecology 2

Thursday (4/13) 3:40-5:00 pm - 3 Sisters

PL 131 3:40-4:00

SPAWNING TIME MITIGATES ITERATIVE SEASONAL TRADE-OFFS BETWEEN REPRODUCTION AND MORTALITY IN THREATENED FRESHWATER MUSSEL

Tadeusz A. Zając & Katarzyna Zając, Institute of Nature Conservation, Polish Academy of Sciences, 31-120 Kraków, Al. A. Mickiewicza 33, Poland.

Life history theory seeks to explain why and how natural selection shape organisms to optimize energy allocation among different fitness components. Because of restricted amount of resources, competing demands arise. One of them is a fundamental trade-off between reproductive effort and survival. Here we show, that in a seasonal environment freshwater mussels adapt to high levels of summer mortality by shifting their reproductive effort to earlier dates during a season and by higher investments in early broods or even by compressing their entire reproductive effort into a short early period. That means, that reproductive effort of the mussels is optimised within iterating seasonal selection episodes: reproductive investment during early spring allows to invest energy later in self-maintenance in order to compromise impact of factors leading to late spring mortality. The recent increase in summer die-offs of mussels implies progressing compress of their reproduction into shorter, early periods. Such time-restriction reduces significantly reproductive output, and may further contribute to decline of this already highly threatened group.

PL 132 4:00-4:20

CHARACTERIZATION OF SPECTACLECASE HOST FISH, HIODON SPP., MOVEMENT PATTERNS IN THE ST. CROIX NATIONAL SCENIC RIVERWAY

Matthew Meulemans [1], Michelle Bartsch [1], Diane Waller [1], Bernard Sietman [2], Zeb Secrist [2], Joel Strias [3], & Marian Shaffer [4]. [1] U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI; [2] Minnesota Department of Natural Resources, Center for Aquatic Mollusk Programs, Lake City, MN; [3] Minnesota Department of Natural Resources, St. Paul MN; [4] National Park Service, St. Croix National Scenic Riverway, St. Croix Falls, WI.

The St. Croix National Scenic Riverway (SACN) is a valuable refuge, harboring populations of unionid mussels that are rapidly declining elsewhere in the United States. Currently, five federally listed mussel species, including the Spectaclecase (Cumberlandia monodonta) reside in the SACN. Spectaclecase were endemic to 44 streams in the Mississippi, Ohio, and Missouri River basins, but now scarcely inhabit 20 streams. The Meramec, Gasconade, and the St. Croix Rivers are the remaining strongholds of Spectaclecase. Spectaclecase have a complex reproductive cycle including an obligate parasitic larval stage (glochidia) on specific fish hosts. In 2017, researchers identified Goldeye (Hiodon alosoides) and Mooneye (H. tergisus) as suitable hosts for Spectaclecase. Sustained recovery of Spectaclecase populations in the SACN depends on co-occurring Hiodon populations during the mussel's larval release. This study aims to determine movement patterns of Hiodon in the SACN to better understand its range, seasonal behavior, spawning site fidelity, and co-occurrence with Spectaclecase during the larval release period. To our knowledge, Hiodon spp. have never been tracked with acoustic transmitters. After a successful pilot study using gizzard shad (Dorosoma cepedianum) as a surrogate species, we implanted Vemco V8 (8mm Ø, 2.0 g) transmitters in wild caught Mooneye (n=15) from the SACN. To ensure tag retention and survival, Mooneye were held 3 days in situ before release. Passive tracking is underway via an existing network of Vemco receivers deployed in stretches of the SACN and Mississippi River. In 2022, we documented movement of 14 tagged Mooneye through the lower undammed portion of the SACN downstream to Pool 4 in the Mississippi River, over 80 miles from the release location. Understanding these movements and habitat preferences of Mooneye will be integral to identification of suitable reintroduction sites for Spectaclecase and potential discovery of unknown populations.

PL 133 4:20-4:40	**DO PARASITIC FRESHWATER MUSSELS MANIPULATE HOST BEHAVIOR? EARLY EVIDENCE OF EXTENDED PHENOTYPE FROM THE MARGARITIFERA MARGARITIFERA – SALMO TRUTTA INTERACTION**
	Sebastian L. Rock [1] , Johan Watz [1] , P. Anders Nilsson [2] , Olle Calles [1] , Martin E. Österling [1] . 1Karlstad University, Biology, 65188 Karlstad, Sweden; 2Lund University, Department of Biology - Aquatic Ecology, 223 62 Lund, Sweden
	Freshwater mussels in the order Unionida are highly adapted to parasitize fish for the primary purpose of dispersal rather than growth, and have been previously shown to alter both host migratory patterns and habitat usage. Here, we present a study which tentatively demonstrates both simultaneously. Wild caught, one-year-old Salmo trutta (N=167) with no history of infestation were caught, PIT tagged, and released back in their home stretch after infesting half with glochidia from Margaritifera margaritifera. The fish were periodically tracked with a portable PIT antenna over the course of a year and recaptured at 30, 270 and 360 days post infestation (dpi | N=100, 28, 7 respectively) to track growth, condition and infestation. Infested individuals showed significantly higher upriver dispersal at 60, 90 and 270 dpi, and arguably also at 150dpi. As the glochidia begin to excise in late May (~270 dpi), we conclude that the glochidia were successfully able to migrate approximately 100m upriver from the infestation point. Infested fish had a consistent significantly lower Standard Growth Rate than their control counterparts, but did not suffer from a decreased Condition Factor. Furthermore, infested fish had a significant preference for habitat with the following descriptors at 270dpi: shallow water depth, medium flow rate and predominantly pebble based substrate (at alpha= 0.1). This was primarily driven by a significant preference for more shallow water (at alpha= 0.05). As this habitat type has been described as optimal for larval mussel development, we tentatively suggest the results presented here to be evidence of host manipulation, though we can propose no specific mechanism through which this might occur, other than behavioural thermoregulation from the host fish.
PL 134 4:40-5:00	**DESCRIPTION OF THE MANTLE LURE AND NOVEL MIMICRY OF THE ENDANGERED CUMBERLANDIAN COMBSHELL (EPIOBLASMA BREVIDENS) IN THE CLINCH RIVER, EASTERN U.S.A.**
	Jess W. Jones [1,2] , Zachary Taylor [2] , and Timothy Lane [3] [1] U.S. Fish and Wildlife Service, [2] Department of Fish and Wildlife Conservation, Virginia Tech University, Blacksburg, Virginia 24061-0321, U.S.A. [3] Aquatic Wildlife Conservation Center, Virginia Department of Wildlife Resources, Marion, Virginia 24354
	The Cumberlandian Combshell (Epioblasma brevidens) is an endangered freshwater mussel endemic to the Tennessee and Cumberland River drainages, major tributaries of the Ohio River of the eastern United States. We conducted mask and snorkel surveys in May and June of 2021 and 2022 to locate, observe, photograph and video female E. brevidens to document their unique mantle lures at sites in the Clinch River in Tennessee and Virginia. The mantle lure is morphologically specialized mantle tissue that mimics prey items of the host fish. The mantle lure of E. brevidens appears to mimic four distinct characteristics of the reproductive anatomy of the underside (ventral) of a gravid female crayfish, to include: (1) the external apertures of the oviducts located on the base of the third pair of walking legs, (2) crayfish larvae still encased in the egg membrane, (3) pleopods or claws, and (4) post-embryonic eggs. Surprisingly, we observed males of E. brevidens displaying mantle lures that were anatomically complex and closely resembled the female mantle lure. The male lure similarly mimics oviducts, eggs and pleopods but are diminutive to those same structures in females. We describe for the first time the mantle lure morphology and mimicry of E. brevidens, showing its close resemblance to the reproductive anatomy of a gravid female crayfish, and a novel form of mimicry in males. To our knowledge, mantle lure displays in males has not been previously documented in freshwater mussels.

Blue = Student Poster

Poster Session Abstracts

Tuesday, April 11th 6:30 - 8:30 pm ---- Ballroom

Life History and Ecology

PO 01

FRESHWATER GASTROPOD 101 EDUCATIONAL POSTER. Sarah Douglass[1] and Nora Straquadine[2]. 1Illinois Natural History Survey, University of Illinois Urbana-Champaign, Champaign, IL; 2Monterey Bay Aquarium, Monterey, CA.

Freshwater gastropods are relatively unknown by the public and their populations are in decline. The scientific and educational communities continue to produce a large body of outreach materials for freshwater mollusks, but most of these materials focus on freshwater mussels. Members of the Freshwater Mollusk Conservation Society's (FMCS) Outreach Committee produced this informational poster to share how amazing these one-shelled mollusks are and to increase awareness of the challenges they face. Using both photos and illustrations, we showcase the status of ~700 species found in North America, shell shapes of snails and limpets, gastropod anatomical terms, differences between lunged and gilled gastropods, and the life cycles of gastropods. Gastropods play a large role in algae primary productivity through nutrient cycling and are an important food source to predators such as crayfish, fish, turtles, and ducks. They are sensitive to habitat modification and degradation, environmental pollution, and the introduction of invasive species. We hope this poster compels its readers to help stop the disappearance of freshwater gastropods by stopping invasive species, voting to protect local bodies of water, participating in environmental clean-up efforts, and by spreading the word! This poster will be available on the FMCS's website for PDF download and for printing. The shell anatomy drawings are based on the work of Dr. John Burch (1989) and his North American Freshwater Snails. The photos are courtesy of the Illinois Natural History Survey and Nora Straquadine.

PO 02

WESTERN PEARLSHELL REPRODUCTION, AS OBSERVED AND PHOTOGRAPHED IN THE NORTH UMPQUA RIVER, OREGON. John C. Ratliff, Beaverton, OR.

On May 28, 1984 I was diving at the head of the Winchester Reservoir on the North Umpqua River, with my Nikonos II camera and Subsea 150 strobe, hoping to get some macro photos of the aquatic creatures in the river. What I witnessed were beds of the Western Pearlshell mussels (Margaritifera falcata), and their glochidia being released into the water. After getting the film developed, I again dove the same area on June 3, 1984 and witnessed more dispersal, documenting it again photographically. This dive resulted in another 30 macro photos of the Western Pearlshell reproductive activity. These photos, and the photos and observations of other fish species in the area, answer some questions concerning the life cycle of Margaritifera falcata in Oregon's North Umpqua River.

PO 03

APPLYING NOVEL METAL ISOTOPES IN FRESHWATER BIVALVE SHELLS AS ENVIRONMENTAL TRACERS IN RIVERINE SYSTEMS. Kristi S. Dobra[1,2], Brian W. Stewart[1], and Rosemary C. Capo[1]. [1]Department of Geology and Environmental Science, University of Pittsburgh, Pittsburgh, PA 15260; [2]Pittsburgh District, U.S. Army Corps of Engineers, Pittsburgh, PA 15222.

	Barium (Ba) and strontium (Sr) readily substitute for calcium in the aragonite lattice of bivalve shells. The isotopic compositions of Ba and Sr are therefore preserved in the shell, and are potentially sensitive recorders of metal geochemistry in riverine systems. To use stable Ba and radiogenic Sr isotopes as freshwater geochemical proxies in historical or fossil shell records, we need to understand the various processes that control how trace metals move from a bivalve's external environment into its shell. We analyzed shells of 31 individual bivalves representing six taxa and six different streams in the upper Ohio River watershed for comparison to co-located stream water samples. Shell and water samples were processed for Ba isotopes, radiogenic Sr isotopes, and trace metal concentrations. To capture potential interspecific differences in trace metal uptake, shell material was derived from several native species (A. plicata, O. reflexa, F. flava, P. alatus) and invasive species (C. fluminea, D. polymorpha). Preliminary data suggest a consistent, but species-dependent, Ba isotope fractionation factor between shells and river water. The Ba isotope composition of native species shells are depleted in the heavy Ba isotope compared to river water by up to ~ 1‰ (typical analytical uncertainty <±0.05‰). This apparent Ba isotope fractionation in native shells is in contrast to our results from shells of invasive C. fluminea, which has an isotope composition indistinguishable from the water. The observed species-dependency in this preliminary dataset may derive from differences in growth rate, mineral ultrastructure, or food sources, the latter of which will be addressed by ongoing Sr isotope studies. Such a large difference in Ba isotope ratios between species could provide important information about shell growth mechanisms in freshwater bivalves, which is also critical to a robust interpretation of shell metal concentrations and the use of isotopes as environmental tracers.
PO 04	**S* HOST FISHES OF THE YELLOW LAMPMUSSEL (*LAMPSILIS CARIOSA*).** Brian Hefferon[1], Dr. Andrew Gascho Landis[2] & Paul H. Lord[1]. [1]Biological Field Station, State University of New York, Oneonta, N.Y. 13820 USA [2]Department of Fisheries, Wildlife & Environmental Science State University of New York, Cobleskill, N.Y. 12043 USA
	Yellow lampmussel (Lampsilis cariosa) is a freshwater mussel native to Atlantic slope drainages from New Brunswick to South Carolina. It is listed as Vulnerable by IUCN and is a New York State Species of Greatest Conservation Need. In comparison to other members of the genus Lampsilis, Yellow lampmussel has not been well studied. Major components of its life history remain poorly defined. Previously, it was unknown which host fish species could be used to complete its parasitic life cycle. To confirm viable hosts, host fishes were inoculated with glochidia in the lab and allowed to transform into juvenile mussels. As drop off occurred, mussels were identified as glochidia or juveniles and enumerated. We confirmed previously undocumented hosts and gained insight for future host fish trials. This research may help inform local regulation and inform managers how to best protect this species as well as aid in the propagation of Yellow lampmussel for restoration efforts.
PO 05	**INVESTIGATING THE ROLE OF RIVER HERRING AS HOSTS FOR FRESHWATER MUSSELS IN THE CONNECTICUT RIVER WATERSHED.** Jacqueline Stephens[1,2,3], Allison H. Roy[4], Adrian Jordaan[1], David Perkins[2] & Kenneth Sprankle[3]. 1 Department of Environmental Conservation, University of Massachusetts, Amherst, MA; 2 U.S. Fish and Wildlife Service, Richard Cronin Aquatic Resource Center, Sunderland, MA; 3 U.S. Fish and Wildlife Service, Connecticut River Fish and Wildlife Conservation Office, Sunderland, MA; 4 U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, Department of Environmental Conservation, University of Massachusetts, Amherst, MA.

	Anadromous river herring (blueback herring Alosa aestivalis and alewife A. pseudoharengus) play important roles as migratory species within coastal watersheds, including acting as hosts for the successful transformation and transportation of the glochidia of freshwater mussels. For At-risk mussel species, using river herring as hosts may become an additional vulnerability as river herring populations have been experiencing declines and phenological shifts to their spawning migration. The conservation status of river herring and freshwater mussels, along with the lack of information on species-specific host fish use, has led to the urgency of this investigation of spatial and temporal patterns of freshwater mussel use of spawning river herring hosts within the Connecticut River watershed. Specifically, we will (1) identify which freshwater mussel species (of the 12 species in the watershed) use river herring as hosts, (2) investigate the spatial and temporal alignment between glochidial infection of river herring and their spring spawning runs, and (3) evaluate associations between river herring characteristics (spawning mark history, age, sex, weight/length) and glochidial infection. We will remove gills from adult river herring collected as part of the U.S. Fish and Wildlife Service Annual Stock Assessment and count glochidia on one gill to estimate glochidial infection (#glochidia/fish). Individual glochidia will also be removed from the gills and identified to species, using morphological shell measurements and genetics as needed. The results of this research will provide insight on the current use of river herring as hosts by freshwater mussels within the Connecticut River watershed and encourage the integration of both the ecology and health of freshwater mussels and river herring to avoid the risk of an extinction cascade.

	Status and Distribution of Mollusks
PO 06	**RANGE EXTENSION AND CO-OCCURRENCE OF *PYRGULOPSIS* SPECIES ACROSS NORTHERN NEVADA.** Almeta Helmig[1], Eric Miskow[2], Delaney Martin[3]. 1Great Basin Institute/Bureau of Land Management, Elko, NV; 2Nevada Division of Natural Heritage, Carson City, NV; 3Great Basin Institute/Bureau of Land Management, Elko, NV.
	Springsnails from the genus Pyrgulopsis are tiny (1-5 mm) aquatic gastropods that are generally found in spring habitats. The Great Basin geographical region in the western United States, and in particular Nevada, arguably hosts the most diverse and speciose springsnail fauna anywhere on earth. Early pioneer work in the 1990's on springsnails indicated they often occur locally as endemics and at times are known to occur at a single spring or restricted geographically to small watersheds (Hershler et al. 2014). However, recent survey efforts and increased sampling in northern Nevada, particularly using modern genetic techniques, has revealed multiple range extensions of once thought of single spring endemics as well as congeners occupying the same spring. Here we will show preliminary findings of our work.
PO 07	**PRELIMINARY RESULTS FROM A STUDY ON THE POPULATION DEMOGRAPHICS OF THE DWARF WEDGEMUSSEL (*ALASMIDONTA HETERODON*) IN NANJEMOY CREEK, MARYLAND.** Matt Ashton[1] and James McCann[1], [1]Maryland Department of Natural Resources, Annapolis MD USA.

	Dwarf Wedgemussel (Alasmidonta heterodon) is a federally endangered mussel distributed from New Brunswick, Canada to North Carolina, USA. In Maryland, it is historically known from 11 streams and extant in four streams. The Nanjemoy Creek watershed supports what may be the largest Dwarf Wedgemussel population in the Chesapeake Bay drainage. In 2020, the Maryland Department of Natural Resources began capture-recapture monitoring of four plots containing PIT tagged Dwarf Wedgemussels after surveys documented an apparent expansion in abundance and range compared to data collected over the past 20 years. This study included 1) an annual survey of monitoring plots to recapture previously tagged Dwarf Wedgemussels and mark any untagged mussels and 2) bi-weekly searches with a submersible PIT tag reader after and prior to annual surveys. Relatively few Dwarf Wedgemussels were recaptured (<20%) and a near equal or greater number of un-tagged mussels were also found during annual visual surveys. Average annual growth was 1.77 mm and 1.54 mm in the 2020 and 2021 cohorts, respectively. We detected a majority of the PIT tagged mussels in the fall and spring sampling events using the submersible tag reader. Closed population demographic models generated in the Program MARK for each cohort found high rates of apparent survival (0.72-0.99) and probability of recapture (0.59-0.94), which declined over time. This project will continue through 2024 with the following modifications to study methods in an attempt to increase the recapture rate to better estimate population demographics and annual growth: elimination of the PIT tag search around the annual survey and conducting at least three additional visual surveys following the annual survey in two monitoring plots.
PO 08	**STATUS AND DISTRIBUTION OF *CUMBERLANDIA MONODONTA* IN MISSOURI, INCLUDING RECENT (2019 AND 2022) RANGE EXTENSIONS IN OSAGE RIVER TRIBUTARIES** Scott Faiman[1], Bryan Simmons[2], Andy Roberts[2], Pablo Oleiro[2], Steve McMurray[1]. [1]Missouri Department of Conservation, Columbia, MO; [2]United States Fish and Wildlife Service, Columbia, MO.
	The Spectaclecase (Cumberlandia monodonta (Say, 1829)) occurs in the United States in larger rivers of the Mississippi and Ohio river basins. In Missouri it occurs principally in the Osage and Gasconade River basins of the Missouri River system, in the Meramec River basin of the Mississippi River system, and sporadically in the mainstem of the Mississippi River. Populations in the Gasconade and Meramec rivers are considered to be 2 of the 3 remaining best populations of Spectaclecase. The St. Croix River in Minnesota and Wisconsin is considered the third. Populations in the lower Osage River, below Lake of the Ozarks, are a relatively recent discovery, as the training structures where they commonly occur were not searched in previous surveys. Recent first-time observations in Osage River tributaries above Lake of the Ozarks, Niangua River (1 articulated weathered dead shell in 2019 above Lake Niangua) and Pomme de Terre River (1 live and 1 articulated relict shell in 2022 below Pomme de Terre Lake), provide evidence of historical ranges pre-dating impoundment. In the case of the Niangua River, the known hosts (Mooneye (Hiodon tergisus) and Goldeye (Hiodon alosoides)) are currently extirpated above Lake Niangua, thereby limiting the distribution of Spectaclecase in that river. We will discuss these recent discoveries and the status of this species in Missouri.
PO 09	**UPPER BLACK RIVER MISSOURI UNIONID ASSEMBLAGES** Rachel M Fox[1], Ronald Kegerries[1], Heidi Dunn[1], Georganne Bowman[2] and Caleb Knerr[2]. 1EcoAnalysts, Inc. O'Fallon, MO; 2Missouri Department of Transportation, Jefferson City, MO.
	The Black River in Missouri and Arkansas has been known to harbor diverse and dense mussel beds. This diversity includes the occurrence of Federally listed species Epioblasma curtisii, Epioblasma triquetra, Lampsilis abrupta and Theliderma cylindrica. It is also home to Cyprogenia aberti, a species recently proposed to be federally listed. As part of the proposal, a section of the Upper Black River in Wayne and Butler counties from Clearwater Dam to the County Road 658 crossing, would be designated critical habitat for C. aberti. From 2020-2022, EcoAnalysts, Inc. and its partners have conducted surveys at 5 sites within this proposed critical habitat reach. Cyprogenia aberti was found as the most abundant unionid at 3 of the 5 sites, and 3rd most abundant at an additional site. Additionally, 3 Lampsilis abrupta and a Theliderma cylindrica were found across two sites. These results have made it clear why the Upper Black River would be listed as critical habitat but may also harbor more listed species than we know.

PO 10	**A SPECIES STATUS ASSESSMENT FOR THREE FRESHWATER MUSSELS FROM THE TENNESSEE AND CUMBERLAND RIVER BASINS.** Daniel B. Fitzgerald[1], Andrew R. Henderson[2] & David R. Smith[3]. 1US Fish & Wildlife Service, Falls Church, VA; 2US Fish & Wildlife Service, Asheville, NC; US Geological Survey (retired), Kearneysville, WV.
	The Species Status Assessment (SSA) is a science-based document used by the US Fish & Wildlife Service (USFWS) to aid in agency decisions. The SSA has various applications but has been used most extensively in species classification recommendation contexts. We recently completed an SSA which summarizes the ecological needs and extinction risk for three species of freshwater mussels: Cumberland Moccasinshell (Medionidus conradicus), Tennessee Clubshell (Pleurobema oviforme), and Tennessee Pigtoe (Pleuronaia barnesiana). M. conradicus and P. oviforme historically occurred throughout the Tennessee and Cumberland Basins, while P. barnesiana only occurs within the Tennessee Basin. All three species have similar habitat requirements, estimates for maximum lifespans, and age at sexual maturity, and appear capable of using multiple host fishes, including several shiners and darters. While these species followed a joint assessment process, classification of current conditions and modeling of future risk was conducted in parallel for each species. All three species have experienced substantial range restrictions, and remaining populations are fragmented and isolated from one another due to numerous threats such as impoundments. We used demographic and distribution criteria to classify the current condition of extant populations, and ordinal regression to assess risk of extirpation. Results of current condition analyses indicate all three species have experienced similar patterns of population loss within watersheds and exhibit limited resiliency, redundancy, and representation across their range. Future projections indicate predominantly high and medium risk of extirpation for M. conradicus, P. oviforme, and P. barnesiana over the next 30 years.
PO 11	**THE FRESHWATER MUSSELS OF CENTRAL AMERICA: EL SALVADOR (MYCETOPODIDAE & UNIONIDAE).** Kentaro Inoue[1], Veronica Melara[2], José Enrique Barraza Sandoval[2]. [1]Shedd Aquarium, Chicago, IL; [2]Ministry of the Environment and Natural Resources, San Salvador, El Salvador.
	Central America (Mexico south to Panama and the Caribbean Islands) is a faunal transition zone between North and South America. This region has species in both Unionidae (87 spp.) and Mycetopodidae (7 spp.), many of which are endemic. However, outdated taxonomy combined with a lack of contemporary field surveys continues to impede efforts to understand the total species diversity and distribution of the mussel fauna in the region. El Salvador, the country bordering with Guatemala and Honduras, is geographically unique because all rivers and lakes in the country drain into the Pacific Ocean. Historic surveys and museum records suggest that 5 species occur in El Salvador. These include Mycetopoda subsinuata (Sowerby, 1868), Nephronaias goascoranensis (Lea, 1858), N. lempensis Marshall, 1926, N. rowellii (Lea, 1859), and Sinanadonta woodiana (Lea, 1834). In this study, we conducted mussel surveys in rivers and lakes in El Salvador and assess phylogenetic structure. Based on field identification and genetic assessment, we confirmed the presence of M. subsinuata and N. lempensis in the rios Lempa and Grande de San Miguel and invasive S. woodiana in Lago de Güija. Further field surveys are required to delineate their distributional ranges. We plan to expand field surveys in the neighboring countries such as Guatemala and Costa Rica.
PO 12	**UNIONID ASSEMBLAGE AND HABITAT ASSESSMENT AFTER MAJOR DAM FAILURES IN MID-MICHIGAN.** Nicole M Vellequette, Ava M Laszlo, David T Zanatta, & Daelyn A Woolnough. Biology Department, Institute for Great Lakes Research, Central Michigan University, Mt. Pleasant, MI USA

	In 2020, two central Michigan dams failed in a chain of four reservoir lakes along the Tittabawassee and Tobacco rivers. In 2021 and 2022, standardized surveys were conducted to assess habitat parameters, current densities, species richness, and spatial distribution of unionid assemblages and threats posed by invasive species in these four lakes (Secord, Smallwood, Wixom, and Sanford). Overall, 23 live species were found in the surveys, but it was discovered that the lentic reservoir habitats generally do not support speciose unionid assemblages. However, in the upstream reaches of the Tobacco River arm of Wixom Lake and downstream of Sanford Dam, more species rich and dense unionid assemblages were recorded. Substrate in Secord, Smallwood, the Tittabawassee River reach of Wixom, and Sanford lakes, were found to be mostly homogeneous and not supportive of listed species. Conversely, substrate in upstream Tobacco River reaches of Wixom Lake was much more heterogeneous and supported dense, species rich unionid assemblages (12 live species). The upstream reach of Wixom Lake was also the location where the only live federally endangered Epioblasma triquetra (Snuffbox) was found. Dense Snuffbox shells were also found in this area, indicating a previously larger population. Beyond areas of high density and species richness, common species more tolerant of varying conditions were found including Pyganodon grandis, Lampsilis cardium, and Lampsilis siliquoidea. Invasive Dreissena polymorpha fouled surfaces and substrates throughout the four lakes and threaten most unionids in the system. Invasive Cipangopaludina chinensis snails were at many sites with high to medium intensity, in Secord Lake specifically, and were primarily absent in Wixom and Sanford Lakes except for one live individual. These data could be used to further understand unionid assemblages and general habitat parameters in dam-affected ecosystems and for guiding dam management practices while protecting unionids.

Surveys and Monitoring

PO 13	**DEVELOPMENT OF A FLEXIBLE MID-SIZED RIVER MUSSEL SAMPLING PROTOCOL AND INVESTIGATION OF STATEWIDE MULTI-SCALE MUSSEL HABITAT RELATIONSHIPS** . Ava M. Laszlo[1], Stephen McMurray[2] & Jacob T. Westhoff[3]. 1School of Natural Resources, University of Missouri, Columbia, MO; 2Missouri Department of Conservation, Aquatic Diversity and Game Fish Unit, Columbia, MO; 3U.S. Geological Survey, Missouri Cooperative Fish and Wildlife Research Unit, Columbia, MO.
	Missouri is home to 65 species of native freshwater mussel within six major ecoregions, of which nearly 50% are listed as state species of conservation concern. A long-term goal for mussel conservation and management in Missouri is implementation of a standardized sampling program at priority locations that would allow inference regarding changes in the status of mussel communities and populations over time. Although standardized methods for sampling mussels exist, there is currently no accepted standard in Missouri that is adaptable across a wide range of habitats and scalable based on information need. Our primary objectives for this recently initiated project are to develop and implement unionid survey methodologies that will allow us to acquire additional information on Missourian unionids and their habitats. We will fulfill these objectives by: 1) developing survey protocols and conducting occupancy-based surveys within the Current and Jacks Fork Rivers; 2) designing and implementing a multi-method sampling protocol in nine mid-sized river reaches across a variety of habitat types where habitat will be intensively mapped in order to link local-scale distributions to habitat characteristics; and 3) summarizing mussel-host fish relationships based on comparing fish community data and unionid community data collected within target rivers. To accomplish our objectives, our survey protocols will incorporate multiple methodologies and field data collection will span multiple field seasons. These data will be used to develop a state-wide mussel sampling program with long-term monitoring implications.
PO 14	**USING CAPTURE-RECAPTURE TO ASSESS THE SURVIVORSHIP OF RELOCATED MUSSELS IN THE LOWER SULPHUR RIVER.** Rachel Lancaster, Dr. Joshua Banta, Jared Dickson, Dr. Matthew Greenwold, and Dr. Lance Williams. University of Texas at Tyler, Tyler, TX.

	Conservation efforts to preserve freshwater mussel communities have become more common as these animals become increasingly threatened by their changing habitats. As humans continue to shape and change the world around them, aquatic species living in modified and disturbed water systems can be negatively impacted leading to the ecosystem decline. Freshwater mussels work as habitat engineers acting as important filter feeders who stabilize the substrate, impact water clarity, and chemistry, and partake in nutrient cycling. The presence of mussel communities within riverine systems allows other organisms, such as macroinvertebrates and algae, to flourish and grow. During disturbance events involving a stream, river, or pond, the relocation of affected mussel beds is becoming more widespread. Although there are few of these studies, many of those that have been conducted are seen as successful in relocating and conserving their mussel communities. This study will focus on the growth, survivorship, and success of relocating a mussel community impacted by a dewatering event to repair a dam on the Wright Patman reservoir on the Sulphur River. We collected mussels along the bank following a receding water line and within the dewatered basin over a three-day period. Collected mussels were transported downstream to a predetermined relocation site. At the relocation site, all mussels were identified to species and a representative number of each species were measured and tagged during our initial survey, we collected and relocated a total of 1199 individual mussels from 11 different species. From the 1199 total relocated, we tagged 229 mussels from 10 of the species we collected. Resampling events will take place over the next two years to assess the success of the relocation efforts using a capture-recapture approach.
PO 15	**DEVELOPING AN EFFICIENT MUSSEL ABUNDANCE ESTIMATION PROCEDURE.** Gabriel T Inoshita[1], Daniel Trujilio[3], Kentaro Inoue[2], Steve Hein[1], and David Berg[1]. 1Department of Biology, Miami University, Oxford, Ohio; 2Daniel P. Haerther Center for Conservation and Research, John G. Shedd Aquarium, Chicago, IL;3 New Mexico Department of Game and Fish, Santa Fe, NM
	American native freshwater mussels are part of one of the most diverse taxa in the world, however, due to climate change, human interaction, and invasive species, many have become extinct or endangered. One of the major ways of monitoring these endangered populations is to get accurate population estimates to follow their population declines and intervene when necessary. To see if the censusing method used in previous studies for a population of endangered Popenaias popeii mussels could be improved upon, we simulated different censusing procedures in R. We used previous data from a 2012 census and a more recent 2018 census. This data was then randomly sampled according to different censusing models. These censusing models were made by sampling different proportions of the pool and riffle habitats and changing the number of transects at each site. The proportion of pool and riffle habitats was changed because the density of mussels in riffles is much higher than in pools and therefore, they have different importance in the census. Each model was simulated 1000 times to create statistical robustness for each models result. The models were evaluated by the variance in the total population estimate and the cost of completing the census. Through this analysis we were able to find the best models for cost and variance. The best cost models reduced cost by upwards of 63% while also decreasing variance minimally (1 to 10%). The best decrease in variance models reduced variance in the population estimates by upwards of 23%. Through similar analysis of censusing methods agencies should be able to produce new censusing procedures that reduce their costs while allowing them to monitor the population in an effective and efficient way. This should aid the protection of endangered mussels across the United States.
PO 16	**DEVELOPING A MODELING FRAMEWORK TO UNDERSTAND DOWNSTREAM TRANSPORT OF FRESHWATER MUSSEL ENVIRONMENTAL DNA.** Brandon J. Sansom[1], Dannise V. Ruiz-Ramos[1], Nathan L. Thompson[1], Maura O. Roberts[1], Zachary Taylor[2], Katie Ortiz[2], Jess W. Jones[2], Catherine A. Richter[1], Katy E. Klymus[1]. [1]U.S. Geological Survey – Columbia Environmental Research Center, Columbia, MO, [2]Virginia Polytechnic Institute and State University – Department of Fish and Wildlife Conservation, Blacksburg, VA.

	Environmental DNA (eDNA) analysis offers a non-invasive approach to supplement traditional surveys and provides the opportunity for increased spatial and temporal information on species detection. The transport of eDNA in lotic environments is an important factor affecting accurate descriptions of where and when a species is present, but eDNA transport phenomena are not well understood. We studied the downstream transport of mussel eDNA in riverine environments by collecting eDNA samples over a spatial and temporal range and assaying for two federally endangered mussels. We then developed a modeling framework to predict the fate and transport of eDNA in two separate rivers, the Big Piney River in Missouri and the Clinch River in Tennessee. To help calibrate our model, we quantified species-specific decay rates in laboratory studies. Numeric and hydraulic models were developed to account for biological decay and the system geomorphology and hydraulics, using field measured eDNA concentration at the mussel source as an upstream boundary condition, and model results were compared to field eDNA measurements. In general, field eDNA measurements showed a decreasing downstream concentration and we detected eDNA as far as 3500 m downstream from source mussel populations. Still, the detection of target species eDNA in field samples was highly variable across seasons and flows and most eDNA concentrations were below the assays' abilities to precisely quantify eDNA concentration. Model results also demonstrated long eDNA transport distances with declining downstream concentration. However, simulated eDNA concentrations generally overestimated field measured concentrations in both rivers. These results indicate that additional biophysical interactions beyond system hydraulics and biological degradation, such as sediment composition, retention, and temperature, may be important factors to integrate in eDNA transport models.
PO 17	***Canceled* FRESHWATER MUSSELS UPSTREAM OF A MAN-MADE WATERWAY: A CASE STUDY OF A TRIBUTARY TO THE TENNESSEE-TOMBIGBEE WATERWAY IN THE SOUTHEASTERN USA.** Ashley Seagroves Ruppel, U.S. Fish and Wildlife Service, Mississippi Ecological Services Field Office, 6578 Dogwood View Pkwy, Jackson, MS 39213.
	The Tennessee-Tombigbee Waterway (Tenn-Tom) is a 234 mile-long shipping channel which was constructed between 1972 and 1984. The waterway connected two major river basins by dredging and creating an extensive lock and dam system between the Tennessee River (Mississippi River Basin) and the Tombigbee River (Mobile River Basin). Although no species were listed at the time of project completion, the decline of mussel richness and subsequent listing of eighteen species in the drainages within Mississippi (Tennessee River: 2 state and 4 federally listed; Tombigbee River: 2 state and 10 federally listed) may be attributed to the alteration of habitats and hydrological function of tributaries which followed construction of the Tenn-Tom. This study aims to survey several affected drainages in upcoming years to assess the status of freshwater mussels in tributaries flowing into the Tenn-Tom. Luxapalila Creek was the first tributary surveyed and resulted in the detection of ten common species, with no state or federally listed species detected. Preliminary results suggest a reduction in species richness within the watershed, and continued surveys will inform listing and recovery efforts within tributaries to the Tenn-Tom Waterway.
PO 18	**LONG-TERM MUSSEL MONITORING ON THE OHIO RIVER FOR THE WILLOW ISLAND HYDROELECTRIC PROJECT, WILLOW ISLAND LOCKS AND DAM (ORM 162), PLEASANTS COUNTY, WEST VIRGINIA.** Katie Jackson[1], Mike Powell[1], Marty Sneen[1]. 1EA Engineering, Science, and Technology, Inc., PBC.

	The Willow Island Hydroelectric Project (American Municipal Power, Inc.) completed construction in 2016 at the existing U.S. Army Corps of Engineers' (USACE's) Willow Island Locks and Dam at Ohio River Mile 162. Due to the known occurrence of several federally listed species in this area of the Ohio River, a mussel monitoring plan and schedule were developed to assess if Project activities affect the state and federally listed species. Monitoring was performed from 2010 to 2020. Semi-quantitative, quantitative, and qualitative mussel sampling was performed along the West Virginia and Ohio shorelines. The 10-year dataset was reviewed and trends within the mussel community were evaluated, including interyear and spatial comparisons of adult and juvenile densities as well as substrate composition. Data were compared among the baseline year, Project pre-operational years, and Project post-operational years. While some spatial and temporal differences in substrate composition were observed, the mean grain size was consistently coarse gravel throughout the study period and along both banks. Mussel densities along the Ohio bank were significantly higher compared to the West Virginia bank during all years. Conversely, mean densities along each bank remained statistically similar among years. Comparisons of juvenile percent abundance and juvenile density statistical groupings were consistent with the 2010 baseline survey. While some observed spatial and temporal differences were evident between banks and among survey years, these appear to be attributable to existing channel morphology, fluctuations in substrate composition, and mussel density variability. The observed fluctuation in downstream substrate was likely associated with annual variability in Ohio River flows. The collection of several federally endangered species during the study period, including seven specimens in 2020, indicates that rare mussel species and the existing bed continue to coexist with operation of the Willow Island Hydroelectric Project.
PO 19	**TARGETED SURVEYS OF *TOXOLASMA PARVUM* (LILLIPUT) IN CANADA.** Mandy P. Gibson, Kelly A. McNichols-O'Rourke, and Todd J. Morris. Fisheries and Oceans Canada, Burlington, Ontario, L7S 1A1.
	Toxolasma parvum (Lilliput) is currently listed as Endangered in Canada under the federal Species at Risk Act (SARA). At the time of its first assessment by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2013, only 47 live individuals had ever been found in Canada. Toxolasma parvum are due for reassessment in 2024 and recent evidence suggests the previous low detection may be due to a lack of targeted sampling in their preferred habitat. During the 2022 field season, Fisheries and Oceans Canada (DFO) conducted targeted surveys to sample T. parvum preferred habitat at 28 sites in the Lake St. Clair watershed, 5 sites in the Lake Erie watershed, and 2 sites in the Lake Ontario watershed. A semi-quantitative timed-search survey was conducted using 4.5 person-hours of search effort at each site. In the Lake St. Clair watershed, 55 live T. parvum were found, with presence at 50% of sites and occurrence in 83% of waterbodies. Mean site CPUE (± standard error) for T. parvum in this watershed was 0.44 mussels/hour ± 0.19. Toxolasma parvum was not detected at any sites in the Lake Erie watershed or Lake Ontario watershed in these targeted surveys; however, there have previously been numerous collections of live T. parvum in Cootes Paradise Marsh located in the western portion of the Lake Ontario watershed. Since the last COSEWIC assessment, 480 individuals have been found in an additional 15 different waterbodies; the discovery of T. parvum in seven of these waterbodies was a direct result of targeted surveys. Information gathered through targeted surveys of the species and assessment of life history characteristics will aid in the upcoming species reassessment and the ongoing management of the species.
PO 20	**MONITORING AND CONSERVING WESTERN PEARLSHELL MUSSELS IN THE LOWER BOISE RIVER.** Colin Custer, Corey Wageman, Dorene MacCoy. City of Boise, Boise, ID.

	The City of Boise (City) recently discovered several populations of Western Pearlshell Mussels (Margaritifera falcata) in the Lower Boise River. The City sampling and monitoring team (SAM) began searching for the presence of mussels to provide background information for Idaho negotiated rulemaking for ammonia aquatic life criteria. After confirming the presence of the mussels in the Lower Boise River, the City shifted to a conservatory role. The SAM utilized several different methods including environmental DNA (eDNA) water sampling along with visual surveys to locate and measure the mussel populations within the mainstem and some side channels of the Lower Boise River. The highest numbers of individuals were found in side-channels of the river where most trout continually spawn. While continuing to search for additional populations in the Lower Boise River, SAM has also collected mussel shells for aging and has PIT tagged mussels in existing populations for life stage, growth, and movement information. The SAM will be using Western Pearlshell Mussels findings to help preserve and protect existing populations and identify areas for habitat rehabilitation in the Lower Boise River.
PO 21	**EFFORTS TOWARD DEVELOPMENT OF A STANDARDIZED VISUAL SURVEY PROTOCOL FOR WESTERN NORTH AMERICAN FRESHWATER MUSSELS.** Emilie Blevins[1], Bryce Frank[2], Emily Johnson[2], Scott Miller[2], Jeff Moss[2], Anna Smith[2], Alexa Maine[3], John Erhardt[4], Doug Nemeth[4], Courtney Newlon[4], & Barbara Adams[5.] 1Xerces Society for Invertebrate Conservation, Portland, OR; 2Bureau of Land Management, Washington, DC; 3Confederated Tribes of the Umatilla Indian Reservation, Pendleton, OR. 4US Fish and Wildlife Service, Washington, DC; 5US Forest Service, Portland, OR.
	Freshwater mussels are among the most endangered organisms globally. Several species of freshwater mussels occur across the Pacific Northwest region in a range of aquatic habitats, although recent evidence indicates their populations may be declining in both abundance and range. Data collected through recent survey efforts by federal, state, tribal, and NGO biologists, using both traditional techniques and emerging technologies such as eDNA, have improved understanding of species' current ranges. However, better understanding of population-level trends has been limited without standardized protocols and metrics for surveying and evaluating western mussel species. While protocols exist for freshwater mussel species elsewhere, these are generally aimed at accurately assessing populations in biologically diverse watersheds, and sampling mussel beds where handling is necessary for species identification. In western North American watersheds, the freshwater mussel fauna is less speciose, visual surveys are generally sufficient for identification, and freshwater habitat varies widely across the species' range, spanning both large river basins and ecoregions. As a result, there is a need for survey protocols that account for these differences. Recent collaborative efforts to develop a visual survey protocol for western species of freshwater mussels, with the intent to help standardize data collection, are described here and should serve to improve status and trend analyses to support conservation efforts.
PO 22	**COMPARISONS OF TWELVE FRESHWATER MUSSEL BED ASSEMBLAGES QUANTITATIVELY SAMPLED AT A 15-YR INTERVAL IN THE BUFFALO NATIONAL RIVER, ARKANSAS.** Anna M. Pieri[1], John L. Harris[1], Mickey W. Matthews[2], Shawn W. Hodges[3], Ashley R. Rodman[3], Jennifer L. Bouldin[1], and Alan D. Christian[4]. [1]Arkansas State University, Jonesboro, Arkansas, USA; [2]Arkansas Department of Transportation, Little Rock, Arkansas, USA; [3]Department of the Interior, National Park Service, Buffalo National River, Harrison, Arkansas, USA: [4]Ursinus College, Collegeville, Pennsylvania, USA.

	The Buffalo National River (BNR) is a 246-km, free-flowing river in northern Arkansas that was established as the first National River and later designated as Wild and Scenic and as an Extraordinary Resource Water. Historically, 23 freshwater mussel species have been reported from the BNR. Potential threats to the BNR include land use/land cover changes, eutrophication, recreational use, physical habitat changes, and various climate change-related effects. Twelve quantitative mussel bed sites were established in 2006 to be monitored at 10- to 15-year intervals. Our study goal was to evaluate changes in population and assemblage characteristics at defined mussel beds between sampling events (2006 and 2020-2021) using a stratified random sampling protocol. Our first objective was to evaluate overall characteristics of mussel bed persistence, sampling confidence levels, and study-wide relative abundances between events. We expected 1) all sites would contain mussel beds, 2) sites would be adequately sampled at ≥ 80% confidence levels, and 3) study-wide relative abundances would be similar between events. Our second objective was to compare 10 overall site assemblage variables between events using paired t-tests. We expected no significant differences in any variables between events. Our third objective was to compare site-level mean density, richness, and diversity indices between events using pair-wise Mann-Whitney U statistics. We expected no significant differences between events. Our fourth objective was to compare assemblage composition between events using Non-Metric Multidimensional Scaling. We expected sampling sites between events would cluster together, and sites would separate across an upstream to downstream gradient with sites in geographic proximity clustering together. While major trends were not observed, our main findings indicate perceptible changes in mussel bed persistence and assemblage variables between monitoring events. Quantitative mussel bed assemblage monitoring in the BNR is essential for documenting changes and providing invaluable data for conservation and management efforts.

Propagation, Restoration and Re-Introductions

PO 23	**GROWTH AND SURVIVAL OF FATMUCKET (LAMPSILIS SILIQUOIDEA) IN THE CUYAHOGA RIVER.** Megan Herbruck[1], Samantha Knapp[2], Robert Krebs[3], Eric Soehnlen[4], Doug Kapusinski[2], Adam Benshoff[5], Andrew Hannes[2], Celia Schwartz[1], and Ryan Trimbath[1]. 1Cuyahoga Valley National Park, Brecksville, OH; 2 US Army Corps of Engineers – Buffalo District, Buffalo NY; Cleveland State University, Cleveland, OH; Northeast Ohio Regional Sewer District, Cuyahoga Heights, OH; EDGE Engineering and Science, Kent, OH.
	The presence of freshwater mussels in rivers provides habitat structure and stability, water filtering services, and mussels are key players in trophic and benthic community dynamics. Few rivers are more infamous than the Cuyahoga River for historic anthropogenic impacts and their almost complete destruction of life by the late 1960s. The health of the river has improved dramatically regarding fish populations and water quality, however freshwater mussel beds remain absent in the long stretches of river running through the Cuyahoga Valley National Park. In this study, we evaluate the survival and growth of 312 1-year old fatmucket mussels housed in silos at five locations in the Cuyahoga River and in one control location in the Grand River to assess suitability for mussel reintroduction. A similar survival rate of 46% in the Cuyahoga River compared to 50% in the Grand River combined with greater growth of survivors in the Cuyahoga suggests the river is ready. Suggestive relationships among growth, particulate matter, substrate, and site locations highlight a need for careful consideration of reintroduction locations, but the Cuyahoga River is ready for a freshwater mussel reintroduction plan.
PO 24	**RECOVERY EFFORTS FOR SPECIES OF FRESHWATER MUSSELS WITHIN THE SUPERFUND SITE IN THE LOWER GRASSE RIVER IN MASSENA, NY.** Colby Bowman, Jessica L. Jock, & Jay Wilkins. Saint Regis Mohawk Tribe. 71 Margaret Terrance Memorial Way, Akwesasne, NY 13655.

	The Saint Regis Mohawk Tribe's (SRMT) Environment Division (Akwesasne, NY) was granted Great Lakes Restoration Initiative (GLRI) funding for efforts to propagate freshwater mussels that are found locally within the Grasse River Superfund Site. To date, at this site, there has been 48 acres dredged with 220,000 cubic yards of PCB contaminated sediment removed and a total of 259 acres capped which caused detrimental effects to the thriving mussel community that inhabit this water body. It has been estimated that without intervention, nearly 1.7 million mussels would have been affected as a result of these activities. Through multiple years (2017-2021) of recovery and relocation by the New York State Department of Environmental Conservation (NYSDEC) and the inputs from our SRMT freshwater mussel propagation project, the efforts will aid in the recovery efforts back to a stable community. SRMT mussel propagation focuses on three of the top four most populated mussel species in the lower Grasse River. This poster will briefly outline the ongoing work with Leptodea fragilis (Fragile papershell), Potamilus alatus (Pink heelsplitter) and Lampsilis radiata (Eastern lampmussel) and the host fish (freshwater drum and largemouth bass) used during the transformation phase of the mussels. This project has adapted continuously and has integrated a variety of holding and rearing systems for freshwater mussels and host fish to achieve recovery goals.
PO 25	**IMPACTS OF DIETARY SUPPLEMENTATION OF WORM CASTINGS ON GROWTH AND SURVIVAL OF CULTIVATED ALASMIDONTA VARICOSA (BROOK FLOATER) AND LAMPSILIS CARDIUM (PLAIN POCKETBOOK).** Marilyn Can[1,2], Jace Nelson[1], David Janetski[2], Rachel Mair[3], & Brian Watson[4]. 1Virginia Tech Conservation Management Institute, Blacksburg, VA; 2Indiana University of Pennsylvania, Indiana, PA; 3Harrison Lake National Fish Hatchery, Charles City, VA; 4Virginia Department of Wildlife Resources, Forest, VA.
	Artificial propagation of freshwater mussels (Order Unionoida) is a primary method of combating population declines and species losses. In propagation facilities such as hatcheries, mussels are often fed mixtures of commercially available algae. Anecdotally, researchers and hatchery staff have been informally experimenting with diet supplements, such as worm castings, to augment mussel growth and survival. To investigate the effects of worm castings additions on mussel growth and survival, we conducted a dietary supplementation experiment using two species: Brook Floater, Alasmidonta varicosa and Plain Pocketbook, Lampsilis cardium. For each species, four treatment and four control tanks were stocked with 200 newly metamorphosed juveniles. Daily, all tanks were fed an algal diet, and the treatment tanks received one ml of a suspension of worm castings. Tanks were sampled monthly to measure survival and growth. For both species, an effect of worm castings addition was not observed on either growth or survival. Unlike other diet supplementation observations, the tanks in this experiment were stocked with fine sediment containing organic material as substrate, which may have provided both control and treatment mussels with similar organic materials found in worm castings. This may have obscured any treatment effect on growth and/or survival. This experiment sheds light on mussel diet and further informs growth, survival, and feeding rates for Brook Floater and Plain Pocketbook. Future research should minimize organic matter in control tanks by using sand as substrate.
PO 26	**EXAMINATION AND RECLASSIFICATION OF MUSEUM SPECIMENS TO IMPROVE RANGE EXTENT OF CANARY KINGSHELL, *LAMPSILIS SIETMANI*** . Kathryn E Conatser[1], Rachel M Vinsel[1], & Alison P Stodola[1]. [1]Illinois Natural History Survey, Prairie Research Institute, University of Illinois, Champaign, IL

	Accurate species identification is critical for ecological monitoring and conservation planning, particularly among imperiled groups like freshwater mussels. Species identifications in field-based studies typically rely on morphological characters to distinguish between similar species within their known geographic distributions. Freshwater mussels can appear morphologically similar yet be phylogenetically divergent. Previous research characterized the genetic and morphological diversity of two phenotypes of Yellow Sandshell Lampsilis teres and determined that these phenotypes represented two similar looking but discrete species with overlapping distributions. We used the morphometric guidelines published in Keogh & Simons (2019) for Lampsilis teres and the newly described Canary Kingshell L. sietmani to re-examine nearly 1800 L. teres specimens from ~950 lots and 18 US states in the Illinois Natural History Survey's Mollusk Collection. We reclassified nearly 100 lots and ~190 specimens as L. sietmani, and these re-classifications included new drainage records to augment distributional data for L. sietmani. We observed significant morphological overlap between L. teres and presumed L. sietmani and encourage further examination of these and other museum specimens. These updates provide additional information regarding distributional limits for L. sietmani and preliminary comparison data on the relative abundance of L. teres versus L. sietmani at sites where they co-exist. Better understanding of species distributions leads to more informed decision-making in the conservation and management of freshwater mussels.
PO 27	**AN UPDATE ON MUSSEL CULTURE AND MUSSEL-ADJACENT WORK AT GENOA NATIONAL FISH HATCHERY.** Elizabeth Glidewell, Megan Bradley, Doug Aloisi. USFWS, Genoa National Fish Hatchery, Genoa, WI.
	Genoa National Fish Hatchery (GNFH) has been involved in the culture of freshwater mussels in the Upper Mississippi River Basin since efforts began in 2000. The program has expanded from working with a single species, using a single technique, to working with as many as 18 species from various river basins, and the techniques used have evolved and been made to suit the culture location or species-specific needs. While many of the species' life cycles depend on game fish, others, such as Salamander Mussel and Snuffbox use non-game or protected host species and require very different culture conditions. The Common Mudpuppy (Necturus maculosus), host for Salamander Mussel, requires specialized culture and rearing efforts. Overturned cage bases with a slightly raised, flat plywood surface were used as spawning structures for a cohort produced in 2017, with recirculating systems used for juvenile rearing, inoculated adult housing, and juvenile mussel collection post-infestation. Logperch (Percina caprodes), fish host for Snuffbox, were spawned on station in 2020, with the intention to utilize pond culture to maintain a sustainable source of host fish on station. Tools and techniques from mussel culture can be applied to the recovery of other invertebrate species. Hine's Emerald Dragonfly (Somatochlora hineana) have been reared on station since 2015, and in 2020 Devils Crayfish (Cambarus diogenes), a burrowing crayfish that seems to create habitat for Hine's Emerald larval development was cultured at GNFH. The overlap of culture needs and the ability to share supplies such as rearing trailers, tanks, cages, and temperature-controlled recirculating systems can make for a more efficient use of staff time for a diverse hatchery's non-traditional species culture program.
PO 28	**USING ANALYTES IN FISH HEMOLYPH TO DETERMINE HOST SPECIFICITY.** Jacqualyn Halmbacher, Thomas Funk, Bailey Gaines, U.S. Fish and Wildlife, Inks Dam National Fish Hatchery, Burnet, TX
	A study was conducted to investigate nutrients glochidia require to transform on fish host. Tritogonia verrucosa is a very host-specific mussel therefore, potential hosts for this species were the subject of this study. Blood samples were acquired from Blue, Channel, Flathead catfish and Black bullhead from both captive and wild populations. Twelve different analytes were quantified in each species. Based on the results, there was a significant difference in the aspartate aminotransferase concentrations in Flathead catfish. Studies are underway to determine if liver proteins provide essential nutrition in glochidia transformation.
PO 29	**RAPID COLONIZATION BY FRESHWATER MUSSELS IN A RESTORED RIVER REACH.** Daniel Kelner[1], Bernard Sietman[2], Mike Davis[2], David Potter[1], Zebulin Secrist[2], Jillian Fedarick[2], Alexie Horner[2], Hunter Poffinbarger[2], Zoe Schroeder[2]. US Army Corps of Engineers, St. Paul, MN; 2 Minnesota Department of Natural Resources Center for Aquatic Mollusk Programs, Lake City, MN.

	Stream restoration in various forms is an important way to improve ecosystem function and diversity. A potential benefit of restoration is the capacity for freshwater mussels to colonize formerly degraded or unavailable habitats. The composition of colonizing assemblages depends, in part, on the composition, proximity, and connectivity of source populations. Colonization rates in these habitats are poorly known. We studied mussel colonization rates and community structure in a restored reach of the Pomme de Terre River, a tributary of the Minnesota River in west central Minnesota. The Pomme de Terre was diverted to a constructed adjacent channel in 1939, abandoning 2.2 km of the lowermost channel to stagnate and fill with sediment. Mainstem flow was reconnected to the abandoned channel in October 2018, 79 years later, restoring aquatic connectivity to the Minnesota River. We surveyed the restored channel in August 2022 during a 19-hour timed search. General observations suggest that up to 6 vertical feet of accumulated sediment was flushed from the channel with portions of the historic riverbed exposed revealing consolidated sand substrate with a small number of relic mussel shells present. We collected mussels at multiple sites totaling 163 individuals of 9 species, representing 60% of potential species from the source assemblages downstream in the Minnesota River and upstream in the Pomme de Terre River. Age estimates from external annuli counts averaged 1.9 years and included all age classes 0 to 5 years. Species with opportunistic and periodic life history strategies made up 98% of colonists, whereas equilibrium and periodic species were most abundant (70%) in the potential source assemblages. Our results showed that colonization by mussels occurred soon after flow was restored, thus providing measurable benefits in a short time.
PO 30	**MUSSEL PROPAGATION AND CONSERVATION RESEARCH AT THE USGS COLUMBIA ENVIRONMENTAL RESEARCH CENTER.** James L Kunz, Ning Wang, Jeff Steevens USGS, Columbia, MO.
	The USGS Columbia Environmental Research Center (CERC) has more than 20 years of experience in working with freshwater mussels, mainly to develop, validate, and apply methods for assessing the effects of toxicants in water, effluent, and sediment. Research recently conducted also evaluated mussel responses to non-contaminant stressors, such as elevated temperatures and suspended sediment. In the past decade, CERC has moved beyond laboratory testing to develop an active mussel propagation program in the laboratory and ponds. With advances like the pulsed flow-through automated feeding system and the use of specialized pond grow-out systems, the program has seen high survival and growth rates of juvenile mussels from almost 30 species across 6 different mussel tribes, including difficult-to-culture mussels, such as Margaratifera falcata and federally endangered Venustaconcha trabalis. Long-term holding of adult mussels and culture of juveniles to sexual maturity has been accomplished using floating upweller systems in ponds. In addition to advanced wetlab facilities and a system of well-water-fed experimental ponds, the construction of a dedicated mussel culture facility has strengthened the program by allowing in-house inoculation of host species. Scientists at CERC are now working with Tribal and other management agency partners to apply these advances in propagation to support freshwater mussel restoration and reintroduction efforts.
PO 31	**SUCCESSFUL CULTURE OF JUVENILE WESTERN PEARLSHELL (*MARGARITIFERA FALCATA*) IN A PULSE FLOW THROUGH AUTO FEEDING SYSTEM.** James Kunz[1], Alexa Maine[2], Jeff Steevens[1], Ning Wang[1], James Barron[3]. [1]US Geological Survey, Columbia, MO; [2]Confederated Tribes of the Umatilla Indian Reservation, Department of Natural Resources, Fisheries Program, Freshwater Mussel Research and Restoration Project, Walla Walla, WA; [3]US Fish and Wildlife Service, Longview, WA.

	Freshwater mussels are important members of intact and functioning lotic systems and were historically used as a First Food by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Western Pearlshell (Margaritifera falcata) is a species of significant cultural and ecological importance to the CTUIR and is of conservation concern in the Pacific Northwest. Western Pearlshell have been historically difficult to culture. Previous efforts to grow out Western Pearlshell juveniles in a laboratory environment have been successful but failed to produce adequate numbers and sizes appropriate for reintroduction into restoration sites. The current study was a collaboration between the US Geological Survey Columbia Environmental Research Center, the CTUIR, and the US Fish and Wildlife Service. The objective of this study was to refine laboratory culture methods to optimize feeding using a pulse flow through auto feeding system to improve survival and growth of juvenile Western Pearlshell in laboratory cultures for reintroduction into CTUIR ceded watersheds. The average survival rate for the Western Pearlshell juveniles was 89% for both treatments, but growth rates were slightly higher in the pond water treatment group. Results from this research will advance cultivation efforts of western mussel species for the use in restoration projects.
PO 32	**FRESHWATER MUSSEL PROPAGATION AT NEOSHO NATIONAL FISH HATCHERY.** Amy Maynard[1] and Nathan Eckert[1]. 1Neosho National Fish Hatchery, United States Fish and Wildlife Service, Neosho, MO.
	Neosho National Fish Hatchery (Neosho NFH) introduced a staff position whose responsibilities are primarily the propagation of freshwater mussels. Our current projects include an in-situ water quality study of juvenile mussel growth and survival within Shoal Creek (Missouri), propagation of Federal Endangered Neosho Mucket in three distinct management units in the Illinois (Arkansas/Oklahoma) and Spring Rivers (Kansas), and freshwater mussel restoration within the Verdigris River (Oklahoma). In 2022, we produced approximately 350,000 juvenile freshwater mussels of three species: Plain Pocketbook, Neosho Mucket, and Ouachita Kidneyshell. Experimental inoculations conducted at the hatchery determined a novel host- fish species for Ouachita Kidneyshell, the Slenderhead Darter. Collaboration with the Kansas City Zoo, paired with implementation of new systems at the hatchery have increased capacity for indoor and outdoor mussel culture. New systems include four tub upweller units, pond-side circular tanks, and floating baskets. In 2022, Neosho NFH released 3,031 mussels in the state of Kansas and transferred 44,783 to conservation partners. We are currently holding 45,529 juveniles propagated in 2022 and an additional 1,817 juveniles and sub-adults propagated in 2021 for stocking and grow-out next year.
PO 33	**HERE FISHY FISHY, WHERE HAVE YOU BEAN? CONFIRMATION OF HOST FISHES FOR THE FEDERALLY ENDANGERED CHOCTAW BEAN, *OBOVARIA CHOCTAWENSIS* (BIVALVIA: UNIONIDAE).** Lauren N Patterson[1], Susan R Geda[1] & Nathan A Johnson[2]. [1]Florida Fish and Wildlife Conservation Commission, Milton, FL; [2]U.S. Geological Survey, Gainesville, FL.
	Knowledge of host fish requirements and gravidity period are vital components in understanding and managing freshwater mussel populations. In Florida, there are 61 known species of unionids, and host fish requirements are confirmed for only 35 of these species. Our objectives were to determine gravidity periods and host fish species for federally petitioned and listed mussels. Here, we present an overview of our methods and experimental findings from two host fish trials for the federally endangered Obovaria choctawensis, Choctaw Bean. We determined fish hosts by inoculating 29 fish species across 10 families with glochidia from three O. choctawensis females. We recovered completely metamorphosed juveniles from nine host fish species representing three families (Fundulidae, Percidae, and Petromyzontidae). Our findings may facilitate future conservation and recovery efforts, particularly those involving captive propagation for augmenting extant or reestablishing extirpated populations.
PO 34	**EFFECTS OF PARASITIC FRESHWATER MUSSELS ON THEIR HOST FISHES: A REVIEW.** Sebastian L. Rock[1], Johan Watz[1], P. Anders Nilsson[2], Martin E. Österling[1]. 1Karlstad University, Biology, 65188 Karlstad, Sweden; 2Lund University, Department of Biology - Aquatic Ecology, 223 62 Lund, Sweden

	Freshwater mussels in the order Unionida are highly adapted to parasitize fish for the primary purpose of dispersal. The parasitic larval stage affixes itself to the gills or fins of the host where it becomes encysted in the tissue, eventually excysting to develop into a free-living adult. Research on the parasitic interactions between unionids and their host fishes has garnered attention recently due to the increase in worldwide preservation efforts surrounding this highly endangered and ecologically significant order. With the exception of heavy infestation events, these mussels cause minor effects to their hosts, typically only observable effect in combination with other stressors. Moreover, the range of effect intensities on the host varies greatly with the species involved in the interaction, an effect that may arise from different evolutionary strategies between long- and short-infesting mussels; a distinction not typically made in conservation practices. Lower growth and reduced osmotic potential in infested hosts are commonly observed and correlated to infestation load. These effects are typically also associated with increases in metabolic rate and behaviour indicative of stress. Host fish seem to compensate for this through a combination of rapid wound healing in the parasitized areas and higher ventilation rates. The findings are heavily biased towards Margaritifera margaritifera, a unique mussel not well suited for cross-species generalizations. Furthermore, the small body of molecular and genetic studies should be expanded as many conclusions are drawn from studies on the ultimate effects of glochidiosis rather than proximate studies on the underlying mechanisms.
PO 35	**GROWTH AND SURVIVORSHIP OF POST-LARVAL JUVENILE MUSSELS RELEASED DIRECTLY INTO BASKETS AT GREEN LANE RESERVOIR.** Roger L. Thomas[1], Alexis Wysocki[2], Kurt Cheng[3], Lance Butler[4], Danielle Kreeger[3,1], and Malcolm Newman[1]. [1]The Academy of Natural Sciences of Drexel University, Patrick Center for Environmental Research, Philadelphia, Pennsylvania 19103, [2]Rosenstiel School of Marine, Atmospheric, and Earth Science, University of Miami, [3]Partnership for the Delaware Estuary, Wilmington, Delaware 19801; [4]Philadelphia Water Department, Philadelphia, Pennsylvania 19107
	Freshwater mussels play an important role in maintaining healthy freshwater ecosystems and can be used as reliable indicators to evaluate water quality in streams and rivers throughout the United States. As filter feeders, mussels significantly reduce seston in the water thereby influencing water quality. In sufficient numbers, mussels can also increase stream-bottom stability and provide habitat diversity for other macroinvertebrates and fishes. Researchers from the Academy of Natural Sciences of Drexel University, the Partnership for the Delaware Estuary, and the Philadelphia Water Department have been involved in freshwater mussel restoration efforts throughout southeastern Pennsylvania and Delaware, including propagating mussels at The Mussel Hatchery in Philadelphia and the future development of a commercial mussel hatchery at Bartram's Garden in Philadelphia. One of the greatest challenges to the success of many propagation programs is the need for standardized culturing techniques and suitable "grow out" sites, where juvenile mussels can be relocated and held until they reach appropriate sizes for reintroduction into local streams. Within Pennsylvania, Green Lane Reservoir in Pennsburg, PA, Van Sciver Reservoir in Tullytown, PA, and several ponds in other local sites were determined to meet these criteria. We present recent data on the survivorship and growth of directly transplanted post-larval Utterbackiana implicata (Alewife Floater) and Sagittunio nasutus (Eastern Pondmussel), and compare it with data collected from other satellite facilities. The immediate release and propagation of newly transformed juvenile mussels within established grow out facilities may provide important nutritional benefits that could increase potential survivorship and allow researchers to take advantage of instances when juvenile production efforts overtax the hatcheries' culturing potential. Situations such as these result in opportunities for propagators to increase capacity for larger scale juvenile deployments in favorable conditions.

PO 36	**COMBATTING MICROBIAL CONTAMINATION DURING *IN VITRO* PROPAGATION OF *ELLIPTIO COMPLANATA* .** Raquel Wetzell[1], Rachel Mair[2], Jennifer Ryan[3], & Rima Franklin[4]. [1]U.S. Fish and Wildlife Service, Chesapeake Bay Field Office, Annapolis, MD; [2]U.S. Fish and Wildlife Service, Harrison Lake National Fish Hatchery, Charles City, VA; U.S. Fish and Wildlife Service, [3]Wildlife and Sport Fish Restoration, Hadley, MA; [4]Virginia Commonwealth University, Richmond, VA.
	In vitro propagation allows for transformation of freshwater mussel juveniles without a fish host using modified cell culture techniques. However, microbial contamination can greatly decrease the likelihood of successful transformation. A broad-spectrum antimicrobial mixture of rifampicin, carbenicillin, gentamycin, and amphotericin b (RCGA) is typically used to curb the proliferation of microbes, but this may not be effective for all types of contamination. Additionally, some antimicrobial compounds such as amphotericin b can negatively impact juvenile transformation at higher concentrations. Primocin™ (InvivoGen, San Diego, California, Cat. #ant-pm-2) was selected as an alternative to the original RCA mixture for in vitro propagation of Elliptio complanata. Primocin™ was assessed on its efficacy for controlling contamination and toxicity to transforming juveniles. Antimycotic components of each mixture were also tested at lower concentrations to determine if microbial contamination can still be controlled without impact to glochidia development. Any contaminated replicates underwent DNA extraction and analysis to identify bacterial and fungal pathogens. While Primocin™ successfully curbed microbial proliferation, Elliptio complanata transformers showed no signs of tissue development. In RCGA treatments, transformation was successful and there was no significant difference between replicates with or without amphotericin b. Results of DNA analysis identified unique contamination for each replicate without antimicrobials and contamination could be attributed to known pathogens that were ubiquitous across a range of environments or common in shellfish and aquaculture production. Comparisons with other in vitro freshwater mussel propagation laboratories suggest that pathogenic microbes may differ between laboratory setups due to multiple environmental factors. Therefore, identifying microbial contamination is essential for determining effective antimicrobial mixtures for use within in vitro freshwater mussel propagation.
PO 37	**DAM REMOVALS IN THE GREEN RIVER BASIN, KENTUCKY.** Taylor Fagin[1], Pam McDill[1], Lee Andrews[1]. United States Fish and Wildlife: Kentucky Field Office
	The Green River is a large tributary of the Ohio River located in South Central and Western Kentucky and portions of Tennessee. It historically supported 71 species of freshwater mussels and is considered the most biologically rich branch remaining of the Ohio River system. The USFWS Kentucky Field Office has recently removed three large navigation lock and dams in the Green River (GR L&D 5 and 6) as well as on the Barren River (BR L&D 1) which has restored upwards of 50 miles of free-flowing riverine habitat. Salvage efforts to relocate freshwater mussels was performed as water levels dropped resulting in relocation of over 2,000 mussels including multiple threatened and endangered species. Further post dam removal studies are underway for 2023 and beyond to better understand recolonization of mussel beds and species compositional changes.

Ecosystems and Community Ecology

PO 38	**HYDRAULICS AND STABILITY OF MUSSEL HABITAT IN A DYNAMIC FLOW REGIME.** Maura O. Roberts[1], Brandon J. Sansom[1], Robert B. Jacobson[1] [1]USGS Columbia Environmental Research Center, 4200 New Haven Rd., Columbia, MO 65201.

	Mussel beds can persist for decades or more at the same location within a river, and substrate stability is thought to be a critical component to the long-term persistence of mussels. Nevertheless, theory and data indicate that sand- and gravel-dominated rivers occupied by mussels experience frequent flood events that mobilize bed sediment on the order of every 1 to 2 years. The objective of this research is to better understand the role of hydraulics and sediment stability on suitable mussel habitat in a ~18,000 m2 mussel bed in the lower Osage River, MO about 16 km downstream from Bagnell Dam. This hydroelectric dam produces a dynamic flow regime characterized by abrupt discharge fluctuations, extended periods of relatively high discharge, and at least one flood peak each year. We deployed radio frequency identification (RFID) and accelerometer tracers to track the movement of sediment, surrogate mussels, and live mussels within and adjacent to the mussel bed. We also collected detailed bathymetry, topography, and velocity data throughout a 4 km reach surrounding the mussel bed and generated 2-dimensional hydraulic and sediment transport models to assess the expected frequency and magnitude of sediment transport within and adjacent to the mussel bed. After one year of tracer deployment, we observed >1m and up to 6m downstream displacements of 4 sediment tracers, one surrogate mussel, and one live mussel within the mussel bed. When calibrated to field evidence of mussel and sediment transport, the models will provide detailed spatial understanding of hydraulics and sediment dynamics associated with the mussel bed across a range of flow events. The results of this study will improve the understanding on what defines optimal mussel habitat and the role of sediment stability on the long-term persistence of mussels.

Genetics and Phylogeny

PO 39	**EVALUATING THE TAXONOMIC VALIDITY OF ROUGH RABBITSFOOT (*THELIDERMA CYLINDRICA STRIGILLATA*) AS A SUBSPECIES AND REEXAMINING PHYLOGENETIC RELATIONSHIPS WITHIN THE GENUS *THELIDERMA*.** Caitlin Carey[1,3], Jess Jones[2,3], Eric Hallerman[3], Rose Agbalog[4], Andrew Henderson[5], Mark Ford[6,3]. [1]Conservation Management Institute; [2]U.S. Fish and Wildlife Service; [3]Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA; [4]U.S. Fish and Wildlife Service, Abingdon, VA; [5]U.S. Fish and Wildlife Service, Asheville, NC; [6]USGS Virginia Cooperative Fish and Wildlife Research Unit.
	The recent unrecognition of federally protected subspecies Theliderma cylindrica cylindrica (threatened) and T. c. strigillata (endangered) has far-reaching recovery and management implications for the species. While ecophenotypic plasticity may explain variabilities in shell morphologies observed between these subspecies (or within T. c. cylindrica) across their range, empirical evidence to support (or refute) this hypothesis as the justification for taxonomic synonymization is limited. Furthermore, the cited molecular support for taxonomic withdrawal of recognition of the two subspecies was based on limited genetic data. Both Serb et al. (2003) and Sproules et al. (2006) explicitly acknowledged the limitations within their studies, emphasizing that taxonomic validity of T. c. strigillata as a subspecies could not be reliably assessed within the scope of their projects due to small sample sizes. Integrated with comparisons of morphological, ecological, and life-history characteristics, a molecular analysis using multiple genetic markers, specimens from across its species' range, and larger sample sizes would provide data needed to more reliably determine whether or not there is evidence for the partitioning of T. cyclindrica into two subspecies. Genetic differentiation within- and among populations of T. c. cylindrica and T. c. strigillata is being assessed using a combination of mtDNA (COI, ND1) and nuclear genetic markers to evaluate subspecies taxonomic validity and determine if there are distinct evolutionarily significant units. Phylogenetic relationships among species within the genus Theliderma (T. cylindrica, T. intermedia, T. johnsoni, T. metanevra, T. sparsa) are also being reexamined as they have not yet fully been resolved. With the exception of the Great Lakes and Cumberland drainages (samples needed), DNA samples have been collected throughout the species' historical range through collaborative volunteer efforts and museum wet-collection loans. Additionally, a better understanding of Theliderma spp. population genetics will help inform captive propagation and population restoration efforts.

PO 40	**MOLECULAR AND MORPHOLOGICAL ANALYSIS OF *LAMPSILIS* SPECIES IN THE POTOMAC RIVER USING 2D MORPHOMETRIC ANALYSIS AND DNA BARCODING.** David Zanatta[1], Alec Smith[1], Curt L. Elderkin[2] ,Emily Allison[2], Shenney Lin[2], John Pfeiffer[3], and Matt Ashton[4]. [1]Central Michigan University Department of Biology, Institute for Great Lakes Research, Mount Pleasant MI USA; [2]The College of New Jersey, Department of Biology, Ewing, NJ USA; [3]The National Museum of Natural History Department of Invertebrate Zoology, Smithsonian Institution, Washington DC USA; [4]Maryland Department of Natural Resources MD USA
	The freshwater mussel genus Lampsilis (lampmussels) is a diverse, geographically widespread, and threatened lineage. In North American drainages species boundaries and specimen identification in Lampsilis is complicated by numerous factors including high intraspecific variation, low interspecific variation, non-native introductions, putative hybridizations, and incomplete lineage sorting. Several of these phenomena appear to be particularly problematic in the Potomac River where a non-native Lampsilis introduction has made accurate morphological specimen identification difficult (e.g., L. cariosa vs. L. cardium vs. L. ovata) . We used a combination of 2D shell morphometric analysis and mitochondrial DNA from the COI gene to investigate the morphological and molecular diversity of Lampsilis spp. in the Potomac River (and adjacent drainages). Results thus far using CVA analysis indicate that the 2D morphometric analysis for 120 specimens from the Potomac and agencent drainages can distinguish three distinct clusters that correspond to L. cariosa, L. cardium, and L. ovata. An initial COI gene tree suggests the presence of at least two divergent molecular lineages in the Potomac: one attributable to native L. cariosa, the other attributable to non-native L. ovata.
PO 41	**DESIGN OF A SNP PANEL FOR LOW-COST MONITORING OF RELATEDNESS OF A FRESHWATER UNIONID.** Alex B. Dunahoo[1], Andor J. Kiss[1,2], Brook L. Fluker[3], David J. Berg[4]. [1] Department of Biology, Miami University, Oxford, OH, USA; [2] Center for Bioinformatics and Functional Genomics, Miami University, Oxford, OH, USA; [3] Department of Biological Sciences, Arkansas State University, Jonesboro, Arkansas, USA; [4] Department of Biology, Miami University, Hamilton, OH, USA.
	The Speckled Pocketbook (Lampsilis streckeri) is a federally endangered mussel endemic to the Little Red River basin in Arkansas. Extant populations occupy multiple tributaries of this river but have been eliminated from its mainstem. Gravid females were brought into captivity and their resulting broods will be returned to their respective tributary habitats. Informed captive breeding programs benefit endangered species by increasing population sizes and retaining genetic variation. We are designing and utilizing a low-density single nucleotide polymorphism (SNP) panel to estimate parentage and sibship within and among tributary populations to optimize the effectiveness of the current captive breeding program. To identify SNPs that are present in L. streckeri individuals, we are using FASTQ files that were generated from a population genomic analysis of the species (ddRADSeq). Over sixteen thousand variants passed preliminary filters (15x read depth, > 20 Phred score, locus present in 90% of samples). Identified variants will be furthered filtered to retain a set of informative, high quality, and evolutionarily neutral SNP markers. A genotyping assay will be developed using these markers and approximately 150 individuals from each brood will have their extracted DNA genotyped at 100-200 loci. By conducting bioinformatic analysis on the genotyping data, we will infer parentage and sibship within and among tributary populations, as well as being able to model the effect of the number of SNPs on the confidence of obtained results to determine the most effective size for the SNP panel. We will create a cost-effective approach for estimating parentage and sibship within and among broods from populations occupying tributaries of the Little Red River. This type of SNP panel can be used more generally for low-cost monitoring of relatedness of captive and wild individuals, which will guide the captive breeding efforts for Lampsilis streckeri and serve as a model for use with other disparate species.

Human Impacts and Climate Change

PO 42	**HYPOXIA TOLERANCE OF *PLEUROBEMA RIDDELLII* (LOUISIANA PIGTOE)** Emalyn Blackwell, Hannah Adkins, Kaelyn Fogelman, Evelyn Pieper, & James Stoeckel. Auburn University, Auburn, AL
	Freshwater mussels are threatened by a wide range of environmental stressors such as rising temperatures and hypoxia. Understanding how sensitivity to stressors differs between species and populations is critical to developing effective conservation plans. Because populations are typically not subjected only to a single stressor at a time, it is important to understand the interactions between concurrent stressors. Of particular interest is the effect of rising temperature on hypoxia tolerance. Does hypoxia tolerance remain relatively constant across temperatures, or does it decrease with increasing temperature? Previous studies by our research group have shown that hypoxia tolerance of some species (i.e. Popenaias popeii, Cyclonaias petrina) decreases with warming temperatures whereas for others, it does not (i.e. C. pustulosa, C. necki). In this study we used the same respirometry techniques to examine the relationship between temperature and hypoxia for an additional species, Pleurobema riddelli. Mussels were collected from the lower Neches River drainage in Texas, shipped overnight to Auburn University and acclimated to 25 or 32℃ for a minimum of 2 weeks. Using closed respirometry, we recorded respiration rates under conditions of progressive hypoxia. At each temperature we calculated the critical dissolved oxygen concentration (DOcrit) - the dissolved oxygen threshold below which a mussel is no longer able to obtain enough oxygen from the ambient water to meet its metabolic needs and transitions to anaerobic respiration. We also calculated the regulation index (RI) which reflects the ability to maintain a constant respiration rate as DO declines. Results are currently being analyzed. Compilation of these metabolic endpoints for an increasing number of species using standard techniques will allow us to begin testing for patterns in hypoxia tolerance across taxa, habitats, and ranges.

Contaminants and Ecotoxicology

PO 43	**THE INFLUENCE OF WATER HARDNESS ON THE SALT-SENSITIVITY OF EARLY LIFE STAGE FRESHWATER MUSSELS.** Patricia L. Gillis[1], Karen Lemon[2], C. James Bennett[1], Joseph Salerno[1], Ryan S. Prosser[2.] [1]Aquatic Contaminants Research Division, Environment and Climate Change Canada, [2]School of Environmental Sciences, University of Guelph.
	The use of road salt for winter road maintenance has led to an increase in the chloride concentration of many freshwater bodies. Freshwater mussels have a heightened sensitivity to salt. Concerns have been raised whether early life stage mussels and other salt sensitive biota will be protected by North American chloride water quality regulations, particularly species that inhabit soft waters as salt is typically more toxic in ion-dilute water. This study investigated the relationship between water hardness and the salt sensitivity of Lampsilis fasciola and Lampsilis siliquoidea. Using standard toxicity testing methods, the acute (24 and 48-hr) toxicity of sodium chloride to glochidia was examined in reconstituted waters of varying hardness. Reconstituted waters were created using US EPA recipes where varying prescribed amounts of NaHCO3, CaSO4·2H2O, MgSO4, and KCl are added to distilled water. Hardness of the seven dilution waters employed ranged from 7 to 290 mg CaCO3/L. Chloride concentrations ranged from 5 to 5000 mg Cl-/L depending on water hardness. As per standard methods, glochidia viability (ability to close valves) was used as a surrogate for survival to derive effect concentrations (i.e., EC10s and EC50s). In both mussel species, increasing water hardness resulted in a sharp reduction in salt sensitivity up to a point (~150-200 mg CaCO3/L, depending upon species) after which no further protection (i.e., increase in EC50) was observed. The 48-hr EC50s for L. fasciola ranged from 7 mg Cl-/L in very soft (7 mg CaCO3/L) water to 390 mg Cl-/L in hard water (180-190 mg CaCO3/L). The 48-hr EC50s for L. siliquoidea ranged from 14 mg Cl-/L in very soft water to 222 mg Cl-/L in hard water. These data demonstrate that glochidia are very sensitive to salt in soft water and that increased water hardness can provide some protection against salt toxicity.

PO 44	**AN EVALUATION OF ACUTE AND CHRONIC TOXICITY OF AMMONIA AND NITRATE TO A NATIVE FRESHWATER MUSSEL (ARKANSAS BROKENRAY, *LAMPSILIS REEVEIANA*) FROM THE BUFFALO NATIONAL RIVER, ARKANSAS.** James L Kunz[1], Ning Wang[1], Jeff Steevens[1] [2]Anna Pieri, [2]Jennifer Bouldin. 1USGS, Columbia, MO; 2Arkansas State University, Jonesboro, AR.
	Historical water quality data have indicated that nitrogen compounds (e.g., ammonia, nitrates) are increasing in the Buffalo National River (BUFF) in northern Arkansas. Degradation of the water quality of this system is likely the result of combined sources including recreational use, runoff from nearby agricultural pastureland, aging private wastewater treatment systems, erosion, and development of concentrated animal feeding operations. The objective of this study was to evaluate acute and chronic toxicity of ammonia and nitrate to a native freshwater mussel (Arkansas Brokenray, Lampsilis reeveiana) from the BUFF. Acute (96-h) and chronic (4- and/or 12-week) toxicity tests were conducted with juvenile mussels at 20 °C in a diluted well water (pH ~8.2, hardness ~100 mg/L as CaCO3). Preliminary results from ammonia tests indicated that the acute EC50 value for survival was 11 mg N/L and chronic EC20s for biomass (total dry weight of surviving organisms in a replicate) were 0.23 mg N/L in 4- week exposure and 0.12 mg N/Lin the 12-week exposure. For nitrate, the acute EC50 was 707 mg NO3-N/L and chronic EC20 for biomass was 31 mg NO3-N/L in 4-week chronic tests. These results provide the toxicity thresholds of ammonia and nitrate to protect Arkansas Brokenray and other mussels in BUFF, can be used in the development and refinement of environmental guidance values for ammonia and nitrate. In addition, the data are being used in combination with in-situ field data and laboratory effluent studies to better understand the potential role of nitrogen compounds in freshwater mussel declines in the BUFF and other protected natural systems.
PO 45	**INFLUENCE OF INCREASING WATER TEMPERATURE ON THE THERMAL TOLERANCE OF *GONIDEA ANGULATA* AND ITS HOST FISH, *COTTUS* SPP.** Rachael Valeria[1], Alexa Maine[2], James Nagler[1]. [1]Department of Biological Sciences, University of Idaho, Moscow, ID; [2]Confederated Tribes of the Umatilla Indian Reservation, Walla Walla, WA.
	Globally, freshwater ecosystems have experienced temperature increases caused by climate change, water management, changes in riparian areas, and thermal pollution. Freshwater organisms are heavily influenced by thermal stress and can only tolerate increasing temperatures until they reach their individual thermal maximum. Increasing water temperatures are impacting freshwater mussels (Bivalvia: Unionoida), which are both ecologically and culturally important. Mussels support aquatic ecosystems much like corals by providing habitat and food, as well as filtering water. They are a First Food for Columbia Plateau Tribes like the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Mussel harvest remains a treaty right for these tribes, but it is not currently practiced because of the recent and widespread declines in freshwater mussel abundance. Populations of the Western Ridged Mussel (Gonidea angulata) have disappeared from 43% of their historic range leading to a petition for listing as Endangered under the Endangered Species Act. Although many factors affecting this mussel species are not thoroughly understood, increasing water temperature may be a substantial stressor for both Gonidea angulata and its host fish, sculpins (Cottus spp.). The gills of Cottus spp. are colonized by mussel larvae for a period of their life history, during metamorphosis to the juvenile stage. This poster will present the research planned to investigate the thermal tolerance of Gonidea angulata and Cottus spp., which will provide important information for future mussel habitat management in the Columbia Basin.
PO 46	**EVALUATION OF THE SENSITIVITY OF A FEDERALLY ENDANGERED MUSSEL (TENNESSEE BEAN, *VENUSTACONCHA TRABALIS*) TO SELECTED CHEMICALS.** Ning Wang[1], Chris Ivey[1], Danielle Cleveland[1], James Kunz[1], Rebecca Schapansky[2], Timothy Lane[3]. [1]US Geological Survey, Columbia Environmental Research Center, Columbia, MO; [2]US National Park Service, Obed Wild and Scenic River and Big South Fork National River and Recreational Area, Wartburg, TN; [3]Virginia Department of Wildlife Resources, Aquatic Wildlife Conservation Center, Marion, VA.

	Tennessee bean (Venustaconcha trabalis) is a critically endangered mussel endemic to the Tennessee river basin and is on the verge of extirpation throughout its range in Tennessee and Virginia in the United States. Previous studies have demonstrated that environmental contamination is a contributing factor to the worldwide decline of freshwater mussel populations and mussels are among the most sensitive freshwater species to a variety of contaminants. However, little is known about the sensitivity of the federally endangered Tennessee bean. The objective of this study was to evaluate the sensitivity of juvenile Tennessee bean to seven chemicals with different modes of toxic action (ammonia, chloride, nitrite, potassium, cobalt, manganese, nickel) in acute 96-h toxicity tests and to three chemicals (nitrite, cobalt, iron) in chronic 28-d tests using ASTM standard methods. Test chemicals were selected based on (1) chemicals of potential concern found in a 2021 field survey in the Obed Wild and Scenic River, Tennessee, where a population of Tennessee bean occurs, (2) chemicals to which other mussels are sensitive, or (3) chemicals that had not been previously tested with unionid mussels. Preliminary results showed that the endangered species has similar sensitivity as other mussel species tested previously. Importantly, mussels were among the most sensitive species to ammonia, chloride (tested as NaCl), potassium (tested as KCl), and nickel in acute toxicity databases and to cobalt and iron (measured as total iron) in chronic databases for all freshwater organisms. Thus, the development or revision of water quality criteria and other water quality guideline values for these chemicals should reflect the sensitivity of mussels.

Invasive Species Impacts

PO 47	**POPULATION DENSITIES AND DISTRIBUTIONS OF NATIVE MUSSEL SPECIES AND RUSTY CRAYFISH IN SCHOHARIE CREEK, NY.** Baileigh Behan[1], Brian Hefferon[1], Jessica Furlong[1], Andrew Gascho Landis[1]. 1State University of New York at Cobleskill, Department of Fisheries, Wildlife, and Environmental Science, Cobleskill, NY.
	Rusty crayfish (Faxonius rusticus) are a relatively recent introduction to Schoharie Creek and may pose a significant threat to native mussels since they are known to be predators of juvenile mussels. Our objective was to examine the influence of rusty crayfish density on mussel abundance, size, and sex ratio of Lampsilis cariosa in Schoharie creek. We conducted timed snorkel surveys for mussels and seined for crayfish at nine sites. We found four species of mussels, Alasmidonta marginata, Lasmigona costata, Lampsilis cariosa and Pyganodon grandis. At sites where crayfish were present, P. grandis was absent and the three other species on average had a shorter shell length. Overall, as mussel CPUE increased, rusty crayfish density decreased. L. cariosa sex ratios were 8 males:1 female. These results may indicate that the rusty crayfish is impacting native mussel species in this region. Specific characteristics such as having a thin shell, like P. grandis or using a modified lure in their reproductive cycle like L. cariosa may put them at higher risk of predation than other mussel species. Controlled releases of predatory fish and restricted fish harvests are possible management strategies for limiting crayfish densities for this area and should be further explored.
PO 48	**ADDRESSING IF INTERSPECIFIC COMPETITION OCCURS BETWEEN INVASIVE FRESHWATER CLAMS AND NATIVE JUVENILE MUSSELS.** Taylor E. Kelley[1]; Garrett W. Hopper[1]; Carla L. Atkinson[1]; Arial J. Shogren[1]. 1 University of Alabama, Tuscaloosa, AL.

	The Southeastern United States is a hotspot for freshwater mussel biodiversity, but species in this region are declining at alarming rates due to a milieu of anthropogenic effects, such as invasive species introduction. However, negative species interactions between native and invasive species are challenging to document in nature. We plan to quantify differences in growth of native Lampsilis fasciola in the absence and presence of invasive Corbicula fluminea using paired mesocosm and field experiments at the Alabama Aquatic Biodiversity Center (AABC). We propose to measure growth of propagated juvenile L. fasciola across a low to high density gradient of C. fluminea in a mesocosm and field experiment. We hypothesize that L. fasciola growth rates will decline with increasing C. fluminea densities due to competition for food resources. With this study, we aim to identify C. fluminea density thresholds in which negative impacts to native mussel survivorship and growth occur, and if these effects are context-dependent. Characterizing negative interactions between invasive species and native communities is essential for designing appropriate control measures for widespread invasive species and developing recovery plans for endangered native species.

Conservation Strategies

PO 49	**THE YATES MILL AQUATIC CONSERVATION CENTER: A NEW AQUATIC SPECIES PROPAGATION FACILITY AT NORTH CAROLINA STATE UNIVERSITY.** Chris B. Eads, Loretta M. Lutackas, and W. Gregory Cope. North Carolina State University, Raleigh, NC
	A large federal highway project around the Raleigh, North Carolina metropolitan area has been developed over multiple decades. The southernmost portion of the expressway, which recently began construction, will cross Swift Creek (Neuse River Basin), which is home to three federally listed freshwater mussel species (Alasmidonta heterodon, Elliptio lanceolata, and Fusconaia masoni). A lawsuit brought by multiple interest groups over the highway and its potential impacts led to a settlement that generated funds to establish a conservation aquaculture and research facility at North Carolina State University. Named the Yates Mill Aquatic Conservation Center, its primary mission is to support conservation of the listed species found in Swift Creek through propagation, research, education, and public outreach. In total, the facility consists of approximately 4400 ft2 of both indoor and outdoor research and production space. An additional 800 ft2 pump house was erected on site capable of delivering up to 500 GPM of flow from the pond filtered down to 25 microns and also similarly filtering and UV-sterilizing the outflow from the facility. Besides the primary wet lab, an additional classroom, office, and laboratory for in vitro mussel propagation allows for a variety of research and educational opportunities. Our location at a county park will provide opportunities for outreach to K-12 students and local citizens who visit the park for education and recreation. This presentation will cover layout and designs of systems to be installed in this newly constructed facility.
PO 50	**UNIONIDS RESTORATION ACTIVITIES AND THEIR EFFECTIVENESS WITHIN WEST VIRGINIA.** Michael E. Everhart, West Virginia Division of Natural Resources, Elkins WV 26241.
	As the most imperiled group of animals in all of North America, the preservation of unionid populations has been at the forefront of restoration activities. Here we explore some restoration efforts conducted by the West Virginia Division of Natural Resources for the purpose of maintaining, increasing and reestablishing freshwater unionid communities. We will focus on our efforts at several of our permanent monitoring sites and areas where freshwater mussel communities have been known to exist historically. We explore several techniques that have been employed with varying effectiveness including: pilot studies, adult translocation, fish inoculation and release, introduction of juvenile mussels and silo deployment. We will review each of these methods and discuss our failures and successes. We will also discuss challenges in assessing restoration success and detecting recruitment following restoration activities.

PO 51	**SHELD, A TRAIT DATABASE FOR FRESHWATER MUSSELS OF THE UNITED STATES OF AMERICA** Garrett W. Hopper[1], Jamie R. Bucholz[1], Traci P. Dubose[2], Kaelyn J. Fogelman[3], Sean M. Keogh[4], Megan E. Kubala[1], Matthew B. Lodato[1], David H. Nichols[5], Irene Sánchez González[1], John M. Pfeiffer[5], James A. Stoeckel[3], Jeffery D. Lozier[1], Carla L. Atkinson[1]. 1. Department of Biological Sciences, University of Alabama, Tuscaloosa, AL, 2. Department of Biological Sciences. Virginia Polytechnic Institute and State University, Blacksburg, VA, 3.College of Agriculture, Auburn University, Auburn, AL, 4.Department of Ecology, Evolution, and Behavior & Bell Museum of Natural History, University of Minnesota, St. Paul, MN, 5. National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA
	The United States of America harbors a diverse collection of freshwater mussels comprising 301 species distributed among 60 genera and two families (Margaritiferidae and Unionidae), each having a unique suite of traits. Mussels are among the most imperiled animals and are critical components of their ecosystems. Successful management, conservation and research requires a cohesive and accessible source for acquiring information on species' traits. Although trait-based analysis for freshwater mussels has increased, only a proportion of traits representing the diversity of species have been individually collated into separate sources. Decentralized and non-standardized trait information impedes large-scale analysis. Assembling trait data in a synthetic database enables comparison across mussel species and lineages and allows for the identification of data strengths and weaknesses. We collated data from the primary literature, books, government reports, theses and dissertations, and museum collections into a centralized database. Our database includes current taxonomy, morphology, reproductive ecology and life history, fish hosts, habitats, thermal tolerance, geographic distribution, available genetic information, and conservation status. By collating these traits, we aid researchers in assessing variation in mussel traits and modeling ecosystem change.
PO 52	**CURRENT ACTIVITIES TO SUPPORT FRESHWATER MUSSEL RESTORATION IN THE SUSQUEHANNA RIVER BASIN.** Zachary Taylor, Matthew Ashton, and Tony Prochaska. Maryland Department of Natural Resources, 10201 Bee Oak Road, Brandywine, MD 20613.
	Freshwater mussels are among the most imperiled faunal groups in North America and provide important ecosystem services, including filtration and transformation of sediment and nutrients, and serving as ecosystem bioindicators. Populations of freshwater mussel species in the Susquehanna River basin that require a migratory fish host to complete their reproductive cycle have been negatively impacted, in part, by the dams on the mainstem of the river. The Maryland Department of the Environment (MDE) and the Maryland Department of Natural Resources (MDNR) have partnered to undertake a significant, multi-state mussel restoration initiative for the Susquehanna River basin with support provided by Constellation Energy Generation, LLC. Funding will be provided for the design and construction of a new mussel hatchery that will be co-located at the MDNR's Joseph Manning Fish Hatchery. Additionally, annual funding will support implementing restoration activities, such as population augmentation and reintroduction via hatchery propagation and other activities, such as translocation and/or infested host fish stocking. Through the partnership with MDE, MDNR has begun to initiate various activities presented herein, including: securing hatchery design and construction services, conducting restoration planning and public outreach, soliciting input from regional partners, and seeking active collaborators for the mussel restoration effort. This large-scale freshwater mussel restoration initiative will increase the size and distribution of mussel populations, helping to preserve regional biodiversity and achieve multi-jurisdictional goals to reduce nitrogen, phosphorus, and sediment pollution to the Chesapeake Bay.

	Mussel Health Assessment and Die-Offs
PO 53	**BIOMARKERS OF HEALTH AND IMMUNOCOMPETENCE IN FRESHWATER MUSSELS: AN ASSESSMENT OF APPLICABILITY TO WILD AND HATCHERY POPULATIONS.** Madison E. Polera[1], W. Gregory Cope[1], Erin McKenney[1], Catherine E. LePrevost[1], Jeffrey A. Yoder[2],Tal Ben-Horin[3], Chris B. Eads[1], Heather Evans[4], Rachael Hoch[4], J. Michael Fisk II[4], Michael J. Walter[4]. [1]Department of Applied Ecology, NC State University, Raleigh, NC. [2]Department of Molecular Biomedical Sciences, NC State University, Raleigh, NC. [3]Department of Clinical Sciences, NC State University, Raleigh, NC. [4]NC Wildlife Resources Commission, Raleigh, NC.
	Freshwater mussels (Order Unionida) are among the most imperiled faunal groups, facing enigmatic die-offs and widespread population declines. Historically, these declines have occurred following conspicuous impacts of habitat destruction, pollution, invasive species, and stream impoundments. Contemporary mussel die-offs often lack such discriminant explanations and diagnoses are often limited to post-hoc mass mortality evaluations. Sublethal metrics and markers serve to proactively identify infection, stress responses, and deviation from physiological homeostasis. We intend to identify, evaluate, and validate a suite of biomarkers reflective of immunocompetence and immunopathology by integrating immunology, microbiology, histopathology, and metabolomics. Samples of wild and hatchery mussels will be used to establish biomarker baseline reference ranges and describe variation across spatial and taxonomic scales. Experimental trials will be used to quantify the response of immune defense parameters in circulating hemolymph such as total and differential hemocyte counts, hemocyte morphology, and hemocyte function in the face of environmental stressors and infectious disease. The correlation between microbiome diversity metrics and mussel immune status will be evaluated in hemolymph and mucosal surfaces. Finally, metabolomics will be used to explore disease mechanisms and identify candidate hemolymph metabolite biomarkers. These assays will combat challenges of conducting health assessments on threatened and endangered species in streamside surveys by evaluating potential surrogate species and cross-validating mobile, accessible, noninvasive, and high throughput methods. We anticipate that these standardized practices of surveying for early warning signs of compromised health or susceptibility will better inform management, propagation, and conservation decisions.