



Newsletter of the Freshwater Mollusk Conservation Society
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Cover Story 1
 Society News 3
 Society Elections . . .5
 Upcoming Meetings 9
 Contributed Articles 10
 FMCS Officers . . . 19
 Committees 20
 Parting Shots . . . 21

The 13th Biennial FMCS Symposium



We can't wait to see you in **Portland, Oregon!** Looking for some inspiration (and dramatic music) to get excited about the trip? Check out <https://youtu.be/dacp557D1dA>. More information can also be found at <https://www.travelportland.com/plan/>.

Our local planning committee is working hard to welcome you April 10-14 to the 13th Biennial FMCS Symposium at the Lloyd Doubletree in Portland, OR. If you missed the early registration cutoff, there's still time to register. Registration remains open until March 31st at: <https://www.molluskconservation.org/EVENTS/2023>

[SYMPOSIUM/2023_FMCS-SYMPOSIUM.html](#). Don't forget to reserve your hotel room as soon as you can to take advantage of our special rates (standard room for \$152 per night). The deadline for our group rate is **March 10**. Reservations can be made online at: [Available Rooms - DoubleTree by Hilton Hotel Portland](#). If you reserve your room by phone, be sure to ask for the "Freshwater Mollusk Conservation Society group rate" to ensure you receive the reduced rate. More information on the venue is available at: [DoubleTree Hotel Portland - Hotels in Portland Oregon \(hilton.com\)](#). Parking is available at the venue for a fee, but public transportation can take you directly from the airport to the hotel. You can plan your trip using the following resources: <https://www.travelportland.com/plan/>, <https://trimet.org/>, and <https://www.amtrak.com/stations/pdx>.

Updated Schedule

Unlike past symposia, we're starting the program on Monday, with the workshop running from 10am-3pm, with lunch provided. The board meeting, a student-mentor mixer, and the welcome reception all take place Monday afternoon and evening! Tuesday morning opens with two incredible plenary speakers, followed by 3 concurrent sessions of platform talks, as well as a poster session and social and a movie showing. Committees will meet over the lunch hour on Tuesday and Wednesday, although the names sub-committee meetings will take place on Monday afternoon.

A boxed lunch is provided to attendees of committee meetings. For those not attending committee meetings, lunch will be on your own each day, with many options in the area. A list and map will be provided.

Additional concurrent sessions will take place on Wednesday and Thursday, with a DEI plenary session on Thursday morning followed by lightning talks, and field trips on Friday.

The following schedule includes additional details about what is planned for each day. A final schedule will be shared closer to the date of the Symposium. Check out our event website, which we will continue to update as we get closer to the event:

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

Society News

2022 Final Treasurer Report

For 2022 calendar year, FMCS assets total \$147,325.43 broken into major assets of Bank of America savings (\$10,017.82) and Bank of America checking (\$137,484.03). In terms of liability and equity, we have no liability, and our equity is \$147,501.85 in retained earnings. The FMCS calendar year 2022 Profits & Losses included a total income of \$88,096.14 and total expenses of \$65,032.31 resulting in a net income of \$23,063.83 (Table 1). Major income sources were: memberships (\$6,610.00), our share of proceeds from the 2022 JASM meeting (\$16,893.00), and income from the 2022 Workshop (\$50,302.13). Major expenses included: Third-party payment processing fees (\$2,909.98), web page maintenance (\$4,588.56), 2023 2023 symposium expenses (\$12,669.00), 2022 workshop expenses (\$34,039.21), and Walkerana/FMBC expenses (\$8,951.42).

2022 P&L Report			Jan - Dec 22
Income			
	Refunds		
		2022 Joint Meeting	16,893.00
	Total Refunds		16,893.00
	Bank Adjustment		0.7
	Amazon Smile income		234.48
	Donations		1,600.00
	Interest income		4.01
	Memberships		
		2022 Memberships	5,810.00
		Lifetime Memberships	800
	Total Memberships		6,610.00
	Workshops and Symposiums		
		2023 Symposium	
		Sponsorship	3,860.00
		Registration	8,591.82
		Total 2023 Symposium	12,451.82
		2022 TN Workshop	
		Venue Refund	900
		Field Trip Vendor Refund	500
		Registration	48,902.13
		Total 2022 TN Workshop	50,302.13
	Total Workshops and Symposiums		62,753.95
	Total Income		88,096.14
Gross Profit			88,096.14

Table 1 continued.

Expense			
	Fliers		79.91
	Service Fees		
		Third-Party Payment Processor	2,909.98
	Total Service Fees		2,909.98
	Award expenses		
		Student award expenses	590
	Total Award expenses		590
	Shipping		480.56
	Webpage		
		International Bank Service Fee	61.56
		Webpage - Other	4,527.00
	Total Webpage		4,588.56
	Office supplies		
		Book Keeping	592.92
		Office supplies - Other	29.9
	Total Office supplies		622.82
	Tax expenses		100.85
	Symposium/Workshop expenses		
		2023 Portland Symposium	
		Venue Expenses	8,370.00
		Virtual Vendor	4,299.00
		Total 2023 Portland Symposium	12,669.00
		2022 TN Workshop	
		Field Trip Expenses	500
		Workshop Refund	2,735.40
		Workshop Supplies	1,380.59
		Venue Expense	29,423.22
		Total 2022 TN Workshop	34,039.21
	Total Symposium/Workshop expenses		46,708.21
	Walkerana/FMBC costs		
		BioOne	1,230.00
		Editing	2,205.00
		Allen Press	5,516.42
	Total Walkerana/FMBC costs		8,951.42
	Total Expense		65,032.31
			23,063.83

Society Elections

Every other year, our Society elects members to serve in three Executive Committee positions: President-elect (who, after two years, goes on to serve as President for two years, then Past President for two years), Secretary (for a 2-year term), and Treasurer (also for a 2-year term). This time, we have two candidates for President-elect, one candidate for Secretary, and one candidate for Treasurer. Photographs and statements from each of the candidates are presented on the next few pages.

Now that you have reviewed their statements, we encourage you to vote for your candidate of choice for each office. Voting will occur online and is open now at the following site: <https://forms.gle/oi1urNMbo9ENgtcU6>

The last day to vote will be April 1st, 2023. The winners will be announced at the April FMCS Symposium at Portland, OR.

Candidates for president-elect

Emillie Blivens



I am a Washington state-based Senior Conservation Biologist with the Xerces Society for Invertebrate Conservation. Originally from Tennessee and a graduate of Berea College in Kentucky, I have always loved fish, wildlife, and the outdoors. My first introduction research as an undergraduate was wading through Kentucky creeks to collect freshwater snails and mussels. I completed my M.S. at Kansas State University, and I have conducted research on a broad range of species and ecosystems in the Southeast, Central U.S., and Pacific Northwest.

Following my graduate research, I have worked in freshwater conservation and restoration and, since 2015, been part of a team of conservation biologists at Xerces, working on freshwater and terrestrial mollusks and insects, with a special focus on freshwater mussels of western North America. My work at Xerces includes surveying and monitoring mussels and snails, leading the development of a regional standardized survey protocol, conducting research, including assessing populations and investigating mass mortality events, developing and sharing best management practices for mussels during in-water construction, and conducting outreach through presentations, workshops, and other trainings. I am the lead author of several Xerces publications on freshwater mussels, including best management practices guidelines, and have authored and coauthored peer-reviewed articles on freshwater mussels and snails, as well as several IUCN Red List profiles and multiple technical reports.

When I became a member of FMCS in 2016, I was delighted to connect with so many experts through our shared passion for mollusks and freshwater ecosystems. In my role at Xerces, I am fortunate to be able to dedicate my time and energy to many activities core to the FMCS mission. As chair of the Pacific Northwest Native Freshwater Mussel Workgroup, I have worked hard to develop community, encourage collaboration, and foster interest in freshwater mollusks both regionally and west wide. Since 2019, I have been more closely involved with the FMCS board, including contributing to the Chapters committee and conducting associated research, as well as co-chairing the local planning committee for the upcoming FMCS Biennial Symposium in Portland, OR. It has been a pleasure to work with the many FMCS members who are committed to the mission and vision of FMCS, and who work daily to make it a successful and impactful organization. In my time working with the board, I have gained a lot of knowledge and understanding of the internal workings of FMCS, which I feel would enable me to hit the ground running if elected. I am honored to be nominated for the position of President Elect and look forward to an opportunity to continue to serve the Society.

Amy Maynard



My experience with mollusks began at Missouri State University (MSU) as a freshman biology student, having seen an opportunity to lend a hand. I am a first-generation college student in my family and am grateful to have been challenged and encouraged by Dr. Chris Barnhart and his graduate students to conduct undergraduate research, learn propagation skills, and pursue graduate study. I completed my master's degree in 2015 at MSU studying genetic characteristics of sperm and spawning habits of Bleedingtooth Mussel, a species endemic to the Ozarks.

As an intern and technician, I spent time monitoring populations of freshwater mussels with the Minnesota Department of Natural Resources and studied their habitat with the Missouri Department of Conservation. After graduating, I propagated Atlantic Slope species of freshwater mussel at Virginia Fisheries and Aquatic Wildlife Center and more recently returned to the Midwest at Neosho National Fish Hatchery propagating Interior Highlands species of freshwater mussel. Collectively, I have worked with thirty-five species of freshwater mussel using traditional and *in vitro* methods of propagation.

I joined the Freshwater Mollusk Conservation Society (FMCS) in 2013 and began serving the society as an active member in 2015, joining the outreach and propagation committees. I worked with outreach committee leaders and my peers to organize student networking events held at subsequent symposia. I have served as an Outreach Committee chair since 2019, posting to our social media accounts and coordinating the production and dissemination of marketing and

outreach materials for the society. I served as the marketing contact for FMCS during the planning of the Joint Aquatic Sciences Meeting in 2022 and during our own virtual symposium in 2021.

The word that best fits my goals as a presidential nominee is SUPPORT. Professionals within our society have a wealth of ideas and are skilled at putting together new programs and resources. The barrier to some of these new opportunities may be funding. My goal is to seek out funding resources for programs our society members have put together. I would not be a malacologist without the people who surround and who (continue to) encourage me. Many of us could say the same. I think it is important to find ways to support each other and to foster opportunities for young and diverse people. I am grateful to have been nominated to run for president-elect and look forward to seeing you all soon.

Candidate for treasurer

Alan D. Christian
Ursinus College



I wish to continue to contribute to FMCS and would be happy and honored to serve a third term as Treasurer if elected by my colleagues. I received my BS from the University of Wisconsin Oshkosh, my MS from Arkansas State University, and my Ph.D. from Miami University. I am a broadly trained aquatic ecologist and environmental scientist with expertise in freshwater and freshwater mussel ecology, evolution, and conservation. My research context and study areas range from near-pristine to heavily disturbed to restored systems. Through the lens of the biological continuum, I integrate molecular to landscape approaches allowing for spatially, temporally, and organizationally integrated research directly or indirectly supporting conservation policy and management.

I have been involved with “FMCS” since 1992 when I attended the Upper Mississippi River Conservation Commission meeting in St. Louis as a graduate student at Arkansas State University and have been active in “FMCS” ever since. My participation includes presenting at meetings and workshops, serving on committees, judging presentations, bringing students to meetings, serving as treasurer from 2019-present, and hosting meetings and workshops. John Harris and I co-chaired and hosted the 2007 Symposium (Directions in Freshwater Mollusk Conservation: Molecules to Ecosystems) and Workshop (Habitat Restoration; Led by Heidi Dunn) in Little Rock, Arkansas. I helped Mary McCann and Rebecca Winterringer organize and host the 2014 Workshop (Mussel Studies and Regulatory Process Associated with Dam Removals) in Portland, Maine. In response to the global COVID-19 pandemic causing the 2021 FMCS Portland Symposium to be postponed until 2023, I volunteered to chair and host the 2021 FMCS Virtual Symposium (Back to the Future: The Virtual Unknown).

Candidate for secretary**Sarah Veselka**

If elected, I would be happy to continue to contribute to FMCS as Secretary for a second term. I have been involved with FMCS since 2015 attending symposiums and workshops, serving on committees, and judging student presentations. Over the past two years as Secretary, I have maintained and updated our membership database and been responsible for timely society news and correspondence, committee reports, and board meeting minutes.

I grew up playing in the Gulf of Mexico in south Florida and spending long summer days in creeks in western Ohio. My love of aquatic ecology was solidified during an extended research course in Costa Rica with the University of Georgia where I received my Bachelor of Science in Biology. After working in a fisheries laboratory there, I furthered my education at West Virginia University with a Master of Science in Fisheries Resources where I studied stream ecosystem response to mitigative limestone treatment. This research was published in *Ecological Applications*. During that time, I also served as President of the WVU Chapter of the American Fisheries Society.

After graduate school, I served as an AmeriCorps Volunteer in Service to America with a non-profit watershed group in Morgantown, West Virginia, and as their Executive Director for four years. There I gained invaluable experience in non-profit management, grant writing, fundraising, community organizing, and environmental education. I also continued applied research in aquatic sciences with a focus on acid mine drainage and stream restoration. For the past 12 years, I have been working as an environmental consultant conducting freshwater mussel, fish, crayfish, and macroinvertebrate surveys across the Eastern United States. I am currently the Co-Founder and a Senior Biologist for BioSurvey Group, a small environmental consulting firm focused on threatened and endangered species surveys and consultations. I am a PADI certified Master Diver and love being underwater especially surveying for freshwater mussels. I also enjoy mountain biking, kayaking, skiing, and camping with my family.

I was formerly a Board Member of the Association of Mid-Atlantic Aquatic Biologists and currently serve as the Secretary for the West Virginia Women's Energy Network. I am excited for the future of FMCS, am looking forward to seeing everyone in Portland, and would be honored to continue my service with the Society.

Upcoming Meetings

- March 26 - 30, 2023** – National Shellfisheries Association 115th Annual Meeting, Baltimore Marriott Inner Harbor at Camden Yards, Baltimore, Maryland, USA. [Annual Meeting \(shellfish.org\)](#)
- April 10 – 14, 2023** – FMCS Biennial Symposium, Double Tree Hotel, Portland Oregon, USA. Theme: *Mountains to Sea and Mollusks Between*. [See page 1]
- June 3 – 7, 2023** – Society for Freshwater Science Annual Meeting, Brisbane Convention and Exhibition Centre, Brisbane, Australia. <https://www.freshwaterdownunder2023.org/>
- August 1 – 5, 2023** – American Malacological Society Annual Meeting will be held in Tuscaloosa, Alabama, United States. <https://ams.wildapricot.org/>
- August 20 – 24, 2023** – American Fisheries Society 153rd AFS Annual Meeting, August 20-24, 2023, **Adaptive approaches to understand and manage changes in fisheries.** <https://afsannualmeeting.fisheries.org/>
- October 15 – 18, 2023** – Southeastern Association of Fish and Wildlife Agencies 77th Annual Conference, Omni Hotel, Corpus Christi, Texas, USA. <http://www.seafwa.org/conference/overview/>
- June 23 – 28 2024** – Society for Conservation Biology North American Sectional Meeting, the 7th biennial North American Congress for Conservation Biology will be held in Vancouver, BC, June 23-28, 2024. <https://scbnorthamerica.org/>
- May (?) 2025** – FMCS Biennial Symposium, somewhere in Michigan, USA. [dates, location, theme, and other details yet to be determined]

Contributed Articles

The following article was contributed by FMCS members and others interested in freshwater mollusks. Contributions like this are incorporated into Ellipsaria without peer review and with little editing. The opinions expressed are those of the authors.

Two new mussel survey and relocation protocols for the State of Michigan

Submitted by: Joe Rathbun (retired from the Michigan DEQ)

The State of Michigan has developed two new protocols for finding and relocating freshwater mussels in the course of (1) lake construction projects (e.g., seawalls, boat ramps, dredging projects) and (2) reservoir drawdowns. Similar to Michigan's existing protocol for finding and relocating mussels in the course of river construction projects (e.g., bridge and culvert replacements or pipeline installations), these new protocols describe procedures for:

- Identifying the area of direct impact and buffer zones of lake construction projects
- Surveying for and collecting mussels
- Relocating mussels to areas outside of the construction site or drawdown zone

Similar to the river construction protocol, the lake construction protocol utilizes a model that uses historic occurrence data to predict which lakes and reservoirs are likely to contain Federal- and State-listed mussel species.

The reservoir drawdown protocol notes the difficulty of finding and relocating the thousands (or more) of mussels that can occur in large reservoirs in the short time before they expire from desiccation and predation, and therefore encourages pre-drawdown surveys to identify mussel density and/or diversity hot spots which would then be priority areas to search when a drawdown occurs.

Finally, the Michigan Department of Natural Resources is organizing a mussel shell identification test, which as of 2024 will be required for all for-profit mussel survey projects. The test will also be available for any other interested parties, including students.

All three protocols are available on the Michigan Natural Features Inventory website:

<https://mnfi.anr.msu.edu/resources/michigan-mussels>.

Increased Population Size of the Federally Endangered *Ptychobranchnus subtentus* in the Wolf River, TN (Fentress and Pickett Co.)

Jack Fetters¹, Amanda Rosenberger², Kristin Irwin Womble¹, Anthony Ford³, Brittany Bajo¹

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[Not Peer-reviewed]

Ptychobranchnus subtentus, commonly known as the Fluted Kidneyshell (Figure 1), was listed as federally endangered species in 2013. Historically, this species had twenty populations within the Cumberland and Tennessee River drainages of the Ohio River basin in Alabama, Kentucky, Tennessee, and Virginia. Several are considered to be extirpated, coinciding with impoundments, degraded water quality, and land development. Currently ten of the twenty

historical populations are extant, with only three occupying the Cumberland drainage. The Obey River, a tributary to the Cumberland drainage, harbors one of the last known populations of *P. subtentus* in this drainage (U.S. Fish and Wildlife Service 2021). A portion of this population occurs in the Wolf River, a direct tributary of the Obey River that is partially inundated by Dale Hallow Reservoir. The Wolf River watershed was historically used for mining coal, stone, and petroleum (Campbell 1995). The impoundment created by the construction of Dale Hallow Dam on the Obey River in 1943 isolates the freshwater mussel populations in the Wolf River. These isolated populations have been understudied and could be critical for future conservation and recovery efforts of *P. subtentus* in the Cumberland drainage.

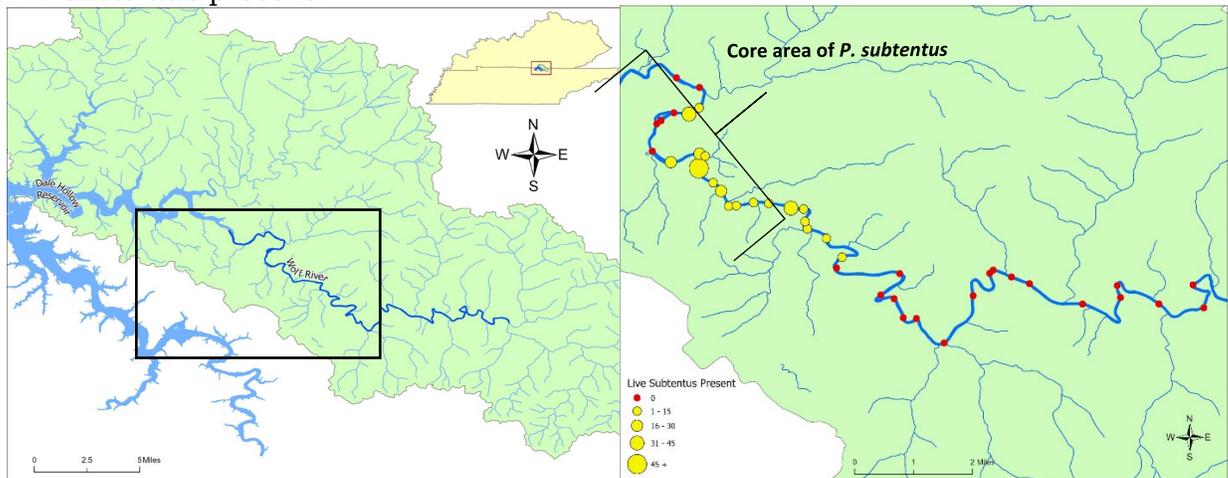
In the most recent study, Moles et al. (2007) performed visual and tactile methods at 45 sites on the Wolf River, with an average of 0.5 person hours per site and a CPUE of 5.42 mussels per person-hour. They observed 357 live and fresh dead individuals of twelve species (Table 1), 25 of those being *P. subtentus* from 24 of the 45 total sites. We revisited the same 45 sites from the previous study during May - September of 2021, using standardized visual and tactile methods modified from Strayer and Smith (2003) and Moles et al. (2007), to update the distribution and status of freshwater mussels in the Wolf River. While snorkeling we used ten-minute replicate intervals with an average of 2.5 person hours per site. Our CPUE was comparable to the previous study at 4.98 mussels per person-hour. However, we observed a total of 659 live and fresh dead individuals of eight species, 311 of them being *P. subtentus*, indicating an increase in *P. subtentus* numbers. During sampling we noted eroded banks (Figure 2), urban development, and the presence of livestock in the river. Contrary to expectation, *P. subtentus* was the most abundant species at several of our sites. Though the majority of *P. subtentus* individuals occurred in the lower sections of the Wolf River, the abundance decreased near inundated portions of the river, and we did not observe the species in the upper section (Figures 3 and 4). While we found fewer species and our effort was significantly higher than the previous survey, the overall increase in abundance and variable sizes (Figures 5 and 6) of *P. subtentus* indicates an increase of the population in, at least, this 10-km portion of this system.

Future directions of this project will include returning to species-rich sites in the summer of 2022 to determine densities and size-structure of all mussel species with more intensive survey methods (quadrats). Additionally, we will conduct a basin-wide habitat assessment using remotely-sensed data, coupled with the collection of several water quality parameters and the determination of food availability. This effort will facilitate the identification of a potential areas that could be targeted for restoration or recovery.

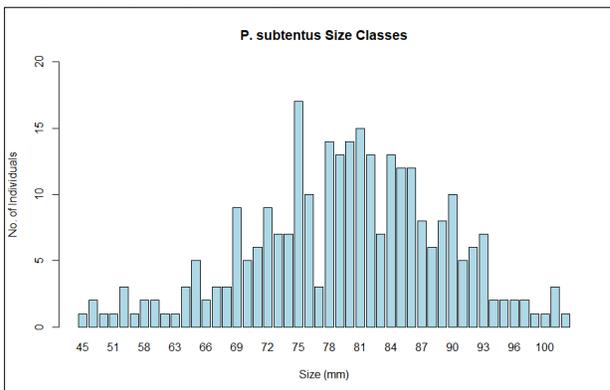
We would like to thank the US Fish and Wildlife Service for funding this project and all the assistance from students in the field. Also, a special thanks to Clay Mahan; without his help, this project could not have been completed. For more information about this project, please contact Jack Feters at jgfeters42@tntech.edu or Amanda Rosenberger at arosenberger@tntech.edu.



Figures 1 and 2. Image of *Ptychobranchus subtentus* aperture and an example of an eroded bank with *P. subtentus* present.



Figures 3 and 4. A map of the Wolf River study area and the spatial extent (10km) of *P. subtentus* in the Wolf River



Figures 5 and 6. Estimated size structure of *P. subtentus* based on individuals captured during visual surveys and a picture of variable sizes of *P. subtentus* collected and returned during visual surveys. Note: Visual surveys are generally biased towards larger individuals; further research will involve quadrat surveys to enhance capture of smaller individuals.

Table 1. Freshwater mussels reported (X = present, D = Dead, A = alive) from the Wolf River, Pickett and Fentress counties, TN.

Mussel Species	Shoup et al. 1941	Hatcher and Ahlstedt 1982 (unpublished)	Layzer and Anderson 1992	Layzer and Madison 1998	Moles et al. 2007 Alive and Fresh Dead	Alive and Fresh Dead 2021
<i>Actinonaias pectorosa</i>		L	D		1	30
<i>Alasmidonta viridis</i>		D	L	L	2	
<i>Amblema plicata</i>	X					
<i>Cyclonaias tuberculata</i>	X					
<i>Lampsilis cardium</i>		D	D	D	2	3
<i>Lampsilis fasciola</i>		D	L	D	8	2
<i>Medionidus conradicus</i>		L	L	D	10	46
<i>Pleurobema oviforme</i>			D	D	2	
<i>Potomilus alatus</i>			D		2	
<i>Ptychobranchnus subtentus</i>		L	D	L	25	313
<i>Pyganodon grandis</i>		D			1	
<i>Strophitus undulatus</i>			D			
<i>Toxolasma lividus</i>				D	14	1
<i>Villosa iris</i>		L	L	D	109	44
<i>Villosa taeniata</i>		L	L	L	183	220
Total					359	659

References:

- Campbell, J. F. and D.L. Newton. 1995. Soil Survey of Fentress and Pickett Counties, Tennessee. United States: The Service.
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- Layzer, J. B., and Anderson, R. M.,. 1992. Impacts of The Coal Industry on Rare and Endangered Aquatic Organisms of The Upper Cumberland River Basin. Final Report. Submitted to the Kentucky Dept. of Fish and Wildlife Res., and the Tennessee Wildlife Res. Agency.
- Layzer, J. B., and Madison. 1995. Microhabitat use by Freshwater Mussels and Recommendation for Determining Their instream flow needs. Reg. Riv.: Res. Mgmt., 10:329-345 – 1999. Zebra Mussel Impacts on Endangered Unionids. Final Report. Submitted to Kentucky Dept. of Fish and Wildlife Res., and Tennessee Wildlife Res. Agency.
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- Shoup, C. S. et al. 1941. A limited Biological Survey of the Obey River and Adjacent Streams in Tennessee. J. Tennessee Acad. Sci., 16:48-76
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- U.S. Fish and Wildlife Service. 2021. Fluted Kidneyshell (*Ptychobranchus subtentum*(=*subtentus*)) Species Status Assessment.

De-icing road salt affects mussels: sodium chloride lowers *Lampsilis siliquoidea* glochidia attachment and metamorphosis success

Hanna Wolf¹, James Vande Glind², Mark Hove^{1,3}, Liz Perelman¹, Dan Hornbach³, Isaac Aune², Willem Bruin², Caedmon Mick², Carrick Mick², Maliki Polowchak², Jacob Ritzema², and Anderson Schuttinga²

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Bodies of freshwater have been increasing in salinity due to high amounts of chloride-rich road salt used as a deicing agent in colder months (Kaushal et al. 2005, Kelly et al. 2012). Increased chloride concentration levels within aquatic ecosystems cause numerous disturbances with the organisms that reside in them, including freshwater mussels (Gillis 2011, Beggel and Geist 2015). Environmentally relevant levels of chloride from salt-impacted winter road runoff have been shown to decrease glochidia host attachment and viability (Prosser et al. 2017). To better understand how increased salinity affects native Minnesota mussels, we compared glochidia attachment and metamorphosis success, as well as juvenile

production, in Fatmucket (*Lampsilis siliquoidea*) placed in low and high chloride concentrations.

We followed methods similar to Blakeslee et al. (2013). Largemouth Bass (*Micropterus salmoides*) (100-230 mm total length) were collected from Twin Cities lakes during Sep. 2022. Gravid *Lampsilis siliquoidea* were collected from Rice Creek, Anoka Cty., on Oct. 5. Fish and mussels were held in untreated drinking water in 38 L aquaria with under-gravel filters, and fed Fathead Minnows (*Pimephales promelas*) and green algae (*Nannochloropsis*, Reed Mariculture), respectively. On Oct. 18, twelve fish and six gravid mussels were placed in 2.7 L (bare) and 38 L (6 cm sand and gravel) aquaria, respectively. Half of the animals randomly assigned to either the freshwater (control) group (2017 and 2019 Fridley drinking water chemistry: chloride 21.3-29.9 mg/L, total hardness 205-290 mg/L (City of Fridley 2019, pers. comm. Jason Wiehle)) or saltwater treatment (drinking water plus 2000 mg/L sodium chloride). Saltwater treatment animals were raised to 2000 mg/L NaCl over 5 d. On Oct. 25, glochidia were flushed from marsupia and checked for viability using treatment-specific water. Fish were inoculated with glochidia from three within-treatment mussels using a 71,000 glochidia/L freshwater bath or 63,000 glochidia/L saltwater bath. Fish were inoculated for 30 sec, checked for attached glochidia, and held in a treatment-specific bath for 45 min for unattached glochidia to be shed, after which time fish were randomly assigned to 2.7 L within-treatment aquaria. Each aquarium held a sponge filter aerator, had 25% daily water changes for the first three weeks, then thrice weekly, and was held at 22 °C. Fish health was observed six d/wk and food was offered three times a week. Twice a week, over the 6+ week study, aquarium contents were filtered through a 125 µm sieve and filtrate was explored with a microscope. Juveniles were identified by a foot or repeated valve closures. Glochidia and juveniles were released from fish at a nonlinear rate so we used a polynomial ANCOVA (Huitema 2011) to compare release rates between chloride treatments. We arcsine square root transformed fraction data and used a Pooled t-Test to compare glochidia attachment and metamorphosis success between treatments. JMP 16.1.0® (SAS Institute, Cary, NC) was used for statistical analysis.

We observed differences between chloride concentrations. All fish survived the study. A polynomial ANCOVA showed a significant effect of the high chloride concentration on the number of glochidia and juveniles observed (Figures 1 and 2). There were also significant differences between treatments for glochidia attachment and metamorphosis success ($p < 0.0001$ and $p = 0.006$, respectively), and juvenile production ($p = 0.008$, Table 1). Anecdotal study observations included: the juvenile release period was shorter in saltwater, saltwater treatment glochidia viability suggested some possible maternal protection from a saline environment, and mussels in tap water appeared to clear algae faster than those in saltwater.

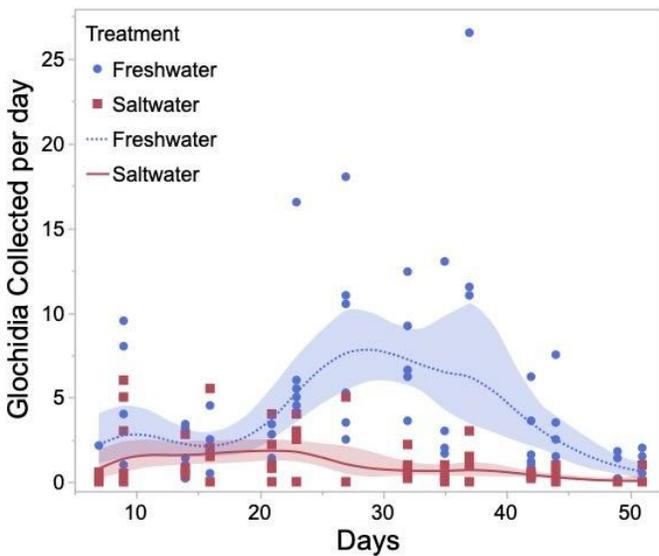


Figure 1. Cubic fit splines (lambda=0.05) with shaded bootstrapped confidence limits showed differences in glochidia abundance released by fish in low (freshwater) versus high (saltwater) chloride treatments. A polynomial ANCOVA showed a significant effect of high chloride:

Treatment (FW vs SW) – $F(1,172 \text{ df}) = 47.21, p < 0.0001$

Days² (covariate) – $F(1,172 \text{ df}) = 20.37, p < 0.0001$

Treatment * Days² (interaction term) – $F(1,172 \text{ df}) = 12.99, p = 0.0004$

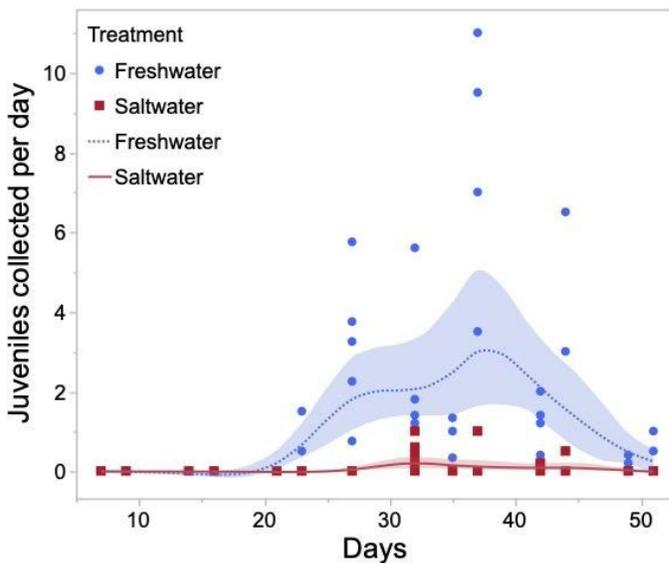


Figure 2. Cubic fit splines (lambda=0.05) with shaded bootstrapped confidence limits showed differences in juvenile abundance released by fish in low (freshwater) versus high (saltwater) chloride treatments. A polynomial ANCOVA showed a significant effect of high chloride:

Treatment (FW vs SW) – $F(1,171 \text{ df}) = 29.94, p < 0.0001$

Days² (covariate) – $F(1,171 \text{ df}) = 10.76, p = 0.0013$

Treatment * Days² (interaction term) – $F(1,171 \text{ df}) = 8.78, p = 0.0035$

Table 2. *Lampsilis siliquoidea* glochidia attachment success (no. of glochidia + juveniles recovered), metamorphosis success (no. of juveniles recovered/(no. glochidia + juveniles recovered)), and juvenile mussel production (no. of juveniles recovered) at two chloride concentrations.

	Chloride concentration (mg/L)	Glochidia attachment success (ave. \pm 1 std. dev.)	Juvenile mussel production	Metamorphosis success
Freshwater (control)	26	219 \pm 44	44 \pm 16	21 \pm 10%
Saltwater (treatment)	1238	43 \pm 19	3 \pm 2	8 \pm 5%

Our results were similar to those observed in other studies, although, to our knowledge, our study uniquely held fish and mussels at test salinities prior to (and throughout) the study. Our high salinity treatment, 2000 mg/L, is comparable to peak US lotic water values (Kaushal et al. 2005, Wenck Associates, Inc. 2014, Minnesota Pollution Control Agency 2016). *Elliptio complanata* exposed to *Anguilla rostrata* held at 2000 mg/L NaCl showed lowered glochidia attachment and metamorphosis success at elevated salinity (Blakeslee et al. 2013). The young of a few abundant and widespread mussel species are sensitive to high, environmentally observed salinity levels (Wang et al. 2018, Bringolf et al. 2022). Other mussel species may be at greater risk.

Road salt toxicity may vary at different temperatures. Chloride levels typically peak during the winter and spring months at northern latitudes (Kelly et al. 2012, Minnesota Pollution Control Agency 2016). With salinity toxicity to invertebrates varying with water temperature (Tiwari and Rachlin 2018, Jackson and Funk 2019, the effects of elevated salt on *L. siliquoidea* near 0 °C needs investigation.

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Ellipsaria is posted on the FMCS web site quarterly: around the first of March, June, September, and December of each year. The newsletter routinely includes Society news, meeting notices, pertinent announcements, and informal articles about ongoing research concerning freshwater mollusks and their habitats. Anyone may submit material for inclusion in *Ellipsaria* and all issues are accessible to anyone on the FMCS website (<http://molluskconservation.org>).

Articles contributed to *Ellipsaria* should be preliminary or initial observations of note (e.g., natural history observations, meaningful new distribution records, interesting finds, etc.) concerning freshwater mollusks, their habitats, and/or their conservation. Articles that include quantitative analyses, draw conclusions based on analyses, or propose taxonomic revisions should not be submitted to *Ellipsaria* and, instead, should be submitted to a peer-reviewed journal such as *FMBC*. Please limit the length of contributed articles to about one page of text (i.e., excluding pertinent tables, figures, and references).

Information for possible inclusion in *Ellipsaria* should be submitted via e-mail to the editors, Bob Anderson and Don Hubbs, at Ellipsaria@gmail.com. Contributions may be submitted at any time but are due by the 15th of the month before each issue is posted. MSWord is optimal for text, but the editor may be able to convert other formats. Graphics should be in a form that can be manipulated using PhotoShop. Note that submissions are not peer-reviewed but are edited for clarity and checked for appropriateness for posting in this freshwater mollusk newsletter. Feel free to contact the editor with questions about possible submissions or transmission concerns.

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If you are interested in participating in committee activities, please contact one of the appropriate chairs.

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Parting Shots



An 18 mm recruit of *Medionidus conradicus*, Cumberland Moccasinshell sampled in Bear Creek, Colbert County, Alabama on 21 June 2022. The specimen was found during periodic fixed monitoring by the Tennessee Valley Authority Aquatics Team. This individual was the first recruit detected from Alabama Aquatic Biodiversity Center (AABC) reintroduction efforts in Bear Creek, initiated on 6 October 2011. The AABC has completed 5 releases totaling 494 animals at the Bear Creek reintroduction site. *Medionidus conradicus* is currently under review by the USFWS for possible listing under the Endangered Species Act. Photograph: Jeff Garner, Alabama Department of Conservation and Natural Resources.

If you would like to contribute a freshwater mollusk-related image for use as a **Parting Shot** in *Ellipsaria*, e-mail the picture, informative caption, and photo credit to Ellipsaria@gmail.com.

