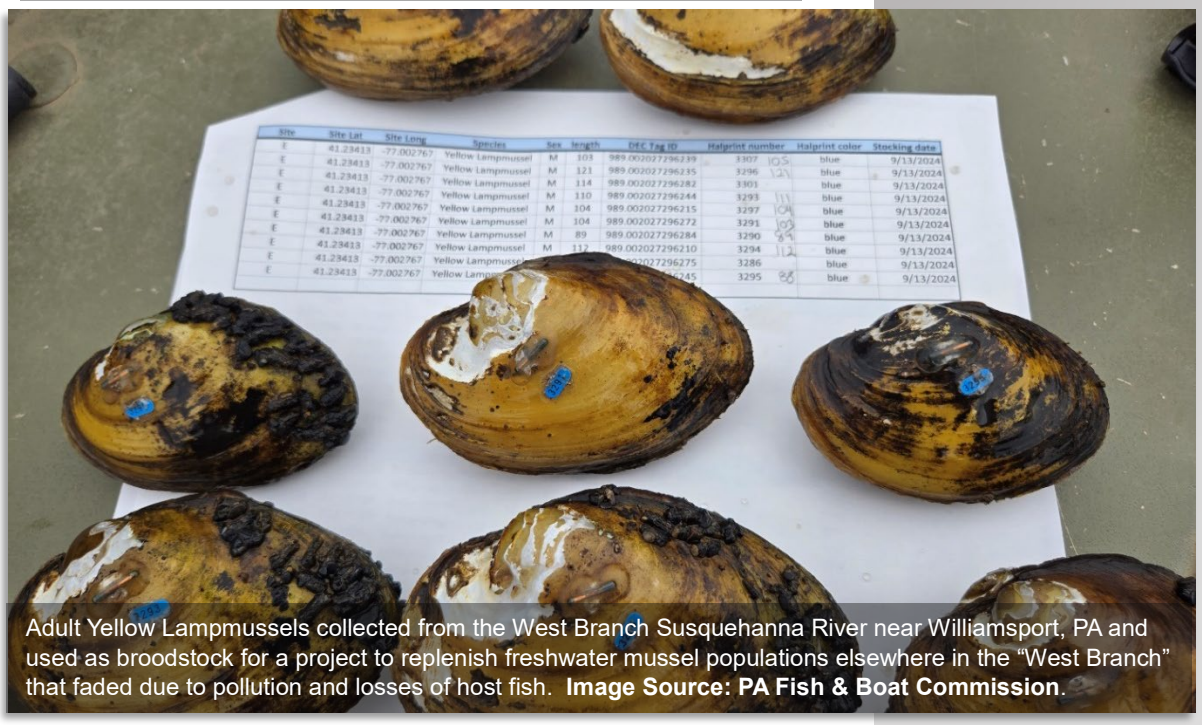
Chesapeake Bay Watershed Freshwater Mussel Partnership

Newsletter | Issue No. 2

JULY 2025



Adult Yellow Lampmussels collected from the West Branch Susquehanna River near Williamsport, PA and used as broodstock for a project to replenish freshwater mussel populations elsewhere in the "West Branch" that faded due to pollution and losses of host fish. **Image Source: PA Fish & Boat Commission**.

Restoration of Freshwater Mussels Begins in Earnest for the West Branch Susquehanna River

In 2023, the Western Pennsylvania Conservancy and its partners Pennsylvania Fish & Boat Commission, Maryland Department of Natural Resources, Commonwealth University of Pennsylvania at Lock Haven, and Susquehanna River Basin Commission were awarded more than $410,000 in funding from the National Fish & Wildlife Foundation's ChesWILD grant program for a 3-year project to reintroduce freshwater mussels to a 40^{+} mile stretch of the West Branch Susquehanna River. In addition to grant funding, the project partners collectively pledged more than $575,000 in matching resources to this project for a total commitment over $985,000.

At Issue: In more than 25 surveys from 2017 to 2023, <*pause for effect*> zero (0) freshwater mussels were found from the West Branch Susquehanna River between Lock Haven, PA and Keating, PA. Known simply as the "West Branch", this largest sub-watershed in the Susquehanna Basin underwent injurious changes to water quality and aquatic habitat from the mid-19th through mid-20th centuries due to

WHAT'S IN THIS ISSUE:

FWM Reintroduced to West Branch Susquehanna | Cover Story (cont. pp 3-5)

FWM, the Chesapeake Bay Watershed Agreement and *Your Call to Action | 2*

Spotlight on Philly's Aquatic Research & Restoration Center | 6 – 7

Virginia Mussel Richness Model/Map | 8

And much more!

FWM DESERVE GREATER VISIBILITY

With its vision for a healthy watershed, clean water, abundant life, conserved lands, and engaged citizens, since 2014 the Chesapeake Bay Watershed Agreement has guided efforts among D.C., six states (NY, PA, MD, DE, VA, WV), the Chesapeake Bay Commission, and USEPA to restore USA's largest estuarine ecosystem. The 2014 Watershed Agreement's Goals and Outcomes are up for revision and for the first time, Freshwater Mussels are cited (see DRAFT Statement below). Creating an explicit Outcome in the Watershed Agreement will put FWM into consideration and accountability for high-level decision makers throughout the Bay jurisdictions and such status may leverage funding/resources for those who "do FWM work" and those value FWM as integral parts of the healthy Bay ecosystem. [In CBP framework, ***Outcomes*** are related to and beneath each ***Goal***. "Outcomes are specific, time-bound, measurable targets that contribute directly to reach a Goal"].

Goal: Thriving Habitat & Wildlife | Outcome: Fish Habitat

What do you think about this DRAFT Statement?

DRAFT Statement: "Develop Freshwater Mussel conservation plans for five tributaries and begin to implement by 2035."

(Click Link) **How You Can Help**

Chesapeake Bay Watershed Agreement | Beyond 2025 Revision DRAFT

Read this Newsletter and read the 19 page DRAFT Chesapeake Bay Watershed Agreement, focus on pp. 9-10; i.e., the "Thriving Habitat and Wildlife" Goal and "Fish Habitat" Outcome, review the FWM Steering Committee's summary (below), carefully consider the DRAFT Statement about FWM, then offer your opinions to CBP here.

- Don't delay: the public feedback period runs now through September 1st, 2025.

The FWM Steering Committee Discussion Summary:

Consensus among steering committee members who commented via email and/or during May & June meetings was the DRAFT Statement above is acceptable, yet "mild" and moreover developing > 5 plans is already underway. The steering committee suggested more value would be delivered from commitments to fund the actions recommended/identified in Conservation Plans [**Note** that CBP is not an entity equipped or otherwise capable of funding activities].

Steering committee members also identified alternative target outcomes including:

(i) Increase FWM Survey Inventory by ***X*** % per year;

(ii) Research FWM aquaculture-like Best Management Practices for stormwater ponds;

(iii) Grow a regional FWM database; and, (Click Link)

(iv) Re-visit and adopt specific recommendations from the 2020 FWM STAC Workshop Report.

West Branch Susquehanna Mussel Restoration (continued from Page 1)

combinations of timber harvest and mining for coal and clay. While clear-cutting and mining were reshaping the character of the West Branch watershed, a series of hydroelectric dams was built from 1905 – 1931 in the lowermost part of the Susquehanna River, from Conowingo, MD to York Haven, PA. These dams cut-off access to and throughout the Susquehanna Basin for migratory fish like river herring, striped bass, American shad, American eel, sturgeon, and others. Before dams eliminated their runs, American shad and American eel historically migrated throughout the entire Susquehanna watershed and accounted for large portions of fish biomass wherever they went; a fact important to note for this story because, in the wonderful life cycle of freshwater mussels, American shad and American eel are preferred fish hosts for several species that inhabit the Susquehanna Basin.

Project Overview: Jordan Allison, Fisheries Biologist with PFBC describes the West Branch FWM re-introduction project in ways that clearly indicate its special and unique qualities. For one, this partnership brings together a blend of complementary skill sets including expertise in freshwater mussel ecology, mussel propagation & culture technique, fisheries ecology, and a trove of experience/capabilities for operations on, in, and under water as well as safe and ethical handling of wildlife.

The partners have set an ambitious and meaningful goal: to increase the distribution and biomass of the predominant FWM species in an intact Susquehanna Basin mussel community; Eastern Elliptio, Eastern Lampmussel, and Yellow Lampmussel, through propagation. Achieving the goal, will enhance the resiliency and redundancy of FWM in the West Branch watershed while also improving overall aquatic habitat and water quality.

The major parts and responsibilities of the project are:

Activity	Partner*
1. Compile existing FWM survey and habitat data	WPC, PFBC
2. Site selection	All
3. Collect brood stock (gravid) Lampmussels, infest host fish (bass & sunfishes)	MDNR, PFBC, WPC
4. Collect brood stock Elliptio mussels, infest host fish (American eel)	CUP, SRBC
5. Propagate and culture FWM	MDNR
6. *In-situ* (silo) FWM culture study to assess site suitability	PFBC, CUP, WPC
7. *In-situ* monitoring surveys	All
8. Project technical reports	All

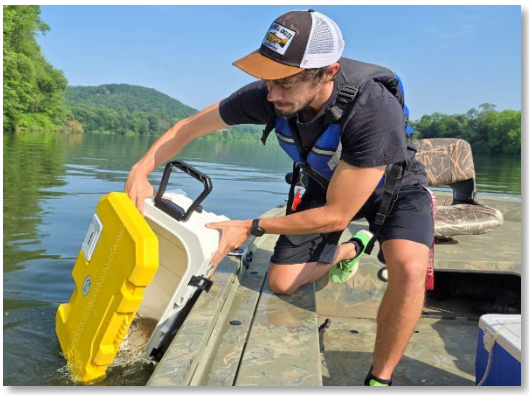
Orientation Map. The green shaded portion of the West Branch upstream from Lock Haven dam to Keating is the ~40 river mile project setting stocked with Yellow and Eastern Lampmussels and American eels infested with Eastern Elliptio mussel larvae. Legend: — dam ✡ town

Brood stock Mussel Processing. Natalie Brown, a graduate student at the Commonwealth University of Pennsylvania, Lock Haven, sorts and tags Eastern Elliptio adults that served as a source of larvae to infest American eel host fish.

Acronyms: * **WPC/**Western PA Conservancy * **PFBC/**PA Fish & Boat Commission * **MDNR/**MD Department of Natural Resources * **CUP/** Commonwealth Univ of Pennsylvania at Lock Haven * **SRBC/**Susquehanna River Basin Commission

Image Source: VA Department of Wildlife Resources

The Amazing Freshwater Mussel Life Cycle. The adult male mussel releases sperm into the water column. The adult female, via a siphon, draws sperm internally to fertilize her eggs. Fertilized eggs develop into larvae called "glochidia" that reside in the adult female's gills for days or weeks. When ready, the female releases her tiny larvae into the water column where they must attach to the gills, fins, or scales of a suitable host fish. In the right host, larvae will "encyst" into tissue as a harmless parasite. During the parasitic phase (called infestation), larvae spend a few weeks undergoing further transformation to develop gills, a foot, and other internal structures to become juvenile mussels. Ranging up to the size of a pencil eraser (depending on species), the juvenile mussels drop from their host to begin a hopefully long life on the stream bed. Through this process, fish hosts unwittingly serve crucial roles as both incubator and transporter for FWM.



Host Fish Release. Ryan Miller, an undergraduate student at the Commonwealth University of Pennsylvania, Lock Haven, tips a batch of American eel elvers infested with Eastern Elliptio into the West Branch near Lock Haven, PA.

Approach: The long-term goal is to establish a self-sustaining FWM footprint in the West Branch where mussels presently do not occur. The partners collect gravid wild female mussels, gather their larvae, introduce larvae to host fish, raise juvenile Lampmussels in a controlled setting, and ultimately release either eels infested with Elliptio larvae or the cultured juvenile Eastern and Yellow Lampmussels.

While serious damage due to legacy resource extraction still persists in the West Branch watershed, forest regrowth has been extensive. Moreover, substantial clean-up/restoration of abandoned mined lands has occurred to an extent that West Branch water quality again supports thriving fish and other aquatic life communities. From the more than 25 surveyed locations between Lock Haven and Keating, the partners selected six locations they expect to best suit FWM colonization. Starting in summer 2025, propagated mussels will be released at these six locations for three consecutive years.

By the Numbers:

With so much investment and ecological high stakes riding on this project, natural resource managers, funders, scientists, and stakeholders of many stripes want to evaluate performance; therefore, various numeric targets and measurements are part of the design, including:

- Release 10,000 propagated Yellow and Eastern Lampmussels across at least 2 of the project years;
- Stock 10,000 American eels infested with Eastern Elliptio mussels over the 3 project years;
- Evaluate juvenile Lampmussel survival and growth by deploying three *in-situ* silos at each FWM release site and monitoring monthly (as well as a West Branch control site near Williamsport, PA); and,
- Repeatedly characterize substrate composition, water quality, & mussel density.

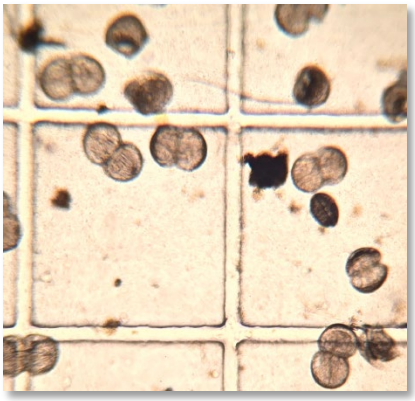
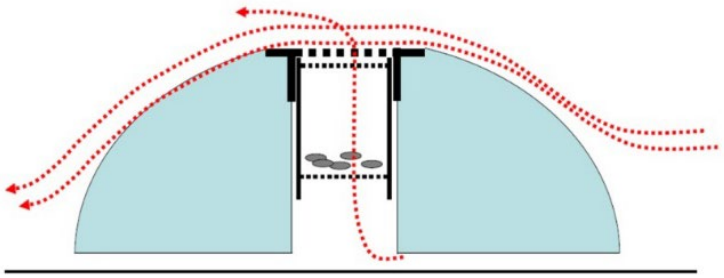


Image Descriptions: Above Left. Magnified view of Eastern Elliptio glochidia. **Center.** Magnified view of Elliptio glochidia affixed to American eel gill filament. **Above Right.** American eels infested with Elliptio glochidia about to be released.

Below Left. Mussel silo deployed *in situ*. **Below Right.** Silo cross-section diagram. FWM are contained in central chamber and river water flows into silo chamber from below, then exits at top. **Photos courtesy of PFBC.**



Lessons Learned: When asked what challenges or surprises had already arisen for the project partners, Jordan Allison spoke to nature's fickleness. Repeated and prolonged rainy weather dampened mussel brood stock and host fish collections, delayed silo deployments, and generally complicated everyone's schedules. Jordan also highlighted one glaring example to prove these scientists really are at the mercy of Nature. He and other project partners had to practice patience and vigilance while waiting for brood stock mussels to release their glochidia when host fish were available to infest. This aspect of the project was particularly nerve-wracking for the Eastern Elliptio mussels that depend on American eel elvers that are collected at the Conowingo Dam fish lifts and then driven from Maryland to Lock Haven, PA in trucks equipped with large, aerated live wells. At times, batches of elvers arrived well before the brood stock mussels were ready to release their larvae and the project partners had to devote unexpected time to keeping thousands of elvers healthy and happy.

Bottom Line: Scientists classify freshwater mussels as "keystone species" in aquatic ecosystems due to their significant positive impacts on water quality, structural habitat, and biodiversity. Freshwater mussels also are indicators that signify the overall condition and health of the waterways they inhabit: for a diverse freshwater mussel community to thrive means that the rest of the community flourishes too. The successful re-establishment into the upper West Branch by three freshwater mussel species that co-dominate functional mussel beds elsewhere in the Susquehanna Basin also will open doors to restore at-risk FWM species including Brook Floater and Green Floater.

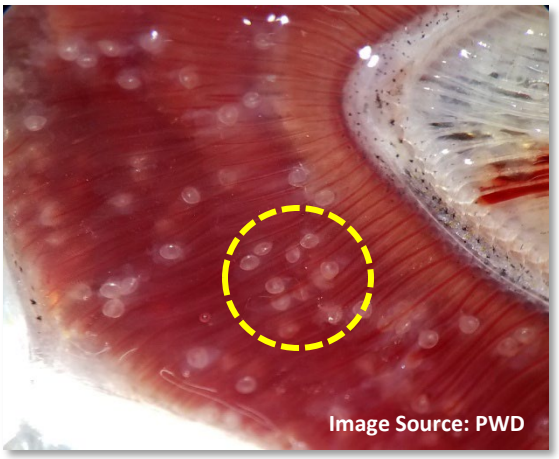
For questions/comments about this fascinating project, please contact Jordan Allison:
jorallison@pa.gov

SPOTLIGHT: URBAN MUSSEL RESEARCH & RESTORATION

In May 2018, the Philadelphia Water Department (PWD), along with key partners including the Partnership for the Delaware Estuary and the Academy of Natural Sciences, signed a Memorandum of Understanding (MOU) to launch the Aquatic Research and Restoration Center (ARRC) and establish the first city-owned freshwater mussel hatchery in the United States. This agreement formalized a collaborative effort to improve the health of Philadelphia's waterways utilizing nature-based solutions – placing freshwater mussels at the forefront of the ARRC's mission.

Mussel Propagation in the Lab. Shannon Boyle, a PWD research scientist, extracts mussel larvae that were expelled from adult female brood stock mussels. These larvae will be introduced to (a.k.a. "infest") gills of host fish as part of the complex life cycle of freshwater mussels.

Filter-feeding FWM were once abundant in Philly's history but each of the many species native to the area are now either imperiled or locally extinct. PWD houses their FWM research and propagation facility at the historic Fairmount Water Works Interpretive Center on the Schuylkill River. There, PWD scientists propagate native mussel species with the goal of reintroduction into Philadelphia's waterways to benefit water quality and habitat diversity. These efforts align with a broader PWD goal of using Nature-Based Infrastructure Technologies



Close-up view of mussel larvae host fish infestation. Dashed oval shows a cluster of the many mussel larvae that infest the gills of a host fish – in this case an alewife.

practices for stormwater mitigation and reduction of nutrients and sediment. PWD's hatchery can propagate up to 50,000 FWM per year and hopes to eventually expand and increase propagation capacity to as many as 200,000 FWM per year.

Lance Butler, PWD senior scientist and hatchery manager, estimates that it takes one-and-a-half

to two years to raise mussels from "juveniles to adolescents," depending on individual species. Hatchery-raised adolescent mussels measure approximately 1.5 to 2 inches in their longest dimension and their odds of survival in the wild are vastly superior to those of their counterparts born *in-situ*. According to Butler, the survivorship rate of wild juvenile mussels is likely less than 0.01% (or 1 in 10,000); however, PWD studies of hatchery-raised mussels reintroduced in cages are surviving at rates between 30%-60%.

PWD scientists have conducted research that has resolved multiple propagation bottlenecks and expanded the understanding of relationships between FWM and their host fish. Recent research has shown that hybrid Striped Bass can successfully serve as hosts for the

Alewife Floater adolescent mussels. These mussels, grown by PWD, were tagged and set into a Philadelphia lake to assess their survivorship/growth.

larvae of Alewife Floater (*Utterbackiana implicata*), while Brook Trout have been confirmed as suitable hosts for Eastern Elliptio (*Elliptio complanata*). Both findings carry important implications for freshwater mussel restoration and augmentation efforts, as these novel host species — hybrid Striped Bass and Brook Trout — are readily available and more resilient to the aquaculture-like conditions required for inoculation. This contrasts with the mussels' natural host species, such as river herring and American eels, which are less tolerant of such handling and environmental stressors.

Having demonstrated that they can efficiently propagate five native species of FWM and successfully reintroduce them in caged systems within the City's urban waterways, PWD scientists are now focusing their research on

Caged mussels. Freshwater mussels are placed in "cages" that protect and secure adolescent mussels so scientists can study their health and ecosystem effects in the wild.

determining mussel filtration rates and quantifying the ecosystem services provided by these animals, including the removal of nitrogen, phosphorus, and bacteria.

Members of PWD's freshwater mussel scientific team pose with caged mussels.

PWD's team hopes to chart a path forward to have the water quality benefits of FWM recognized through regulatory compliance and look forward to measuring those benefits as reintroduction efforts into the City's waterways ramp up in the coming years.

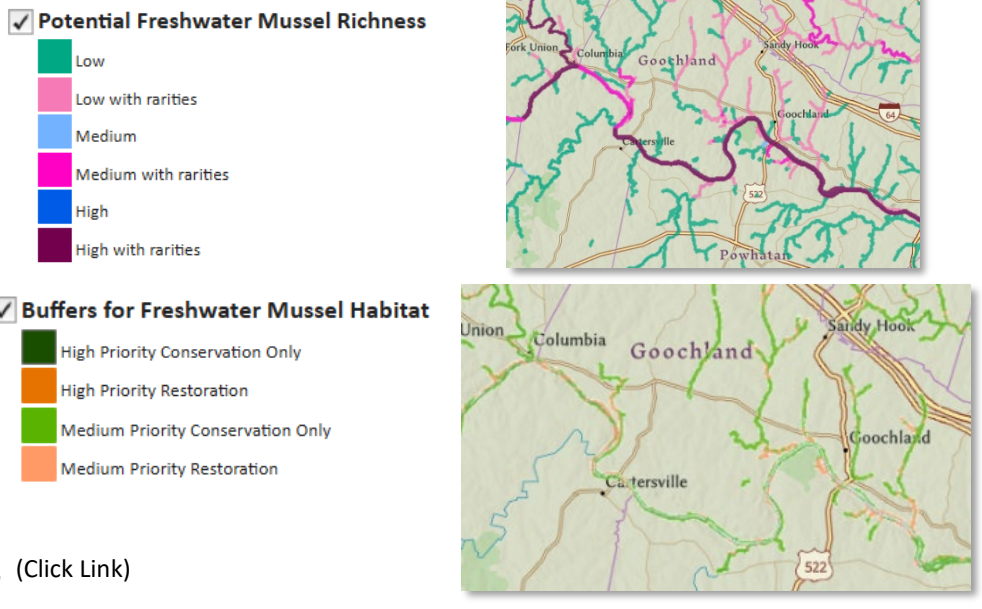
Have Questions? Contact Lance.Butler@phila.gov or William.whalon@phila.gov or Visit The Mussel Hatchery

VIRGINIA MUSSEL RICHNESS & CONSERVATION MAPPING TOOLS

Predicted Suitable Habitat (PSH) models and mapping tools have applications in conservation planning. With funding from the National Fish & Wildlife Foundation, scientists from Virginia Department of Conservation and Recreation (DCR) and Virginia Natural Heritage Program (NHP) developed an interactive map to help identify areas in the Commonwealth where freshwater mussel protection and restoration efforts can enhance biodiversity, improve ecosystem services, and engage citizens. The *Potential FWM Richness* map layer can indicate where conservation and restoration activities will yield the greatest ecological benefits.

Vegetated, especially forested, riparian buffers are well-correlated with FWM occurrence, richness, and density. Studies consistently find that forested buffers at least ~100 feet (~30 meters) wide protect the *hyporheic zone,* which is where water flows from the water column into spaces in the underlying streambed, then returns to the stream. Hyporheic zone exchange is crucial for benthic life like FWM and ecosystem services as this exchange influences dissolved oxygen availability, water quality, habitat, and nutrient cycling.

The *Potential FWM Richness* layer is closely related to the *Buffers for Freshwater Mussel Habitat* layer, which delineates flow buffers for targeted conservation and restoration efforts. Buffers are strategically prioritized based on mussel richness and rarity, nutrient loading, and land cover characteristics. By considering topographic flow paths, the buffer layer can be used to guide projects and ensure buffers are placed where they will have the most impact on water quality and opportunity for FWM habitat enhancement. **Would tools like these benefit other Bay jurisdictions?**



DCR Map Screen Captures | Upper image shows Potential FWM Richness and Lower image shows close-in part of same area showing Buffers for FWM Habitat. FWM Richness Low/Medium/High equates as: 1-3/4-6/7-13 species, respectively. By this tool, buffers are not mapped where predicted FWM Richness is Low.

ZOTERO FWM PARTNERSHIP GROUP LIBRARY – Your Resource for Information

The Chesapeake Bay Watershed Region Freshwater Mussel Partnership's coordinators at SRBC set up a Group called "FWM Partnership" that is on the free and easy-to-use open source resource-sharing platform known as Zotero (refer to Newsletter Issue no. 1 for a brief orientation; or visit Zotero.org, search under the Groups menu tab for "FWM Partnership", then begin your exploration).

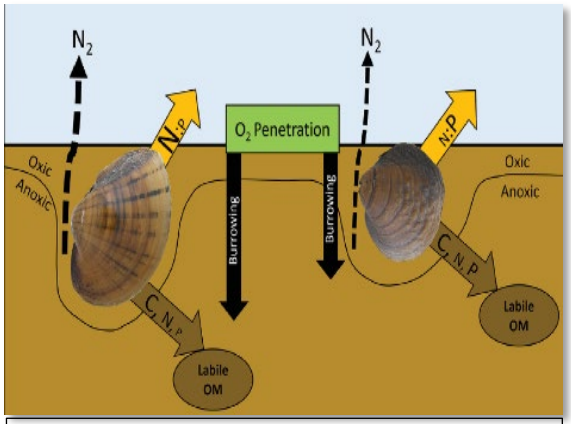
As of July 2025, the FWM Partnership Group had over 260 "items". Most items are peer-reviewed scientific publications, although some are media articles, conservation plans, FWM community descriptions, newsletters, etc. Typically, an item links to a publisher's portal with the item title, author name(s), Digital Object Identifier (DOI), technical citation, abstract, and other information. Most peer-reviewed items have a pathway to download the item as a subscriber, for a fee, and in some cases, for free. In effort to streamline the FWM Partnership Group user experience, the SRBC coordinator team uses Zotero's "tag" feature. Tags are key words assignable to items that can be filtered and searched in Zotero. Hint: one tag you should keep in mind is "SRBC has .pdf".

The Partnership encourages you to explore and use this resource in your own work.

A pair of peer-reviewed items, published in 2024, were added to the FWM Partnership Group library. Each of these items offers insight and a "deep-dive" into the science of FWM in ways relevant articles in this Newsletter and the Chesapeake Bay Watershed Freshwater Mussel Partnership.

In a paper by Megan Kubala *et. al.* titled **Freshwater mussels enhance sediment nitrogen-removal potentials and alter bacterial communities via nutrient release and bioturbation,** scientists studied how mussels physically and chemically influence sediment-water nutrient processes and the authors concluded that FWM are ecosystem engineers that supply bacteria with the nutrients and energy those bacteria need for crucial biogeochemical processes.

And in a paper by Al Lu *et. al*. titled **The relationship between riparian vegetation buffer size and unionid mussel habitats**, scientists analyzed relationships between mussel assemblages, streambed conditions, and riparian traits and the authors concluded that intact riparian buffers have higher quality mussel habitats mainly because vegetated buffers prevent/minimize fine sediment particles from reaching waterways where such particles clog the spaces between coarse substrate material and thereby interfere with hyporheic exchange processes.



Conceptual illustration showing ecosystem engineering aspects of FWM (from Kubala *et. al.* 2024). Note that FWM species burrow to different depths and exchange nutrients differently; i.e., high diversity FWM beds have greater ecosystem efficiency.

Contact the SRBC coordinators if you have questions, comments, and suggestions.

GET INVOLVED | STAY INVOLVED!

The FWM Partnership coordination team from SRBC provides and maintains a web page for the Partnership – check it regularly for News & Announcements and send us your comments.
https://www.srbc.gov/our-work/what-we-do/chesapeake-bay-freshwater-mussel-partnership.html

Reach out to tell us what you'd like to see from the Partnership.

Share Your News, Stories, & Successes With Us

- What is your 2025 FWM-related experience?
- Have you received a grant?
- Do you have funding or other resources to offer others?
- Did you author or encounter any new FWM publications in 2024?
- Do you have events, activities, or links you'd like to promote on the FWM Partnership web page?
- Show your Mussels! (send FWM photos or video links that we can add to the web page)
- Would you like to contribute content/ideas to a future issue of this Newsletter?

UPCOMING EVENTS & DEADLINES

Advance registration (free) is required to attend this in-person event!

Public Feedback Period

From July 1 – September 1, the public is invited to provide written feedback on the proposed revisions to the *Chesapeake Bay Watershed Agreement*. Feedback will be accepted via email to comments@chesapeakebay.net. Once received, this feedback will be reviewed by a team of subject matter experts within the partnership to inform the next version of the revised *Watershed Agreement*, which will be presented to the Management Board in October 2025.

Chesapeake Bay Program
Science. Restoration. Partnership.

comments@chesapeakebay.net

Use this QR Code to send email with your comments about the Chesapeake Bay Watershed Agreement to the Chesapeake Bay Program!