Muscling our way to Restoration of the Delaware Estuary with the light foot mussel *(Elliptio complanata)*

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Abstract

The health of freshwater mussel assemblages represents an ideal indicator of watershed health for many reasons. First, they are imperiled in terms of both biodiversity and population abundance. Second, freshwater mussels require a complex suite of suitable conditions, including healthy riparian and in-stream habitats, good water quality and flow, and free passage of fish that serve as hosts for their larvae. Third, their long life spans (upwards of 100 years) integrates environmental conditions over much longer time spans, compared with short lived fauna. Fourth, being sessile, their status is indicative of local ecological conditions. For these same reasons, freshwater mussels represent ideal targets for ecosystem restoration.

The Freshwater Mussel Recovery Program was implemented to restore diversity, population biomass, and resilience of native mussel communities using conservation, reintroduction, and range expansion. Phase I has consisted of screening candidate streams for restoration (see Gray, Poster). Phase II will be achieved by reintroducing hatchery reared juvenile mussels and transplanted adults that are reproductively active. Initial phases of the project have commenced in Southeastern Pennsylvania, where broodstock of the lightfoot mussel (*Elliptio complanata*) were collected from Ridley and Brandywine Creeks which contain two of the remaining populations.

For hatchery propagation trials, fish hosts for mussel larvae were also collected from the study sites, including pumpkinseed (*Lempomis gibbosus*), white suckers (*Catostomus commersonii*), and banded killifish (*Fundulus diaphanous* & *F. heteroclitus*). At Cheyney University, approximately 165 of 508 fish were successfully infested with mussel glochidia (larvae) in 2008. The successful production of seed mussels is scheduled for 2009 using lessons learned from 2008 trials, such as a preference for American eels (*Anguilla rostrata)* which were deemed to be the preferred fish hosts.

Enhancing ecosystem services, boosting population resilience, and filling open niches are only some of the objectives we hope to achieve by reintroducing freshwater mussels not only into Southeastern Pennsylvania but throughout the Delaware Estuary.

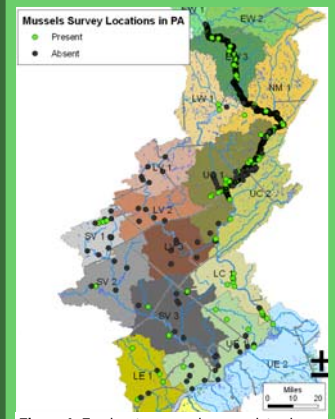

Figure 1. Freshwater mussel survey data show the decline of mussel ranges in the Pennsylvania portion of the Delaware Basin. Mussels were historically reported in most streams and rivers.

Figure 2 (left). *Elliptio complanata.*

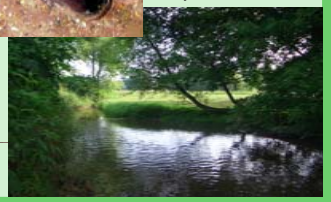

Figure 3 (below). Preferred habitat of freshwater mussels in Pennsylvania.

Freshwater Mussels

Status. Freshwater mussels are bivalve mollusks that live in lakes, rivers, streams and tidal freshwater areas. They once thrived across the Delaware Estuary watershed, but only one of the native 12+ species can be readily found in southeast Pennsylvania. What species can be found, has its distribution and reproduction greatly reduced. The severe local impairment of these animals is symptomatic of the rest of the United States – more than 75% of our native 300+ species are severely impaired and freshwater mussels are regarded as the most imperiled of all plant and animal taxa in North America.

Ecology. These mussels can play a critical role in the function and structure of their ecosystem. By feeding at the base of the food chain on a rich mixture of suspended matter, they can grow to large sizes and reach tremendous population biomass much like marine species (oysters, clams and mussels). As filter-feeders, they improve water quality and clarity by removing particles and contaminants. They enrich sediments for fauna and flora. And like their marine counterparts, they are habitat-formers, providing for greater stabilization and complexity of the bottom.

Life History. Though vitally important to the ecology of freshwater systems, their complex life cycle makes freshwater mussels susceptible to shifts in water and habitat quality. For example, freshwater mussels require fish as hosts for their larvae, a tactic that allows mussels to maintain themselves upstream and disperse across the watershed without the adults having to moving themselves. Many mussel species depend on specific fish species as hosts.

Impairment. When fish that serve as hosts for mussel larvae are impaired or restricted in movement such as by dams, the life cycle of mussels is short-circuited. Mussels are also impaired by contaminants, habitat degradation and other factors. Once they are impaired, mussels recover slowly even if conditions rapidly improve because they grow slowly and it takes approximately 8-10 years until a mussel reaches sexual maturity. Many freshwater mussels can live up to 100 years.

Figure 4. FMRP Scientists

Why Restore Mussels?

Bivalves have long been regarded worldwide as some of the best bioindicators of environmental conditions, particularly of long-term status and trends. But we are only now beginning to appreciate the role that they play in maintaining ecosystem fitness. Where abundant, they are referred to as "ecosystem engineers" because they are habitat-forming animals that can dominate functional processes by large scale filter-feeding at the base of the food chain. Bivalves filter suspended solids, phytoplankton and perhaps even pathogens resulting in water quality improvement. This mass filtration leads to an increase in light penetration through the water column, improving growing conditions for bottom plants and algae. Their biodeposits enrich sediments which benefit other fauna and flora. They also provide structural complexity and stabilize bottom sediments, providing habitat for other organisms.

Generally, the presence, diversity, and population health of bivalve shellfish throughout watersheds is directly indicative of the overall health of the system. Therefore, they also represent an excellent "common denominator" target on which to base ecosystem restoration because to improve mussel populations, we will also need to improve water quality, riparian coverage and fish passage. And since mussels themselves boost water and habitat quality, mussel-based restoration will provide diverse positive feedbacks to ecosystem restoration.

Figure 5. Fish tanks at Cheyney University used to hold fish with glochidia on their gills.

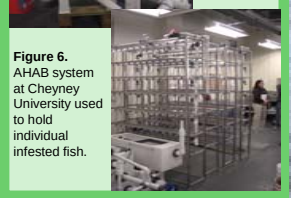

Figure 6. AHAB system at Cheyney University used to hold individual infested fish.

Freshwater Mussel Restoration Project (FMRP)

The Freshwater Mussel Restoration Program (FMRP) is a collaborative endeavor to rebuild the overall, population vigor of native species throughout the Delaware Estuary and its Watershed. PDE in conjunction with The Academy of Natural Sciences, Cheyney University, and U.S. Fish and Wildlife Services, takes a holistic approach to the program that includes biodiversity conservation, range expansion, and most importantly, enhanced overall population abundance of a blend of species that fill different ecological niches. Initial efforts are aimed at expanding the range of common species to boost population resilience and develop methods that later can be used for more sensitive species.

Figure 7. Infesting rainbow trout (*Oncorhynchus mykiss)* with glochidia in a bucket.

Figure 8. Flushing glochidia from adult *Elliptio complanata.*

FMRP Progress

Studies are currently underway to determine which streams can support the reintroduction of mussels (see Gray, poster). Once candidate streams are selected for restoration, we will reintroduce mussels that are either reproductively active adults or hatchery raised juveniles. Juveniles will be propagated at the aquaculture facility at Cheyney University of Pennsylvania. In experiments conducted in 2008, fish hosts for *Elliptio complanata (EC)* were tested, including; pumpkinseed (*Lempomis gibbosus*), white suckers (*Catostomus commersonii*), and banded killifish (*Fundulus diaphanous & F. heteroclitus*). Approximately 165 of 508 of these fish were successfully infested with mussel glochidia (larvae). We anticipate the production of juvenile mussels by using American eels (*Anguilla rostrata)* as the preferred fish host. The initial goal is to produce and plant 10,000 juvenile *EC* in several streams in the Christina watershed and adjacent streams such as Chester Creek. Seed will be monitored to gauge growth and project success. Each batch of 10,000 seed is projected to filter 0.8 million liters of water in their first year in-stream, totaling 1.92 billion liters of water over their first 30 years, not including the water filtered by any progeny.

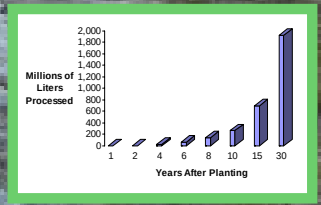

Figure 9. Projected potential water processing by 10,000 planted seed over first 30 years, not including progeny.

We would like to thank the sponsors of this project for their generous support:

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