Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
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# Growth and Survival of Caged Mussels in the Non-tidal Delaware River

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## Why study mussels in the Delaware River?

Mussels are an important part of the Delaware River freshwater aquatic community and provide valuable ecosystem services to the river. Mussels help stabilize the streambed and protect the substrate during flood events. Mussels also help to clean the river's water by filter-feeding. Additionally, mussels provide food and habitat for other animals in the river ecosystem.

***Figure 1**. Mussel cage deployed in Delaware River*

Historically, mussels were abundant in the Delaware River basin with records showing as many as 12-14 species (PDE 2012). Mussel populations have declined greatly over time due to a variety of factors such as water pollution, overharvesting, habitat loss, dams, and concurrent declines in fish populations that act as hosts for larval mussels. A recent study of the lower Delaware River resulted in the identification of just seven species of mussel with the eastern elliptio (*Elliptio complanata*) being the only species found in abundance (Silldorff and Schwartz 2014). Additionally, the study noted a drastic decline in mussel abundance downstream of the Lehigh River.

To begin to investigate the influence of the Lehigh River on Delaware River mussel populations, we installed caged mussels into several locations on the mainstem Delaware River upstream and downstream of this major tributary. The objectives of this pilot study were to 1) quantify growth and survival of freshwater mussels upstream and downstream of the Lehigh River and 2) evaluate the feasibility of installing mussel cages in a large, rocky river.

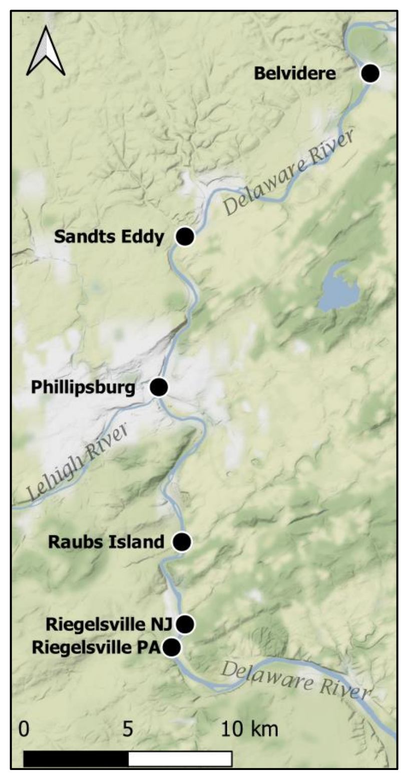


***Figure 2**. Study sites along the Delaware River*

## Study Design and Methods

A total of 24 mussel cages (Figure 1) were installed in the Delaware River across six locations, three upstream of the Lehigh River and three downstream (Figure 2). Three sites were on the Pennsylvania side of the river (Riegelsville PA, Raubs Island, Sandts Eddy) and three sites were on the New Jersey side of the river (Riegelsville NJ, Phillipsburg, Belvidere). Cages were set along approximately 100 yds of shoreline at each site. Each cage consisted of a plastic tray wrapped in plastic mesh fixed with zip ties. Cages were partially filled with river substrate, weighted down with river rocks, and anchored to the substrate with rebar. Most sites were in areas with nearby shoreline access and soft substrate suitable for the rebar anchors. One site, Sandts Eddy was in a rocky stretch of river and concrete blocks were used to anchor the cages. Cages were deployed at low river flows (~3,000 cfs at Trenton, NJ) in water 18-24 inches deep. This would ensure that the cages would be inundated while remaining as close to the shoreline as possible for ease of access. Each cage was stocked with twelve alewife floater (*Anodonta implicata*) provided by Kurt Cheng of the Partnership for the Delaware Estuary. While this species is not as abundant as the eastern elliptio, it is present in the non-tidal river and is a species that shows a population decline immediately downstream of the Lehigh (Silldorff and Schwartz 2014). Prior to stocking, each mussel was measured and tagged with a unique identifier so growth could be tracked through the course of the experiment (Figure 3). Cages were deployed in September 2019, checked in July

2020, and removed in September 2020. Upon removal of the cage, each mussel was measured to calculate total growth during the experiment. At the completion of the experiment, all mussels were frozen for potential future contaminant analysis.

*Figure 3. DRBC staff tag and measure mussels for deployment*

## Results and Discussion

A total of 288 mussels were stocked at deployment. Mussels ranged in size from 19.06 to 72.23 mm shell length at the time of stocking. Due to high flows and staffing restrictions related to the COVID-19 pandemic, cages were not checked as frequently as would have been ideal. Because of this, mussel cages were heavily impacted by both sedimentation and foul play which made determining causes and timing of mortality difficult. Survival rates for mussels that were found at the end of the study ranged from 14% to 82% but were heavily affected by factors other than water quality (Table 1). These non-water quality impacts made determining the effects of Lehigh River water quality on growth and survival difficult.

*Table 1. Survival of caged mussels at sites in the Delaware River upstream and downstream of the Lehigh River*

| | Site | Survival | Comments |
|---|---|---|---|
| Upstream of Lehigh R | Belvidere, NJ | 14% | Cages experienced heavy sedimentation and were found buried under sediment |
| | Sandts Eddy, PA | 65% | Deployment was largely successful. 1 cage removed by foul play |
| | Phillipsburg, NJ | 25% | Cages experienced foul play and sedimentation. 3 /4 cages removed by foul play |
| Downstream of Lehigh R | Raubs Island, PA | 23% | Cages experienced heavy sedimentation and were found buried under sediment |
| | Riegelsville, NJ | 82% | Deployment was largely successful. Some sedimentation |
| | Riegelsville, PA | 74% | Some sedimentation. Two cages lost, likely foul play |

While site-level differences in growth and survival were difficult to determine, an interesting pattern in growth did arise across all sites. Smaller mussels (<50 mm) grew much faster than larger mussels (>50 mm, Figure 4). Growth rates for smaller mussels were ~0.08 mm/day which is typical for alewife floaters (K. Cheng, personal communication). The larger mussels displayed almost no growth. It is common for larger organisms to grow slower than smaller organisms, however the differences seen here are stark. Possible causes for these differences in growth rate include food availability or tradeoffs between growth and reproductive investment in a potentially food limited environment. Additional studies would be needed to truly determine the cause.

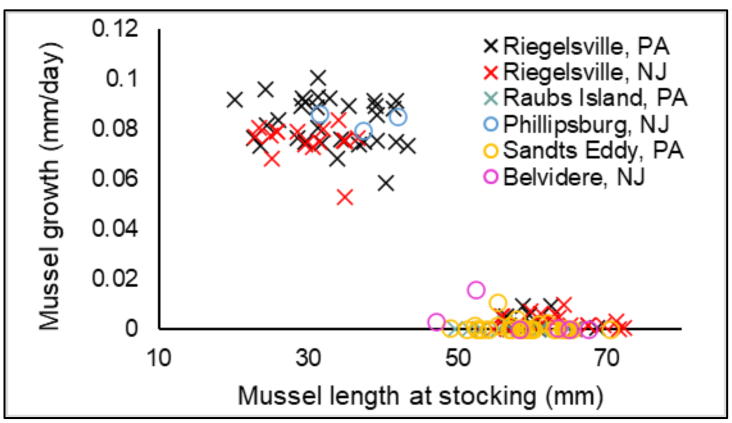


***Figure 4.** Growth of caged mussels in Delaware River. X's and O's represent sites downstream and upstream of the Lehigh River respectively*

While impacts of water quality on mussel growth and survival were difficult to determine from this pilot study, several key takeaways about the logistics of a caged mussel deployment on the Delaware River were gathered. Cages anchored in soft sediments were frequently buried by sediment deposition. Cages in these locations would need to be frequently maintained, which was unfeasible during this project due to high flows and COVID-19 staffing restrictions. One set of cages (Sandts Eddy) was deployed over hard substrate and anchored with concrete blocks. Cages at this site experienced no issues with sedimentation, making this deployment over hard substrate a feasible solution for potential future studies. Another common problem during the deployment was foul play from the general public. Using a boat to deploy mussels further from access points would be recommended for future studies.

## References


Partnership for the Delaware Estuary. 2012. Freshwater Mussel Recovery Program in the Delaware Estuary. PDE Report No. 12-02.

Silldorff E and Schwartz A. 2014. Freshwater Mussel Community Composition and Relative Abundance in the Lower Delaware River. Delaware River Basin Commission.