Monitoring Fitness of Caged Mussels to Prioritize Streams for the Freshwater Mussel Restoration Project

Matthew Gray, Drexel University 3141 Chestnut Street, Philadelphia, PA 19104, matthew_w_gray@yahoo.com ; **Danielle Kreeger** and **Angela Padeletti,** Partnership for the Delaware Estuary, One Riverwalk Plaza, Suite 202, Wilmington, DE 19801

Abstract

Within the Delaware Estuary Watershed, declines in the diversity and population abundance of freshwater mussels (Unionidae) has prompted the Partnership for the Delaware Estuary to initiate a Freshwater Mussel Recovery Program (FMRP) (see poster by Padeletti). The FMRP seeks to replenish both species and abundance of native mussels throughout their natural range with a suite of conservation, propagation, and reintroduction methods. For reintroduction into streams where mussels once lived but have been reduced or extirpated, it is helpful to first determine whether candidate streams are capable of sustaining viable freshwater mussel populations.

A method was developed to screen candidate streams for their ability to support reintroduced juvenile mussels (reared in the hatchery) or reproductively active adults (transplanted from streams that still have mussels). Caged adult mussels were deployed into 7 streams within 2 watersheds in Southeastern Pennsylvania. Approximately 15 adult mussels were added to each cage, and 4 cages were positioned in similar habitats of each stream. Controls consisted of cages of mussels held in source streams as well as uncaged animals (to test for caging effects.) Sampling of 3 mussels per cage was conducted 5 times during a one-year period. These mussels are being analyzed for survivorship, condition index and proximate biochemical composition to assess their physiological status over the study period.

No caging effects were observed and survivorship was nearly 100% over the one-year period; however, preliminary results suggest that the seasonal pattern and final condition of mussels varied significantly among streams (mean = 31-56). Some streams that appear to harbor no mussels (e.g. Chester Creek) supported similar fitness as source streams (Ridley and Brandywine Creeks), suggesting that they are more suitable for restoration than other waterways where condition declined or was perturbed seasonally. These findings, along with future biochemical and water analyses, will be used to guide site selection for he Freshwater Mussel Recovery Program in 2009.

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

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For more information contact: Matthew Gray 215-595-6404 mwg36@drexel.edu

Introduction

The Plight of Mussels. Freshwater mussels (Order: Unionoida) were once abundant and diverse throughout the Delaware Estuary watershed. However, declines in both species diversity and abundance have been precipitous throughout the 20th century, and they are currently listed as the most imperiled taxa in the watershed as well as across North America. Accompanying the decline of freshwater mussels is the loss of their functional role and ecological services. Long-lived, sessile, and filter feeding, unionids are usually functional dominants in aquatic ecosystems where they are abundant, having profound beneficial effects when the ratio of filtering capacity to water volume is high. Under these conditions, unionids can substantially reduce particulates and contaminants, redistribute nutrients, and stabilize substrates. Beds of mussels also enhance benthic habitats, benefiting other plants and animals by adding structural complexity. Thus, the restoration of these organisms not only conserves imperiled taxa, but also restores transformative ecosystem services.

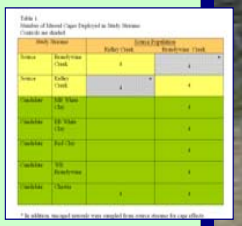
Where to Restore Mussels? The Freshwater Mussel Recovery Program seeks to restore native populations of mussels to streams where they historically thrived but currently are absent. To increase the chance that restoration is successful, caged mussels of a representative species, *Elliptio complanata*, were deployed in five southeastern Pennsylvania streams that are candidates for mussel restoration (White Clay Middle Branch, White Clay East Branch, Red Clay, Brandywine West Branch, Chester Creek.) We then monitored their fitness over the course of one year, compared to caged mussels held in source streams (Brandywine Creek, Ridley Creek.) Streams that held mussel condition similar to source streams will be targeted for restoration efforts in 2009. 0

Methods and Procedures

Mussels were collected from Brandywine and Ridley Creek, tagged and measured for shell height. 15 mussels were assigned to a cage with at least 4 cages being deployed at each restoration candidate stream, which consisted of Middle Branch White Clay Creek, East Branch White Clay Creek, Red Clay Creek, West Branch Brandywine Creek, and Chester Creek. Mussels from source streams (Brandywine and Ridley Creeks) were also deployed in cages back into the source streams as experimental controls, along with uncaged but tagged mussels released back into source streams (see Table 1). Cages were stocked with mussels in October 2007, and up to 4 mussels were thereafter removed from each cage during December 2007, April, May, June, and October 2008.

Sampled mussels were shucked, freeze dried, homogenized, and then divided into subsamples for weight-on-ignition, protein, lipid, and carbohydrate analyses.

Weight data were used to calculate condition index, a measure of meat fatness per shell volume. Survivorship and condition data for mussels from different streams were contrasted against one another as well as controls. Comparisons between source streams, and between caged and uncaged controls, were examined. Data were statistically analyzed using Statgraphics version 5.0



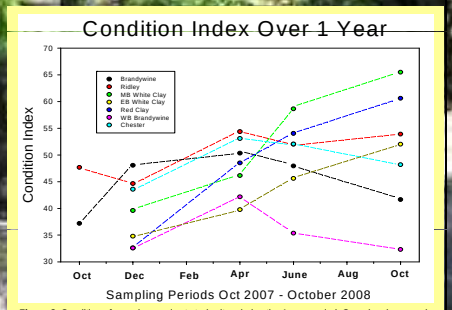


Figure 2. Condition of caged mussels at study sites during the 1 year period. Caged and uncaged mussels at source streams were combined due to no significant difference in condition.

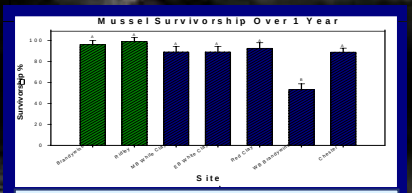


Figure 1. Survival of caged mussels in source (green bars) and candidate (blue bars) streams during the 12-month assessment period, 2007-2008.

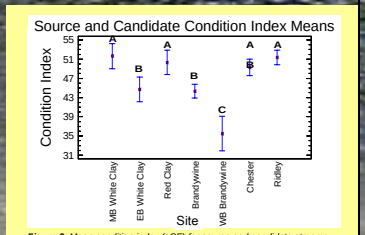


Figure 3. Mean condition index (±SE) for source and candidate streams.

Results

Condition index varied significantly among streams (mean range, 35- 51). No caging effects were observed, and so data from source streams were combined between caged and uncaged animals.

Condition index varied seasonally for all streams, which is expected since reproductive development and overwintering typically drive a seasonal physiological cycle. The condition index of mussels in both source streams was statistically similar between October 2007 and October 2008, showing that the seasonality of expected condition index was repeatable and also confirming that the one year period of caging had no detrimental effect on mussel physiological status. This finding was further evidenced by the high survivorship of mussels over the study period (Fig. 1).

Importantly, mussels held in cages in most candidate restoration streams held their condition at least as well as in the source streams, although the seasonal timing of high and low condition may have begun to shift as animals started to adapt to the ambient conditions (e.g. temperature, food). Candidate streams that supported good mussel fitness were East Branch White Clay, West Branch White Clay, Red Clay, and Chester Creeks. In contrast, the West Branch of the Brandywine did not support equivalent condition (Figs. 2, 3) and mortality was also greater there (Fig. 1.)

Discussion

These preliminary results suggest that 4 out of the 5 candidate streams can sustain *Elliptio complanata* if chosen for restoration. Besides East Branch Brandywine, all of the candidates do not presently contain native mussels. However, if these streams were to be ranked for fitness, the top 3 streams within the study group are MB White Clay (mean condition 51.6) > Ridley (51.3) > Red Clay Creek (50.3), based on the average condition index over the final six months of the caging period.

In the future, these results will be combined with additional physiological data (proximate biochemical composition of mussel tissues) and water quality analyses (in the source streams) to finalize restoration recommendations for the FMRP.

This caging methodology proved to be a highly effective and inexpensive tool for identifying and ranking suitable habitats for unionids.

Conclusion:

Caging mussels works:

-no caging effects

- better indicator of habitat quality than survivorship

Streams Varied

Effective method of prioritizing streams for mussel habitats and streams for future restoration effort.