Ribbed Mussel Nutrient Bio-Extraction Pilot Project

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Nitrogen Problem

2003 Greenwich Bay Fish Kill

[Diagram showing the effect of excessive nitrogen and phosphorus inputs on the ecosystem, leading to algal blooms and decreased oxygen levels, resulting in unhealthy habitat and the death of fish.]

[Image of a beach with a large number of dead fish, indicating the impact of the fish kill.]
Narragansett Bay Watershed
Impervious Surface & Impaired Waters

% Impervious
0% - 8%
9% - 12%
13% - 15%
16% - 25%
26% - 82%
Impaired Waterbody

RDEP combined similar imperviousness datasets for MA & RI into seamless grid clipped to the watershed extent. The data represent man-made 100% impervious areas such as pavement, rooftops and other structure.

The impervious areas were then calculated as percentage of the stream segment catchments taken from the National Hydrography Dataset and described as "elevation derived drainage areas" for each NHD reach.

The resulting map highlights portions of the watershed with significantly high percentage of impervious areas.

www.watershedcounts.org
Specific Problem

• Excess nitrogen in upper bay
  – Holistic approach: Upper Narragansett Bay Water Quality Stakeholders
    – Salt Marsh/Shoreline Restoration
    – Tidal Restrictions/Circulation Improvements
    – Shellfish Propagation/Bio-Extraction
    – Stormwater Management
    – Fresh Water Wetland Buffers

• Non-Commercially Harvested Species
Ribbed mussels (*Geukensia demissa*)

- Filtration rate measured in the lab to be 6.80 liters of seawater per hr (Riisgard 1988).
- One of the few bivalves able to forage on small-sized bacterioplankton (Newell and Kambeck 1995, Kreeger et al. 1990).
Objectives

• Assess ribbed mussels as a bioextraction species
• Assess various growing mediums for efficiency
• Outreach to the public
• Restoration (WQ, Shellfish, & Salt Marsh)

https://www.youtube.com/watch?v=saAy7GfLq4w
Figure 1. Approximate Site Coordinates (Active and Passive) are 41° 47.11’N, 71° 22.98’W: Red box = Upweller (active), Green box = Socks (passive) and Red star = Control (natural).
Figure 2: FLUPSY. The upweller portion has four silos on both the long sides of the trough. Each silo is able to hold 125,000 seed at 4-10mm in size.
Fig 3. Shows the constant water flow through the FLUPSY. Water in the trough is being pushed out by the motor. In order to maintain a balance, water is continuously being taken in through the mesh bottom of the silos past the shellfish (which are feeding by filtering on the water going by them). The water leaves the silo and enters back into the trough through PVC pipes that connect the silos to the trough.

http://www.govemorsislandalliance.org/newsite/upload/2009/05/FLupsy%20Illustrated.jpg
Passive Flow
Proposed Research

• Collect samples of ribbed mussels from nearby salt marsh
• Measure/weight samples
• Determine nutrient content of shellfish (Pre- & Post-)
• Monitor growth and survival rates
• Form a regression line to see correlation between dimension/total mass & tissue mass & nutrient extraction
Results

• Survival among treatments was: Active = 83%, Passive = 92% and Control = 93%.

• We found no significant difference in the variables among the different treatments.
  • Initial
  • Final

• Overall, we found no significant difference in the growth rates among the different treatments.
Results

\[ y = 0.0368273 \times X^{3.02336} \]
\[ R^2 = 0.98 \]

\[ y = 0.366024 + 0.540936 \times X \]
\[ R^2 = 0.99 \]

Figure 1. Best-fit models predicting ribbed mussel soft tissue mass from direct measurements at the onset of the experiment.
Results

Figure 2. Mean total mass and length of ribbed mussels before and after a single growing season, where C = Control, P = Passive, A = Active, S = Start (i.e. before the growth period), and F = Finish (i.e. after the growth period).
Lessons Learned

• Ribbed mussels can survive and grow under constant submersion in the lower Providence River
  – High quality food available
  – Good place to grow shellfish for nutrient remediation

• Future decisions about allocation of resources into one or the other will vary depending on the primary outcomes desired (Passive vs. Control)
Lessons Learned

• Site specific
• Growth rates decreased as a function of increased starting size.
• Regression models based on length measurements taken at the onset of the measured growth study, predicted tissue mass (and therefore nitrogen accumulation)
Lessons Learned

• Restoration to intertidal salt marsh may be the most efficient way
  – Where food availability and suitable intertidal areas are not limited
  – Ecosystem services
  – No maintenance
  – No special equipment required

• Passive Method: for bulkheaded shorelines
  – Target small animals that grow faster to maximize nitrogen removal potential.
  – Removing the grown-out animals completely from the system would be easier
  – Below floating treatment wetlands
## Lessons Learned

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Nitrogen removed/season/mussel</th>
<th>Number of mussels</th>
<th>Bioextraction Rate per season</th>
<th>Mussel density source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive</td>
<td>80 mg</td>
<td>840,000</td>
<td>67.2 kg</td>
<td>Newell (2013)</td>
</tr>
<tr>
<td>Control</td>
<td>12 mg</td>
<td>12,360,000</td>
<td>148 kg / Ha</td>
<td>Bertness and Grosholz (1985)</td>
</tr>
</tbody>
</table>
Thank You

• Senators Jack Reed and Sheldon Whitehouse.
• Save The Bay Staff
• BioProcesses H20
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