RIBBED MUSSEL NUTRIENT BIO-EXTRACTION PILOT PROJECT

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Project Description

The waters in the upper portions of Narragansett Bay have high levels of anthropogenic nitrogen. Excess nitrogen can lead to overproduction of algae, which reduces light infiltration, can directly smother benthic organisms, and can reduce local oxygen levels in the water when it decomposes. Filter feeding bivalves can indirectly reduce water-column nitrogen by consuming plankton, but edible bivalves can pose a human health threat in polluted waters, making their restoration controversial. Ribbed mussels are not commonly eaten and thus could be useful for bioextraction in polluted systems. Ribbed mussels can effectively consume nutrient-rich seston from the water column while in their natural intertidal settings or while continually submerged. We compared growth rates of 100 adult ribbed mussels in each of three settings: (1) a fringing salt marsh, (2) hanging continually submerged in shallow water from a floating raft, and (3) in a shellfish aquaculture upweller that continually forced water past the animals to theoretically increase feeding rate (Figs. 1 and 2). We used total mass and dimensions (primarily shell length) to estimate tissue mass growth (Fig. 3), which we used as a proxy for net seasonal bioextraction efficiency. We additionally measured the bioextraction efficiency of a small number of mussels in real time using the biodeposition method.

Figure 1. Ribbed mussels growing in an upweller (active), subtidal media (passive), and natural fringe salt marsh (control) settings.

Figure 2. Locations of treatments in upper Narragansett Bay, Rhode Island; the solid red rectangle represents active treatment, the green rectangle represents passive treatment, and the red stars represent control sites.

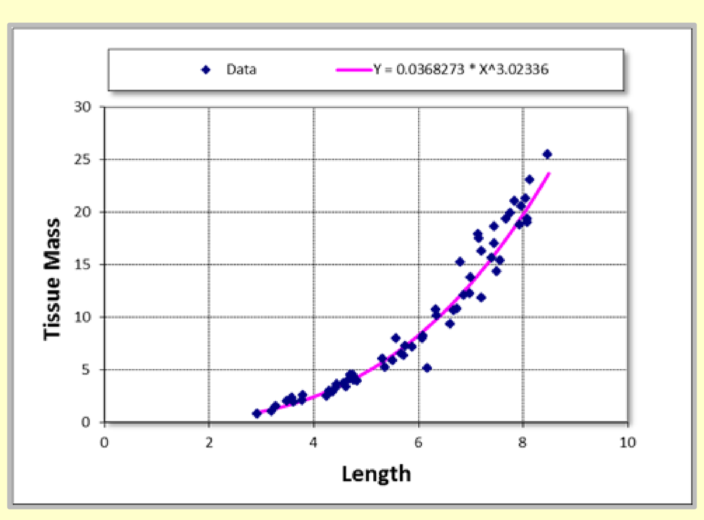

Figure 3. Best-fit model predicting ribbed mussel soft tissue mass from direct measurements of 60 animals at the onset of the experiment.

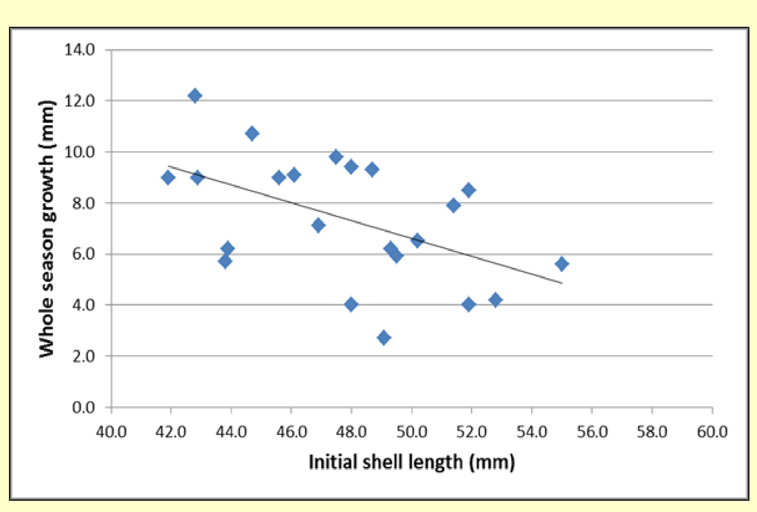

Figure 4. Seasonal growth of ribbed mussels as a function of initial size among 25 animals in the Providence River in 2014.

Results/Conclusions

Mean seasonal growth in length of typical-size adult mussels (mean initial length = 6.23 cm) ranged from 0.15 cm to 0.28 cm among the settings during the growth season (Table 1), whereas smaller animals grew more rapidly (0.27 to 1.2 cm over a similar period; Fig. 4). We estimate an average net nitrogen bioextraction rate of 7 to 13 mg per animal over the period using growth data (Fig. 5). While no significant differences in growth rate among treatments were detected, continually submerged and intertidal animals appeared to grow similarly; whereas animals subjected to increased seston delivery by an aquaculture-style upweller appeared to grow slowest, indicating that factors associated with increased seston delivery, including equipment problems we encountered during this project, may have suppressed growth. In comparison, we estimated a nitrogen bioextraction rate of 0.03 to 0.09 mg per hour per g of dry weight using the biodeposition method (Fig. 6). Our findings suggest that ribbed mussels were able to successfully acclimate to constant submersion and that our field site had sufficient quantity and quality of food to support good growth. Our bioextraction estimates may be useful to inform projects aimed at nitrogen mitigation of eutrophic estuarine waters using ribbed mussels.

Table 1. Net growth of ribbed mussels over the growing season in 2015.

	Length (cm)	Width (cm)	Depth (cm)	Mass (g)
Change Active	0.15	0.03	0.18	1.17
Change Passive	0.28	0.17	0.23	3.28
Change Control	0.25	0.14	0.13	1.56

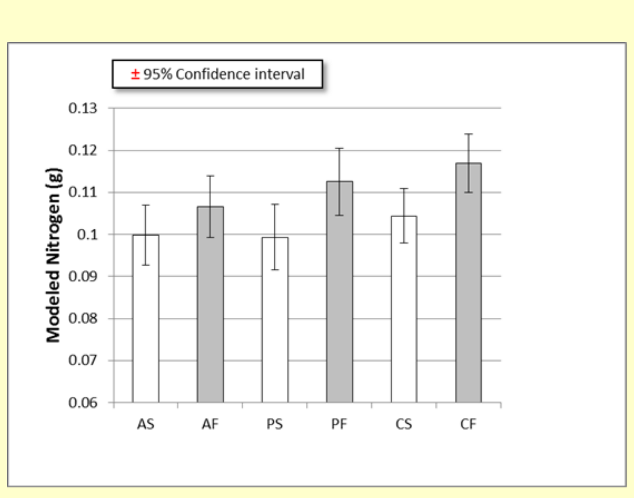

Figure 5. Modeled nitrogen content per adult ribbed mussel per growing season in the Providence River, where C = Control, P = Passive, A = Active, S = Start and F = Finish; n = 100 mussels per setting × 3 settings.

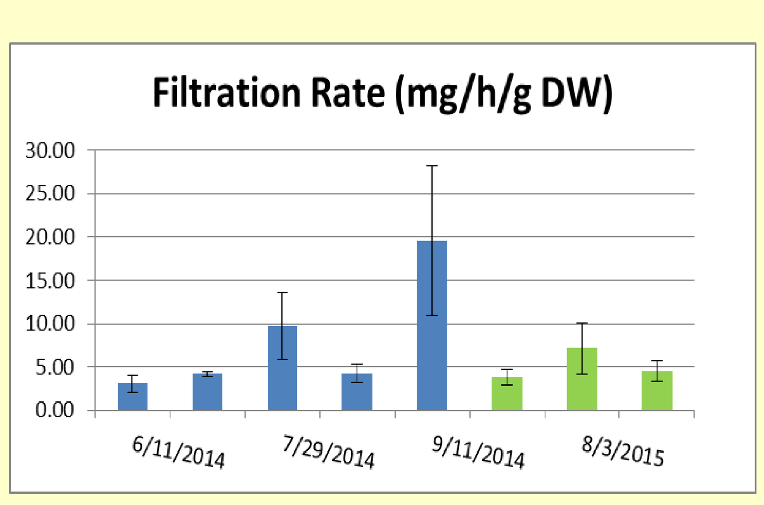

Figure 6. Real-time filtration rates of ribbed mussels measured during the growing periods in 2014 (n = 16) and 2015 (n = 16).

Acknowledgments

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