Evaluation of BioHaven® Floating Islands Matrix as a Medium for *Geukensia demissa* Spat Collection and Cultivation and as a Nitrifying/Denitrifying Platform in Various Coastal Ponds of Martha's Vineyard
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Introduction

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The ribbed mussel, *Geukensia demissa* is a critical component of coastal marsh habitat. It has excellent filtration capabilities making it a prime candidate for water quality bioremediation. Ribbed mussels can even filter and digest bacteria. In addition, because it is not considered desirable for human consumption, it can be deployed in waters prohibited to shellfish harvest without the problem of it creating an "attractive nuisance" to public health where other species such as oysters cannot. These closed areas are often the locations in greatest need of bioremediation.

Ribbed mussels inhabit the outer edge of the marsh at the point of greatest wave energy. Growing in dense clumps held strongly in place and to each other with byssal threads, they provide a natural shield stronger and more resilient than the marsh vegetation. The ribbed mussel, *Geukensia demissa*, is present in almost all salt marshes and its intimate association with *Spartina alterniflora*, suggests a coevolution of the two species with each species benefitting from the presence of the other. In return for its defense of the edge of the marsh, the mussel receives a unique intertidal site to attach. Here it is protected from subtidal predators. It is not surprising that they are also linked nutritionally. In addition to phytoplankton, the mussels gain sustenance from marsh detritus. The mussels in turn deposit nutrient rich feces and pseudofeces to fertilize the marsh grass. In addition, the organic material that the mussels filter from the water is added to the surface of the marsh helping to build marsh elevation.

Natural populations of ribbed mussels within an estuary appear to be limited by available marsh edge habitat. Increasing ribbed mussels to numbers required to enhance filtration and bioremediation in degraded estuaries will require the development of artificial habitat providing attachment sites and predator protection similar to that afforded by natural marsh.

This evaluation is designed to test the viability of the BioHaven® Floating Island matrix as a structural platform for ribbed mussel cultivation, propagation and spat collection. Small floating structures made of the BioHaven matrix material will be installed in various coastal ponds of Martha's Vineyard that are noted as having impaired water quality with significant decreases of eelgrass beds and shellfish production.

Observations & Questions

1. Will the BioHaven® matrix bio-foul from natural marine aquatic organisms or suspended detritus to a point where the matrix will not provide positive benefits in these marine environments at this scale.
2. Does the matrix have any application for *Geukensia demissa* spat collection and/or culture?
3. Does the periphyton that becomes attached to the matrix exhibit nitrification and/or denitrification potential? If so, to what extent.

Hypotheses

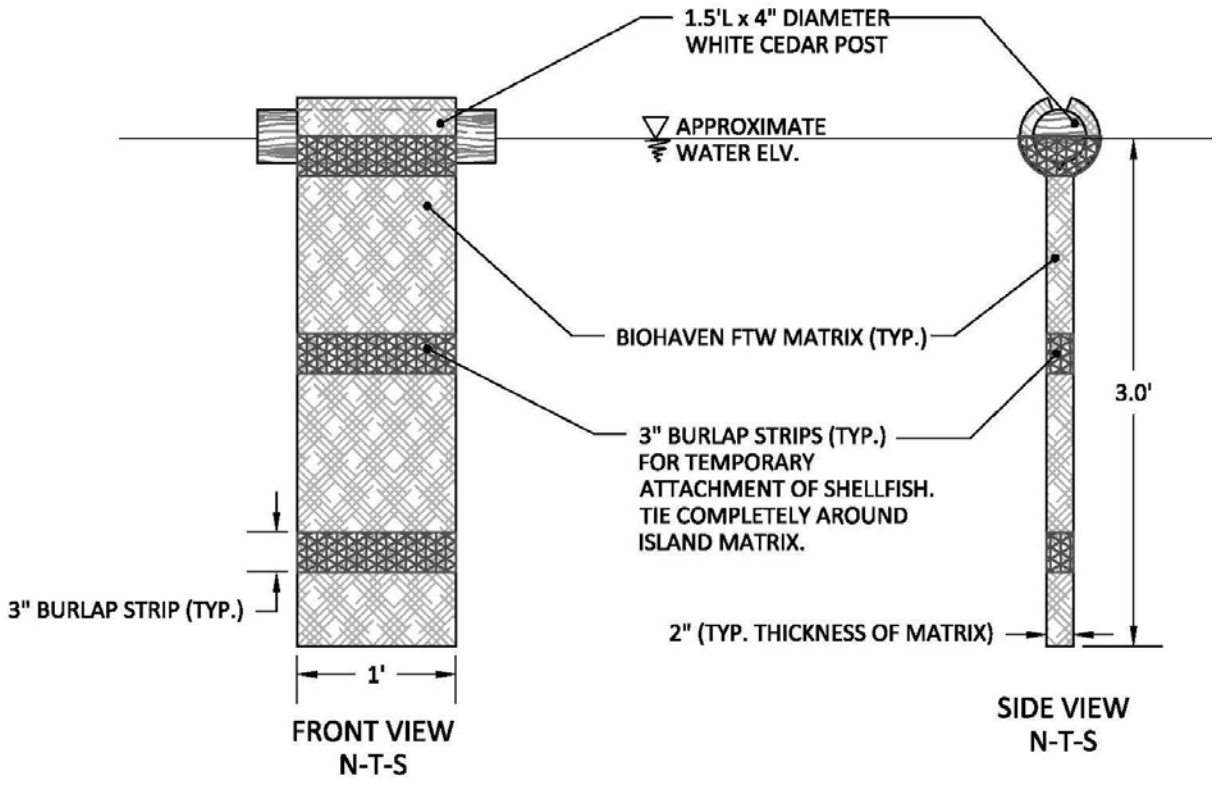
Refer to Experiment section for description of FTW locations and configurations.

1. It is expected that FTW 1 will show the greatest propensity to bio-fouling with FTW 2 – FTW 4 showing a lessening propensity toward bio-fouling in order.
2. FTW-1 and FTW-3; it is expected that Geukensia and/or other bivalve spat will attach to the media if spat from these organisms are naturally within the water column passing through these FTWs. FTW 2 and FTW4; if the Geukensia that will be artificially attached to the media remain and survive, it is expected that the spat from these animals will attach to the media.
3. It is expected that both aerobic and anoxic zones will be formed in natural periphyton biofilms that are expected to develop on the matrix providing both nitrification and denitrification ecologies on all four FTWs.

Materials and Methods

Floating Treatment Wetland Construction

Figure 1 - BioHaven Floating Treatment Wetland Construction Details

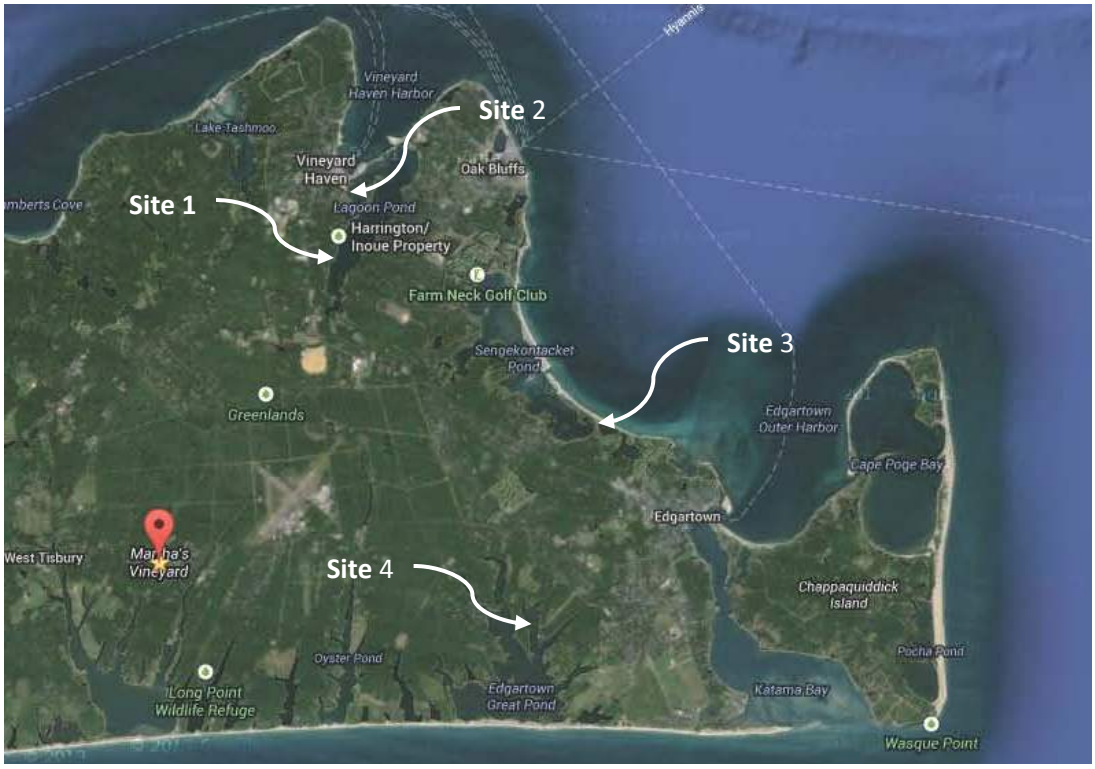


Installation Locations with Salinity & Average Total Nitrogen (TN) concentrations:

Site No.	Location	Salinity, ppt	Average Total Nitrogen, mg/l
Site 1	Lagoon Pond (South Basin) at the Martha's Vineyard Shellfish Group Hatchery docks	30[1]	0.371[1]
Site 2	Muddy Creek west of Lagoon Pond Drive (Head of Lagoon Pond West Arm)	30[1]	0.3 - 0.42[1]
Site 3	Trapps Pond at outlet to Sengekontacket Pond	21[2]	0.6[2]
Site 4	Mashacket Cove at Edgartown Great Pond	12 - 28[3]	0.6[3]

[1]	MEP, Linked Watershedd-Embayment Model to Determine Critical Nitrogen Loading Threshold for the Lagoon Pond System, DRAFT: June 2010
[2]	MEP, Linked Watershedd-Embayment Model to Determine Critical Nitrogen Loading Threshold for the Sengekontacket Pond Embayment, FINAL: January 2011
[3]	MEP, Linked Watershedd-Embayment Model to Determine Critical Nitrogen Loading Threshold for the Edgartown Great Pond Pond System, FINAL: December 2008

Figure 2 - Approximate Test Site Locations



Floating Treatment Wetland Configurations

The experiment will include four separate FTW installation Configurations at **Site 1** including:

FTW 1. Control: BioHaven® matrix alone floating with the sheet of matrix extending approximately 3.0-feet into the water column.

FTW 2. BioHaven® matrix installed as FTW 1 with adult and/or juvenile *Geukensia demissa* artificially attached in each of the three burlap attachment strips on both sides and ends of the FTW after baseline length, width and thickness measurements (Independent Variable 1).

FTW 3. BioHaven® matrix alone floating with the sheet of matrix extending approximately 3.0-feet into the water column with recirculation by an air lift system (Independent Variable 2).

FTW 4. BioHaven® matrix installed as FTW-3 with adult and/or juvenile *Geukensia demissa* artificially attached in each of the three burlap attachment strips on both sides and ends of the FTW after baseline length, width and thickness measurements (Independent Variable 3).

Only FTW-1 and FTW-2 will be installed at Sites 2 – 4.

Replications

Each installation will include one replicate of each FTW installed. There will be 2-each of FTW 1 - 4 configurations at Site 1 and there will be 2-each of FTW-1 and FTW-2 configurations at Sites 2 – 4.

Monitoring

The FTWs will be monitored monthly beginning one month after installation through October. A sample Field Data Collection Worksheet is attached.

The FTW will be visually observed and evaluated for the following:

1. Extent of bio-fouling:
    a. Density of biomass
    b. Dominant organism
    c. Are invasive Tunicates present?
    d. Take picture of each side of each FTW
2. Number and characteristics of remaining Geukensia that were attached at installation
    a. Record quantity remaining and measure length, width and thickness of each mussel
    b. Record any notable observations associated with planted Geukensia
        i. Condition of burlap attachment strip
        ii. Differences in physical characteristics of mussels at different depths in the water column
3. Evidence of spawning of Geukensia
    a. If evidence of spawning is present sample matrix for laboratory analysis to include spat count and health of larvae.
4. Nitrification/Denitrification potential of biomass formed within the BioHaven matrix
    a. Sample for laboratory analysis if available through Woods Hole Marine Biological Laboratory according to their sampling protocol.

SAMPLE: Field Data Collection Worksheet

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DATE:														
Field Technician(s):														
			Bio-fouling					Planted Geukensia			Spat Collection		Nirification/Denitrification	
			Density	Dominant species	Tunicates	Picture	Comments	Remaining	Dimensions	Comments	Observations	Comments	Sampled?	Comments
Lagoon Pond at the MVSG Hatchery dock	Group 1	FTW-1												
		FTW-2												
		FTW-3												
		FTW-4												
	Replicates	FTW-1												
		FTW-2												
		FTW-3												
		FTW-4												
Muddy Creek	Group 1	FTW-1												
		FTW-2												
	Replicates	FTW-1												
		FTW-2												
Trapps Pond	Group 1	FTW-1												
		FTW-2												
	Replicates	FTW-1												
		FTW-2												
Edgartown Great Pond	Group 1	FTW-1												
		FTW-2												
	Replicates	FTW-1												
		FTW-2												