Toward More Environmentally-Friendly (BMP) Methodologies For Intertidal Oyster Restoration: An Experimental Study Evaluating Stabilizing Mesh And Related Approaches

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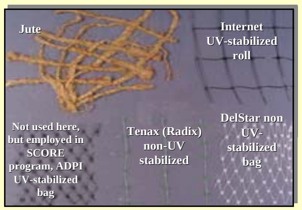
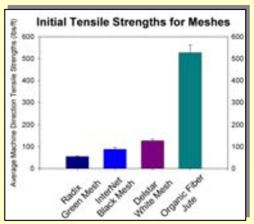
INTRODUCTION

Small- and large-scale oyster restoration projects across the U.S. have been increasing exponentially, with some programs beginning to use stabilizing mesh (e.g., bags, flat material) to: (1) simplify setting & later shell deployment (e.g., Chesapeake Bay); (2) minimize community restoration program logistics (e.g., Hadley & Coen, 2002, SC Oyster Restoration Program or 'SCORE'); or (3) stabilize shell in areas with high disturbance (e.g., Coen & Fischer 2002, boat wakes & wave energy). As part of our expanded SCORE Program, we have been investigating the suitability of "eco-friendly" 'biodegradable' & 'non-photostabilized' mesh, as Best Management Practices (BMP) alternatives to 'stabilized' meshes for intertidal oyster restoration.

The purpose of this project was to investigate the suitability of biodegradable & non-photo-stabilized mesh types for estuarine restoration especially as it applies to oyster restoration. '*Photo-degradable*' is a term given to products that degrade when exposed to sunlight. *Photodegradability* typically means that the product will break down into small pieces if left uncovered in sunlight. However, these smaller pieces of plastic often make these products not truly 'biodegradable.' Degradation rates were quantified for samples deployed both in the field & at our lab (=control) site by directly measuring changes in tensile strength (lbs/ft) & 'survivability' over time.



Mesh types being studied in this experiment



Initial tensile strength measurements for machine direction (MD) for the four meshes used for the study

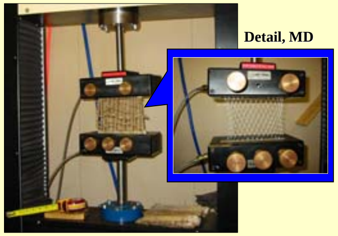
STUDY SITES

Three field sites were used for this experiment: (1) Charleston Harbor; (2) Palmetto Islands County Park (where we are also doing extensive oyster reef restoration); & (3) the Cape Romain Wildlife Management Area. The latter two are also smaller-scale SCORE restoration sites. These three sites were chosen for their proximity to our lab & their site characteristics. Both the Cape Romain & the Palmetto Park site are relatively similar (both are in tidal creeks with widths of 27 m & 61 m, respectively), with regard to current/wave energy, boat traffic, & bank characteristics. The Charleston Harbor site differs significantly as it encounters high wave energy & has a large fetch versus the two other creek sites. Our two land-based platforms were constructed on the grounds of our facility (Marine Science Center) at Fort Johnson. It was chosen so that it was exposed to the sun at all hours of the day.

Replicate mesh plots (4' x 5') being deployed at various sites

Palmetto site with replicate mesh plots

Cape Romain shoreline with deployed mesh plots

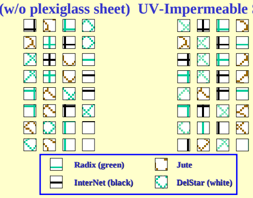


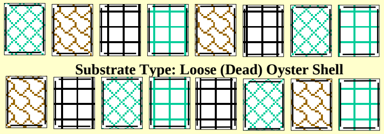
Tensile Strength Machine, Tenax

METHODS AND MATERIALS

Recently, some companies have begun producing "eco-friendly" meshes that are popular in agriculture, road construction, landscaping, & land rehabilitation. Four of these mesh types were used in our experiments: (1) a loosely woven organic jute fiber mesh; (2) a non-UV stabilized green mesh by Tenax called "Radix"; (3) a biodegradable white tube mesh (DelStar) cut flat; & (4) a non-biodegradable UV-stabilized black mesh currently being used by us in for our large-scale restoration. After suitable sites were selected, mesh were cut into 4' x 5' rectangle sections. These sections were then laid side by side, alternating mesh types, with replicates assigned randomly at each plot. At the Palmetto Islands & Cape Romain sites, eight mesh plots (n = 2 for each mesh type, see below) were laid over loose shell on the shoreline & eight plots (n = 2 for each mesh type) over live oyster clusters. Plots at the Charleston Harbor site were all placed over a sandy-shell matrix bank. Plots were anchored using 5' x 3/8" rebar on all four sides, with two 2.5' "J" rebar on each end to hold down the rebar. Each plot was spaced approximately 2' apart.

Control Board (4' x 8') Design



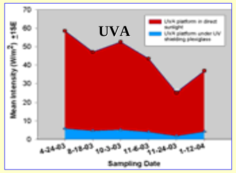


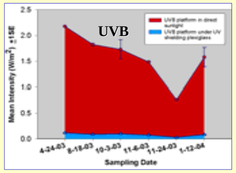
Typical layout for field deployment of mesh types (4' x 5' blocks)

Two control platforms were constructed on April 23, 2003 at Fort Johnson to evaluate mesh degradation under natural exposure conditions. Platforms were elevated off the ground, with 4" x 4" to prevent warping of the 4' x 8' plywood sheets. One platform was covered with a sheet of 1/8" (0.118") thick UV-opaque plastic (OP-3 Acrylite® by Cyro Corp.). This material is sold to reduce UVA & UVB by 90-95%. The plastic sheet was suspended above the platform using PVC pipe 'stands' with a central supporting bolt with plastic nuts. The other platform was left uncovered, exposing the replicate mesh squares to natural environmental conditions (e.g., rain & UV). Eight pieces of each mesh type were stapled to each platform in a randomized block design. Meshes were first sampled on August 15, 2003 & sent to Tenax Corp. for tensile strength analysis (see below).

Control (right photo panel above) & plastic- (UV-opaque, OP-3 Acrylite®) covered platform (see left photo panel) with meshes in place

UV measurements being recorded using optical radiometer





UV measurements over time for UVA (left) and UVB (right) for control & UV-opaque platforms (note scale differences)

METHODS AND MATERIALS CONT.

Monthly UV readings for both UVA & UVB intensities were taken at the two platforms using a MACAM 203 Optical Radiometer. Readings (in W/m^2) were made at predetermined points on each platform, along with time of day, weather conditions, & temperature. Results are shown above, with red (Figure above) for direct exposure (control) & blue (Figure above) for UV-opaque. As advertised, incident UV values were reduced by 96% for UVA & 98% for UVB.

Data on mesh condition were collected on a quarterly basis at all field sites. Palmetto & Cape Romain were constructed on May 13 & 16, 2003, respectively. These sites were sampled on August 13-14, 2003. The Charleston Harbor site was constructed on May 12. To facilitate mesh sampling in the field, a 1 ft^2 quadrat was placed over each mesh plot as a template for collecting replicate samples. Only one sample ('swatch') was cut from each of the mesh plots at a given time. After samples are collected, they were labeled & brought back to the lab for cleaning. Each 'swatch' was rinsed with freshwater to remove silt & allowed to dry before being sent to Tenax Corp., our industry partner for tensile strength analysis (see left, using ASTM 4595 "Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method). *Tensile Strength* is defined as "the maximum resistance to deformation developed for a specific material when subjected to tension by an external force." Platform samples at Fort Johnson were also sampled on a quarterly basis. Two replicate swatches were randomly selected & removed for processing as above.

FINDINGS & CONCLUSIONS

- ✓ In order of initial tensile strength (highest to lowest):

  Jute > DelStar (white) > Internet (black, stabilized) > Radix (green)

- ✓ Mesh tensile strength values greatly decreased over time, as expected. Environmental stresses caused some of the meshes to breakdown more rapidly than others.
- ✓ Samples from field sites degraded at a slower rate than those on the land-based (FJ) platforms. Meshes deployed at the three field sites showed very little, if any UV-associated damage. Water & mud appear to be acting as significant filters to UV. The unstabilized 'Radix' (green) mesh seemed to be the most sensitive to UV & high wave action.
- ✓ Most meshes recovered from these sites were not very brittle, had good color, & changed little from pre-deployment. The jute mesh deteriorated completely at all field sites. The DelStar (white) mesh seemed to hold up best at the high energy, Charleston site, possibly due to its smaller mesh diameter & increased material per unit area. Overall, mesh deterioration appeared to be due primarily to wave/current action.
- ✓ The Jute mesh was the most sensitive to wave action.
- ✓ To date, the tightly weaved, small diameter (white mesh from DelStar) appears to be the most appropriate for restoration applications at this time.

Mesh Type	Treatment	Experiment 1: Initial (3/25/03)	Experiment 1: 5 Month (8/15/2003)	Experiment 1: 6.5 Month 10/2/2003)	Experiment 2: Initial (8/20/03)	Experiment 2: 3 Month 11/24/03
Jute	UV-exposed	Green	Yellow	Yellow	Green	Yellow
	UV-oblique	Green	Green	Green	Green	Green
InterNet UV-Stabilized black	UV-exposed	Green	Green	Green	Green	Green
	UV-oblique	Green	Green	Green	Green	Green
Tanex Non-UV Stabilized green	UV-exposed	Green	Red	Red	Green	Red
	UV-oblique	Green	Green	Green	Green	Green
DelStar Biodegradable white	UV-exposed	Green	Red	Red	Green	Yellow
	UV-oblique	Green	Green	Green	Green	Green

Green: Mesh still "strong', with little or no discoloration or obvious damage
Yellow: Mesh significantly weakened, with some fading
Red: Mesh very brittle, not testable

Materials Information:

- DelStar Technologies, Inc. #191-4667 ¾ × ¾"
  Austin, TX www.delstarinc.com
- Tenax (Distributed by InterNet as 'Radix') # OG4511 0.9 ×1.25"
  Baltimore, MD www.tenaxus.com
- InterNet (UV-stabilized) # OV-4885 1.25 × 1.5"
  Minneapolis, MN www.internetmesh.net
- Protec Environmental Supply, Inc. organic fiber, jute 1 × 1"
  Charlotte, NC www.scnla.com/protect.htm

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SCORE Website: http://www3.csc.noaa.gov/scoysters/

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