Making Extreme Weather Event Stable Shorelines with Hyacinth

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Water Hyacinth

The goal of this project is to create a low-tech mesh out of water hyacinth, an invasive aquatic plant species, that is easily manageable by rural or socioeconomically disadvantaged regions. The main purpose of the hyacinth mesh is to manage erosion and support the germination of dune-stabilizing plants along degraded shorelines, especially during extreme weather events. This project targets shorelines along the southern coast of the United States and utilizes hyacinth harvested in rivers and lakes surrounding San Marcos, Texas. Hyacinth found in the local river is first used to create prototypes of simple mesh squares so that Texas State University students can understand the most effective ways to process the hyacinth into products. Besides making hyacinth cord, paper, or powder and then composting hyacinth material, the group made a simple guide on how to teach community members to make their own mesh.

Environmental Effects of Shoreline Erosion
Shoreline erosion is becoming a larger issue as sea levels rise globally due to climate change. This change in sea level is accompanied by an increase in extreme weather events annually, which often cause impactful losses of beach sand at once. It can be hard to measure or predict shoreline erosion as one storm can cause more erosion in a few days than what would normally occur in a century. More than 80% of the world's shorelines are rapidly eroding which threatens human-made structures. Changes in shoreline position can range from a few centimeters to a few meters each year depending on the beach's location (Pilkey et. al., 2001).
There are many ways to manage shoreline erosion, but implementing hard structures to break wave energy often does nothing to support the natural ecosystem that exists within shorelines. Using natural elements to create a resilient living shoreline alleviates the pressures of extreme weather events and does so in a way that uplifts the surrounding ecosystem and is affordable for all communities. These elements could include soft structures like marsh grass plantings or coir logs or hybrid structures like breakwaters made of rocks, stones, reef material, rubble, or concrete. Water hyacinth mesh is a soft structure that mimics articulated mats or concrete block walls that have been used to successfully prevent shoreline erosion in the past, but hyacinth mesh is fully biodegradable and has the added benefit of potentially repopulating the shores with native vegetation (Texas General, pg. 1-24).

Composting MESH

Water Hyacinth is an invasive species (Fig. 1) and so using it for a product like MESH, with the intention of disposing it through composting requires consideration of the continued invasiveness of the seed or propules. This research includes a study conducted at Bobcat Blend at Texas State University to determine whether hyacinth can be effectively composted on a large scale. Using water hyacinths as a feedstock and combining them with composting process renders hyacinth seeds and propagules nonfunctional. Firstly, the water hyacinth was tested for germination and one hundred water hyacinth seeds (50 scarificed and 50 unscarificed) were placed in Petri dishes on filter paper with media soaked with distilled water for 14 days. Seeds were scourged by soaking in a 15% vinegar solution for 30 min (Blazich and Evans, 1999).

The compost pile used in the study consists of wood chips (50%), water hyacinth plants (25%), poultry litter (15%), and food waste (10%), and the procedure for composting was developed by specialists at the Texas Commission on Environmental Quality (William Carter, personal communication). The piles were built 3 to 3.5m wide and 1.5 to 1.8m tall by following the procedure prescribed by Rynk et al. (1992) and throughout the process of composting, moisture and heat were monitored. Piles were allowed approximately 4 weeks to decompose and be ready for curing when the pile's temperature dropped steadily and reached mesophilic temperatures lower than 40 C. To determine the compost quality using water hyacinth as feedstock, organic matter, pH, carbon to nitrogen ratio, and micro and macro nutrients were tested. The samples were sent to the Pennsylvania State Agricultural Analytical Services Laboratory which follows the procedure recommended by the U.S. Compost Council's Test Methods for the Examination of Composting and Compost (TMECC, 2002) Seal of Testing Approval (STA) program.

The seed germination test results found there was no difference between the scarified and unscarified seeds, besides the fact that 33(66%) unscarified seeds compared to 29 (58%) scarified seeds germinated. Large-scale composting used 9,900kg of water hyacinth, 11,300kg of poultry litter, and 8,100kg of food waste from the university cafeteria. All this material was collected, mixed, and allowed to decompose and produce 50.5m3 (66 cubic yards) of compost valued at $1980 from the materials that were problematic to the environment. The food waste from the cafeteria was composted and water hyacinth was treated as waste after harvesting from the Spring Lake.

The composting process renders the seeds and the propagules of water hyacinth to be unable to regrow. 3.78L of compost samples were collected in this study and then the samples were screened to observe if there were seeds and other propagules present in the mixture; but there were no seeds or propagules of water hyacinth found in the sample. These results verified that the seeds and propagules of water hyacinth can be composted without any dangerous threat of spreading into the surrounding environment.

Harvesting and Processing

Hyacinth Collection
The beginning phase of MESH consisted of searching for hyacinth in local waterways. Hyacinth ideally grows in weather that is between 75-85 degrees and prefers stagnant water. This was a challenging factor as collection efforts began in October when the weather was cooling down. Three trips were made to find water hyacinth in the river in San Marcos without success, but there was a small population found nearby in Staples, Texas in a more rural part of the San Marcos River (Fig. 2). The condition and location in which the hyacinth was found was in a stagnant crook in the river, nearing a cow pasture, in a large matted structure. The variation of the plant found was very short and clumped together, which is not ideal for making the long cords needed for weaving mesh. Two trips were made to the Staples location in the first week of October. During the first collection effort about forty gallons of hyacinth were harvested and during the second attempt about twenty gallons were harvested.

Drying & Storage
After the hyacinth plants were collected, the first batch was stored in tap water and the second batch was stored fresh, exactly as they were harvested from the lake for three to five days (Fig. 3). Both portions were then rinsed and a portion of the root clumps were discarded. The portion of the plants that were stored without water were much harder to pull apart, but the portion that was stored in water was slimy and had a pungent scent. It was later found that keeping the roots attached for as long as possible helps reduce odor and make the plant easier to process. A small section of the stems were then placed back in water, while the majority of the stems were dried in the courtyard outside of the Texas State FCS building for three to five days. The stems were still kept separate depending on the date they were collected. It was found that the stems that were fresher and not kept in water did not dry or shrink as fast as the ones that were a bit older and stored in water. Both batches were brought inside and it was observed that the older stems that were stored in water were still decently moist and the fresher stems that were stored as they were harvested (moist) were dry enough to twist and be used to make cord. The older stems dried for two days longer and then both batches were stored in tightly closed plastic bags.

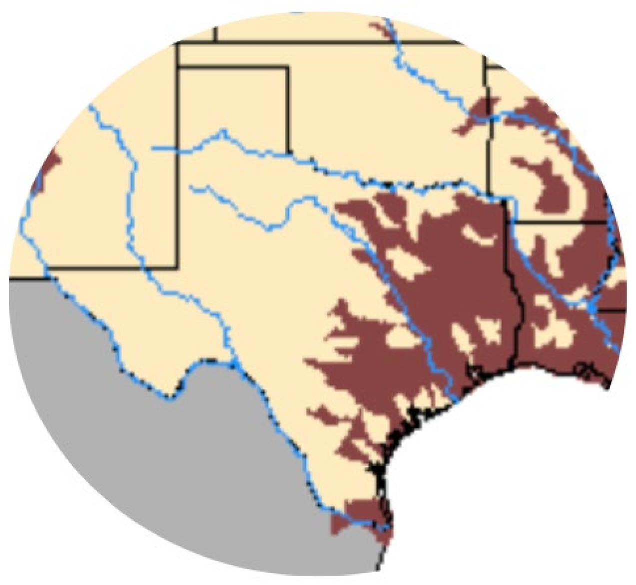

Fig. 1 Range of Hyacinth Invasion

Fig. 2 Harvesting in San Marcos River

Fig. 3 Processing Harvested Hyacinth

Fig. 4 Knotted Hyacinth Stem Cord

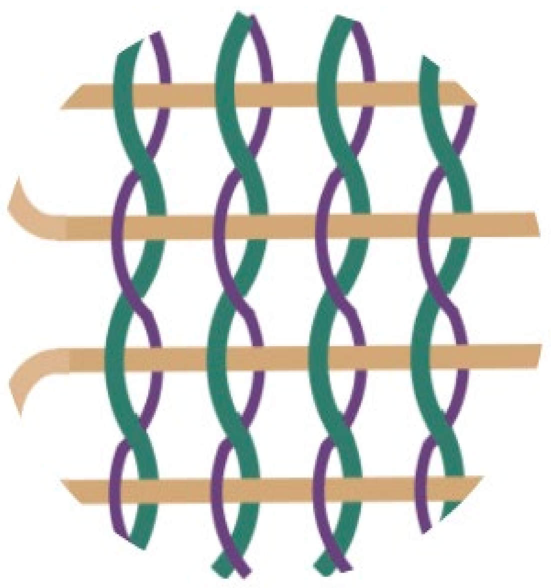

Fig. 5 Leno Weave Structure

Fig. 6 MESH Prototype

MESH Production

Weaving Prototype Cord & Mesh
Once the stems were separated and dried they could be used to make cord, but if the stems got too dry they could have become too brittle to work with (Fig. 4). Fortunately, the stems are very easy to rehydrate, no matter how long they have been sitting. In order to rehydrate the stems they need to be sprayed with water and left to sit in a tight container or bag for three to five days. The flexible partially moist stems were easily knotted together to make longer chains of hyacinth. To knot the stems, it worked best to twist them and then tie them together slowly, pushing the knot tighter incrementally. The variation of stems that were being used were about two to four inches in length, so making enough cord could take many gallons of material. There are longer hyacinth variations that would require less collection to garner the same length of cord, so the time duration of this step widely varies depending on the form of hyacinth harvested. After a sufficient amount of hyacinth cord was made, it was weaved into prototype mesh squares. In order to weave mesh, simple looms were constructed out of PVC pipes, threaded metal rods, and metal nuts.

Since local hyacinth was not easily accessible for the bulk of the project, other natural materials were used in conjunction with the sixty gallons of hyacinth we were able to harvest to help create the mesh prototype squares. The material that was first used to warp the looms was jute, which ended up being too rough and hard to knot and tighten around the looms. The second material used was a hemp cord, which was smooth and much easier to tighten and knot. The hemp cord and the hyacinth cord were the two materials used to make the first prototype square. The hemp cord was used as the warp yarn and was tied in a way that created two rows of hemp parallel to each other on the front and back sides of the loom. The hyacinth did not need any pretreatment, but it was misted throughout the weaving process to keep it flexible and durable. The hemp and hyacinth cords were then weaved together using a Leno weaving technique. A Leno weave (Fig. 5) consists of twisting the warp material in one direction and threading the weft through one way, then twisting the warp in the other direction when the weft is passed back through the warp to the side it originally started on.

Other Products & Future

Making Hyacinth Powder & Paper
Hyacinth powder and paper were made to start exploring ways hyacinth material could support the germination of other dune-stabilizing plants. The idea was that hyacinth powder could be added as a soil amendment when planting other plants, or a sheet of hyacinth paper embedded with native seed could act as an independent germination structure. When making the hyacinth paper, the stems were first blended into a powder; a portion of the hyacinth was blended into a really fine powder and a portion was blended into a coarser mix. Water was then added to each of the blended hyacinth batches to form different variations of a simple paste. One batch was also made only using the bulbs of the hyacinth stems, which ended up creating a smooth paste. This paste was then spread onto mesh screens and left to dry. After the hyacinth and water combination had completely dried it was observed that when the finer powder was used the mixture was not able to coagulate enough to form a durable sheet, but the coarser material was able to hold together. Gaillardia flower seeds were embedded in the coarser paste (made with leaves and stems, no bulbs) and the paper made with this mixture was used to test the potential of dune-stabilizing plant germination.

Vermiculture and Mycelium Efforts
The goal of the digesting the MESH using worms is to produce castings from post-consumer textile materials. The casting and soil will be used to grow indigo dye for textiles, thus creating "circular fashion." The MESH can also serve as a growth medium for fungal spore for edible mushrooms, creating a shore to table effort. Preliminary testing are being conducted on both with promising starts.

Future Research
Since water hyacinth only grows in warmer weather and a large portion of this segment of the project was conducted during the Winter, there will need to be more time allocated to the project throughout the Summer. The MESH team has plans to travel to an EPA sustainability exposition in Maryland during June, where all of the work done up until that point will be showcased. Most of the work during May and June will go towards finalizing a mesh structure and carrying out tests pertaining to water hyacinths' ability to support other dune-stabilizing plants. After June, the MESH team will continue to test how the hyacinth mesh supports erosion management, deters the regrowth of hyacinth, and absorbs pollutants.

Erosion management testing will need to be done after a final hyacinth mesh is selected from the prototype squares (Fig 6). This will be done by simulating a shoreline structure by adding rocks and sand to a small pool and coving the artificial dune with hyacinth mesh. The pool will then be tilted sharply from side to side to simulate wave energy within an extreme weather event. There will also be a second test in which sprayers and hoses will be used within the small pool to simulate surge conditions. The goal is for the mesh and the dune structure to stay intact.