2013 Final Report

FINAL REPORT
FOR
CITY OF GULF BREEZE DEADMAN'S ISLAND RESTORATION PROJECT
FLORIDA PANHANDLE COASTAL PROGRAM, U.S. FISH & WILDLIFE SERVICE
Grant # F00AP005
GULF BREEZE, SANTA ROSA COUNTY, FLORIDA

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Project Abstract

The City of Gulf Breeze, of Gulf Breeze, Florida has partnered with several agencies, to restore, protect the degrading aquatic ecosystem and ongoing erosion due to permitted activities, of Deadman's Island, Pensacola Bay, Florida. The loss of the salt marsh in this area is generally the result of increased erosion due to wave energy and the impact of an 12 mile fetch. The proposed restoration project utilizes the offshore placement of reef structures along approximately 1,240 linear feet of shoreline to reduce the wave energy and use dredge spoil behind the structures for planting of emergent salt marsh for wetland creation. An incidental benefit of this project would also be to provide protection to 17 acres of a combination of salt marsh, dune vegetation, marine oak hammock and seagrass. In addition, this project protects numerous historic cultural resources artifacts identified at the site. Dredged spoil is located within one half mile of the site. This is a beneficial use of dredge spoil material with similar sediment characteristics needed for the emergent grass plantings. The proposed project places the oyster reef structures on existing open-water bay bottom and emergent salt marsh where no such vegetation currently exists. The project has grown into an established living oyster reef which enhances estuarine habitat, estuarine emergent vegetation, estuarine water column, and sandy substrates at the Deadman's Island, Pensacola Bay project area to accommodate various life stages of fish species.

The Deadman's Island Restoration Project is located at 30.3685°N, 87.1868°W (WGS84) in tidal waters of Pensacola Bay near the U.S. Highway 98 bridge on the north side of Gulf Breeze in Santa Rosa County, Florida. The project site primarily consisted of barren sandy, uninhabited substrate. The benthic population consists of polycheate species and various amphipods. There is a 6- by 6-foot seagrass bed consisting of Halodule wrightii and Ruppia maritima. Six historic structures dating from the 1600s and 1800s protrude from the water at low tide. In addition, the remnant of a marine railway is exposed at all times. Behind Deadman's Island a pristine ten thousand year, old juncus salt marsh is in jeopardy of be permanently destroyed due smothering from erosion and permitted activities. The City of Gulf Breeze is designated as a bird sanctuary and a migratory drop zone habitat. Deadman's Island provides habitat for most of these birds due to its various ecotones. The adjacent cove is 12-25 ft deep and provides marine habitat for deeper water species and for juveniles migrating from the nursery habitat of the salt marsh.

As of 2013, the project is not complete and is still seeking funding to finish the breakwater footprint and replace the oyster dependent vertical breakwater which suffered a mass oyster and fish died off in 2010 and 2011, post Deep Water Horizon Oil Spill. The degraded after the oyster die off and is failing as a breakwater. This breakwater was protecting the hard work and collaborative efforts of many funding partners and the general public. Once the entire breakwater footprint has been filled with the proven successful current breakwater and replaces the sand and vegetation, recently lost, this project will be complete. Five years monitoring is scheduled for a portion of the breakwater.

1.0 Project Elements (All Tasks)

1.1 Task 1- Breakwater

To provide a natural reef breakwater to reduce wave action and protect the shoreline and the unique resources of Deadman's Island and to provide additional fisheries and aquatic ecosystem and habitat.

The aquatic ecosystem restoration at this site involves the placement of oyster reef and fish habitat vertical breakwaters units along an area encompassing the remaining one-quarter acre footprint two hundred and thirty feet north west of the shoreline of the north end of Deadman's Island. In the summer of 2009, one third of the breakwater goal was placed and in 2011 additional and unique breakwater is in place. Currently, all but 200 feet of the breakwater are in place, and 840 feet of the pre oil spill reef died off in 2011 following the Deep Water Horizon Oil spill. The reef breakwater will reduce wave energy to the shoreline and create productive oyster reef habitat for resident species of shellfish and finfish, and improve water quality via the filter-feeding bivalves.

For scientific and transferability purposes, there will be a comparison of breakwater design, geo-fabric engineering, and materials the units will contain recycled oyster shells and fossilized oyster shells. Spat recruitment, spat settlement, species population and biodiversity will be measured as part of the monitoring task. This wave break will increase the population of fish, including sports fish, native oyster habitat by providing a foundation for a natural oyster reef made from oyster shells. This fish habitat and oyster wave break structure will also provide a marine habitat for large fish and marine organisms. In addition, these unique oyster wave attenuators not only provides protection for the existing coastal and marsh habitat, but has increased species population and biodiversity.

The reef additionally provides benefits to shore birds as it protects the wetland and new habitat creation. The area of Deadman's Island is a migratory bird drop zone. This project provides a better understanding of nutrient cycling on oyster reefs, as well as trophic and non-trophic species interactions, which is required to understand the ecosystem benefits of a restored oyster population. Such information is used in research and statistical modeling, food web simulations, and the development and application of biophysical models, dependent on continuing evaluation of reef impacts in the future.

This project is monitored and will be scientifically evaluated after five years. The monitoring of this restoration project will address spat recruitment in various locations of Pensacola and East Bay, Pensacola, using slightly different reef designs. These projects are placed in various locations of the Pensacola and East Bay system that contain variations in salinity, water quality, sedimentation, wave action etc. Evaluation of the project success will involve documenting the development of the physical reef structure, the marsh and seagrasses which are recruited adjacent to the reefs, and the development of oyster reef, submerged aquatic vegetation (SAV), and marsh dependent biota as the

structure matures. Additionally, water quality, analysis and functional aspects of the reef structure will be addressed. This monitoring is budgeted for five years after placement, within this process, the additional information for management plans addressing the protection of Deadman's Island and other restoration, will be to evolve according to the recent needs of the project.

1.2 Task 2- Natural erosion Control and Shoreline Stabilization

In an effort to preserve the area and ultimately build up the north end of the spit area native coastal vegetation will be planted for stabilization. Upland vegetation including seashore dropseed, (Sporobolus virginicus), Saltmeadow cordgrass (Spartina patens), Seashore paspalum (Paspalum vaginatum), panicum sp, (Panicum Amarium), (Uniola paniculata) seaoats(Uniola paniculata), Muhly grass (Muhlenbergia filipes), beach elder (Iva imbricate), Railroad vine (Ipomoea pes-capre), sea purslane (Sesuvium portulacastrum), marsh elder (Iva frutescens), and evening primrose(Oenothera humifusa) will be planted.

The plan required Spartina alterniflora (saltmarsh cordgrass) to be planted at an elevation ranging from -0.5 to 1-foot National Geodetic Vertical Datum (NGVD) 83 along the shoreline of Deadman's Island and over the placed fill around the North end covering the unmarked cemetery and the marine oak trees toppling into the water.

While waiting for the permits, small "band-aid" projects were created and placed by volunteers in an effort to save, raise and level the root system of the declining Marine Oak hammock of sand oak trees in danger of toppling over due to erosion by using sandbags and geofabric. The projects created a stable shoring for the proper stabilization for planting the areas of the North end of Deadman's Island containing the unmarked cemetery. Stabilization of the trees and root systems were created by using coir logs, sand bags, sand fill and geofabric to support and secure the existing living upland tree roots that were exposed from erosion and scarping. Sand bags and coir logs were placed under the root system of the existing trees, to support and restore the vulnerable marine oak trees. Areas of the north end of Deadman's Island has been filled with sand, raised and sloped appropriately to create a stable shoring for the proper stabilization for planting vegetation.

1.3 Task 3- Island Wetland Creation

In an effort to cover unsafe protruding historic structures providing beneficial use of dredged material by creating an island stabilized with vegetated Spartina alterniflora and Juncus sp. This island will has a bare sand center for bird habitat, including least terns.

Sixteen thousand cubic yards of dredged material for fill from nearby spoil site was transported from a nearby spoil site, to fill areas designated in the permit; emergent aquatic vegetation was planted along the existing shoreline area of Deadman's Island for stabilization. The proposed restoration project will provide the beneficial use of dredged

material to cover and preserve historic artifacts while providing an erosion barrier to the west side of the island. The spoil covering the cultural resources is stabilized by wetland plants. Previously, historic structures are protruding out of the water which makes this area behind the breakwater a safety hazard to the public. An unmarked historic cemetery has been unearthed by hurricanes and amateur artifact collectors. To prevent further vandalization and "treasure hunting", The City of Gulf Breeze along with the permission and recommendation of the State Historic Division, placed fill on top of the structures and converted this area to a wetland using emergent marsh. The project has enhanced estuarine habitat, estuarine emergent vegetation, estuarine water column, and sandy substrates at the Deadman's Island. Thus, the project increases productivity and diversity of flora and fauna indigenous to the Florida area as well as stabilize the existing shoreline. Studies have shown that tidal marsh provides the primary source of food or nutrients used by estuarine animals. Over time, the created marsh would serve as nursery and feeding grounds for many important species of fish and invertebrates, such as shrimp and crabs.

Along with the 16,000 yds3 of fill from a nearby clean sand spoil site, emergent aquatic vegetation will be planted along the outside of created island leaving a bare sand center for nesting. The time period for planting will be from March - November. The plan requires Spartina alterniflora (saltmarsh cordgrass) to be planted at an elevation ranging from -0.5 to 1-foot National Geodetic Vertical Datum (NGVD) 83. Juncus roemerianus (blackneedlerush) will be planted at elevations ranging between 1- and 2-foot NGVD 83 while Spartina patens (saltmeadow cordgrass) will be planted above the 2-foot NGVD 83. The Island center will contain bare sand and no grass for the nesting of many birds such as terns. Except for anthropogenic stressors of residents not honoring the request to keep out of the nesting area, the area is somewhat isolated inhibiting animal predators unlike other areas of the beach on Deadman's Island.

1.4 Task 4-Seagrass Expansion

Began in 2013 the project is to expand the existing seagrass beds in the area using sediment tubes and field propagated Ruppia seagrass.

Submerged aquatic vegetation patches are located within the project location. After the breakwater and fill are placed, this project proposes to use sediment tubes to expand the existing Halodule sp. patch. After placement of the breakwaters and fill are completed, existing vegetation will be given time to stabilize, small sprigs of Ruppia sp. will be transplanted throughout the area for reestablishment and ultimately expansion of the seagrass within the site. This project is expected to promote the re-establishment of submerged aquatic vegetation in the area. Over time, the mature seagrass bed would serve as a nursery and feeding ground for many important species of fish and invertebrates. Seagrass will be protected by turbidity curtains at the time of construction and is far enough from the historic resources impacted by the placement of fill.

Deadman's Island is an ideal test site to improve the methodology of transplanting seagrass in the various sediment types of Pensacola Bay. Methodology to determine the long-term success of transplanted seagrass in the Panhandle is incomplete. There have not been enough successful studies of transplant data in the northern Panhandle area to determine what works and, what doesn't when it comes to seagrass restoration. This is an area in which transplanted seagrass will be closely monitored and methods documented. This project will require a five year plan monitoring component, and the sites behavior to future hurricanes before success or failures can be determined.

1.5 Task 5-Bird Habitat

The wetland creation provides a bird habitat for sand loving birds.
Signage from FWCC was placed to request privacy for the bird nesting.
Gulf Breeze is a migratory drop zone and designated bird sanctuary. The population of birds that this habitat will benefit include: the American Oystercatcher (Haematopus palliatus), Osprey (Pandion haliaetus), Common Loon (Gavia immer), Pied-bill Grebe (Podilymbus podiceps), Horned Grebe (Podiceps auritus), White Pelican (Pelecanus erythrorhynchos), Brown Pelican (Pelecanus occidentalis), Double-crested Cormorant (Phalacrocorax auritus), Lesser Scaup (Aythya affinis), Magnificent Frigatebird (Fregata magnificens), Great Blue Heron (Ardea herodis), (See Table 1 for Additional Bird species).

1.6 Task 6-Dune Restoration

Fifteen small dunes, were created, and sea oats were planted for stabilization. Hurricanes have flattened the small dunes on Deadman's Island which were scarped due to erosion. This action left the marine oak hammock and the pristine salt marsh vulnerable and at risk. This project will restore and provide protection to the area resources which are now vulnerable to erosion and suffocation. A vegetation survey and inventory was taken by Dr. James Burkhalter, of the University of West Florida, to identify all native plant species as a guide for plants to use in this restoration project. Sand from area spoil sites, approximately 500 cubic yards of sand was moved by a backhoe tractor, taking care not to destroy or go near any existing vegetation. Using dune vegetation appropriate for the front and back of the dune and smaller plants for the top of the dune, sand fences, and Sporrey-Reed tents were erected to protect the dunes and keep people off the dunes during the stabilization and establishment period. At a later date, woody dune plants will be planted in the back of the dune.

1.7 Task 7-Gulf Sturgeon monitoring

Three transmitter receiver monitors were purchased in 2011, in an effort to monitor the presence of the Gulf Sturgeon. One monitor was missing in 2013. Gulf Sturgeon are monitored and mapped throughout the area of Escambia River to Pensacola Bay by the USFWS. The distance of Pensacola Bay is too large to locate particular radio tags of the

sturgeon. This project will assist in the Gulf Sturgeon tracking and tagging efforts and provide a monitoring station and erect the necessary NOAA technological tracking equipment throughout the restoration area of Deadman's Island so scientists will be able to detect the tags, download GIS coordinates to map and monitor the sturgeon migration of the Pensacola Bay Area.

2.0 Outreach

Funding of $1.1 million from various partners has been used for the oyster breakwater, shoreline stabilization, and the wetland creation portion using spoil from dredged material currently placed on an upland spoil site. The City of Gulf Breeze constructed natural oyster reef breakwaters made from recycled oyster shell inside engineered iron frames and later created "fish habitat condos" called Ecosystems. The first oyster shell prototype was created by Little Flower elementary school. The students of the Vocational schools are welded a portion of the first phase, rebar breakwater units. Students of grades K-12 helped make oyster garden mobiles help seed the reefs and also, older students learned how to monitor. Four additional tasks, in this project are dune restoration, creation of living shorelines, sea grass expansion and bird habitat restoration. All these projects had an outpour of volunteers. This project has also increased the number of partnerships with government, educational facilities, agencies and private groups to educate, conserve, protect, restore, and enhance coastal resources and habitat.

The restoration project provides enhance estuarine habitat, estuarine emergent vegetation, estuarine water column, and sandy substrates at the Deadman's Island, Florida, project area necessary to accommodate various life stages of fish species. Thus, the proposed project would increase productivity and diversity of flora and fauna indigenous to the Florida area as well as stabilize the existing shoreline. Studies have shown that tidal marsh provides the primary source of food or nutrients used by estuarine animals. Over time, the created marsh would serve as nursery and feeding grounds for many important species of fish and invertebrates, such as shrimp and crabs. This restoration project demonstrates the ability to combine a successful technique of creating vertical reef habitat to dissipate wave energy, and to create an essential fish and bird habitat.

3.0 Baseline Survey

2007 Pre Baseline Monitoring, funded by Florida Panhandle Coastal Program, U.S. Fish & Wildlife Service and the project performed by the Florida Department of Environmental Protection Coastal Research Program Florida Geological Survey (FGS) was conducted to provide insight on the type of design needed for the project. A side scan sonar was used to find and document any anomalies which need to be avoided in the placement of the breakwaters. Bathymetric measurements were made toto create a baseline of elevations of the subtidal floor in the project area, in addition, to determine barge accessibility and other equipment needed for deployment and construction. A vibracore system was used to perform granular metric surveys and retrieve sediment samples of each spoil site below the surface. A ground penetrating Radar was used to find any upland anomalies which may be affected by storms or unearthing at a later date, similar to the coffins unearthed from hurricane Dennis in 2005. FDEP CAMA and UWF performed a vegetative inventory to identify the endemic, native plants and any invasive species present on Deadman's Island. ECS, FDEP CAMA and FDEP Northwest District Biology lab performed the benthic survey to determine foraging sources for the Gulf sturgeon before and after placement of the breakwaters.

In addition to these surveys, erosion stakes and spat collectors were placed to monitor spat settlement, and to verify survival for the oyster reef proposed to protect Deadman's

Figure 1:FGS Baseline monitoring site map for GPR, Side scan sonar and bathymetry for Deadman's Island, Gulf Breeze, Florida.

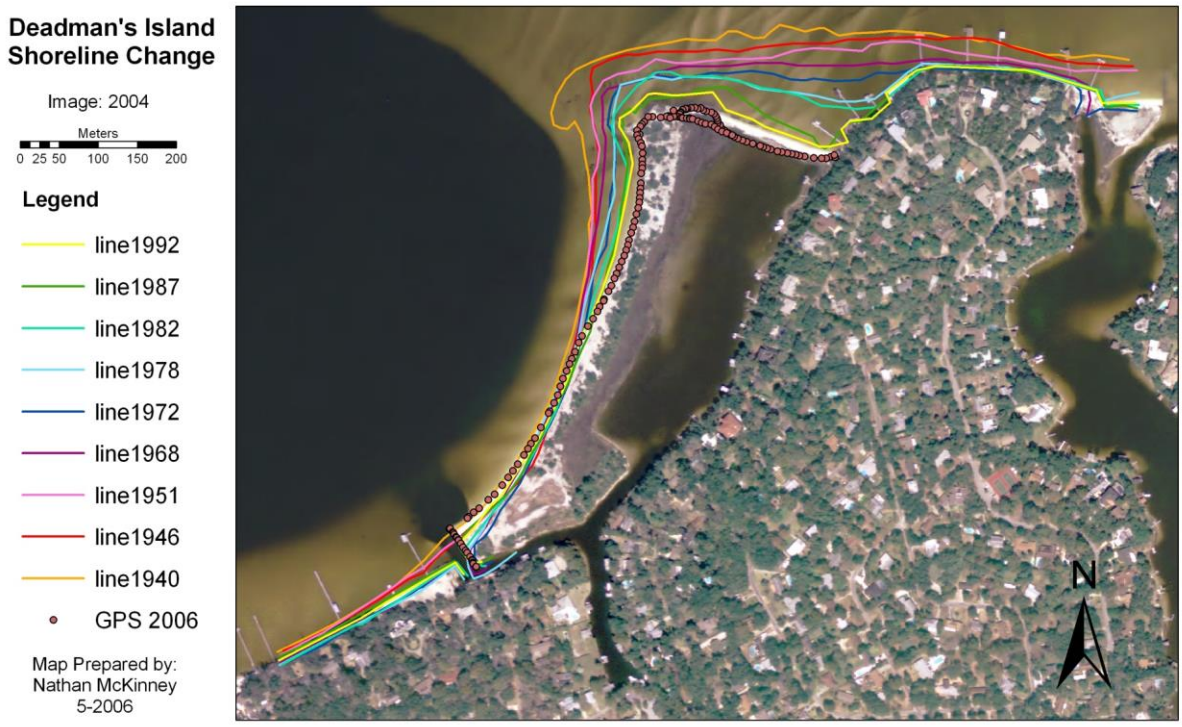

Figure 2: Shoreline Change over time dating from 1940-2006

3.1 Side Scan

The Marine Sonic side scan sonar digital data acquisition system operated at 1200 kHz. The sound frequencies typically used in side scan sonar surveys range from 100 to 1200 kHz. The higher frequencies yield better resolution but allow less side view range.

The FGS conducted the survey using a 1200 kHz tone fish set at 20 m side image, imaging a 40 m/131.2 foot wide swath. The intended centerline to centerline distance was 15.2 m/50 feet. This resulted in substantial overlap with each adjacent line and insignificant redundancy in coverage. Measurements were taken in the cove using a deep water system (Fig 2), and the measurements were taken along the subtidal floor with a shallow water system (Fig 3). The range of depth inside the cove was 6 foot to 17 foot. This is an acceptable depth for marine construction equipment to access the area to deploy the breakwaters or transport equipment to Deadman's

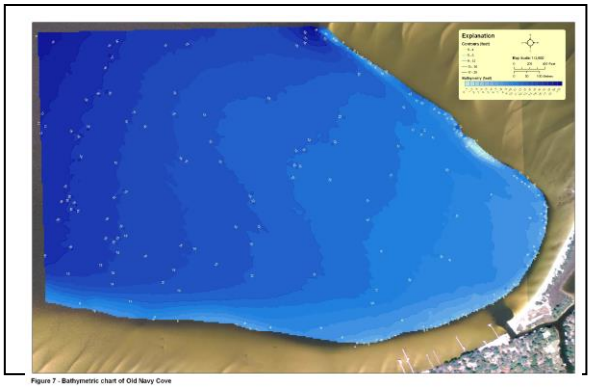

Figure 3: Depth readings of the cove adjacent to Deadman's Island

Island.
The shallow water side scan scanned the entire area where the proposed breakwater footprint was proposed. The idea was to avoid and protect as many natural and historical resources as possible.

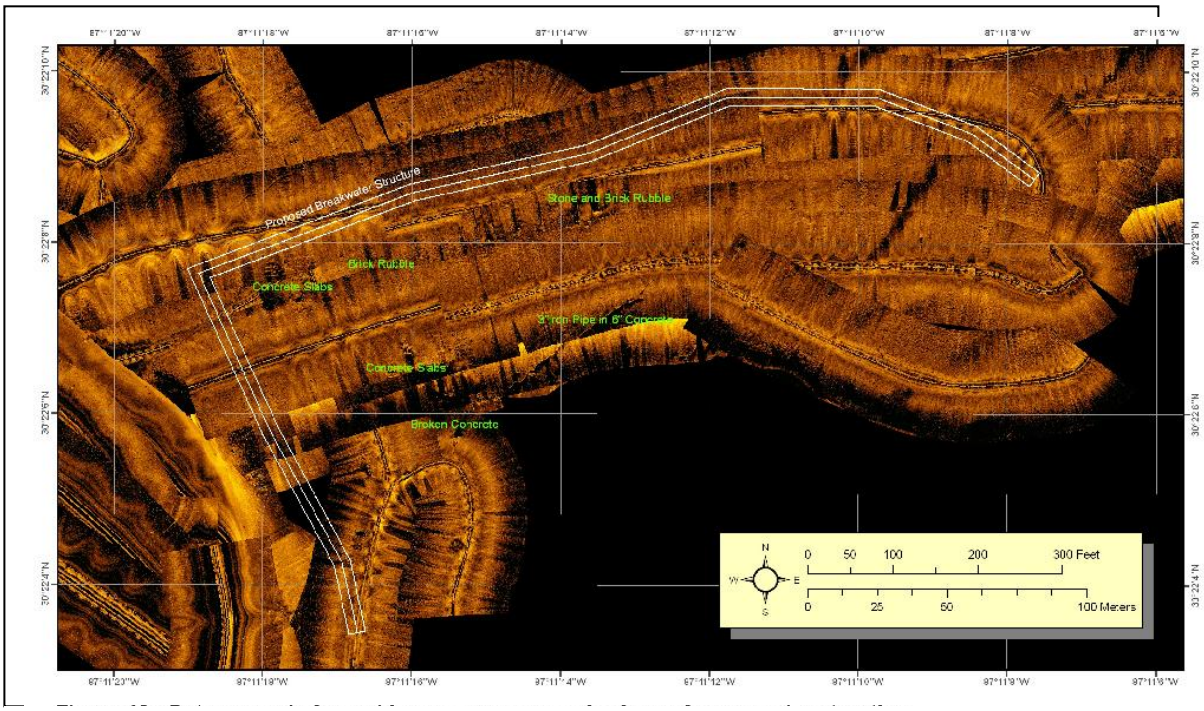

Figure 4: Side scan sonar and magnetometer survey to identify any anomolies present on the site area to determine the placement of the protective breakwaters.

FGS used a backpack based GPR system modern, all digital, fiber-optic data transfer. GPRS allows rapid analysis of shallow strata and the DPR registers differences in ground electromagnetic properties much as seismic does acoustic properties. Two transects were taken from the north end of the isthmus to the sound end which contains the existing spoil site of dredged material from Gilmore bayou channel mouth (Fig 4).

The GPR showed several anomalies in the area of the unmarked cemetery on Deadman's Island as well as several anomalies shaped in

Figure 5: Ground penetrating radar transects on Deadman's Island

which could be middens or additional graves (Fig 5). These areas were documented and placed in consideration of additional protection from erosion or avoidance.

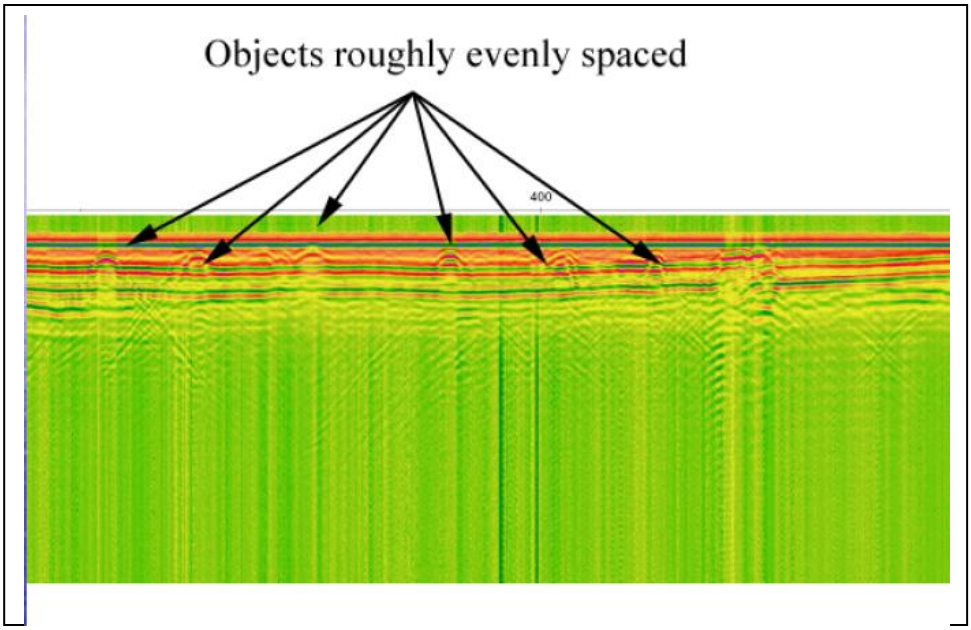

Figure 6: Anomalies found verifying the presence of additional historical resources

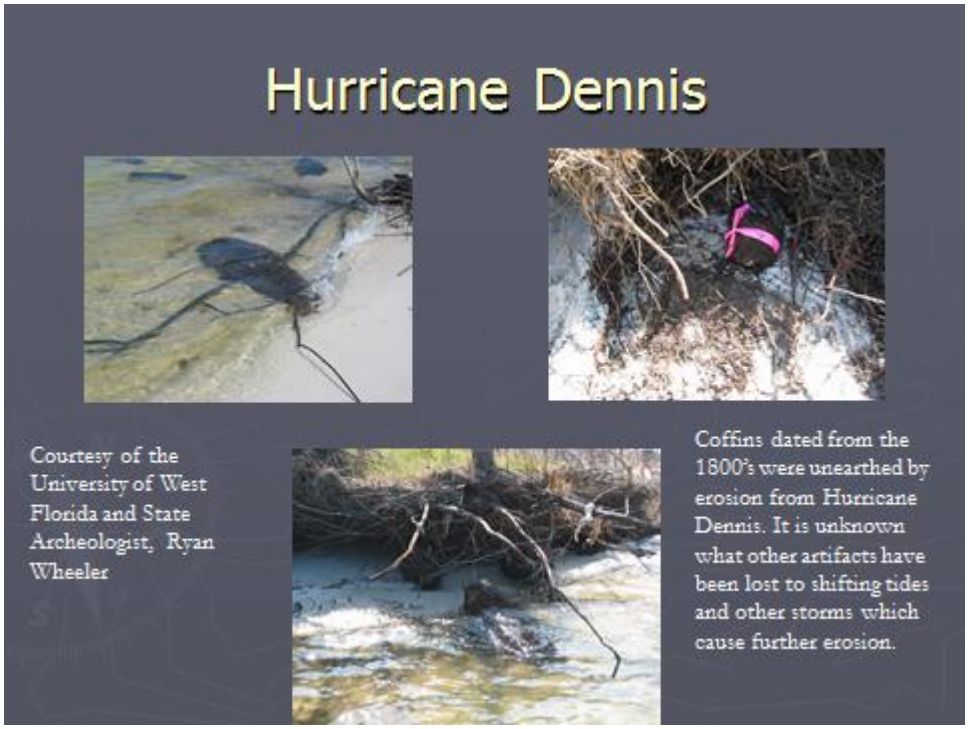

Figure 7: Coffins exposed in 2005- revealing an unmarked cemetery of a Yellow Fever Quarantine Station on Deadman's Island

3.3 Granular Metric Survey

Graphical comparisons were done between the GSD curve of samples collected from Vibra cores taken from potential borrow sites containing natural sand which, has been transported by the littoral drift of various locations in north Pensacola Bay.

Grain size analysis were conducted in several areas of on Deadman's Island, including the spoil site located on Deadman's Island and also, Woodland Bayou. Woodland Bayou has an all sand spoil site which is 0.8 mile from the Deadman's site, and because it is in the direct littoral transport path of Deadman's Island, was the preferred type of spoil to use as a beneficial use of dredged material. Beach samples were collected from the North end of the island peripheral to the area to be remediated (SRV – 06 thru SR B – 09). Samples, (hammer cores S RBC – 01 and S RBC – 03 and vibracore be as RB – 08), were collected in the area to be remediated off the North end of the island.

Results:

All tests showed compatibility, but the laboratory chemical tests showed the cleaner sand and free of any chemical compound was the Woodland Bayou site. This is understandable, due to the percolation over time, since 1970, when the spoil was first placed. The Gilmore Bayou spoil was placed on site every few years. In addition, the Woodland site was filled to its max permitting height and was overflowing in the adjacent salt marsh. Therefore, the Woodland site was more beneficial not only for Deadman's Island but also for the homeowners of Woodland Bayou who needed their channel mouth dredged where the spoil site could not be used, as it was filled to its max capacity.

3.4 Bathymetric

A baseline bathymetric survey was performed using a professional surveying company. This survey will give insight to the existing bathymetry of the breakwater footprint area and the surrounding areas behind the breakwaters. Bathymetric surveys are taken after placement of each structure set to measure accretion, subsidence or scouring.

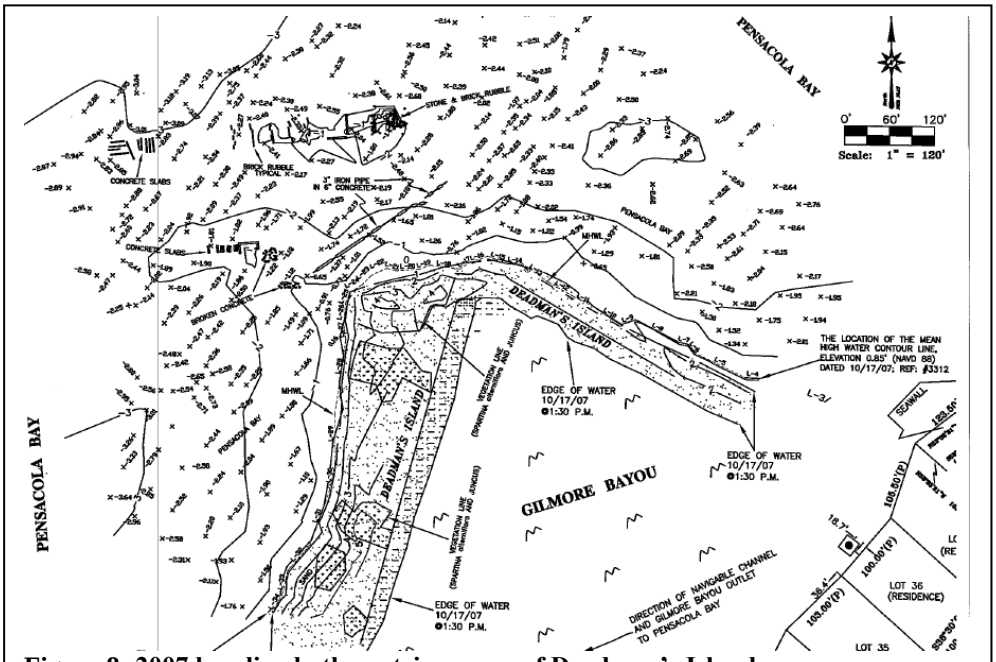

Figure 8: 2007 baseline bathymetric survey of Deadman's Island

To understand the impact, the shoreline was being subjected to, it was important to identify the shear stress regimes and shallow micro-mesotidal systems of Pensacola Bay. The fetch, ranging from 11-12 miles originating from the northeast increased in speed over various of depths before approaching Deadman's island. Historical wind data from the NOAA database showed what is currently happening as far as the winds speed and gusts. The NOAA information helped discern where the currents and sediment transport are originating from and traveling throughout the bay. On average, wind gusts range from 10 to 15 kts; however, the fetch is the critical factor. There is an 11 mile fetch from the Northeast, and a 3 to 4 mile fetch and the rest of the area. The 11 mile fetch depending on speed, current and the wind is the most damaging to the peninsula. This impact is due to water elevations below mean low low water (MLLW), when an increase in fetch is counteracted by an increase in depth so that the average bottom shear stress and erosion potential is maintained constant. For elevations between MLLW and mean sea level (MSL), the increase in water depth dominates the increase in wave height, thus reducing the bottom shear stresses. In other words, the longer the waves travel with a fast current and shallow depth the increase in shoreline impact.

Immediately after deployment of the structures, the underwater current and the heavy wave impact ceased. The erosion along the shoreline did decrease and was verified by erosion stakes placed along the shoreline. There has not been enough funding available to complete the entire breakwater project outlined in the permit. However, the first deployment of breakwaters showed how effective the structures were to stop the fast flowing underwater current, which can reach speeds up to 8 kts, depending on the wind parameters and impact portions of Deadman's Island.

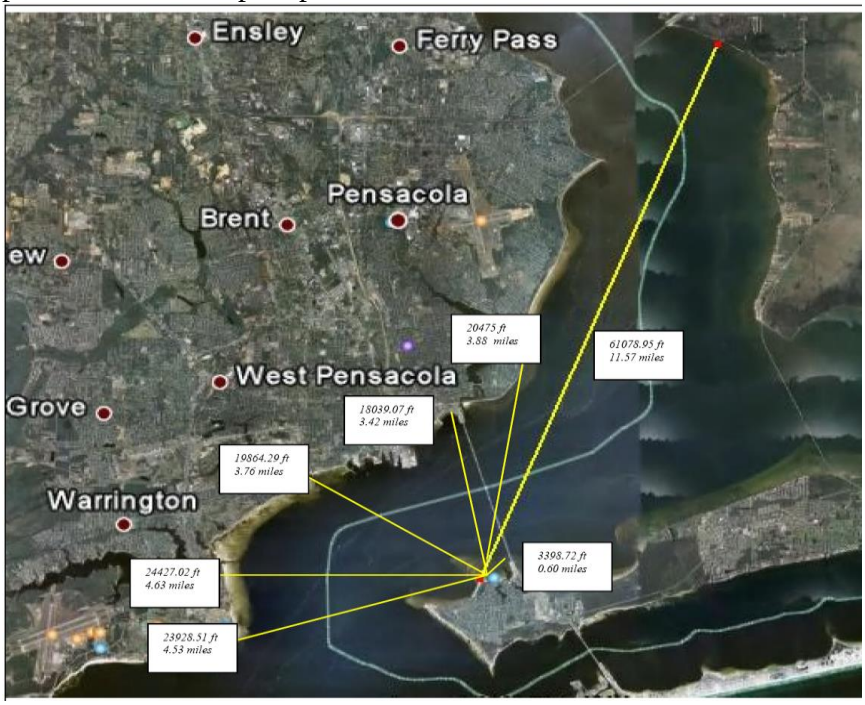

Figure 9: The fetches within Pensacola Bay impacting the shoreline of Deadman's Island.

3.5 Designs and permitting

Several designs were created to protect Deadman's Island, the adjacent salt marsh, coastal habitat and historic structures. Riparian rights, lease guideline, navigational channels and adverse impacts were addressed in the first phases of the permit. Since this was a coastal ecosystem in a bay, it was difficult to apply all the wetland permitting guidelines to this project. In addition, a legal issue with a homeowner dictated the final design. The permit was almost denied by the State. Political influence from the State Representative, public interest, and science were the main factors in the permit authorization. In the end, this was the first case where FDEP legal, other homeowners and the City of Gulf Breeze came together in a court case against the objecting homeowner. The lesson learned in this case was the value of educating our homeowners of particular projects.

The homeowner initially agreed to the project on the stipulation in which the closest breakwater ~350 feet from their property be removed (Fig 8). This was proven at a later date, to be a destructive decision, for the project, and the permit was modified, to add the east breakwaters, as originally planned.

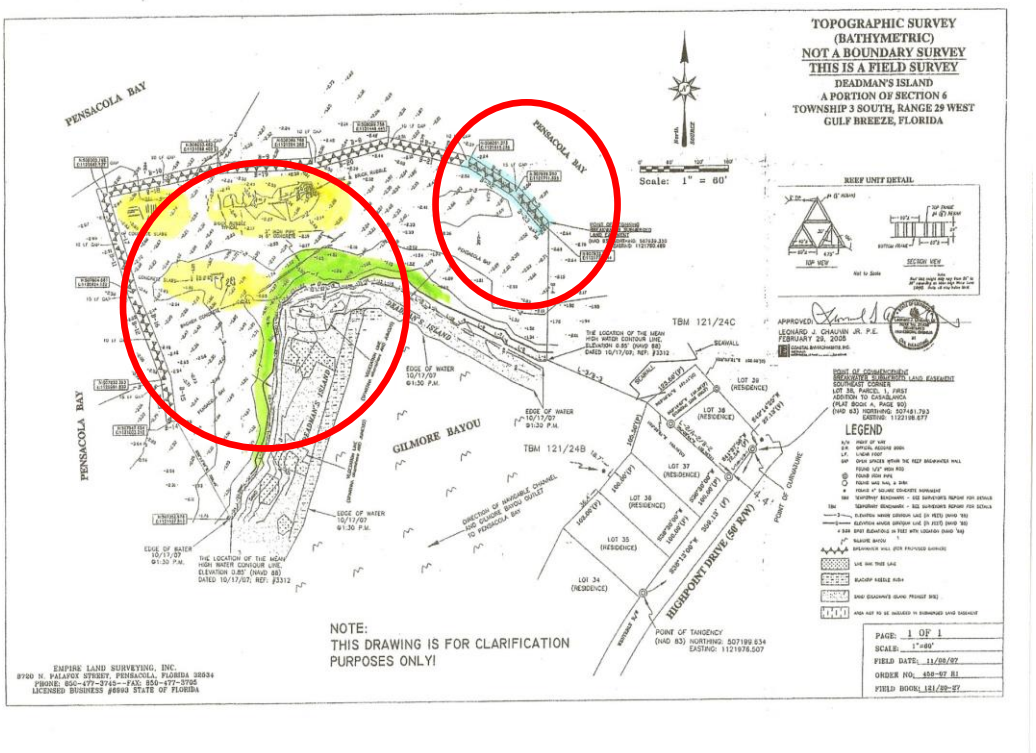

Figure 10: The agreement between the homeowners and the City of Gulf Breeze. The areas circled were areas of concern. The blue color the right is the breakwater agreed to be removed and the yellow area (left) is where the fill was to be placed.

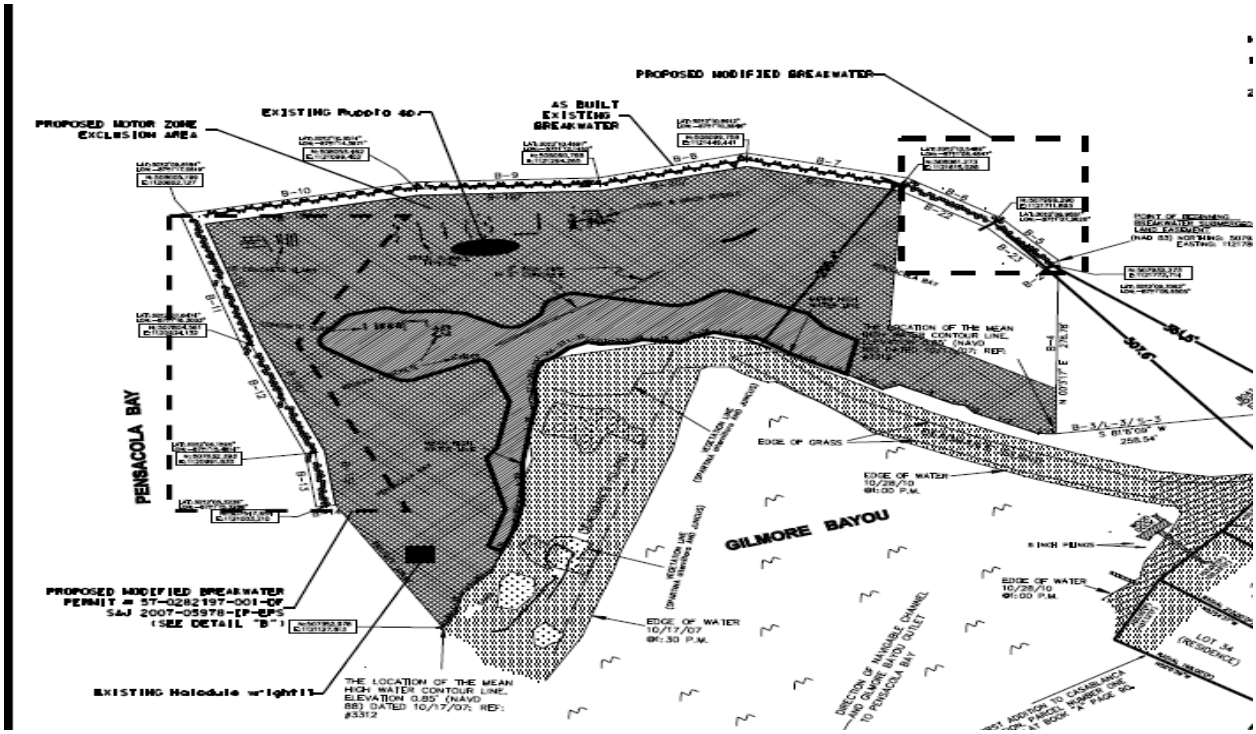

Figure 11: The final design of all phases of the restoration project.

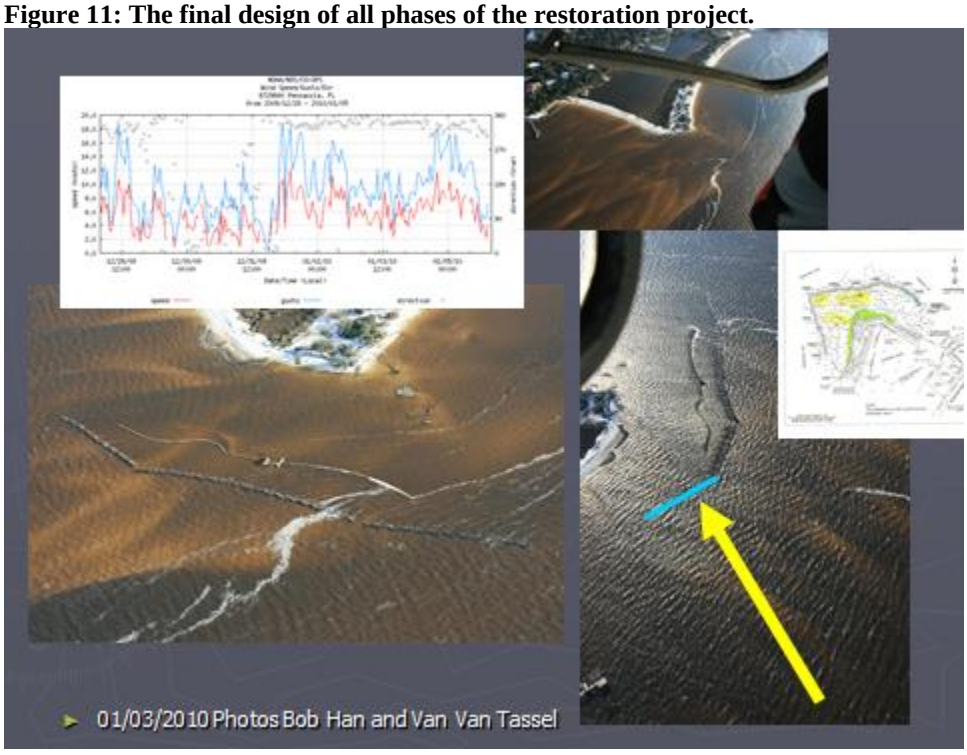

Figure 12: An aerial of the phase 1 rebar breakwater a year later. This photo showing the wind and current from the northeast (right), showed the wave action impacting the shoreline and therefore, the need for additional breakwater as originally planned.

4.0 Project Progress:

4.1 Breakwater

The ideal breakwaters for this project were offshore vertical oyster reef breakwaters. Vertical breakwaters allow more circulation and less chance of being smothered by sedimentation as dumped or bagged oyster shells. Dumped or bags oyster shell are usually so dense; circulation does not occur unless the bags are alternately spaced. There was also a risk of hurricanes scattering the reefs and creating more maintenance. The first reef was more economical and many lessons were learned before using another type oyster habitat vertical reef system.

4.1.1 Reefblk

The Reefblk units were funded by NFWF, Five Star and US Fish and Wildlife. These were the first breakwater units placed at Deadman's Island within the permitted breakwater footprint. Geofabric was placed under these structures. Behind the breakwater the geo fabric was weighed down and in front of the structures, waterward, the fabric was left to move up and down in the current.

Figure 13: These rebar breakwaters designed by Coastal Environments were required by the regulatory agencies, to be placed below mean high water as opposed to above mean high water as the later breakwater design

These breakwaters were required by the regulatory agencies, to be placed below mean high water as opposed to above mean high water as the later breakwater design. The mesh bags were filled according to the height of the unit and tamped to prevent settling. The shells in the bags settled as the crane lifted the unit and placed it in the water on the subtitle floor. This settlement caused a reduction in height of the breakwater. For example, 33 inch tall structure had a settlement on average from 3 to 6 inches. The bags expanded in width but lost height. Depending on the depth of the water the height would determine the effectiveness of wave attenuation. The shells in the bags settled as the crane picked up the unit and place it in the water on the subtitle floor. This settlement

Figure 14: Oyster coverage March 2010

caused a reduction in height of the breakwater. For example, 33 inch tall structure had a settlement on average from 3 to 6 inches. The bags expanded in width but lost height.

4.1.2 Anchoring system for the Reefblk rebar reefs

Hurricane stability is important when it comes to offshore reefs within Pensacola Bay. Reef structures can topple or roll on the subtidal floor without some sort of anchoring. This lack of anchoring, along with hydrologic impact, not only reduces wave attenuation, but can be a marine hazard with boats and can be costly when trying to retrieve, relocate or dispose. The anchoring system was designed and is a trade secret by ECS to allow enough flexibility to prevent the anchoring system to rip out of the ground and work only in storm situations. The anchor system of the reefblk is comprised of two methods. The first method use manta anchors which twist into the sand and have three cables attached to the anchor. The anchors are located in the center of each rebar unit and on the outside of every other unit. The system was designed to provide a resistance when the unit would start to topple or raise off the ground. The second system was an interlocking system of 12 foot of rebar pounded into the ground and interlocked between two rebar breakwaters.

The anchor system was designed to only work during storms. Meaning the cable system tied to the auger anchors were not adding resistance constantly, until lifted by force. Each breakwater is triangular, 33 inches high and 5 feet on both sides. Each breakwater is secured on the inside and outside with cables, ties to anchors. In addition, rebar, was placed in between the ends of the structures, to adjoin the units together.

The cable anchoring system was very effective during many storms. The interlocking system was just as effective, except after a few heavy storms and storm surges maintenance was needed to readjust any rebar which was pulled straight up out of the ground. Out of 400 rebar interlocking systems, only 15 of them needed readjusting after the storms.

Hurricanes should not be a concern for an offshore reef because the water levels increase in height and the wave action moves over the structure and the natural land, rather than directly impact at MHW. The main concern for the erosion of the shoreline and reef structures are rogue surges and tropical storms. Rogue surges are a strong and steady wave which is the normal water level height and causes scarps and directly impacts the reef. This direct impact causes the anchored Reefblk to lift off the tidal floor and slam back down. A strategic anchoring system is used to prevent the Reefblk from rolling and also interlocks the reefs together.

An example of the sustainability of the system was Hurricane Ida. Ida was reduced to a tropical storm. A low tidal tropical storm provides the most impact to the project over the impact of a hurricane, to the offshore, shallow depth, wave breaks. Ida gave the perfect opportunity to test the structures due to the gust and wind direction changing throughout the storm. Ida's wind direction came from the west and then north, east and south. The

structures had an opportunity to be tested. Over a four day period, the structures were lifted in various directions and the wave action constantly pound the reefs. There was no difference in the size of the structures whether they were single units or the mega units, consisting of three structures welded together. In fact, the larger structures were sinking. Even though there was accretion and beach pockets behind the breakwaters there was scouring where there was no geofabric in front of the breakwaters, facing North. These mega unit breakwaters are subsiding into the waterward side, yet the water depth remains the same, the landward side is gaining accretion, therefore; the water depth is decreasing.

Figure 15: October 2013 - algae covered bags within the rebar structures.

Depending on the depth of the water the height would determine the effectiveness of wave attenuation.

The Reefblk continues to lose shell within the bags due to wave action. Since the shells are being tumbled and worn to a smaller size, the wave break height is decreasing.
As of October 2013, The bags are still covered with algae present in 2012. The algae prevents any spat from adhering to the bags. The live oysters, which are present, are on the top portion of the rebar inside the breakwater. Monitoring involved measuring the shell height in every bag on each side of the unit. Some bags are cable tied and others are not. For example, the unit has three sides and each side has three bags. Every two units are mirrored with the back side facing either land direction or water waterward. Every unit has an east and west side. A measuring stick is placed in each of the three bags and the distance to the top of the shell to the top of the bag was measured. For monitoring, each unit has a numbered tag attached and there random fixed quadrat on selected units.

Figure 16: 2012 -Reefs completely barren and all oysters are no longer attached to the mesh bags. which creates an ineffective breakwater.

Figure 17: November 2013 The loss of shell inside the mesh bags of the rebar breakwater units.

Figure 18: October 2013 Monitoring surface area using fixed quadrats of the rebar Reefblk reefs. Fixed quadrats have been present since 2009 for QA purposes when monitoring.

5.0 Experiments

5.1 Hypothesis – There were several hypotheses when planning the experimental design of the rebar breakwaters.

The oyster growth would increase each year and form a strong solid structural breakwater

Results: Upon deployment, the breakwater immediately stopped the under water current eroding the north end of Deadman's Island. This wave break did increase the population of native oyster habitat by providing a foundation for a natural oyster reef made from recycled oyster shells. Immediately after placement of the reef in 2008, there was spat settlement. This settlement occurred because of the temperature change in the water two weeks before deployment. This temperature change caused an oyster spawning event, most likely from the stock in East Bay, since the currents flow straight to Gulf Breeze. The fresh shell was a perfect substrate for the spat to detect by chemosynthesis

5.2 It was also hypothesized the shell in the open bags would have lost more shell than the closed bags.

Results: The 2013 results showed no difference in shell loss with closed bags versus the open bag. The shell loss in both type bags were the same. Tumbling in the bags through wave action was observed. This tumbling wore the shell to a smaller size and could fall through the mesh. Evidence of oyster "gravel" is present around the reef.

5.3 In addition, another experiment was scouring versus accretion and the anchoring of geo cloth versus non anchoring.

Results: The geocloth located under a portion of the structures waterward of the rebar breakwater units, was not weight down and was allowed to flow and move freely underwater**.** This constant movement has not allowed sand to settle or weigh down the fabric.

5.4 Oyster growth inside of the rebar units would be more than the growth outside of the rebar unit.

Results: Monitoring showed there was more growth inside the oyster units. Inside the oyster units provide a light turbulence and circulation. This turbulence is substantially less than outside of the unit which is high impact waves and current. Inside of the breakwaters were more ideal, food for the filtering is more isolated inside the structures for the oysters and overall, promoted for rapid oyster growth for the season.

5.5 The five larger mega unit breakwaters would be more effective as wave attenuators.

Results: The larger units caused more subsidence than the smaller units- most likely due to increased weight from the unit which was three units welded together. One unit weighs over 400 lbs when filled with shell. A megaunit would be 1200 lbs. These units were developed with foresight in the event of a hurricane. The larger unit did not move during the hurricanes and heavy surges, however; it is sinking. The lesson learned is the larger the mass placed on sediment and geocloth, the more likely subsidence will be encountered. It is better to use smaller spaced out units.

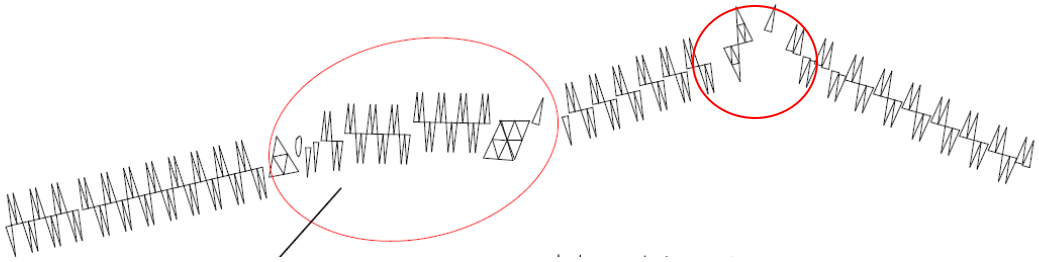

Figure 19: The Reefblk unit layout on the north end. The units within the red circle are the megaunits where three individual units were welded together to make one large unit. These units were larger and heavier and accretion developed the fastest with the units but also subsidence occurred on the waterward side due to shear weight.

5.6 Fisheries would increase from the presence of the reef

Results: This oyster wave break structure did provide a marine habitat for large fish and marine organisms upon deployment. Immediately after deployment the fish population increased 60% on the reef two days later.

5.7 The oysters would recover after a die off from the unexpected impact of the Deep Water Horizon timeframe.

Results:

During the deep water horizon oil spill, area fish began to show red skin lesions and die off. Once the fish died off, there were no "janitors" of the reef to control the algae or

predators. Although the oysters' tissues began to show high PAH levels of crude oil chemical compounds in their tissues by the end of 2010, in 2011, there were no oyster tissue to test. The algae was very bad on the reef as well as the predators. It is speculated since there were lots of algae blooms when oil was reported in the bay, the algae uptakes the hydrocarbons in the oil and grows rapidly, such as marine miracle grow. This algae outbreak continued even in the colder months. Oyster spat could not settle on the bags or the remaining shell. In addition, any oyster spat which settled on the rebar of other non algae covered structures, did not get a chance to survive. Even when the fish population began recovering in 2012 and began prey on the oyster predators, as of 2013, the oysters did not recover from the complete die off. The indirect impacts of the events of 2010 and 2011 were too great. The lack of recovery is partly because there is no shell for the oysters to settle and non-beneficial brown algae has covered the units' bags. This algae prevents the oyster spat from settling. To remedy the situation, adding additional oyster shell was considered, however; there is a serious health and safety issue when working around an established and fouled reef. Barnacles, rusted metal, other oysters in the area can carry vibrio when the temperatures are warmer in the water. Vibrio vulnificus is a gram – negative bacterium, is dangerous not only for consumption or assimilation, but dangerous when exposed to open wounds and saliva, which is common out in the field. A person with a low immune system exposed to vibrio can be fatal. After seen many accidents through monitoring and being around the oyster reefs almost on a daily basis, refilling the bags with oyster shell on a fouled reef, is not advisable. In addition, this would be costly in the long run due to ongoing maintenance in case of another oyster die off. Even though the State health department says vibrio can be contracted by ingestion only, emergency room doctors and biologist, exposed to vibrio without ever eating and oyster and have been hospitalized, will have a different view.

5.8 The original theory speculated, since the waterward side is exposed to wave action AND a strong North east underwater current, the shell height of the water ward side would be substantially lower in comparison of the shell height facing other directions.

Results: As of 2013 monitoring, there is no significant difference in relation to direction versus loss of shell inside the bags. Recording datum from all breakwaters and shell loss in each bag, 1270 points were created to substantiate replication and counteract any outliers. .

5.9 There would be no different in settlement preference of the fossilized shell versus the recycled oyster shell

Results: Monitoring data shows there is no significant difference between fossilized shell and recycled restraint oyster shell. Recording datum from all breakwaters and shell loss in each bag, 1270 points were created to substantiate replication and counteract any outliers. However; the fossilized shell does not appear to break down in the wave action as much as the then recycled shell. The fossilized shell sometimes are larger than the recycled oyster shell and therefore, has a higher amount of surface area than recycled

shell. Fossilized shell is recommended for higher wave impact projects, because fossilized shell can tolerate higher wave impact churning.

5.10 The reef units will increase the bird population. Oyster shell would wash on the beach, creating a nesting site for some birds.
Results: The oyster reef provided a feeding and perching area to the area shore birds and migratory species. Oyster catchers, night herons, heron and pelicans were perched on the reef and ospreys were feeding around the reef. There were no oyster shell washed on the beach significant enough to create a nesting habitat.

5.11 The Geo fabric will prevent subsidence. The Geo fabric which is not weight down will not allow accretion.
Results: The fabric placed on waterward side is still moving with the current today and no accretion has occurred. With the larger units, the geofabric did not prevent subsidence, however, the geofabric did reduce the rate of subsidence.

5.12 Water quality will improve. Water quality test results have remained the same. There is no difference in the results when the baseline was tested until now in 2013. This is partly because the reef is in an open system within the bay, which is constantly flowing and cannot be isolated for testing. Tissue testing has shown to be successful, in understanding what oysters are filtering from the bay. Although, oysters do filter the water in a closed and semi closed system, it is unlikely the oyster can contribute to filtering of the entire bay. The ratio of oysters in relation to the size of the bay is not proportional to the depth and size of the bay area being filtered. However, there are other benefits to having sustainable live oyster reefs in the bay. The seed spat from this project can be transported to areas which are semi closed and help maintain filtration in other areas of the bay. The reasons this point is introduced is because millions of dollars are proposed to spend in dumping oyster cultch in areas in which oysters will not survive, due to sediment or salinity regimes, nor are needed in an area. Most importantly, the use of natural resources in areas which won't sustain the oyster reef ecosystem, is a waste of natural resources, money and risk to the overall oyster seed population. Understanding and being educated in the site area, being able to consolidate the shell in one location and provide additional water column habitat is better use of using natural resources.

5.13 The anchoring system would prevent the structures from rolling over during hurricanes.
Results: The anchor system for the Reefblk has held in placed during many normal storms and tropical storms. Hurricane Ida 2009, Tropical storm Debbie 2012, and several rogue surges gave the opportunity to see how the anchoring system would hold out with the winds coming from the various directions and set short time frames. During hurricane Ida, the winds came out of the Northeast, lifting the structures repeatedly for three or four days. Four of the 200 rebar poles were lifted about four feet, out of the substrate, however; no units were flipped or anchors pulled out.

5.1.1 Reefblk overall summary

The breakwater provided an additional safety measure in the protection of the salt marsh and new habitat. This project did demonstrate the ability to combine a successful technique of creating vertical reef habitat to dissipate wave energy, and to create essential fish and bird habitat. The concern with these structures is the reef is live oyster dependent and in the event of a die off, the reef may no longer function as a wave attenuator, leaving the shoreline vulnerable to erosion, once more. Die offs can be catalyzed by anything that upset the microbial community, from salinity, to pollution, the effects of the recent oil spill, to predators such as oyster drills. Non-predators such as algae or sediment can also impact the sustainability of a live oyster reef by smothering or prevention of spat settlement due to the inability to adhere or grab on to normal settlement substrate.

The breakwater provided an additional safety measure in the wetland and new habitat creation. This project did demonstrate the ability to combine a successful technique of creating vertical reef habitat to dissipate wave energy, and to create essential fish and bird habitat. The concern is this reef is live oyster dependent and in the event of a die off, the reef may no longer function as a wave attenuator, leaving the shoreline vulnerable to erosion, once more. Die offs can be catalyzed by anything that upset the microbial community, from salinity, to pollution, the effects of the recent oil spill, to predators such as oyster drills. Non-predators such as algae or sediment can also impact the sustainability of a live oyster reef by smothering or prevention of spat settlement due to the inability to adhere or grab on to normal settlement substrate.

The certain portions of landward (South) side of the structures have Geo fabric underlay which is weighed way down with concrete block, to allow the build up of sand. Half of the structure, waterside (North), underlay is not weighed down and is allowed to flow freely. Erosion pins have been placed to monitor accretion. There has been no accretion on the Pensacola Bay waterward side. It would suggest the free-flowing Geo fabric is preventing the accretion and also verifies the lack of sediment transport on the Bayside. It is suspected the depth between the breakwater structures and land is decreasing and causing the most accretion on the back side (land word) of the structures.

The unit height is consistent at 33inches, with bags averaging 30 inches of shell height. These units are below mean high water; therefore, wave attenuation is difficult to compare as the breakwater sets in more than 4ft of depth. The reef consists of a shallow, middle and deep section- oyster growth is different in each area. Since oyster growth is more prevalent on the inside of the units rather than outside, there was a concern of the rebar breaking down as the unit begins to rust and weaken; the units may collapse from the sheer weight of the growing oysters and lack of structural support. It is not certain, how long it will take for the rebar to rust, when exposed constantly to saltwater and air on an inconsistent tidal basis. The need for future maintenance of these structures would be ongoing and costly.

Spat settlement occurred within two weeks of deployment. This type of sediment is not typical when deploying reefs. There was a concern on the day of placement, tropical storm Claudette came through the day before the structures were placed. There was a concern Claudette caused an early spawning event. After reviewing the temperature trends and other journal articles, it was determined May and late October would be spawning dates. However, there was a spike in temperature two weeks before unit deployment. The temperature raised to 105° according to the NOAA charts. This extreme temperature increase was not cross referenced with other weather resources because either way, it was obvious there was at least a 10 degrees temperature change.

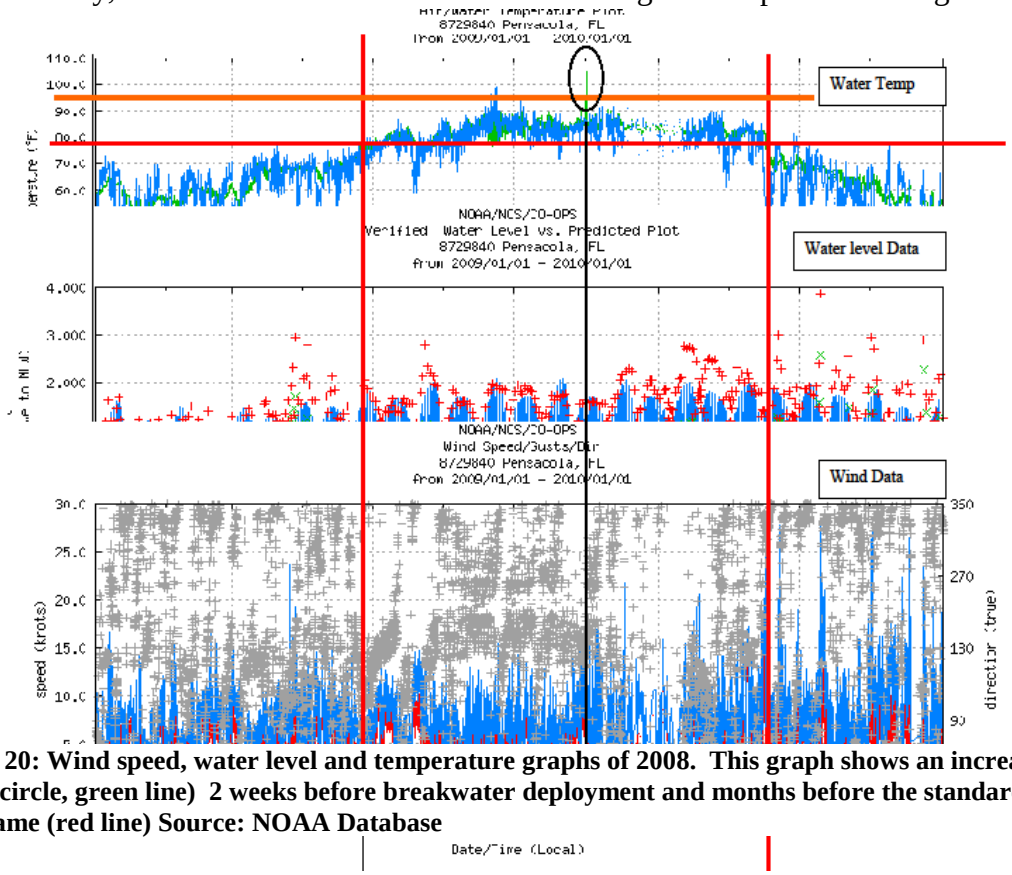

Figure 20: Wind speed, water level and temperature graphs of 2008. This graph shows an increase in temperature (black circle, green line) 2 weeks before breakwater deployment and months before the standard spawning timeframe (red line) Source: NOAA Database

Even though, documentation addresses show spawning occurs in the spring and fall, it has been observed, in this area, when there is a 10° temperature change, a spawning is triggered. Oyster's ideal condition of salinity is between 10 to 15 parts per thousand in the temperature of 68 to 78°. This temperature change occurred two weeks before the structures were deployed. Therefore, spat was already in the water column of the day the units were deployed. Due to an early spawning in the summer, if we had not deployed in this timeframe, the next spawning event would be predicted as spring instead of the upcoming fall. It is speculated the fall spawning would not have occurred.

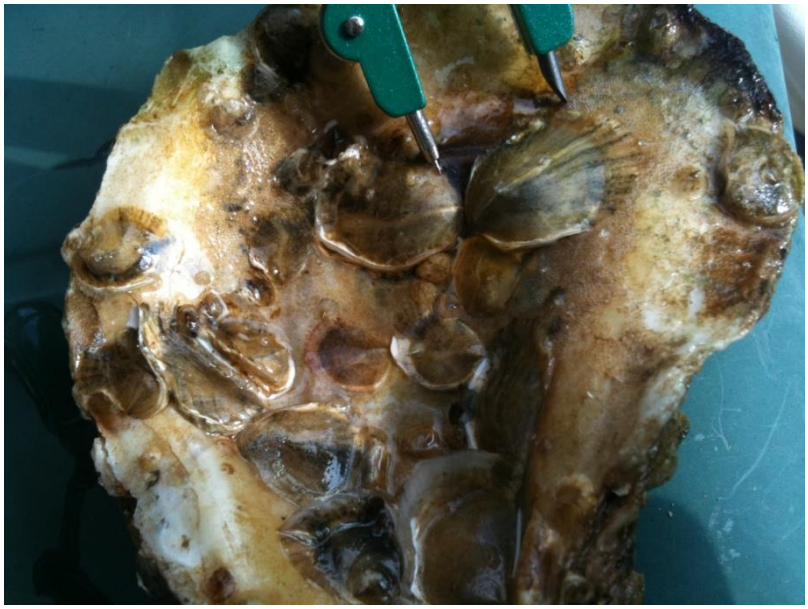

Figure 21: Measurement of spat, two weeks after breakwater deployment

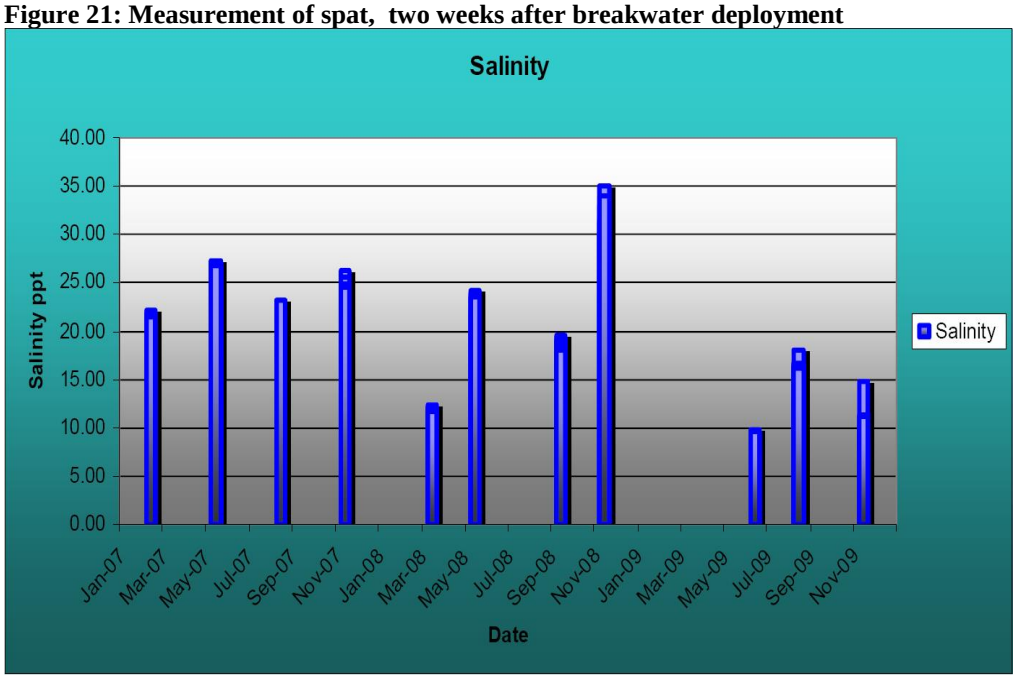

Figure 22: To determine possible health/stress problems in the new oysters, historic salinity trends were observed for 2007 and 2009. The salinity was ideal for oyster growth and no predators during the year of deployment

Although variable factors determine the success of this breakwater, overall in a perfect controlled setting, this is a very effective breakwater. Meaning, if this breakwater was placed in an area of ideal salinity and can sustain live oysters all year round, this would be a feasible breakwater.

5.2 Breakwater Phase 2- Ecosystems discs- deployed July 2011

Phase one of Deadman's Island has the Reefblk design oyster rebar structures. Due to this project being 240 ft offshore it was determined to pilot another type structure to be used as a breakwater and reef.

The decision to create a stackable, non- live oyster dependent reef, occurred after the observation of the die off of the first oyster reef and the decrease in wave attenuation of the over-all structures. It was important to have a structure that promoted more oysters, than bagged shell, promoted more fisheries and a stacked oyster reef and in case of any environmental impact which would kill off oysters, the structural integrity of the wave break would not be compromised. It was also shown by the first wave breaks, breakwaters subjected to high wave impacted area and long fetched should be placed above mean high water as opposed to below mean high water. The scientific information helped with the authorization of the new permit modification for the new design above mean high water.

There is a strategy of knowing how to prepare an area for spat settlement for oyster growth. There is a traditional way of dumping shell and hope something grows or prepare an area to attract the right "maintenance" species to protect the newly settled spat. The plan was to reseed the pre 2010 existing oyster reef, using a new breakwater by Reefmakers, with minor modifications by ECS, to counteract the problems observed with the Reefblks over time. The problems with reseeding, were fluctuating salinity trends, which may inhibit healthy oyster growth, the height of each breakwater was the same, but the depths were different. There was a deficiency of the breakwaters below mean high water in various depths and less anchoring. The Ecodiscs were stacked according to the depths of the water. Pearson pilings, solved the anchoring dilemma and subsidence is not likely to occur, due to the collar bolted to the piling. The Ecodiscs molds were filled with fossilized and recycled oyster shell and the design. Each tier had a space to promote water flow. Reefmakers later modified the unit design to contained a leg system which allowed more space for habitat but the legs also attenuated and deflected the waves.

The EcoSystems uses pilings to anchor at least seven feet into the ground Each unit has a hole in its center. A sturdy piling is driven into the ground. Ecosystems are stacked on the piling layer by layer until the desired height is reached. The piling has a stop-device to prevent the EcoSystems discs from settling vertically into the bottom. Ecosystems cannot move up, down or sideways on its piling, where water can escape under the unit.

Funded by South Eastern Aquatic Resources Partnership (SARP) and US Fish and Wildlife, the ecodiscs were created. The original ecodiscs were used as artificial reefs and not as wave breaks. They were mostly concrete and limestone shell. The units at Deadman's Island were modified. The project manager, Heather Reed, contacted Reefmaker of Alabama and asked if they could modify the design to fit the

project. The modification to the design was to make the underwater reef structures, into wave attenuators, which stack according to depth. To add protruding oyster shell to the design molds where the units are covered in oyster shell, which create additional settling habitat for oyster spat. The manufacturer agreed and allowed the children of various schools create the prototypes. The first school was Little Flower Elementary students. The were called the "Little Flower Lillypads" Ecodiscs.

Figure 23: Little Flower school created the first oyster filled ecosystems manufactures by Reefmakers.

Figure 24: Student volunteers filled the Ecosystem mold with oyster shell.

Monitoring 1 year later

Spat and healthy oysters are growing, and healthy green algae, as opposed to brown algae is growing on the reef which is great food source for the oysters as the algae breaks down into small filaments. The juvenile fish were observed on various height levels of the stacked unit. For example, the stacked disc at the water level is teaming with small juvenile fish, the next disc down, the juveniles are bigger and underneath the last disc are the larger adult fish such as sheepshead, grouper, spadefish, snapper. This "nursery" system hierarchy appears to be more abundant than the Reefblks. the reefblks harbored larger fish in the deeper areas along the west side of the northern Reefblk reefs.

Often, most first settlement of spat are males, so it wasn't expected to have the Reefblks reseeded until 2013. Future monitoring on the Reefblks will be performed as funding is allowed.

The stacked tiered system offered a multitude of space for fish and crabs. The piling system was a very sturdy anchoring system which required no maintenance.
As lessons were learned, the designs changed three times, each time, adding better efficiency to the goals of protecting Deadman's Island.

Figure 25: Diver counting oysters and fish on the Phase 1 Ecosystems.

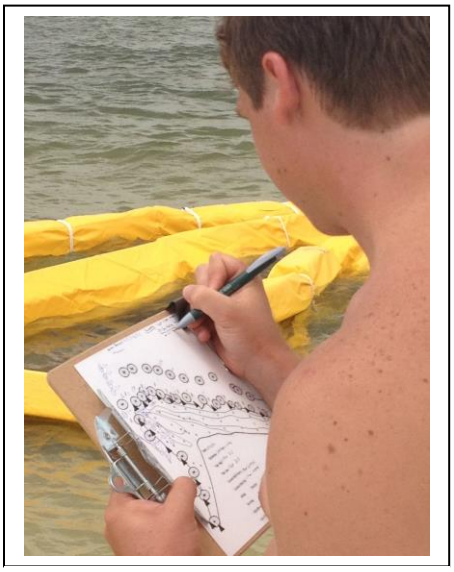

Figure 26: Student intern monitoring the barrier system daily for 4 months

5.3 Ecosystem 2012-2013 Results

The monitoring results in 2012 and 2013 show an abundance of oysters over the entire reef system. The oysters are not market size as of 2013. Every tier contained small juvenile fish of various species.

The "lilypad discs" were only about six inch spacing between tiers, eventually these tiers compressed in 2012 and 2013. In 2012, a new design was made to increase the spacing the between tiers for easier monitoring. These were called table top Ecosystems. These systems were round and had deflector pedestals, which increased the spacing between tiers. The deflector provided better wave attenuation and was still flow through and provided circulation.

Monitoring methods include SCUBA gear and a flashlight, waterproof paper and pens. Percent coverage of spat and oysters were measured, and the number of fish, crabs, oyster drills, coral, blennies and any other species found on the reef were counted and documented.

The new Ecodisc (Lilypads) were placed in front of a heavily impacted on the west end of Deadman's island where the storm surges and rogue waves have scoured out the root system of marine oak trees and exposed cemetary. This breakwater immediately stopped the high wave action and allowed the placement of coir logs and bio sand bag to prop up the trees and roots systems.

5.4 Ecosystems discs (Table tops) Sept 2011

The permit was finally modified to include the east breakwater which were subjected to a high impact fast flow current system originating from the northeast. These discs were deployed September 2011 to stop the 12 mile fetch impacting Deadman's Island. The new "table top" ecosystems were placed as well as the lilypad Ecodiscs. The monitoring events of 2012 are showing there is spat on the reef but not as abundant as the July West side Ecodiscs. This was expected. The West side area is only subjected to a four mile fetch and is more sheltered than the East side discs being exposed to the 12 mile fetch. Accretion is slow and is building but only around the structure units with the flat pad on the subtidal floor. The Ecosystems with the piling only has not shown any accretion nor scouring. This design would be ideal for Gulf Sturgeon concerns to reduce any chance of trapping fish behind the breakwaters.

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Figure 27: Two varieties of Ecosystems together- the left unit sits on the subtidal floor and the other system leaves the bottom exposed for better flow through and overhang fish habitat.

The 2013 monitoring events show an increase to 80% oyster coverage, a 90% increase in adults and juvenile fish. The stone crabs which control the oyster drill population, were found on every unit, and the largest stone crabs were found underneath the ecosystems. These observations show the new ecosystems with the

larger space in between the tiers are more ideal for monitoring rather than the lily pads.

6.0 Monitoring 2012 Entire Breakwater Footprint

2013 Monitoring results are addressed in the ACOE Estuary Act 2013 report. The ACOE Estuary Act grant has funded $13,000 for five years comprehensive monitoring report for a portion of the breakwater project, wetland creation and dune restoration.

6.1 Oyster Spat Settlement, Recruitment, Growth Rates, Predation, and Health

Figure 28-Divers monitoring and recording the spat and oyster settlement on the eastern and western Phase 2 Ecosystems reefs of Deadman's island

6.1.1 Oyster Spat Settlement Monitoring :

Sampling will look for absence/ presence-percent cover- size-species-disease (Functional) two weeks after placement, each oyster spawning, then quarterly, (every three months) for the first year. After the first year, sample twice a year every year for the next five years.

Monitoring results showed no settlement on the new Eastern Reefs but there was a small percentage of established settlement on the older Western reefs. Therefore, there is a possibility older oysters were present on the westside established reefs which contributed to more spat settlement.

6.1.2 Oyster Recruitment Measurement Method:

Sampling will examine percent coverage at random stations, evaluation of spat settlement measured at the time of placement and two-weeks after placement, then quarterly (every three months) for the first year. After the first year, sample twice a year every year for the next five years.

Monitoring results showed no settlement on the new Eastern Reefs, but there was a small percentage of established settlement on the older Western reefs. Therefore there is a possibility older oysters were present on the westside established reefs which contributed to more spat settlement.

6.1.3 Oyster Growth Rates:

A cash stock of oysters will be marked and measured and other stations will be used by the quantitative underwater ecological surveying techniques. Sampling will occur twice a year for a period of five years.

Oyster Growth Rates: There were no cash stocks to measure and compare to from the phase one reef, due to the die-off. However, new spat growth was found on the Ecosystems. The random oyster spat size was 0.25 inch to 1 inch in length.

6.1.4 Oyster Predation:

Evaluation will be done throughout random stations- using the point count method of the quantitative underwater ecological surveying techniques. Sampling will occur twice a year for a period of five years.

Predators – oyster drills were much less in 2012 yet still abundant in 2012, the predators for oysters drills are starting to return to the reef from the ecosystem die off in 2011. The Sheepshead, which are predators to oyster drills, showed an increase in juveniles and were more abundant this year than last. Crushed oyster drill shells were found all over the reefs and sub tidal bottom. The presence of crushed shells, showed the oyster drill population were beginning to be controlled by Sheepshead and stone crabs, unlike the previous year where there was a lack of.

Oyster Predation: Oyster drills, sheepshead and crabs

Success Criteria: The number of predators on the ecosystem will be less than or equal to the number of live oysters.
The success criteria were not met in 2012

6.1.5 Oyster Health:

Evaluation will be done throughout random stations- using the point set method of the quantitative underwater ecological surveying techniques. Sampling will occur twice a year for a period of five years.

There were no market size (<3") oysters to test for tissue or disease.

In the pre monitoring assessment in the Spring and fall spat season in 2012 showed the fall of 2012 has a 60% increase in spat than the spring of 2012. The was a 20% die off of the fall spat within two weeks. The Pensacola Bay is still trying to cover from the impact of the oil spill activities, which included the dredging of East Bay by poachers for live oysters. The oyster population was slowly dying off during in 2010 according to fishers testimonies, and in order to maintain their harvest quota, East Bay was dredged. It is unsure how much of the population was dredged, but the lack of spat on the reefs, can cause speculation the impact was greater than normal harvesting methods with tongs. This dredging activity impacted the spawning. Once the oysters begin to recruit, the male to female ratio must be established due to the oyster spat which do spawn are predominantly male, and after a few years the ratio is in balanced. It was anticipated 2012 would contain a recovery in spat settlement, however, a brief observation in the fall season shows the recovery may be balanced in 2013.

6.1.6 Oyster settlement-

The fall season showed no oyster present. When spat was found, it was normally dead due to predation of oyster drills and crabs. This is expected the first two seasons until the male to female ratio of oysters becomes balanced where the spawning and settlement rate increase and out number the predator population.

7.0 Submerged Seagrass Survival, Mortality and Coverage

Currently, the area seagrass patches have been mapped by GPS and the expansion project will begin in 2013.

8.0 Shoreline Vegetation Survival, Mortality and Coverage

Shoreline Vegetation Monitoring: Monitoring two weeks after placement, quarterly for the first year and after every major storm.

Measurements:

1. Survival/mortality percent coverage increase/decrease (Functional)
2. Measurement method- percent coverage (Functional)
3. Species composition-identify the species of seagrass within the sampled area and determine percent contribution of each species to the cover.

Timeline: First two weeks after planting, monthly for three months and twice a year thereafter for the next five years.

Species composition –Vegetation were a combination of Spartina patens and Spartina alternaflora 92% coverage over the entire site.

Measurements:

1. *Survival/mortality percent coverage increase/decrease- plants washed away at the West End point within three days after each planting.*
   When barriers were present, the plants along the shoreline lasted up to two weeks.

The emergent grasses planted in June, July and August, were ten feet past the shoreline were very successful in establishment. Storms impacted the grasses by washing sand over the grass. However,; the grass immediately recovered. It is expected the grass patches will increase in density in 2013.

The shoreline vegetation behind breakwaters seems to have stabilized. The sand shifting has covered the protected plants, but the plants seem to have 70% recovery. The vegetation located on the west and north end has not shown stabilization due to heavy wave action and no protection. The west location of the newly placed fill does not contain breakwaters to protect the shoreline grasses. The breakwaters facing north are failing in many ways and have washed away 70% of the shoreline plants along the north side. The remaining plants have seem to stabilize. It is anticipated upon complete funding and placement of the breakwater, the shoreline vegetation will have less wave action to tolerate and can place the plant's energy toward growth only.

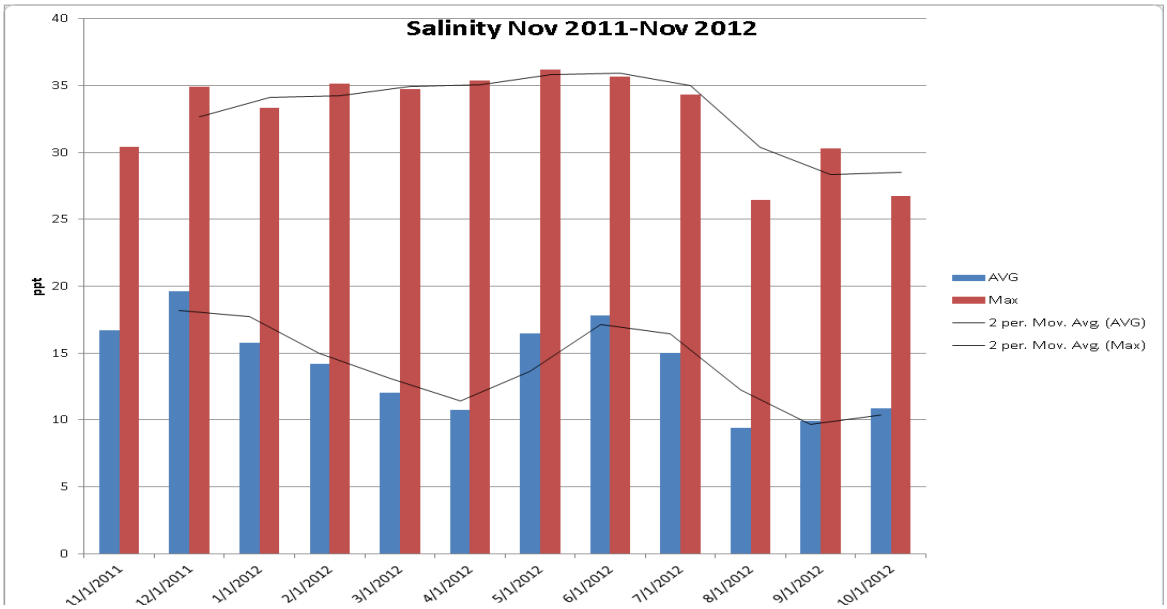


Figure 29: The salinity trends of 2011 and 2012 of Deadman's Island

9.0 Fish Surveys

Fin Fish Surveys: Evaluation will be done throughout random stations- using the visual the visual census method of the quantitative underwater ecological surveying techniques. Time frame was daily (weather dependent) for three months on every reef unit and tier. After placement of the wave attenuators – two weeks 2% spat (1/2 inch size) – immediate fish presence (most likely from the adjacent reefs) showed on all reefs. Pinfish are the first species to appear on the reef within the first two weeks. One month later, all species as adults were present. Most juveniles species, such as mangrove snapper, did not appear for another season.

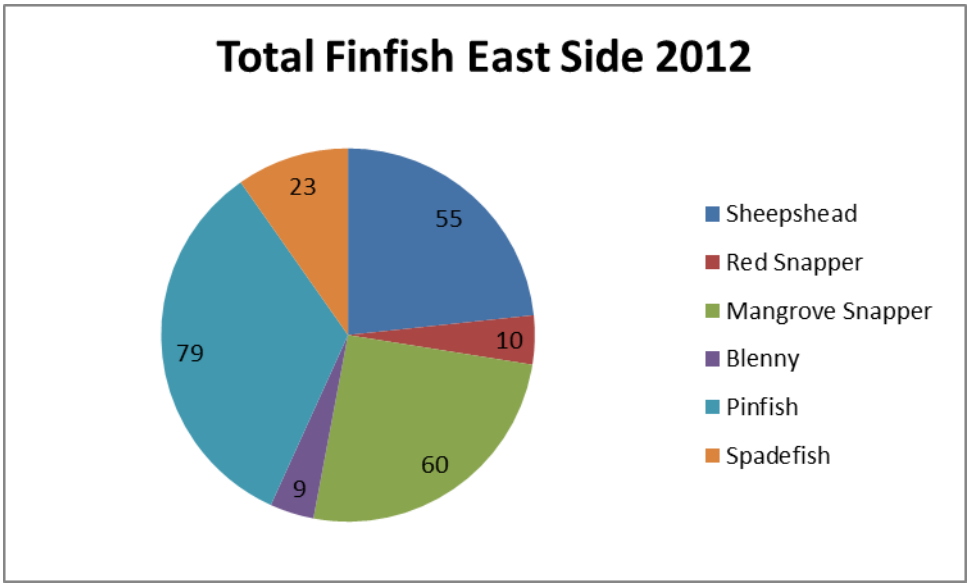


Figure 30-Total number of finfish for the east side breakwaters

Competition and Species present:

This reef was deployed late July 2011 after spring spat season-
Dates of monitoring July 2012

Table 1- The total abundance of species for both breakwaters of the east and west section of the project

Species	Common	East	West
Urosalpinx cinerea	Oyster Drills (OD)	1277	4300
Urosalpinx cinerea	Egg Casing (EC)	38	30
Crassostrea virginica	Live Oyster (LO)	43.01	402
Crassostrea virginica	Dead Oyster (DO)	368	1265
Archosargus probatocephalus	Sheepshead	55	128
Lutjanus campechanus	Red Snapper	10	41
Lutjanus griseus	Mangrove Snapper	60	0
Zooanthis sp.	Zooanthids	13	25
Hypsoblennius hentzi	Blenny (Feather)	9	177
Balanus sp	Acorn Barnacles	157	504
Cerianthus spp.	Tunicates	18	168
Callinectes sapidus	Blue crab juv	11	130
Menippe mercenaria	Stone crab	4.01	50
Pagurus longicarpus	Hermit Crab	49	336
Lagodon rhomboides	Pinfish	79	448
Chaetodipterus faber	Atlantic Spadefish	23	12
Astrangia danae	Coral	1	21
Crassostrea virginica	Live Spat	0	6690
Crassostrea virginica	Dead spat	0	10807
Opsanus beta	Toadfish	0	7
Brevoortia patronus	Menhaden juv	0	57
Sabellidae spp	Feather duster worm	0	21

Cerianthus spp	Anemone	3	111
Haemulon album	Grunt	0	1
	Total	2220.02	25731
	Land Side	695.02	8447.34
	Bay Side (North Side)	747	8169
	East Side	196	2445
	West Side	505	7233

Figure 31: Large Sheepshead (*Archosargus probatocephalus)* found on the reefs of Deadman's island

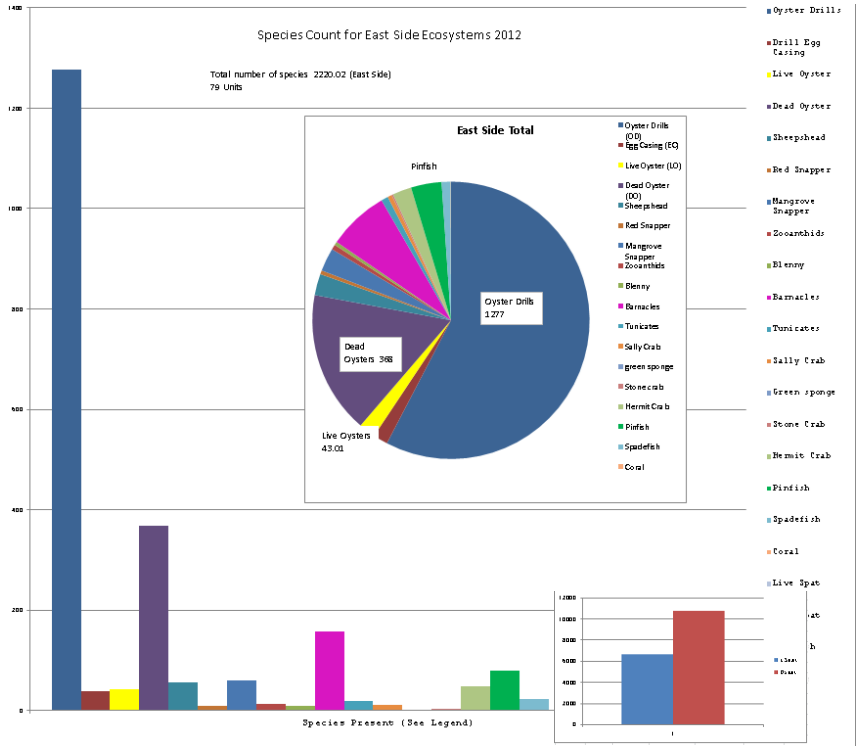


Figure 32- Species count for the entire east side reef

Figure 33- Species count for the entire west side reef

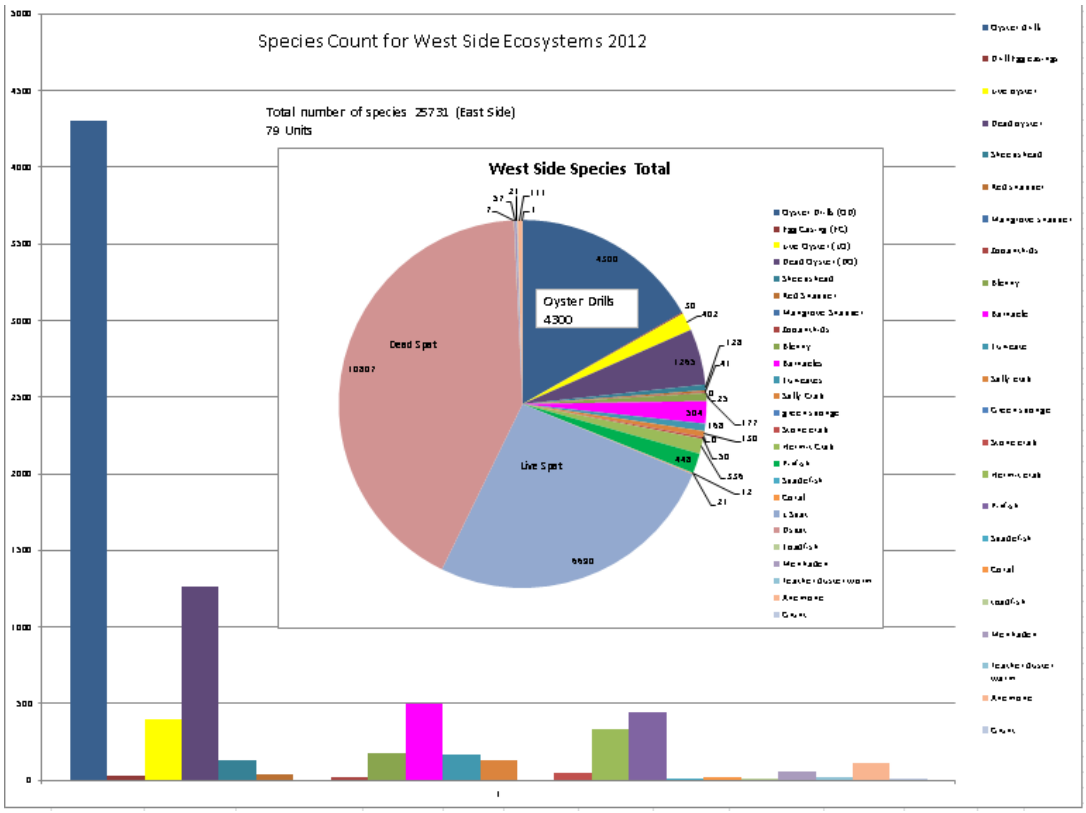


Table 2- Total reef, live oyster and fish species abundance in relation to all tiers of each unit, all directions of north, south (Land), east, west and the two different structure designs.

	#units	Total All Species abundance	Live Oyster Relative Abundance	Fish relative abundance	Shannon Weiner Diversity Index	Simpson's Diversity Index
Tier 1	62	111	0	71	1.04437692	0.53833171
Tier 2	62	185	3	111	1.16156894	0.59352085
Tier 3	62	690	18	438	1.06182216	0.61406365
Tier 4	62	467	13	59	1.129841	0.69497569
Tier 5	62	376	8	76	0.93666305	0.58145499
Tier 6	62	122	0	51	1.0575529	0.76209186
Land	62	736	20	736	1.70784715	0.68301339
North	62	816	10	816	1.43075945	0.58030494
East	62	165	1	165	1.35476194	0.57184035
West	62	514	12	514	1.29067669	0.61304147
Table Tops Ecodiscs	36	2027	38	974	1.64909462	-1.7145199
Lillypads Ecodiscs	26	1392	41	1392	1.70979866	0.17563693

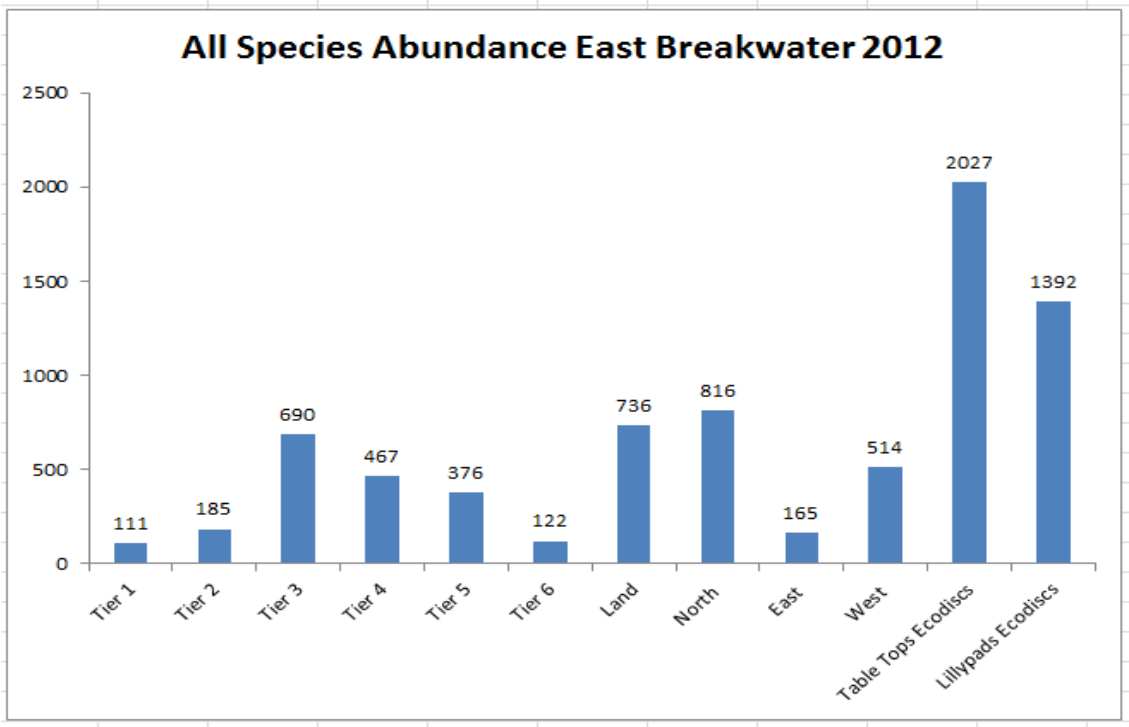


Figure 34- Graph showing total reef species abundance in relation to all tiers of each unit, all directions of north, south (Land), east, west and the two different structure designs.

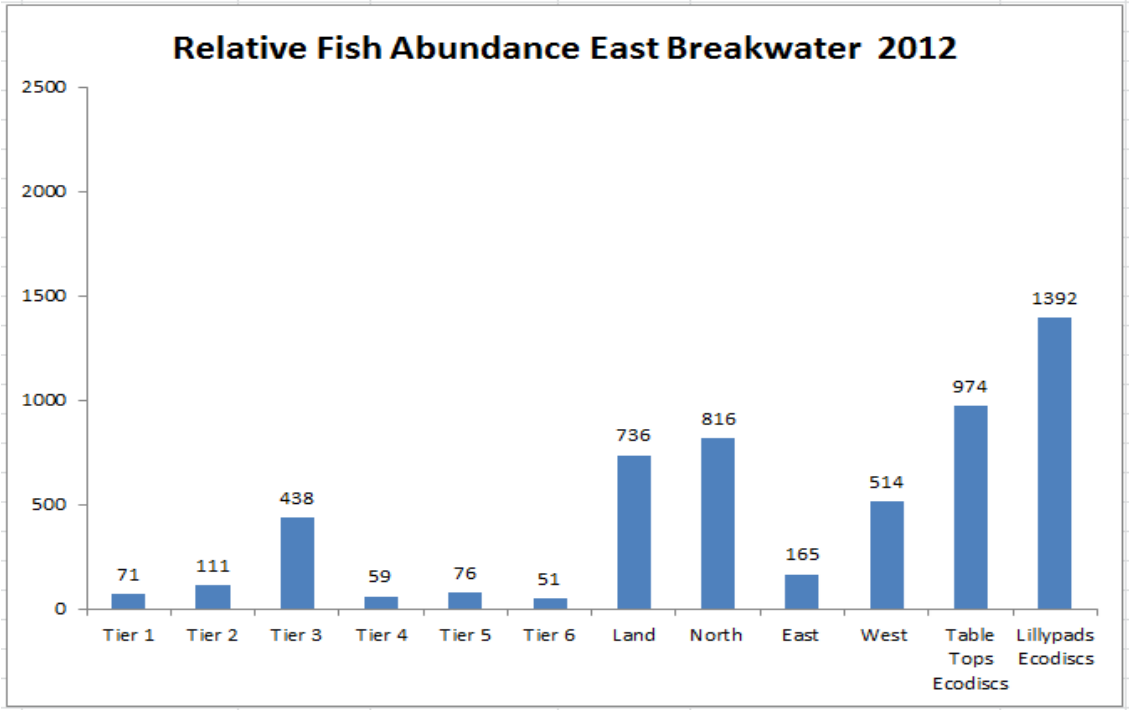


Figure 35-Graph showing relatives fish abundance in relation to all tiers of each unit, all directions of north, south (Land), east, west and the two different structure designs.

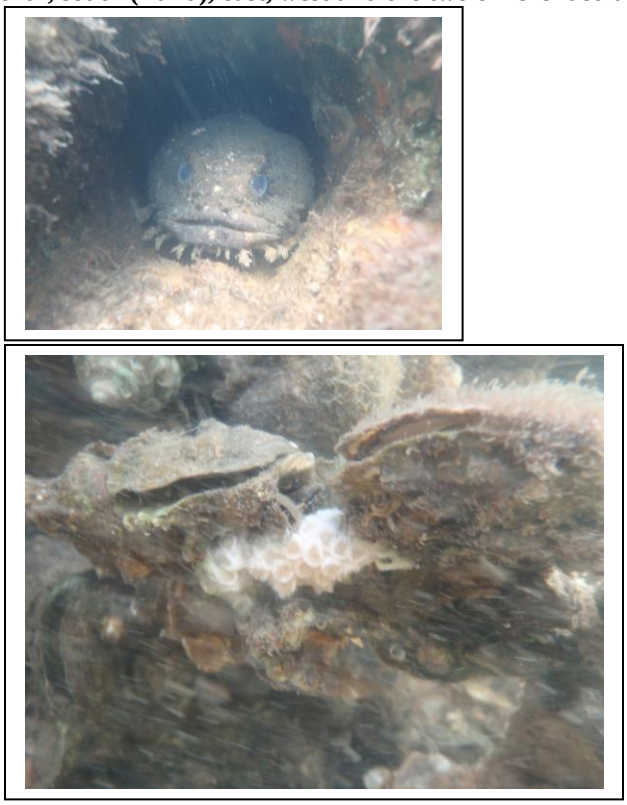


Figure 37: (top) Oyster Toad fish (*Opsanus beta)*
(Bottom) Coral (*Astrangia danae*) found on the oyster reefs of Deadman's Island

Figure 36: Hermit crabs on tp of exposed spartina sp.

10.0 Isthmus planting 2008-2013

Funded by Five Star, NFWF and the US Fish and Wildlife from 2008-2011. The Isthmus on the northern end of Deadman's Island was less than 3 inches at mean high water in 2007. Four varieties of vegetation containing various root systems used for pioneering dune planting and building were used. In 2008, Sporrey-Reed Tents were created to increase the time for Dune restoration Sporrey-Reed tents is a trade secret from ECS and are used to catch the sand during the dormant months and become stabilized by upland vegetation in the planting months. The tents are all natural, stem reed based, biodegradable if buried, and highly effective for collecting and building up sand. Strategically laid the tents are showing to be very effective in building dune systems for dune restoration. In just one weekend, two inches of sand were captured from tidal washing. At first observation, it appeared the high water washed away much of the plants along the shoreline. In reality, the plants were covered with sand.

Results

The surge from Hurricane Gustav and Ike had completely covered the entire peninsula. The first plantings of 2008 not only survived, but trapped additional sand onto the island, creating a slope and higher elevation for further planting protection. In 2009, Fourteen varieties of plants were planted, to utilize the additional sand, accumulated by the Sporrey–Reed tents. In 2010, the third succession type of plants to develop the back side of the isthmus was planted. In 2011 and 2012, woody plants were placed on the back side of the now 3 ft forming dune.

Figure 38: 2008 Isthmus planting on the north end of Deadman's Island

Figure 39: 2013 Isthmus on the north end of Deadman's Island

11.0 Wetland creation

Funded by the Florida Panhandle Coastal Program, U.S. Fish & Wildlife Service and Estuary Act, Army Corps of Engineers, in the summer of 2012, 16,000 yd.^{3} of sand were placed in the permitted area of the North West end, a Deadman's island. Sand placement was measured each day, as well as elevation. The elevation of the newly placed sand decreased 6 inches due to settling and shifting. Barriers surrounded the area in the outline shape according to the legal agreement and elevations from previous bathymetric surveys. These barriers, secured by grounded PVC pipe, prevented the sand from washing away during stabilization. This placement of sand restored the northwest area of Deadman's Island to 1972 aerials. The sand placement covered and protected the unmarked Cemetery and the eroding shoreline immediately. Wetland vegetation was planted along the shoreline, and in the entire area 18 inches apart.

Figure 26: Sand being piped from the spoil site to Deadman's Island

2012 brought extremely high tides due to the "super moon" and tropical storms. Vegetation planted along the shoreline did not have a chance to become established due to these high tides. The sand on the northwest end was not protected by breakwater and was constantly shifting and eroding. Until the footprint in the submerged lands permit is completed, the shoreline of newly placed sand, is always in danger of erosion. The barrier system contained most of the sand and was constantly maintained but needed to be removed at certain times due to wave action. The barrier system was effective but expensive to maintain. The maintenance of the barrier system was almost daily during the summer high tides. Because of the break down of the original rebar Reefblk reef, the north end on days where North winds prevailed, would also cause erosion along the shoreline. This erosion would not allow plants to become established in a short period of time.

Due to this frustration, of ongoing barrier maintenance, experiments with several volunteer plantings and monitoring of sifting sand, and wetland bogs. The idea was to create small ponds and random areas of the wetland creation vicinity. The idea was to create an established deep root system before the erosion reached the area. Once the erosion reached the area, the plant would be strongly rooted and not erode. This was a very interesting project. By digging and using hydraulic engineering. *Spartina Alternaflora* and *Juncus Romerius* were planted in these ponds. These plants quickly became established with a strong root system, mainly due to because of protection from the elements such as tides, wind and wave action. Unfortunately, tropical storm Debbie, covered these pond areas with sand. No sunlight could get to the stems of these plants to grow. Over time, the wave action exposed these wetland bogs. The

plants looked as if they were dead. The plants seem to be recovering from such a shock, due to the wind and tide completely burying them then exposing them. The root system still seems to be strong and alive, there is still some greenery observed. It is anticipated this particular patch which was once part of the wetland bog, may become dormant this winter and become reestablished in the spring.

Figure 42: 4 months after placement and tropical storm Debbie 2012

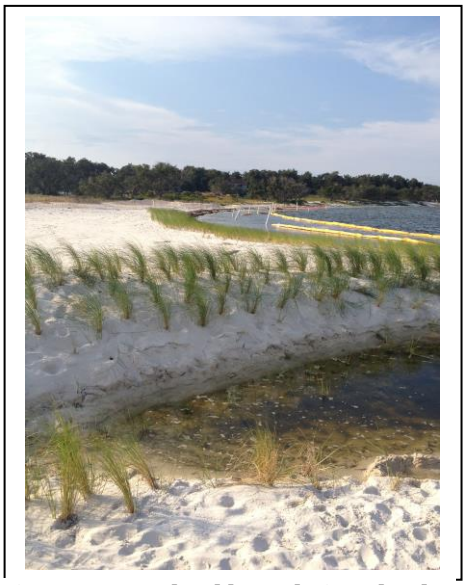


Figure 41: Wetland bogs designed to be created upland to stabilize the root system with no stress of wave action

The wetland bogs appeared to be a good idea from this experimental pilot study. The main problem will be making sure there is enough water to sustain the plants within the ponds. A small pipe system with holes was hammered into the ground until water seeped through the pipes. Without this small pipe system, the water that was placed in the ponds will seep through and will not be large enough amounts to sustain the plants.

Upon the placement of 16000 cubic yards of sand, pvc pipe was placed to hold the barriers together for sand placement, in the event the sand washed out or shift while still settling. In addition, the pvc pipe placed were also reference points to help monitor any sand shifting or erosion. The shoreline was measured with a GPS and mapped after major storm events or surges, to get a better understanding to the effects of the breakwater and lack of breakwaters, which still remains on the northwest portion of the permitted footprint. When the sand appeared to have settled, the barrier was removed, but the PVC pipe remained in place as reference points and also anchoring pipes for future deflection curtains. Currently, the deflection curtain remains in place until funding becomes available for breakwaters to be placed in the unprotected footprint.

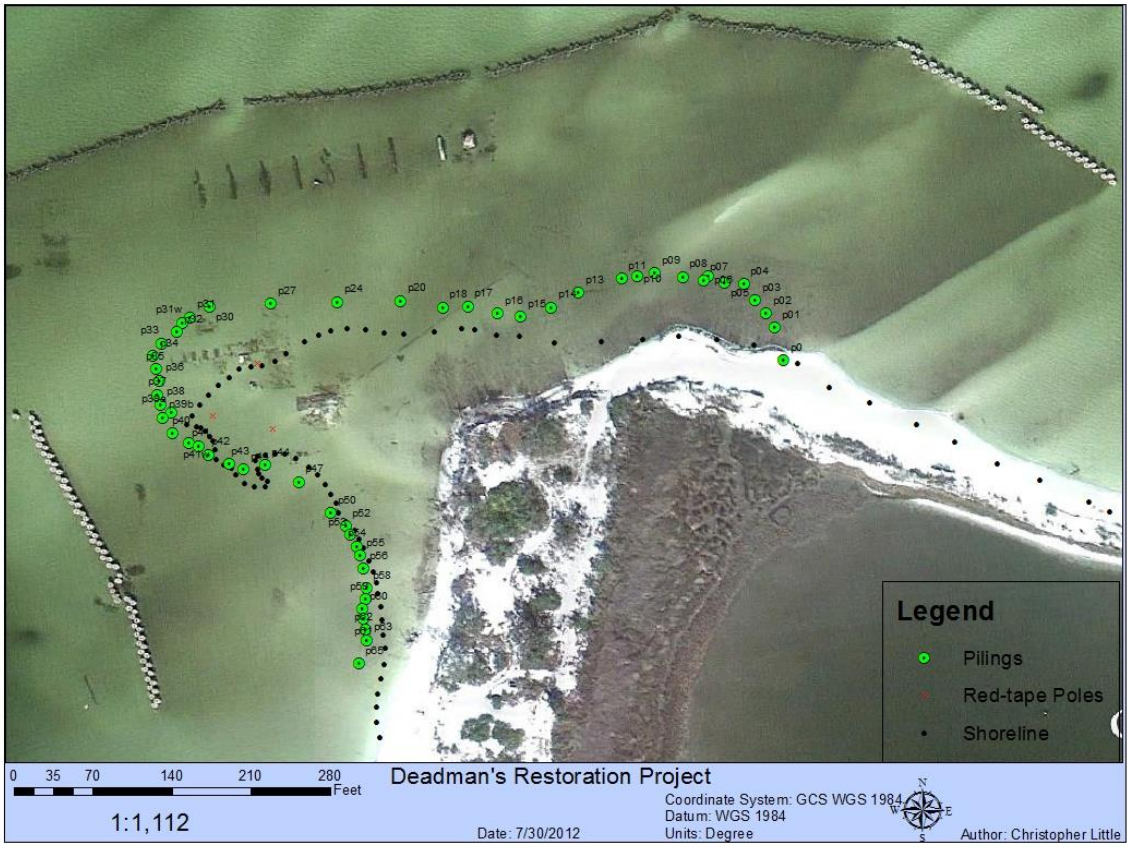
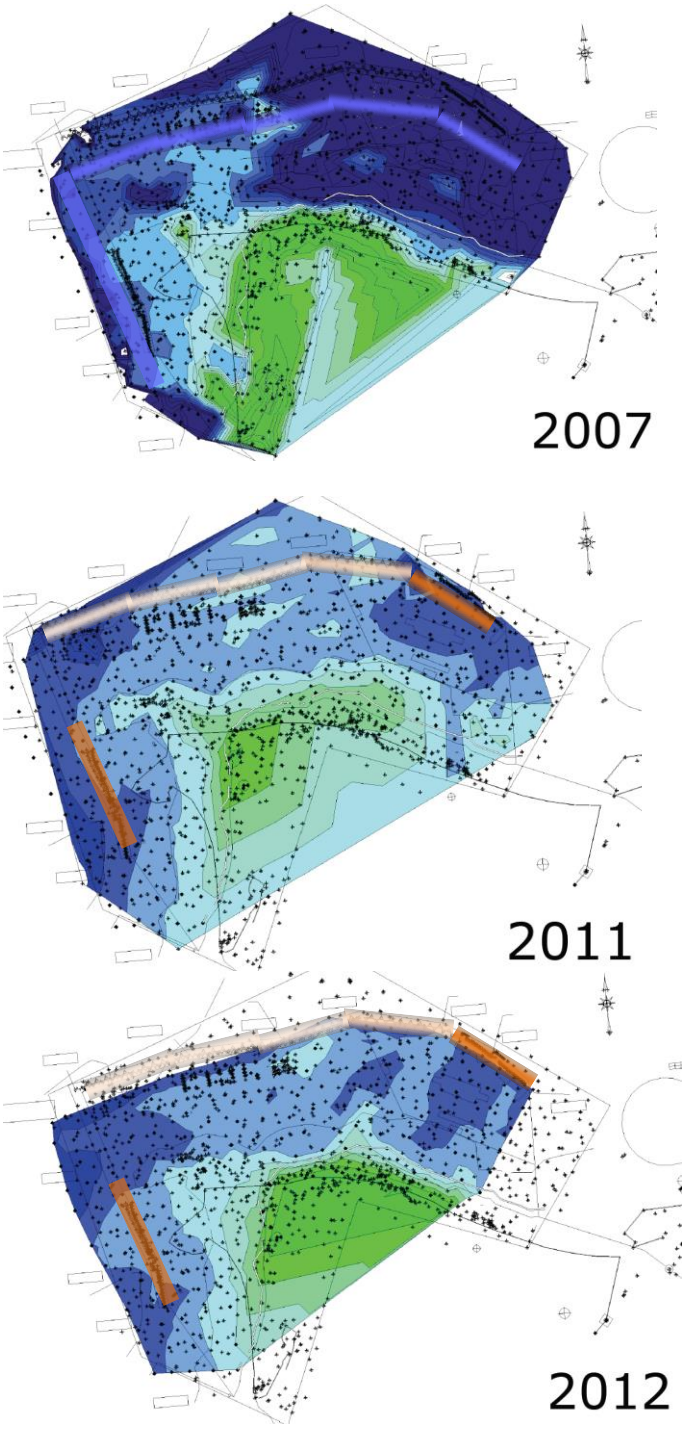


Figure 43: Sand shifting: map of the north end of Deadman's Island fill site. The green dots represent the fixed barrier reference poles where the sand was filled to in the summer of 2011 and the black dots represent the current shoreline in 2012.

After Tropical Storm Debbie, the shoreline moved farther back from the original marker placement. The shoreline (Black dots) kept its shape along the reference pvc pipes, but the sand shifted to the southwest and created a small sandy point.

Figure 44: Sand shifting within the barriers of the fill site. te blue dots represent Aug 2012 and the red dots represent July 2013. The sand is shifting the south west and forming a small spit.



The baseline of 2007 funded by US Fish and Wildlife (left) was before any breakwater was placed around Deadman's Island. For reference purposes, a phantom breakwater was placed in the same footprint of the current permitted breakwater footprint of today.

The darker blue shade represents the deeper elevation, and the lighter blue shade represents the more shallow elevation.

The 2011 funding became available by the ACOE Estuary Act for professional bathymetric surveys. Elevations are compared to the 2007 baseline bathymetric. 2011 east side breakwaters were a pilot design to not accrete sand. 2012 shows the area, behind the breakwaters, becoming more shallow. This perception of shallow depth could also be from the sand shifting from the shoreline to various locations behind the breakwaters. The East side breakwaters are still showing no accretion behind the breakwaters and are maintaining the same depth behind the breakwaters. The rest of the area behind the breakwater is building sand and becoming more shallow. The area to upper west side where no breakwater is present is increasing in depth through scouring.

Figure 45: A comparison of bathymetric survey results from 2007-2012

12.0 Anthropogenic stressors

Upon completion of the 16,000 yd.^{3} of sand being transported in the wetland created, people seem to think a new section of the beach was placed for their recreational purposes. Campfires were created; the area was littered with fireworks during Fourth of July, and dogs roam the area and holes were dug throughout the Sandy creation. To alleviate and compromise with the general public, a dune fence was placed around the restoration project and approximately 50 feet of Sandy area was left between the previous remnants of Deadman's Island and the fence. In addition, aesthetic and elevation appropriate vegetation was placed along the fence line and signs were placed requesting no admittance into the area. In 2013, FWC gave the project bird nesting signage. It is anticipated the fence and the signage will deter the general public from entering the ongoing restoration project. This is measured by simply observing the footprints found within the area. Since the fence and signage has been erected, a majority of the disturbance has stopped. There has only been a few footprints, possibly only one resident and their pet to enter the area on a daily basis.

Figure 47: Least tern nesting signage

Figure 46: Least Tern

Figure 49: Least terns along the shoreline of Deadman's Island

Figure 48: Flocks of Least terns at Deadman's Island

13.0 Gulf Sturgeon

Sturgeon receivers which detect VR transmitters were placed in three locations of the breakwater to monitor the present of the protected Gulf Sturgeon. There were 157 tags total and the sturgeons' presence at the reef varied. Data is compared each year to determine the migration patterns of the Gulf Sturgeon.

Figure 50-Sturgeon receiver sites fixed for transmitter detection- three sites- Site 1 represents shallow sand bar (265), site 2 represents (266)both shallow sandbar and near deeper cove, and site 3 represent near deeper cove (267),

157 Tags total

Receiver 1(265)- 134

Receiver 2(266)-142

Receiver 3 (267)-155

Table 3-Number of sturgeon transmitters detected according to origin of tagged event

River	Sum of tags detected	Sum of Tagged Sturgeon
Blackwater	49	77
Choctawhatchee	19	135
Escambia	42	52

Yellow	58	69
Grand Total	**168**	**333**

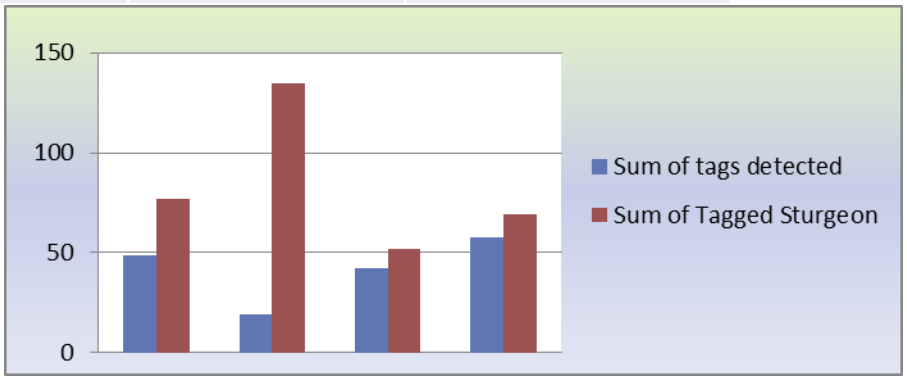


Figure 51-The number of transmitters detected vs the number of sturgeon transmitters detected

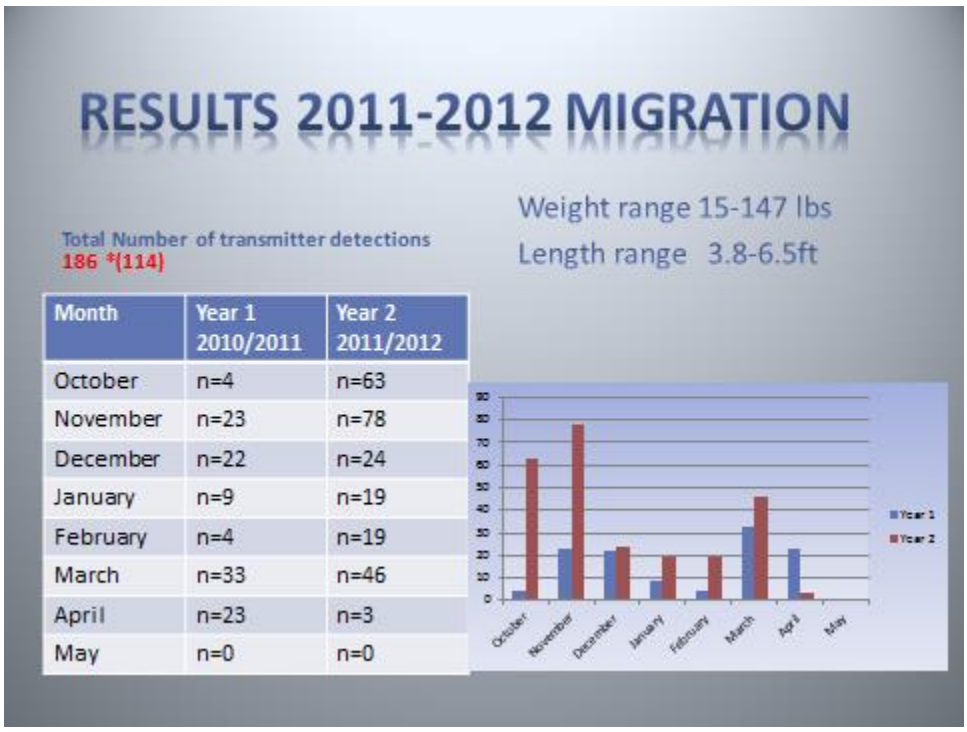


Figure 52-The two year comparison of the number of tags detected by month

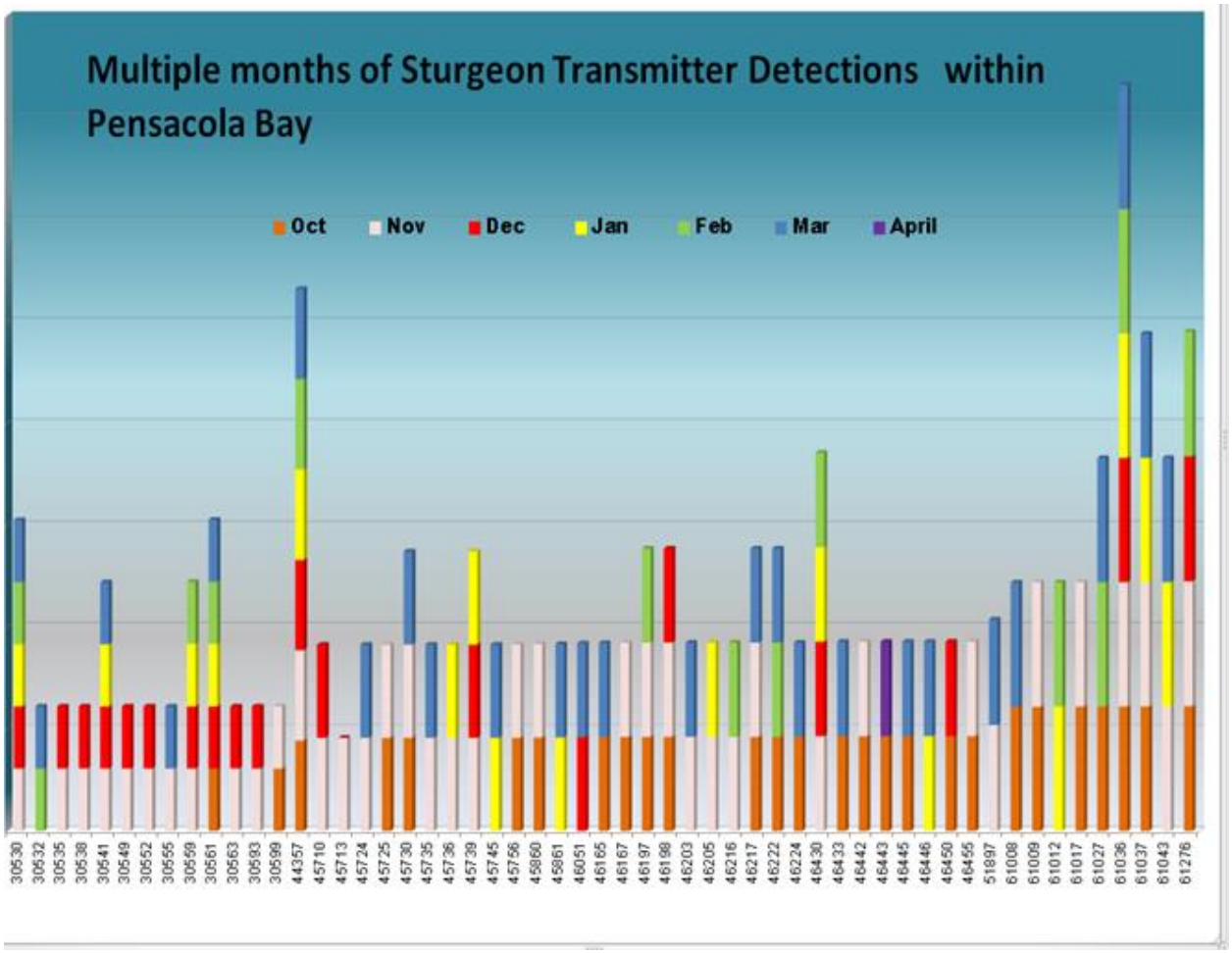


Figure 53-The presence of tagged sturgeon throughout the month of migration in Pensacola Bay

13.1 Challenges to address

- Assessing Gulf sturgeon population status is difficult due to a combination of:
- untagged juveniles
- life history characteristics
  (skip spawning where individuals do not return to spawn each year)
- behavior (gear avoidance)
- and variations in sampling programs (effort and location) that all contribute to uncertainty in current population estimates.

14.0 Environmental Stressors

14.1 Deep Water Horizon Oil spill

In the early April monitoring of 2010, pre-oil spill, the reef was entirely covered with healthy oysters and abundant with various species of juvenile and adult fish. In July 2010, post oil spill, the fish showed lesions and algae was abundant in an abnormal amounts and also, smothered many oysters. The algae eating mollusks were also abundant and not only ate the algae but the remaining oysters and laid many eggs.

As one of the few restoration project managers of Pensacola Bay, monitoring and observation in the water, occurred on a daily basis all summer. The Deadman's island restoration project manager was part of City of Gulf Breeze Oil Spill Response and Environmental resource impact prevention team during the oil spill frame. The bird population was decreased 99%, leaving only a family of ospreys. The Great Blue herons, night herons, loons, pelicans, oyster catchers, sandpipers, etc., ALL birds disappeared. Since the oil spill did not come into Pensacola Bay until late may and early June, these birds I don't believe, were effected by the oil spill at that time. They simply migrated. Only a few birds returned two years later. The fish population decreased to nothing. In June 2010, very large horseshoe crabs were washed up dead on the beach. In late June, several hermit crabs were covered with oil but seem to be thriving on the reef. Observing the decline in the fish population and increased numbers of oyster mortality, tissue sampling for oysters and fish were performed to hopefully, provide more insight of what was causing dead horseshoe crabs and fish, lesioned fish and dying oysters.



The States criteria level to test PAH (Petroleum aromatic hydrocarbons) is only 13 compounds. These 13 PAH compounds are designed for pollution indicators such a runoff and chemicals. These PAH levels were normal and showed no detection. Through a specialized laboratory, certified in petroleum testing, Pace laboratories, further EPA tests were recommended to conduct tissue testing on a forensic level to determine whether there was any correlation to the biological observations. These results are where the test results finally matched the biological observations. The tissues of fish and oysters were tested for the 60 compounds. When compared to the blank tissue used, the sample tissue showed much higher concentrations. The 60 compound testing are designed to find evidence of the crude oil because the compounds are detected in the diesel range, but the 13 compounds designed to find pollution indicators are not designed to find crude oil.

Figure 54: 2010-Numerous oil sightings in Pensacola by the City of Gulf Breeze Coastwatchers who scouted the transport currents daily, every four hours.

By December of 2010, it was more difficult to find enough live samples of oyster to test. There was no fish to maintain the reef and manage species predation from crabs, oyster drill and whelks, which dominated the reef. This was also the same time frame submerged oil was being stirred up by the DEP led sediment coring project and BP clean-up crew in Fort Mcrae and Barrancus near the mouth of the pass. This area, according to SERT GATOR reports is where the oil flooded and pooled in June 12, 2010 and then sank. It is unknown if there is a correlation of the stirring up from these activities and the rapid mortalities surrounding Gulf Breeze and Deadman's Island. However, the most observed affected fish and invertebrates occurred during this time frame. Submerged oil in Fort Mcrae was found by the project manager and two other staff members. The concern of the submerged oil was whether any of the chemical components, mainly toxic compounds, were leaching into the water column and affecting the environmental sensitive areas. This leaching may possibly support the biological observation of increase mortality in fish, bottom dwelling invertebrates and the oysters on the breakwater of Deadman's Island. The Coast Guard and DEP was alerted. A sample was taken by DEP, and the test results showed no detection. I sent in a sample to a certified petroleum lab and found the chemical compounds were off the charts of normal readings

for this area. This sample was pure MC252 oil according the lab.

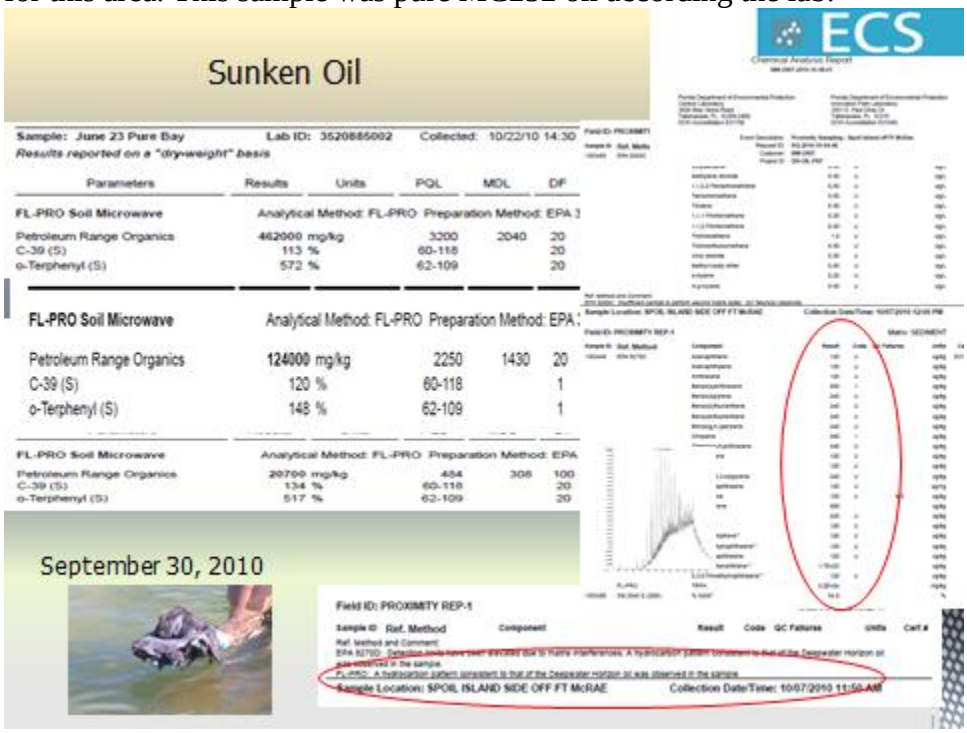


Figure 55: Conflicting lab results of the same sample of the sunken oil found at Fort Mcrae

Perplexed as to why the sample results differed, the two results and analysis type were compared. In comparison to the DEP sample, the DEP sample did not contain any dilution factors. In fact, after reviewing the data results and chromatograms, the machine used to obtain a profile was not able to obtain a readable curve. The product sample was so concentrated, and with no dilution, the State agency's tests showed undetected for any crude compounds, yet it was a pure sample of crude oil. The petroleum lab had to dilute the sample over 100 times to obtain a readable curve to view the chemical compounds. In DEP defense, the DEP lab is an environmental lab and not trained to detect crude oil nor contain the equipment for crude oil detection. In April 2011, an entire monitoring of the reef was performed and found the drill population was abundant, and there were very few oysters alive, mostly covered and smothered by algae. Monitoring of the submerged oil continued throughout the year. Three more submerged samples were taken from Fort Mcrae and tested through the year. In comparing the same method with other area crude oil submerged samples, it was found the submerged oil pocket contains pure crude properties. The test results show the chemical compounds within the pocket, remain concentrated in high levels, until the pocket is disturbed and broken up, by some means. When the submerged oil "pockets" were disturbed, either by shovels, coring, handling, air exposure, etc., the chemical compounds with lighter chemical specific densities, showed a decrease in these chemicals, with each test result. The heavier more toxic chemical compounds would remain in the sediment. Looking over the Escambia County oil collection records on a daily basis, from the records, there seem to always show an increase in poundage each day, such as Day 1, 3000 lbs, Day 2 5000 lbs, Day 3 7000 lbs

but the numbers never seemed to start over at the beginning of each day. I would see the crews take oil from the Fort Mcrae area, but the later DEP reports showed there were no submerged oil in Fort Mcrae. The logic was confusing, therefore; monitoring continued until the Deadman's Island oysters completely died off. BP staff and the Coast Guard was very cooperative, helpful and knowledgeable. They worked together with the City of Gulf Breeze until the turnover of both agency's staff occurred a few months later, and City of Gulf Breeze was basically ignored, most likely due to the overwhelming tasksplaced on other response agencies. The City of Gulf Breeze, being surrounded by water, had teams of oil watchers on the water and reported all oil findings to several numbers, including unified command of Mobile. When reported, the overwhelmed SCAT team did not respond until three months later after the oil was gone. Jelly type oil blobs were found on Deadman's Island, but the SCAT team collected only sampled the organic matter next to the jellied crude oil. When questioned, the team verbally verified the substance was oil and said the oil product would be listed in their reports. There was no indication of oil on any of the reports. The reports only showed organic matter, which contained no petroleum hydrocarbons. Therefore, the SCAT reports gave the impressions there was never any oil found in Gulf Breeze.

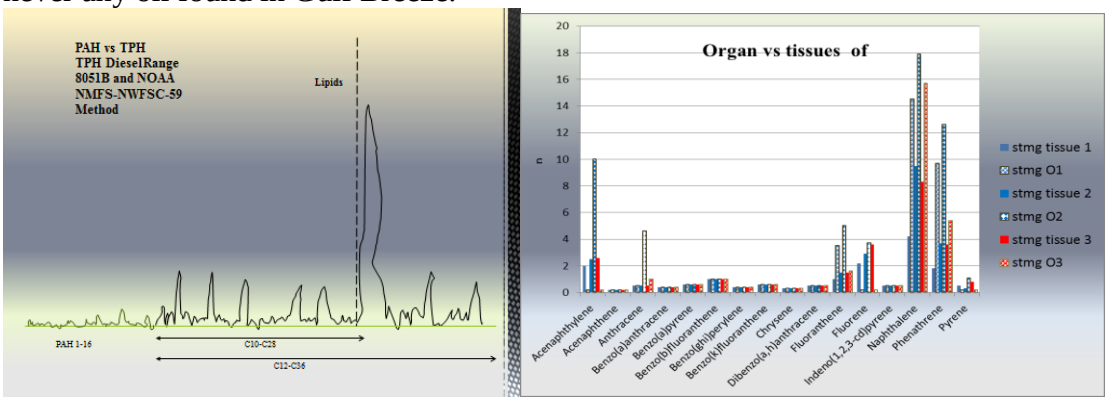


Figure 56: A curve comparison of PAH and TPH- It was found the C10-C28 PAH (State criteria) could not detect the toxic compounds in the crude. The PAH was not able to penetrate the fatty tissue. TPH (C12-C36) could detect toxic crude compounds through the fatty tissue layer. The TPH results matched the biological observations of lesioned and dying marine organisms. The chart on the right (Organs vs tissue) shows when organs are inundated with toxins, the tissue, depending on the fish, shows evidence of the toxins as well. When the organs do not show high amounts of toxins, the tissue does not show any indication of harmful compounds. Since the organs were made to filter and process; the oysters could not process any of the harmful toxins and over time and died off, some of the fish could process or was not exposed to the toxins long term in oreder to uptake and inundate the organs.

The March 2012 monitoring showed no oysters on the reef and subsequentially, could not test any tissue for comparison. The entire reef died off, and the oyster shell has fallen off the bags and onto the ground. There is a slimy algae coating existing reefblk reef which does allow settlement of oysters. This algae is different from the algae observed during the oil spill. My conclusion about the oil spill is if there any adult species were alive during the oil spill that generation has died off. Judging by small amounts of spat seen on the Ecodiscs, there will be a new generation of oysters, but like most marine species, the

new generation are males and will not change to females until a later date, when the male to female ratio is balanced. There must have been some females in the bay because there is spat settlement on the Ecodiscs, however, not as much as the settlement plates in 2008 and 2009 showed. The algae seen on the reef showed interesting characteristics, during the BP oil spill algae was abundant everywhere, in the water column and on the breakwater reefs, so much, the reef was being smothered by the algae, and the oysters were covered. Algae uptakes petroleum hydrocarbons and may be comparable to plant food to accelerate growth, such a marine "miracle grow". An EPA study from Valdez oil spill showed the used of fertilizer to increase the oil eating microbes caused a large algae bloom but seem to help rid the oil. This is speculation, but if the algae uptakes the hydrocarbons and there was a catalyst to increase the uptake, possibly dispersant used in the oil spill, then this would make sense why the algae increased on the reef, especially the shallow reef where the light and heat are more abundant. During this time frame, the oysters continued to die off. The algae is now a brown slime on the remaining empty reef shells.

Oyster shells, which fell off the bags, were scattered on the ground. The dead oyster shells inside the reef have been observed to be both, to be a great substrate for fish eggs, crab habitat and increased benthic community such as polychaetes, anemones. Small pieces of star coral are growing on the stainless steel cables of the anchoring the structures. However, there are no oysters in the bags to act as a wave break to the lack of "cemented" shells in bags the reef once had.

It is still unknown if the oil spill directly, caused the rapid mortalities within the Reefblk oyster reefs as well as the rest of the bay. However, the timeframe of the test results show the oil may have been a catalyst for the varying observations, on the breakwater reefs and the bay ecosystem. These indirect effects are expected especially since there is submerged oil and the Gulf of Mexico has very large upwelling events which bring the sediment to the surface. It is shown once the oil product is exposed the air the breakdown process begins. Our storms and hurricanes will be essential in cleansing the Gulf. In addition, since these 60 compounds EPA tests used were discovered during the oil spill, there is no baseline other than normal 13 compound PAH. The laboratory test results on the submerged oil, shows when the crude oil "pocket" is disturbed, or exposed to air there are fewer chemical compounds. Therefore, any remaining pockets of submerged oil in the bay which get disturbed over time, may not have an effect on the bay due to the proportion of the sample size to the size of the bay with several fast flowing currents. Is it anticipated using the advance tissue tests in further monitoring as the oyster population returns, termed as a "reverse baseline". The reverse baseline may give more insight to the detection limits found in the oysters and fish in relation to exposure time and toxicity.

14.2 Observations of nature during the oil spill

As part of the on-the-water daily oil spill response and environmental resource protection team for the City of Gulf Breeze, these were a few interesting observations by the project manager, Heather Reed, on how nature recovered from this large environmental impact.

2011 showed the presence of more sharks than ever within the bay, it could be speculated the sharks came in to scavenge of the large amounts of dying fish in the bay. Deadman's Island was no exception, several sharks frequented the reef site during the monitoring events. As the oil spill affected the microbial environment and killed off the sensitive creatures, this allowed the hardy marine organisms, usually predators come in and "clean up" the area. This clean up allowed the pioneer species to come into the affected sites and begin the recovery process.

The project manager taught the Coastguard and Coastwatchers about the local currents, longshore and converging currents and eddies of Pensacola Bay, which made the oil transport easily predicable and Coastguard and BP staff was ready for response in a faster timeframe than waiting for verification from the Mobile district or other source. The most interesting observation was even though the City of Gulf Breeze bought their own skimmer and oil absorbing clean up supplies, which they used quite a bit, the sargassum seaweed was the best collector of the oil product at any stage of product composition. The seaweed collected the oil whether the product was the first red Vaseline like crude or the extremely pure black crude. When an ebb tide occurred, the oil covered sargassum would gather the in convergence current and could easily be collected. This was almost like clockwork and made BP staff, Coastguard and the City of Gulf Breeze's job much easier.

Although the oil spill and its effects was heart breaking to watch each day, the natural recovery process provided a hope and overall the Deep Water Horizon oil spill allowed technology and science to advance in environmental protection, monitoring and future prevention and response methodology.

15.0 Restoration work and ecological benefits

The City of Gulf Breeze's Deadman's Island was the first true restoration project of Pensacola Bay. True restoration restores the area back to its historical design and natural resources, whereas, creation projects are designed to enhance and add natural resources. Creation projects usually have more ideal parameters to sustain the environmental goal. The danger to each type project is determining whether the already established area needs to be restored or created and the type of impact it may have on the current natural resources. The project, through documents and aerials, has been affected from anthropogenic stressors, since 1940. Thanks to our generous funding partners, currently, Deadman's Island north end has been restored to 1972, is a flourishing ecosystem and is protecting much history and cultural resources.

This project is a perfect reflection of the benefits that are derived from protecting and improving the environment. This project is using science to utilize stabilization techniques that use natural habitat elements to protect shorelines from erosion while also providing critical habitat for bay wildlife.

The purpose of these projects is to restore or protect critically important habitat for living resources by facilitating natural coastal processes such as sediment trapping and nutrient reduction; wave attenuation; free movement of sands, sediment and gravel in the littoral zone and detritus cycling. This project is crucial to habitat development and to the conservation of fish, birds and other wildlife.

When the surges from the offshore Hurricanes of 2008 occurred, the plant root system was spread enough to allow the incoming sand to accumulate, trap and build up approximately two feet deep and 12 feet wide additional shoreline and close the breach in the isthmus protecting the saltmarsh. This build up helped protect and restore critical habitats for keystone species, and maintaining the ecological integrity of tidal marshes in the Gilmore Bayou of Deadman's Island. The marsh reduces erosive wave energy, reduces nutrient and sediment runoff, and provides valuable habitat.

The surges from the offshore Hurricanes of 2008, covered the isthmus with water and sand. The plant root system was spread enough to allow the incoming sand to accumulate, trap and build up approximately two feet deep and 12 feet wide additional shoreline. The sand build up also closed the breach in the isthmus protecting the saltmarsh. The sand build up helped protect and later, restore critical habitats for keystone species. The additional sand maintained the ecological integrity of tidal marshes in the Gilmore Bayou of Deadman's Island. The marsh reduces erosive wave energy, reduces nutrient and sediment runoff, and provides valuable habitat.

Due to this additional sand build up; the valuable fiddler crabs were more abundant. The additional sand helped the crabs create additional burrows and habitat. Fiddler crabs are known for scavenging which helps keep Florida's coasts clean.

Other ecological benefits include providing vital habitat and food for particularly for a variety of fish species and crabs in their critical early life stages, (herons, kingfishers, crabs, oysters, mussels, sportfish, wetland plants, etc.). Indirectly, this project can help in filtering and removing nutrients, pollutants and reducing sediment loads from upland sources. This increased sediment load, through trapping sediments, helps living resources like fish and submerged aquatic vegetation to prosper, improve water quality through trapping sediments, and other pollutants carried by runoff and groundwater from uplands to rivers and the bay, provided flood, erosion buffering, and also, providing recreational opportunities for the community without compromising the mission of preserving and protecting the area.

16.0 Educational Benefits

The important educational benefits of this project were the involvement of volunteers and students in the creation of living shoreline projects

Additional benefits include, increased environmental stewardship and awareness through hands-on education about the various ecosystems, such as, wetlands, dunes, bays and river. This stewardship is expanded through environmental education and volunteer services.

The teachers were provided with various classroom activities based on the Tampa Grasses to Classes and the Mobile School Grasses to Classes program but modified to fit the Florida Panhandle region. These activities were incorporated with the nursery created by the students of Gulf Breeze High School, the first "Grasses to Classes in the Panhandle of Florida".

Students who assisted in monitoring of living shorelines projects demonstrated their value in protecting shorelines and providing habitat benefits for fish and wildlife species.

Landowners, public agencies, contractors, and regulators were given presentations, throughout the years, about the benefits of living shorelines and the process and techniques used in this project and how they can use the same techniques to create living shorelines instead of hardening the shorelines.

Due to the newspaper and television media, this project has been expanded to other educational institutes as well as landowners, public agencies, local governments, contractors, watershed organizations and others, in an effort to understand, encourage and support ongoing restoration efforts

16.1 Educational and Funding Partners

- Florida Panhandle Coastal Program, U.S. Fish & Wildlife Service-2007 CP funding for $25,000 was allocated for geotech monitoring and biological monitoring Provided the funding needed to conduct soil sampling and side scan sonar for permitting needs.
  2009 CP funding for $20,000 was allocated for a portion of both type oyster breakwaters
  2012 CP funding for $4,500 was allocated for plants for shoreline stabilization and wetland creation. 2007, 2013

- ACOE, Mobile District Corps of Engineers- The Estuary Act funded $715,000 Under section 206 of the water Resources Development Act of 1996, the U.S, Army Corps of Engineers was given authority to restore the degrading aquatic ecosystems . As a result, the Mobile District partnered with the City of Gulf

Breeze, in 1996. The project was held up in the DEP permitting phase for two years and eventually had to be withdrawn due to the loss of funding. In 2009, The Estuary Act funded a majority of the project transporting 16,000 cubic yards of sand for the wetland creation, maintenance, a portion of the Ecosystems breakwater unit, five years of monitoring.

- The National Association of Counties, Southern Company, Environmental Protection Agency, National Fish and Wildlife Foundation, the United States Fish and Wildlife in collaboration as the Five Star Restoration Challenge Grant, funded $30,000 for the volunteer efforts of planting, purchase of marsh plants, nursery and planting supplies to be set up at area high school "Grasses to Classes" programs and also supplies for students to weld vertical breakwater units. 2007-2008

- The National Fish and Wildlife Foundation Shell Marine Habitat Program awarded a total of $183,000. The remaining balance of $146,295 is being applied toward two separate portions of the project itself - $113,000 allotted for the oyster breakwaters, and $33,000 allotted for Phase Two of the wetland creation .2007-2010

- Southeastern Aquatic Resources Partnership funded $40,000 towards the first student created prototypes of the oyster shelled Ecosystems breakwater 2010

- The Department of Environmental Protection Northwest Florida Coastal Aquatic Managed Areas, Preserve Manager: Shelley Alexander provided $56,000 baseline monitoring and incorporating Deadman's Island as a State aquatic preserve. Northwest Aquatic Preserves Office/Coastal Managed Areas: Provided monitoring, MOU write-ups, implementation of the Aquatic Preserve Management Plan of 1992 and benthic surveys and boat support. 2007-2008.

- School districts of Escambia Counties are providing students and supervisors to weld and manufacture a portion of the rebar oyster structures under supervision in their classes. 2009 125 hours

- School District of Santa Rosa County provided the students and the space for the nursery and wet pools in their "Grasses to Classes" program. 2008-2009 150 hours

- The University of West Florida Archeological , Science, and Plant division is providing volunteers and assistance with historic artifact studies, monitoring, and invasive plants.2008-2009

- University of West Florida: Provided a detailed vegetation inventory of the island by James Burkhalter PhD. 2008

- Ecological Consulting Services- Managed, implemented, designed the projects, supervised and managed all construction tasks of the project, coordinated volunteer events and Eagle scout projects, for planting vegetation, nursery. Educational kiosks and environmental education and awareness workshops, trained the students for monitoring, fish counting, proper plant care and planting, designed the breakwaters structures project. Provides all ongoing permitting needs, wrote grant proposals, budget and project management and post project maintenance ECS developed a comprehensive monitoring plan which is used by various non-profit and educational facilities of today. 2007-2013

- State Florida Historic Preservation- funded $5000 to the underwater educational kiosk project. 2012

- The family of Wayne Lee donated 1710.00 towards the Deadman's Island project. A portion of the funds went to Deadman's Island educational kiosks with special recognition and memory to Wayne Lee and Mike Wein who has placed much time and energy to restoring Deadman's Island years before the project came to fruition as well as after the start of the project.

- Chic- Fil-A of Gulf Breeze donated $200 to the Deadman's Island educational kiosk project.

Additional partners:

The important educational benefits and key efforts for this project were because of the involvement of volunteers and students in the creation of living shoreline projects. Additional benefits include, increase environmental stewardship and awareness their hands on education about the various ecosystems, wetlands, dunes, bays and River and expand environmental education through volunteer services. The teachers were provided with various classroom activities based on the Tampa grasses to classes program but modified to fit the first of the Florida Panhandle Regents grasses to classes program. These activities incorporated the efforts of the nursery created by the students at Gulf breeze high school. Students assisted in monitoring living shoreline projects, demonstrating their value and ownership in protecting shorelines by observing and documenting the habitat benefits for fish and wildlife species.

Presentations were given to landowners, public agencies, contractors and regulatory agencies about the benefits of living shorelines and the process and techniques used in the Deadman's Island project and how they can use the same techniques to create living shorelines for their residential properties instead of hardening their shorelines.

Gulf Breeze Garden Club-09/18/2008 4 hours
Emerald Coast Keepers-10/20/08 4 hours
Mira Flores Garden Club-10/23/08, 2009 8 hours
Boy Scouts of America-4/2008,6/2008,7/2008,8/20089/2008,10/2008,11/2008 325 hours (Eagle Scout and boy scout) Boy Scout troop 44 – 10 – 12 – 22 and Milton division – 2009 to 2013
Girl Scouts of America-10/2008/11/2008 15 hours
Pensacola Catholic High School- 2010-2013 15 hours
Stand Up Paddleboard girls (SUP'n)-2011-2012 6 hours
Gulf Breeze Rotary Club-9/2008 4 hours
Little Flower School- 2011 – created the first prototype of the oyster shell ecosystems
Gulf Breeze Interact Club-8/2008,10/2008 4 hours
Gulf Breeze High School- 2/2008-11/2008 257 hours $20,000 includes property facilities and faculty and hours
Emerald Coast Keepers-2009 4 hours
Bream Fishermen Association-2011, 2012
Socialize With Education-2009-2012 30 hours
US Navy Seals- 2009 12 hours
University of West Florida students- 2008-2013 345 hours
General Electric 2011 4 hours
Gulf Power 2010, 2011, 2012 12 hours
Gulf Breeze Homeowners 7/2008 4 hours

Media and Presentations:

Pensacola News Journal
Nov/22/08 Emerald Coastkeepers Kayak and Canoe trip to Deadman's Island
Gulf Breeze News-11/24/2008,
05/02/2008 Deadman's Island gets new life from student projects
05/2008 Coffins Stir interest from Deadman's Island
10/9/2008 Driftwood Garden Club (presentation of Deadman's Island)
Ballinger Publishing- Fall 2008 Gallery night
Gulf Breeze Magazine-Fall 2008 Deadman's Island
Living Shorelines Workshop-1/2008, 6/2008, 2009
Santa Rosa Insider Media Com Television Company-10/16/08
Theresa Grillo Laird- an artist donating her painting and prints to the Deadman's Island Project.
Bay Area Resource Council – 2008, 2009
Gulf Coast Restoration Summit- 2011
Audobon Society- 2011
Pensacola women's club – 2009
Gulf breeze Chamber of Commerce – 2010
Pensacola beach optimists club – 2010
Florida Association of environmental professionals 2009, 2010
Pensacola Heritage Society – 2010

Gulf Coast science Café – 2010, 2011
Restore Americas Estuaries- 2012
Gulf of Mexico Bays and Bayou- 2012
Southern Environmental Law Center,Sybil H. Smith Charitable Trust Living Shoreline Workshop Five Rivers Delta 2013
Reefmaker (the weather channel) 2012
Santa Rosa media – Deadman's Island two segments 2009

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Appendix 1

US Fish and Wildlife Coastal Program Progress Report Conclusions

1) Deviations from the scope of the agreement-

The original scope of work was to place 240 artificial vertical oyster reef structures and open bay bottom. The reef structures will be made from a metal frame filled with bags containing up to 400 pounds of oyster shell cultch. These structures were made by students of Escambia school district.- This reef is no longer dissipating the wave action as anticipated, due to the deterioration of the oyster shells within the mesh bags inside the Reefblk.

b. Dredge spoil was placed on the norther west end, behind the structures, to provide substrate for the planting of a saltmarsh. Volunteers planted approximately 1.04 acres of emergent marsh vegetation. This was completed in 2012.

c. Water quality, benthic recruitment, and fishery and oysters community has been

monitored before the placement of oyster structures and for two years after placement. This was completed and is currently being extended another two years.

d. To plant coastal dune vegetation on upland portions of Deadman's island. This project has been in progress since 2008, allowing a slow buildup of the dunes using appropriate upland vegetation over time. The isthmus is now built up to 2.5 elevation. The first pioneer plants to start the establishment of the dune system, are still present, 14 varieties of plants have been placed to allow succession of this area. This area is now mostly covered by sea oats, sea purslane, dune sunflowers, salt bush, spartina patens, and other dune plants. The Sporrey-Reed tents continue to catch sand during the dormant season, to be stabilized by additional plants in the spring as funding allows.

2. Phase 2 -No deviations. The additions to this project, funded by the Army Corps of Engineers and southeastern aquatic resource partnership (SARP), are the stacked according to height, Ecosystems breakwater. Originally designed as a underwater reef, I saw the potential in these systems as a breakwater. The manufacturer was contacted about using the proposed oysters modified system as breakwaters. Little flower school created the first eco disc to use at Deadman's island. Oyster shells were added to these breakwaters, and these breakwaters were placed in a design where wave action could be deflected and reduced. The discs were stacked on a hollow Pearson piling. The piling was driven 6 feet in the ground. It's not recommended to use wooden pilings for the structures. Wooden pilings under heavy pressure with each disc that weigh over 200 pounds each and a minimum of five discs on each piling would break, crack or weaken the wooden piling. These new modifications will be monitored over the years for structural and functional stability. A substantial amount of funding is needed to replace the 840ft of Reefblks with a functional breakwater not dependent on oyster growth but yet enhances oyster growth and fish populations. However; the main priority is to complete the entire footprint of breakwater surrounding the area. This includes the 250feet left of open area within the permitted footprint. There were legal issues at the time, therefore it was important to maintain the shape and design of the sand placement.

2) Maps containing pertinent information- See attached timeline survey

3) Summary of any data related to the project collected to date. Very little spat observed this season until fall, but the what spat settled did not survive. It is anticipated predators killed any spat which settled. No oysters but the number of fish and crabs are increasing which mostly feed on these predators. Drill population is still present.

4) Monitoring results- Summary- *Full explanation of 2013 results are found in ACOE Estuary Act 2013 draft report*

2012 summary - there were no oysters or spat found on the original reef block reefs. There was an abundance of fish eggs on the old oyster shells, which have fallen off the bags during 2010 and 2011.

On the entire reef which includes the Reefblock and the Ecosystems. The drill population has reduced to 25%, the Stone crabs, sheepshead, gray trout, spadefish and mangrove snapper have increased 60%. Oyster spat on the entire reef was approximately 4%.

Other species found on the reef was coral (Astrangia danae), tube worms and other polychaetes and unusually small horseshoe crabs and a scallop was found in the sand next to the Ecosystems.

Present/absent Benthic- 10% of polychaetes were found within the substrate.

2013 monitoring results

2013 summary -Reefblks there were no oysters or spat found on the original reef block reefs. There was an abundance of fish eggs on the old oyster shells, which have fallen off the bags during 2010 and 2011. There was a 65% decrease in shell loss and 75% in wave attenuation since the structures are below mean high water. The red algae is fairly thick on the mesh bags which inhibits any type of spat settlement.

On the entire reef which includes the Reefblock and the Ecosystems. The drill population has reduced to 25%, the Stone crabs, sheepshead, gray trout, spadefish and mangrove snapper have increased 80%. Oyster spat on the entire reef was approximately 64%.

According to monitoring results when ecosystems were abundant with oyster coverage, the Ecosystems appear to attract oysters and more fish than the reefblks (Due to design) and is extremely sturdy and a structural component in high wave actions and storms. The center section of the Reefblks housed small juvenile fish. These juveniles could move in and out of the mesh and therefore could be protected from the larger predator fish outside of the reef.

Present/absent Benthic- 20% of polychaetes were found within the substrate.

Overall, the project is still considered successful in 2013. There is a large build up of sand, the west point has been restored to 1972. The fish and oyster population have been more abundant than any other year. The presence of birds in the restoration site has increased. The erosion caused by the continued loss of oyster shell in the northern

reef and the open area with no breakwater is the biggest concern. When these two phases are funded, it is anticipated, this project, will be complete and goals will be reached in regards to restoring Deadman's Island.

Highlights of Volunteer projects of Deadman's Island 2008-2013

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Fig.1 – Hurricane debris cleanup 2008

Fig. 2 –Gulf Breeze Interact Club participating in a planting 2008

Fig. 3 – The first community planting of Deadman's Island, Ray Palmer and Mike Wein 2008

Highlights of Volunteer projects of Deadman's Island 2008-2013

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Fig.4 – Deadman's Island cleanup

Fig. 5 – The first Grasses to Classes of Gulf Breeze High School

Fig. 6 – Rotary Club volunteer day

Fig. 7 – Hurricane clean up

Highlights of Volunteer projects of Deadman's Island 2008-2013

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Fig. 8 – mapping and planting along the eroded north end 2008

Fig. 9 – Our first volunteer crew 2008 – Includes Mike Wien and Wayne Lee.

Fig. 10 – Father- daughter planting and fence project

Fig. 11 – Hard working volunteer

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Fig.12 – More debris clean up

Fig. 13 – Isthmus planting

Fig. 14 – Oyster bag filling volunteer event

Fig. 15 – Teaching the ecological benefits of shoreline stabilization

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Fig. 16- a bandaid attempt of shoreline protection to allow plants to become stabilized 2008

Fig. 18 – Signs made by the students

Fig. 17 – Volunteers placing temporary shoreline protection 2008

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Fig.19 – mass amount of fossilized and recycled shell for the breakwaters

Fig. 21 – Sporrey- Reed tents- after one weekend of placement

Fig. 20 – Volunteer filling oyster bags

Fig. 22 – Volunteer planting

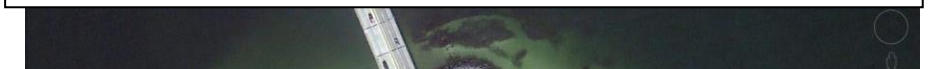

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Fig. 23 – Students of Catholic High School coastal cleanup

Fig. 24 – Make a Difference Day shoreline planting

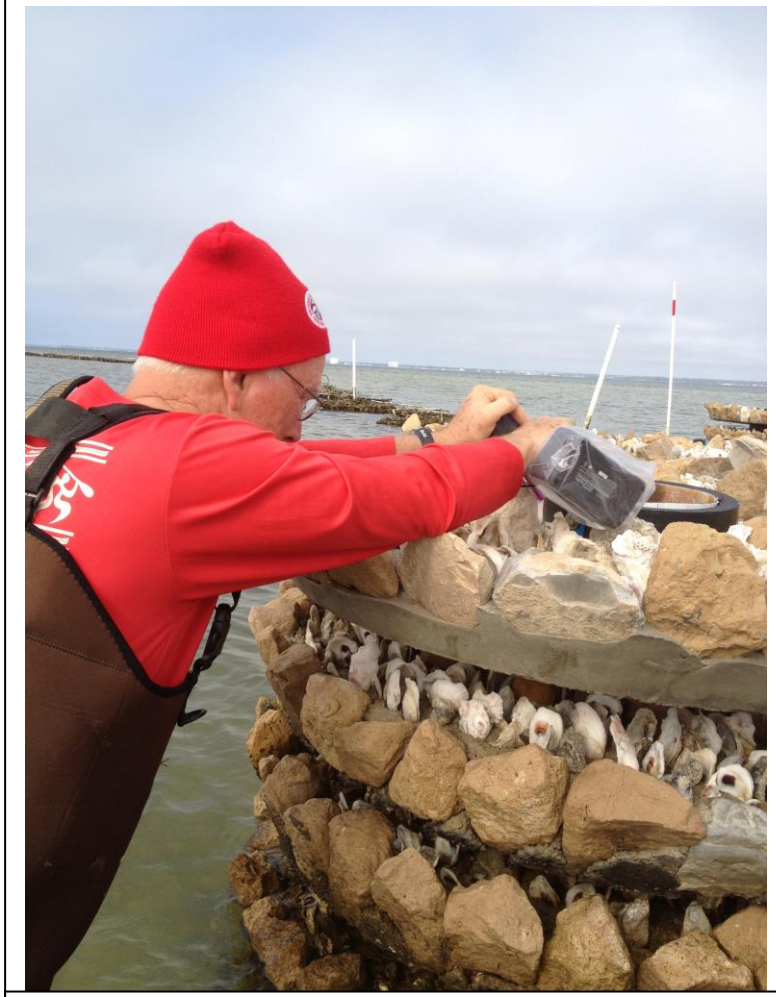

Fig. 25 – Volunteer, Joe Concannon, drilling into the collars and placing number tags on the Ecosystems

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Fig. 26 – Planting vegetation on the newly trapped sand

Fig. 27 - Wayside shores facing Northwest 2012

Fig. 28 - Wayside shores facing South 2012

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Fig.29 – Church group building monitoring quadrats

Fig. 31 – Volunteer planting 2011

Fig. 30– Setting up additional Sporrey- Reed tents

Fig. 32 – Marine education day 2011

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Fig. 33 – Oyster drill picking party 2010

Fig. 34 – GE Company volunteer planting, clean up and monitoring event

Fig. 36 – Loading up the plants for volunteer day 2011

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Fig.37 – Marine Education Event

Fig. 38 – Garden Club

Fig. 39 – The Garden Club planting event

Fig. 40 – The Garden Club planting event

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Fig. 41 – Volunteer event GE team

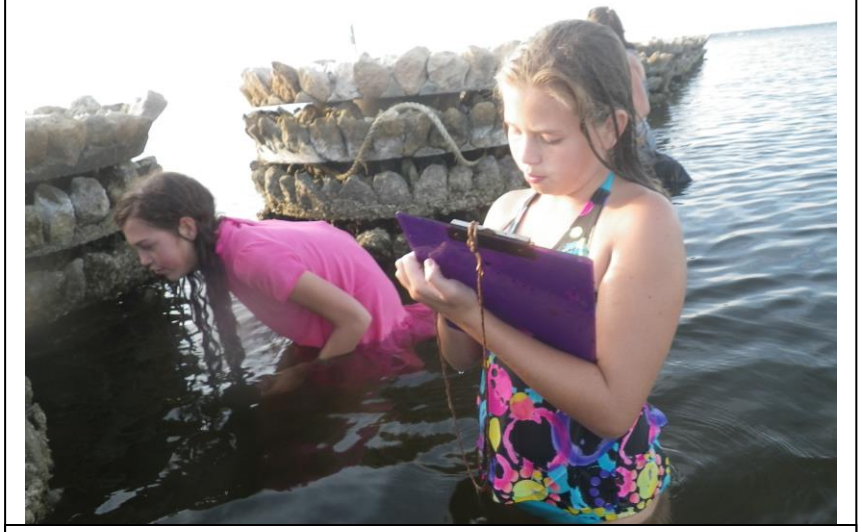

Fig. 42 – Girl Scout water badge project

Fig. 43 – Pine Forest Garden Club

Fig. 44 - Wayside shores facing East 2012

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Fig.45 – Planting more vegetation on shifted sand

Fig. 46– Catholic High 2012

Fig. 47 – emergent vegetation planting

Fig. 48 –Maritime History underwater Educational Kiosks

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Fig. 49 – Volunteers help build educational kiosks

Fig. 51– Historical culture underwater educational kiosks

Fig. 50 – building the covers for the underwater educational kiosks

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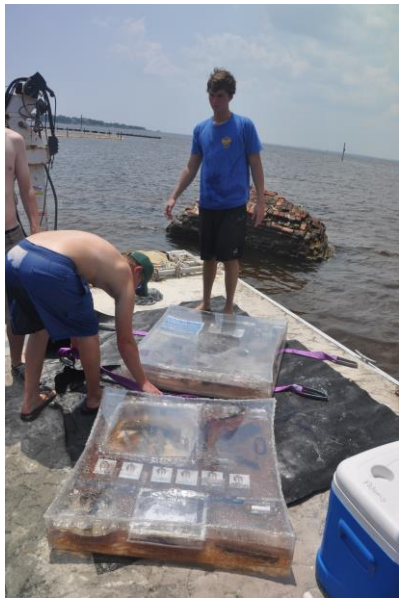

Fig.52 – Deploying the underwater educational kiosks

Fig. 53 – Catholic High School Make a difference day

Fig. 54 – Volunteer planting event 2012

Fig. 55 – Giant Coir log UWF volunteer project

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Fig. 56 – Socialize With Education Sponsored planting event

Fig. 57 – Volunteer event retrieving and replacing old, torn barrier

Fig. 58 – Maintaining the barrier requires much maintenance due to being buried by storms

Fig. 59– 2013 planting

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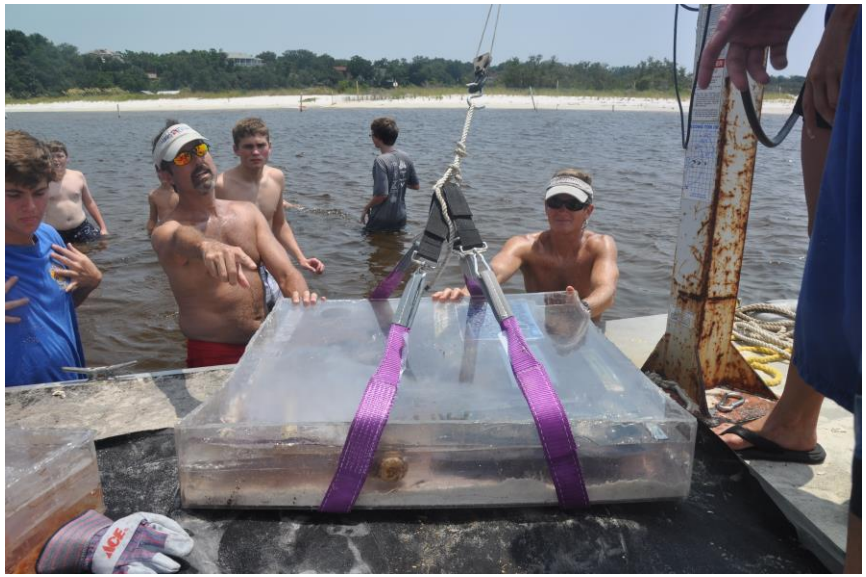

Fig.60 – Deploying underwater educational kiosks

Fig. 61 – Deploying the underwater maritime history kiosk

Fig. 62 – Deploying the Gulf Sturgeon receiver monitors

Fig.63 – Removing a bad resin layer for the underwater educational kiosks

Highlights of Volunteer projects of Deadman's Island 2008-2013

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Fig. 64 – Maritime underwater educational kiosk

Fig. 66 – Using a pvc pipe to dig deep for bare root Spartina alternaflora

Fig. 65 – Barrier maintenance

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Fig. 67– Student finding an inventive method to dig a hole for plants

Fig.68 – measuring the shoreline erosion from the shoreline to the reference pipes

Fig. 69 Volunteer planting event 2013

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Fig. 70 – bring in damaged barrier curtain

Fig. 71 – Chic Fil-A Marine Education Family Night Island

Fig. 72 – creating inventive ways to remove buried barrier

Fig. 73 – Mother teaching daughter about the light meter