Santa Rosa Dunes Condominium

Shoreline Stabilization Project

For the Santa Rosa Dunes Homeowners Association

By Heather Reed, Ecological Consulting Services

2016

ECS

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Santa Rosa Dunes Condominium

Shoreline Stabilization Project

Site History

Santa Rosa Dunes is located on the sound side of Pensacola Beach, Florida. Originally, the shoreline was a typical wetland with scrub brush bordering the boundaries of the dune vegetation and Gulf Shoreline of Pensacola Beach. Overtime, as vegetation was lost or filled, the site became more sandy. Historically, this area was the location of a reconstruction of an old 1723-1724 Spanish village. The Spanish Village became the site of the current Santa Rosa Dunes Condominium (Figure 1).

FIGURE 1:1959 PHOTO OF THE SOUND SIDE OF PENSACOLA BEACH AND THE CURRENT LOCATION OF THE SANTA ROSA DUNES HOMEOWNERS ASSOCIATION (PHOTO CREDIT: DEPARTMENT OF COMMERCE COLLECTION: FLORIDA STATE HISTORIC PRESERVATION OFFICE)

Project Goal

The project goal was to protect the shoreline and the western land slope of the Santa Rosa Dunes Condominium homeowners and prevent historic remnants, from the historic Spanish Village, from unearthing and being destroyed. The project site has a bank of riprap protecting un-stabilized upland sand. Wind erosion was slowing impacting and wearing the upper slope as the rip rap slid down the slope in to the water. The wave action was causing the existing rip rap to scour and slowly slide into the water, causing the slope to slowly erode the property of the Santa Rosa Dunes Condominium owners.

Shoreline History

The documented shoreline erosion began when an adjacent homeowner built a westerly seawall. This homeowner, whom also needed to protect his property from another adjacent seawall. The adjacent seawalls and riprap restricted the longshore current and blocked sediment transport. Sediment transport is necessary to nourish the beach and maintain the current shoreline. The shoreline change was tracked using aerial photography and ARCGIS (Figure 2). According to aerial photos dating to 1994, the lack of sediment caused ongoing erosion and eventually unearthed the remains of the foundation of the building from the Spanish Village closest to the sound side (Figure 1).

The shoreline change is represented by colored lines; each line has a date associated with it. For example, 1994 is red, 2012 is gold, etc. There were no legible aerials for 2010 and 2011. There is no readily available aerials of the same elevation to measure prior to 1994. The most erosion occurs from 1994 to 2012. The purple line for 2013 shows the location of the shoreline near the existing breakwater.

Santa Rosa Dunes Shoreline Change Full View

FIGURE 2: SANTA ROSA DUNES SHORELINE CHANGE FROM 1994 TO 2016.

The homeowners took many actions to maintain the historic natural setting of the shoreline landscape to prevent further erosion, however, the adjacent westerly seawall to the west of the property, continued to create significant erosion.

After several storms, the homeowners had no alternative but to continue the hardening of the shoreline using riprap and sand fill to repair the shoreline. The riprip was placed starting from the westerly section of the property and ending under the bridge.

The riprap was affecting the shoreline from the topside and the bottom side. Overtime the riprap continued to slide down the slope of the western shoreline and scoured from the lower part of the tidal floor underneath the rip rap. As the scouring continued, the heavy rip rap on the western side slid down the bank and exposed the upland area on top of the slope, to wind erosion. The riprap located under the bridge was the end point of placement. This placement mosly caused the same affect of the adjacent seawall and continued to scour the property to the east.

To protect the historical anomalies and the shoreline, the homeowners sought a permit for a shoreline stabilization project.

Project History Phase One -2012

In 2012, The phase one project consisted of placement of a wave-attenuator consisting of bagged recycle oyster shell and riprap placed ten feet of mean high water. Shoreline vegetation was planted behind the breakwater in the water. About 20% of the existing riprap was used for the project and the rest of the materials were trucked on site. All deployment was upland. Upland vegetation was planted along the slope as the existing riprap was removed.

Phase one consisted of 100 linear feet of the breakwater and oyster shell filled bags. Twenty thousand plants of shoreline vegetation and dune vegetation were planted behind the breakwater. Each breakwater has a length of 20 feet with a three foot sheltered spacing to allow fish passage. The vegetation stabilized the shoreline behind the breakwater and allowed accretion of sand behind the breakwater.

Four types of vegetation were planted to allow pioneer growth, to start a viable root system and long term growth of a deeper root system, to continue to accrete sand behind the breakwaters and protect the historical anomaly and the shoreline.

The design of the breakwater followed the natural contour of the shore and was placed ten foot from the surveyed mean high water.

The breakwater height was constructed to be a lower height under water as the breakwater approached under the dock. The breakwater size and height was reduced to allow tidal passage and accrete sand behind the breakwater. Rip rap was already behind the dock to protect the property. This small section, as with the westerly seawall, caused additional scouring of the soft sand on the eastern side of the dock and along with the abnormally high tides, killed off the shoreline and upland vegetation which was holding the shoreline together.

Santa Rosa Dunes Shoreline Change Section A

FIGURE 3: SHORELINE CHANGE FROM 1994-2016 FOR SECTION A WESTERN SIDE

FIGURE 4: PHASE 1 PURCHASED OYSTER SHELL LOADED INTO MESH BAGS

FIGURE 5: PHASE 1 CONSTRUCTION OF THE BREAKWATER

Preparation

Preparing a project is essential for the health of the environment and ecosystem about to be created. Figure 4 shows oyster shells in the mesh bag. These shells will make micro reefs in the water. All shells are thoroughly washed and dried out in the sun before placement in the water. All rock are washed before placement in the water. This method will reduce sedimentation which can initially kill fish and smother seagrass.

Figure 6: Before photo of phase 1 2011 and after photo 2015

Figure 7: Aerial of completion of Phase 1

Santa Rosa Dunes Shoreline Change Section B

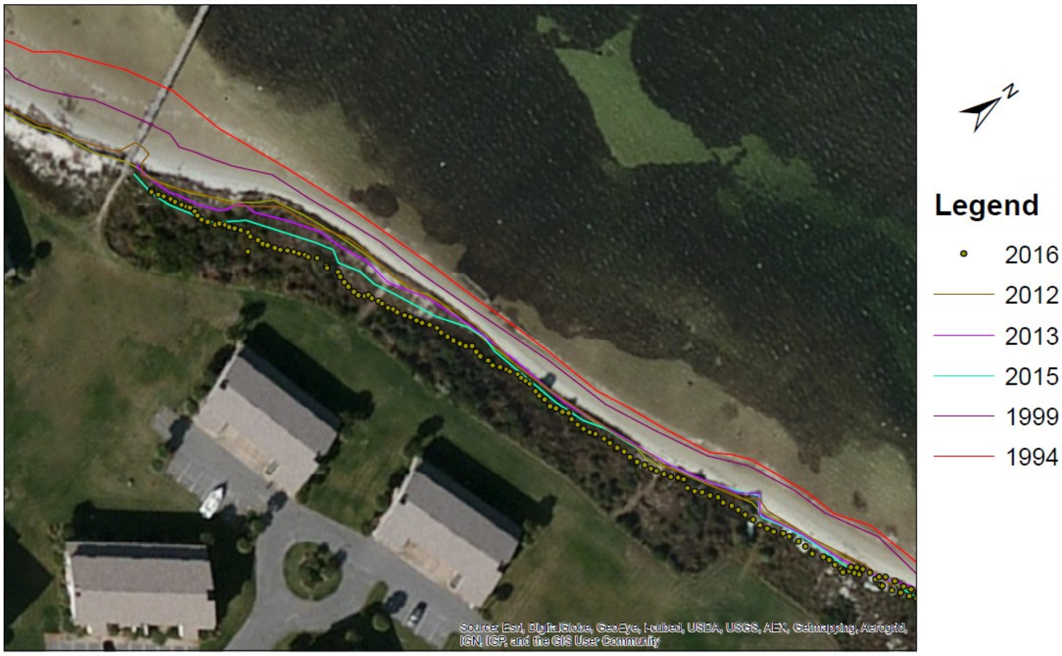

FIGURE 8: SHORELINE CHANGE FOR SECTION B IS EAST OF THE EXISTING DOCK FROM 1994- 2016

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Phase Two - 2016

Phase two is a progressive impact reduction project. This project is intended to alleviate the impact from the harsh wave action, the scouring from the rip rap under the dock, and lessen the strength of the shoreline current. Erosion is expected to slow where vegetation becomes established on the shoreline. In 2016, another permit was acquired to place 175 feet of the breakwater in front of the shoreline east of the dock. Nine staggered-20' x 5' x 4' riprap and oyster breakwaters (total footprint of 900 square feet) along 175' of shoreline along which will be planted native emergent vegetation. The breakwaters consisted of 2 layers: riprap and oyster shell. This breakwater was designed differently than phase one due to the distance of how the waters travel in the bay. This action is known as fetch. For this site, the fetch distance ranges from 11 miles, 8 miles, six miles, and two miles. The breakwater was similar to Phase 1 except the breakwaters were staggered to offset the long distant fetches which impact the property. The breakwater was placed offshore and designed in sections to block the 8 mile, fetch 6 mile fetch and two mile fetch.

Figure 9. Fetch Impact to Santa Rosa Dunes Project the normal fetch distance is 6 miles (Yellow), 7 miles, 2miles and 2.5 miles (Red)

The length of one hundred and seventy five feet was chosen due to the location of the seagrass and the historic shoreline change. Seagrass beds which lie underwater are known for the benefits of onshore shoreline stabilization. The seagrass root system is a very resilient protective mat and stabilizes the shoreline underwater. Due to higher tides, it is not common for seagrass beds to be destroyed during storms. Seagrass beds are usually destroyed by anthropogenic activities such as anchoring, prop scarring from boats and dredging. Santa Rosa Dunes Homeowners Association recognizes this and has placed mooring anchors which allow boats to be secured with out destroying the seagrass. This step has been instrumental in protecting the far east shoreline. The east shoreline has a very healthy seagrass bed which developed over many years. Along the rest of the shoreline, the emergent grass vegetation root system, and rhizomes are very thick and sturdy and possibly sustainable by adding a few additional plant types The far east section of the property, the recreational beach section, appears to be increasing in size. This would mean less vegetation and future erosion. In the middle section of the property, on the shoreline, there is erosion but not as accelerated as the westerly portion of the property. This erosion on the far east of the property is most likely due to the strong north winds. Gulf Breeze blocks the longer fetches on the far east location and protects the east section. In this site, the protective shoreline vegetation is not present and contains mostly upland vegetation. Overtime, if wetland shoreline vegetation is not planted, this area will experience future erosion because the upland plants located, although are saltwater tolerant, are not designed to be in salt water.

Concerns

Normally, once hardening of the shoreline is started, there is a domino effect to the adjacent property. Recently, in the past three years, the tides have been abnormally high and usually one foot greater than the NOAA prediction charts. These high tides have cause havoc to shorelines all over the Pensacola Bay and sound side area. The higher tides can eventually kill and uproot upland vegetation. The current vegetation which is not accustomed to constant higher tides and salinity, cause sand to cover the shoreline and the area of dying grasses becomes vulnerable to erosion.

The methods of Phase one and Phase two was the best plan of action at the time for this site. The concern of placing a breakwater along the entire property is the whether the adjacent shoreline and neighboring property will be impacted through a domino affect. If the shoreline can remain stabilized, there will be no need for the additional expense of a breakwater. In the situation of Santa Rosa Dunes shoreline property, the length of the property (~900 feet) is not completely eroding, and the breakwater length was be reduced to a shorter distance. For future considerations, instead of using a breakwater and obtaining various easement required by the Florida Department of Environmental Protection permitting department, it would be more cost effective and beneficial to place more of the appropriate wetland vegetation in front of the existing vegetation. The current vegetation is not shoreline stabilization vegetation.

Seagrass

Seagrass is a natural stabilizer. Notice in Section C (Figure. 10). The only real erosion is the beach area to the east. The shoreline in front of the seagrass has changed VERY little over the years. Once again this is because of underwater seagrass root system stabilizing the shoreline. If the seagrass ever gets destroyed and boaters keep anchoring in the seagrass, this shoreline area will also face erosion. If the beach recreational area sandy area becomes larger, the sand may also erode, reducing the shoreline.

Santa Rosa Dunes Shoreline Change Section C

FIGURE 10: SHORELINE CHANGE OF THE EASTERN SECTION OF THE PROPERTY

Reinforcing the shoreline with a wetland buffer

Through a site inspection of the property, a natural *juncus* wetland buffer was once present along the shore. The wetland buffer and scrub have been choked out and smothered with sand most likely through storms. The entire middle area of the buffers contained dead vegetation. The root system of the *juncus* marsh, below the buffer area, was still intact and very deep. This dead vegetation in phase two was cleared by the excavator. Additional soil appropriate vegetation, which once existed in this site and trees were planted to restore this area. If the *juncus* area remains wet, this root system is expected to come back. It is not anticipated to become a wet marsh such as a mosquito pond. It does need to be somewhat wet to restore the root system. This type of system is the betting system to protect property from the tidal influx. The stabilization plants need to be able to tolerate long term salt water intrusion.

Restoring the wetlands, although may not be as aesthetic as a sandy beach, are the best alternative for protecting the shorelines. The solid root system protects the property from shoreline erosion.

It is suggested to create small wetlands in front of and behind the shore to have a secondary reinforcement in case the existing brackish vegetation fails. The current vegetation along Section C is not the primary vegetation for underwater stabilization. The root system along the shoreline is sustainable at this time, but long term, with the constant exposure to saltwater, the exisitng vegetation cannot survive and die off and can loosen the soil. This loose soil is susceptible to continued erosion which cause more property loss.

Sea Level Rise

The question arises, why have the water lines appeared to be higher and seem to be eroding more shoreline?

After carefully studying the National Oceanographic Atmospheric Administration (NOAA) database of the Pensacola Beach area, the answer is very abnormally high tides (Fig. 11).

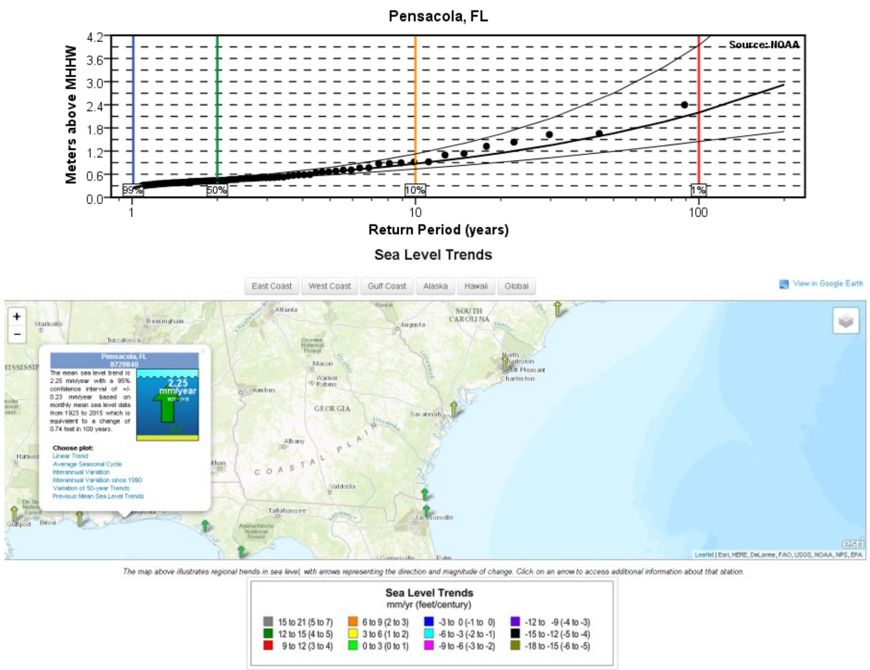


FIGURE 11: SEA LEVEL TREND FOR PENSACOLA BEACH 2.25 MM/YEAR IS PREDICTED WITH A CHANGE OF 0.74FEET OVER A 100 YEAR PERIOD.

Station ID

The Federal NOAA Water Level Observation Network (30.404 N 87.211 W) and Buoy station is located at the port in Pensacola, Florida. There are other buoys stations offshore of Pensacola Pass and Mobile Bay used as a cross reference for the Gulf but the wind action and movement through the deeper water is not a good indicator. This information for this station can be found http://www.ndbc.noaa.gov/station_page.php?station=pclf1 (active site as of July 9, 2016).

When examining the historical data of tide charts in 2016. The year 2016 showed abnormally high tides. The blue color represents the tide prediction charts which is what is used in planning according to tides.

2016 Historic Tide Data- Verified

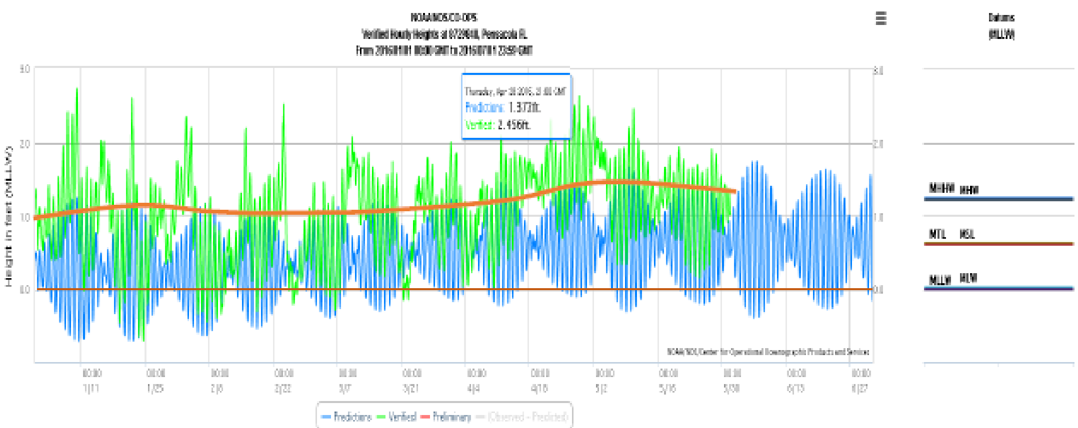


FIGURE 12: THE 2016 HISTORIC TIDES DATA FROM STATION # 8729840. THE BLUE LINES ARE THE PREDICTED TIDES GIVEN, AND THE GREEN LINES ARE THE VERIFIED TIDES WHICH WERE THE ACTUAL TIDES. THE ORANGE LINES SHOW THE DIFFERENCE BETWEEN THE VERIFIED AND THE PREDICTED. IN SOME CASES FROM JANUARY TO JULY, THE TIDES WERE 1.3 FEET HIGHER THAN NORMAL TIDE. FROM JULY TO DECEMBER THE TIDES WERE ALSO APPROXIMATE 1.2 FEET ABOVE NORMAL EXCEPT A FEW STORMS IN OCTOBER AND NOVEMBER RAISING TO 2.09 FEET ABOVE NORMAL.

The green color represents the actual tides for that day or month. The actual high tides were much highe than the predicted tides through out the entire year. The predicted tides are from models based on the last 100 years. In most cases, not only was the high tide greater than normal but the low tide in some months represented more of a high tide and remained above zero high water. In other words, the verified data, which is green, shows the low tide were absent at a time when salt tolerant plants needed to recover from the lengthy duration of high tides.

In the month of March through May, it shows the higher tides are 1.5 higher then the average. This boundary is indicated by the orange tideline. The lower tides are a half a foot higher than the average low tide. This suggests in the month of March through May the brackish vegetation along the shoreline may have suffered through out the Bay from salt-water inundation. This salt-water inundation would not allow the plants to recover from the extremely high tides for months.

This saltwater inundation was also observed in nearby areas of Pensacola Bay, such as another highly studied area, Deadman's Island. Extremely high tides and north winds in April transported sand in areas of no breakwater and smothered the upland dune vegetation and the dunes eroded causing a breach into the saltmarsh. An adjacent seawall is also causing more scouring and loss of land, this high tide event accelerated the problem. In some cases and other areas around Deadman's island, during the unforgiving high tides, sand shifted and smothered the upland plants, erode living shoreline and moved the isthmus twenty feet into Gilmore bayou.

Throughout the months of January February and April, May and June, the tides for higher than normal from .252 feet to 1.0 feet higher than normal.

2015 Historic Tide Data- Verified

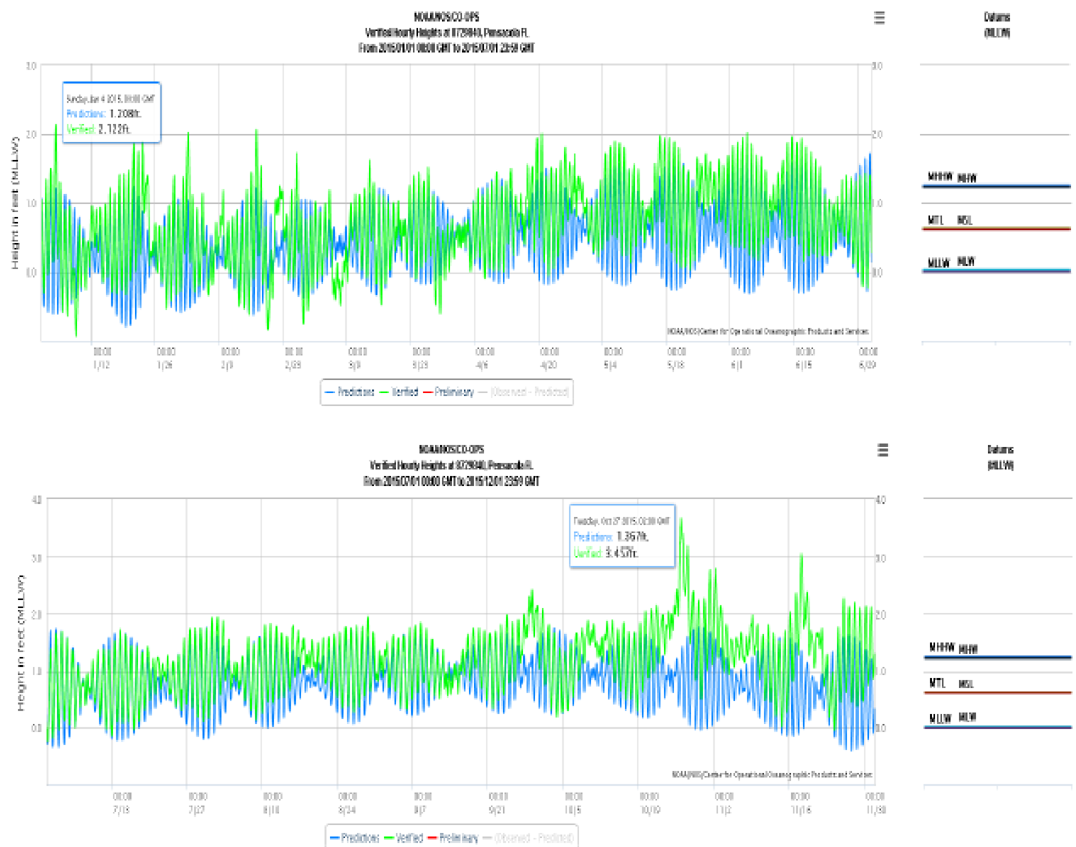


FIGURE 13. 2015 HISTORIC TIDES DATA FROM STATION # 8729840. THE BLUE LINES ARE THE PREDICTED TIDES GIVEN, AND THE GREEN LINES ARE THE VERIFIED TIDES WHICH WERE THE ACTUAL TIDES IN SOME CASES FROM JANUARY TO JULY, THE TIDES WERE .69 FEET HIGHER THAN NORMAL TIDE. FROM JULY TO DECEMBER THE TIDES WERE ALSO APPROXIMATE .85 FEET ABOVE NORMAL EXCEPT A FEW STORMS IN OCTOBER AND NOVEMBER RAISING TO 2.45 FEET ABOVE NORMAL.

In April, May and June 2015, low tides were also higher than normal and never actually allowed a normal low tide. In all months of 2015 after July, the verified high tides ranged from 1 to 2 1/2 feet above normal tide. In the months of November and December where we are supposed to have extreme low tides, this was an average summer tide, which was 1/2 to 1 foot higher than the normal low tide.

2014 Historic Tide Data- Verified

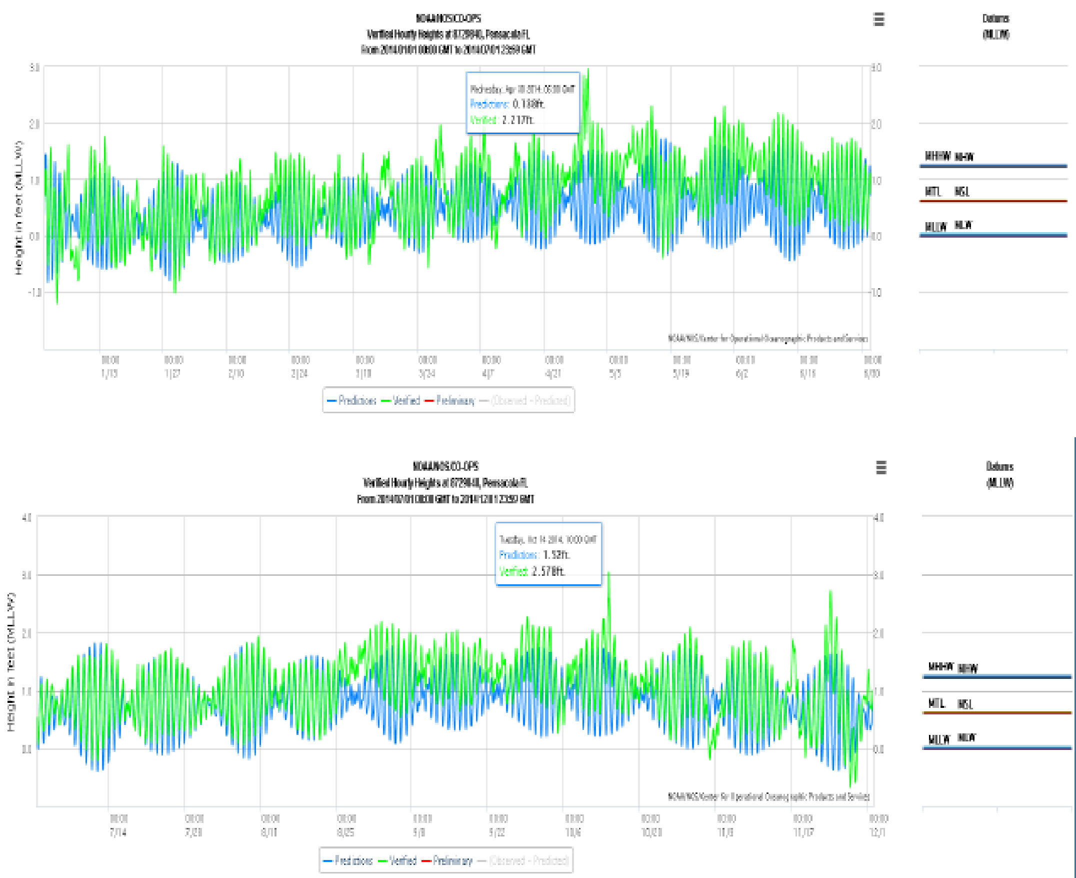
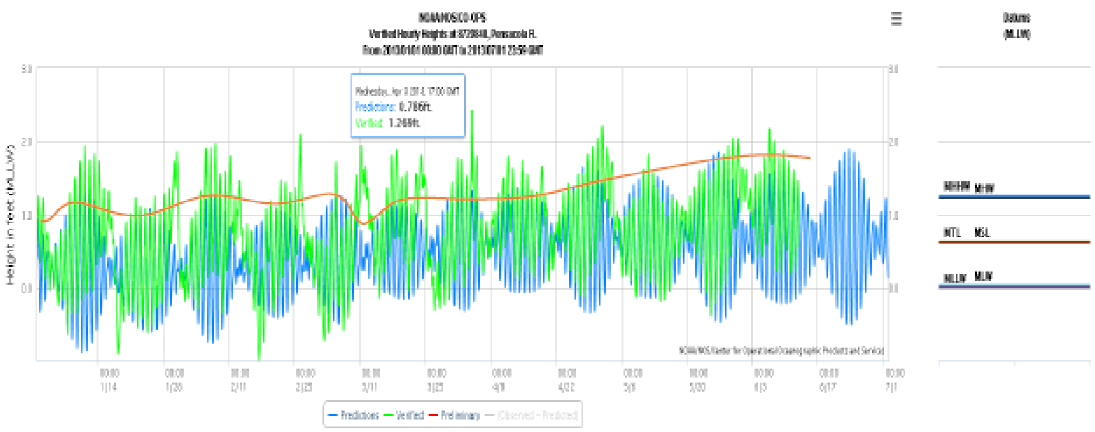


FIGURE 14: 2014 HISTORIC TIDES DATA FROM STATION # 8729840. THE BLUE LINES ARE THE PREDICTED TIDES GIVEN, AND THE GREEN LINES ARE THE VERIFIED TIDES WHICH WERE THE ACTUAL TIDES. IN SOME CASES FROM JANUARY TO JULY, THE TIDES WERE 2.079 FEET HIGHER THAN NORMAL TIDE. FROM JULY TO DECEMBER THE TIDES WERE ALSO APPROXIMATE 1.058 FEET ABOVE NORMAL.

2013 Historic Tide Data- Verified



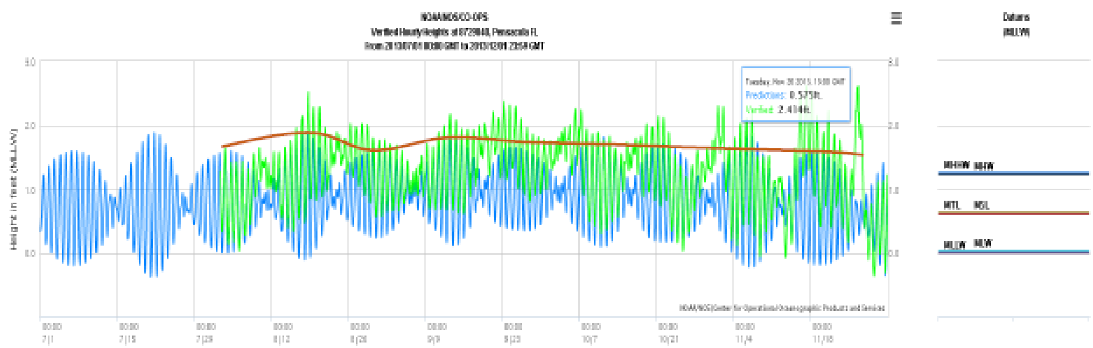


FIGURE 15: 2013 HISTORIC TIDES DATA FROM STATION # 8729840. THE BLUE LINES ARE THE PREDICTED TIDES GIVEN AND THE GREEN LINES ARE THE VERIFIED TIDES WHICH WERE THE ACTUAL TIDES. THE ORANGE LINES SHOW THE DIFFERENCE BETWEEN THE VERIFIED AND THE PREDICTED. IN SOME CASES FROM JANUARY TO JULY, THE TIDES WERE 1.19 FEET HIGHER THAN THE NORMAL TIDE. FROM JULY TO DECEMBER THE TIDES WERE ALSO APPROXIMATE 1.839 FEET ABOVE NORMAL.

Final Recommendation

Santa Rosa Shores is an ideal place for any resident who appreciates nature. The rare natural, healthy seagrass bed is a field for nursery grounds for fish. The site is a beautiful recreation site for kayaking, paddle boarding, snorkeling, fishing and mainly to provide stabilization to protect a homeowners investment. Seagrasses are the kidneys to the bay. Educating the homeowners about seagrasses is important. Not only for the benefit of the environment and improving fishing and nursery grounds, but to protect their investment. It is important to stress, to keep boats from anchoring in the seagrass. Each anchor tears a root system and like a ripped mesh, the root system will continue to fray once impaired. Once impaired the underwater seagrass system can no longer provide stabilization to the shoreline.

In Section B, east of the dock, if the root system of the current marsh dries out, it is imperative to replant a new marsh with the appropriate plants. This will double the reinforcement of shoreline from storm surge. Currently, the restoration of the wetland seems to have recovered.

Section C shows a stable shoreline, but the current salt tolerant plants along the shore need reinforcement, waterward, by wetland plants that can tolerate the saltwater. It is recommended to plant only new wetland vegetation in front of the existing vegetation. This vegetation will help trap sand. Behind this shoreline, it is recommended to remove the dead vegetation by cutting only and replanting more soil appropriate bushes and plants.

The east end of Section C (Fig. 10), is where the property's beach area is. This beach will eventually erode more over time from the lack of stabilization of the root system. To keep the beach area the same size, and prevent any further vegetative stress from trampling , it is important to create a nice vegetative border of bushes to maintain the boundaries of the beach. The bushes are less likely to get trampled and will protect the shoreline grasses. Section C East, is also the highest area of boat anchorings in the seagrass. Distributing educational pamphlets and signs about seagrass and the importance of keeping the root system intact, enforcing the mooring buoys and discouraging anchoring, may help alleviate any impact to the rare inshore grass beds.

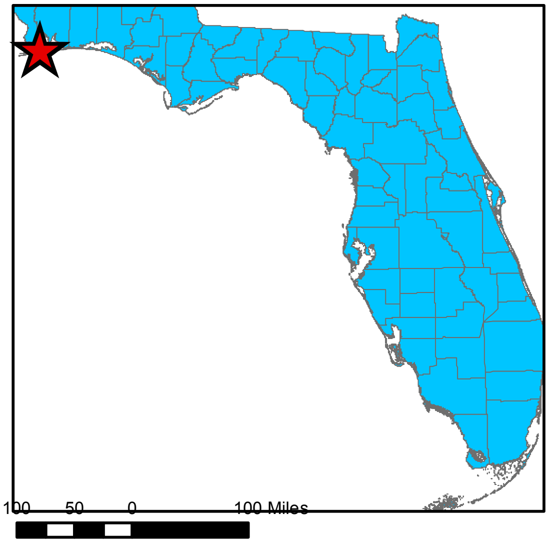
Summary

In summary, years ago the homeowners were faced with erosion because of the construction of a western seawall. In the phase one shoreline stabilization project, the homeowners agreed to control erosion and try to reduce the effects of scouring and to protect property, rocks were placed on the slope through adding a breakwater an living shoreline. Phase Two is expected to slow the domino effect of erosion. The project was placed only on a portion of the 800 foot shoreline. One hundred and seventy five feet of breakwater with tapering the riprap on the eastern slope ten foot from the mean high water. This taper is expected to reduce the wave impact along the shoreline transport.

The aerial shoreline change shows the shoreline eroding since 1994. The shoreline change map shows very little erosion in the far eastern section of the property. Although, currently it may appear the shoreline is eroding at an exponential rate this year (2016). We have had abnormal high tides which cause the water to come up higher over the shoreline. It may appear there is no sandy beach area on the east end. In reality, the sand and shoreline is still there but the tides are higher and this area is under water. Phase two is expected to protect the shoreline, accrete sand and re-nourish the location as long as no human stressors such as widening the beaches and anchoring in seagrasses occur. The NOAA charts from 2013-2016 show the shoreline on the east end has not eroded in the past two years; it is suspected to just be the abnormal high tides. If the existing vegetation along the shoreline stays intact, the shoreline is expected to return, once the tides are normal. The abnormal high tides can stress the existing upland plants along the shoreline. Some of these plants are observed as uprooting and dying off. If additional reinforcement of wetland vegetation is not planted in front of the existing vegetation the high tides with cause slow die off the non wetland vegetation and cause more erosion.

As long as the seagrass beds are not disturbed or damaged, it is expected the seagrass will keep the far eastern end from the eroding at a fast rate.   By planting more emergent shoreline vegetation in a strategic manner, more of the Santa Rosa, Dunes property can be protected long term and for future generations to come.

Project Vicinity Map - Santa Rosa Dunes Condominiums
Pensacola Beach, Escambia County



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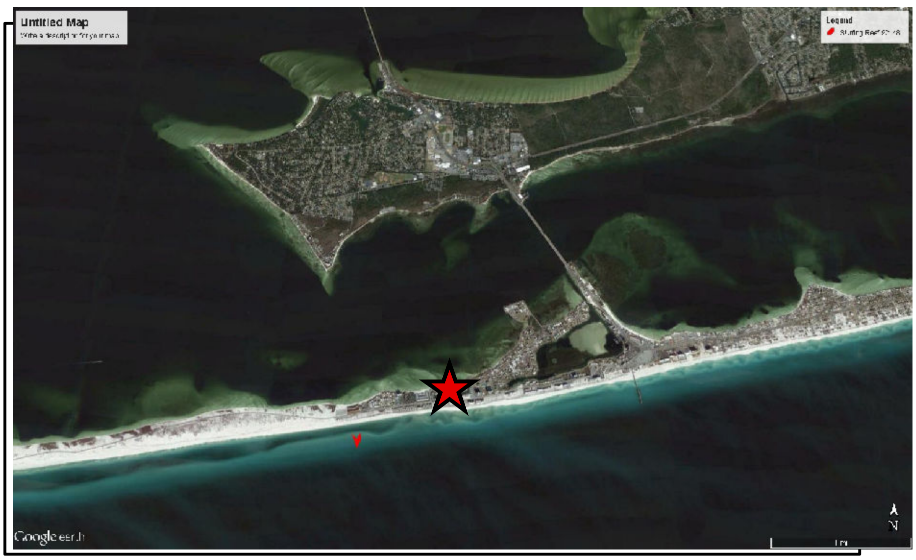

Pensacola Beach

900 Fort Pickens Road

ECS

Date: 7/3/2016
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Santa Rosa Dunes Shoreline Change Full View

Legend

- 2016
- 2012
- 2013
- 2015
- 1999
- 1994

200 100 0 200 Feet

Reference Scale: 1:0

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree Elevation:NAVD 88

Author: Project Manager, Heather Reed
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850-417-7004

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Santa Rosa Dunes Shoreline Change Section A

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree Elevation:NAVD 88

Author: Project Manager, Heather Reed
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850-417-7004

ECS

Santa Rosa Dunes Shoreline Change Section B

Reference Scale: 1:0

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree Elevation:NAVD 88

Author: Project Manager, Heather Reed
www.ecologicalconsultingservices.com
850-417-7004

ECS

Santa Rosa Dunes Shoreline Change Section C

Reference Scale: 1:0

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree Elevation:NAVD 88

Author: Project Manager, Heather Reed
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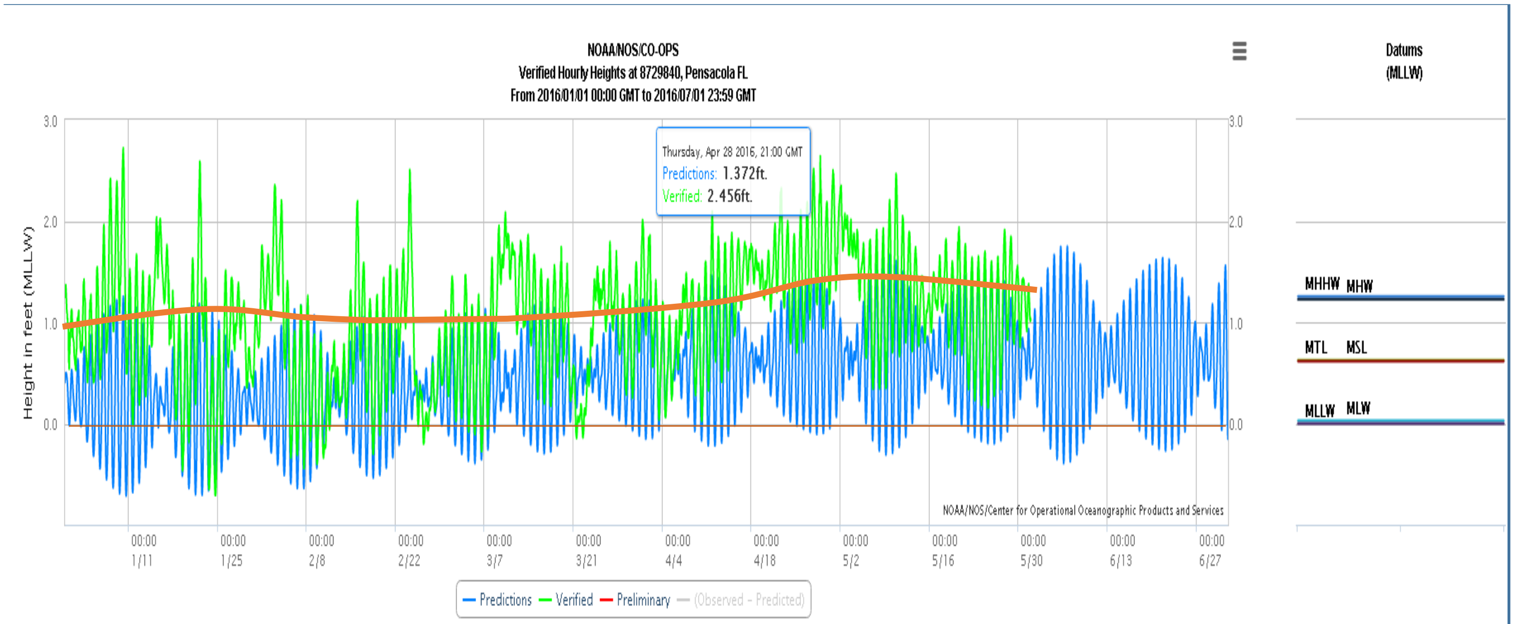
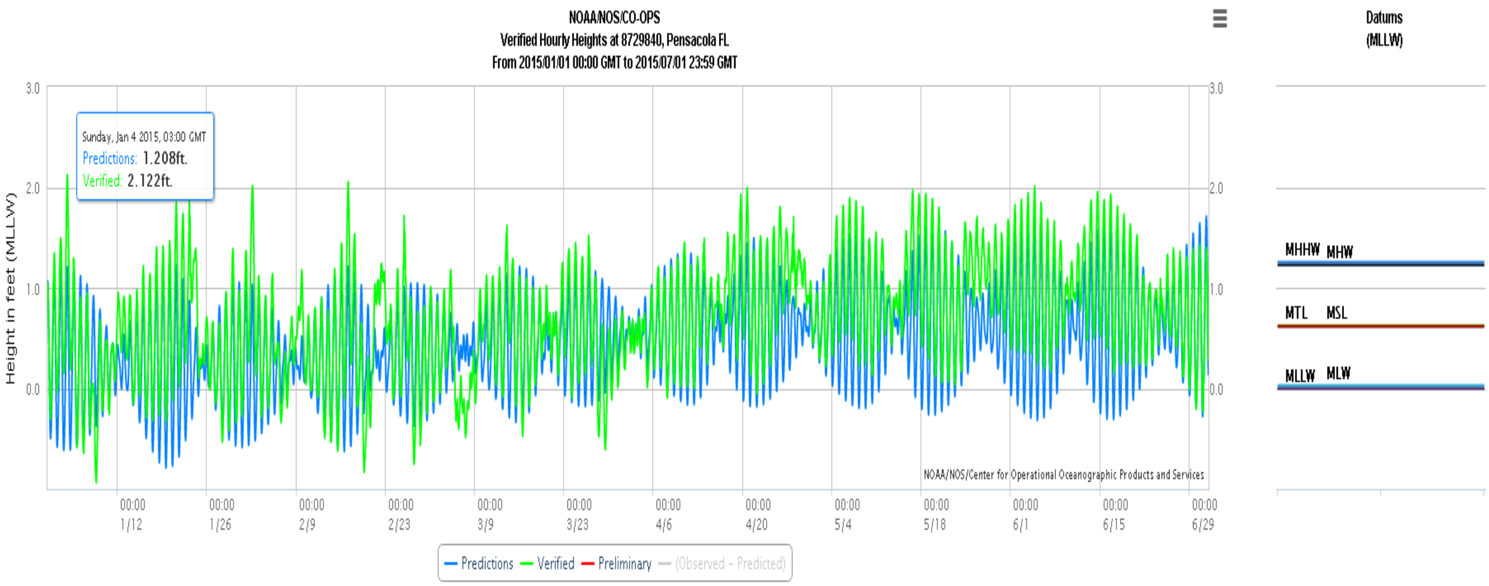
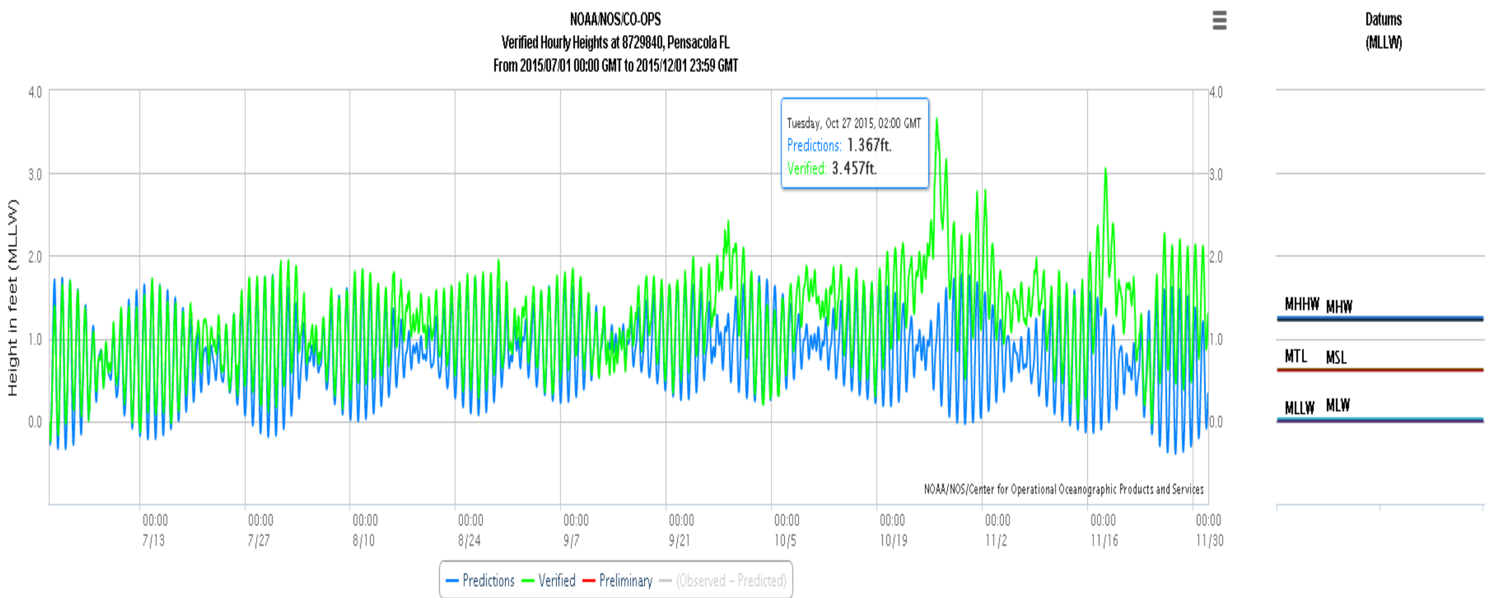
2016 Historic Tide Data- Verified



2016 Historic Tides data from Station # 8729840. The blue lines are the predicted tides given and the green lines are the verified tides which were the actual tides. The orange lines show the difference between the verified and the predicted. In some cases from January to July, the tides were 1.3 feet higher than normal tide. From July to December the tides were also approximate 1.2 feet above normal with the exception of a few storms in October and November raising to 2.09 feet above normal.

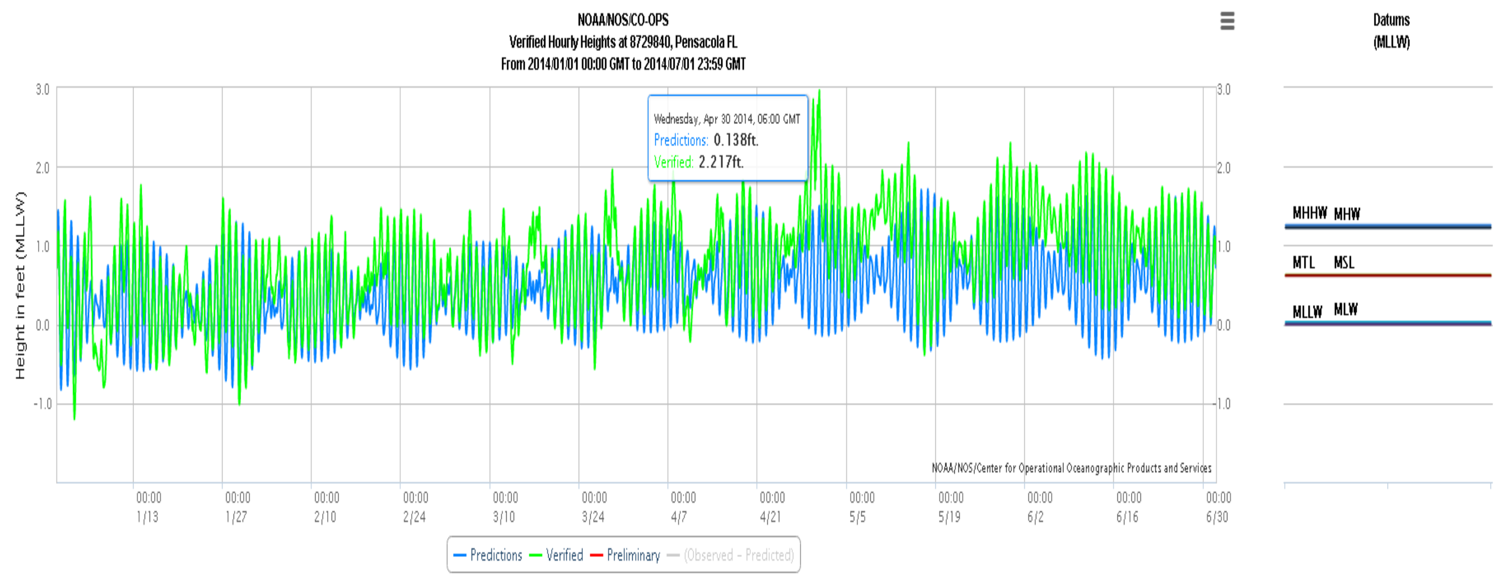
2015 Historic Tide Data- Verified





2015 Historic Tides data from Station # 8729840.

2014 Historic Tide Data- Verified



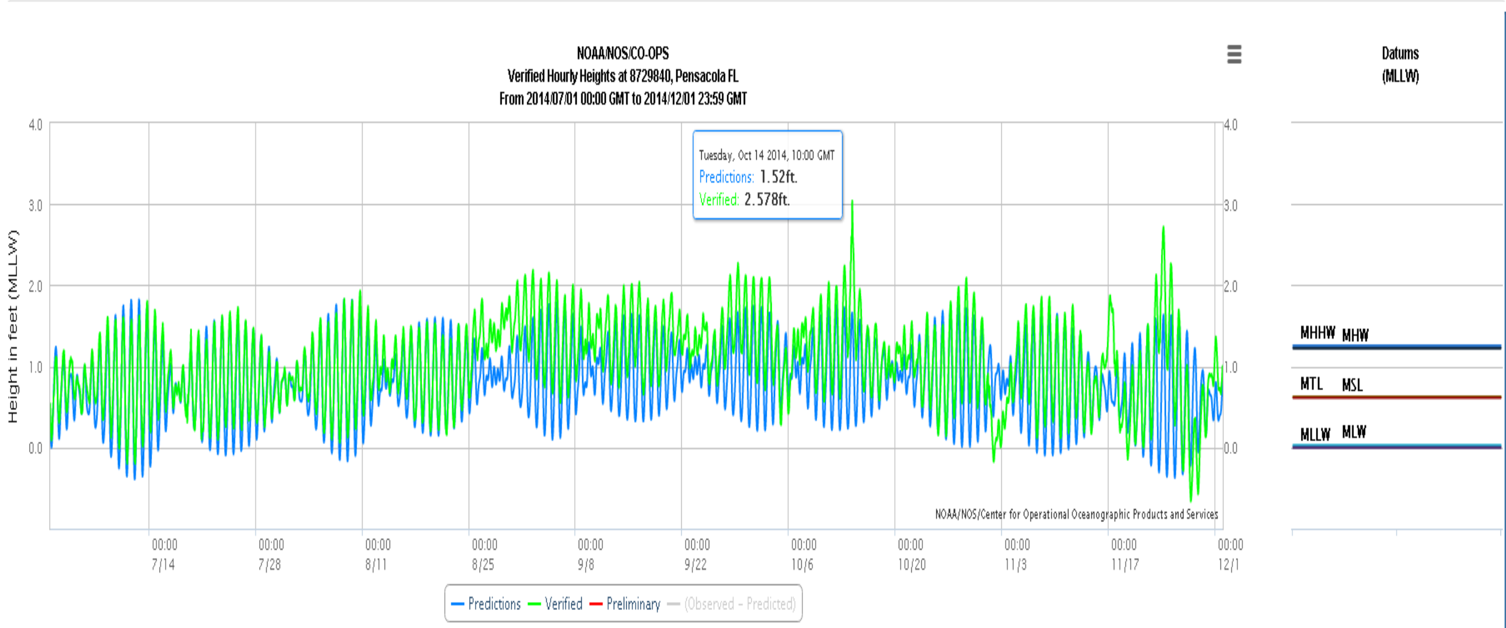
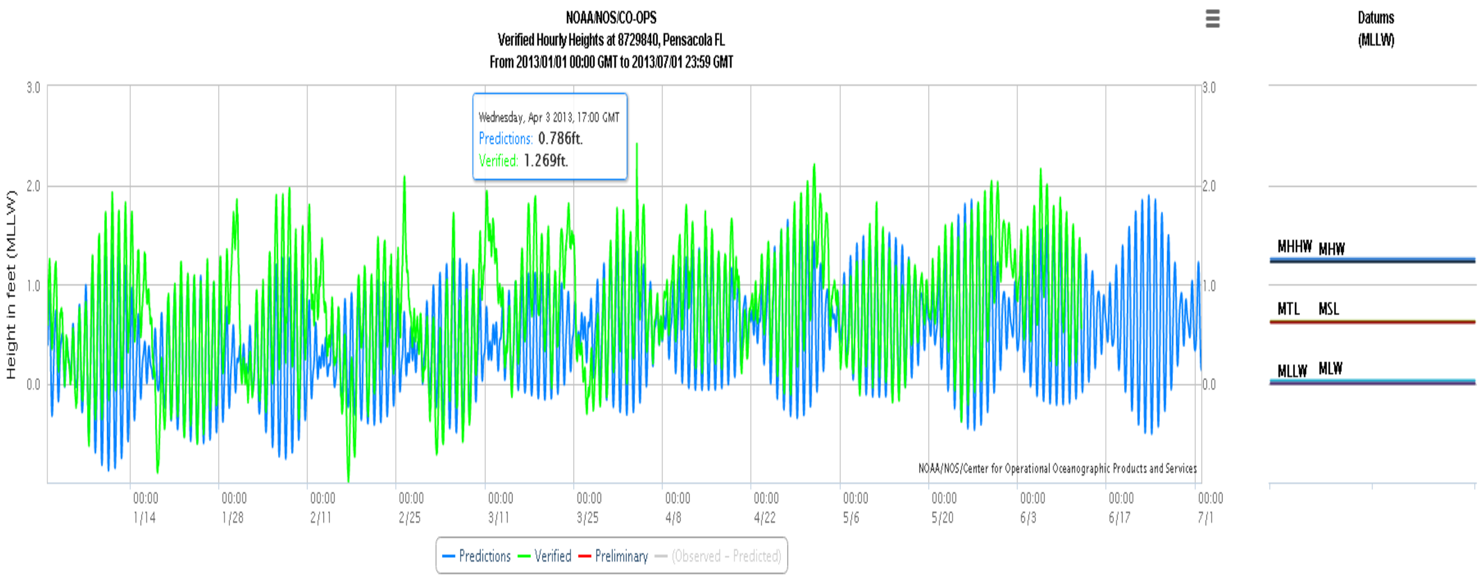


Fig. 2014 Historic Tides data from Station # 8729840.

2013 Historic Tide Data- Verified



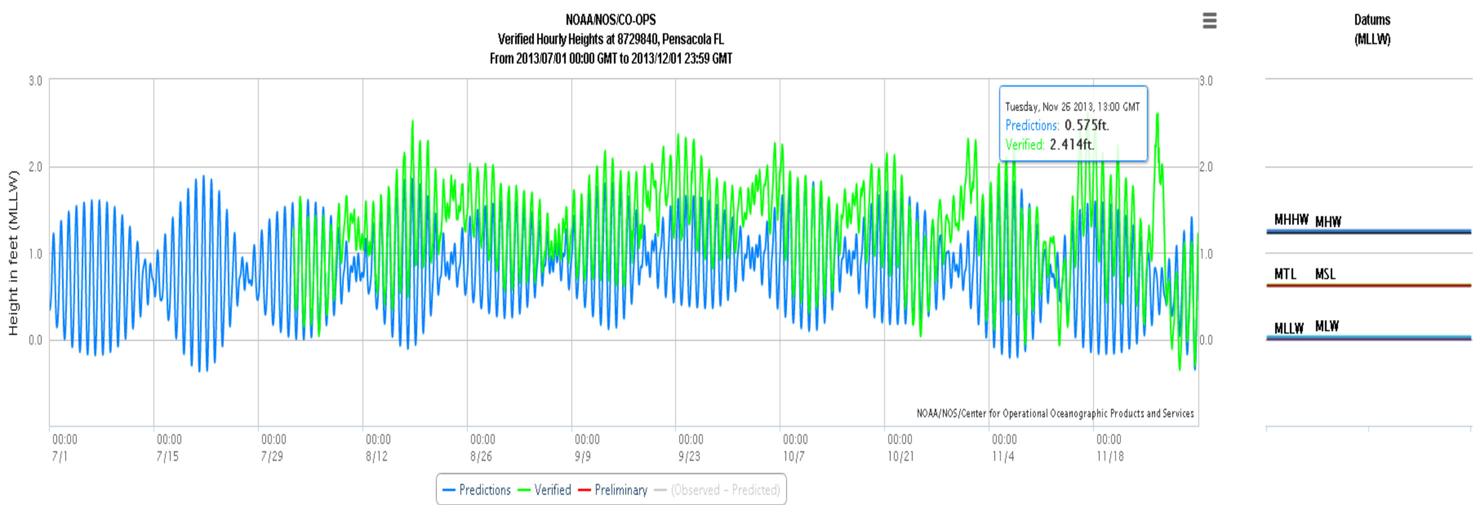


Fig. 1 -2011 Historic anomoly exposed

Fig. 2 -Laying of the geofabric and verifying footprint

Fig. 3 -Staging recycled oyster shell bags

Fig. 4 -Least destructive method to property to tranport oyster shell bags- slide

Fig. 5 -Placement of oyster shell bags

Fig.6 -Foundation to be formed

Fig. 7 -Initial hand placement of rocks to test the hydrodynamics of the current

Fig. 8 -Placement of riprap

Santa Rosa Dunes Condominiums
Shoreline Stabilization Project Phase 1 2012

Fig. 9 -Before 2011

Fig 10. After- July 2012

Fig. 11 -2014

Fig. 12 -2015

Fig. 8 -April 30, 2016 Start of breakwater construction

Fig. 9- Placement of rock

Fig. 10 -Curtain to protect seagrass and water quality

Fig. 11 Survey markers for footprint

Fig. 13 -Survey markers for footprint

Fig. 14-Placement of rock at high tide

Fig. 15 -Berming of the side to create a slope to protect the property

Fig. 16- The turbidity curtain containing the silt and sediment

Fig. 17- Two sets of curtains were used to control sediment and maintain water clarity

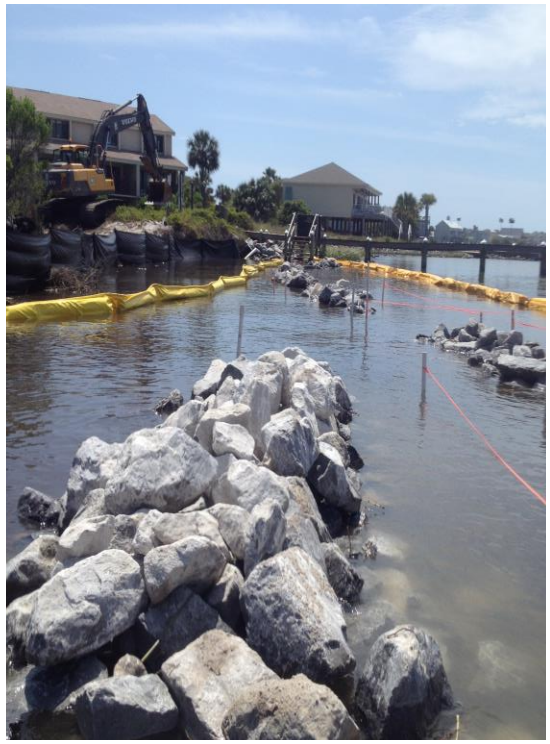


Fig. 18- Repositioning the rocks to displacement water evenly

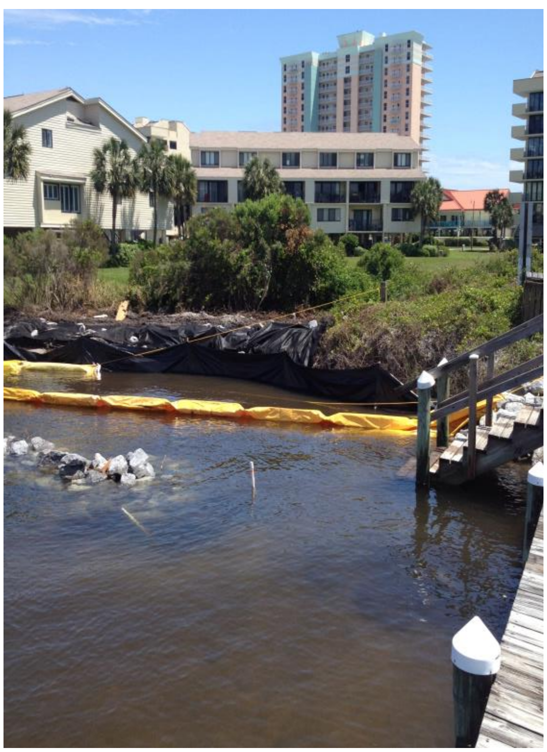


Fig. 19 -Clarity check

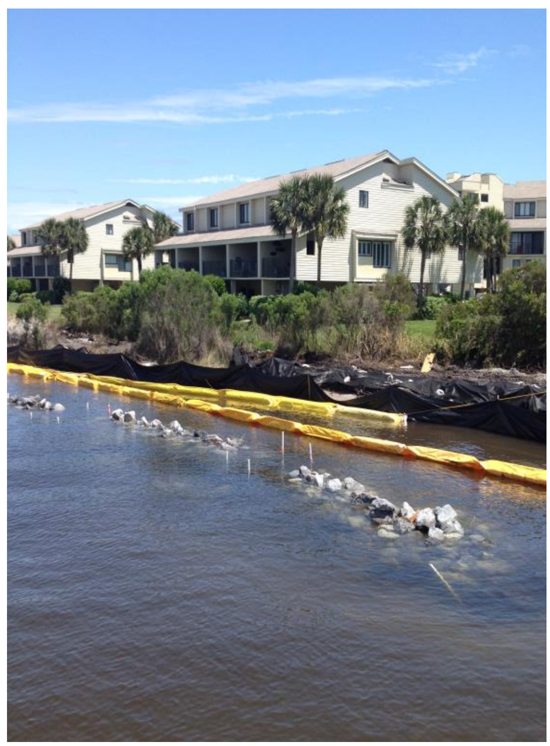


Fig. 20- Clarity check

Fig. 21- Cleared field for new vegetation

Fig. 22- Stabilizing the shoreline and planting bushes and trees

Fig. 23 Area containing rip rap- this area was replanted

Fig. 24 Moving the curtain closer to shoreline to protect the new plants while becoming extablished

Fig. 25- Setting up oyster reef foundation

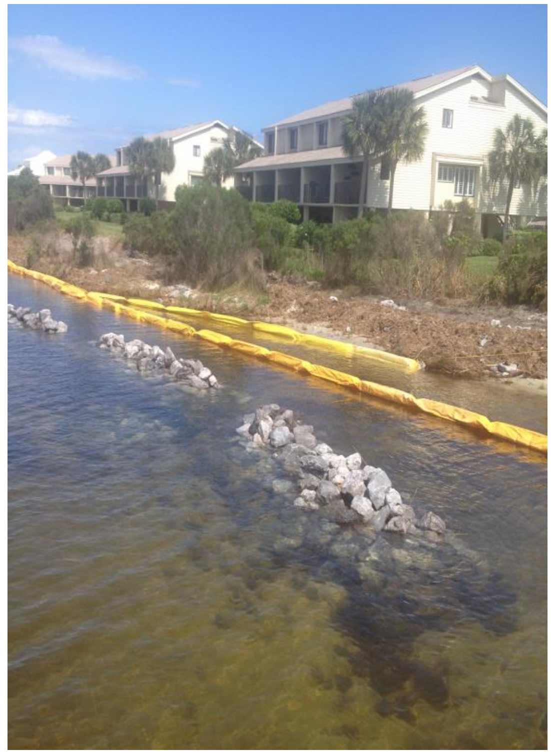


Fig. 26- Riprap placement over the oyster reef foundation

Fig. 27- Planting phases

Fig. 28 Planting phases

Fig. 29 -Spreading out sand to determine the elevation for the approriate plants

Fig. 30- Area where rip was staged is growing

Fig. 31

Fig. 32

Fig. 33 Mid section left at sea level to flush into wet area

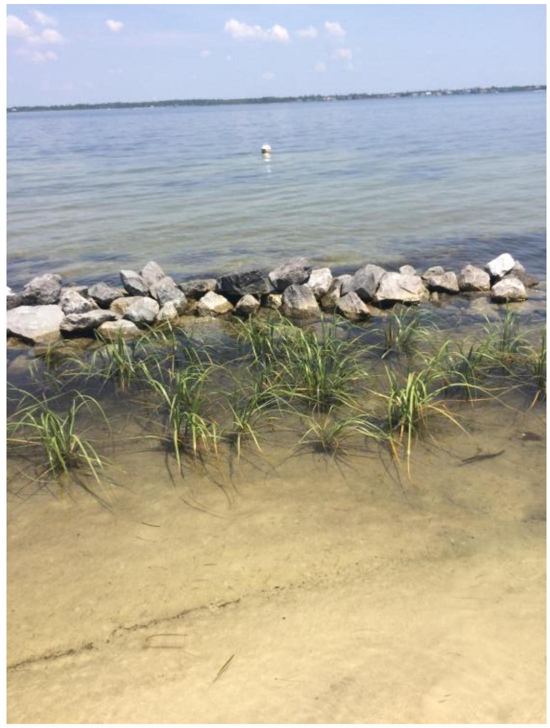


Fig. 34

Fig. 35-Finished project left to establish

Fig. 36- Meshed mat used to provide additonal stabilization to the shoreline

Fig. 37-Phase 2 Project one week later

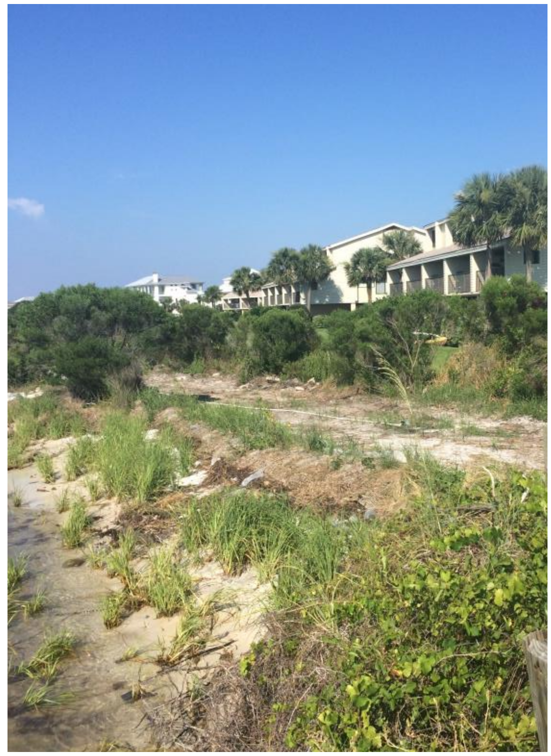


Fig. 38- Phase 2 Project one week later

Fig. 39- Phase 2 Project two weeks later

Fig. 40- Phase 2 Project two weeks later