# EXPERIMENTAL
# LONGSHORE BARS
# SEAGRASS RESTORATION
# 5th ANNUAL MONTIORING REPORT

**Tampa Permit No. 07-155**
**FDEP Permit No. 29-0268608-004**
**USACE Permit No. SAJ-2007-5671 (LP-MLS)**

***Prepared for:***
Tampa Port Authority
1101 Channelside Drive
Tampa, FL 33602

***Prepared by:***
Scheda Ecological Associates, Inc.
5892 East Fowler Avenue
Tampa, FL 33617

**Monitoring Dates:**
September 21 & 22, 2015

**Report Date:**
January 2016

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## 1.0 PROJECT BACKGROUND

Scheda Ecological Associates, Inc. (Scheda) was contracted as a sub-consultant to Arcadis, Inc. to permit the construction of four, 200-foot longshore bar structures as part of a pilot study aimed at restoring seagrass and Essential Fish Habitat (EFH) within Tampa Bay. Environmental permits from the Florida Department of Environmental Protection (FDEP) (Permit No. 29-0268608-004), United States Army Corps of Engineers (USACE) (Permit No. SAJ-2007-5671, LP-MLS), and the Tampa Port Authority (Permit No. 07-155) were obtained to construct these longshore bars, with the intent of recruiting seagrass within the wave shadow of the bars. The longshore bars were designed to be approximately two feet below the surface of the water, during mean high tide, and are spaced approximately 50 feet apart, for a total length of approximately 950 feet. In addition to constructing the longshore bars, six "danger, submerged structure" warning signs were installed around the perimeter of the bar structures in an effort to warn boaters of the presence of these structures. The longshore bars are located approximately 1,650 feet south of the existing shoreline at MacDill Air Force Base (AFB) in Tampa, Florida, Section 33, Township 30 South, and Range 18 East within the boater exclusion zone surrounding the Air Force Base (**Figure 1**). The channel leading to the MacDill AFB marina is located approximately 1,100 feet east of the easternmost longshore bar (Experimental Bar 4).

The experimental study was designed to use varying materials for each bar in an effort to determine which materials would facilitate the most seagrass growth production. The four experimental bars consisted of the following, from (west to east):

- Experimental Bar 1 was constructed from medium-sized riprap with a minimum diameter of 12 inches, and is 200 feet long and 15 feet wide. The material was placed in the designated location in two layers.
- Experimental Bar 2 is 200 feet long and 12.5 feet wide, consisting of two parallel rows of Jersey barriers, with oyster shells placed between the rows and at the foot of the barriers.
- Experimental Bar 3 was constructed from sand-filled bags covered with geo-fabric and topped with small sized riprap material. This bar has a length of 200 feet and a width of 23 feet.
- Experimental Bar 4 is constructed from reef balls that were placed in three staggered, off-set rows. The total width of the bar is 13.3 feet with a length of 200 feet.

The construction of the bars began in September 2010 and was completed by January 2011. The as-built survey and time zero monitoring report were submitted to the FDEP and USACE in March 2011. Subsequent monitoring events, including the six-month and first annual events summarized in this report, analyze the amount of seagrass recruitment and the structural integrity of the four longshore bars. Monitoring events occurred semi-annually during May and September, for 3 years with an annual monitoring report submitted to the agency following the September event. Furthermore, annual bathymetry monitoring (>20 spot elevations) was conducted for a period of three years following the submittal of the Time Zero Monitoring Report and in conjunction with the annual monitoring events beginning in September 2011. The anticipated and recommended surveying, monitoring, and reporting event schedule is provided in **Table 1**. While this monitoring schedule differs slightly from DEP permit condition number 31 (instead of annual reporting in March when the as-built surveys were submitted), shifting the annual monitoring events to September of each year better corresponds with the seagrass growing season. This way, the semi-annual and annual monitoring events each year are also done within the same growing season.

This report contains the results of the fall 2015 field observations for the 5$^{th}$ Annual Monitoring Report requirements, as outlined in the above referenced permits.

## 2.0 METHODOLOGY

The monitoring protocol includes sampling six bar transects (BT1 through BT6) and two reference transects (RT1 and S3T12) (**Figure 2**). The transects begin 150 feet south of the bars and extend 600 feet north of bars (not including the bar itself), for a total length between 750 to 775 feet.

- Reference transect RT 1 was located approximately 200 feet west of Bar 1.
- BT1 was located 100 feet west of Bar 1 and 100 feet east of RT1.
- BT2 through BT5 traverse through the middle of Bars 1 through 4, respectively.
- BT 6 was located 100 feet east of Bar 4.
- Finally, reference transect S3T12 is located approximately 2,500 feet to the west of the project area and near Broad Creek. This transect was pre-established by the City of Tampa Bay Studies Group (COTBSG); however, Scheda is only monitoring a 750-foot portion of this transect that exhibits similar water depths to the other bar transects.

The start, mid-point, and end of each transect was staked with a six-inch section of PVC and recorded using a sub-meter accuracy Global Positioning System (GPS) receiving unit. Scientists then used a measuring tape to extend along the transect to identify the sampling locations. Sampling along each transect occurred at 50-foot intervals and consisted of:

- Estimating seagrass density within a $1m^2$ quad using the Braun-Blauqet (BB) method for each seagrass species,
- measuring the blade lengths (cm) for each seagrass species,
- estimating epiphytic coverage (heavy, moderate, and light) for each seagrass species,
- documenting presence of drift algae (heavy, moderate, and light), and
- documenting sediment type (i.e. sand, silt sand, mud, etc).

To capture the change in the coverage of seagrass beds, all of the seagrass beds within the project study area were mapped using the sub-meter accuracy GPS receiving unit (**Figure 3**). The project study area consisted of an area 125 feet north and south of the bars and approximately 25 feet from the eastern and western ends of the longhshore bars. All seagrass beds with a BB density of 1 or greater were mapped. To further supplement this data, an oblique angle aerial flown on January 15, 2011 was used to evaluate the time zero seagrass coverage (**Appendix A**).

All of the quantitative data were entered into Excel for statistical analysis, and are provided in **Tables 2, 3, and 4**. Seagrass density was estimated by calculating the sum of each BB midpoint value along the transect and dividing it by the total number of sampled quads.

Additionally, scientists walked parallel to the bar structures beginning on the east side of the structures and recorded observations of marine organisms and other wildlife in the project field book. Representative photographs were taken of each longshore bar and marine life associated with the bars; the photographs are provided in **Figure 4**. Furthermore, qualitative observations were made to describe notable changes with the seagrass beds, sediment composition, longshore bar structures, and other relevant observations.

## 3.0 RESULTS & DISCUSSION

The field inspections were conducted on September 21 and 22, 2015. In general, all of the field days had partly cloudy skies, high air temperatures between 85 to 90 degrees Fahrenheit, and less than 10 mile per hour winds. The water visibility ranged from approximately 2 to 3 feet.

### Bar Transects

The project area contained a combined seagrass coverage of 2.7 percent in the May 2008 baseline monitoring report, which corresponds with the findings of the pre-construction (July 2010) seagrass survey where an estimated 2.8 percent seagrass coverage was recorded, with shoal grass (*Halodule wrightii*) being the only seagrass species present. In 2015, the seagrass within the project area consisted primarily of shoal grass and manatee grass (*Syringodium filiforme*), with a few scattered areas of turtle grass (*Thalassia testudinum*). Shoal grass has remained the primary species found within the study area, and although 2015 showed an overall decrease of seagrass coverage the coverage by manatee grass has increased. Additionally, the project area contained numerous amounts of drift macroalgae.

A total of 128 quads were sampled during the fall 2015 field surveys (**Table 2**). All of the transect summary data are provided in **Table 3**. Transects BT1 through BT6 were calculated to have combined seagrass coverage of 34.3 percent, which is a 31 percent decrease in seagrass density from the September 2014 values. The September 2014 combined seagrass density was estimated to have increased more than 11.5 times the coverage observed during the baseline pre-construction survey in 2008. All of the transects evaluated, with the exception of S3T12, showed decreases in density from the September 2014 to September 2015 monitoring events. BT6 showed the largest decrease from the September 2014 to September 2015 monitoring events. The average blade lengths for BT1 through BT6 were 15.7 centimeters (decrease of 3.7 centimeters from September 2014), with light to moderate epiphytic coverage.

In comparison to the bar transects, reference transect RT1 showed a similar decrease in coverage (decrease of 26 percent) from the September 2014 to September 2015 monitoring events, while S3T12 showed a 23 percent increase in its coverage from 2014 to 2015. The average blade lengths were 13.6 centimeters, with light to moderate epiphytic coverage. It should be noted that both reference transects previously contained seagrass, whereas the majority of the bar transects have historically only contained sparse amounts of seagrass.

## Seagrass Bed Coverage

The results of the seagrass bed mapping effort are presented in **Figure 3** and **Table 4**. In general, all the seagrass beds within the project study area contained Braun Blaquet densities of 2 or greater, and were clearly identified from the areas of bare ground. **The percentage of seagrass coverage within the study area has increased over 22 times, from 2.8 percent observed during the July 2010 pre-construction survey to 61.9 percent during the September 2015 survey.** Density of seagrass behind Bars BT5 and BT6 was the lowest value following construction. Density measured at other bar transects was similar to or slightly lower than values measured in other monitoring events with the lowest density values measured for most transects during the May 2011 monitoring event.

## Structural Integrity

During the September 2015 surveys, the longshore bars were visually observed to verify that they remain intact and are of good structural integrity. During the May 2013 survey, it was noted that the individual Jersey barriers comprising Experimental Bar 2 (Jersey Barriers) had shifted slightly. While a couple of the landward barriers have tilted over, they have not fallen and there have been no notable change since the May 2013 survey. Experimental Bar 3 had a few small areas on the eastern side where the rip rap shifted and the geofabric was exposed. The condition of the other bars is consistent with the observations noted in the Time Zero Monitoring Report. Per the engineer's inspections, all of the bars remain structurally sound and intact.

## Wildlife

Numerous fish, crustaceans, and birds were observed during the September 2015 monitoring events. These species were utilizing the longshore bars for cover, feeding, and as a resting place. All of the longshore bars were observed to have near complete coverage by oysters, algal mats, and/or barnacles. Groups of oystercatchers (*Haematopus palliates*), various terns, seagulls, and other shorebirds were commonly observed foraging amongst the bars. The reef balls (Bar 4) clearly contained the greatest number and density of fish, whereas the rip rap bars (Bars 1 and 3) had the least amount of fish. A complete list of the observed wildlife is represented in **Table 5**.

## 4.0 CONCLUSION

Overall, the experimental longshore bar structures appear to be functioning as designed and have improved the stability of the sediment and may have facilitated an increase in seagrass coverage from the pre-construction conditions. Transects BT1 through 6 showed a 31 percent decrease in seagrass density from September 2014 to September 2015; this may be associated with heavy precipitation during the summer 2015 growing season. Overall, the project area has supported five years of dramatic increases in seagrass density and coverage observed from the pre-construction survey to the 2015 monitoring events. Increases in seagrass coverage cannot be solely attributed to the longshore bar project, as similar increases were observed in both reference transects, and it appears that seagrass has expanded naturally in the region. As anecdotal data, the long term water quality data associated with Environmental Protection Commission station number 11 (27°48'46.43"N & 82°28'44.02"W), which is located less than half a mile southeast of the project area, shows that this site has had virtually the same salinity, better water clarity, and less total nitrogen and phosphorus from 2009 through 2014, when compared with the average results obtained from 1972 to 2008 (**Table 6**).These improvements in water quality may have been the most influential in seagrass gains in this and other parts of Tampa Bay.

The extent of this study to date has not conclusively proven the question of whether the construction of the experimental bars has helped facilitate the growth and expansion of seagrass. Based on SWFWMD's yearly seagrass mapping efforts, there has been significant expansion of seagrass coverage throughout Tampa Bay; therefore, future investigations of this area will help to prove if the experimental bars will have an effect on improving the resiliency of the seagrass in this area, especially after storm events. Interestingly, the seagrass data has generally shown increased density from the May to September monitoring events in 2011 and 2012; however, the 2013 results indicated that only BT1 through BT-6 had increased density from the May to September monitoring events, while RT-1 and S3T12 showed a decrease in seagrass density over the same period. This may suggest an improved resiliency of seagrass along transects associated with a bar. In any event, seagrass has significantly increased in density and coverage over the several years of monitoring efforts, and this information may prove useful in assisting with selection of the type(s) of bars that provide the best design, use of materials, functionality, and stability over time.

At this time, the applicant believes that the regulatory required monitoring has demonstrated that these structures are stable and do not constitute a threat to the

surrounding seagrass communities. In addition, they are providing the essential fish habitat anticipated.

# Figures

**Figure**


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**Figure 1 - Location Map**

**Tampa Bay Longshore Bar Project**
**Hillsborough County, Florida**

0 3,000 6,000 9,000 Feet

N

Data Source:
-Scheda Scientists
Imagery Source:
-N/A

Coordinate System:
NAD 1983 Florida
State Plane West

Date: 10/27/14 Rev. Date: N/A PM: BG GIS Analyst: JSG Map Document: location_map.mxd Project Number: 002722.10 C PDF Document: 2722_location_map_20141027.pdf Plot Size: 11x17

## Legend

- Project Study Area
- Photostations
- Longshore Bars Locations
- Transect Quad Locations
- Transects

S3T12

RT1
BT1
BT2
BT3
BT4
BT5
BT6

1
2

Bar 1
Bar 2
Bar 3
Bar 4

MacDill Marina Channel


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# Figure 2 - Transect Sampling Locations Map

**Tampa Bay Longshore Bar Project**
**Hillsborough County, Florida**

0 400 800 1,200 Feet

Data Source:
-Scheda Fieldwork
Bar As-Built Marsh 2011
(May and September 2011)
Imagery Source:
-N/A

Coordinate System:
NAD 1983 Florida
State Plane West

N

Date: 10/27/14 Rev. Date: N/A PM: BG GIS Analyst: JAG Map Document: TransectSamplingLocations.mxd Project Number: 002722.10 C PDF Document: 2722_transect_locations_map_20141027.pdf Plot Size: 11x17

## Legend

- Project Study Area (6.06 Ac.)
- Seagrass (3.54 Ac.)
- Longshore Bars Locations (0.34 Ac.)
- Bare (2.18 Ac.)

Bar 1

Bar 2

Bar 3

Bar 4


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**Figure 3 - 2015 Seagrass Boundaries within the Study Area**

**Tampa Bay Longshore Bar Project**
**Hillsborough County, Florida**

0 80 160 240 Feet

N

Data Source:
-Scheda Scientists
Imagery Source:
-N/A

Coordinate System:
NAD 1983 Florida
State Plane West


Photo 1. Photostation 1 - Longshore Bar 1 (large riprap), facing east (10/05/2012)

Photo 2. Longshore Bar 1 (large riprap), facing west (10/09/2013)

Photo 3. Jersey barriers (Bar 2) facing East (10/09/2013)

Photo 4. Representative photo of jersey barriers (Bar 2) on east side of structure, facing west (10/09/2013)

Photo 5. West end of Bar 3 (sand-filled bags covered with small riprap) facing southwest. (10/09/2013)

Photo 6. Representative Photo of Bar 3 (sand-filled bags covered with small riprap), facing west (10/09/2013)

Photo 7. Bar 3 (sand-filled bags covered with small rip-rap), close up on east end of exposed geofabric (10/09/2013)

Photo 8. Photostation 2 east of Bar 4 (Reef Balls), facing west-northwest (10/09/2013)

Photo 9. Close up of Bar 4 (Oyster domes), facing west. (10/9/2013)

Photo 10. Juvenile stone crab (*Menippe mercenaria*) found on Bar 3.

# Tables

**Table**

**Table 1. Schedule of Surveying, Monitoring, and Reporting Events**

| Event Type* | Date |
|---|---|
| As-built Survey and Time 0 Monitoring Report | March 30, 2011 |
| Semi-Annual Monitoring | May 26 & 27, 2011 |
| Semi-Annual Monitoring | September 13 & 14, 2011 |
| Bathymetry Monitoring | September 13, 2011 |
| 1st Annual Report | November 1, 2011 |
| Semi-Annual Monitoring | May 30, 2012 |
| Semi-Annual Monitoring | September 30, 2012 |
| Bathymetry Monitoring | September 30, 2012 |
| 2nd Annual Report | November 1, 2012 |
| Semi-Annual Monitoring | May 30, 2013 |
| Semi-Annual Monitoring | September 30, 2013 |
| Bathymetry Monitoring | September 30, 2013 |
| 3rd Annual Report | November 1, 2013 |
| Annual Monitoring | October 1, 2014 |
| 4th Annual Report | November 1, 2014 |
| Annual Monitoring | October 1, 2015 |
| 5th Annual Report | November 1, 2015 |
| *Shading indicates a completed event | |

## Table 2. 2015 Transect Data - Seagrass Density Estimates

| Transect | Quad (feet) | Species | Fall | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Braun-Blanquet Rank[1,2] | Mid Point % | Blade Length (cm) | Epiphyte Coverage (L, M, or H) | Drift Algae/Algae Coverage (L, M, or H) | Sediment Type | Comments[3] |
| S3T12 | 0 | *Halodule wrightii* | 5 | 88 | 22 | M | - | sand | |
| | 50 | *Halodule wrightii* | 5 | 88 | 18 | M | - | sand | |
| | 100 | *Halodule wrightii* | 5 | 88 | 17 | M | - | sand | |
| | 150 | *Halodule wrightii, Ruppia maritima* | 5 | 88 | 16 | L | - | sand | |
| | 200 | *Halodule wrightii* | 5 | 88 | 15 | L | - | sand | |
| | 250 | *Halodule wrightii* | 5 | 88 | 17 | L | - | sand | |
| | 300 | *Halodule wrightii* | 4 | 63 | 16 | L | - | sand | |
| | 350 | bare | 0 | 0 | 0 | - | - | sand | |
| | 400 | *Halodule wrightii, Ruppia maritima* | 5 | 88 | 14 | L | - | sand | |
| | 450 | *Ruppia maritima* | 4 | 63 | 15 | L | - | sand | |
| | 500 | *Halodule wrightii* | 5 | 88 | 14 | L | - | sand | |
| | 550 | *Halodule wrightii* | 5 | 88 | 15 | L | - | sand | |
| | 600 | *Halodule wrightii* | 5 | 88 | 17 | L | - | sand | |
| | 650 | *Halodule wrightii* | 5 | 88 | 17 | L | - | sand | |
| | 700 | *Halodule wrightii* | 5 | 88 | 16 | L | - | sand | |
| | 750 | *Halodule wrightii* | 2 | 15 | 0 | L | - | sand | |
| | **AVERAGE** | | **74.8%** | | **13.8** | | | | |
| RT1 | 0 | bare | 0 | 0 | 0 | - | - | sand | |
| | 50 | *Halodule wrightii* | 1 | 3 | 17 | M | - | sand | |
| | 100 | *Halodule wrightii* | 4 | 63 | 22 | M | - | sand | |
| | 150 | *Halodule wrightii* | 5 | 88 | 20 | M | - | sand | |
| | 200 | bare | 0 | 0 | 0 | - | - | sand | |
| | 250 | *Syringodium filiforme* | 4 | 63 | 31 | M | - | sand | |
| | 300 | bare | 0 | 0 | 0 | M | - | sand | |
| | 350 | *Halodule wrightii* | 5 | 88 | 17 | M | - | sand | |
| | 400 | *Halodule wrightii* | 5 | 88 | 19 | M | - | sand | |
| | 450 | bare | 0 | 0 | 0 | - | - | sand | |
| | 500 | bare | 0 | 0 | 0 | - | - | sand | |
| | 550 | *Halodule wrightii* | 5 | 88 | 15 | M | - | sand | |
| | 600 | *Halodule wrightii* | 4 | 63 | 18 | M | - | sand | |
| | 650 | *Halodule wrightii* | 1 | 3 | 20 | M | - | sand | |
| | 700 | *Halodule wrightii* | 5 | 88 | 19 | M | - | sand | |
| | 750 | *Halodule wrightii* | 2 | 15 | 17 | M | - | sand | |
| | **AVERAGE** | | **40.6%** | | **13.4** | | | | |
| BT1 | 0 | *Halodule wrightii* | 5 | 88 | 16 | H | - | sand | |
| | 50 | *Halodule wrightii* | 5 | 88 | 15 | M | - | sand | |
| | 100 | *Halodule wrightii* | 5 | 88 | 17 | M | - | sand | |
| | 150 | *Halodule wrightii* | 3 | 38 | 19 | M | - | sand | |
| | 200 | *Halodule wrightii* | 2 | 15 | 17 | M | - | sand | |
| | 250 | *Halodule wrightii* | 3 | 38 | 16 | M | - | sand | |
| | 300 | *Halodule wrightii* | 1 | 3 | 20 | M | - | sand | |
| | 350 | *Halodule wrightii* | 4 | 63 | 17 | M | - | sand | |
| | 400 | *Halodule wrightii, Syringodium filiforme* | 4 | 63 | 30 | M | - | sand | |
| | 450 | *Halodule wrightii* | 1 | 3 | 15 | M | - | sand | |
| | 500 | *Halodule wrightii* | 5 | 88 | 21 | M | - | sand | |
| | 550 | *Syringodium filiforme* | 5 | 88 | 35 | M | - | sand | |
| | 600 | *Halodule wrightii* | 2 | 15 | 18 | M | - | sand | |
| | 650 | *Halodule wrightii* | 3 | 38 | 16 | M | - | sand | |
| | 700 | *Halodule wrightii* | 4 | 63 | 14 | M | - | sand | |
| | 750 | *Halodule wrightii* | 3 | 38 | 18 | M | - | sand | |
| | **AVERAGE** | | **51.1%** | | **19.0** | | | | |
| BT2 - Rip rap | 0 | *Halodule wrightii* | 4 | 63 | 15 | M | - | sand | *Caulerpa prolifera* |
| | 50 | *Halodule wrightii* | 5 | 88 | 20 | M | - | sand | |
| | 100 | *Syringodium filiforme* | 1 | 3 | 27 | M | - | sand | |
| | 150 S | bare | 0 | 0 | 0 | - | - | sand and pebble | |
| | 150 N | bare | 0 | 0 | 0 | - | - | sand and pebble | |
| | 200 | bare | 0 | 0 | 0 | - | - | sand | |
| | 250 | *Syringodium filiforme* | 5 | 88 | 27 | M | - | sand | |
| | 300 | *Halodule wrightii* | 3 | 38 | 20 | M | - | sand | |
| | 350 | *Halodule wrightii* | 0 | 0 | 18 | M | - | sand | |
| | 400 | *Halodule wrightii* | 4 | 63 | 17 | M | - | sand | |
| | 450 | *Halodule wrightii* | 1 | 3 | 18 | M | - | sand | |
| | 500 | *Halodule wrightii* | 1 | 3 | 15 | M | - | sand | |
| | 550 | *Halodule wrightii* | 4 | 63 | 18 | L | - | sand | |
| | 600 | *Halodule wrightii* | 3 | 38 | 20 | M | - | sand | |
| | 650 | *Halodule wrightii* | 1 | 3 | 19 | M | - | sand | |
| | 700 | *Halodule wrightii* | 5 | 88 | 17 | M | - | sand | |
| | 750 | *Syringodium filiforme* | 5 | 88 | 26 | M | - | sand | |
| | **AVERAGE** | | **39.3%** | | **16.3** | | | | |

## Table 2. 2015 Transect Data - Seagrass Density Estimates

| Transect | Quad (feet) | Species | Fall | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Braun-Blanquet Rank[1,2] | Mid Point % | Blade Length (cm) | Epiphyte Coverage (L, M, or H) | Drift Algae/Algae Coverage (L, M, or H) | Sediment Type | Comments[3] |
| BT3 - Jersey Barrier | 0 | *Syringodium filiforme* | 5 | 88 | 33 | H | - | sand | |
| | 50 | *Halodule wrightii* | 0 | 0 | 16 | M | - | sand | *Caulerpa prolifera* |
| | 100 | *Halodule wrightii* | 2 | 15 | 17 | M | - | sand | |
| | 150 S | bare | 0 | 0 | 0 | - | - | sand | |
| | 150 N | bare | 0 | 0 | 0 | - | - | sand | |
| | 200 | *Halodule wrightii* | 4 | 63 | 19 | M | - | sand | |
| | 250 | *Halodule wrightii* | 5 | 88 | 20 | M | - | sand | |
| | 300 | *Halodule wrightii* | 4 | 63 | 21 | M | - | sand | |
| | 350 | *Halodule wrightii* | 5 | 88 | 15 | M | - | sand | |
| | 400 | *Halodule wrightii* | 5 | 88 | 16 | M | - | sand | |
| | 450 | *Syringodium filiforme* | 3 | 38 | 29 | M | - | sand | |
| | 500 | *Halodule wrightii* | 5 | 88 | 17 | M | - | sand | |
| | 550 | *Thalassia testudinum*, *Halodule wrightii* | 2 | 15 | 19 | M | - | sand | |
| | 600 | *Halodule wrightii* | 5 | 88 | 18 | M | - | sand | |
| | 650 | *Halodule wrightii* | 1 | 3 | 16 | M | - | sand | |
| | 700 | *bare* | 0 | 0 | 0 | - | - | sand | |
| | 750 | *Halodule wrightii* | 2 | 15 | 15 | M | - | sand | |
| | **AVERAGE** | | **46.3%** | | **14.9** | | | | |
| BT4 - Sand Bags | 0 | *Syringodium filiforme* | 4 | 63 | 34 | H | - | sand | |
| | 50 | *Halodule wrightii*, *Syringodium filiforme* | 2 | 15 | 30 | H | - | sand | |
| | 100 | *Halodule wrightii* | 1 | 3 | 15 | L | - | sand | |
| | 150 S | bare | 0 | 0 | 0 | - | - | sand and shell | |
| | 150 N | bare | 0 | 0 | 0 | - | - | sand and shell | |
| | 200 | *Syringodium filiforme* | 3 | 38 | 26 | M | - | sand | |
| | 250 | *Syringodium filiforme* | 4 | 63 | 33 | M | - | sand | |
| | 300 | *bare* | 0 | 0 | 0 | - | - | sand | *Caulerpa prolifera* |
| | 350 | *Halodule wrightii* | 5 | 88 | 23 | M | - | sand | |
| | 400 | *Syringodium filiforme* | 3 | 38 | 22 | M | - | sand | |
| | 450 | *Halodule wrightii* | 5 | 88 | 24 | M | - | sand | |
| | 500 | *Halodule wrightii* | 2 | 15 | 18 | M | - | sand | |
| | 550 | *Thalassia testudinum*, *Halodule wrightii* | 3 | 38 | 20 | M | - | sand | |
| | 600 | *Halodule wrightii* | 4 | 63 | 22 | L | - | sand | |
| | 650 | *Halodule wrightii* | 2 | 15 | 18 | L | - | sand | *Caulerpa prolifera* |
| | 700 | *Halodule wrightii* | 4 | 63 | 20 | L | - | sand | |
| | 750 | *Halodule wrightii* | 2 | 15 | 19 | L | - | sand | |
| | **AVERAGE** | | **37.8%** | | **19.1** | | | | |
| BT5 - Reef Balls | 0 | *bare* | 0 | 0 | 0 | - | - | sand | |
| | 50 | *Halodule wrightii* | 0.1 | 0 | 20 | L | - | sand | |
| | 100 | *bare* | 0 | 0 | 0 | - | - | sand | |
| | 150 S | Halodule wrightii | 0.1 | 0 | 14 | M | - | sand | |
| | 150 N | bare | 0.1 | 0 | 14 | M | - | sand | |
| | 200 | *Halodule wrightii* | 2.0 | 15 | 14 | M | - | sand | |
| | 250 | *Halodule wrightii* | 0.1 | 0 | 20 | L | - | sand | *Caulerpa prolifera* |
| | 300 | bare | 0 | 0 | 0 | - | - | sand | *Caulerpa prolifera* |
| | 350 | *Syringodium filiforme* | 5.0 | 88 | 32 | M | - | sand | |
| | 400 | *Halodule wrightii* | 3.0 | 38 | 17 | L | - | sand | |
| | 450 | bare | 0.0 | 0 | 0 | - | - | sand | *Caulerpa prolifera* |
| | 500 | *Halodule wrightii* | 1.0 | 3 | 21 | L | - | sand | |
| | 550 | *Halodule wrightii* | 2.0 | 15 | 16 | L | - | sand | |
| | 600 | *Halodule wrightii* | 4.0 | 63 | 20 | L | - | sand | |
| | 650 | *Halodule wrightii* | 5.0 | 88 | 16 | L | - | sand | |
| | 700 | *Halodule wrightii* | 2.0 | 15 | 17 | M | - | sand | |
| | 750 | *Halodule wrightii* | 2.0 | 15 | 16 | L | - | sand | |
| | **AVERAGE** | | **21.3%** | | **13.9** | | | | |
| BT6 | 0 | *bare* | 0 | 0 | 0 | - | - | sand | |
| | 50 | *Halodule wrightii* | 1 | 3 | 20 | L | - | sand | *Caulerpa prolifera* |
| | 100 | *bare* | 0 | 0 | 0 | - | - | sand | |
| | 150 | *bare* | 0 | 0 | 0 | - | - | sand | *Caulerpa prolifera* |
| | 200 | *bare* | 0 | 0 | 0 | - | - | sand | *Caulerpa prolifera* |
| | 250 | bare | 0 | 0 | 0 | - | - | sand | *Caulerpa prolifera* |
| | 300 | *Halodule wrightii* | 2 | 15 | 17 | - | - | sand | |
| | 350 | bare | 0 | 0 | 0 | - | - | sand | *Caulerpa prolifera* |
| | 400 | *bare* | 0 | 0 | 0 | - | - | sand | *Caulerpa prolifera* |
| | 450 | *Halodule wrightii* | 1 | 3 | 19 | M | - | sand | |
| | 500 | *Halodule wrightii* | 0 | 0 | 15 | L | - | sand | |
| | 550 | *Halodule wrightii* | 2 | 15 | 17 | L | - | sand | |
| | 600 | *Halodule wrightii* | 1 | 3 | 19 | L | - | sand | |
| | 650 | *Halodule wrightii* | 2 | 15 | 20 | L | - | sand | |
| | 700 | *Halodule wrightii* | 2 | 15 | 21 | L | - | sand | |
| | 750 | *Halodule wrightii* | 5 | 88 | 18 | L | - | sand | |
| | **AVERAGE** | | **9.8%** | | **11.1** | | | | |

**Notes:**

L= Light, M = Moderate, and H= Heavy

[1]Braun-Blaquet cover classifications consisted of: 0.1 = solitary, with small cover, 0.5 = few, with small cover, 1 = numerous, but less than 5%, 2 = Any number, with >5% to

[2]Braun-Blaquet Total Coverage Estimations were made using the mid-point of each coverage classification divided by the total # of quads.

[3]Drift algae, when present, consisted primarily of *Acanthaphora spicifera* .

**TABLE 3. Yearly Transect Seagrass Density Summary Data [1]**

| | | | 1st Annual | | 2nd Annual | | 3rd Annual | | 4th Annual | 5th annual |
|---|---|---|---|---|---|---|---|---|---|---|
| **Transect ID** | **Baseline Dec-08** | **Time 0 - March 2011** | **May 2011** | **Sept 2011** | **May 2012** | **Sept 2012** | **May 2013** | **Sept 2013** | **Sept 2014** | **Sept 2015** |
| BT1 | 0.0% | 3.5% | 22.8% | 52.3% | 36.5% | 48.0% | 33.9% | 37.3% | 55.4% | 51.1% |
| BT2 | 0.0% | 3.0% | 27.2% | 47.3% | 23.0% | 31.6% | 28.8% | 40.8% | 49.4% | 39.3% |
| BT3 | 0.0% | 3.0% | 32.1% | 58.6% | 49.6% | 43.7% | 40.4% | 51.0% | 52.3% | 46.3% |
| BT4 | 0.0% | 2.0% | 36.6% | 54.6% | 42.5% | 42.8% | 36.4% | 50.8% | 38.6% | 37.8% |
| BT5 | 0.0% | 2.5% | 41.3% | 63.8% | 43.8% | 45.9% | 36.7% | 41.9% | 48.5% | 21.3% |
| BT6 | 0.0% | 2.5% | 46.2% | 62.4% | 49.4% | 35.8% | 35.6% | 40.0% | 55.8% | 9.8% |
| BT2-4 Combined | 0.0% | 0.0% | 34.3% | 56.1% | 39.7% | 41.0% | 35.6% | 46.1% | 47.2% | 36.2% |
| **BT1-6 Combined** | **2.7%** | **2.8%** | **34.4%** | **56.5%** | **40.8%** | **41.3%** | **35.3%** | **43.6%** | **50.0%** | **34.3%** |
| **RT1** | **1.2%** | **3.0%** | **19.9%** | **64.1%** | **43.3%** | **41.5%** | **50.4%** | **45.0%** | **54.8%** | **40.6%** |
| **S3T12** | **n/a** | **n/a** | **37.5%** | **66.1%** | **49.9%** | **52.3%** | **59.6%** | **50.3%** | **60.7%** | **74.8%** |

**Notes:**

[1]Seagrass density calculated as sum of Braun Blanquet midpoint values per each quad / total # of potential quad values

[2]Not located in the exact same project area, but was located in the general vicinity of the current project area.

| Highest Value Post Construction | Lowest Value Post Construction |
|---|---|

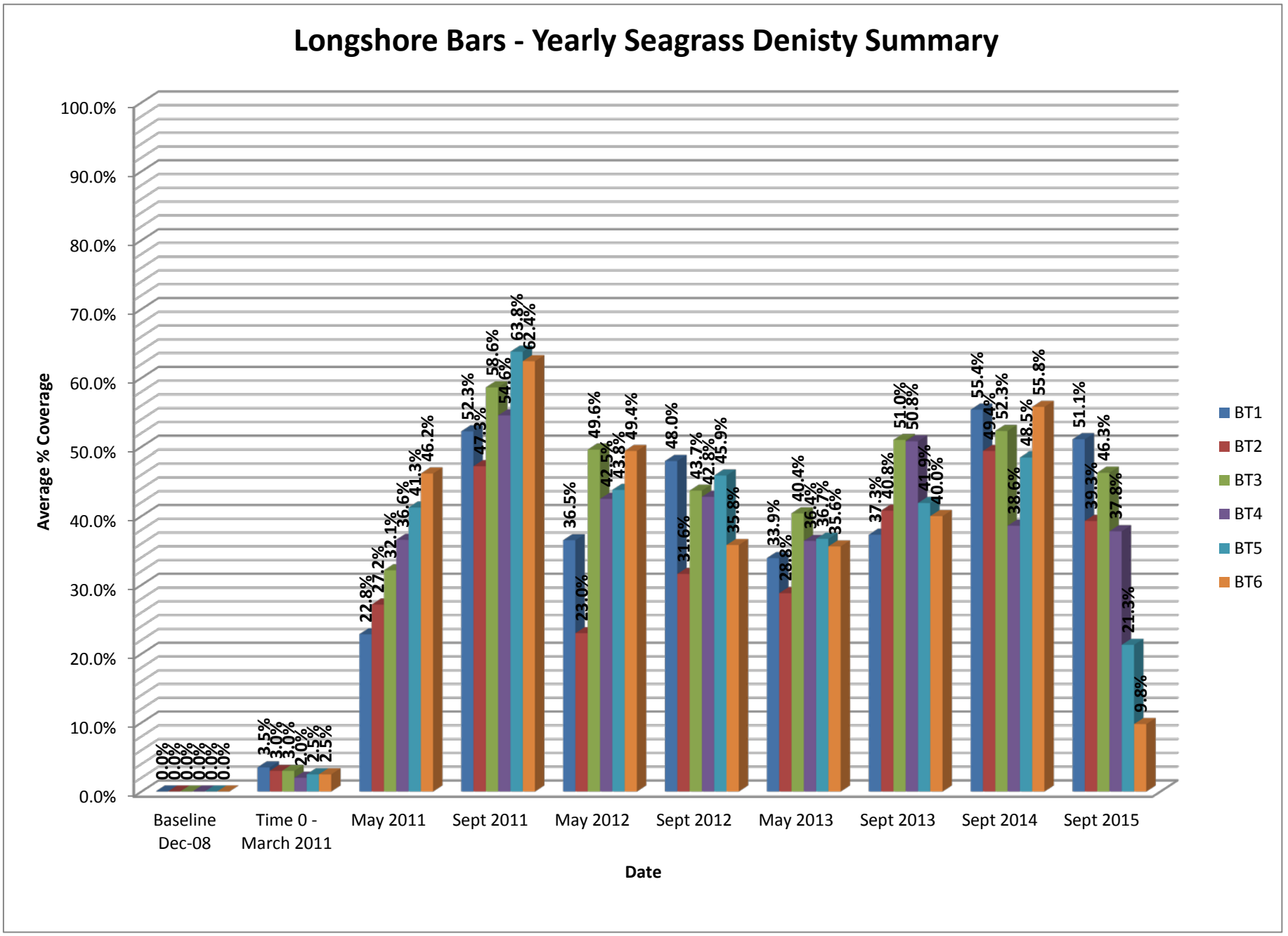
Longshore Bars - Yearly Seagrass Denisty Summary
Average % Coverage
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0% 0.0% 0.0% 0.0% 0.0%
3.5% 3.0% 3.0% 2.0% 2.5% 2.5%
22.8% 27.2% 32.1% 36.6% 41.3% 46.2%
52.3% 47.3% 58.6% 54.6% 63.8% 62.4%
36.5% 23.0% 49.6% 42.5% 43.8% 49.4%
48.0% 31.6% 43.7% 42.8% 45.9% 35.8%
33.9% 28.8% 40.4% 36.4% 36.7% 35.6%
37.3% 40.8% 51.0% 50.8% 41.9% 40.0%
55.4% 49.4% 52.3% 38.6% 48.5% 55.8%
51.1% 39.3% 46.3% 37.8% 21.3% 9.8%
Baseline Dec-08
Time 0 - March 2011
May 2011
Sept 2011
May 2012
Sept 2012
May 2013
Sept 2013
Sept 2014
Sept 2015
Date
BT1
BT2
BT3
BT4
BT5
BT6

**TABLE 4. Yearly Seagrass Bed Coverage within the Study Area Summary Data[1]**

| Parameter | Pre-Construction Survey - July 2010 | 1st Annual | 2nd Annual[2] | 3rd Annual | 4th Annual | 5th Annual |
|---|---|---|---|---|---|---|
| | | Sep-11 | Sep-12 | Sep-13 | Oct-14 | Sep-15 |
| **Bare Acreage** | 5.56 | 1.84 | 1.84 | 1.50 | 1.42 | 2.18 |
| **% Bare** | 97.2% | 32.2% | 32.2% | 26.2% | 24.8% | 38.1% |
| **Seagrass Acreage** | 0.16 | 3.88 | 3.88 | 4.22 | 4.30 | 3.54 |
| **% Seagrass** | 2.8% | 67.8% | 67.8% | 73.8% | 75.2% | 61.9% |

**Notes:**

[1]Seagrass coverage delineated by wading boundaries at low tide and recording positions with a handheld geoXT Tremble unit

[2]Seagrass coverage slightly decreased in some areas and slightly increased in other areas coincidentally resulting in the same acreages in 2011 and 2012.

| Table 5. Fauna Observations | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Scientific Name** | **Common Name** | **Bar 1 - Medium sized riprap** | **Bar 2 - Jersey Barriers** | **Bar 3 - Sand-filled bags covered with mall riprap** | **Bar 4 - Reef Balls** |
| Birds | *Haematopus palliatus* | American oystercatcher | X | | | X |
| | *Larus atricilla* | laughing gull | X | | X | X |
| | *Pandion haliaetus* | osprey | X | X | X | X |
| | *Pelecanus occidentalis* | brown pelican | X | X | X | X |
| | *Phalacrocorax auritus* | double-crested cormorant | X | | | |
| | *Sternula sp.* | tern | X | | | |
| | *Tringa semipalmata* | willet | X | | | |
| | | | | | | |
| Chelicerata | *Limulus polyphemus* | Atlantic horseshoe crab | X | | | |
| | | | | | | |
| Crustaceans | *Callinectes sapidus* | blue crab | | | | X |
| | Cirripedia (Order) spp. | sessile barnacles | X | X | X | X |
| | *Menippe mercenaria* | stone crab | | | X | |
| | *Synalpheus regalis* | popping shrimp | X | | | |
| | | | | | | |
| Fish | *Dasyatis americana* | southern stingray | X | X | X | X |
| | *Lagodon rhomboides* | pinfish | | | | X |
| | *Mugil cephalus* | mullet | | | | X |
| | *Platybelone argalus* | needlefish | | | | X |
| | *Diodon hystrix* | porcupine puffer | | | X | |
| | *Archosargus probatocephalus* | sheepshead | X | X | | X |
| | *Lutjanus griseus* | grey snapper | | X | | X |
| | *Aluterus scriptus* | blue srawled filefish | | | | X |
| | *Centropomus undecimalis* | snook | | | | X |
| | *Abudefduf saxatilis* | sergeant major | | | | X |
| | | | | | | |
| Molluscs | *Busycon contrarium* | lightning whelk | X | X | | |
| | *Fasciolaria lillium* | banded tulip | X | X | X | |

| Table 6. EPC Water Quality Monitoring Station 11 - Yearly Average Comparison | | | | | |
|---|---|---|---|---|---|
| **Year** | **Salinity (ppt)** | **Sechi (ft)** | **Turbidity (NTU)** | **TN (mg/l)** | **TP (mg/l)** |
| 1972-2008 | 25.98 | 4.24 | 6.09 | 0.72 | 0.52 |
| 2009 | 28.63 | 5.6 | 3.34 | 0.44 | 0.2 |
| 2010 | 25.14 | 5.14 | 3.62 | 0.43 | 0.19 |
| 2011 | 26.21 | 5.22 | 4.15 | 0.38 | 0.15 |
| 2012 | 25.67 | 5.79 | 2.33 | 0.32 | 0.16 |
| 2013 | 24.9 | 6.23 | 1.78 | 0.35 | 0.22 |
| 2014* | 25.98 | 7.28 | 1.8 | 0.33 | 0.15 |

*2014 samples averaged only through May for Salinity, Sechi, and Turbidity; Samples averaged only through March for TN and TP

# Appendix A