COMPARITIVE STUDY ON

SEAGRASS COVERAGES

IN TAMPA BAY

SCUBANAUTS INTERNATIONAL

MASTERNAUT PROJECT

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Comparative Study on Seagrass Species Coverages

Abstract:

Seagrass coverage surveys were conducted at two locations along the South Skyway Bridge Rest Station during the fall to investigate growth over time of a released mitigation site and compare its most current coverage to a natural seagrass bed. Snorkeling surveys displayed that the mitigated site possessed slightly higher total vegetative cover than the natural seagrass bed. The released seagrass mitigation site had a coverage increase of 18.5 percent from 2011 to 2018. Moving forward with the study it may prove useful to expand research to the other side of the Skyway Bridge to evaluate differences in seagrass species and coverage in the overall region.

Introduction:

Seagrasses are a class of angiosperms referred to as monocotyledons; they have similar organs and tissues to other flowering plants (Kuo and Hartog 1). They possess leaves, root masses, flowers, seeds, and vascular bundles that extend through the plant. Seagrasses undergo photosynthesis to produce amino acids and carbohydrates, and provide a stable environment for organisms to live in. They are affected by a variety of abiotic factors including but not limited to sunlight availability, salinity, depth, nutrient availability, and pH levels (McGuire 12). Seagrasses are resilient, and many coastal areas are dominated by several species. Three of the most common seagrass species in Tampa Bay are *Thalassia testudinum, Halodule wrightii*, and *Syringodium filiforme.* They possess the ability to survive in water ranging from three to nine feet deep (Reynolds et al.). Seagrass beds are an incredibly important ecosystem and provide vital functions globally (McKenzie et al. 13). They serve the roles of providing important habitat zones, sediment stabilization, and nursery grounds, so their success is vital to coastal communities (McGuire 19).

Seagrass composition in the survey area can be used to estimate seagrass diversity in the overall area. This can provide insight into how effective the mitigation release process for the studied seagrass bed was when compared to a nearby natural site. In addition to this, a released mitigation seagrass bed can have its vegetative coverage compared pre-and post-release. This can be monitored through quantitative data analysis using quadrat placement along transect lines (McKenzie et al. 13). Transect lines allow for the division of a studied site into various sections, while quadrats allow for the comparison of coverages. The abundance of seagrass coverage over the total site when compared to bare ground and dead vegetative coverage provides an estimate as to the health of the seagrass bed; further analysis includes the collection of data to determine the individual species coverages (Morrison 19).

Study Site History:

The Florida Department of Transportation (FDOT) needed to do roadway construction associated with the I-275 Sunshine Skyway Bridge and South Rest Area and acquired a permit from the Florida Department of Environmental Regulation (FDER). As part of this permit, impacts to shallow-water submerged bottoms FDOT was required to create approximately seven acres of seagrass mitigation behind a breakwater wall along the South Skyway Rest Area. To accomplish this an approximately seven-hundred linear foot breakwater wall made of limestone riprap and concrete rubble. Between the existing seawall and the newly constructed breakwater wall, dredged sand material was brought in to create appropriate elevations for seagrass.

Three seagrass species from a donor site in Tampa Bay were transplanted into this area at an unknown density and composition.

Based off previously collected data, I hypothesized that the overall vegetative coverage would be higher for the location, and that the mitigated site would have higher vegetative coverage than the natural site. The experiment is centered around the central questions of how the average percent vegetative coverage between a natural (which will function as the control) and released mitigation seagrass bed (where sediment grading and replanting have occurred) compare when the seagrass species *Thalassia testudinum*, *Halodule wrightii*, and *Syringodium filiforme* individual coverages are summed to find the total vegetative coverage? In addition, how has the data from the Wetland Mitigation Monitoring Report regarding the mitigation site pre-and post-release compare?

Methodology:

Data for the project was collected in the Tampa Bay ecosystem along the South Rest Station to the Sunshine Skyway Bridge. The natural (27°35'1.62"N and 82°36'59.08"W) and mitigated (27°34'58.37 N and 82°36'51.04"W) seagrass beds were within one quarter kilometer of one another, however they were separated by a manmade breakwater wall and sandbar that developed around it. Research collection happened on September 9, 2018 for the mitigation site and November 4,2018 for the natural seagrass bed. Data collection began with pre-site evaluations being conducted to determine when high tide would occur as the depth is shallow at these locations, and researchers needed to be able to be suspended high enough above the bottom. An ecological quadrat survey was conducted using a $1m^2$ quadrat and four constructed transect lines. Transects were determined using a GIS application that overlaid transect lines on the Google Maps image of the site. The application, Avenza Maps, was then used off a smartphone to determine exactly where researchers would begin the transects. Before entering the water, researchers conducted water quality testing that focused on salinity, temperature, general hardness, pH level, carbonate hardness, nitrates and nitrites using testing strips for aquariums and separate devices for temperature and salinity (refractometer for salinity and probe setup for temperature). Along each transect there are ten quadrat placements with an approximate swim value of ten equal kicks (single leg movement counted as one kick) between each placement. Once the quadrats had been laid carefully on the seagrass bed, the percentages for the three species could be determined in a pre-filled data sheet and from this the bare coverage and total vegetative coverage could be calculated. Coverage error was determined using visual inspection for an error of ±5% based off information found in the Florida Seagrass Manager's Toolkit and previous quadrat studies. The numerical values were then manipulated using Microsoft Excel.

Results:

Figure 1. Percent vegetative coverage (±5%) of a natural seagrass bed compared to a formerly mitigated site for *Thalassia testudinum, Syringodium filiforme, and Halodule wrightii*, and the total vegetative coverage

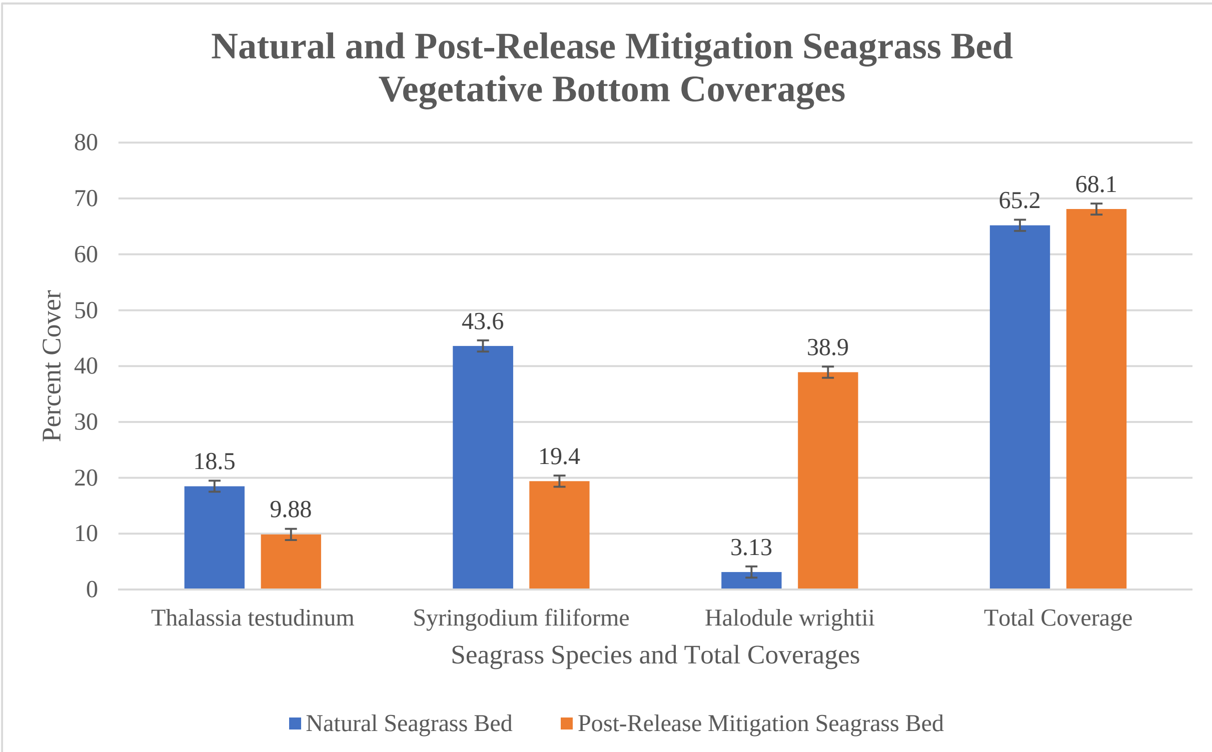

Figure 1 compares the vegetative bottom coverages for the mitigated and natural sites. From the graph the mitigated site has a slightly higher value of 68.1 % when compared to the natural site's 65.2 % total coverage. This is then broken down into the largest difference between the two being with the species *Halodule wrightii* of 35.77 %, followed by *Syringodium filiforme* at 24.2 % and lastly *Thalassia testudinum* at 8.62 %.

Figure 2. Percent vegetative coverage (±5%) of a seagrass bed before and after mitigation release for *Thalassia testudinum*, *Syringodium filiforme, and Halodule wrightii*, and the total vegetative coverage

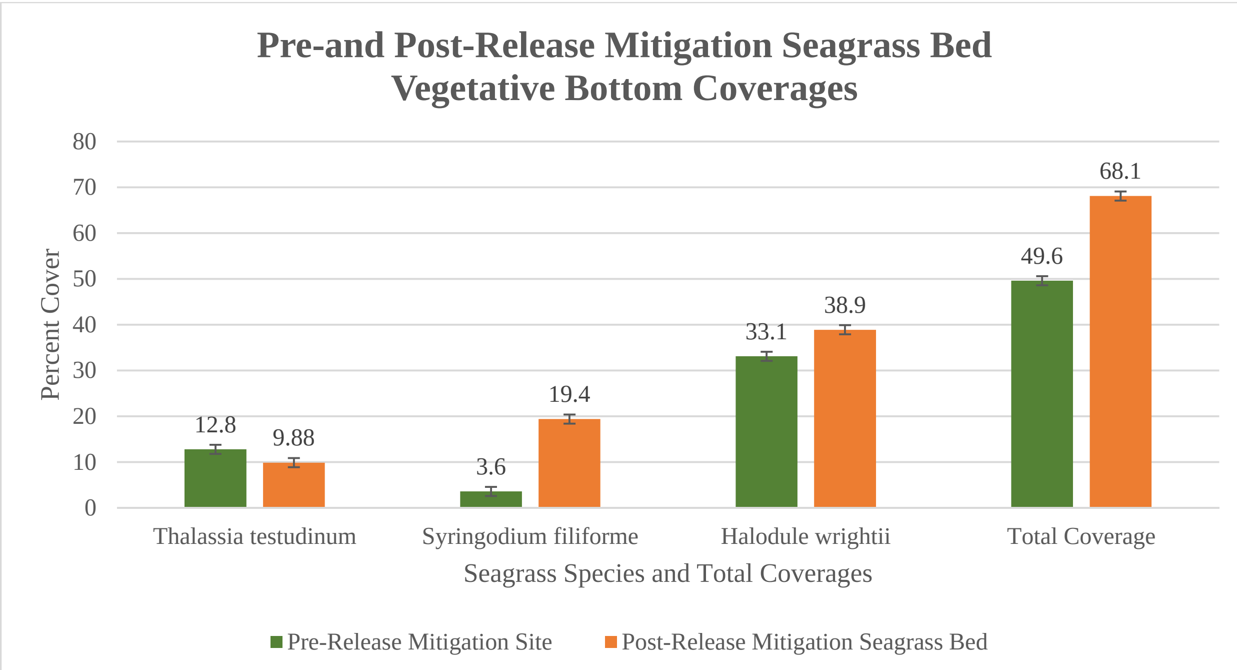

Figure 2. displays the change in bottom cover of seagrass from a 2011 study and this study conducted in 2018. The site shows a 18.5 % overall increase in vegetation while also having increases for *Halodule wrightii* and *Syringodium filiforme* at 5.9 % and 15.8 % respectively. The species *Thalassia testudinum* displays a slight negative percentage change of -2.92%.

Figure 3. T-Test: Two-Sample Assuming Unequal Variances was conducted in Microsoft Excel to compare the overall coverage values to determine the statistical significance in the difference of the mean values between the two seagrass bed locations

Statistics		
Mean	65.2	68.1
Variance	309.1	107.1
Observations	4	4
t Stat	-0.29	
t Critical two-tail	2.57	

Figure 3. shows that there is no statistically significant difference in the mean values for Total Vegetative Seagrass Coverage between the Natural and Post-Release Mitigation seagrass beds. This is based on the t stat value of -1.31 and the t Critical two-tail value of 2.57 the t stat value is less than the Critical value. The null hypothesis is accepted, and there is no statistically significant difference between the average seagrass coverage between the Natural (Control) and Post-Release Mitigation seagrass beds. The statistical analysis possessed three degrees of freedom.

Figure 4. A table showing the average vegetative coverage (±5%) and Standard Deviations of a natural seagrass bed for *Thalassia testudinum*, *Syringodium filiforme*, and *Halodule wrightii*, and the total vegetative coverage

Seagrass Species (Natural Bed)	**Average Percent Coverage (±5%)**	**Standard Deviation**
Thalassia testudinum	18.45	18.5
Syringodium filiforme	43.6	32.8
Halodule wrightii	3.13	4.3
Total Coverage	65.2	17.6
Seagrass Species (Mitigated Bed)	**Average Percent Coverage (±5%)**	**Standard Deviation**
Thalassia testudinum	9.88	17.5
Syringodium filiforme	19.4	26.6
Halodule wrightii	38.9	40.1
Total Coverage	68.1	10.3

The Average Percent Coverage values are determined using the AVERAGE function by averaging the value for all transect lines, and the Standard Deviation values are determined from the average coverage values per species and total coverage using the STDEV.S function in Microsoft in Excel. The average total coverage values are within six-percent of one another, however the species composition by site differ greatly.

Discussion:

The null hypothesis (H_0) was that there is no significant difference in overall vegetative coverage between the post seagrass mitigation release area and natural seagrass bed. The H_0 was not rejected because there was not a significant difference in the mean vegetative coverages, as is conveyed in the T test. To support this, the t Stat value of -0.29 is less than the t-test Critical Value of 2.57, which shows the lack of a statistically significant difference between the two sites. However, as shown in Processed Data Graph One, the two sites do have differences in the average vegetative coverage percentages for each species. From Processed Data Table One it is seen that *Syringodium filiforme* is the most abundant seagrass at the Natural Site with an average coverage of 43.6 % ±5 while *Halodule wrightii* is the most abundant seagrass species at the Post Release Mitigation Site with an average coverage of 38.9% ±5. Processed Data Tables One and Two show that the Standard Deviation value (4.3) for *Thalassia testudinum* at the former mitigation site and the Standard Deviation (40.1) for *Halodule wrightii* at the Natural Site display that the variation for the two species at these sites is relatively small. This indicates that while the average bottom for the most abundant seagrass at both sites is similar that the species compositions are varied.

Furthermore, seagrass species are subject to change due to varying depths (Reynolds et al.) This could be a reason why the seagrass species compositions varied at the two sites, in addition to the initial seagrass replanting and sediment grading that the mitigation location received. At this depth there is not a detectable difference in sunlight availability that would account for the species coverage differences (NOAA Editors). Varying seagrass coverages differed across each transect but when averaged for all transects the mean seagrass coverage is similar between both the natural and mitigation area. This provides further evidence not rejecting the null hypothesis, although the individual species coverages are not considered with this. The low uncertainty of the quadrat method based off researcher visual findings increases confidence in the outcome of the experiment and acceptance of the H0.

With respect to differences between the initial data collected by Quest Ecology and the recent data collection from the Post-Release Mitigation Site, the seagrass coverage has greatly increased. The initial value of 49.6 % has increased to 64.9 % for the total vegetative coverage. The most noticable finding is the increase of *Syringodium filiforme* as the increase from 3.6 % to 38.9 % was the most dramatic change; other growth in percent coverage is seen with *Halodule wrightii*. The final species of *Thalassia testudinum* decreased in percent coverage, but with the total coverage of the site increasing and the two other species gaining cover at such a dramatic amount this loss can be put into perspective. The gains made by the site throughout and following the mitigation process show great promise for future mitigation projects and studies in the Tampa Bay area regarding seagrass.

Conclusion:

By collecting data on the former and current conditions of a released mitigation seagrass bed and a natural seagrass bed in the same location there is an ability to analyze the effect of mitigation on seagrass beds near the Sunshine Skyway Bridge. It was hypothesized that the mitigation process was a success, but the difference in total vegetative coverage between the natural and mitigated site was much smaller than expected. As the overall seagrass coverage values increased highly for the mitigated site over time and ended up higher than the natural site, the results support the determination that the mitigation process for this location was successful. The two seagrass beds are thriving ecosystems that support a wide variety of marine organisms and human activity in the area. With a larger data set there is a possibility to explain the success of mitigation projects on seagrass beds throughout the Tampa Bay area. Moving forward with the experiment, modifications such as the use of more aerial and satellite images as well as surveying additional flora could be made to collect more data at the two surveyed seagrass beds on the south side of the Skyway Bridge as well as the North Side to determine differences between the two regions over time. We can use seagrass studies to effectively gauge the health of Tampa Bay by comparing current seagrass bed size and prior size using aerial photography and satellite images to determine bed growth and decay. Software programs like ArcGIS or similar applications can be used in conjunction with annual aerial imagery to document the progress of growth or reduction seagrass coverage in areas like Tampa Bay. This application would provide a big picture view of overall coverages, but snorkeling surveys would be required to address the coverage of individual species.

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Data Appendices:

Figure 1. Percent vegetative coverage (±5%) of a natural seagrass bed for *Thalassia testudinum, Syringodium filiforme, Halodule wrightii*, and the total vegetative coverage

Natural Site: Transect One										
Species	*Seagrass Coverage Percentages*									
Turtle Grass *(Thalassia testudinum)*	*15*	*30*	*65*	*60*	*45*	*35*	*50*	*20*	*30*	*45*
Manatee Grass *(Syringodium filiforme)*	*5*	*5*	*0*	*10*	*0*	*0*	*0*	*0*	*0*	*0*
Shoal Grass *(Halodule wrightii)*	*10*	*5*	*0*	*5*	*10*	*10*	*5*	*0*	*0*	*0*
Total Vegetative Coverage	*30*	*40*	*65*	*75*	*55*	*45*	*55*	*20*	*30*	*45*
Natural Site: Transect Two										
Species	*Seagrass Coverage Percentages*									
Turtle Grass *(Thalassia testudinum)*	*20*	*10*	*15*	*5*	*5*	*10*	*5*	*40*	*7*	*5*
Manatee Grass *(Syringodium filiforme)*	*55*	*80*	*35*	*50*	*55*	*45*	*85*	*55*	*10*	*15*
Shoal Grass *(Halodule wrightii)*	*0*	*0*	*10*	*10*	*10*	*5*	*0*	*0*	*0*	*0*
Total Vegetative Coverage	*75*	*90*	*60*	*65*	*70*	*60*	*90*	*95*	*17*	*20*
Natural Site: Transect Three										
Species	*Seagrass Coverage Percentages*									
Turtle Grass *(Thalassia testudinum)*	*4*	*0*	*0*	*0*	*5*	*10*	*2*	*5*	*5*	*5*
Manatee Grass *(Syringodium filiforme)*	*85*	*85*	*85*	*85*	*90*	*85*	*80*	*90*	*80*	*85*
Shoal Grass *(Halodule wrightii)*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Total Vegetative Coverage	*89*	*85*	*85*	*85*	*95*	*95*	*82*	*95*	*85*	*90*
Natural Site: Transect Four										
Species	*Seagrass Coverage Percentages*									
Turtle Grass *(Thalassia testudinum)*	*5*	*0*	*15*	*5*	*30*	*20*	*40*	*0*	*50*	*20*
Manatee Grass *(Syringodium filiforme)*	*35*	*25*	*25*	*60*	*50*	*30*	*35*	*30*	*40*	*60*
Shoal Grass *(Halodule wrightii)*	*10*	*5*	*15*	*0*	*5*	*0*	*5*	*0*	*5*	*0*
Total Vegetative Coverage	*50*	*30*	*55*	*65*	*85*	*50*	*80*	*30*	*95*	*80*

Figure 2. Percent vegetative coverage (±5%) of a released mitigation seagrass bed for *Thalassia testudinum*, *Syringodium filiforme*, *Halodule wrightii*, and the total vegetative coverage

Mitigation Site: Transect One										
Species	*Seagrass Coverage Percentages*									
Turtle Grass *(Thalassia testudinum)*	*0*	*0*	*0*	*5*	*0*	*10*	*20*	*5*	*10*	*35*
Manatee Grass *(Syringodium filiforme)*	*0*	*90*	*65*	*95*	*60*	*50*	*10*	*30*	*20*	*10*
Shoal Grass *(Halodule wrightii)*	*90*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*5*	*0*
Total Vegetative Coverage	*90*	*90*	*65*	*100*	*60*	*60*	*30*	*35*	*35*	*45*
Mitigation Site: Transect Two										
Species	*Seagrass Coverage Percentages*									
Turtle Grass *(Thalassia testudinum)*	*5*	*0*	*0*	*0*	*0*	*0*	*0*	*30*	*10*	*10*
Manatee Grass *(Syringodium filiforme)*	*0*	*0*	*0*	*0*	*10*	*15*	*5*	*40*	*0*	*55*
Shoal Grass *(Halodule wrightii)*	*95*	*95*	*80*	*45*	*80*	*40*	*80*	*0*	*75*	*0*
Total Vegetative Coverage	*100*	*95*	*80*	*45*	*90*	*55*	*85*	*70*	*85*	*65*
Mitigation Site: Transect Three										
Species	*Seagrass Coverage Percentages*									
Turtle Grass *(Thalassia testudinum)*	*5*	*30*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*15*
Manatee Grass *(Syringodium filiforme)*	*0*	*0*	*5*	*0*	*0*	*0*	*0*	*0*	*0*	*40*
Shoal Grass *(Halodule wrightii)*	*80*	*50*	*80*	*95*	*90*	*80*	*65*	*65*	*70*	*0*
Total Vegetative Coverage	*85*	*80*	*85*	*95*	*90*	*80*	*65*	*65*	*70*	*55*
Mitigation Site: Transect Four										
Species	*Seagrass Coverage Percentages*									
Turtle Grass *(Thalassia testudinum)*	*0*	*0*	*0*	*0*	*35*	*20*	*80*	*0*	*60*	*10*
Manatee Grass *(Syringodium filiforme)*	*0*	*0*	*15*	*60*	*10*	*10*	*0*	*20*	*10*	*50*
Shoal Grass *(Halodule wrightii)*	*100*	*80*	*10*	*0*	*5*	*0*	*0*	*0*	*0*	*0*
Total Vegetative Coverage	*100*	*80*	*25*	*60*	*50*	*30*	*80*	*20*	*70*	*60*

Figure 3. The vegetative coverage percentage values determined from the initial Wetland Mitigation Monitoring Report from Quest Ecology for the Pre-Release Mitigation Site

Pre-Release Mitigation Site Values								
Transects	T1 1	T 2	T 3	T 4	T 5	T 6	T 7	Overall Mean
Species	Seagrass Coverage Mean							
Turtle Grass *(Thalassia testudinum)*	11.7	16.3	29	10	3.3	0	0	12.8
Manatee Grass *(Syringodium filiforme)*	11.7	8.8	2.6	0	0	0	0	3.6
Shoal Grass *(Halodule wrightii)*	38.3	16.8	39	55	55	0	0	33.1
Total Vegetative Coverage	61.7	41.8	70.6	65	58.3	0	0	49.6

Figure 4. A The tested chemical, temperature and starting and ending depth values for the post-release mitigation and natural seagrass beds

Tested Quality	**Natural Seagrass Bed**	**Post-Release Mitigation Seagrass Bed**
Salinity	27 ppt ± 1 ppt	28 ppt ± 1 ppt
Nitrite	1 ppm (mg/L) ± 1 ppm	1.5 ppm (mg/L) ± 1 ppm
Nitrate	30 ppm (mg/L) ± 5 ppm	20 ppm (mg/L) ± 5 ppm
pH level	7.5	7.5
General Hardness	180 ppm (mg/L) ± 5 ppm	180 ppm (mg/L) ± 5 ppm
Carbonate Hardness	120 ppm (mg/L) ± 5 ppm	140 ppm (mg/L) ± 5 ppm
Temperature	30.8 °C ±.01 °C	31.2 °C ±.01 °C
Starting Depth (Seagrass bed average)	1.20 m ± 10 cm	1.30 m ± 10 cm
Ending Depth (Seagrass bed average)	1.45 m ± 10 cm	2.20 m ± 10 cm