

Final Report to the Gulf Islands National Seashore

**Post Hurricane Katrina Damage Assessment of Seagrass Resources of the Mississippi
Islands--Gulf Islands National Seashore**

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Abstract

On November 8th and 9th, 2005, the northern shores of the Mississippi Gulf Islands were surveyed to assess changes in seagrass distribution and abundance that may have occurred after Hurricane Katrina. Of the 51 sites visited along the Mississippi Gulf Islands National Seashore, 33 sites had seagrass present either as a pure stand of *Halodule wrightii*, a mixed bed of *Halodule wrightii* and *Syringodium filiforme*, or a pure stand of *Syringodium filiforme*. Comparison of the 2005 survey to the Heck et al. (1996) survey showed both decreases and increases in seagrass coverage, with decreases seen mainly at the Ship Islands. *Halodule wrightii* mean shoot density was 2104 $\pm$ 891 shoots/m² ($\pm$ s.e.) at East Ship Island, 2287 $\pm$ 231 shoots/m² at Horn Island, and 3380 $\pm$ 454 shoots/m² at Petit Bois Island. Aboveground biomass estimates showed decreases at all three islands where seagrass was present, but belowground biomasses showed relatively little changes at East Ship Island and Horn Island and an increase at Petit Bois, indicating that aboveground biomass measurements may be underestimated due to the time of year in which the samples were taken. Finally, we conclude that Hurricane Katrina did not devastate the majority of seagrass beds along the Mississippi Gulf Islands National Seashore, but this was possible only because historical data on the distribution and abundance of seagrass species existed.

Introduction

Seagrasses are important, productive components of nearshore environments that provide food and shelter for many economically important species (Heck & Orth, 1980; Zieman, 1982; Williams and Heck 2001). Since the early 1970's there have been worldwide declines in the distribution and abundance of seagrass habitats, and drastic losses of seagrasses have also occurred throughout the Gulf of Mexico. (Cambridge et al., 1986; Dennison et al., 1993; Carlson et al. 1998). In most instances, declining water quality has been blamed for seagrass die-off.

Seagrass distribution is known to be determined primarily by the availability of light (Duarte, 1991; Dunton 1994). Because seagrasses support non-photosynthetic root and rhizome tissue, seagrasses require more light than most algal species. *Halodule wrightii* (shoal grass) and *Ruppia maritima* (widgeon grass) often grow in shallow water and are exposed to nearly full sunlight, while *Thalassia testudinum* (turtle grass) usually grows at greater depths and receives only a fraction of incident light due to attenuation by the water column. *Syringodium filiforme* (manatee grass) often grows at deeper depths than *T. testudinum*, but has light requirements that

are similar to those of turtlegrass (Dawes et al. 2004). Among these seagrass species in the northern Gulf of Mexico, *T. testudinum* survives longer under low light conditions (Czerny & Dunton, 1995), presumably because it has larger belowground storage reserves. Typically, turtle grass has about 15% to 20% of its biomass in emergent leaves, and the remainder in roots, rhizomes, growing short-shoots, and leaf sheaths (Zieman, 1982). Since *H. wrightii* and *R. maritima* only have limited rhizome storage reserves to draw on during periods of low light availability, long-term light reduction can slow their reproduction and lower the plants' ability to replenish themselves after high levels of shoot loss (Backman & Barilotti, 1976; as cited in Thayer et al., 1984).

In addition to light availability, hydrodynamic processes may also influence seagrass distribution. Wave energy, tidal current speed and water depth (which directly effects both the mechanics of the hydrodynamic processes and light availability) have all been found to influence seagrass distribution (Fonseca and Bell, 1998). When these forces are intensified by an event such as a hurricane, losses of seagrass habitat may occur via uprooting of the whole plant or by burial from shifting sediments. Thus, the recent landfall of Hurricane Katrina near the Louisiana-Mississippi state lines may have negatively impacted the abundance of seagrasses in the Mississippi portion of the Gulf Islands National Seashore (GUIS). However, this is not necessarily the case, as seagrasses are resilient to many hurricanes. For example, the very strong Hurricane Ivan did not produce severe seagrass loss in coastal Alabama (Byron and Heck, in press), in contrast to what was observed in Santa Rosa Sound, FL after the passage of another major storm, Hurricane Opal (Heck et al., 1996).

A survey of submerged aquatic vegetation (SAV) in the GUIS was carried out in 1992, and this work included photointerpreted aerial imagery of SAV that was groundtruthed and

monitored during the subsequent 4 years (Heck et al., 1996). Thus, we have a very good idea of where seagrasses existed through 1996. The goal of the present study was to assess how the passage of Hurricane Katrina may have impacted the seagrass resources of the GUIs. To do this we located all stations identified by Heck et al. (1996) that previously supported seagrass, determined whether seagrass species were still present, and if so, what their identities and abundances were.

Methods

On November 8th and 9th, 2005, the northern shore of the Mississippi Gulf Islands National Seashore (West Ship, East Ship, Horn and Petit Bois Islands) was surveyed to assess changes in seagrass distribution and abundance that may have occurred after the 2005 hurricane season, specifically after Hurricane Katrina. Sampling locations were taken from the 1993 – 1996 seagrass monitoring project conducted by the Dauphin Island Sea Lab for the Gulf Islands National Seashore and were at ½ – minute map intervals (0.5 nautical miles = 0.57 statute miles = 0.93 km) along the barrier islands for a total of 51 sites (Table 1). Data on seagrass species composition and abundance (presence/absence) at tide table corrected depths of 1.0 and 2.0 m were recorded and a core sample (i.d. = 16.2 cm) of seagrass to a depth of 15 cm was collected from each location in order to sample both the above ground leaves and the below ground roots and rhizomes. Core samples were placed on ice and returned to the lab, where the above- and below-ground components from all species present at each location were separated, scrapped free of epiphytes, and dried. The dried material was weight and then archived at DISL for future reference.

Water temperature, salinity and measurements of photosynthetically active radiation (PAR) using a Li-Cor spherical sensor were also measured at each sampling location.

Results

Of the 51 sites visited along the Mississippi Gulf Islands, 33 sites had seagrass present either as a pure stand of *Halodule wrightii*, a mixed bed of *Halodule wrightii* and *Syringodium filiforme*, or a pure stand of *Syringodium filiforme* (Figure 1). *Halodule wrightii* was the dominant species found, but not as a continuous bed spanning the length of the islands. Instead, *H. wrightii* occurred in discrete patches of meters to tens of meters in diameter. Patches were found within waters that were less than or equal to 1m deep and no patches were found at any of the 2 m depth locations. This lack of seagrass at the 2m depths was most likely due to high light attenuation in the water column. Comparison of the 2005 survey to the survey conducted in 1996 showed a 100% loss of seagrass along West Ship Island, a 57% decrease in seagrass coverage at East Ship Island, a 14.8% increase at Horn Island, and a 72.5% increase in seagrass occurrence at Petit Bois Island (Figure 2). The decrease at East Ship Island represents both a decline in seagrass abundance and an increase in the number of sites visited from the 1996 survey (1996, n = 6; 2005 n = 7). The opposite occurred at Petit Bois, where the increase in percentage is due to an increase in seagrass abundance and a decrease in the number of sites visited (1996 survey, n = 12; 2005 survey n = 11). The dramatic losses (over 50%) at West and East Ship Island are likely due to their proximity to the eye of Hurricane Katrina as the storm made second landfall at Waveland, Mississippi. Seagrass losses at these islands occurred from areas on the islands that were devoid of trees and appear to be a result of over-wash from the large storm surge that was associated with this storm.

When compared to the results of Heck et al. (1996), *Halodule wrightii* short shoot densities and biomass estimates at each site where seagrass was present showed that there was a decrease in island mean shoot density at Horn Island from 3273 +/- 298 to 2287 +/- 231 shoots/m² (+/- s.e.), an increase in island mean shoot density at Petit Bois Island, and essentially

no change at East Ship Island (Figure 3). Aboveground biomass estimates showed decreases at all three islands where seagrass was present (Figure 4), but belowground biomasses showed relatively little changes at East Ship Island and Horn Island and an increase at Petit Bois (Figure 5). The decrease in aboveground biomass may be a consequence of the time of year in which we were able to sample the sites, as the production of new seagrass shoots and leaves tends to slow as temperatures decline with increasing frequency of cold fronts that typically begin to arrive in November. This is suggested by the belowground biomass estimates, which showed relatively few changes over the last decade.

Syringodium filiforme was found at both Horn and Petit Bois Islands. The 2005 survey was the first reported occurrence of *S. filiforme* along Horn Island and although *S. filiforme* had been previously seen at Petit Bois in both 1993 and 1994, the 2005 survey found two different locations that supported *S. filiforme* either as a pure bed or as a mixed bed with *H. wrightii* (Table 1). Measures of mean shoot density, aboveground biomass and belowground biomass by island can be found in figures 6-8. Although *H. wrightii* was the species most often encountered, when *S. filiforme* was present, it was typically the dominant species with greater shoot density, aboveground biomass and belowground biomass (see Appendix A for detailed data).

Data collected on water temperature ($^{\circ}\text{C}$), salinity (ppt) and PAR($\mu\text{E m}^{-2} \text{s}^{-1}$), expressed as percent surface radiation reaching the canopy surface, are presented as island averages in Figures 9 -11. We have also included the water quality data from the 1993 – 1996 surveys to assess whether there have been any large deviations in water quality since the last survey. Surface water temperatures still ranged between 21 and 23 $^{\circ}\text{C}$ (Figure 9) and were typical for the time of year that this survey was conducted. Salinities were slightly higher than those recorded from previous years and ranged between 31 and 32 ppt, but this may also be related to the time

of year the sampling occurred (Figure 10). Percent PAR reaching the canopy was between 40 and 50%, which although lower than what was recorded in 1996, is still above the minimum of approximately 20% that is needed to ensure seagrass growth and survival (cf. Dawes et al. 2004).

Discussion

Tropical storms and hurricanes are a regular feature of the Caribbean Sea and the Gulf of Mexico. A recent summary of the effects of hurricanes on seagrass meadows of the Caribbean by Cruz-Palacios and van Tussenbroek (2005) suggested that impacts are usually less dramatic than those reported from the tropical Pacific Ocean, and total destruction of large portions of seagrass meadows is infrequent. However, most studies of the effects of hurricanes on seagrass meadows in the western Atlantic have not included pre-storm data, so firm conclusions are difficult to draw. One exception is a recent study of south Florida seagrasses by Fourqurean and Rutten (2004), who found substantial (19%) losses of *Syringodium filiforme*, but only a 3% loss of *Thalassia testudinum* after the passage of Hurricane Georges, a category 1 hurricane, in 1998. Prior to the present study there was a paucity of information on the impacts of hurricanes on meadows dominated by *H. wrightii* (Byron and Heck, in press). Our data generally support those of previous investigators, and do not indicate large losses of *H. wrightii* following the passage of Hurricane Katrina, except at the Ship Islands, where much of the Islands' area was lost, and burial of *H. wrightii* was likely. It is possible, however, that buried *H. wrightii* could emerge from the overlying sediments and this could easily be evaluated by future surveys.

During a post- Katrina survey of the western portion of the Alabama's coast in late 2005, we found no loss of seagrass from the areas previously found to support beds in 2004 (Byron and Heck, in press), and we are confident that Hurricane Katrina did not cause major impacts to the seagrass meadows along the western portion of Alabama's coastline. Thus, even though

Hurricane Katrina was a large and powerful storm that made landfall just west of the GUIS Mississippi barrier islands, with the exception of the Ship Islands, seagrass meadows in Mississippi and Alabama were not seriously damaged by this storm.

Recovery of seagrass and recolonization after losses are rare, and destruction of seagrass habitat may have long-term consequences for sediment stability and production of economically important finfish and shellfish (Williams and Heck 2001). For this reason, many coastal states with substantial seagrass resources assess the distribution and abundance of seagrass meadows every few years. Mapping of seagrass habitat may be conducted using digitized aerial photography, georectified and assembled in a Geographic Information System (GIS), with photos over multiple years used to carry out time series analyses where seagrass bed size and movement can be monitored and tracked.

During 2002, the Gulf Islands National Seashore supported the collection of photointerpreted imagery of the GUIS, which may soon be available (Riley Hoggard GUIS, personal communication). These data, combined with historic data and this survey, can aid in determining if the losses of seagrass patches, especially along West and East Ship Islands, were a direct consequence of Hurricane Katrina or had been an on-going process through the natural erosion/movement of the island.

Finally, we note that we were able to conclude that Hurricane Katrina did not devastate the majority of seagrass beds along the Mississippi Gulf Islands National Seashore, but this was possible only because historical data on the distribution and abundance of seagrass species existed. This demonstrates the importance of regular monitoring programs and we strongly recommend that periodic mapping, via aerial photoimagery and groundtruthing, be conducted every few years to help maintain this vital coastal resource.

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List of Tables

Table 1: Latitude and longitude of the 51 locations surveyed during the 2005 survey with indication of seagrass species present during the present survey as well as from the previous surveys during 1993 – 1996. *Halodule wrightii* is indicated by Hw and *Syringoidum filiforme* is indicated by Sf.

Table 1

West Ship Island			Seagrass present				
Station #	Longitude	Latitude	1993	1994	1995	1996	2005
1	88° 59' 00" W	30° 12' 42" N	no	no	no	no	no
2	88° 58' 32.7" W	30° 12' 49.6" N	no	no	no	no	no
3	88° 58' 03.9" W	30° 12' 55" N	no	no	no	no	no
4	88° 57' 44.2" W	30° 12' 59.9" N	Hw	Hw	Hw	Hw	no
5	88° 57' 00.3" W	30° 13' 11.2" N	Hw	Hw	Hw	Hw	no
6	88° 56' 30.7" W	30° 13' 12.2" N	no	Hw	Hw	Hw	no
7	88° 56' 01.2" W	30° 12' 58.8" N	ND	ND	no	no	no

East Ship Island			Seagrass present				
Station #	Longitude	Latitude	1993	1994	1995	1996	2005
-1	88° 54' 58.3" W	30° 13' 02.7" N	ND	ND	no	no	no
0	88° 54' 30" W	30° 13' 30" N	Hw	Hw	no	Hw	no
0.5	88° 54' 00.8" W	30° 14' 00.4" N	Hw	Hw	Hw	no	no
1	88° 53' 30.2" W	30° 14' 35.2" N	Hw	Hw	Hw	Hw	Hw
1.1*	88° 53' 37.9" W	30° 14' 33.6" N					Hw
2	88° 52' 59.9" W	30° 14' 49.3" N	Hw	Hw	Hw	Hw	Hw
3	88° 52' 29.1" W	30° 14' 55.6" N	Hw	Hw	Hw	Hw	no
3.5	88° 52' 02" W	30° 15' 01.3" N	ND	ND	no	ND	no

Horn Island, West End			Seagrass present				
Station #	Longitude	Latitude	1993	1994	1995	1996	2005
0	88° 46' 30.1" W	30° 14' 44.9" N	ND	ND	no	no	no
1	88° 46' 01.0" W	30° 14' 42.3" N	no	no	no	no	no
2	88° 45' 26.7" W	30° 14' 42.9" N	Hw	Hw	Hw	no	Hw
3	88° 44' 58.1" W	30° 14' 53.3" N	Hw	Hw	Hw	Hw	Hw
4	88° 44' 30.1" W	30° 14' 57.5" N	Hw	Hw	Hw	Hw	Hw
5	88° 43' 59.4" W	30° 14' 55.2" N	Hw	Hw	Hw	no	Hw
6	88° 43' 28.3" W	30° 15' 00.4" N	Hw	Hw	Hw	Hw	Hw
7	88° 43' 00.4" W	30° 15' 21.0" N	Hw	Hw	Hw	Hw	Hw
8	88° 42' 30.2" W	30° 15' 13.9" N	no	Hw	Hw	Hw	Hw

Table 1 continued

Horn Island, Central			Seagrass present				
Station #	Longitude	Latitude	1993	1994	1995	1996	2005
9	88° 42' 01.1" W	30° 15' 08.6" N	no	no	Hw	Hw	Sf
10	88° 41' 29.6" W	30° 14' 46.2" N	no	Hw	Hw	Hw	Hw
11	88° 40' 59.8" W	30° 14' 39.8" N	no	no	Hw	Hw	Hw
12	88° 40' 29.8" W	30° 14' 30.5" N	no	no	no	Hw	Hw
13	88° 40' 00.1" W	30° 14' 18.3" N	no	no	no	no	no
14	88° 39' 30.2" W	30° 14' 07.4" N	no	no	Hw	Hw	Hw/Sf
15	88° 39' 00.7" W	30° 14' 08.6" N	no	no	no	no	Hw
16	88° 38' 30.2" W	30° 13' 59.6" N	no	Hw	Hw	Hw	Hw
17	88° 37' 59.9" W	30° 13' 54.4" N	no	Hw	Hw	Hw	Hw
18	88° 37' 30.1" W	30° 13' 51.5" N	no	Hw	Hw	Hw	Hw

Horn Island, East End			Seagrass present				
Station #	Longitude	Latitude	1993	1994	1995	1996	2005
19	88° 37' 00.6" W	30° 13' 47.4" N	no	Hw	no	Hw	Hw
20	88° 36' 29.7" W	30° 13' 45.6" N	no	Hw	Hw	Hw	Hw
21	88° 35' 59.2" W	30° 13' 42.0" N	no	no	Hw	Hw	Hw
22	88° 35' 29.5" W	30° 13' 40.0" N	no	no	Hw	Hw	Hw
23	88° 35' 01.2" W	30° 13' 36.0" N	no	no	no	no	no
24	88° 34' 31.0" W	30° 13' 15.8" N	no	Hw	no	no	no
25	88° 34' 00" W	30° 13' 00" N	no	no	no	no	no

Petit Bois Island			Seagrass present				
Station #	Longitude	Latitude	1993	1994	1995	1996	2005
1	88° 29' 57.0" W	30° 12' 53.4" N	no	no	no	no	no
2	88° 29' 30.6" W	30° 12' 36.9" N	Hw	Hw	no	no	Hw
3	88° 29' 00" W	30° 12' 32.8" N	Hw	Hw	no	no	Hw
4	88° 28' 30.3" W	30° 12' 27.2" N	Hw	Hw	Hw	no	Hw
5	88° 27' 59.9" W	30° 12' 15.8" N	no	no	no	no	Hw/Sf
6	88° 27' 30.1" W	30° 12' 12.0" N	no	Hw	no	no	Sf
7	88° 26' 59.6" W	30° 12' 07.5" N	Hw	Hw	no	no	Hw
8	88° 26' 29.4" W	30° 12' 12.9" N	Sf	no	Hw	no	Sf
9	88° 25' 59.6" W	30° 12' 30.4" N	Hw/Sf	no	no	no	Hw
10	88° 25' 29.4" W	30° 12' 39.2" N	Hw	Hw/Sf	Hw	Hw	Hw
11	88° 24' 59.2" W	30° 12' 38.0" N	no	Hw	Hw	Hw	Hw
12	88° 24' 30" W		no	no	no	Hw	ND

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Figure 1

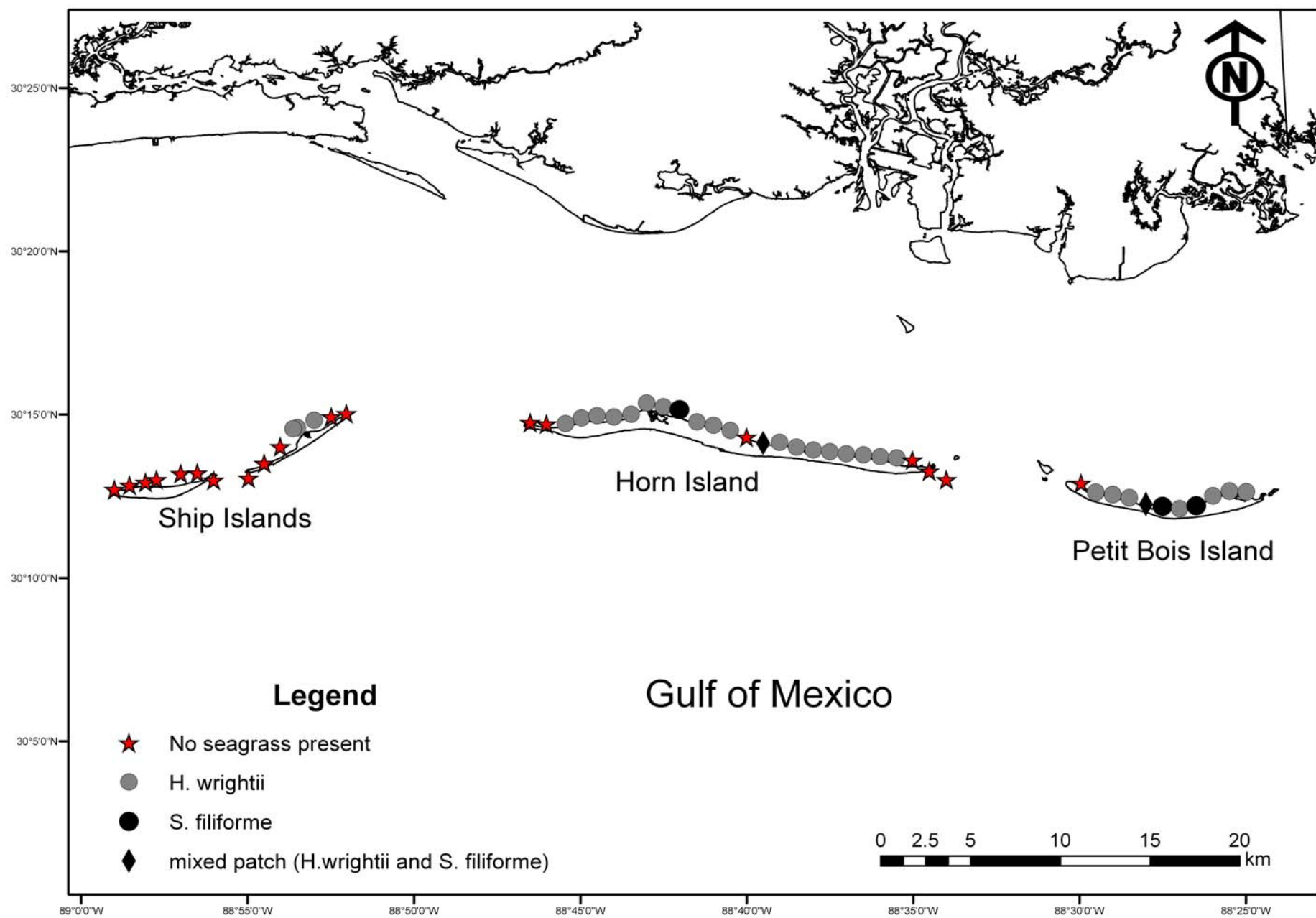


Figure 2

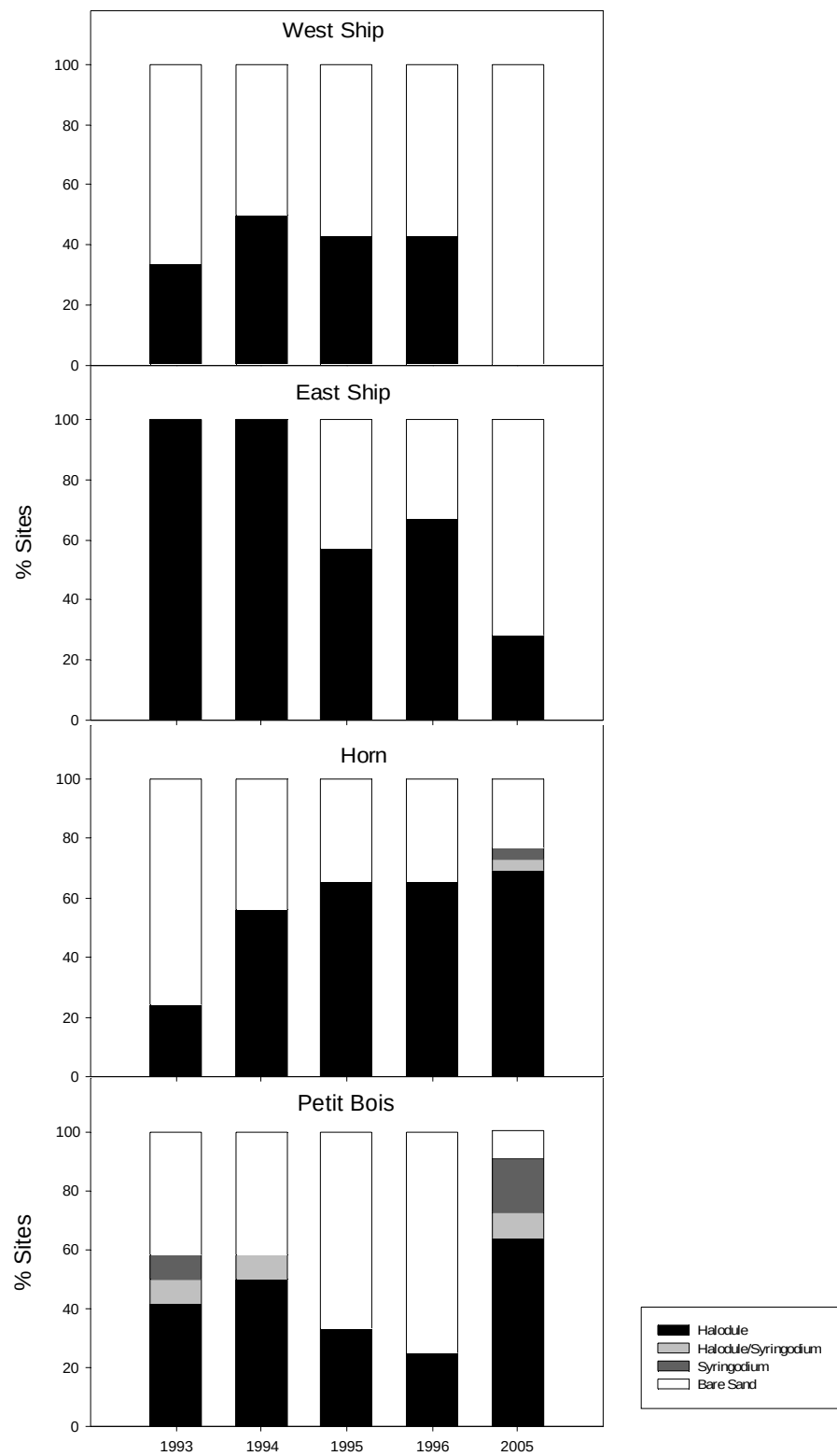


Figure 3

Short Shoot Densities
1993 - 1996, 2005
Halodule wrightii

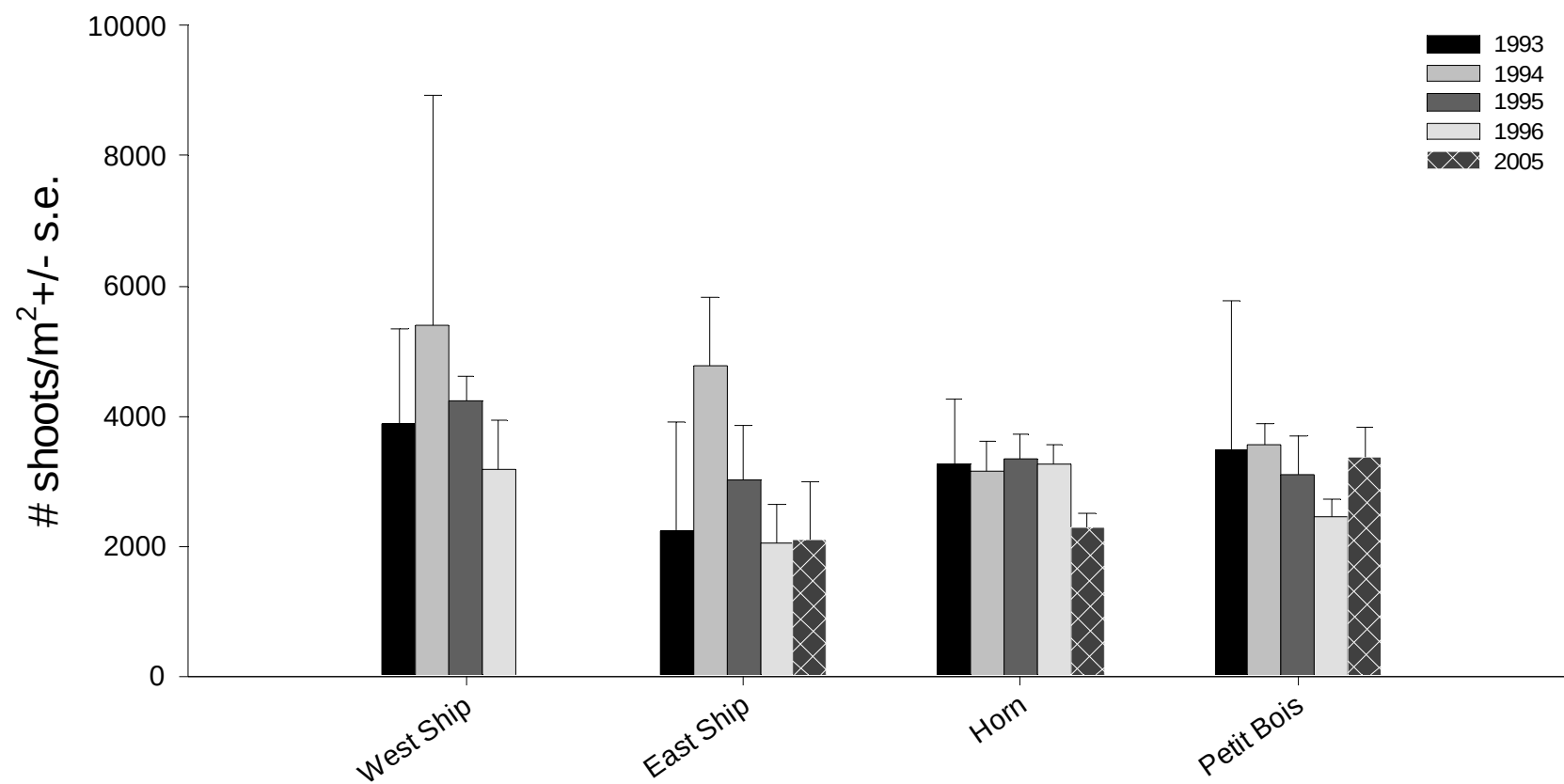


Figure 4

Aboveground Biomass
1993 - 1996, 2005
Halodule wrightii

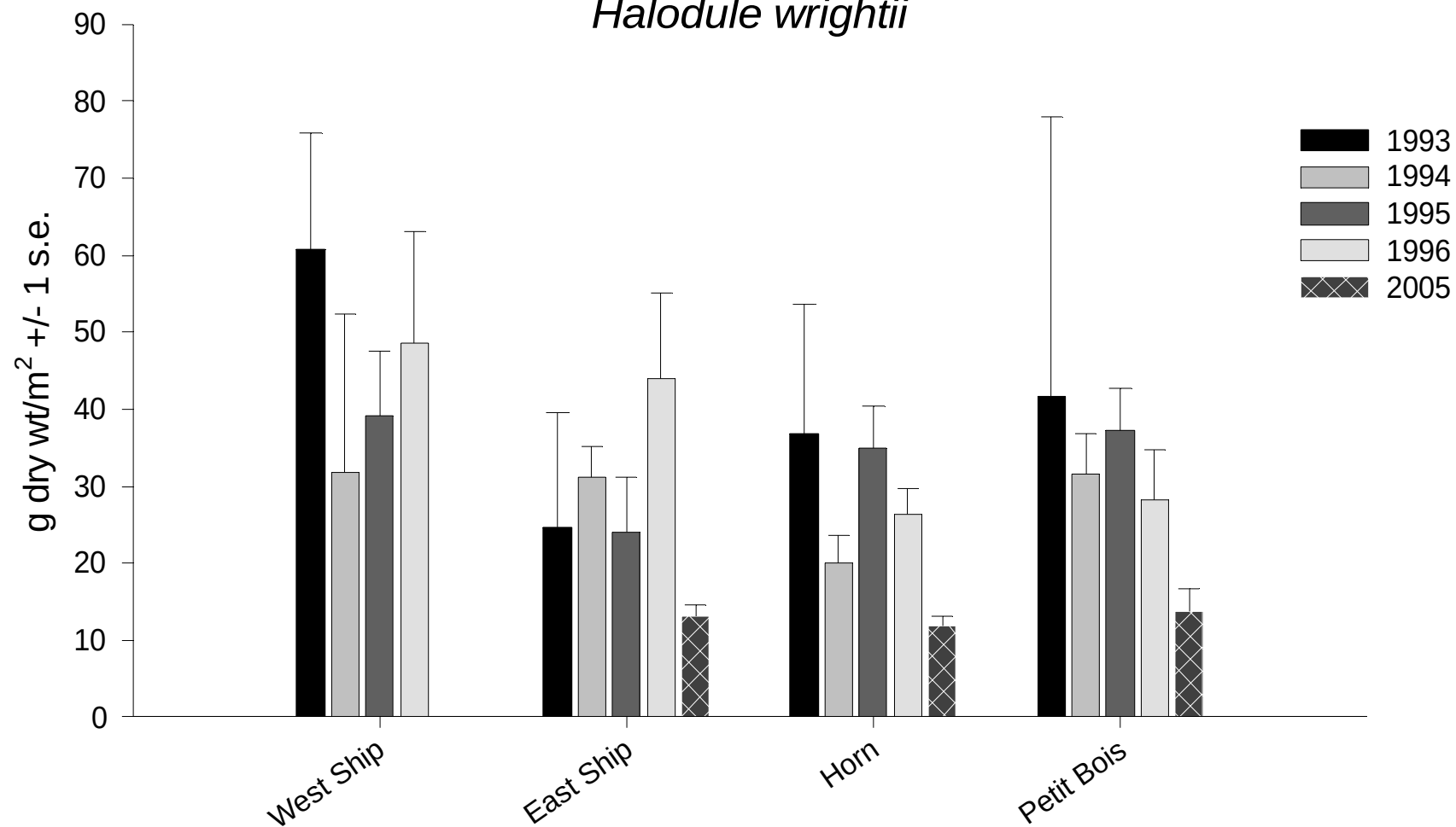


Figure 5

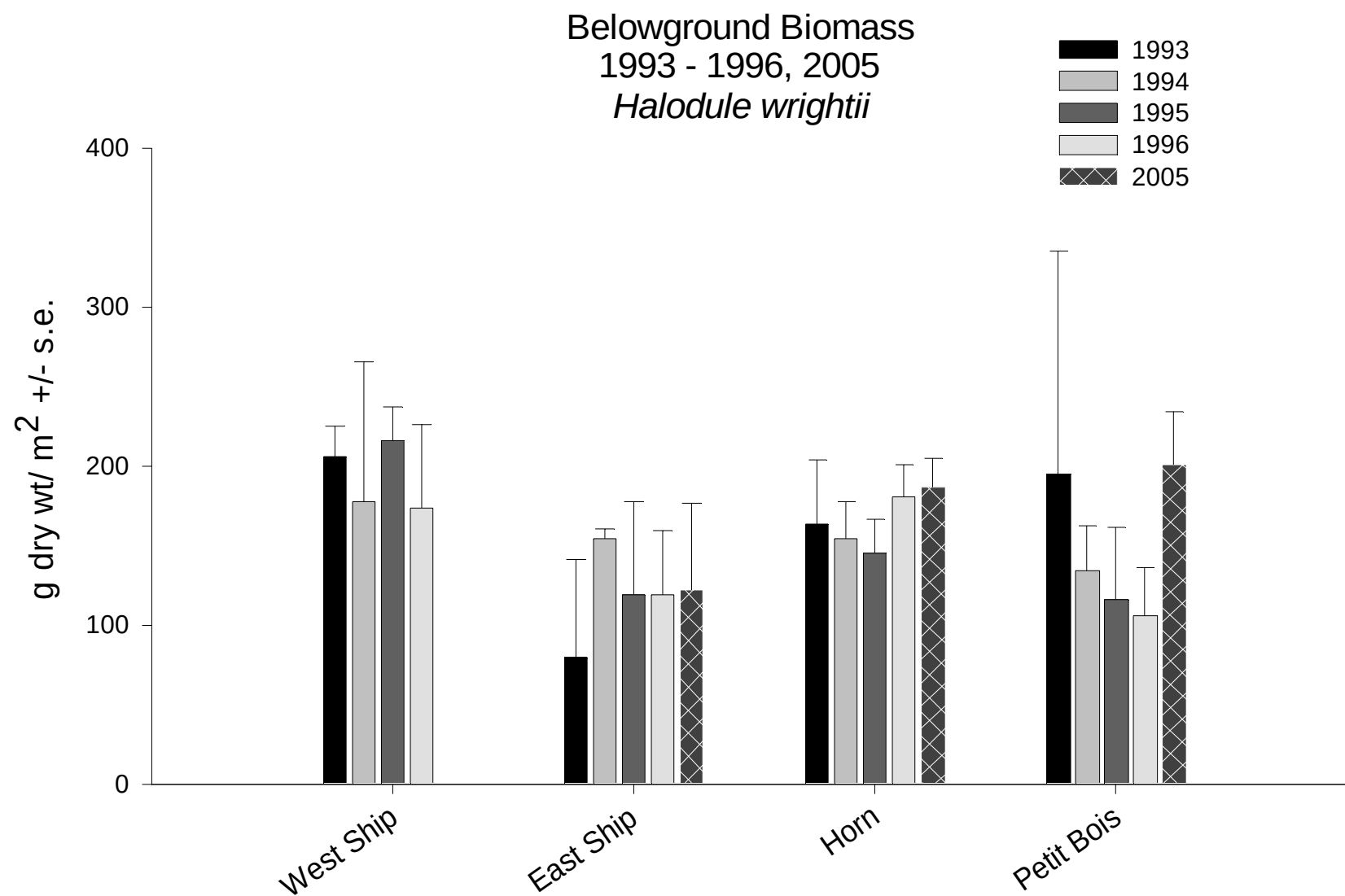


Figure 6

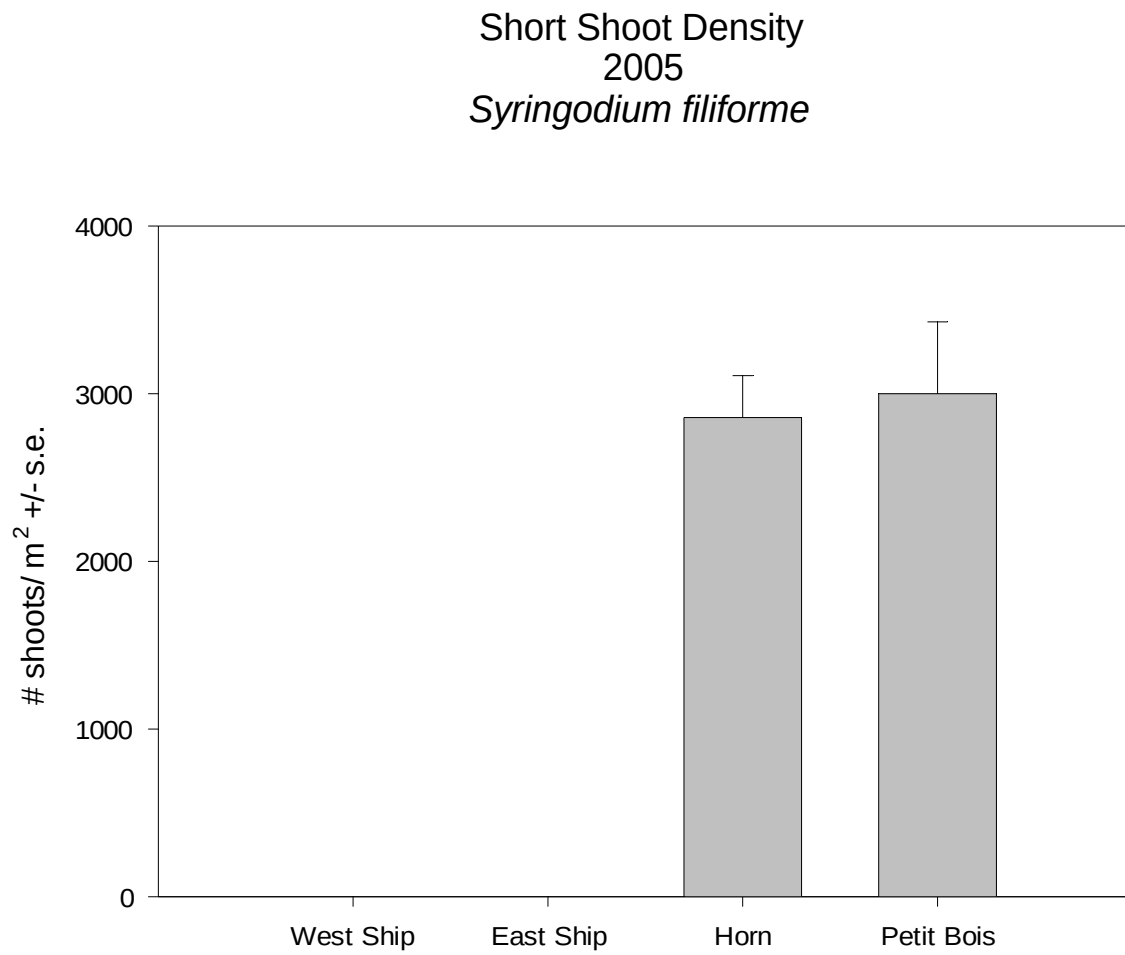


Figure 7

Aboveground Biomass
2005
Syringodium filiforme

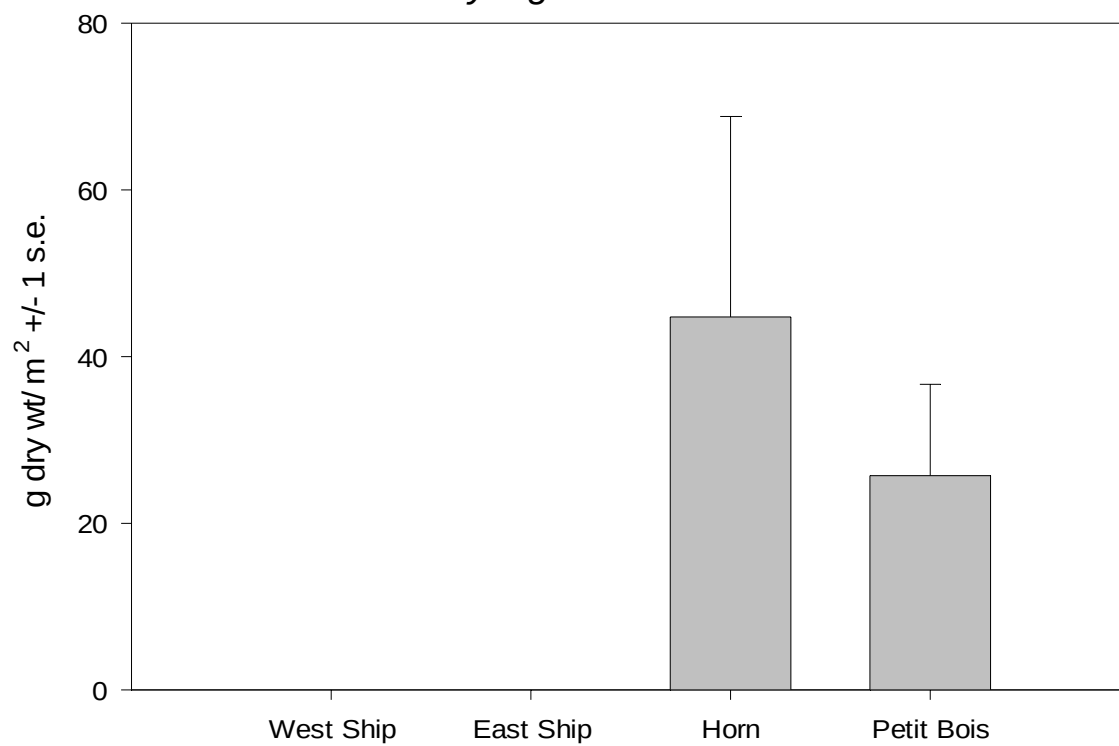


Figure 8
Belowground Biomass
2005
Syringodium filiforme

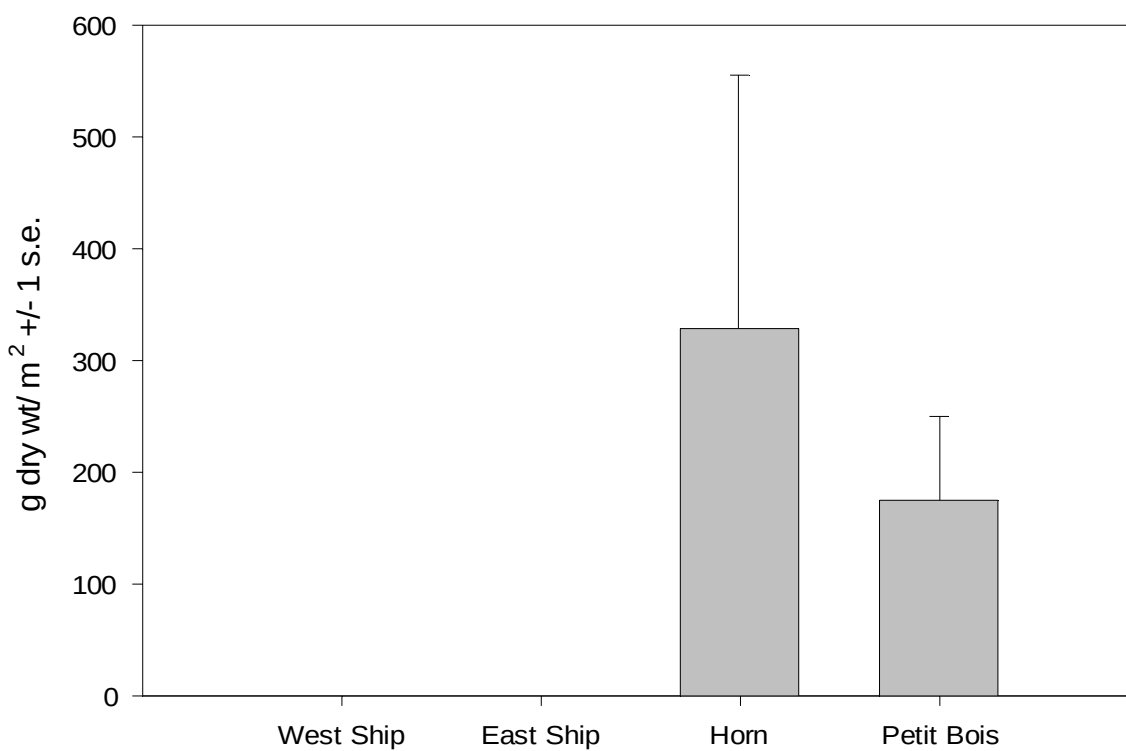


Figure 9

Surface Temperatures
October 1994 - 1996, November 2005

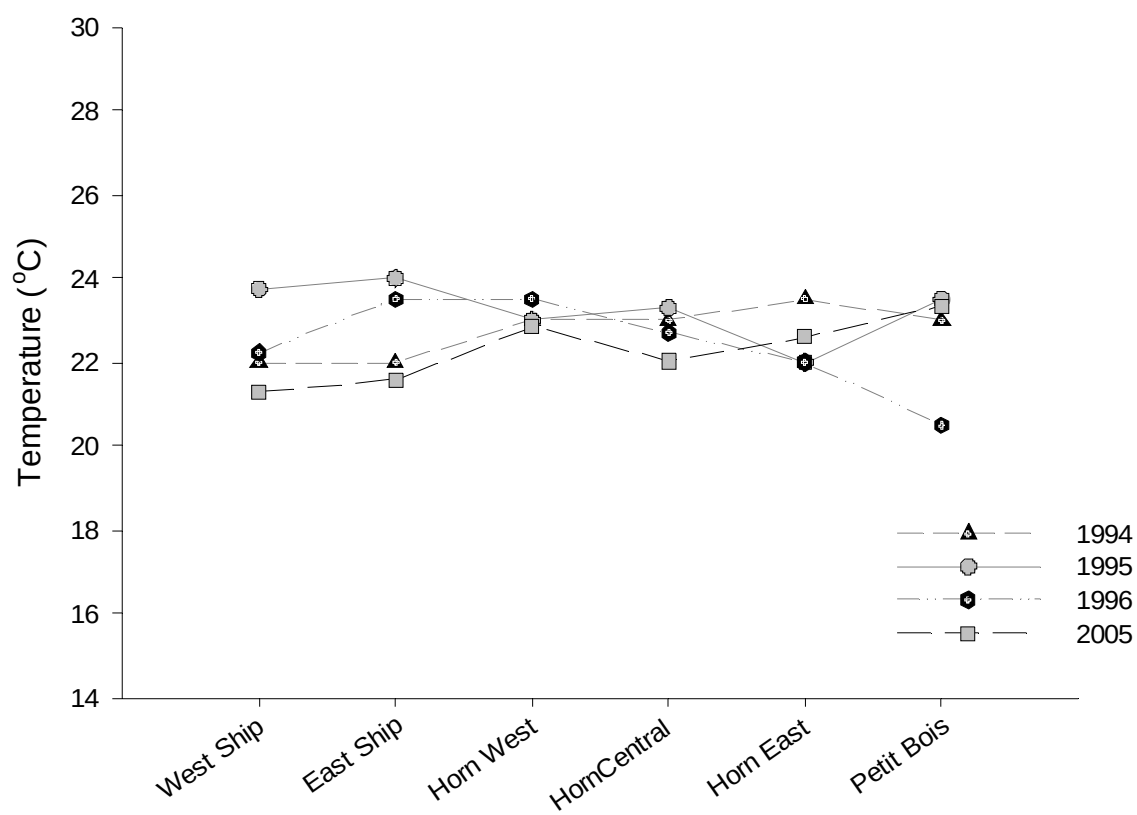


Figure 10
Surface Salinities
October 1994 - 1996, November 2005

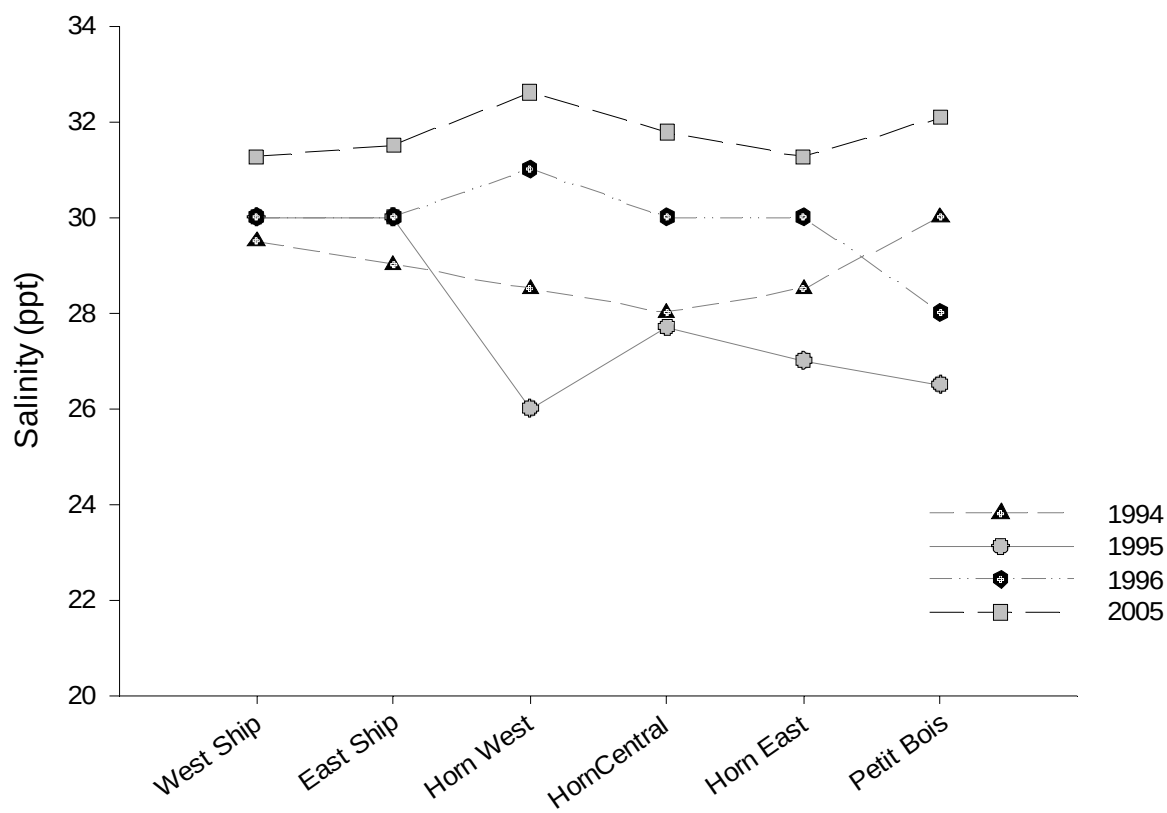
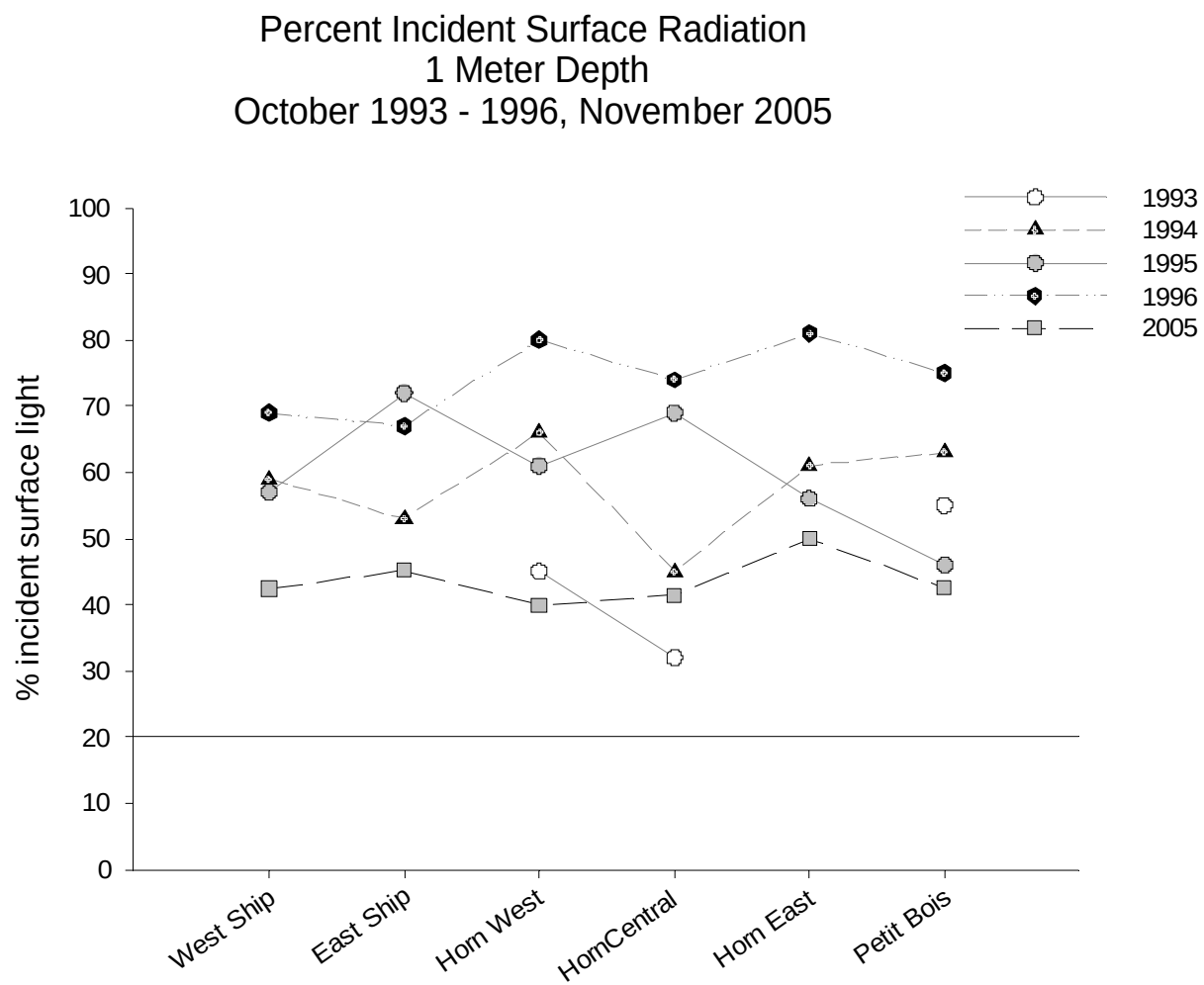


Figure 11



List of Appendices

Appendix A: Shoot density (shoots/m²), aboveground biomass (g dw /m²), and belowground biomass (g dw/ m²) of *Halodule wrightii* for each location surveyed. Data for *Syringodium filiforme*, when present, is in parenthesis.

Appendix A

East Ship Island

Station #	Shoots/m ²	Aboveground Biomass/m ²	Belowground Biomass/m ²
-1	--	--	--
0	--	--	--
0.5	--	--	--
1	3834.95	15.53	124.76
1.1*	873.79	13.11	25.73
2	1601.94	10.68	214.56
3	--	--	--
3.5	--	--	--

Horn Island, West End

Station #	Shoots/m ²	Aboveground Biomass/m ²	Belowground Biomass/m ²
0	--	--	--
1	--	--	--
2	2087.38	11.65	218.45
3	1796.12	11.17	119.42
4	2087.38	16.50	264.08
5	2135.92	12.14	260.19
6	1067.96	9.22	152.43
7	1262.14	15.05	282.04
8	2281.55	8.74	292.23

Horn Island, Central

Station #	Shoots/m ²	Aboveground Biomass/m ²	Belowground Biomass/m ²
9	(3106.80)	(68.93)	(556.80)
10	1747.57	7.28	192.72
11	2281.55	12.62	145.15
12	2912.62	27.67	203.40
13	--	--	--
14	97.09 (2621.36)	0.00 (20.87)	4.85 (102.43)
15	2038.83	11.65	110.19
16	2912.62	8.74	181.07
17	4660.19	14.56	296.12
18	2087.38	12.62	211.65

Horn Island, East End

Station #	Shoots/m ²	Aboveground Biomass/m ²	Belowground Biomass/m ²
19	2135.92	9.71	82.04
20	3834.95	15.53	242.23
21	2621.36	8.25	75.24
22	3398.06	11.17	206.80
23	--	--	--
24	--	--	--
25	--	--	--

Petit Bois Island

Station #	Shoots/m ²	Aboveground Biomass/m ²	Belowground Biomass/m ²
1	--	--	--
2	3252.43	9.22	180.10
3	4466.02	13.59	321.36
4	4077.67	12.14	107.77
5	1067.96 (3689.32)	2.91 (7.77)	56.31 (126.70)
6	(3106.80)	(45.15)	(321.84)
7	1893.20	8.74	152.91
8	(2233.01)	(24.76)	(80.10)
9	4757.28	30.10	233.98
10	3980.58	19.90	253.40
11	3543.69	13.11	302.43
12	--	--	--