A LONG-TERM SEAGRASS MONITORING PROGRAM FOR CORPUS CHRISTI BAY and UPPER LAGUNA MADRE

Report to the Coastal Bend Bays and Estuaries Program

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Draft Report

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INTRODUCTION

In 1999, the Texas Parks and Wildlife Department (TPWD), along with the Texas General Land Office (TGLO) and the Texas Commission on Environmental Quality (TCEQ), drafted a Seagrass Conservation Plan that proposed, among other things, a seagrass habitat monitoring program (Pulich and Calnan, 1999). One of the main recommendations of this plan was to develop a coast wide monitoring program. In response, the Texas Seagrass Monitoring Plan (TSGMP) proposed a monitoring effort to detect changes in seagrass ecosystem conditions prior to actual seagrass mortality (Pulich et al., 2003). However, implementation of the plan required additional research to specifically identify the environmental parameters that elicit a seagrass stress response and the physiological or morphological variables that best reflect the impact of these environmental stressors.

Numerous researchers have related seagrass health to environmental stressors; however, these studies have not arrived at a consensus regarding the most effective habitat quality and seagrass condition indicators. Kirkman (1996) recommended biomass, productivity, and density for monitoring seagrass whereas other researchers focused on changes in seagrass distribution as a function of environmental stressors (Dennison et al., 1993, Livingston et al., 1998, Koch 2001, and Fourqurean et al., 2003). The consensus among these studies revealed that salinity, depth, light, nutrient concentrations, sediment characteristics, and temperature were among the most important variables that produced a response in a measured seagrass indicator. The relative influence of these environmental variables is likely a function of the seagrass species in question, the geographic location of the study, hydrography, methodology, and other factors specific to local climatology. Because no generalized approach can be extracted from previous research, careful analysis of regional seagrass ecosystems is necessary to develop an effective monitoring program for Texas.

Conservation efforts should seek to develop a conceptual model that outlines the linkages among seagrass ecosystem components and the role of indicators as predictive tools to assess the seagrass physiological response to stressors at various temporal and spatial scales. Tasks for this objective include the identification of stressors that arise from human-induced disturbances, which can result in seagrass loss or compromise plant physiological condition. For example, stressors that lead to higher water turbidity and light attenuation (e.g. dredging and shoreline erosion) are known to result in lower below-ground seagrass biomass and alterations to sediment nutrient concentrations. It is therefore necessary to evaluate long-term light measurements, the biomass of above- versus below-ground tissues and the concentrations of nutrients, sulfides and dissolved oxygen in sediment porewater when examining the linkages between light attenuation and seagrass health.

This study is part of the Texas seagrass monitoring program, with specific focus on Corpus Christi Bay (CCB; Figure 1) and the Upper Laguna Madre (ULM; Figure 1), following protocols that evaluate seagrass condition based on landscape-scale dynamics. The program is based on a hierarchical strategy for seagrass monitoring outlined by Neckles et al. (2012) to establish the quantitative relationships between physical and biotic parameters that ultimately control seagrass condition, distribution, persistence, and overall health. This approach follows a broad template adopted by several federal and state agencies across the country, but which is uniquely designed for Texas (Dunton et al. 2011) and integrates plant condition indicators with landscape feature indicators to detect and interpret seagrass bed disturbances.

The objectives of this study were to (1) implement long-term monitoring to detect environmental changes with a focus on the ecological integrity of seagrass habitats, (2) provide insight to the ecological consequences of these changes, and (3) help decision makers (e.g. various state and federal agencies) determine if the observed change necessitates a revision of regulatory policy or management practices. We defined ecological integrity as the capacity of the seagrass system to support and maintain a balanced, integrated, and adaptive community of flora and fauna including its characteristic foundation seagrass species. Ecological integrity was assessed using a suite of condition indicators (physical, biological, hydrological, and chemical) measured annually on wide spatial scales.

The primary questions addressed in the 2015 annual Tier-2 surveys include:

1) What are the spatial and temporal patterns in the distribution of seagrasses over annual scales?
2) What are the characteristics of these plant communities, including their species composition and percent cover?
3) How are any changes in seagrass percent cover and species composition, related to measured characteristics of water quality?

METHODS

Sampling Summary

Tier-2 protocols, which are considered Rapid Assessment sampling methods, are adapted from Neckles et al. (2011). Tier-2 sampling was conducted during the month of August 2015. For statistical rigor, a repeated measures design with fixed sampling stations was implemented to maximize our ability to detect future change. Neckles et al. (2011) demonstrated that the Tier-2 approach, when all sampling stations are considered together within a regional system, results in > 99% probability that the bias in overall estimates will not interfere with detection of change.

Site Selection

The Tier-2 sampling program is intended to compliment ongoing remote sensing efforts. Sites were therefore selected from vegetation maps generated with aerial and satellite imagery during the 2004/2007 NOAA Benthic Habitat Assessment. The vegetation maps were then tessellated using polygons, and sample locations were randomly selected within each polygon (Figure 1). Only polygons containing > 50 % seagrass coverage were included in 2015 sampling efforts.

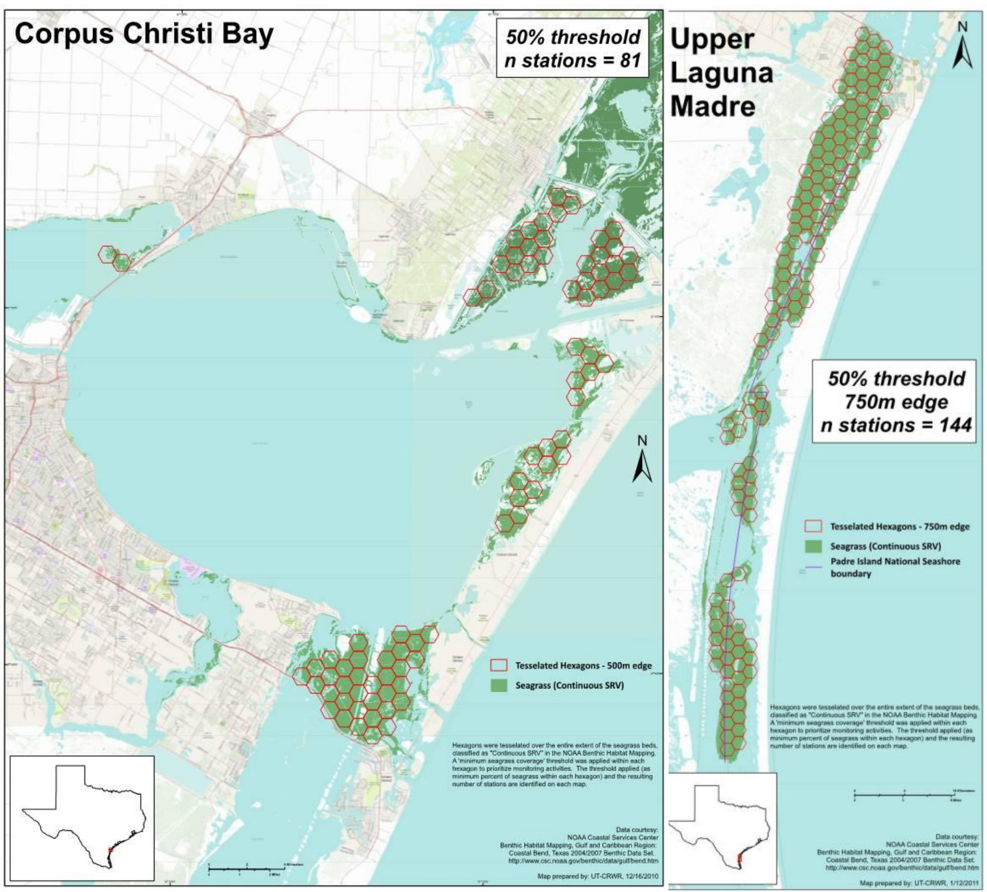

Figure 1. Tessellated boundaries of submerged vegetation delineated during the 2004/2007 NOAA Benthic Habitat Assessment where seagrass coverage > 50%. Resulting stations (Upper Laguna Madre n = 144; Corpus Christi Bay n = 81) are identified in text on map. Stations outside the park boundary in Upper Laguna Madre are funded by CBBEP (n = 92) and are delineated by the light purple line on the map.

Water Quality

All sampling stations were located in the field using a handheld GPS device to within a 10 m radius of the pre-determined station coordinates. Upon arrival to a station, hydrographic measurements including water depth, conductivity, temperature, salinity, dissolved oxygen, chlorophyll fluorescence and pH were collected with a YSI 6920 data sonde. Water samples were obtained at each station for determination of Total Suspended Solid (TSS) concentration. Water transparency was derived from measurements of photosynthetically active radiation (PAR) using two LI-COR spherical quantum scalar sensors attached to a lowering frame. All sonde measurements and water samples were obtained prior to the deployment of benthic sampling equipment.

Seagrass Coverage

Species composition and areal coverage were obtained from four replicate quadrat samples per station at each of the four cardinal locations from the vessel. Percent cover of areal biomass was estimated by direct vertical observation of the seagrass canopy through the water using a 0.25 m^2 quadrat framer subdivided into 100 cells. Previous research has demonstrated that the probability of achieving a bias is less than 5% of the overall mean when using only four subsamples (Neckles, pers. comm.).

C_{org} in Living Seagrass Biomass

Seagrass cores were collected from representative stations within Corpus Christi Bay and Upper Laguna Madre for *Halodule wrightii*, *Thalassia testudinum*, and *Syringodium filiforme* using a 9 cm corer. Samples were scraped of epiphytes, separated into above- and below-ground tissue, dried in a 60°C oven, and weighed. Organic carbon stored in living seagrass biomass was estimated in these regions by using a regression equation between observed percent cover and seagrass biomass gathered from the representative cores. We assumed the % C content for *H. wrightii*, *T. testudinum*, and *S. filiforme* was 35% of dry weight. This value has been used extensively and is widely accepted for Gulf of Mexico seagrasses (Fourqurean et al. 2012).

Spatial Data Analysis and Interpolation

ArcGIS software (Environmental Systems Research Institute) was used to manage, analyze, and display spatially referenced point samples and interpolate surfaces for all measured parameters. An inverse distance weighted method was used to assign a value to areas (cells) between sampling points. A total of 12 sampling stations were identified from a variable search radius to generate the value for a single unknown output cell (100

m^2). All data interpolation was spatially restricted to the geographic limits of the submerged vegetation map created during the 2004/2007 NOAA Benthic Habitat Assessment.

RESULTS

Water Quality

Corpus Christi Bay

The CCB region stations exhibited a depth of 59.2 ± 24.4 cm (mean ± standard deviation) and a mean water temperature of 30.90 ± 3.76 °C (Table 1). Salinity was relatively consistent among sampling stations in this region, with a mean of 38.9 ± 3.4 (Table 1). Salinity values (> 40) were observed in the southeastern portion of Redfish Bay, east Corpus Christi Bay and northeast of the JFK Causeway. Dissolved oxygen concentration in the CCB region was 6.12 ± 2.21 mg L^{-1} with a saturation of 103.47 ± 39.73% (Table 1). Two stations revealed concentrations below 3 mg L^{-1}. The lowest dissolved oxygen concentrations were found in east Corpus Christi Bay and the southwest portion of Redfish Bay near Ingleside and Aransas Pass. The pH values were lowest in Redfish Bay and increased southwards into CCB, with greatest pH values just north of JFK Causeway. Mean pH values for CCB were 8.28 ± 0.34 (Table 1).

Upper Laguna Madre

The ULM region stations had a mean depth of 84.7 ± 42.0 cm and an average water temperature of 31.41 ± 1.55 °C (Table 1). This region exhibited hypersaline conditions (44.4 ± 5.5; Table 1). It is interesting to note that salinities greater than 40 were observed south of JFK Causeway, extending into Bird Island Basin and in Nine Mile Hole. However, maximum salinities (50-75) were observed just south of Baffin Bay near Middle Ground. This area is near the southernmost portion of the Laguna Madre and lies at the greatest distance from any significant tidal inlet or freshwater source. As a result, these high salinity values are likely attributed to long water residence times with minimal flushing. ULM had a lower mean dissolved oxygen concentration (5.98 ± 1.94 mg L^{-1}; Table 1) and saturation (101.41 ± 36.02%; Table 1) than CCB. Hypoxic conditions were observed at one sampling station, while one additional station recorded dissolved oxygen concentrations less than 3 mg L^{-1}. The highest dissolved oxygen concentrations were observed near Bird Island Basin, and lowest concentrations were found near the mouth of Baffin Bay, extending south towards Middle Ground. Finally, ULM recorded a mean pH of 8.17 ± 0.35 (Table 1), with lowest values generally observed at the near Baffin Bay and highest values at Middle Ground south to Nine Mile Hole.

Table 1. Summary of water column hydrographic parameters by region.

		Depth (cm)	Temperature (°C)	Salinity	Dissolved Oxygen (mg L^{-1})	Dissolved Oxygen (%)	pH
CCB							
	Mean	59.2	30.90	38.9	6.12	103.47	8.28
	Standard Deviation	24.4	3.76	3.4	2.21	39.73	0.34
ULM							
	Mean	84.7	31.41	44.4	5.98	101.41	8.17
	Standard Deviation	42.0	1.55	5.5	1.94	36.02	0.35

Water Column Optical Properties

Corpus Christi Bay

The CCB region stations were characterized by moderate water clarity with a mean downward attenuation coefficient (K_d) of 1.07 ± 0.57 m^{-1} (Table 2). Light attenuation was greatest in east Corpus Christi Bay and Redfish Bay near Ingleside. High water column chlorophyll was observed in the southwest portion of Redfish Bay near Ingleside with moderate concentrations along the eastern banks of Redfish and Corpus Christi bays. High TSS concentrations were observed in the southeast portion of Redfish Bay. The highest attenuation values were generally recorded in locations with greater water column chlorophyll (6.02 ± 3.73 μg L^{-1}; Table 2) and TSS (19.8 ± 43.4 mg L^{-1}; Table 2) concentrations. Mean secchi depth was variable (56.2 ± 22.3 cm; Table 2) but water transparency was good at most stations. Visibility at most stations was near the entire depth of the water column or within 3 cm of the vegetated or sediment surface, on average.

Upper Laguna Madre

The ULM stations exhibited a mean K_d of 1.42 ± 0.96 m^{-1} (Table 2). Although the mean downward attenuation coefficient was greater in ULM than CCB, variability was greatest in this region. Higher light attenuation values were observed north of Baffin Bay and in Middle Ground south to Nine Mile Hole. These areas generally coincided with greater chlorophyll levels and TSS concentrations. Water column chlorophyll (3.46 ± 2.97 μg L^{-1}; Table 2) was lower in ULM than CCB but TSS concentrations (21.2 ± 26.1 mg L^{-1}; Table 2) were greater. Highest water column chlorophyll and TSS concentrations were observed in Nine Mile Hole. Mean secchi depth was variable (74.5 ± 34.6 cm; Table 2) but water transparency was high. At most stations, visibility was near the entire depth of the water column or within 10 cm of the vegetated or sediment surface, on average.

Table 2. Summary of water transparency property indicators by region.

		K_d (m^{-1})	Secchi (cm)	Chlorophyll *a* (µg L^{-1})	Total Suspended Solids (mg L^{-1})
CCB					
	Mean	1.07	56.2	6.02	19.8
	Standard Deviation	0.57	22.3	3.73	43.4
ULM					
	Mean	1.42	74.5	3.46	21.2
	Standard Deviation	0.33	34.6	2.97	26.1

Seagrass Coverage and Species Distributions

Corpus Christi Bay

Total seagrass coverage in the CCB region was 78.7 ± 23.3%. The seagrass assemblage in CCB was dominated by *Halodule wrightii* (42.4 ± 42.4%; Table 3, Figure 1), followed by *Thalassia testudinum* (16.6 ± 34.4 %; Table 3, Figure 2), *Syringodium filiforme* (10.2 ± 27.1%; Table 3, Figure 3), *Ruppia maritima* (2.7 ± 13.1%; Table 3, Figure 4) and *Halophila engelmannii* (5.4 ± 20.8%; Table 3, Figure 5). Vegetation was present at all stations in CCB, with only moderate coverage in the southern regions of Redfish Bay (Figure 6). *Halodule wrightii* coverage was high and widely distributed, except for minimal coverage in the southwest portion of Redfish Bay where *Thalassia testudinum* dominated. Established *Thalassia testudinum* populations are likely excluding *Halodule wrightii* from expanding into this area but it should be noted *Halodule wrightii* coverage was greatest in southeast Redfish Bay where *Thalassia testudinum* was absent. Lastly, the CCB region contained the greatest coverage of *Halophila engelmannii*, with a distinguished population located north of JFK Causeway, interspersed with *Syringodium filiforme*. *Syringodium filiforme* canopy height was tallest 31.3 ± 11.4 cm (Table 4), followed by *Thalassia testudinum* (27.9 ± 9.4 cm; Table 4), *Halodule wrightii* (18.1 ± 6.5 cm; Table 4), *Ruppia maritima* (16.1 ± 5.8 cm; Table 4) and *Halophila engelmannii* (6.0 ± 2.0 cm; Table 4). The average canopy height was tall, likely attributed to the large amount of *Thalassia testudinum* and *Syringodium filiforme*.

Upper Laguna Madre

ULM total seagrass coverage was 72.3 ± 37.2%. The seagrass assemblage was again dominated by *Halodule wrightii* (68.4 ± 40.2%; Table 3, Figure 1), followed by *Syringodium filiforme* (3.7 ± 15.5%; Table 3, Figure 3), *Ruppia maritima* (0.2 ± 2.2%; Table 3, Figure 4), *Halophila engelmannii* (0.4 ± 5.2%; Table 3, Figure 5), and was devoid of *Thalassia testudinum*. Twelve sampling stations in this region had no vegetation present. Seagrass coverage was lowest in the southern portion of ULM from Middle Ground south to Nine Mile Hole. *Halodule wrightii* was found throughout ULM, but was largely absent south of Baffin Bay and north of JFK Causeway. Interestingly, *Syringodium filiforme* was found in abundance north of JFK Causeway. It should also be noted that some areas west of the ICW experienced a loss in *Syringodium filiforme* with minimal recolonization by *Halodule wrightii*. *Syringodium filiforme* canopy height was tallest 31.0 ± 11.0 cm (Table 4), followed by *Halodule wrightii* (20.0 ± 9.6 cm; Table 4), *Ruppia maritima* (8.5 ± 8.5 cm; Table 4) and *Halophila engelmannii* (6.5 ± 2.4 cm; Table 4). Mean canopy height was shorter in ULM than CCB region.

Table 3. Summary of plant areal coverage by species and region.

		H. wrightii **(% cover)**	***T. testudinum*** **(% cover)**	***S. filiforme*** **(% cover)**	***R. maritima*** **(% cover)**	***H. engelmannii*** **(% cover)**	**Bare (% cover)**
CCB							
	Mean	42.4	16.6	10.2	2.7	5.4	22.7
	Std. Dev.	42.4	34.4	27.1	13.1	20.8	30.2
ULM							
	Mean	68.4	0	3.7	0.2	0.4	27.3
	Std. Dev.	40.2	0	15.5	2.2	5.2	38.8

Table 4. Summary of plant canopy height by species and region.

		H. wrightii (cm)	*T. testudinum* (cm)	*S. filiforme* (cm)	*R. maritima* (cm)	*H. engelmannii* (cm)
CCB						
	Mean	18.1	27.9	31.3	16.1	6.0
	Std. Dev.	6.5	9.4	11.4	5.8	2.0
ULM						
	Mean	20.0	0	31.0	8.5	6.5
	Std. Dev.	9.6	0	11.0	8.5	2.4

C_{org} in Living Seagrass Biomass

Corpus Christi Bay

Halodule wrightii and *Syringodium filiforme* total organic carbon was estimated by considering both species as one as they are more similar in morphology than *Thalassia testudinum*. High C_{org} storage potential for all three species occurred along the east side of Corpus Christi and Redfish bays due to greater percent coverage in these areas (Figure 7). Above- and below-ground biomass for *Halodule wrightii* and *Syringodium filiforme* at mean percent cover was 32.4 and 79.3 g m^{-2}, respectively (Table 5). *Thalassia testudinum* above-ground biomass was estimated at 17.6 g m^{-2} and 66.1 g m^{-2} for below-ground biomass. Above-ground C_{org} for CCB was estimated at 0.06 Mg C_{org} ha^{-1} (*Thalassia testudinum)* and 0.11 Mg C_{org} ha^{-1} (*Halodule wrightii and Syringodium filiforme*; Table 5). *Thalassia testudinum* and *Halodule wrightii* and *Syringodium filiforme* below-ground C_{org} was 0.23 Mg C_{org} ha^{-1} and 0.28 Mg C_{org} ha^{-1}, respectively (Table 5). Below-ground carbon storage potential was higher than above-ground in all species but C_{org} was largest in *Thalassia testudinum*, where below-ground carbon storage was roughly three times greater largely due to the dense roots and rhizomes. Total carbon stock for *Thalassia testudinum*, *Halodule wrightii* and *Syringodium filiforme* within the Coastal Bend region (approximately 11,000 hectares) was approximated at 0.01 Tg C using 17% coverage for *Thalassia testudinum* and 53% coverage for *Halodule wrightii* and *Syringodium filiforme*.

Upper Laguna Madre

Greatest C_{org} storage potential for *Halodule wrightii* and *Syringodium filiforme* was in ULM as these species dominated this region (Figure 7). Above- and below-ground biomass for *Halodule wrightii* and *Syringodium filiforme* was 48.0 and 106.0 g m^{-2}, respectively. Above-ground C_{org} for ULM was estimated at 0.23 Mg C_{org} ha^{-1} (*Halodule wrightii* and *Syringodium filiforme*; Table 5). *Halodule wrightii* and *Syringodium filiforme* below-ground C_{org} was approximately 0.37 Mg C_{org} ha^{-1} (Table 5), where below-ground carbon storage was greater than above-ground. Estimated total carbon stock for *Halodule wrightii* and *Syringodium filiforme* in ULM (25,000 hectares) was estimated at 0.02 Tg C. All C_{org} and total carbon stock estimates were made using a mean percent cover of 72% for *Halodule wrightii* and *Syringodium filiforme*.

Table 5. Summary of above-ground (AG) and below-ground biomass and carbon storage by species and region based on mean seagrass percent coverage.

		H. wrightii* and *S. filiforme		***T. testudinum***	
		Biomass ($g\ m^{-2}$)	**C_{org} ($Mg\ C_{org}\ ha^{-1}$)**	**Biomass ($g\ m^{-2}$)**	**C_{org} ($Mg\ C_{org}\ ha^{-1}$)**
CCB					
	AG	32.4	0.11	17.6	0.06
	BG	79.3	0.28	66.1	0.23
ULM					
	AG	48.0	0.23	0	0
	BG	106.0	0.37	0	0

CONCLUSIONS

Corpus Christi Bay

Stations characterized by high light attenuations in CCB correlated to areas with increased TSS and water column chlorophyll. Despite lower water transparency, seagrass coverage was moderate to high in these areas and overall, high throughout CCB. These areas were generally high in both dissolved oxygen and pH. The greatest *Halophila engelmannii* percent cover was observed north of JFK Causeway, west of the ICW, interspersed with *Syringodium filiforme. Halodule wrightii* coverage was observed east of the ICW, north of JFK Causeway. In south Redfish Bay, *Thalassia testudinum* dominated the west portion and *Halodule wrightii* the east. Salinities were greater in east CCB than west and this difference may explain seagrass distribution in the CCB region. Overall, the mixed assemblage of seagrasses cover approximately 79% of the bay floor in CCB and communities appear to be relatively stable.

Upper Laguna Madre

Overall, water quality in the ULM region was much less amenable to seagrasses. Light attenuation was greater, likely due to elevated chlorophyll and TSS in the water column. Despite reduced water clarity, seagrass coverage was high, particularly from JFK Causeway south to Baffin Bay. Low seagrass coverage was observed near Bird Island Basin as well as from Middle Ground south to Nine Mile Hole and the Land cut. Nine Mile Hole experienced prolonged hypsersaline conditions, which may have attributed to a decline in *Halodule wrightii* in this area. The decreased seagrass cover near Bird Island Basin resulted from *Syringodium filiforme* decline that likely was caused by increased salinities. Due to minimal flushing and freshwater inflow, ULM is susceptible to periods of hypersaline conditions during extended periods of aridity. Overall, seagrasses covered approximately 72% of the bay floor in ULM. Seagrass beds in portions of this region experienced a shift from *Syringodium filiforme* to *Halodule wrightii*. ULM also experienced a decline in seagrass coverage in the southern portion near Nine Mile Hole to the Land Cut, however, it should be noted that *Halodule wrightii* appears to be increasing in this area.

C_{org} in Living Seagrass Biomass

Our quantification of carbon storage in living seagrass biomass (*Halodule wrightii*, *Thalassia testudinum*, and *Syringodium filiforme*) and within the Corpus Christi Bay and Upper Laguna Madre regions is a considerably raw estimate based upon specific amounts of percent cover. We approximated C_{org} using 2015 mean percent coverage for each species by region utilizing a regression between percent cover and biomass. It should be noted that biomass of Texas seagrasses fluctuates with season and carbon content may vary. For this study, we sampled during peak growth and assumed that % C content was 35% of dry weight. Furthermore, seagrass coverage varied spatially in both Corpus Christi Bay and Upper Laguna Madre, where seagrass coverage was quite variable. Thus, stations with greater percent coverage, specifically in ULM, had greater potential for total carbon storage, both above- and below-ground tissue (1.00 Mg C ha^{-1}; Figure 7). If a higher percent cover were used other than the reported mean, a new estimate would be 0.01 Tg C in Coastal Bend and 0.03 Tg C in Upper Laguna Madre. However, it should be noted that these might still underestimate carbon storage due to few cores sampled and the lack of sediment carbon data. Moreover, we only estimated carbon storage in living biomass for three out of the five seagrass species. Future studies with additional replicates and % C values obtained from Texas seagrasses should be conducted to gain a better understanding of carbon storage in living biomass. Additionally, sediments below seagrass meadows can store vast amounts of carbon (Fourqurean et al. 2012), and should be considered in future analyses; therefore, the estimates presented in this study potentially underestimate carbon storage in Texas.

FIGURES

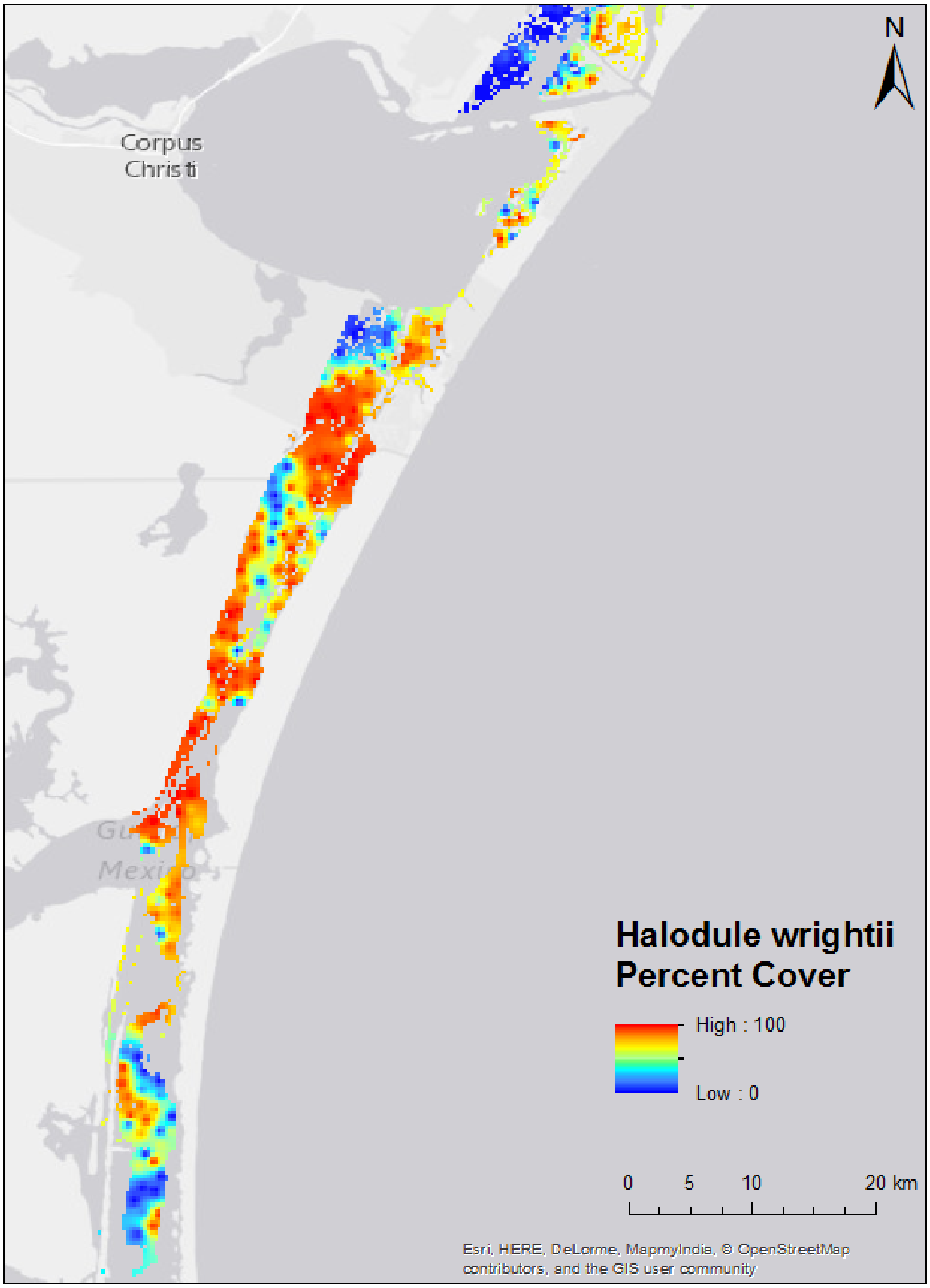

Figure 1. Spatial representations of percent cover for *Halodule wrightii* for 2015. The spatial data interpolation is limited to the boundaries of seagrass habitat delineated during the 2004/2007 NOAA Benthic Habitat Assessment.

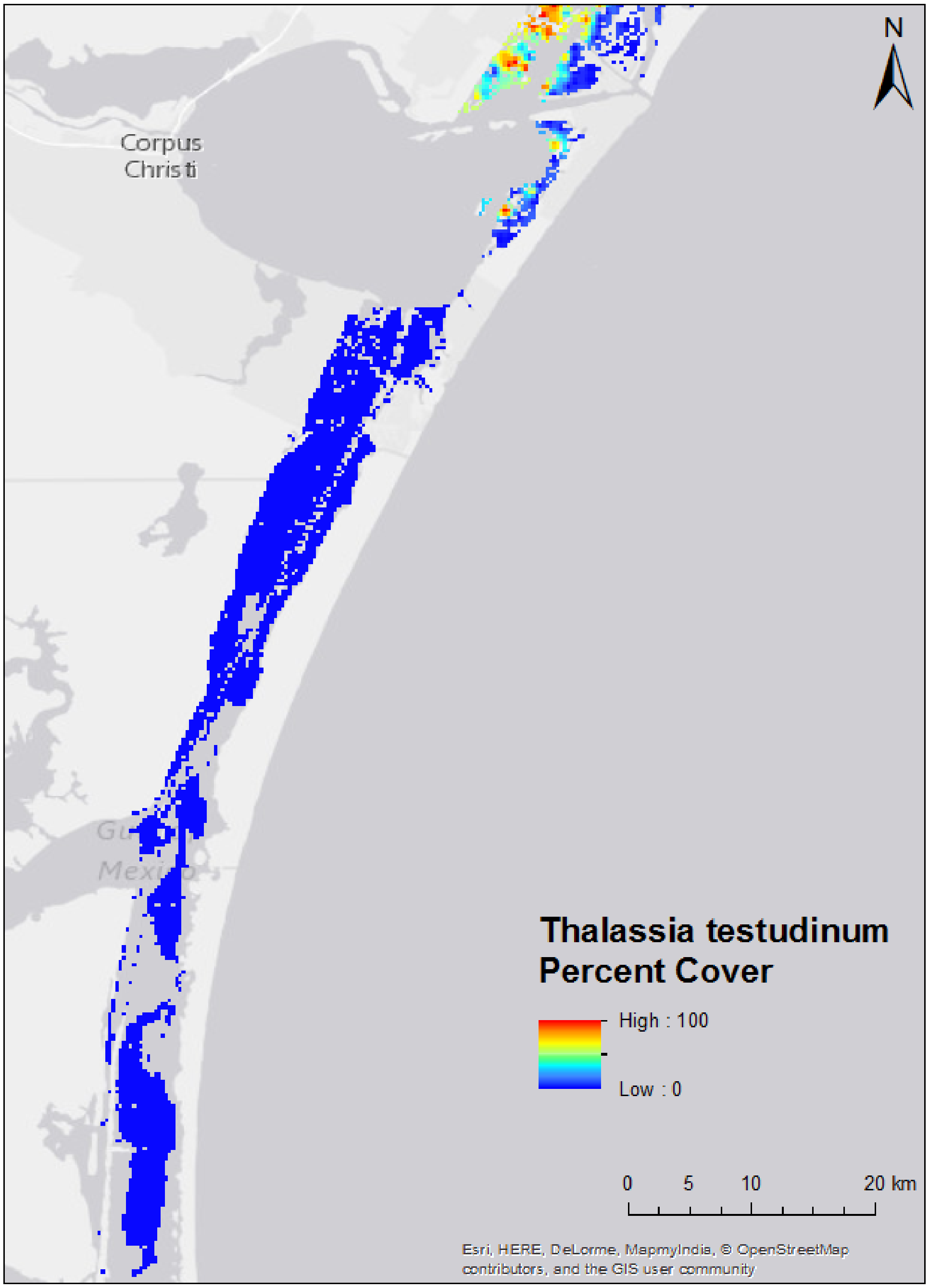

Figure 2. Spatial representations of percent cover for *Thalassia testudinum* for 2015. The spatial data interpolation is limited to the boundaries of seagrass habitat delineated during the 2004/2007 NOAA Benthic Habitat Assessment.

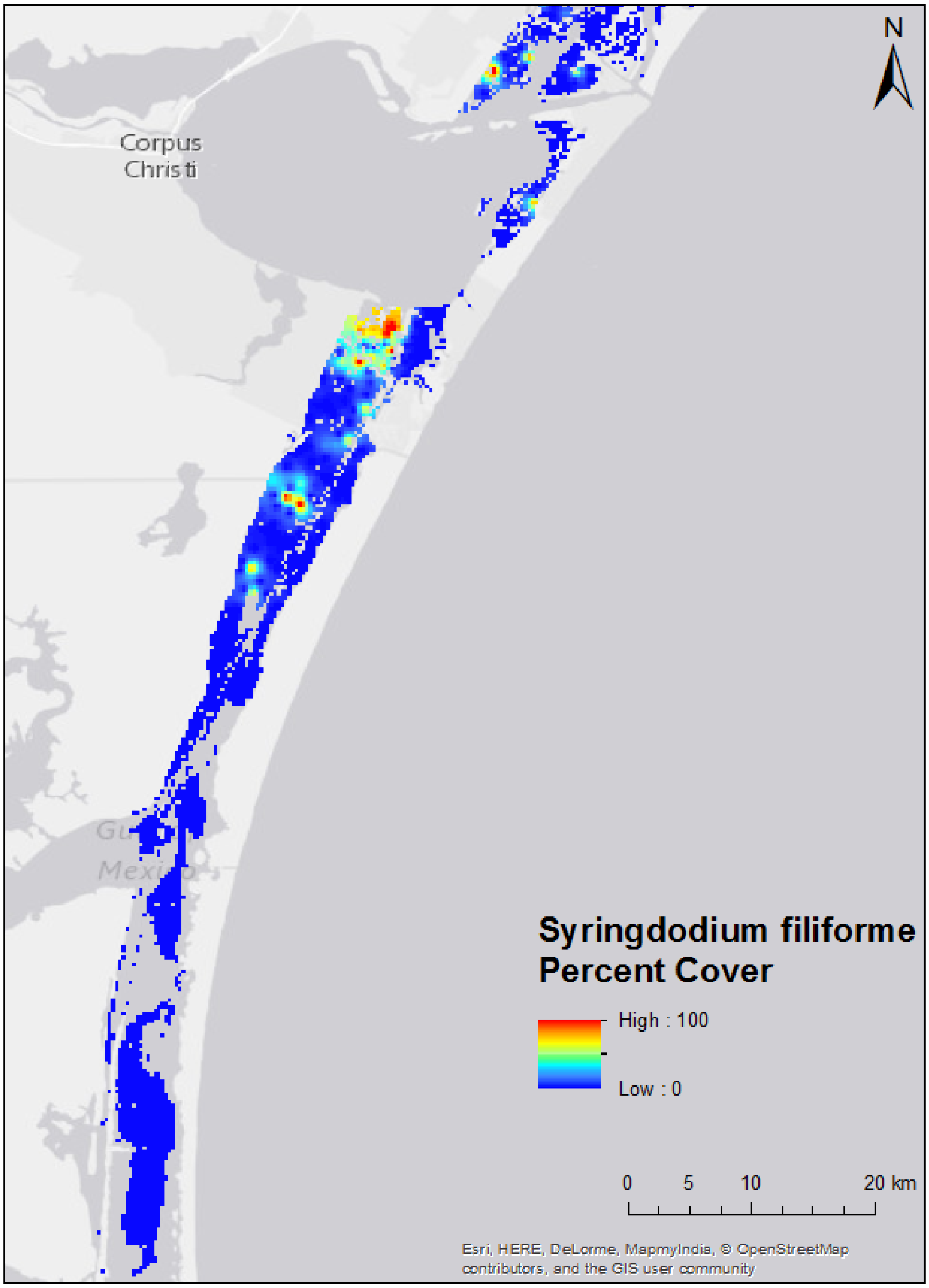

Figure 3. Spatial representations of percent cover for *Syringodium filiforme* for 2015. The spatial data interpolation is limited to the boundaries of seagrass habitat delineated during the 2004/2007 NOAA Benthic Habitat Assessment.

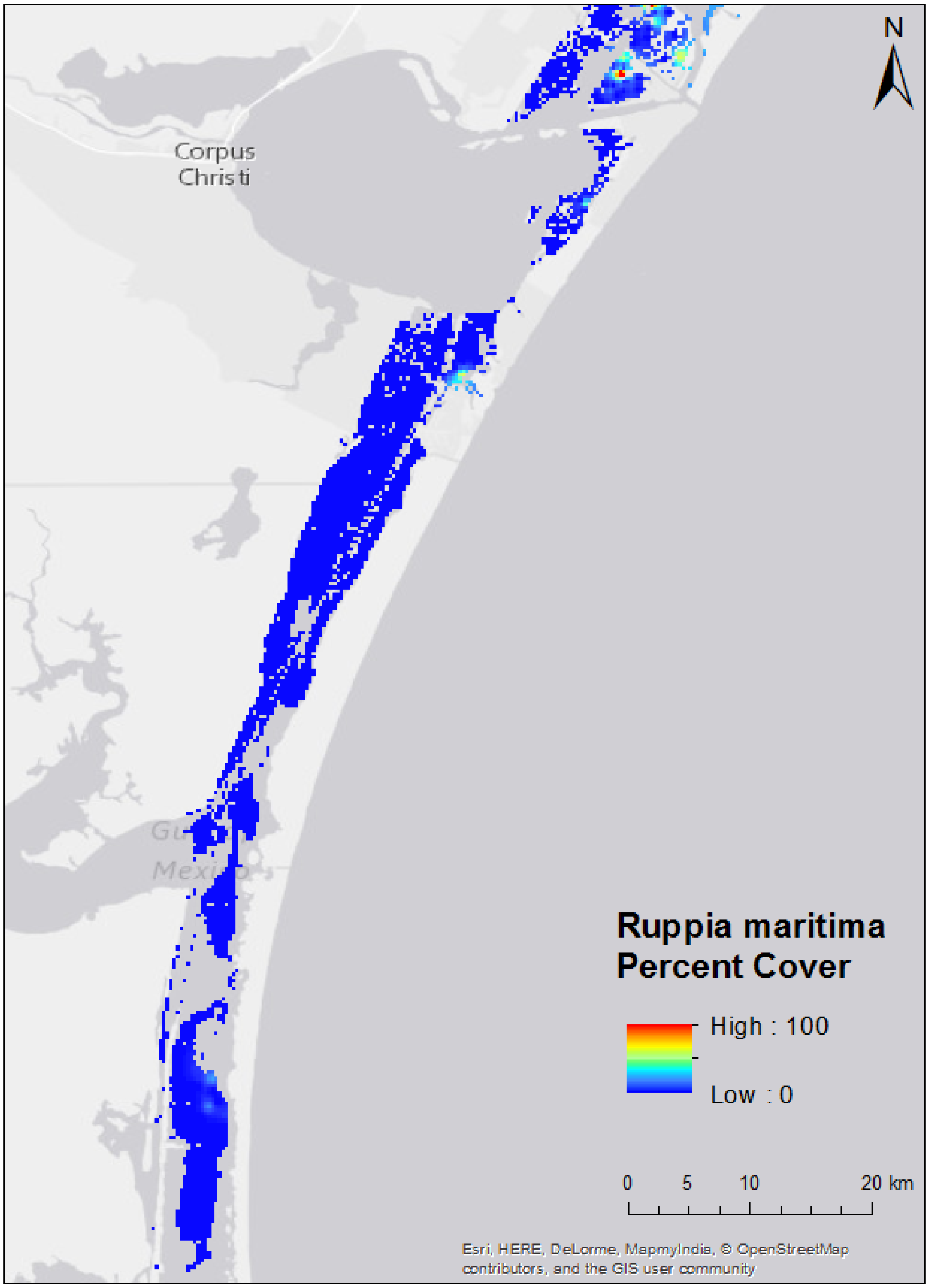

Figure 4. Spatial representations of percent cover for *Ruppia maritima* for 2015. The spatial data interpolation is limited to the boundaries of seagrass habitat delineated during the 2004/2007 NOAA Benthic Habitat Assessment.

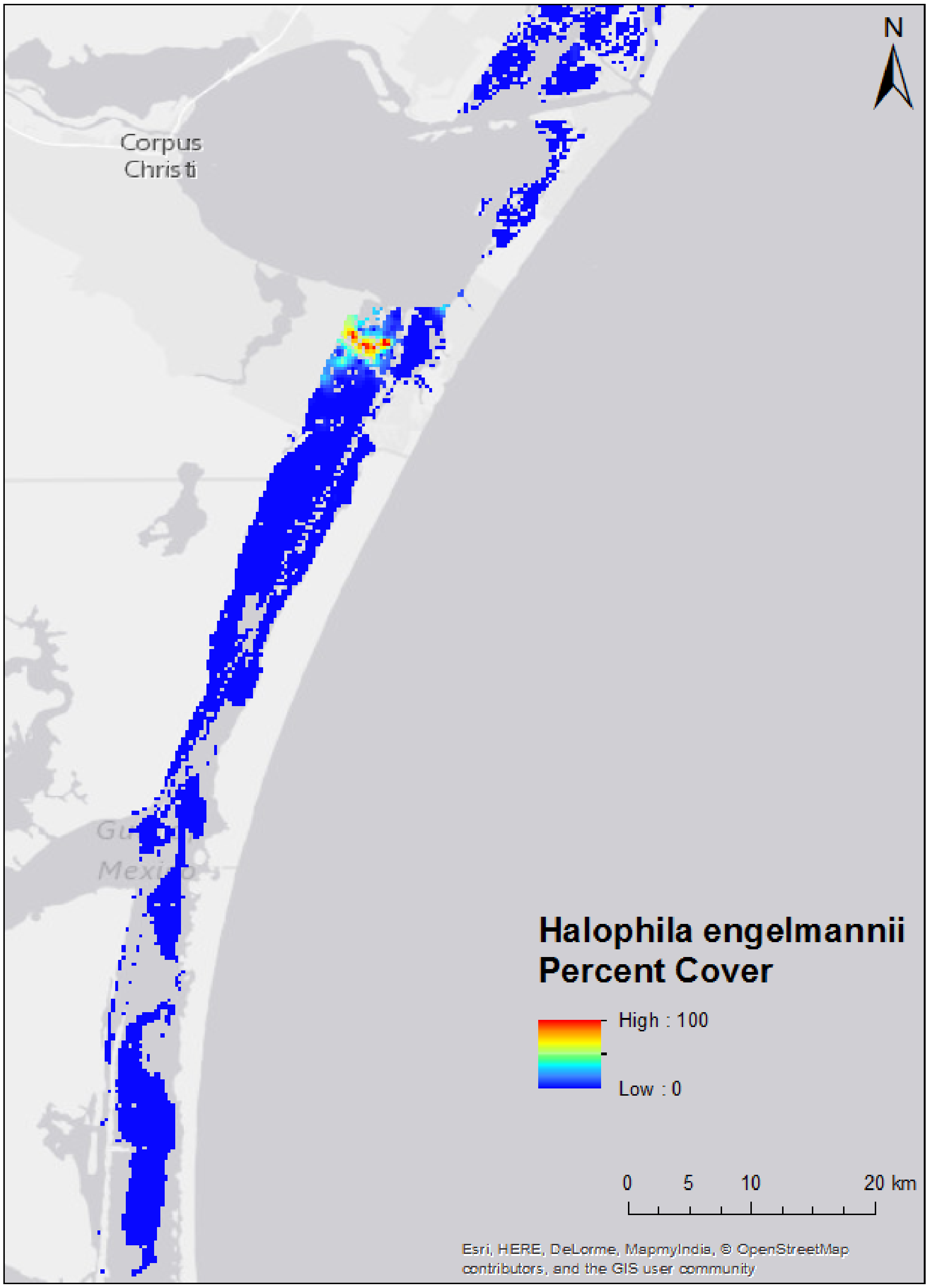

Figure 5. Spatial representations of percent cover for *Halophila engelmannii* for 2015. The spatial data interpolation is limited to the boundaries of seagrass habitat delineated during the 2004/2007 NOAA Benthic Habitat Assessment.

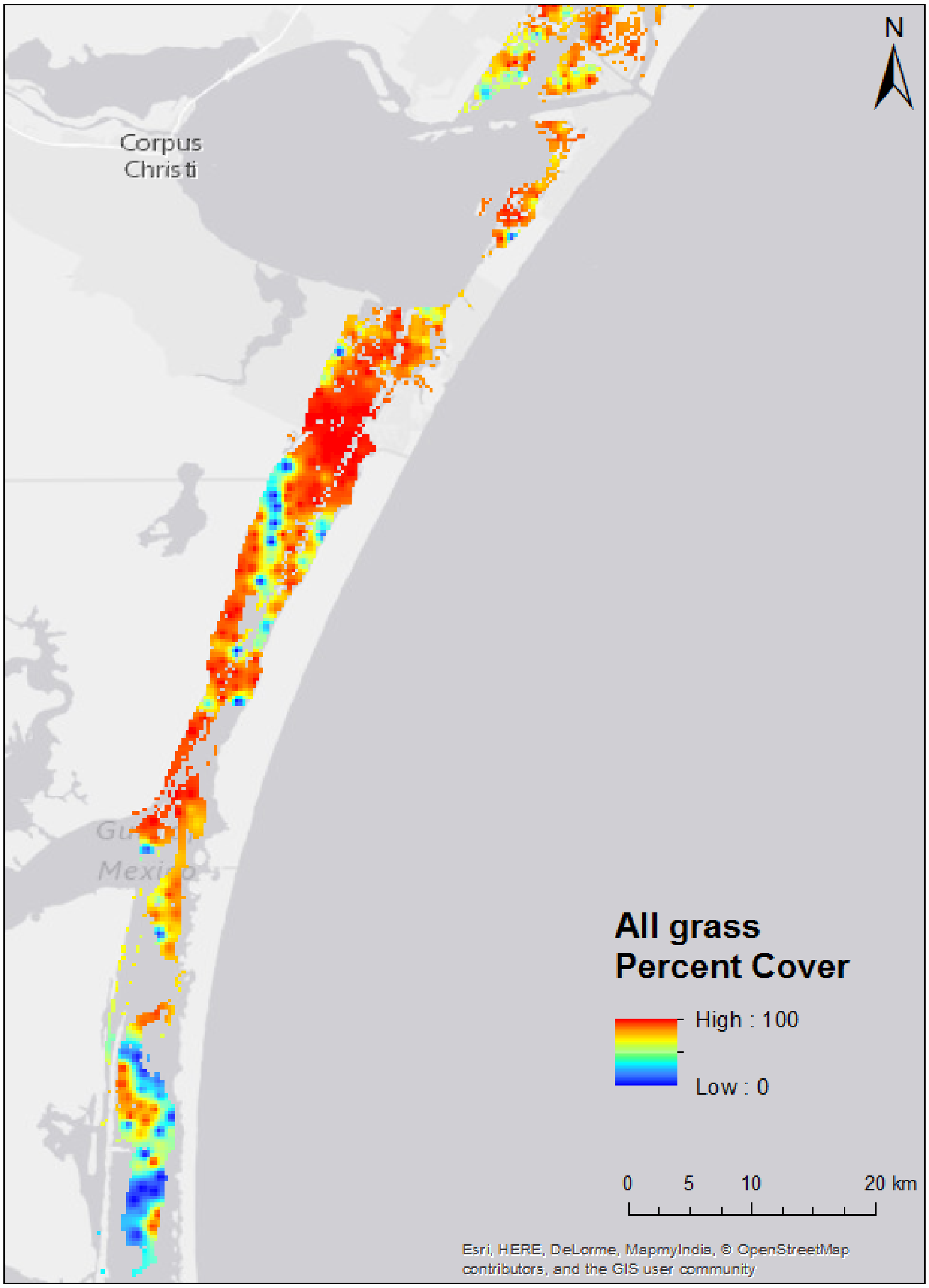

Figure 6. Spatial representations of percent cover for all seagrass species for 2015. The spatial data interpolation is limited to the boundaries of seagrass habitat delineated during the 2004/2007 NOAA Benthic Habitat Assessment.

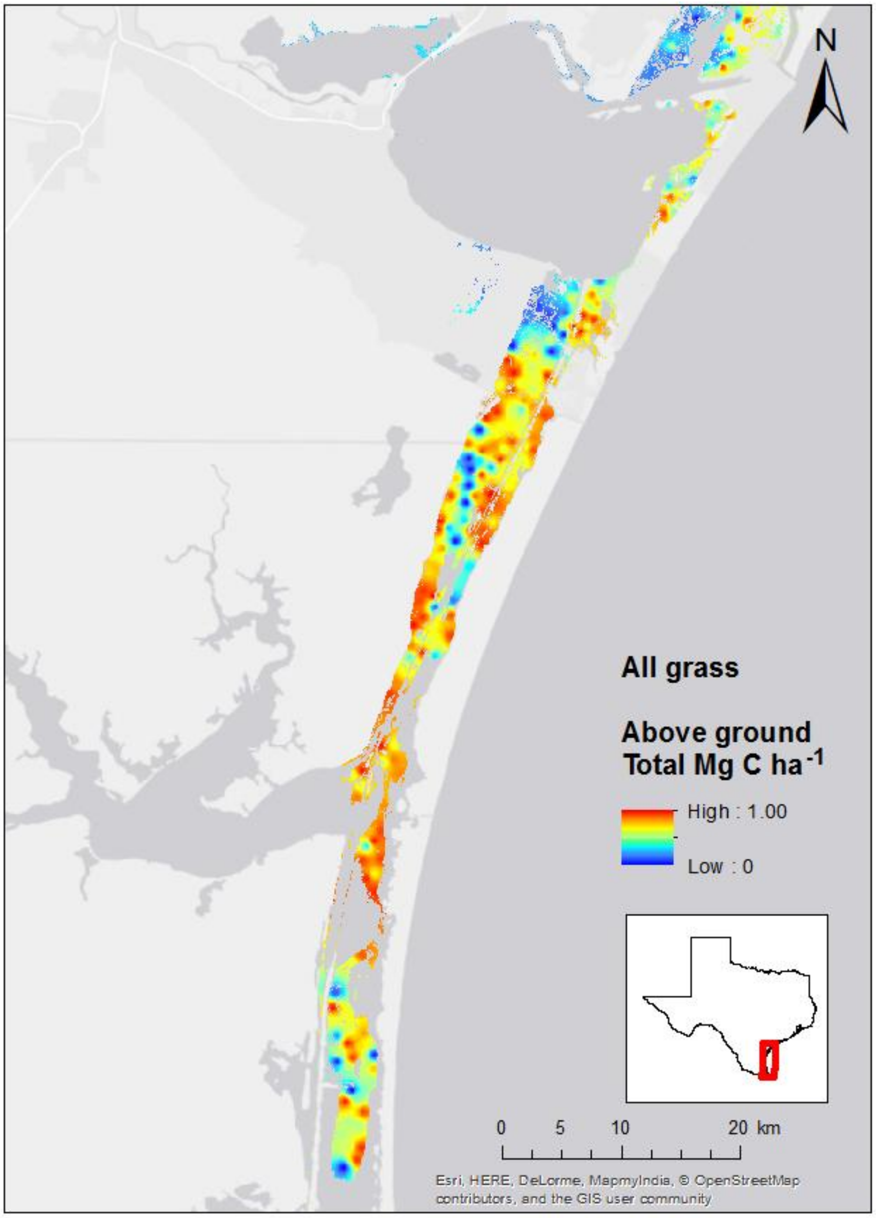

Figure 7. Spatial representations of carbon storage for *Halodule wrightii*, *Thalassia testudinum*, and *Syringodium filiforme* for 2015. The spatial data interpolation is limited to the boundaries of seagrass habitat delineated during the 2004/2007 NOAA Benthic Habitat Assessment.

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