Surveys for Invasive Aquatic and Native Marine Vegetation on the Mississippi Barrier Islands

A report submitted to the U.S. National Park Service

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GRI Report #5089

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EXECUTIVE SUMMARY

- More than half of the surveyed lagoons are serving as habitat for native sea grasses and federally protected fauna.
- Aquatic invasive plant species have invaded roughly two-thirds of the lagoons surveyed in 2020.
- Future surveys should focus on lagoons not surveyed in 2020.
- Control measures should be implemented on individual populations of invasive species in order to protect nursery populations of seagrasses.

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BACKGROUND

The southeastern U.S. has been impacted by dozens of aquatic invasive plant species (AIS), many of which are present in Mississippi (Turnage & Shoemaker 2018; Turnage et al. 2012, 2019a; Cox & Madsen 2009). Some AIS, including torpedograss (*Panicum repens*), Common reed (*Phragmites australis*), and Eurasian watermilfoil (*Myriophyllum spicatum*), are capable of surviving in brackish water environments (estuaries, barrier island tidal pools, and barrier island lagoons; Madsen 2005; Prince & MacDonald 2020). Barrier island lagoons can act as refugia for seagrass species; many of which are vital components of marine ecosystems. Unfortunately, lagoons can also act as refugia for AIS (e.g., common reed) to produce propagules capable of colonizing new sites or re-infesting previously managed sites. Fortunately, there are management solutions for removal of AIS in aquatic environments (Turnage et al. 2019b, 2020).

Loss of ecosystem function has been documented in many systems that have AIS present (Lovell & Stone 2005; Olden et al. 2004), including brackish and saline habitats (Prince and MacDonald 2020). This suggests that colonization of barrier island sites by AIS can further reduce seagrass abundance in island lagoons such that these populations no longer function as nursery populations for seagrass beds in the Gulf of Mexico and the Mississippi Sound. Historically, only five seagrass species were recorded in the Mississippi sound (Pham 2017): shoal grass (*Halodule wrightii*), star grass (*Halophila engelmannii*), widgeon grass (*Ruppia maritima*), manatee grass (*Syringodium filiforme*), and turtle grass (*Thalassia testudinum*). Because seagrasses have declined in the Mississippi Sound since the late 1960's (Moncrief 2007a, 2007b), it is imperative that any nursery populations be identified, monitored, and protected from AIS persistence.

The goal of this project was to systematically survey the aquatic and marine vegetation in select lagoons on the 4 major barrier islands (Petit Bois, Horn, Ship, and Cat) of Mississippi to 1) determine the plant community composition of each lagoon and 2) determine if AIS were present in these systems. Data collected during this project can be utilized by state and federal resource managers for future management decisions.

MATERIALS AND METHODS

This project was conducted under research permit # GUIS 00283. Lagoons over 0.4 ha (1 ac) in size on Petit Bois (7 lagoons), Horn (19 lagoons), Ship (4 lagoons), and Cat (8 lagoons) Islands were identified as potential survey sites from historical satellite imagery. In total, 38 lagoons were identified (Table 1; Figures 1-4). The survey team, consisting of 8 people, traveled to each island by motorized boat. At each island, two people remained on the boat to coordinate survey efforts and survey offshore reference sites while the remaining six people split into two-man sub-units (three sub-units). Each sub-unit hiked to target lagoons and deployed inflatable kayaks. Each survey sub-unit was equipped with a handheld GPS unit for logging data points and a weighted plant rake to collect plant specimens from lagoon bottoms. All plant specimens were returned to the water once a positive ID was made. Plant ID was based on plant descriptions in Weakley (2020).

Each lagoon was surveyed using the point intercept method (Madsen and Wersal 2018; Turnage and Madsen 2015) utilizing a pre-determined grid of points; each lagoon had a minimum of 10 survey points except Horn Island lagoon # 10 (Horn 10), which had only seven points. In addition to the lagoon surveys, one site on the north side of Petit Bois Island, three sites on the north side of Horn Island, two sites on the north side of Ship Island, and one site on

the south side of Cat Island were surveyed in the MS Sound. Surveys from these sites were used to generate baseline density of seagrasses, against which seagrass densities from individual lagoons were compared. Reference sites were 4.04 to 10.12 (10 to 25 ac) in size. The point intercept survey method was chosen because it can be repeated as often as needed, survey teams return to the same GPS points each time, and recorded data can be used to conduct statistical analyses to determine changes in plant communities over time. By hiking to each lagoon, the survey team minimized human impacts to each island. No more than one day was spent surveying each island; this resulted in a randomly selected subset of identified lagoons being surveyed in 2020.

Statistical analysis consisted of using binomial tests to compare prevalence of seagrasses in lagoons and seagrasses in reference sites in the Mississippi Sound for each island and total species prevalence in the Sound. Statistical tests were only conducted on lagoons with a target seagrass species present in the lagoon and in reference sites. All statistical tests were conducted at the alpha=0.05 significance level (R Core Team 2021).

RESULTS AND DISCUSSION

Shoal grass and Widgeon grass were the only seagrasses observed in the Mississippi Sound reference sites. Shoal grass was observed in all reference sites while Widgeon grass was only observed in the Cat Island reference site. Manatee grass was observed in one survey site on Ship Island but not in any reference sites. Star grass and turtle grass were not observed at any location. Shoal grass was recorded at 25.0% of survey points in the Petit Bois reference site, 31.8% of points in the Horn Island reference sites, 13.8% of survey points in Ship Island

references, and 19.4% of points in the Cat Island reference site. Prevalence of Shoal grass across all reference sites in the Mississippi Sound was 23.9%.

Non-target species of interest were observed on each island. Smooth cordgrass (*Spartina alterniflora*) was observed along the margins of various lagoons on Horn, Ship, and Cat islands. Black needle rush (*Juncus roemerianus*) was observed around the margins of various lagoons on all four islands. American alligators (*Alligator mississippiensis*) were observed in lagoons on Petit Bois, Horn, and Ship islands.

Three lagoons were surveyed on Petit Bois Island (PB1-PB3) but due to a GPS malfunction, data were lost for two sites (PB1-PB2); however, common reed, torpedograss, and shoal grass were recorded in field notes for both lagoons. Shoal grass prevalence was higher in PB3 (67.6%; $p<0.0001$) compared to the Petit Bois reference site and higher than total prevalence in the Mississippi Sound ($p<0.0001$). Torpedograss was the only AIS present in PB3 (32.4%; Table 2).

Seven lagoons were surveyed on Horn Island (H9-H11, H15-H18). Torpedograss was the only AIS recorded on Horn Island and was present in four lagoons: 14.3% in H11, 14.8% in H16, 45.8% in H17, and 7.7% in H18 (Table 2). Shoal grass was the only seagrass observed in Horn Island lagoons (H9, H10, and H15, Table 2). Shoal grass prevalence was lower in H9 (14.7%) than in Horn Island reference sites ($P<0.0001$) and total prevalence in the Sound ($p=0.0275$). Shoal grass prevalence in H10 was similar to Horn Island references and total prevalence across all Sound reference sites. Shoal grass prevalence in H15 (14.7%) was lower than Horn Island reference sites ($p=0.0408$) but similar to total prevalence in the Mississippi Sound (Table 2).

Two lagoons were surveyed on Ship Island (S1 and S2). Torpedograss was the only AIS observed on Ship Island and was present in one lagoon (S2, 15.8%). Shoal grass and Manatee grass were observed in S2; Manatee grass was only observed at one point (7.1% survey points; Table 2). Shoal grass was present at higher densities in S2 (35.7%) than in Ship Island reference sites ($p=0.0339$) but was still similar to prevalence across all Mississippi Sound reference sites (Table 2).

Two lagoons were surveyed on Cat Island (C1 and C3). Torpedograss was the only AIS observed at survey points on Cat Island (C1; 33.3% of points); common reed was also observed on Cat Island but was not encountered at survey points. Shoal grass was present in both sites on Cat Island while Widgeon grass was only present in one site (C1). Shoal grass prevalence in C1 (61.1%) was greater than the Cat Island reference site and total prevalence across all reference sites in the Sound ($p=0.0001$ and 0.0008, respectively; Table 2). Shoal grass prevalence in C2 (40.0%) was similar to Cat Island and MS Sound reference sites. Widgeon grass prevalence in C1 (16.7%) was similar to prevalence in the Cat Island reference site (Table 2).

Of the 12 lagoons surveyed, torpedo grass was present in eight, Shoal grass was present in seven, and Manatee grass was present in one (Table 2). Torpedograss co-occurred with Shoal grass in five lagoons (PB1-PB3, H9, and C1; 41.7% of lagoons surveyed), with Widgeon grass in one lagoon (C1), and did not co-occur with Manatee grass (Table 2). Common reed co-occurred with Shoal grass in two lagoons (PB1-2) but did not co-occur with any other seagrass species.

This work has confirmed that multiple seagrass species are present in lagoons on the Mississippi barrier islands. Higher seagrass prevalence in lagoons compared to reference sites suggests that some lagoons may be acting as nursery habitat for seagrass populations to produce propagules capable of recolonizing near shore marine habitats during flood, high tide, or storm

events. The co-occurrence of AIS in many of these lagoons, specifically torpedo grass presence, increases the chances that seagrass populations may decline in these locations. Torpedo grass produces submersed and emergent foliage and stems can grow so dense that they trap sediment and form floating islands (called tussocks) that can cover individual waterbodies and inhibit sunlight from reaching littoral sediments. Chemical management (i.e., herbicides) of torpedograss should be constrained to glyphosate and imazapyr. Both herbicides are legal for use in aquatic environments and have been documented to control torpedograss (Prince and MacDonald 2020); however, neither herbicide is active under water and thus should not affect submersed seagrass populations. Management of AIS in lagoons of the barrier islands is critical to preserve these habitats as seagrass refugia.

CONCLUSIONS

- More than half of the surveyed lagoons are serving as habitat for native sea grasses and federally protected fauna.
- Aquatic invasive plant species have invaded roughly two-thirds of the lagoons surveyed in 2020.
- Future surveys should focus on lagoons not surveyed in 2020.
- Control measures should be implemented on individual populations of invasive species in order to protect nursery populations of seagrasses.

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TABLES AND FIGURES

Table 1. Lagoons identified for survey efforts; only those with an X in the 2020 column were surveyed in 2020.

ISLAND	LAGOON ID	SIZE Ha (ac)	2020
Petit Bois	PB1	1.16	X
Petit Bois	PB2	2.08	X
Petit Bois	PB3	7.70	X
Petit Bois	PB4	2.22	
Petit Bois	PB5	1.86	
Petit Bois	PB6	6.29	
Petit Bois	PB7	1.77	
Horn	H1	4.29	
Horn	H2	1.42	
Horn	H3	9.91	
Horn	H4	1.66	
Horn	H5	7.72	
Horn	H6	4.89	
Horn	H7	2.18	
Horn	H8	2.81	
Horn	H9	43.48	X
Horn	H10	7.91	X
Horn	H11	29.33	X
Horn	H12	6.30	
Horn	H13	1.52	
Horn	H14	1.13	
Horn	H15	57.91	X
Horn	H16	5.98	X
Horn	H17	2.00	X
Horn	H18	2.64	X
Horn	H19	2.36	
Ship	S1	1.91	X
Ship	S2	3.88	X
Ship	S3	3.34	
Ship	S4	7.04	
Cat	C1	1.06	X
Cat	C2	3.59	
Cat	C3	1.34	X
Cat	C4	1.29	
Cat	C5	6.08	
Cat	C6	14.05	
Cat	C7	3.38	
Cat	C8	2.36	

Table 2. Total survey points and species prevalence of Torpedo grass, Shoal grass, Widgeon grass, and Manatee grass within survey sites. In the Shoal grass and Widgeon grass columns, a superscript ‘A’ denotes difference from the corresponding islands reference site(s) and a superscript ‘B’ denotes statistical difference from prevalence across all reference sites in the Mississippi Sound. Mean prevalence of Shoal grass was 25.0% in the Petit Bois reference, 31.8% in Horn references, 13.8% in Ship references, 19.4% in the Cat reference, and 23.9% across all reference sites in the Mississippi Sound. Mean prevalence of Widgeon grass was 32.3% in the Cat reference. Data from PB1 and PB2 were lost due to a GPS malfunction.

SITE	TORPEDO GRASS	SHOAL GRASS	WIDGEON GRASS	MANATEE GRASS
PB3	32.4%	67.6%[A, B]	0.0%	0.0%
H9	14.6%	14.6%[A, B]	0.0%	0.0%
H10	0.0%	28.6%	0.0%	0.0%
H11	14.3%	0.0%	0.0%	0.0%
H15	0.0%	14.7%[A]	0.0%	0.0%
H16	14.8%	0.0%	0.0%	0.0%
H17	45.8%	0.0%	0.0%	0.0%
H18	7.7%	0.0%	0.0%	0.0%
S1	15.8%	0.0%	0.0%	0.0%
S2	0.0%	35.7%[A]	0.0%	7.1%
C1	33.3%	61.1%[A, B]	16.7%	0.0%
C3	0.0%	40.0%	0.0%	0.0%

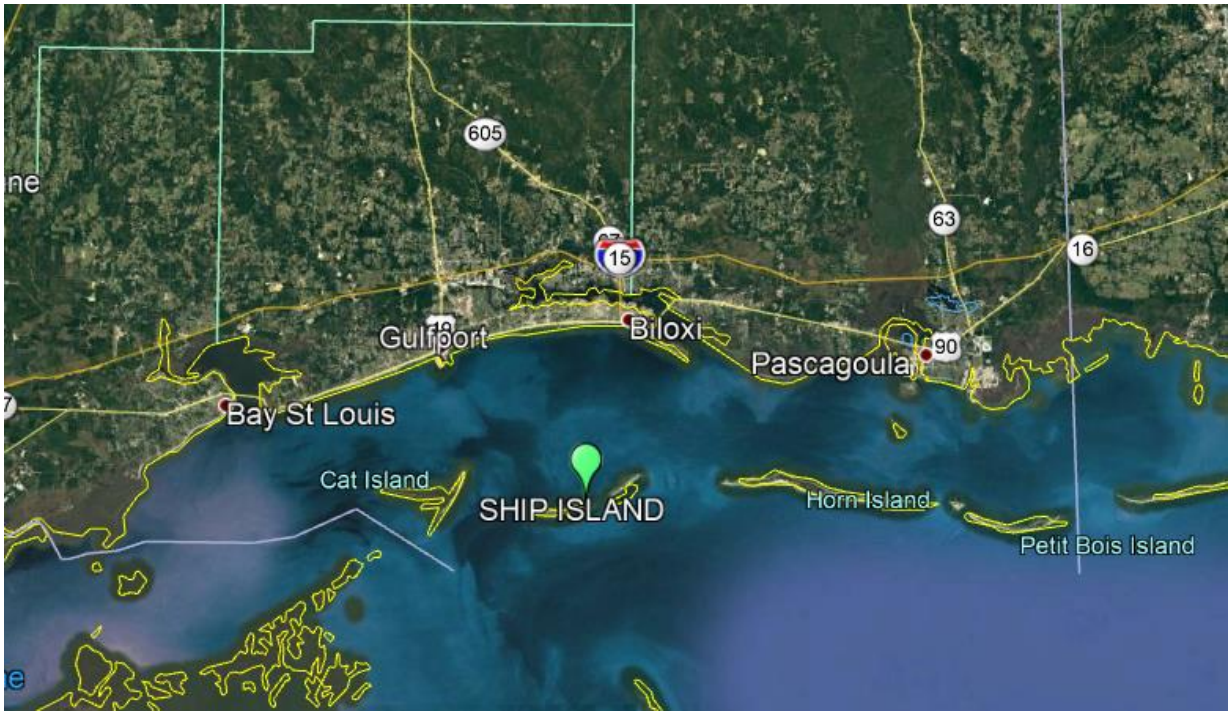

Figure 1. Barrier islands off the coast of Mississippi.

Figure 2. Petit Bois Island with lagoon locations.

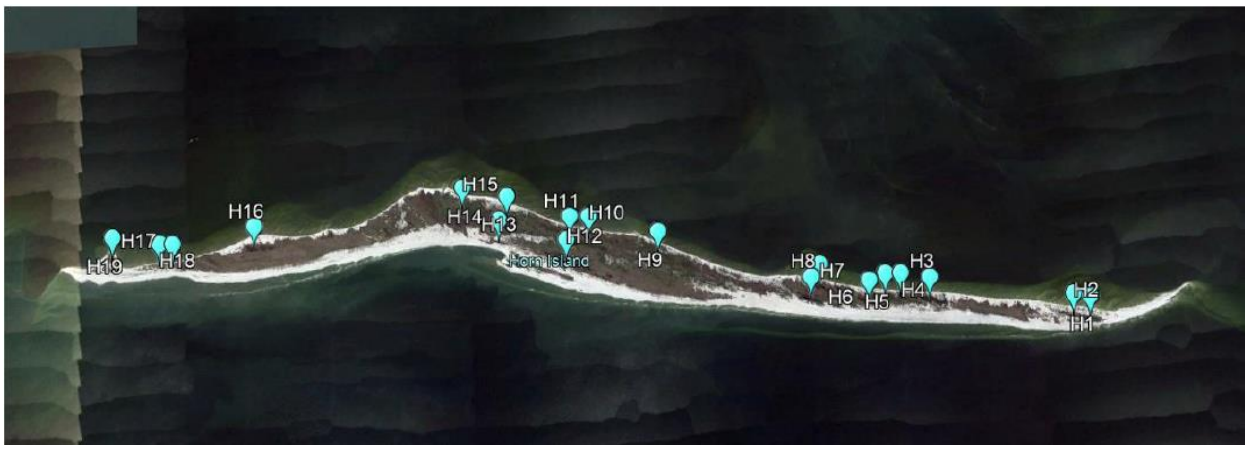

Figure 3. Horn Island with lagoon locations.

Figure 4. Ship Island (restored) with lagoon locations.

Figure 5. Cat Island with lagoon locations.