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Florida Salt Marsh Vole Habitat: Lower Suwannee National Wildlife Refuge

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Abstract

The rare Florida salt marsh vole (*Microtus pennsylvanicus dukecampbelli*) was discovered in spring 2004 by U.S. Fish and Wildlife Service (USFWS) personnel on the Lower Suwannee National Wildlife Refuge. The discovery of three individuals in the southern portion of the refuge renewed hope for effective recovery and protection of this rare animal. Further protection of the Florida salt marsh vole will rely on distribution surveys of the animal and conservation of potential habitat. This report details an effort by the U.S. Geological Survey to map potential habitat sites within the refuge. The Florida salt marsh vole is known to utilize a specific type of salt marsh called saltgrass (*Distichlis spicata*) as habitat. Hyperspectral imagery acquired in 2002 for mapping general intertidal habitats of the lower Suwannee River and estuary was re-evaluated for this specific habitat. The results of the mapping effort and field reconnaissance identified potential habitat in the salt marshes north and south of the Suwannee River. Saltgrass habitat was field-identified at flooded and elevated sites, near the shoreline and toward the marsh interior, and was found occurring with several other marsh species, including three-square sedge, smooth cordgrass, black needlerush, and glasswort. Image-derived saltgrass mapping was only 62% accurate. Positive identification of saltgrass from the imagery was hindered by the variety of environmental conditions and the co-occurrence of saltgrass with other species. Image-derived sites were mapped separately from field-verified locations. The tidal marsh around the Suwannee River delta itself did not support extensive saltgrass-dominant habitat. This was due largely to freshwater flow and dominance of freshwater marsh species in those areas. Where saltgrass was identified as a sparse understory, it could become the dominant cover under different conditions such as drought or decreased river discharge.

Introduction

Background

The Florida salt marsh vole (*Microtus pennsylvanicus dukecampbelli*) is listed as an endangered species and has been known historically from only one site in coastal Levy County, Florida (USFWS, 1997). Dominant vegetation at the original site consisted of saltgrass (*Distichlis spicata*), cordgrass (*Spartina alterniflora*), and glassworts (*Salicornia* spp.). Black needlerush (*Juncus romerianus*) is also common in the surrounding area. In spring 2004, personnel from the Lower Suwannee National Wildlife Refuge (LSNWR) collected three specimens of the Florida salt marsh vole from a new site farther north and west from the original site (USFWS, 2004). This new site is a remnant sand island dominated by cordgrass and black needlerush salt marsh with sufficient topography to support coastal hammock of southern red cedar, cabbage palm (*Sabal palmetto*), oak, and palmetto scrub. Included in the salt marsh are patches of saltgrass, glasswort, and high-marsh species.

The discovery of a new and separate population of Florida salt marsh vole spurred an effort to identify additional habitat sites that may support current or future populations of the rare rodent. Current understanding of Florida salt marsh vole habitat consists of an association with saltgrass. This specific salt marsh vegetation was used as an indicator to map sites with habitat potential elsewhere in the refuge.

Saltgrass

Saltgrass, also known as spike grass, is tolerant of a wide range of tidal flooding and salinity variations (Coultas and Lasley, 2001; Bordovsky et al., 2002; Eleuterius, 2000). Saltgrass is a dioecious plant with 15 to 45 cm-tall, spreading rhizomes that form dense vegetative mats (Eleuterius, 2000). It can thrive in infrequently inundated zones near the high water line but can also withstand frequent flooding (Barnett and Crewz, 1990). Saltgrass may be more resistant to environmental stressors, such as drought, than cordgrass (McKee et al., 2004), and can tolerate high salinity and other harsh conditions (Brewer et al., 1998; Eleuterius, 2000). However, saltgrass has been shown to be susceptible to decreased oxygen levels in the substrate and to increased flooding over time and may be vulnerable to sea-level rise (Donnely and Bertness, 2001).

Saltgrass has been used successfully in wetland-restoration efforts (Howard, 2003), and many consider it to be a pioneer species in salt marsh development (Mitsch and Gosselink, 2000). Research suggests saltgrass may compete for nutrients more effectively than other marsh species in nutrient-limited conditions (Levine et al., 1998). Opportunistic species, such as saltgrass, may colonize disturbed areas (Shumway, 1995; Coultas and Lasley, 2001). In the Gulf Coast marshes, saltgrass commonly occurs as a colonizing species after disturbance, such as wrack deposition after a storm (Clewell et al., 1999).

Saltgrass is a clonal species, spreading vegetatively over large areas. A strength of clonal reproduction lies in the benefits to both parent and offspring clones from the integration of available resources through inter-connecting rhizomes (Pennings and Callaway, 2000; Shumway, 1995). A single saltgrass clone may cover a large area and, as a dioecious species, produces only male or only female flowers. Female plants tend to dominate lower-elevation sites, and female seedlings are more likely to survive flooded conditions (Eppley, 2001). These traits may further influence the character of a particular site and its suitability as habitat.

Saltgrass is a food supply for many birds and small mammals and provides habitat to species besides the Florida salt marsh vole (Barnett and Crewz, 1990). As habitat, it is associated with the southeastern beach mouse, clapper rail, seaside sparrow, cinnamon teal, long-billed curlew, wandering skipper butterfly, and others.

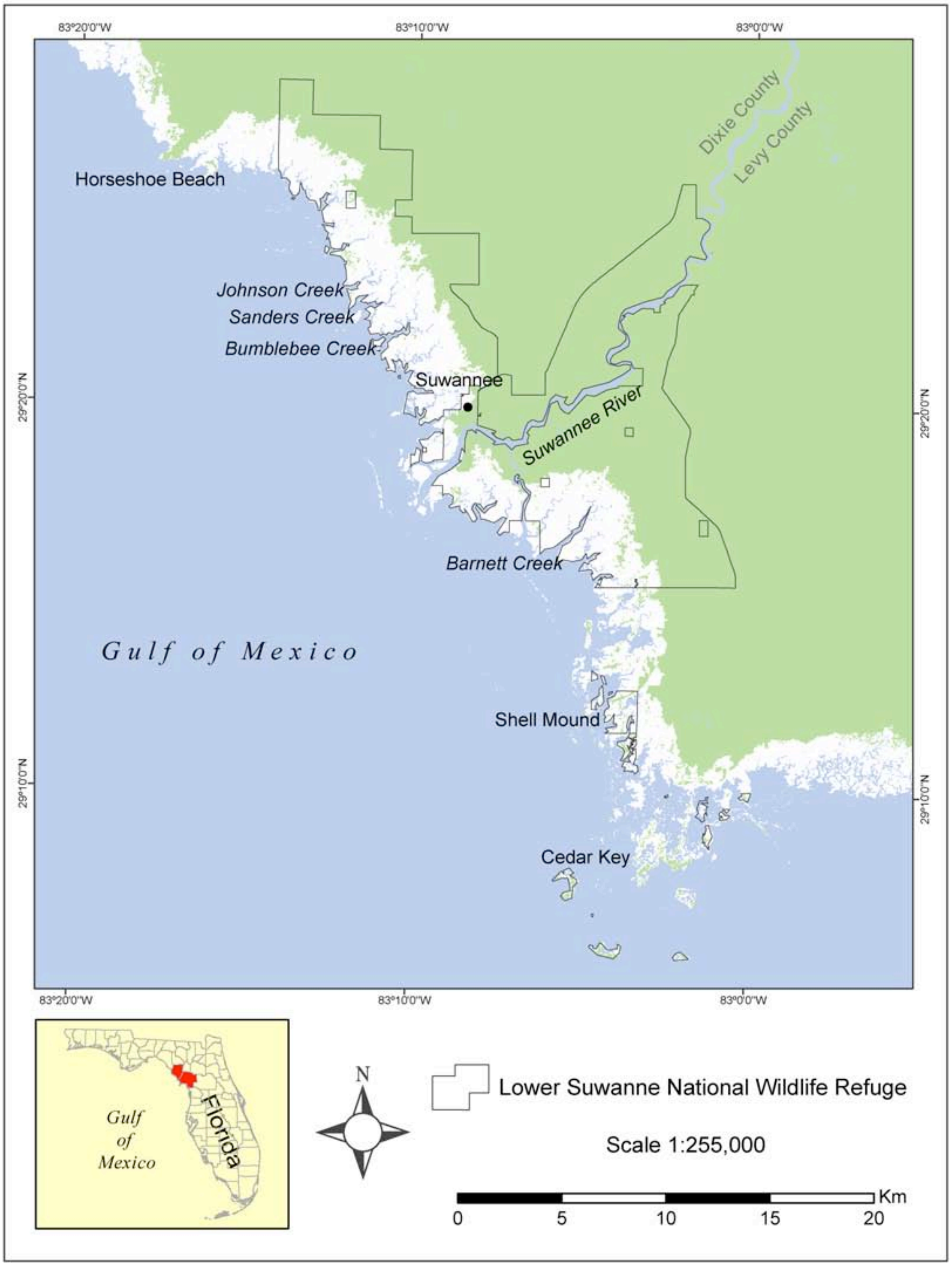
Study Area

The sites of known Florida salt marsh vole populations are in Levy County on the Gulf coast of Florida, near Cedar Key (Figure 1). The intertidal zone of the Lower Suwannee NWR is characterized by an open coast and is protected to the west by emergent oyster reef (Orlando et al., 1993). The Suwannee Estuary marsh coast is part of the Big Bend marsh coast extending to the north and south along Florida's Gulf Coast (Fretwell et al., 1996). The region is characterized by a shallow offshore shelf, low wave energy, 1-m tidal range, low sediment supply, near-surface limestone, and indeterminate flow from the Floridan aquifer (Raabe et al., 2004; Davis, 1997; Montague and Odum, 1997).

The Suwannee River is a black-water river with an average annual discharge of 295 m/s (Tillis, 2000; Siegel et al., 1996). Salinity variation in the estuary is most closely related to variation in river discharge, which reflects climatological conditions of the headwaters in southern Georgia (Orlando et al., 1993). High discharge typically occurs between February and April, when the plume extends south toward Cedar Key. The delta marsh and tidal creeks directly adjoining the river support a greater variety of coastal-wetland species than is typical of the Big Bend (Clewell et al., 1999; Coultas and Lasley, 2001; Raabe et al., in prep.). However, both known Florida salt marsh vole sites were located farther to the south, where vegetation is more consistent with typical Big Bend salt marsh (Raabe et al., in prep.).

The typical intertidal zone of the region is characterized by broad stretches of salt marsh, remnant stands of coastal forest, meandering tidal creeks, and oyster bars (Raabe and Stumpf, 1997). Relict sand dunes, shell mounds, and exposed limestone outcrops provide minimal relief in the intertidal environment (Davis, 1997). Depending on elevation, flooding, wave energy, and salinity gradient, the tidal marsh supports smooth cordgrass, common black needlerush, saltgrass, and other high-marsh species and salt-tolerant species (Clewell, 1997; Montague and Weigert, 1990).

Figure 1. Study area for Florida salt marsh vole habitat, Levy and Dixie Counties, Florida.



Methods

Background

The mapping effort consisted of a re-evaluation of hyperspectral imagery acquired for general habitat mapping, and ground surveys of the intertidal zone of the Lower Suwannee NWR (Borstad Associates, 2002a; 2002b). The hyperspectral imagery was acquired in September 2002 to map general habitats of the Suwannee River estuary and consists of 12 bands of data at 4-m resolution (Borstad Associates, 2002b; Raabe et al., in prep.). Although the imagery does not encompass the whole refuge, it covers the marshes from Sanders Creek to Barnett Creek (see Figure 1).

Field surveys

Field surveys were conducted to evaluate accuracy of the mapping from remotely sensed imagery. Field records include Global Positioning System (GPS) positions, photographs, and field descriptions of the 153 sites. Fieldwork was conducted in the summer of 2005 to canvas areas from Johnson Creek to Shell Mound. Coordinates of known saltgrass sites were entered into a table format and were displayed and prepared for use in a Geographic Information System (GIS). Field data were used to verify potential saltgrass sites derived from the imagery and to augment areas not covered by the imagery.

Image Processing

Fourteen flight lines of hyperspectral imagery were reprocessed for saltgrass identification. The original flight lines were reprojected from Albers to Universal Transverse Mercator (UTM), zone 17R, WGS 84. A land model for each of the 14 flight lines was created for categorizing only emergent and landward features. Two classification methods were applied, supervised classification and unsupervised classification. The supervised classification relied on known sites for saltgrass training sites. Separability was determined by comparing ranges for saltgrass against non-saltgrass sites and evaluating range of values for saltgrass sites in each band. Potential sites were mapped, and areas adjacent to accessible tidal creeks were selected for field reconnaissance on August 11, 2005.

An unsupervised classification was performed on all 12 bands of data for the 14 flight lines using the land models. Existing field-verified locations were overlaid on the unclassified images to select classes that could represent saltgrass sites. The process was repeated for each flight line. Potential sites were mapped, and areas adjacent to accessible tidal creeks were selected for field reconnaissance on August 24, 25 and 26.

Results

Mapping

The supervised classification was unsuccessful. Field verification showed saltgrass was present at less than 10% of the identified sites. Separability of saltgrass from known sites was complicated by a wide range of site conditions and plant-community variations. Some saltgrass sites had similar reflectance to non-saltgrass sites, and saltgrass did not have consistent range of values from one site to another.

The unsupervised classification was relatively successful. Potential saltgrass sites derived from hyperspectral imagery were evaluated with field data, and an error evaluation was conducted to determine the accuracy of the final map (Table 1). Approximately 62% of known saltgrass sites was successfully mapped. This means that 38% of the known saltgrass sites was not identifiable with the imagery. However, other features were less frequently mapped incorrectly as saltgrass, with a low error of 8%.

These potential saltgrass sites are mapped in Figure 2. No sites were mapped in the delta region of the Suwannee intertidal zone. Saltgrass was noted in field reconnaissance in this area but always as a thin understory. Some differences in marsh-reflectance characteristics and artifacts from flight patterns are inherent in this product.

Table 1. Error matrix for potential saltgrass sites derived from hyperspectral imagery.

	# Sites Mapped	# Sites Not Mapped	Total # Sites	% Mapped
# Saltgrass Sites	33	20	53	**62%**
# Non-Saltgrass	8	95	103	**8%**
Total # Sites	41	115	156	

Field Reconnaissance

Several extensive saltgrass sites were identified in the process of field checking the image-derived sites. Sites covering the largest area and sites with extensive small patches mosaicked in the marsh were selected for mapping and descriptive purposes. Positive field-checked saltgrass sites were distributed north and south of the river delta marsh, but not within the delta marsh itself. Some sites were dominated by saltgrass, others were a saltgrass mix, and in other areas saltgrass occurred as small patches or single stems within the larger salt marsh mosaic.

Figure 3 shows the location of 26 known saltgrass sites. Although the presence of saltgrass was identified at other locations, each of the selected sites was either an extensive area of saltgrass or surrounded by many pockets of saltgrass in the larger salt marsh mosaic. These sites represent a range of saltgrass-habitat conditions. A summary of the selected sites is presented in Table 2 with brief field descriptions and links to photographs of the sites.

Saltgrass often occurred as part of a mix of other grass species, either as a dominant or as an understory vegetation. Frequent co-occurring species included three-square sedge or glassworts and less frequently, cordgrass, black needlerush, or sea oxeye (*Borrichia frutescens*). Canopy heights of 20 – 85 cm were observed in the field. Many of the sites were observed at the beginning or during the 2005 blooming season, which occurs from spring through late fall. This may explain the taller stems.

Figure 2. Potential saltgrass sites north (a) and south (b) of the Suwannee River mouth derived from hyperspectral imagery.

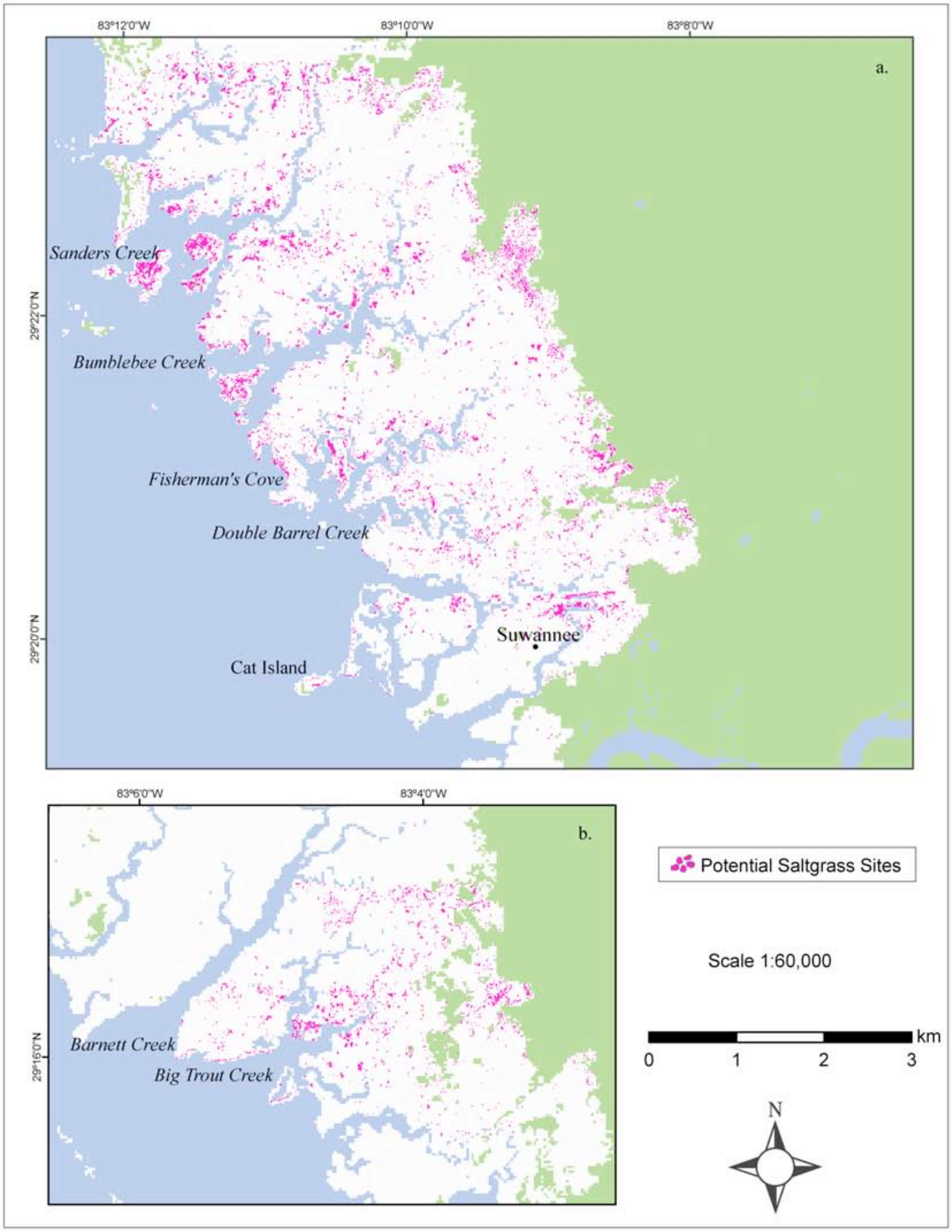


Figure 3. Known saltgrass sites north (a) and south (b) of the Suwannee River mouth.

(Click points to link to image files)

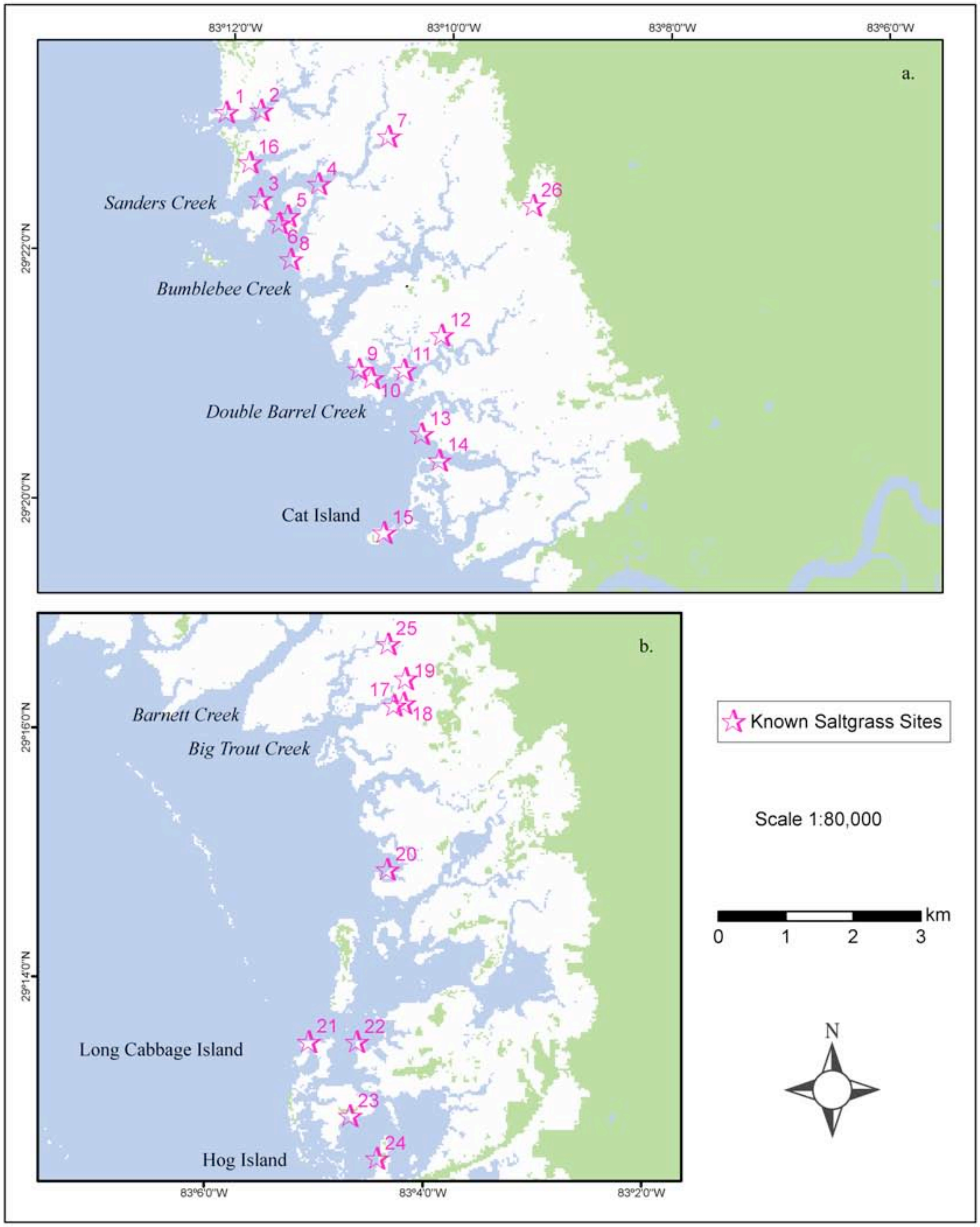


Table 2. Location (UTM 17 R WGS84) and description of known saltgrass sites.

Site #	UTM E	UTM N	Creek/Location	Description	Photo links to images
Site 1	286393	3252655	Johnson Creek	Black needlerush dominant with saltgrass throughout area, east 11 m	Johnson1.jpg
Site 2	286903	3252681	Johnson Creek	Blooming saltgrass ~ 0.5 m tall along shore. Mix with cordgrass 40 m SE.	Johnson2.jpg
Site 3	286893	3251367	Sanders Creek	Saltgrass and three-square ~10 m to east and patches extend along north and east of feature in a mosaic with black needlerush. Saltgrass up to ~85 cm tall and 66% of canopy.	Saltgrass_bloom1.jpg
Site 4	287761	3251589	Sanders Creek	Blooming saltgrass with cordgrass and black needlerush 30 m south and east. Saltgrass is dominant to south. Saltgrass is ~ 50% of the canopy and 0.75 m tall.	Saltgrass_bloom2.jpg
Site 5	287308	3251118	East of Little Pine Island	Saltgrass mixed with cordgrass and three-square to south and east. Very muddy site.	Sanders1.jpg
Site 6	287179	3251007	East of Little Pine Island	Saltgrass mixed with smooth cordgrass and three-square. Saltgrass in understory up to ~50% canopy.	no photo
Site 7	288795	3252299	Sanders Creek	Saltgrass patches mixed with wrack and black needlerush to south and SW, around hammock and along creek meanders. Saltgrass is ~50-60% of canopy.	no photo
Site 8	287348	3250474	Bumble Bee Creek SE	Large patch of low saltgrass with scattered scrub extends east and south 150 m and north 50 m. Firm substrate.	Saltgrass1.jpg
Site 9	288356	3248844	Fisherman's Cove	Large stretch of saltgrass. Some patches mixed with three-square (see photo). To east is edge with black needlerush and west is elevated scrub line. Saltgrass extends to south ~100 m. Shell hash along shore and in substrate.	Fishermans.jpg
Site 10	288542	3248710	Back of Fisherman's Cove	Patch of flooded saltgrass on shore that extends north ~ 150 m.	Saltgrass_Flooded1.jpg
Site 11	298025	3248837	North Double Barrel Creek	Flooded saltgrass and cordgrass at shore and northwest 15 m to thin saltgrass with wrack, leading to mix with black needlerush mix. Mixed throughout with floating wrack.	Saltgrass_Flooded2.jpg
Site 12	289584	3249348	North Double Barrel Creek	Steve Barlow trap site. Not visited.	no photo
Site 13	289283	3247885	South Double Barrel Creek	Dominant black needlerush with saltgrass northeast 45 m. Patch extends north along shore 100 m including a mound with sabal palm and scrub.	no photo
Site 14	289551	3247495	North of Palm Island	Saltgrass here up to 0.85 m tall with no seed heads.	no photo
Site 15	288730	3246420	Cat Island	Patch of saltgrass with three-square bordered by black needlerush extends north 25 m to wrack line. Saltgrass feature is broken by patches of wrack or black needlerush but extends south and southwest.	Cat_Island.jpg
Site 16	286741	3251913	East of Big Pine Island	Saltgrass and black needlerush mix north and west and along edge of hammock.	Saltgrass2.jpg

Site 17	298675	3239692	Big Trout Creek	Saltgrass patch behind scrub levee and along edge of creek to north and west along meanders. Mix with three-square and cordgrass. Patches along creek to Site 18.	Big_Trout1.jpg
Site 18	298814	3239724	Big Trout Creek	Saltgrass with cordgrass and three-square south 50 m.	Big_Trout2.jpg
Site 19	298844	3240084	Big Trout Creek	Saltgrass patch on back of creek levee to west 50 m and to the southeast. Saltgrass is blooming, ~ 0.5 m tall and thick. Many patches along this creek.	Big_Trout3.jpg
Site 20	298574	3237256	West of Erickson Creek	Saltgrass mix with cordgrass and three-square, extends east 50 m, west 100 m, south 50 m. Elevated marsh.	Saltgrass_bloom3.jpg
Site 21	297408	3234705	Long Cabbage Island	Thin bands of saltgrass along back of 0.5 m-tall sandy levee with sea-daisy and cordgrass in mosaic around meandering creek and tidal impoundments.	Long_Cabbage.jpg
Site 22	298117	3234703	Raleigh Island NW	Saltgrass patch west 50 m and southwest 100 m with male and female flowers ~0.4 m-tall and full canopy. Mix with cordgrass and saltwort. Many grasshoppers.	Raleigh Island.jpg
Site 23	298020	3233603	Buck Island South	Large saltgrass meadow extends to tree line north, and ~ 200 m east and west. Shoreline bordered by scrub. Mix with cordgrass, sea oxeye and other low-growth speces. Saltgrass is low (~0.3 m) and blooming.	Buck_Island.jpg
Site 24	298403	3233017	Hog Island West	Saltgrass, both male and female flowers, up to 0.5 m mix with cordgrass, saltwort, and glasswort south 45 m. Bounded to east by oak/palmetto scrub, and to west is shoreline.	Hog_Island.jpg
Site 25	298585	3240594	Big Trout Creek	Saltgrass is patchy but consistent along the creek. At low tide, these banks are substantially elevated.	no photo
Site 26	290941	3251270	Bumble Bee Creek South	Saltgrass in understory of morbid and downed trees on firm, wet, and muddy sediments and limestone outcrops. Intermixed with black needlerush, cordgrass, and salt scrub in patches throughout area adjoining upper creek.	Bumble_Bee.jpg

On the Lower Suwannee NWR, saltgrass was common as a nearshore meadow, or behind or along low natural levees, where the only sign of topography variation was a rough band of salt scrub on elevated sand or shell hash. Saltgrass in the Lower Suwannee NWR does not appear to be limited to locations adjoining obvious uplands, as described for Atlantic Coast wetlands. Only one location, Site 26, occurs at the marsh interior. This location at the head of Bumblebee Creek is also the location of coastal forest die-off, where tidal flow has intruded and salt marsh species are colonizing the substrate (Williams et al., 1999; Raabe et al., in prep.).

Conclusions

Potential habitat sites for Florida salt marsh vole were located in the Lower Suwannee NWR by two methods, using saltgrass as an indicator of habitat suitability. Verified saltgrass sites were located during field-reconnaissance efforts along tidal creeks north and south of the river. Other potential locations were derived from imagery using an unsupervised classification. Saltgrass occurred both as a dominant species and as an understory in mixed salt marsh sites. Where dominant, it typically co-occurred with three-square or glasswort. Saltgrass also co-occurred with black needlerush, cordgrass, sea oxeye, salt scrub, and saltwort. It was found in a variety of environments and substrates. Saltgrass occurred at shoreline and interior locations, on sand and shelly deposits, on muddy marsh sediments, and on thin mineral sediments over exposed limestone surfaces. Saltgrass frequently occurred on elevated marsh surfaces and near features with a slight topographic rise. Saltgrass also occurred in flooded areas and was found in swales behind coastal levees. The clonal, vegetative nature of saltgrass reproduction may facilitate persistence in low-elevation, flooded, saline, or other extreme environments. The parent plant can derive support through rhizomes connected to a daughter clone with different resources and vice versa.

Mapping of saltgrass from imagery was hindered by the broad tolerance of the plant to a variety of physical conditions and co-occurrence with various species from differing environments. This widespread species co-occurrence is common in the marshes near the Suwannee River and is attributed to localized variations in salinity and freshwater flow and patterns of colonization in disturbance patches (Coultas and Lasley, 2001). Changes in plant-canopy dominance may have occurred during the last three years in response to change away from drought conditions (Clewell, 2000; Coultas and Lasley, 2001). As scientists learn more about the Florida salt marsh vole habitat requirements, its life history, and home range, habitat may be better defined with additional parameters.

The majority of identified saltgrass-dominated sites are north and south of the Suwannee River, but not directly adjoining the river. Saltgrass was present in the marshes adjoining the river, but occurred primarily as an understory species. The delta marshes have been shown to have a stronger contribution of freshwater and brackish species and a higher tendency to flooding by freshwater (Bales et al., 2005; Coultas and Lasley, 2001; Raabe et al., in prep.). The presence of saltgrass in different environments indicates that it may alternate as dominant, co-dominant, and understory species depending on conditions. For instance, during prolonged low river discharge or drought conditions, the areas immediately adjoining the river may show increased cover of saltgrass. Clewell (2000) documented the appearance or increase of saltgrass during the 2000 drought along transects in Lower West and East Passes. This suggests that the plant or seed stock was present and ready to colonize. The reverse may apply during times of increased freshwater flow.

The recovery and protection of endangered or rare species relies on knowledge of habitat at known locations. This mapping effort of potential habitats was limited to the 'understood' preference for a specific type of salt marsh environment, seashore saltgrass (*Distichlis spicata*). More data on life history, mobility, and resource needs of the animal are needed.

This study raises several questions regarding the relation between the Florida salt marsh vole and saltgrass as habitat:

1. Does the Florida salt marsh vole select for open, low-growth vegetation, where saltgrass occurs with saltworts or glassworts, or will it be equally as likely to select a mix with sedge, blackneedle rush, or cordgrass?
2. Does the Florida salt marsh vole select for substrate, slope, flooding, or salinity characteristics of a site?
3. Does the Florida salt marsh vole have secondary or seasonal habitat preferences that must occur near or alongside the saltgrass habitat?
4. Is the association of Florida salt marsh vole with saltgrass an association with environmental characteristics less suitable to predators or competitors?

5. Or is the association between Florida salt marsh vole and saltgrass indicative of a commensal relation to another bird, mammal, or other organism also using the habitat?
6. Does the Florida salt marsh vole select for canopy characteristics of the plant or a product of the plant, such as seeds, rhizomes, or salt extrusion?
7. Since saltgrass clones may occupy large areas, and a site may be dominated by male or female plants, does Florida salt marsh vole prefer one to the other?
8. Will many small patches of saltgrass satisfy habitat requirements, or does the Florida salt marsh vole require large areas of continuous saltgrass?

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Photographs

Site 1 - Johnson1.jpg

Site 2 - Johnson2.jpg


Site 3 - Saltgrass_bloom1.jpg


Site 4 - Saltgrass_bloom2.jpg

Site 5 - Sanders1.jpg

Site 8 - Saltgrass1.jpg


Site 9 - Fishermans.jpg


Site 10 - Saltgrass_Flooded1.jpg


Site 11 - Saltgrass_Flooded2.jpg

Site 15 - Cat_Island.jpg

Site 16 - Saltgrass2.jpg

Site 17 - Big_Trout1.jpg

Site 18 - Big_Trout2.jpg


Site 19 - Big_Trout3.jpg


Site 20 - Saltgrassbloom_3.jpg


Site 21 - Long_Cabbage.jpg


Site 22 - Raleigh_Island.jpg

Site 23 - Buck_Island.jpg

Site 24 - Hog_Island.jpg


Site 26 - Bumble_bee.jpg