POPULATION DENSITY AND HABITAT ASSOCIATIONS OF THE SEASIDE SPARROW ON LAGUNA ATASCOSA NATIONAL WILDLIFE REFUGE, CAMERON COUNTY, TEXAS

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POPULATION DENSITY AND HABITAT ASSOCIATIONS OF THE SEASIDE SPARROW ON LAGUNA ATASCOSA NATIONAL WILDLIFE REFUGE, CAMERON COUNTY, TEXAS

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TABLE OF CONTENTS

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

ABSTRACT

POPULATION DENSITY AND HABITAT ASSOCIATIONS OF THE SEASIDE SPARROW ON LAGUNA ATASCOSA NATIONAL WILDLIFE REFUGE, CAMERON COUNTY, TEXAS

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SUPERVISING PROFESSOR: THOMAS R. SIMPSON

In 2000, a resident population of Texas Seaside Sparrows (*Ammodramus maritimus*) was identified at Laguna Atascosa National Wildlife Refuge on the lower Texas coast, extending its known breeding distribution further south than previously described. I studied this breeding population of Texas Seaside Sparrows on the Laguna

Atascosa National Wildlife Refuge to obtain population density estimates and describe habitat associations. I estimated seasonal density during one year using a distance sampling approach. I identified plant species and estimated percent ground cover using a 20x50 cm frame placed systematically along bird survey transects.

Seaside Sparrow density estimates by season were 3.49/ha (CV = 8.27) for spring 3.59/ha (CV = 18.16) for summer, 4.07/ha (CV = 9.69) for fall, and 1.91/ha (CV = 21.92) for winter. The dominant plant species along the intertidal zone transect where Seaside Sparrows were detected include Saltwort (*Batis maritima*), Saltgrass (*Distichlis spicata*), and Sea oxeye daisy (*Borrichia frutescens*). Previous studies indicated cordgrasses (*Spartina* spp.) to be a dominant plant species strongly associated with Seaside Sparrows and a predictor of nest success. However cordgrasses were absent from the intertidal zone where Seaside Sparrows were detected during my study. Habitat associations should be revised to include the plant community found in this study.

CHAPTER I

INTRODUCTION

Seaside Sparrows (*Ammodramus maritimus*) are a small songbird inhabiting the Atlantic and Gulf Coasts (Figure 1). Males and females are not sexually dimorphic; their plumage generally consists of a dark olive-to-grey dorsal coloration with a yellow supraloral spot, a buffy malar stripe, and a white throat. Their diet consists primarily of seeds, a variety of insects (including grasshoppers, moths, and spiders), crustaceans, mollusks (Post and Greenlaw 1994), and fruits or leaves from halophytic plants (Bartosik 2010). Currently, 10 subspecies are recognized, two of which, the Dusky Seaside Sparrow (*A. m. nigrescens*) and the Smyrna Seaside Sparrow (*A. m. pelonota*), are extinct. Further, the Cape Sable Seaside Sparrow (*A. m. mirabilis*) is federally endangered (Post and Greenlaw 1994). The Seaside Sparrow is considered a species of concern by the U.S. Fish and Wildlife Service given their restrictive habitat requirements and sensitivity to disruptive activity along coastal wetland (The Nature Conservancy [TNC] 1998).

The Seaside Sparrow is a habitat specialist restricted primarily to salty-to-brackish tidal marshes, with the exception of the Cape Sable Seaside Sparrow, which is found in mostly fresh waters of Everglades National Park, Florida (Lockwood et al. 1997).

Subspecies residing in northeastern states prefer habitats where salt meadow grass (*Spartina patens*), black grass (*Juncus gerardi*), marsh elder (*Iva frutescens*), and smooth cordgrass (*Spartina alterniflora*) (Marshall and Reinert 1990) are dominant. Seaside

Figure 1. Texas Seaside Sparrow (*Ammodramus maritimus senneti*) photographed in March 2013 on Laguna Atascosa National Wildlife Refuge, Cameron County, Texas.

Sparrows along the Gulf Coast occupy similar wetland vegetation, with the addition of saltgrass (*Distichlis spicata*), drop-seed grasses (*Sporobolus virginicus*), and needlerush (*Juncus roemerianus*) (Post and Greenlaw 1994).

Seaside Sparrows forage on the ground in salt marshes where tides manipulate plant and invertebrate communities and periodic floods influence nest success (Gjerdrum et al. 2005). Nests can be described as top-entrance nests relatively close to the ground (ca. 14 cm above ground in New York and 27 cm in Florida) in areas where there is adequate ground cover offering protection against predators and floodwaters (Post and

Greenlaw 1994). Seaside Sparrows display territorial behavior but have been observed nesting relatively close to one another (i.e., observation of five pairs within a 15 m span, Tomkins 1941). Population density is likely dependent on insect activity where sparrow density and insect activity tend to be higher in unaltered habitat (Post 1974). In areas where food availability is high there is lower competition and "jealous" behavior is decreased so that feeding areas are shared and defended areas are centered around nest sites (Tomkins 1941). In habitat where dredging occurred, males used greater total activity spaces where defending, singing, and foraging distances were greater than those of males in unaltered habitat. Seaside Sparrows in the northeastern United States exhibit migratory behavior while Florida populations tend to be non-migratory (Boulton et al. 2009). It has been suggested that Gulf coast populations are sedentary as well (Post and Greenlaw 1994); however, there is currently little information to support this claim.

Much research has been focused on northeastern populations, as well as the Dusky and Cape Sable Seaside Sparrows of Florida because of their conservation status. Current threats include pesticides, habitat loss or degradation, flooding, and succession from low marshes to high (Post and Greenlaw 1994; TNC 1998). Seaside Sparrows can thus be viewed as an indicator species of coastal marsh conditions. The decline of the Dusky Seaside Sparrow on Merritt Island National Wildlife Refuge, Florida, has been attributed largely to the use of pesticides and flooding in attempts to control mosquito populations, resulting in modification and fragmentation of habitat (Sykes 1980). Limited information, however, is available on populations along the southwestern coast of the Gulf of Mexico. The Nature Conservancy has recommended management strategies be focused on habitat protection and restoration of cordgrass coastal wetlands based on research conducted on northeastern and Florida populations. The Gulf Coast Joint Venture (GCJV) has established management and monitoring programs along the Gulf Coast from Alabama to Texas which recommend creation or restoration of medium height smooth cordgrass marshes and prescribed burning every three years.

The Texas Seaside Sparrow (*A. m. sennetti*) is generally associated with the Texas Gulf Coast, specifically the Corpus Christi area, where they are year round residents with known breeding populations only as far south as Nueces and Copano bays (Post and Greenlaw 1994). Areas south of Corpus Christi are generally regarded only as wintering grounds for this sparrow (Rising 2005). In August of 1999, a juvenile Texas Seaside Sparrow was captured on the Laguna Atascosa National Wildlife Refuge (NWR), Texas. Further search efforts in August of 2000 found Seaside Sparrows consistently in the northern and northeastern parts of the refuge, as well as in southern sections near the Laguna Madre. Phillips and Einem (2003) observed five adult Seaside Sparrows and one young near the Rio Grande delta during spring and summer months with vocalizations recorded. They also described old nests and eggshell remnants presumed to be from Seaside Sparrows, suggesting suitable nesting and foraging habitats were available to support breeding populations in the area.

The plant community along the Cayo Atascosa at Laguna Atascosa NWR where Seaside Sparrows were found is unique because of the high salinity of the Laguna Madre. It is atypical of habitats previously described in the literature for Seaside Sparrows, consisting primarily of saltwort (*Batis maritima*), sea oxeye daisy (*Borrichia frutescens*), saltgrass (*Distichlis spicata*), glasswort (*Sarcocornia perennis*), and scattered black mangroves (*Avicennia germinans*).

Objectives

My objectives for this study were to investigate a previously unreported population of Seaside Sparrows in the southern region of Texas where information on this species is limited. I estimated density of Seaside Sparrows in the northern region of Laguna Atascosa National Wildlife Refuge and investigated associations between Seaside Sparrows and the plant community they inhabit on Laguna Atascosa NWR. My findings contribute new ecological knowledge, including management implications, about this species. Further, my study will serve as a baseline for future research on this population and other populations in southern Texas.

CHAPTER II

STUDY AREA

The Laguna Atascosa NWR is located near the southernmost tip of Texas, west of the Laguna Madre. Landscapes are typically flat coastal prairies of short grasses, lomas (low sandy hills), mesquite, and thornscrub. Soils of this region are alkaline and the Laguna Madre is hypersaline, promoting a unique biodiversity on the refuge. I surveyed Seaside Sparrows in the hypersaline marsh along the eastern shore of the Cayo Atascoso, a water impoundment system stretching 4.5 km along the north boundary of the refuge (Figure 2). I also surveyed a 4 km portion of the loma running parallel to the eastern boundary of the marsh and adjacent to intertidal mudflats as well. Although Seaside Sparrows have not previously been seen in the uplands of the lomas, I surveyed this area because it contains vegetation characteristics previously described for Seaside Sparrows at other localities.

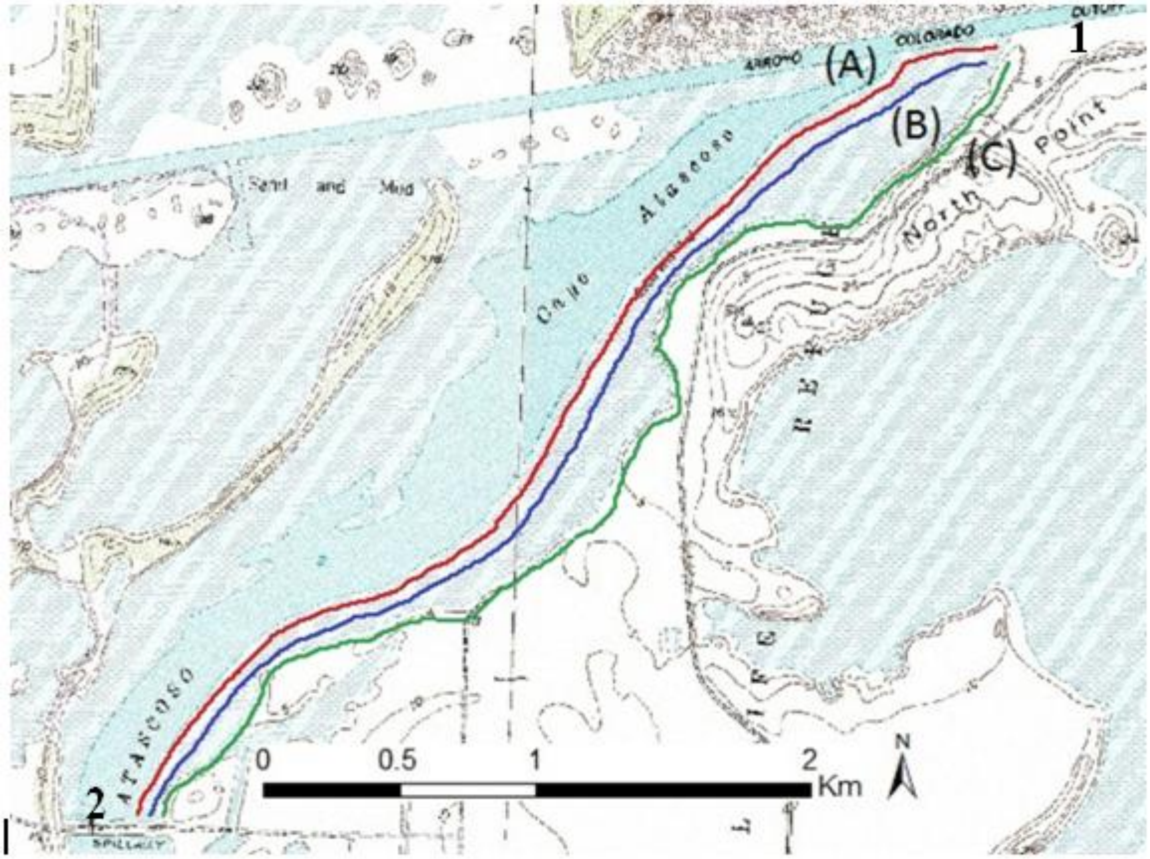

Figure 2. Northern boundary of the Laguna Atascosa National Wildlife Refuge, Cameron County, Texas. I surveyed three transects between North Point (1) and Crossing Two (2) [A: Intertidal zone; B: Mudflats; and C: Upland] to estimate density and presence/absence of Texas Seaside Sparrows (*Ammodramus maritimus*), as well as vegetation community associations.

CHAPTER III

METHODS

Bird Surveys

Beginning in April, 2012, I estimated Seaside Sparrow density for each season through January 2013, using a distance sampling approach on the Laguna Atascosa NWR between North Point and Crossing Two (Figure 2). Distance sampling is used to obtain density estimates based on line or point transects where distance from the object of interest (e.g. plant, animal, nest) to the line or point is recorded. Three assumptions for reliable results from distance sampling are required (Buckland et al. 2001): 1.) objects on the line or point are detected with certainty, 2.) objects are observed at their initial location prior to any movement, and 3.) distance measurements are accurate. A second observer was present during surveys to help keep track of birds that were flushed and avoid doubling counting. We walked three line transects measuring ca. 4.5 km each for distance sampling: the intertidal zone transect (shoreline of the Cayo), the mudflats transect, which paralleled the Cayo ca. 100 m from shore, and the upland transect, which ranged 250-400 m from shore along the loma. A second observer and myself walked transects at a moderate pace (ca. 2 km/hr) and for each visual confirmation of Seaside Sparrows recorded distance to the initial position of each individual or small group using a rangefinder, number of birds per cluster, and the angle from my transect to the observed individual(s) in order to calculate the perpendicular distance from the transect line to the cluster. Because sex is difficult to determine without capture, sex ratios were not investigated in this study. I surveyed each transect three times during each season, with surveys beginning at 7:30 am and ending no later than 11:30 am. I alternated starting points to mitigate potential temporal bias in detection. Detection probability was calculated using the equation:

$$P_a = \int_0^w g(x)\, dx/w$$

where the detection function, g(x), is the probability of detecting an object at distance x (dx) from the line and *w* is the maximum width of which objects were detected (Buckland et al. 2001). The mean number of objects detected, E(*n*), within the area surveyed, 2*w*L (L is the length of the transect), is multiplied by the detection probability so that density, D, is equal to:

$$D = E(n) / 2wL * P_a$$

Sparrows during this study were detected in small groups so that the object of interest was not the individual but rather the group, or cluster, thus E(*n*) is the mean number of clusters. The above equation was then multiplied by mean cluster size, E(*s*):

$$D = E(s)*E(n) / 2wL * P_a$$

I used program DISTANCE, version 5.0 (Thomas et al. 2005), to select an appropriate detection function. A basic concept of distance sampling is the probability of detection for an object decreases as distance of the object from the line increases. Obtaining a detection function that fits the distribution of the dataset is critical for estimating the detection probability. Cluster size was estimated using the default size-bias regression settings. It is recommended that to find a detection function that best fits the dataset a series of models be tested (Buckland et al. 2001). I tested hazard-rate and half-normal key functions with a combination of series expansions (i.e. simple polynomial, hermite polynomial, and cosine) with two adjustment terms. The following models were tested: hazard-rate simple polynomial, hazard-rate cosine, hazard-rate hermite polynomial, half-normal simple polynomial, and half-normal cosine. Detection functions were strictly constrained for monotonicity. No distance measurements were truncated as I did not appear to have any outliers in my dataset.

In addition to density estimates of the Seaside Sparrow, other similar Passeriforms were counted to investigate what other species might be utilizing this habitat and possible competition for the Seaside Sparrow. No distance data was recorded for other species as this was beyond the scope of my study.

Habitat Measurements

To investigate fine scale habitat associations of the Seaside Sparrow, I measured habitat parameters (percent ground cover, height, and species composition) using a 20x50 cm frame placed on the ground at 75 m intervals along the length of each transect (n = 60 plots). Percent ground cover for each plant species inside the frame was recorded with one of the following discrete cover category ranges: 1 = >0 – 5%, 2 = 6 – 25%, 3 = 26 – 50%, 4 = 51 – 75%, 5 = 76 – 95%, 6 = 96 – 100% (Daubenmire 1959). Midpoints for each category were later used to calculate mean percent ground cover for each species per transect. I measured maximum plant height inside each frame and averaged them together for mean plant height. To characterize plant community composition and to assess differences in community composition among transects, or habitat types, I used canonical correspondence analysis (CCA), an extension of canonical analysis (CA) that includes explanatory variables. For this study I was interested in determining if plant community composition differed by transect. I chose CCA, a unimodal model, over linear redundancy analysis (RDA) because gradient lengths were long (>4; Lepš and Šmilauer 2003). I used a Monte Carlo permutation test to determine if plant community composition was associated with transect.

Because plant community composition might differ by season, I initially tested season as a predictor of plant community composition using the two sampling periods (i.e., summer and fall) in which I collected plant data on all 3 transects. For this analysis I included transect as a covariate and randomized data within, but not among, transects. I determined *a priori* that if the permutation test indicated community composition did not differ by season I would combine data from all 4 sampling seasons and include transect as the predictor of plant community composition. I summarized the associations between plant species and transect graphically using a species-environment biplot (Lepš and Šmilauer 2003). I conducted all multivariate analyses using the program CANOCO (version 4.5).

CHAPTER IV

RESULTS

I detected Seaside Sparrows only along the intertidal zone transect during all four seasons. Table 1 summarizes all sampling efforts for each season with number of observations, total number of Seaside Sparrows detected, and cluster size (number of individuals per observation) for each replicate. Cluster size ranged from 1-10 with the highest mean cluster size, number of observations, and total number of Seaside Sparrows recorded during the summer sampling period. I recorded the fewest observations, total number of Seaside Sparrows and smallest mean cluster size during the winter sampling period.

Density Estimates

Using the Akaike Information Criterion corrected for small sample size (AICc) to select the best detection probability model for each sampling period (Table 2 and Figure 3), I estimated density of individuals per hectare and mean cluster size for spring, summer, fall, and winter. All models were selected based on lowest AICc scores, with the exception for the summer sampling period where the highest Kolmogrov-Smirnov p was used to select the best fit model because AICc scores were not substantially different for competing models.

I estimated population densities for each season and a pooled estimate across all four seasons. A detection probability (p) of 0.34 (CV = 7.43, 95% CI = 0.29 - 0.39) was calculated during spring with a mean cluster size of 1.4 (CV = 4.27, 95% CI = 1.33 - 1.57). Summer had the highest *p* of 0.47 (CV = 6.97, 95% CI = 0.41 - 0.54) and the highest mean cluster size of 1.9 (CV = 4.97, 95% CI = 1.70 - 2.07). Fall had a *p* of 0.26 (CV = 6.75, 95% CI = 0.22 - 0.29) with a mean cluster size of 1.6 (CV = 6.83, 95% CI = 1.35 - 1.61). Winter had the lowest *p* of 0.25 (CV = 7.43, 95% CI = 0.21 - 0.29) and the lowest mean cluster size at 1.4 (CV = 5.37, 95% CI = 1.14 - 1.41). Seasonal densities ranged from 1.91 individuals/ha to 4.07 individuals/ha (Table 3.) with a mean density over all seasons of 3.26 individuals/ha (CV = 7.01, 95% CI = 2.79 - 3.81). Confidence intervals for seasonal density estimates overlapped, indicating there was no significant difference in density among seasons.

Ten additional passerine species were detected throughout all surveys with April and January having the highest species richness (Table 4). July had the lowest species richness with only Red-winged Blackbirds (*Agelaius phoeniceus*) observed along the intertidal zone transect.

Habitat Measurements

Habitat parameters and plant composition of the plant communities differed significantly between the intertidal zone, mudflats, and upland transects ($P > 0.01$; Figure 4). Community composition did not differ by season ($P = 0.29$). I identified 11 plant species along the intertidal zone transect, with a mean vegetation height of 0.42 m (SD = 0.19 m). The dominant plant species with their respective percent coverage for the intertidal zone were 35.8% saltwort (*Batis maritima*), 26.7% saltgrass (*Distichlis spicata*), and 19.5% sea oxeye daisy (*Borrichia frutescens*). Bare substrate (sand, mud) was also a substantial component, covering 5.2% of the area. Seaside Sparrows were seen perching primarily on sea oxeye daisy and saltwort stems. I observed them foraging in areas where bare ground was visible below bunches of saltgrass, saltwort, and sea oxeye daisy. I did not observe Seaside Sparrows in areas where saltwort and sea oxeye were not dominant. I identified seven plant species along the mudflats transect, with a mean height of 0.15 m (SD = 0.11 m). Percent cover of dominant plant species in this habitat were 12% saltwort, 6.9% shoregrass (*Monanthochloe littorales*), 4.4% sea purslane (*Sesuvium portulacastrum*), and 3.5% glasswort (*Sarcocornia utahensis*). Bare substrate covered 60.2% of the area. I identified 45 plant species along the upland transect, with a mean height of 0.7 m (SD = 0.31 m). Coverage by dominant plant species for this upland habitat was 28% gulf cordgrass (*Spartina spartinae*), 14.5% bufflegrass (*Pennisetum ciliare*), 13.5% big sacaton (*Sporobolus airoides*), 3.0% screwbean mesquite (*Prosopis pubescens*), 2.3% sea oxeye daisy, 1.8% shoregrass, and 1.7% leatherleaf (*Maytenus phyllanthoides*), with bare substrate covering 12.2%. Appendix 1 provides a complete list of all plants found with percent ground cover.

Table 1. Summary table for all Seaside Sparrow surveys at Laguna Atascosa NWR. Distance sampling for each season was surveyed three times. # Obs. = total number of observations; Total No. Birds = total number of birds; Mean Cluster Size refers to the mean number of individuals per observation.

	Survey	# Obs.	Total No. Birds	Mean Cluster Size
April	1	52	79	1.5
	2	53	76	1.4
	3	53	74	1.4
	Mean	**52.7**	**76.3**	**1.4**
July	1	47	92	2.0
	2	60	118	2.0
	3	82	145	1.8
	Mean	**63**	**118.3**	**1.9**
October	1	52	71	1.4
	2	45	69	1.5
	3	44	82	1.7
	Mean	**47**	**74**	**1.5**
January	1	28	41	1.5
	2	62	48	1.5
	3	15	16	1.1
	Mean	**35**	**35**	**1.4**

Table 2. Model selection table reporting Akaike information criterion corrected for small sample size (AICc) for distance sampling of the Seaside Sparrow. All models were tested for each season. Δ = delta, ω = AICc weight, k = number of parameters.

	Model	AICc	Δ	ω	k
Spring	Hazard-rate simple polynomial	1142.92		0.398	2
	Hazard-rate cosine	1144.18	1.26	0.212	2
	Hazard-rate hermite polynomial	1143.74	0.82	0.264	2
	Half-normal simple polynomial	1146.69	3.77	0.060	2
	Half-normal cosine	1146.57	3.65	0.064	2
Summer	Hazard-rate simple polynomial	1497.10	0.08	0.203	2
	Hazard-rate cosine	1497.14	0.12	0.199	2
	Hazard-rate hermite polynomial	1497.14	0.12	0.199	2
	Half-normal simple polynomial	1497.02		0.212	2
	Half-normal cosine	1497.28	0.26	0.186	2
Fall	Hazard-rate simple polynomial	998.21	1.33	0.183	2
	Hazard-rate cosine	999.10	2.22	0.117	2
	Hazard-rate hermite polynomial	998.11	1.23	0.193	2
	Half-normal simple polynomial	998.63	1.75	0.148	2
	Half-normal cosine	996.88		0.357	2
Winter	Hazard-rate simple polynomial	507.36	1.01	0.174	2
	Hazard-rate cosine	507.75	1.4	0.143	2
	Hazard-rate hermite polynomial	507.43	1.08	0.168	2
	Half-normal simple polynomial	506.83	0.48	0.226	2
	Half-normal cosine	506.35		0.288	2

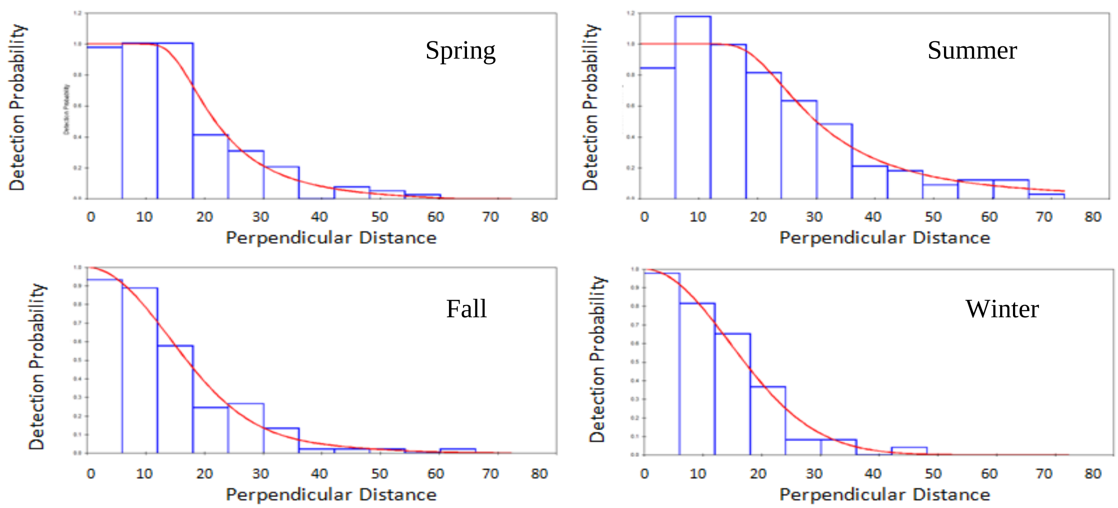

Figure 3. Detection functions fitted to the perpendicular distances of Seaside Sparrow (*Ammodramus maritimus*) observations to the line transect during each season from April 2012-January 2013 at Laguna Atascosa National Wildlife Refuge, Cameron County, Texas.

Table 3. Seaside Sparrow density estimates for each season at Laguna Atascosa NWR using program Distance. #Obs = total number of observations, ESW = effective strip width (m), D = estimated number per hectare, CV = coefficient of variation, 95% CI = upper and lower confidence intervals, K-S ρ = Kolmogrov-Smirnov goodness-of-fit p-value.

Season	Model Selected	# Obs	ESW	D	CV	95% CI		K-S ρ
Spring	Hazard-rate polynomial	158	24.5	3.49	8.27	2.97	4.1	0.670
Summer	Hazard-rate hermite[a]	189	34.3	3.59	18.16	2.05	6.27	0.927
Fall	Half-normal cosine	141	18.8	4.07	9.69	3.33	4.9	0.642
Winter	Half-normal cosine	74	18.1	1.91	21.92	0.95	3.93	0.872

[a] The Hazard-rate hermite model was selected for summer based on the K-S ρ-value because competing model AICc weights did not differ substantially.

Table 4. Other passerine species detected along the intertidal zone transect. I tallied all individuals that were detected each day during sampling events and used the highest count for each month.

Common name	Species	April	July	October	January
Common Yellow Throat	*Geothylpis trichas*	11	0	12	17
Dickcissel	*Spiza Americana*	3	0	0	0
Eastern Meadowlark	*Sturnella magna*	0	0	6	9
Eastern Phoebe	*Sayomis phoebe*	0	0	0	1
Horned Lark	*Eremophila alpestris*	1	0	0	0
Marsh Wren	*Cistothorus palustris*	8	0	19	19
Red-winged Blackbird	*Agelaius phoeniceus*	35	30	0	0
Savannah Sparrow	*Passerculus sandwichensis*	47	0	5	38
Sedge Wren	*Cistothorus platensis*	0	0	0	3
Swamp Sparrow	*Melospiza georgiana*	1	0	3	17

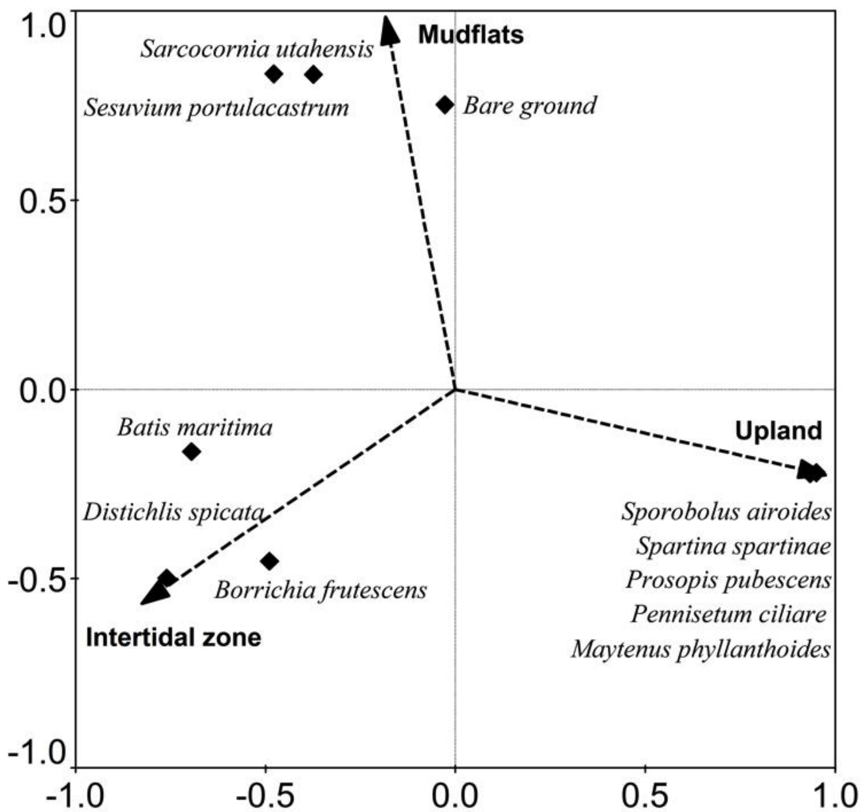

Figure 4. Species-environment biplot from a Canonical Correspondence Analysis (CCA) used to assess vegetation-habitat associations at Laguna Atascosa NWR, Cameron County, Texas. Intertidal zone was closest to the shore at 30 meters, mudflats transect was ca. 100 m from the shore, and the upland transect was on a loma 250-400 m from the shore. The CCA indicated strong differences in vegetation composition among habitat types (P = 0.001). Of the 50 species, only the 11 with the highest model fit were included in the figure.

CHAPTER V

DISCUSSION

Seaside Sparrows have been documented breeding along the Texas Gulf Coast only as far south as Copano Bay (Rising 2005). I provide evidence of a breeding population at Laguna Atascosa NWR, nearly 200 km south of Copano Bay. Further, I documented that Seaside Sparrows are year round residents on Laguna Atascosa NWR, with little density variation among seasons. Cluster size during the summer had the widest variation with the largest cluster of 10 individuals. The large cluster of sparrows were primarily juveniles that were likely beginning to disperse and not territorial. The widest part of the intertidal zone area where sparrows were present measured 120 m, but on average was approximately 50 m wide. The furthest distance for my detection function was 70 m, thus detection of sparrows would be lower in areas that were less than 70 m resulting in possible underestimates. Mean breeding density estimate on Laguna Atascosa NWR was 3.54 individuals/ha, larger than Whitbeck's (2002) estimates of 1.86 individuals/ha further north along the Texas Gulf Coast but lower than Gabrey and Afton's (2000) estimates of 11.9 males/ha along the Gulf Coast Chenier Plain of Louisiana. Because of monogamous behavior of these sparrows (Pos and Greenlaw 1994) one singing male can be assumed to represent a mated pair. Therefore, I can compare my results with previous studies by doubling male/ha or pair/ha estimates to obtain individual based densities. Because I counted all Seaside Sparrows during my surveys and was only able to distinguish males based on singing activity it would be inappropriate to divide my estimates in half for comparison with previous studies. Gabrey and Afton's estimates can then be interpreted as 23.8 individuals/ha. Marshes of the two latter studies were dominated by smooth cordgrass (*S. alterniflora*), saltmeadow cordgrass (*S. patens*), and saltgrass, of these only saltgrass was present in my study area and a dominant species as well. Densities along the northeastern coast were larger than my estimates with 9.8 males/ha (equivalent 19.6 individuals/ha) on Long Island (Greenlaw 1983), 5.5 males/ha (equivalent 11 individuals/ha) on Rhode Island (DeRagon 1988), and as high as 24 pairs/ha (equivalent 48 individuals/ha) in southern New York (Post 1974). Although density estimates vary widely throughout the range of the species, Seaside Sparrows have been shown to have higher densities in habitat that has been unaltered by dredging or impoundments (Post 1974). It is possible the human activity along the coast is responsible for the wide range in density estimates previously reported.

There were no major flooding events during my study and active nests were found during mid July indicating pairs may be able to successfully produce multiple broods. Double, triple, and rarely quadruple brooding has been reported for the Seaside Sparrow after nest failures (Marshall and Reinert 1990, Post 1974). Currently the only information available on reproductive timing of the Seaside Sparrow along the Texas Gulf Coast are nests found in early May by Phillips and Einem (2003) in the Rio Grande delta. The earliest record of egg laying is in the Florida Everglades during late February

(Werner and Woolfenden 1983). Replacement rates of a population in New York were averaged over two years at 2.72 (Post et al. 1983) indicating the population would increase over time. Further investigations should be made concerning Seaside Sparrow breeding ecology in Texas.

It is difficult to visually differentiate males from females and I considered two adults present as bonded pairs because of male territorial behavior. I observed agonistic behavior between males during the spring, summer, and fall months, indicating males may be territorial with regard to foraging areas or potential nest sites. However, in general, individuals seemed to live in relatively close proximity to each other. Marshall and Reinert (1990) estimated isolated territories in Massachusetts at 4730 m^2 while aggregated territories were smaller at 1814 m^2. Territory sizes have also been shown to differ depending on bird activity. For example, Post (1974) estimated singing activity space at 484 m^2 and foraging activity space much higher at 1,039 m^2 for group territories of Seaside Sparrows. Because the habitat on my study area is narrow, territories appeared to be grouped close together and may better fit the description of Post (1974), who estimated Seaside Sparrows defended a mean activity space of 393 m^2.

I found three active Seaside Sparrow nests in my study area, providing further evidence that this is a breeding population. Additional observers witnessed adults visiting these nests, confirming they belonged to Seaside Sparrows. Two of the nests were located 30-40 m from the shore, and a third 70-80 m from the shore. All three nests were built in sea oxeye daisy and saltwort vegetation stands, approximately 0.4 m high.

Potential predators of the Seaside Sparrow include the Short-eared Owl (*Asio flammeus*), Brown-headed Cowbird (*Molothrus ater*) and red imported fire ants

(*Solenopsis invicta*). During two of the three surveys in January a Short-eared Owl was flushed at the same location. An abandoned Red-winged Blackbird nest with three eggs (one Red-winged Blackbird and two Cowbird eggs) was located in July along the intertidal zone. Fire ants were also found in the nest; it was not clear whether the nest

Figure 5. Seaside Sparrow nest with four nestlings in sea oxeye daisy and saltwort vegetation stand. Top nest height was 49 cm, nest diameter was 9 cm, cup diameter was 5 cm, cup depth was 7 cm, and distance from water was 32 m. Substrate height was 67 cm.

had been abandoned as a result of Cowbird parasitism, fire ant invasion, or both. The plant community along the intertidal zone, dominated by saltwort, saltgrass and sea oxeye daisy, provided Seaside Sparrows with nesting structure and material, sufficient ground cover, and food and foraging space along the ground between stems. Previous studies found cordgrass (*Spartina* spp.) to be a dominant plant species in Seaside Sparrow habitat and positively correlated with nest success (Gabrey and Afton 2000, Leenhouts and Baker 1982, Marshall and Reinert 1990, Reinert and Mello 1995, Pepper and Shriver 2010, Kern et al. 2012). However, no cordgrass was found where I detected Seaside Sparrows and I saw no Seaside Sparrows along the upland transect where Gulf Coast cordgrass (*S. spartinae*) was a dominant plant species. This habitat was located on a raised hill 250-400 m from the shore with significantly different plant species composition and higher plant diversity than other habitats surveyed. Although this habitat appeared to be structurally suitable (tall bunch grasses with a high percentage of ground cover), Seaside Sparrows did not utilize this habitat. This area was not regularly influenced by tidal fluctuations because of the distance from the Cayo and higher elevation and thus may not provide a suitable food source for the Seaside Sparrow. Optimal habitat for this sparrow consists of adjacent nesting and foraging sites (Post and Greenlaw 1994). Post (1974) reported males in high density populations spend 95% of their time within a mean area of 802 m^2, indicating nesting and foraging activities were in close proximity. Further research should be conducted to investigate the food habits of this population and assess differences in food availability for habitat types.

Saltwort had the highest percent ground cover along the intertidal zone in my study area at 35.8%, but has not been documented in Seaside Sparrow habitat north of Texas. Bartosik (2011) documented Seaside Sparrows feeding on leaf tips and fruits of saltwort near Freeport, Texas. Phillips and Einem (2003) also observed Seaside Sparrows in cordgrass marshes with prominent saltwort ground cover near the Rio Grande in Brownsville, Texas. Saltgrass had 26.7% ground cover, the second highest ground cover in my study area. Previous studies indicated saltgrass is a dominant plant species in cordgrass marshes along the northern range of Seaside Sparrows in Connecticut, Deleware, and New York (Post 1974, Benoit and Askins 2002, Gjerdrum et al. 2005, Pepper and Shriver 2010), as well as their Gulf Coast range in Texas (Whitbeck 2002, Phillips and Einem 2003). Sea oxeye daisy was the third dominant plant species at 19.5% cover. Leenhouts and Baker (1982) was the only other study to document sea oxeye daisy within Seaside Sparrow habitat for the now extinct Dusky Seaside Sparrow. Sea oxeye daisy was not a dominant species and was encountered only once during their study.

Seaside Sparrow populations are vulnerable to human activity, primarily dredging flooding, or any activity that alters natural tide fluctuations within coastal marsh habitat. Coastal wetlands are especially vulnerable to human development and natural disturbances. Turner (1990) estimated the annual loss of coastal wetlands in the northern region of the Gulf of Mexico at 288,414 ha/yr. Causal agents for this decline may include sea level rise, man-made water control structures, and river diversions that alter hydrology and plant communities. Additionally, wetlands along the southeastern coast between 1950 and 1970 decreased by 7% and only 46% of coastal wetlands in the United States remain (Tiner 1984, Hefner 1985).

The Seaside Sparrow is vulnerable to coastal wetland disturbances because of its narrow habitat requirements and dependence on natural tidal activity. The endangered Cape Sable Seaside Sparrow population is located within the Everglades National Park, Florida, and has been in decline since 1992 (Pimm et al. 1996). It has been suggested that water management practices, such as drainages and canals, have altered the plant communities, negatively influencing Seaside Sparrows populations (Curnutt et al. 1998). Nest success also declined as a result of altering natural drainages and seasonal water

A B

Figure 6. Visual comparison of Seaside Sparrows located in a typical smooth cordgrass dominated wetland in Florida (A) [photograph courtesy of Everglades National Park, Florida photo gallery] and a wetland dominated by saltwort and sea oxeye daisy at Laguna Atascosa NWR (B).

movements (Jenkins et al. 2003). The Dusky Seaside Sparrow has been extinct since 1977 as a result of salt marsh flooding and insecticide spraying on Merritt Island, Florida, in an attempt to control mosquito populations (Sykes 1980, Trost 1968).

Additional pressure was added to this population when a railroad causeway was built in 1963 north of Merritt Island creating further impoundments and a decrease in those plants that could not tolerate flooding. Declines of both the Cape Sable and Dusky Seaside Sparrow populations are a direct result of human activities that have changed natural water movements. Freshwater inflow is essential for maintaining salinity levels in coastal bays and estuaries (USFWS 2010). In 2009 the Whooping Crane wintering population at Aransas National Wildlife Refuge experienced a 20% decrease that was attributed to overuse of the Guadalupe and San Antonio Rivers by humans (Whooping Crane Conservation Association 2010). This decrease in freshwater inflow altered salinity causing a change in food availability for the cranes.

The Cayo Atascoso consists of freshwater from the Arroyo Colorado and water from the hypersaline Laguna Madre. Because the population of Seaside Sparrows on Laguna Atascosa NWR is dependent on tidal activity and salinity of the Cayo, development and water usage by landowners and cities along the Arroyo Colorado may alter freshwater inflow to the Cayo and might result in loss of this population.

CHAPTER VI

MANAGEMENT IMPLICATIONS

The Seaside Sparrow is restricted to brackish tidal wetlands and, throughout much of its range, appears to be restricted to habitats dominated by cordgrasses (TNC, 1998). Current management strategies for this species include maintaining stable populations by monitoring coastal habitat. The Nature Conservancy (TNC) has created a wetland management plan for the Seaside Sparrow aimed at restoring low marshes with medium height smooth cordgrass (*S. alterniflora*) for optimal conditions to support populations. Additionally, the Gulf Coast Joint Venture (GCJV) has made efforts to restore and conserve wetlands with smooth cordgrass for this species and control potential predators (primarily rodents).

My study provides evidence of a population of Seaside Sparrows utilizing areas with significantly different plant composition. Habitat associations should be revised to include tidal wetlands dominated by saltwort, saltgrass, and sea oxeye daisy. The Seaside Sparrow population on the Laguna Atascosa NWR is dependent on the Cayo Atascoso water levels and activity as it influences the plant and invertebrate community along the shore. The primarily freshwater Arroyo Colorado, a watershed with headwaters near

Mission, Texas, drains into the hypersaline Laguna Madre and the Cayo Atascoso providing the Cayo with brackish water. The Arroyo Colorado is primarily used for commercial boating, fishing, and agriculture making the Seaside Sparrow vulnerable to human activity. High amounts of DDE and other pesticides were detected in fish samples near Mission,Texas from 1968-1979 and by 1983 had not been shown to have significantly decreased (White et al. 1983). Additionally, White et al. (1983) found elevated amounts of DDE in piscivorous bird species near the mouth of the Arroyo Colorado. It is possible that chemicals in the Arroyo may contaminate the Cayo and become toxic to this population of Seaside Sparrows. Approximately 330,000 acres of land within the Arroyo Colorado watershed are used for agricultural purposes (The Arroyo Colorado Watershed Partnership); poor water management and the development of freshwater drainages may alter the flow of freshwater into the Cayo Atascoso changing the plant community and food availability. These changes in water levels and salinity content could have greater impacts on Seaside Sparrow populations along the Cayo.

APPENDIX A

Plant species found and their percent cover on three transects, intertidal zone, mudflats, and upland, on the Laguna Atascosa NWR

	Common Name	Species	Percent Cover
Intertidal Zone	Saltwort	*Batis maritima*	35.76
	Saltgrass	*Distichlis spicata*	26.68
	Sea oxeye daisy	*Borrichia frutescens*	19.51
	Bare ground		5.23
	Shoregrass	*Monanthochloe littoralis*	2.66
	Glasswort	*Salicornia bigelovii*	2.34
	Cenicilla	*Sesuvium portulacastrum*	1.26
	Flat Sedge	*Cyperus odoratus*	0.46
	Black Mangrove	*Avicennia germinans*	0.4
	Wolfberry	*Lycium carolinianum*	0.13
	Seepweed	*Suaeda linearis*	0.04
Mudflats	Bare ground		60.16
	Saltwort	*Batis maritima*	12.94
	Shoregrass	*Monanthochloe littoralis*	6.94
	Cenicilla	*Sesuvium portulacastrum*	4.39
	Glasswort	*Salicornia bigelovii*	3.5
	Saltgrass	*Distichlis spicata*	1.33
	Sea oxeye daisy	*Borrichia frutescens*	0.82
	Seepweed	*Suaeda linearis*	0.13
Upland	Gulf Cordgrass	*Sparina Spartinae*	28.75
	Buffelgrass	*Pennisetum ciliare*	14.53
	Big Sacaton	*Sporobolus wrightii*	13.55
	Bare ground		12.24
	Screw Bean Mesquite	*Prosopis pubescens*	2.95

Upland cont'd.	Sea oxeye daisy	*Borrichia frutescens*	2.34
	Shoregrass	*Monanthochloe littoralis*	1.79
	Leather leaf	*Chamaedaphne calyculata*	1.7
	Desert Yaupon	*Schaefferia cuneifolia*	1.66
	Fiddlewood	*Citharexylum berlandieri*	1.33
	Coyotillo	*Karwinskia humboldtiana*	1.03
	Glasswort	*Salicornia bigelovii*	0.52
	South Texas Bristlegrass	*Setaria vulpiseta*	0.49
	Colima	*Zanthoxylum fagara*	0.4
	Milkweed vine	*Matelea sagittifolia*	0.38
	Leather stem	*Jatropha dioica*	0.37
	Lacegrass	*Eragrostis capillaris*	0.33
	Vidrillos	*Batis maritima*	0.32
	Saltgrass	*Distichlis spicata*	0.29
	Silver bluestem	*Bothriochloa saccharoides*	0.26
	Yucca	*Yucca glriosa*	0.25
	Prickly pear	*Opuntia engelmannii*	0.23
	Sideoats grama	*Bouteloua curtipendula*	0.22
	Lotebush	*Zizyphus obtusifolia*	0.18
	Cenizo	*Leucophyllum futescens*	0.17
	Seepweed	*Suaeda linearis*	0.17
	Horse Crippler	*Echinocactus texensis*	0.16
	Huisache	*Acasia Farnesiana*	0.16
	Palmers Golden weed	*Neonsomia almeri*	0.16
	Granjeno	*Celtis pallida*	0.13
	Kearnys three awn	*Aristida longespica*	0.13
	Texas Baccharis	*Baccharis neglecta*	0.12
	False ragweed	*Parthenium hysterophorus*	0.11
	Honey mesquite	*Prosopis glandulosa*	0.1
	Pinweed	*Lechea san-sabeana*	0.08
	Peppervine	*Ampelopsis arborea*	0.07
	Texas nightshade	*Solanum triquetrum*	0.07
	Texas Vervain	*Verbena halei*	0.07
	Capmhor Daisy	*Rayjacksonia phyllocuephala*	0.06
	Creeping Ladys sorrel	*oxalis corniculata*	0.04
	Mountain grape	*Vitis sp.*	0.03
	Emorys Milkweed	*Asclepias emoryi*	0.01
	Lantana	*Lantana urticoides*	0.01

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