2007

Potential impact of common reed expansion on threatened high-marsh bird communities on the seaside: wintering bird surveys of selected high-marsh patches

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February 2008

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Recommended Citation:

Paxton, B. J. 2007. Potential Impact of Common Reed Expansion on Threatened High-marsh Bird Communities on the Seaside: Wintering Bird Surveys of Selected High-marsh Patches. Center for Conservation Biology Technical Report Series, CCBTR-07-13. College of William and Mary, Williamsburg, VA. 21pp.

Project Funded By:

Virginia Coastal Zone Management Program
(Department of Environmental Quality)

The Center for Conservation Biology
College of William and Mary

This project was funded in part by the Virginia Coastal Zone Management Program at the Department of Environmental Quality through Grant #NA*06NOS4190241* of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972, as amended. The views expressed herein are those of the authors and do not necessarily reflect the views of the U.S. Department of Commerce, NOAA, or any of its subagencies.

EXECUTIVE SUMMARY

Tidal wetlands are important to coastal ecosystems. They provide flood protection, erosion control and improve water quality. Tidal wetlands also provide essential habitats for numerous species of wildlife, many of which rely on these marsh habitats as a site for breeding and development. Historical wetland surveys indicate that as much as half of the marshes present along the Atlantic and gulf coasts in 1900 have disappeared. While direct human activities are still a leading cause of wetland loss, the structure and functioning of high marsh habitats are currently threatened from invasion of exotic and/or invasive plant species such as the common reed (*Phragmites australis*), and sea level rise due to global climatic change. Disturbance of habitat from dredging, filling, ditching, draining, and clearing, as well as the introduction of more invasive genotypes from the Old World, has enabled *P. australis* to invade habitats where it was once absent.

Stands of *P. australis* are considered poor wildlife habitat and large, monocultures of *P. australis* offer little habitat for birds and support few individuals and low diversity. High-marsh habitats, which provide wintering habitat for several avian species of concern, including Saltmarsh Sharp-tailed Sparrows, Seaside Sparrows, Black Rails, Sedge Wrens, are most at risk from invasive *P. australis*.

Ninety-nine 250-m transects were established within 55 marsh sites on the Delmarva Peninsula of Virginia. Eighty-three transects were established within 45 high-marsh sites and 16 transects were established within lower marsh sites dominated by *Spartina alterniflora*. All high-marsh study sites were established in marsh complexes with at least 5 hectares of high marsh habitat and were selected to include marsh patches along the gradient of *P. australis* invasion and latitudinal position on the peninsula.

A total of 66,000 m of transects were surveyed, resulting in 1,364 detections of 63 species. The most commonly detected species were Yellow-rumped Warblers, Sharp-tailed Sparrow, and American Robins. Four species of high conservation concern; Sharp-tailed Sparrow, Marsh Wrens, Sedge Wrens and Seaside Sparrows, were found in significant numbers within marsh study sites. Sharp-tailed Sparrows, Marsh Wrens, and Sedge Wrens were detected along the entire gradient of the large marsh patches in the northern portion of the Virginia Delmarva Peninsula to the smaller marsh patches in the southern portion of the Virginia Delmarva Peninsula, regardless of *P. australis* presence. However, while these species were detected within *P. australis*, they were most often detected within marsh grass habitats. Detections of Seaside sparrow were restricted mainly to the marsh patches on Parramore Island, and were never detected within *P. australis*.

BACKGROUND

Context

Tidal wetlands are a vital component to coastal ecosystems for a variety of reasons. They provide flood protection by storing and slowing runoff from upstream sources, this storing and slowing of runoff also contributes to erosion control and improves water quality by trapping sediments and pollutants. Tidal wetlands also provide essential habitats for numerous species of wildlife, many of which require these marsh environments as a site for breeding and development. Many of the wildlife species that rely upon these habitats, such as fish, shellfish and waterfowl, are not only critical components to the ecosystem, but are both economically and recreationally important.

Historical wetland surveys indicate that as much as half of the marshes present along the Atlantic and gulf coasts in 1900 have disappeared. Prior to the 1970's, when measures to curb wetland loss were enacted, most marsh losses were attributable to human activities, including dredging, filling, ditching and draining that were rapidly destroying marsh habitats (Dahl, 1990). While direct human activities are still a leading cause of wetland loss, the structure and functioning of high marsh habitats are currently threatened from invasion of exotic and/or invasive plant species such as the common reed (*Phragmites australis*), and sea level rise due to global climatic change.

Phragmites australis is a grass native to the United States that was historically found in wet meadows, riversides, and freshwater marshes. It is increasingly considered an invasive pest due to its rapid spread into habitats where it often quickly dominates native vegetation. Its rapid invasion over the last century has been facilitated by the human activities that were the primary causes of wetland loss. Disturbance of habitat from dredging, filling, ditching, draining, and clearing has enabled *P. australis* to invade habitats where it was once absent. In addition to the disturbance factors, introduction of more invasive genotypes from the Old World have promoted rapid invasion of this species (Marks et al. 1994).

Stands of *P. australis* are considered poor wildlife habitat. Within monocultures of *P. australis* faunal diversity is generally low (Roman et al. 1984). While some bird species utilize the edges of *P. australis* stands for roosting and foraging, the tall, dense growth generally restricts bird use (Benoit and Askins, 1999). Large, monocultures of *Phragmites* are considered poor habitat for birds and support few individuals and low diversity (Meyerson et. al., 2000). Surveys of tidal marshes along the Pamunkey River, VA found the lowest species richness values at points associated with *P. australis* (Paxton and Watts, 2002)

High-marsh habitats are most at risk from invasive *P. australis*. The marsh zone where *P. australis* occurs at the greatest density is the zone of integration between the upland and the irregularly flooded marsh (Fig. 1). The irregularly flooded zone is favored by the short marsh grass species (*Spartina patens, Distichilis spicata*) which provide breeding and wintering habitat for several avian species of concern, including

Saltmarsh Sharp-tailed Sparrows, Seaside Sparrows, Marsh Wrens, Sedge Wrens, Black Rails, and Willets. Encroachment of *P. australis* into the lower portions of the irregularly flooded zone will reduce the amount of available habitat for species adapted to short marsh grasses and has been shown to significantly reduce the densities of these short grass specialists (Benoit and Askins, 1999).

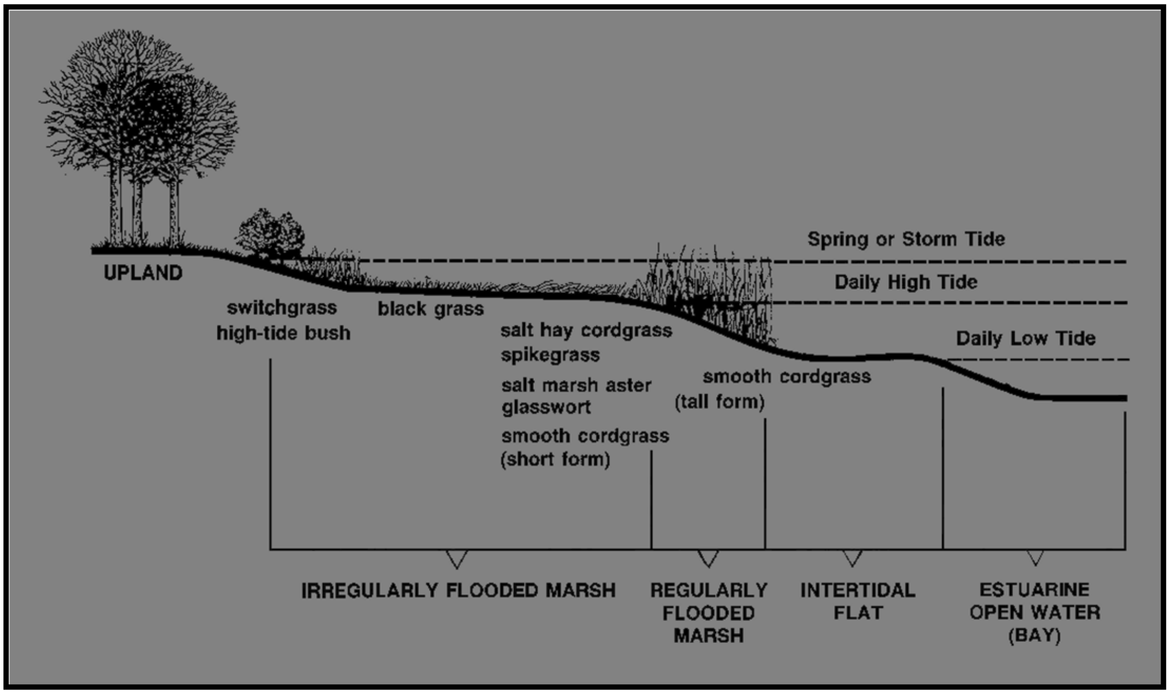

Figure 1. Salt marsh zones, from: Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Fish and Wildlife Service Biological services program. FWS/OBS-79/31

Continued efforts to control the spread of *P. australis*, on the Delmarva Peninsula of Virginia, resulted in a mapping and monitoring project conducted by the Virginia Department of Conservation and Recreation (DCR) – Division of natural heritage in 2004, and an assessment of *Phragmites* Invasion of High Marsh Habitats by The Center for Conservation Biology in 2006. The GIS layers that resulted from these efforts aid in the assessment of the impact of *P. australis* invasion on high marsh bird communities the lower Delmarva seaside.

Objectives

The primary objective of this study is to determine the effect the invasion of *P. australis* into the marsh habitats of the lower Delmarva seaside is having on the high-marsh wintering bird communities. Findings will provide benchmark data on high-marsh bird numbers and distributions to be used in future studies looking at habitat changes within this marsh system. This information will be also prove useful in guiding the *P. australis* removal and control efforts on the Delmarva seaside.

METHODS

Study Area

The area of interest for this study was high-marsh areas of the Lower Delmarva seaside of Virginia, including the lagoon system and barrier islands of Accomack and Northampton Counties. Particular emphasis was given to the eastern edge of the peninsula from just west of Wallops Island south to the tip, and the barrier and lagoon islands of Accomack County. The area of interest was subdivided into four latitudinal classifications (Fig. 2).

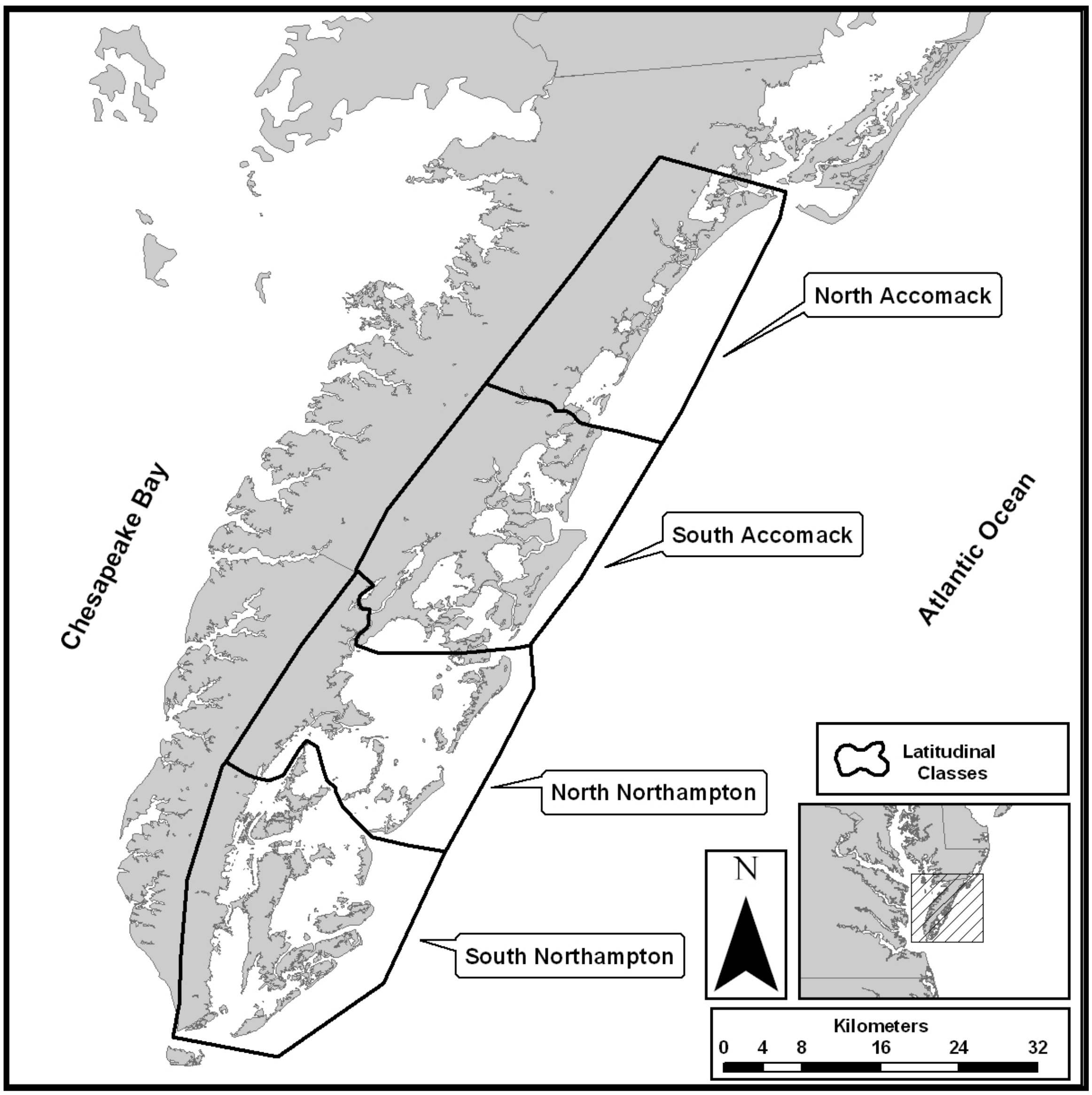

Figure 2. Map of study area of the Lower Delmarva Peninsula showing latitudinal classes.

Surveys

Ninety-nine 250-m transects were established within 55 marsh sites on the Delmarva Peninsula of Virginia (Fig 3). Eighty-three transects were established within 45 high-marsh sites and 16 transects were established within lower marsh sites dominated by *Spartina alterniflora*. All high-marsh study sites were established in marsh complexes with at least 5 hectares of high marsh habitat and were selected to include marsh patches along the gradient of *P. australis* invasion and latitudinal position on the peninsula. (See table 1 for list and description of transects).

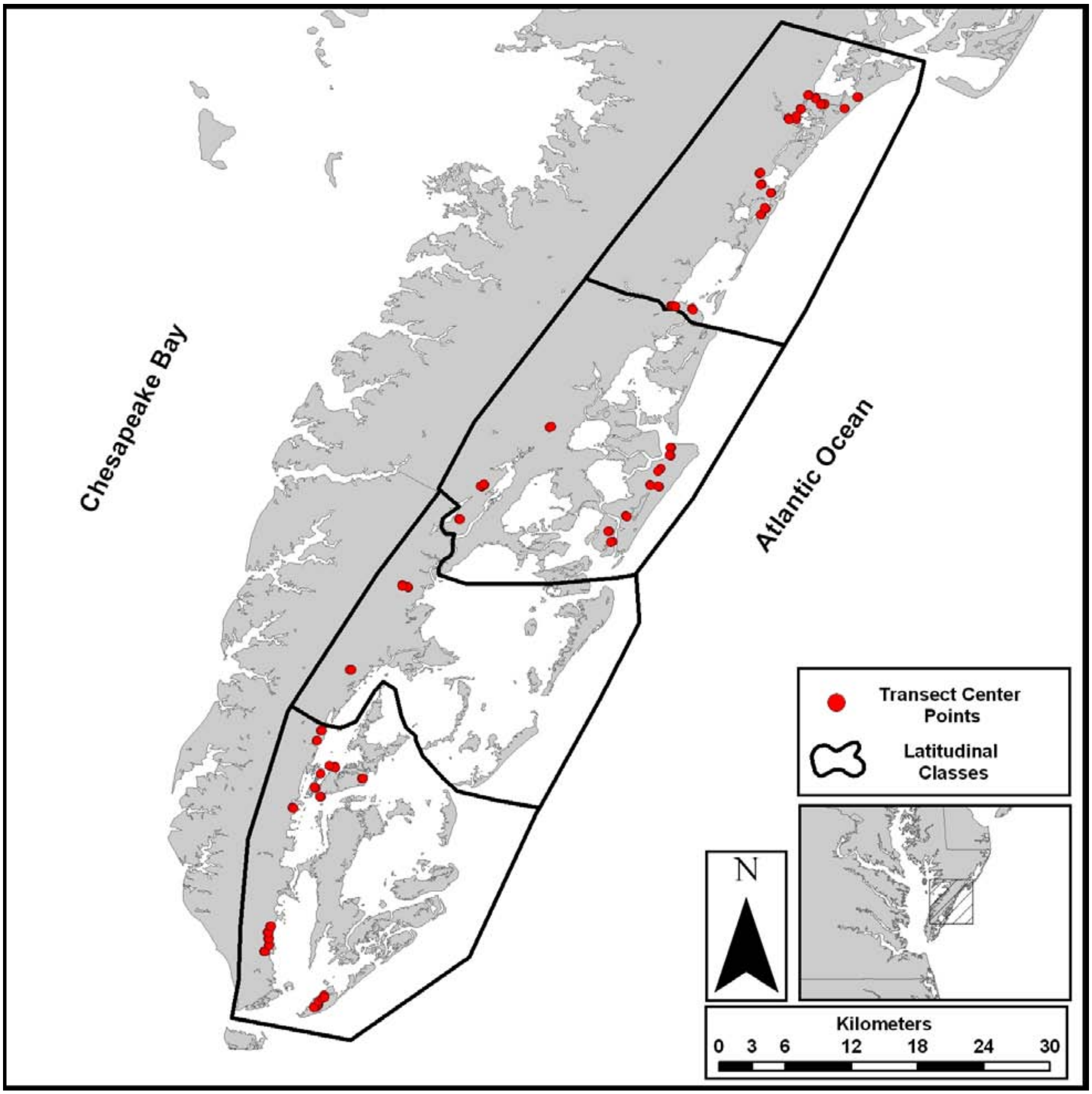

Figure 3. Map showing the center point locations of high-marsh wintering bird transects on the Lower Delmarva Peninsula.

Table 1. High-marsh wintering bird transect names, midpoints, and latitudinal segments (midpoint coordinates are in NAD 1983 State Plane Feet Virginia South).

TRANSECT	MIDPOINT X	MIDPOINT Y	LATITUDINAL SEGMENT	TRANSECT	MIDPOINT X	MIDPOINT Y	LATITUDINAL SEGMENT
ARBN-1-1	12343010	3843951	North Accomack	OYST-2-1	12241680	3648918	South Northampton
ARBN-1-2	12343116	3843596	North Accomack	OYST-2-2	12241868	3648502	South Northampton
ARBN-2-1	12344835	3844655	North Accomack	OYST-3-1	12240383	3649036	South Northampton
ARBN-2-2	12344855	3843711	North Accomack	OYST-4-1	12238489	3646515	South Northampton
ARBN-3-1	12345715	3846958	North Accomack	OYST-5-1	12237420	3642472	South Northampton
ARBN-3-2	12345961	3846787	North Accomack	OYST-5-2	12237197	3642591	South Northampton
ASSO-1-1	12337402	3824248	North Accomack	OYST-6-1	12238749	3639896	South Northampton
ASSO-1-2	12337194	3823967	North Accomack	OYST-6-2	12238453	3639764	South Northampton
ASSO-2-1	12339816	3821699	North Accomack	OYST-7-1	12248544	3645560	South Northampton
ASSO-2-2	12339566	3821739	North Accomack	OYST-7-2	12248232	3645534	South Northampton
BELL-1-1	12274817	3733314	South Accomack	PARR-1-1	12318304	3745581	South Accomack
BELL-1-2	12274666	3733471	South Accomack	PARR-1-2	12318614	3745617	South Accomack
BELL-2-1	12274174	3732715	South Accomack	PARR-2-1	12318510	3743207	South Accomack
BELL-2-2	12273838	3732958	South Accomack	PARR-2-2	12318171	3743359	South Accomack
BELL-3-1	12269103	3722912	South Accomack	PARR-3-1	12316160	3739405	South Accomack
BELL-3-2	12269367	3722845	South Accomack	PARR-3-2	12315566	3738536	South Accomack
BOXT-1-1	12244537	3677658	North Northampton	PARR-4-1	12313872	3734531	South Accomack
BOXT-1-2	12244918	3677699	North Northampton	PARR-4-2	12313919	3734336	South Accomack
BRAX-1-1	12227698	3601118	South Northampton	PARR-5-1	12315765	3734091	South Accomack
BRAX-1-2	12228024	3601078	South Northampton	PARR-5-2	12316067	3734003	South Accomack
BROW-1-1	12257707	3702447	North Northampton	PARR-7-1	12308399	3725024	South Accomack
BROW-1-2	12257517	3702562	North Northampton	PARR-7-2	12308654	3724906	South Accomack
BROW-2-1	12256184	3703090	North Northampton	PARR-8-1	12304617	3720342	South Accomack
BROW-2-2	12256166	3702779	North Northampton	PARR-8-2	12304359	3720375	South Accomack
FOLL-1-1	12317147	3787584	North Accomack	PARR-9-1	12305534	3717382	South Accomack
FOLL-1-2	12317440	3787603	North Accomack	PARR-9-2	12305074	3717165	South Accomack
FOLL-2-1	12317808	3787569	North Accomack	PIGG-1-1	12289631	3750821	South Accomack
FOLL-2-2	12318169	3787425	North Accomack	PIGG-1-2	12289988	3750969	South Accomack
FOLL-3-1	12322012	3786870	North Accomack	SMIT-10-1	12239804	3579263	South Northampton
FOLL-3-2	12322341	3786645	North Accomack	SMIT-1-1	12239823	3578244	South Northampton
GATN-1-1	12227489	3595455	South Northampton	SMIT-11-1	12240588	3580016	South Northampton
GATN-1-2	12227696	3595430	South Northampton	SMIT-12-1	12241238	3580365	South Northampton
GATS-1-1	12226513	3593596	South Northampton	SMIT-13-1	12241077	3581042	South Northampton
GATS-1-2	12226761	3593604	South Northampton	SMIT-2-1	12239742	3577953	South Northampton
HOPE-1-1	12336641	3827496	North Accomack	SMIT-3-1	12239619	3577708	South Northampton
HOPE-1-2	12337056	3827551	North Accomack	SMIT-4-1	12238990	3577572	South Northampton
INDI-1-1	12238110	3659410	South Northampton	SMIT-5-1	12238730	3577273	South Northampton
INDI-1-2	12238399	3659443	South Northampton	WALL-1-1	12347741	3851025	North Accomack
INDI-2-1	12237149	3656444	South Northampton	WALL-1-2	12347464	3850902	North Accomack
INDI-2-2	12237434	3656366	South Northampton	WALL-2-1	12350681	3848408	North Accomack
MAGN-1-1	12227135	3599263	South Northampton	WALL-2-2	12350486	3848249	North Accomack
MAGN-1-2	12227423	3599330	South Northampton	WALL-3-1	12349165	3850091	North Accomack
MAGS-1-1	12227347	3597525	South Northampton	WALL-3-2	12349364	3850303	North Accomack
MAGS-1-2	12227624	3597503	South Northampton	WALL-4-1	12351393	3848533	North Accomack
METO-1-1	12338546	3817164	North Accomack	WALL-4-2	12351229	3848329	North Accomack
METO-1-2	12338278	3817224	North Accomack	WALL-5-1	12356304	3847222	North Accomack
METO-2-1	12337625	3815203	North Accomack	WALL-5-2	12356124	3847325	North Accomack
METO-2-2	12337416	3815262	North Accomack	WALL-6-1	12359297	3850742	North Accomack
OYST-1-1	12232058	3636409	South Northampton	WALL-6-2	12359056	3850791	North Accomack
OYST-1-2	12232314	3636244	South Northampton				

Birds were surveyed between 6 December 2006 and 1 March 2007. To reduce the effects of seasonal bias, censuses were conducted within rounds such that all transects were surveyed before the beginning of the subsequent round. Each transect was surveyed at least twice, with most transect being surveyed three times during the study period. Due to tidal variations and access restrictions on some properties, surveys were not restricted to morning time periods and resulted in some transects only being surveyed twice. All surveys were completed within 0.5 hours after sunrise and 0.5 hours before sunset.

Birds were surveyed along marked transects using a variation of the standard, variable-width transect technique (Emlen 1974). Due to the secretive nature of many of the species being surveyed, we only included birds detected within 25 meters perpendicular to the transect line. A single observer moved along transects at a slow, constant speed and searched for birds within 25 m of the transect line. All individuals encountered were identified to species and recorded. In addition to the species, how the bird was initially detected was also recorded. Detection types included aural, visual, and flushed. Distances between the observer and the birds detected (detection distance) and the distance between the bird and transect (transect distance) were also recorded in order to facilitate density estimation. Because of the inherent difficulties with unreferenced distance estimation, a stratified approach was used. For birds believed to be within 10 m of the observer, distances were estimated to 1-m resolution. For birds believed to be within 10 and 50 m away, distances were estimated to the nearest 5 m. For birds between 10 and 100 m away, distances were estimated to the nearest 10 m, and for birds greater than 100 m away distances were estimated to the nearest 50 m. When birds and time allowed, laser range finders were used to estimate distances more accurately. For analyses, Nelson's Sharp-tailed Sparrows, Saltmarsh Sharp-tailed Sparrows, and Unidentified Sharp-tailed Sparrows were grouped as Sharp-tailed Sparrows, and Marsh Wrens and Sedge Wrens were grouped as *Cistothorus* Wrens

Vegetation Mapping

Vegetation characteristics of each survey area were determined by mapping the actual vegetation, with the aid of laser range finders, on aerial photographs of individual study areas. The resulting vegetation patch map was then digitized using ArcView 3.3, and ArcMap 9.1 to produce a GIS layer of the habitat type present within study area. Digitized transect lines were buffered at 25 meters (effective survey distance) to generate a layer of surveyed area. The surveyed area layer and habitat layer were merged to produce a layer for habitat analyses.

RESULTS

A total of 66,000 m of transects were surveyed, resulting in 1,364 detections of 63 species (Appendix 1). The most commonly detected species were Yellow-rumped Warblers, Sharp-tailed Sparrows (Nelson's Sharp-tailed Sparrows, Saltmarsh Sharp-tailed Sparrows, and Unidentified Sharp-tailed Sparrows), and American Robins, which accounted for 26, 12, and 12 percent of the total detections. Species richness values for individual transects ranged from 0 to 13 (Table 2). The number of birds detected varied by habitat, with the most detections, 60.0% (N=819) coming from the high-marsh shrub and grass habitats. Bird detections from *P. australis* habitat accounted for only 5.5% (N=75) of all detections (Table 3). Several species of high conservation concern; Sharp-tailed Sparrows (Nelson's Sharp-tailed Sparrows, Saltmarsh Sharp-tailed

Sparrows, and Unidentified Sharp-tailed Sparrows), *Cistothorus* Wrens (Marsh Wrens and Sedge Wrens) and Seaside Sparrows, were found in significant numbers within marsh study sites.

Sharp-tailed Sparrows detections numbered 166, from 42 transects. This species was detected along the entire gradient of the marsh patches surveyed, from the large marsh patches in the northern portion of the Virginia Delmarva Peninsula to the smaller marsh patches in the southern portion of the peninsula (Figure 4). The density of Sharp-tailed sparrows was not significantly different between patches with any degree of *P. australis* intrusion and those without (t_{97}=0.65, P>0.50). However, while Sharp-tailed Sparrows were occasionally detected within *P. australis*, they were most often detected within marsh grass habitats. Based available habitat, Sharp-tailed sparrows were detected within the *P. australis* habitat at significantly lower numbers than expected ($\chi^2_7 = 16.46$, $P < 0.05$). Of the 166 Sharp-tailed sparrow detections, only 5.4% (N=9) were using the *P. australis* habitat. All of the remaining detections were from the high-marsh shrub habitat (27.7%, N=46) and the high-marsh grass habitat (66.9%, N=111).

A total of 58 *Cistothorus* Wrens (Marsh Wrens and Sedge Wrens) detections were made on 30 transects. Similar to Sharp-tailed sparrows, *Cistothorus* Wrens were also detected along the entire gradient of the marsh patches surveyed, from the large marsh patches in the north to the smaller marsh patches in the south (Figure 5). Densities of *Cistothorus* Wrens did not vary significantly between high-marsh patches with and without *P. australis* intrusion (t_{97}=0.02, P>0.50). As with Sharp-tailed Sparrows, *Cistothorus* Wrens were most often detected within high-marsh grass and high-marsh shrub habitats. Of the 58 detections, grass and shrub habitats accounted for 62.1% (N=36) and 29.3% (N=17) of detections respectively. Detections within *P. australis* habitat accounted for only 6.9% (N=4) of the total *Cistothorus* Wren detections, however the detection rate of this species within *P. australis* habitat was not significantly lower that expected ($\chi^2_7 = 9.57$, $P > 0.05$).

Seaside sparrow detections numbeedr 20, from 7 transects, and were restricted mainly to the marsh patches on Parramore Island (Figure 6) and were never detected within *P. australis*, or in marsh patches with *P. australis* intrusion. Other species, that are not considered high-marsh birds, were detected within *P. australis* at much higher rates. Detections within *P. australis* habitat, for Song Sparrows, White-throated Sparrows, and Swamp Sparrows, accounted for 43.6% (N=27), 40.0% (N=4), and 25.5% (N=13) of all detections respectively.

DISCUSSION

The high-marsh patches of the Lower Delmarva seaside are important breeding, stopover, and winter habitat for a variety of bird species. Many avian species utilize the high-marsh grass and high-marsh shrub habitat as wintering substrates. Several

Table 2. High-marsh wintering bird transects with species richness values and habitat composition (“other” includes; water, mud, sand and shell).

TRANSECT	% MARSH GRASS	% MARSH SHRUB	% *P. australis*	% Upland	% Other	Richness Value	TRANSECT	% MARSH GRASS	% MARSH SHRUB	% *P. australis*	% Upland	% Other	Richness Value
ARBN-1-1	21	4		75		6	OYST-2-1	100					4
ARBN-1-2	100					3	OYST-2-2	100					3
ARBN-2-1	70	12	12	6	0	4	OYST-3-1	100					2
ARBN-2-2	100					1	OYST-4-1	100				0	3
ARBN-3-1	59	7	32	0	1	3	OYST-5-1	78				22	0
ARBN-3-2	100					2	OYST-5-2	100					2
ASSO-1-1	100					1	OYST-6-1	100					2
ASSO-1-2	100					1	OYST-6-2	100					2
ASSO-2-1	82				18	4	OYST-7-1	100					1
ASSO-2-2	100					1	OYST-7-2	100					2
BELL-1-1	71	26			3	3	PARR-1-1	72	6	10		12	7
BELL-1-2	75	16			10	3	PARR-1-2	86	13	1			4
BELL-2-1		88		10	2	1	PARR-2-1	48	52				10
BELL-2-2	12	69			19	2	PARR-2-2	95	5				6
BELL-3-1	15	46		39		6	PARR-3-1	96	4				7
BELL-3-2	87	0		13		3	PARR-3-2	85	15				6
BOXT-1-1	64	27	1	7	1	6	PARR-4-1	55	45				5
BOXT-1-2	96				4	2	PARR-4-2	95	5				5
BRAX-1-1	76	11		12		2	PARR-5-1	9	91				3
BRAX-1-2	100					3	PARR-5-2	5	95				5
BROW-1-1	89	2	3	3	4	7	PARR-7-1	44	56				5
BROW-1-2	23	8		68	0	5	PARR-7-2	15	85				1
BROW-2-1	49	40		12		7	PARR-8-1	82	8		7	4	4
BROW-2-2	100					2	PARR-8-2	82	18				3
FOLL-1-1	7		34	59		2	PARR-9-1	59	41				5
FOLL-1-2	8			77	14	1	PARR-9-2	0	100				2
FOLL-2-1		85			15	1	PIGG-1-1	60	14		26		3
FOLL-2-2	1	99				1	PIGG-1-2	68	32				4
FOLL-3-1	95				5	9	SMIT-10-1	48	52				4
FOLL-3-2	81	12			6	1	SMIT-1-1	68	32				11
GATN-1-1	24	38	1		37	5	SMIT-11-1	73	11			16	8
GATN-1-2	74				26	1	SMIT-12-1	6	94				6
GATS-1-1	50	14	34	2		0	SMIT-13-1					100	0
GATS-1-2	96	4				0	SMIT-2-1	100					7
HOPE-1-1	55	28	17			2	SMIT-3-1	100					7
HOPE-1-2	95	5				4	SMIT-4-1	100					5
INDI-1-1	35	23	6	36		6	SMIT-5-1	1	99				4
INDI-1-2	100					1	WALL-1-1	9	72	19			5
INDI-2-1	61	39				5	WALL-1-2	57	21	5		17	3
INDI-2-2	100					1	WALL-2-1	71	18	11			7
MAGN-1-1	56	17	8	18	2	1	WALL-2-2	98				2	1
MAGN-1-2	100					2	WALL-3-1	67	17	16			3
MAGS-1-1	53	14		31	2	3	WALL-3-2	51	14	34			1
MAGS-1-2	91			7	2	5	WALL-4-1	59	17	24			2
METO-1-1	100					5	WALL-4-2	62	30	7			1
METO-1-2	100					0	WALL-5-1	81	5	4		10	4
METO-2-1	72	5	8		15	5	WALL-5-2	54	46				2
METO-2-2	93		7			2	WALL-6-1	11	41	30	18		13
OYST-1-1	58	10	32			6	WALL-6-2	96	4				5
OYST-1-2	100					1							

Table 3. Species and numbers of bird detected within different habitat types during winter surveys. ("other" includes; water, mud, sand and shell) (see appendix I for key to species codes).

SPECIES	MARSH GRASS	MARSH SHRUB	*P. australis*	Upland	Other	TOTAL	SPECIES	MARSH GRASS	MARSH SHRUB	*P. australis*	Upland	Other	TOTAL
ABDU	0	0	0	0	97	97	NOFL	1	0	0	0	2	3
AMRO	0	0	0	164	0	164	NOHA	1	1	0	0	1	3
AMWI	0	0	0	0	3	3	NOMO	0	2	0	0	4	6
ATBR	21	0	0	0	0	21	NSHO	0	0	0	0	3	3
BLJA	0	2	0	0	0	2	NSTS	5	17	6	0	0	28
BLVU	0	0	0	0	2	2	PEFA	0	0	0	1	0	1
BTGR	0	0	0	0	1	1	PIWA	0	0	1	0	0	1
BUFF	0	0	0	0	8	8	RBGU	1	0	0	0	0	1
CACH	0	10	1	2	0	13	RBME	0	0	0	0	21	21
CAGO	2	0	0	0	5	7	RBWO	0	1	0	2	2	5
CARW	0	2	0	0	0	2	RCKI	0	4	1	2	0	7
CLRA	5	0	0	0	0	5	RTHA	0	1	0	3	0	4
COHA	0	0	0	1	0	1	RTLO	0	0	0	0	1	1
COYE	0	1	0	0	0	1	RWBL	24	0	8	0	0	32
DCCO	0	0	0	0	1	1	SAVS	8	7	2	0	0	17
DOWO	0	0	0	0	3	3	SESP	2	18	0	0	0	20
DUNL	1	0	0	0	48	49	SEWR	25	16	3	0	1	45
EABL	0	0	0	0	4	4	SOSP	2	31	27	2	0	62
EAME	45	0	0	0	0	45	SSHA	0	1	0	0	0	1
GADW	0	0	0	0	2	2	SSTS	4	0	1	0	0	5
GBHE	2	0	0	0	6	8	STSP	102	29	2	0	0	133
GCKI	0	1	0	1	0	2	SWSP	6	32	13	0	0	51
GRCA	0	1	0	0	0	1	TCHE	0	0	0	0	1	1
GREG	1	0	0	0	0	1	TUVU	0	0	0	2	1	3
GRYE	0	0	0	0	4	4	UIDU	0	0	0	0	1	1
HOME	0	0	0	0	13	13	UIME	0	0	0	0	1	1
IPSP	4	0	0	0	1	5	UISP	5	2	1	0	0	8
MALL	0	0	0	0	9	9	WEKI	0	0	0	0	1	1
MAWR	11	1	1	0	0	13	WISN	10	0	0	0	24	34
MERL	1	0	0	0	0	1	WTSP	0	6	4	0	0	10
MYWA	0	333	2	13	5	353	YSFL	0	2	1	1	0	4
NBD	0	0	0	0	0	0	All Grps	289	530	75	194	276	1364
NOCA	0	9	1	0	0	10							

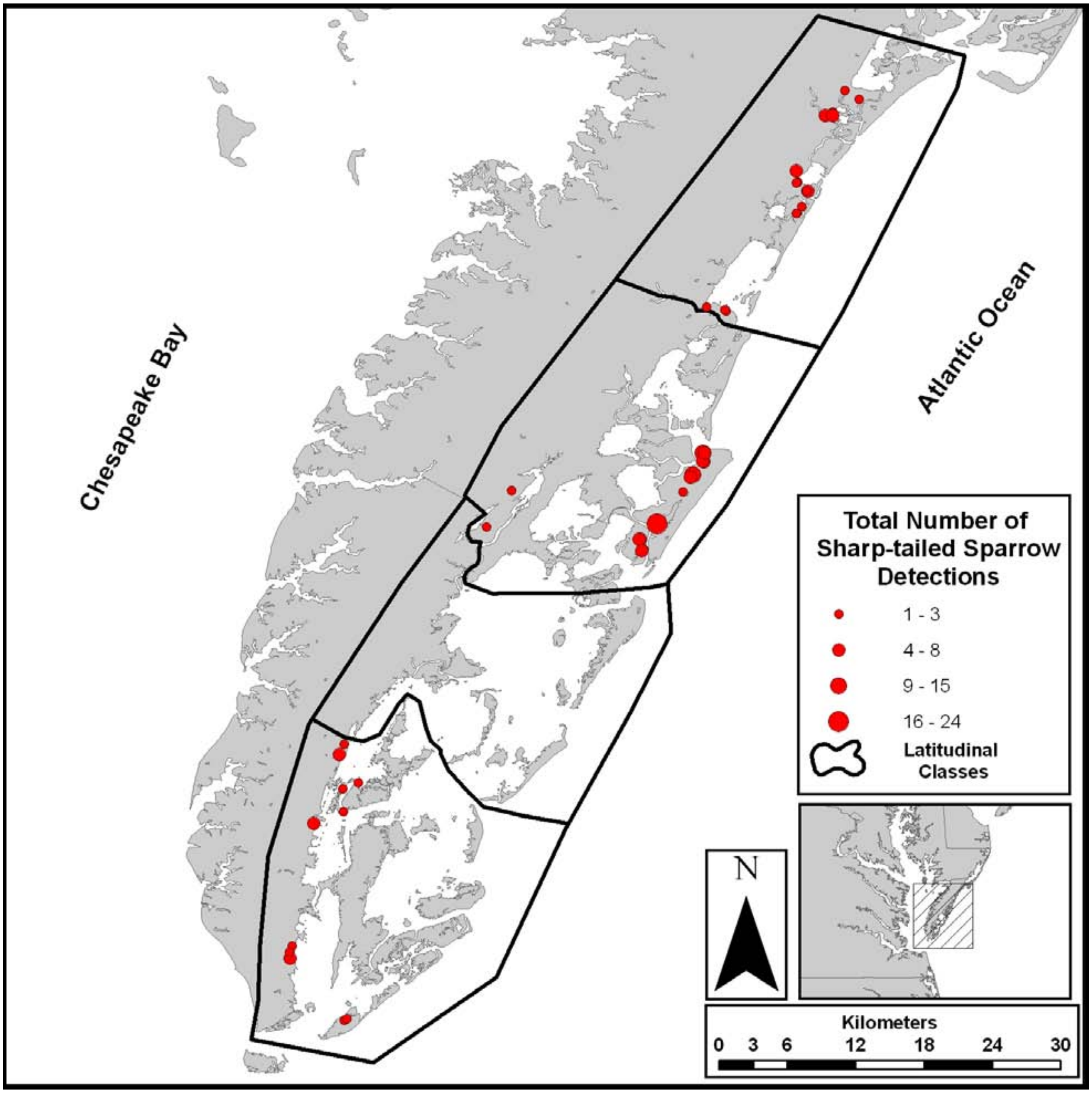

Figure 4. Map showing the location and number of Sharp-tailed Sparrow detections from high-marsh wintering bird transects on the Lower Delmarva Peninsula.

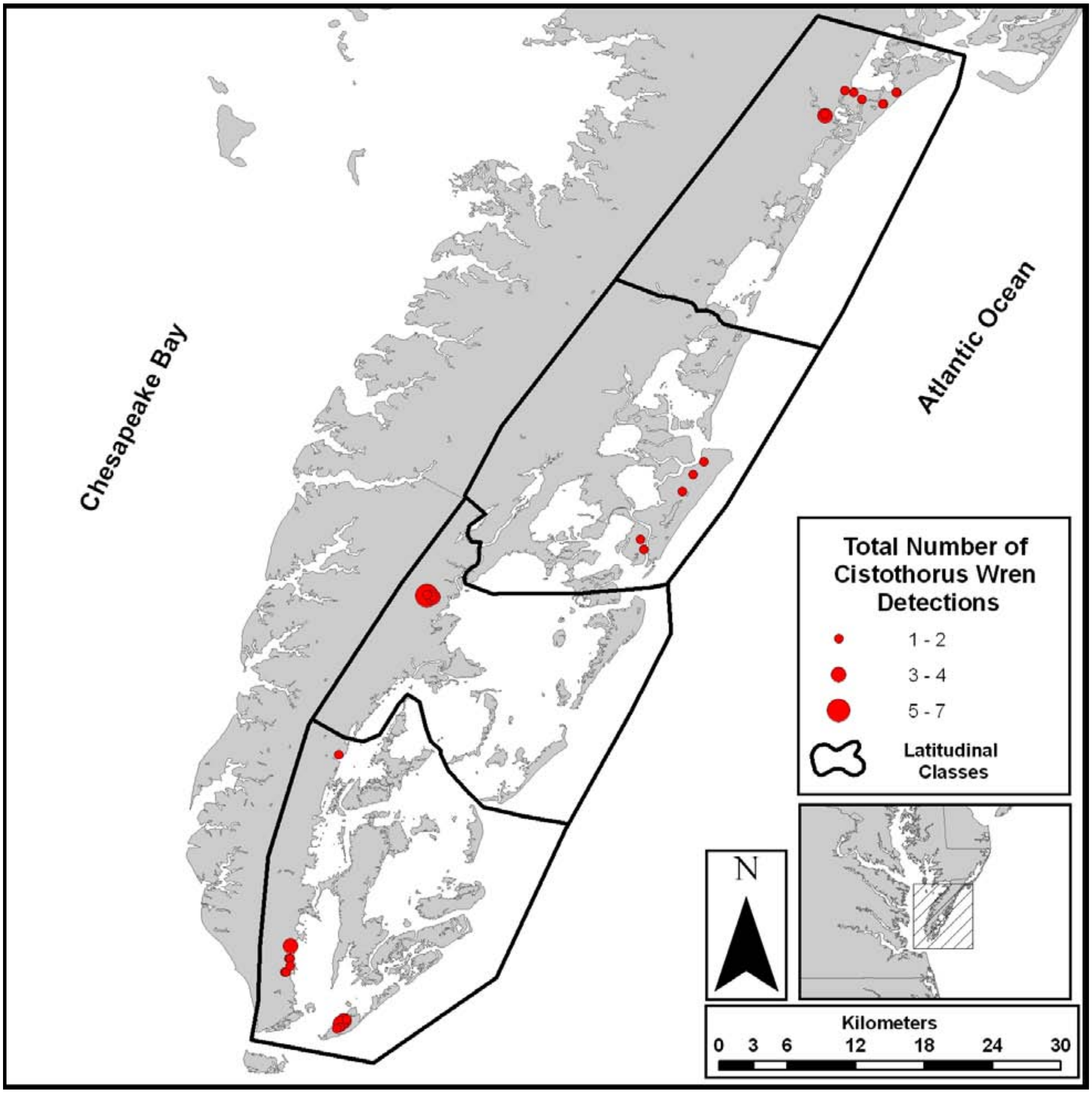

Figure 5. Map showing the location and number of *Cistothorus* Wren detections from high-marsh wintering bird transects on the Lower Delmarva Peninsula.

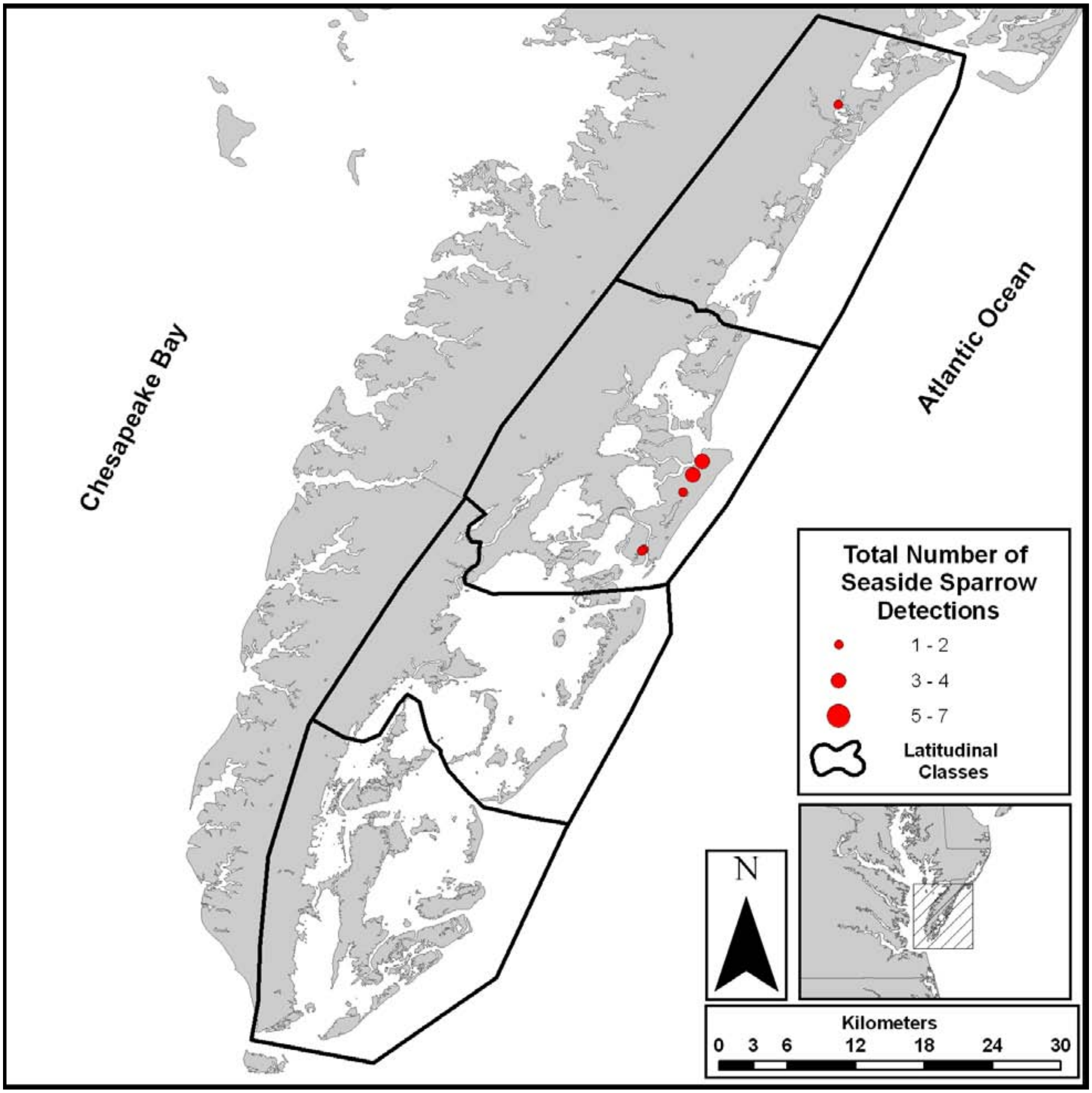

Figure 6. Map showing the location and number of Seaside Sparrow detections from high-marsh wintering bird transects on the Lower Delmarva Peninsula.

species of high conservation concern were found in significant numbers during winter high-marsh surveys.

Sharp-tailed Sparrows, which include Nelson's Sharp-tailed Sparrows and Salt-marsh Sharp-Tailed Sparrows, are two species of conservation concern that use the high-marsh habitats at high rates. The Nelson's Sharp-tailed Sparrow, which breeds north of Virginia but winters in Virginia's high-marsh habitats, has as Partners in Flight (PIF) conservation score of 14 (Rich 2004). The Salt-marsh Sharp-tailed Sparrow uses the high-marsh habitats of Virginia's eastern shore seaside for both wintering and breeding, and was found breeding in high numbers within the large high-marsh patches in the northern portion of the Virginia Delmarva Peninsula (Paxton 2007). The Salt-marsh Sharp-tailed Sparrow has as PIF conservation score of 21, and is recommended for management attention (Rich 2004).

Sharp-tailed Sparrows do not seem to be as restricted by habitat during the winter as this species is during the breeding season. During winter surveys 5.4% of all Sharp-tailed sparrows detections occurred within *P. australis* habitat. This percentage is slightly higher than the 1.1% of Sharp-taileds observed within *P. australis* during the breeding season (Paxton 2007). The slightly higher rate of *P. australis* use, coupled with the use of smaller, more linear, high-marsh patches in the southern portion of the peninsula , suggest that this species is not as habitat selective during the winter.

Cistothorus Wrens, which include Marsh Wrens and Sedge Wrens, were detected at high rates, indicating that the high-marsh habitats surveyed are likely an important wintering area for these species. The Marsh wren possesses a PIF score of 16 and management attention is suggested (Rich 2004). This species was detected at very low numbers, within the same habitats, during the breeding season (Paxton 2007). Based on breeding and wintering surveys in appears that the seaside high-marsh habitats of the Virginia Delmarva Peninsula are used more as wintering area for this species.

Sedge wrens were detected at high rates within high-marsh habitats surveyed suggesting that these are important wintering habitats for this species. The Sedge wren has a PIF conservation score of 17 and recommended for critical recovery in the action plan (Rich 2004).

The Seaside Sparrow, wintered within the high marsh system at much lower levels than were observed during the breeding season (20 detections during the winter compared to 291 during the breeding season). As in the breeding season, this species was never detected in *P. australis* habitat. This species has a PIF conservation score of 18 and suggested action includes planning and responsibility (Rich 2004). The limited numbers of this species that winter within the high-marsh system appears to be as habitat selective during the winter as during the breeding season. All winter detections of this species occurred within relatively *P. australis* free, large high-marsh patches in the northern portion of the study area.

The low number of bird detections within the *P. australis* habitat is not entirely due to the poor avian habitat *P. australis* provides. Transects were established to survey the high-marsh edge, and within many marshes the intrusion of *P. australis* has not encroached well into the high-marsh zone. Thus, on several transects with a *P. australis* component, the actual amount *P. australis* habitat surveyed was limited to a small amount of the larger *P. australis* patch. Some species, especially “edge” species such as Song Sparrows and Swamp Sparrows, were detected within *P. australis* at much higher rates than high-marsh species.

At the present time, the majority of *P. australis* invasion seems to be restricted to the extreme high marsh edge, along the high marsh/upland ecotone, and extending into the upland habitat. The current level of *P. australis* invasion does not restrict the presence of high-marsh avian species. However, the abundance of high-marsh avian species may be reduced if *P. australis* is occupying areas that otherwise would be high-marsh habitat. Based on winter and summer surveys, and the ecology of high-marsh birds, it is recommended to focus *P. australis* control and eradication efforts on large contiguous patches of high marsh, if preserving and reclaiming habitat for high marsh avian species is a goal. Furthermore, control and eradication efforts in the in the northern portion of the peninsula should be given priority. Although *P. australis* invasion is more prevalent within the northern and southern portions of the Lower Delmarva Peninsula, removal and control of *P. australis* within the larger high marsh patches in the northern half of the peninsula would be most beneficial for high marsh avian species, given the habitat requirement of many of these species during the breeding season.

ACKNOWLEDGEMENTS

This project would not have been possible without the efforts of many people. Kevin Heffernan and Rick Meyers of the Virginia Department of Conservation and Recreation – Division of Natural Heritage produced and provide the Phragmites GIS layer. We appreciate Mike Ludwick, Renee Peace, Cheryl Pope, Mark Roberts, and Gloria Sciole for providing important administrative support from the College of William and Mary. Laura McKay of the Coastal Zone Management Program provided administrative oversight. Financial support was provided by the Coastal Zone Management Program. Fletcher Smith and Kristina Baker performed all surveys.

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Appendix I. List of species detected with AOU Alpha code, scientific name, and total number detected.

Common Name	AOU Alpha Code	Scientific Name	Total Number Detected
Canada Goose	CAGO	*Branta canadensis*	7
Atlantic Brant	ATBR	*Branta bernicla*	21
Gadwall	GADW	*Anas strepera*	2
American Wigeon	AMWI	*Anas americana*	3
American Black Duck	ABDU	*Anas rubripes*	97
Mallard	MALL	*Anas platyrhynchos*	9
Northern Shoveler	NSHO	*Anas clypeata*	3
Bufflehead	BUFF	*Bucephala albeola*	8
Hooded Merganser	HOME	*Lophodytes cucullatus*	13
Red-breasted Merganser	RBME	*Mergus serrator*	21
Unidentified Merganser	UIME	*Merganser sp.*	1
Unidentified Duck	UIDU	*Duck sp.*	1
Red-throated Loon	RTLO	*Gavia stellata*	1
Double-crested Cormorant	DCCO	*Phalacrocorax auritus*	1
Great Blue Heron	GBHE	*Ardea herodias*	8
Great Egret	GREG	*Ardea alba*	1
Tricolored Heron	TRHE	*Egretta tricolor*	1
Black Vulture	BLVU	*Coragyps atratus*	2
Turkey Vulture	TUVU	*Cathartes aura*	3
Northern Harrier	NOHA	*Circus cyaneus*	3
Sharp-shinned Hawk	SSHA	*Accipiter striatus*	1
Cooper's Hawk	COHA	*Accipiter cooperii*	1
Red-tailed Hawk	RTHA	*Buteo jamaicensis*	4
Merlin	MERL	*Falco columbarius*	1
Peregrine Falcon	PEFA	*Falco peregrinus*	1
Clapper Rail	CLRA	*Rallus longirostris*	5
Greater Yellowlegs	GRYE	*Tringa melanoleuca*	4
Dunlin	DUNL	*Calidris alpina*	49
Wilson's Snipe	WISN	*Gallinago delicata*	34
Ring-billed Gull	RBGU	*Larus delawarensis*	1
Red-bellied Woodpecker	RBWO	*Melanerpes carolinus*	5
Downy Woodpecker	DOWO	*Picoides pubescens*	3
Yellow-shafted Flicker	YSFL	*Colaptes auratus*	4
Northern Flicker	NOFL	*Colaptes auratus*	3
Western Kingbird	WEKI	*Tyrannus verticalis*	1
Blue Jay	BLJA	*Cyanocitta cristata*	2
Carolina Chickadee	CACH	*Poecile carolinensis*	13
Carolina Wren	CARW	*Thryothorus ludovicianus*	2
Sedge Wren	SEWR	*Cistothorus platensis*	45
Marsh Wren	MAWR	*Cistothorus palustris*	13
Golden-crowned Kinglet	GCKI	*Regulus satrapa*	2

Appendix I (continued). List of species detected with AOU Alpha code, scientific name, and total number detected.

Common Name	AOU Alpha Code	Scientific Name	Total Number Detected
Ruby-crowned Kinglet	RCKI	*Regulus calendula*	7
Eastern Bluebird	EABL	*Sialia sialis*	4
American Robin	AMRO	*Turdus migratorius*	164
Gray Catbird	GRCA	*Dumetella carolinensis*	1
Northern Mockingbird	NOMO	*Mimus polyglottos*	6
Myrtle Warbler	MYWA	*Dendroica coronata*	353
Pine Warbler	PIWA	*Dendroica pinus*	1
Common Yellowthroat	COYE	*Geothlypis trichas*	1
Savannah Sparrow	SAVS	*Passerculus sandwichensis*	17
Ipswich Sparrow	IPSP	*Passerculus sandwichensis*	5
Nelson's Sharp-tailed Sparrow	NSTS	*Ammodramus nelsoni*	28
Saltmarsh Sharp-tailed Sparrow	SSTS	*Ammodramus caudacutus*	5
Sharp-tailed Sparrow	STSP	*Ammodramus sp.*	133
Seaside Sparrow	SESP	*Ammodramus maritimus*	20
Song Sparrow	SOSP	*Melospiza melodia*	62
Swamp Sparrow	SWSP	*Melospiza georgiana*	51
White-throated Sparrow	WTSP	*Zonotrichia albicollis*	10
Unidentified Sparrow	UISP	*Sparrow sp.*	8
Northern Cardinal	NOCA	*Cardinalis cardinalis*	10
Red-winged Blackbird	RWBL	*Agelaius phoeniceus*	32
Eastern Meadowlark	EAME	*Sturnella magna*	45
Boat-tailed Grackle	BTGR	*Quiscalus major*	1
Total			1364