LAND USE / LAND COVER CHANGES

AND ECOLOGICAL HEALTH INDICATORS

IN THE BLACKBIRD CREEK WATERSHED:

WITH RECOMMENDATIONS FOR RESTORATION

by

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ABSTRACT

The objectives of this study were to 1) assess changes in land use and land cover of the Blackbird Creek watershed (New Castle County, Delaware) from 1937 to 1997, 2) present landscape metrics which can be applied to land cover data derived from remotely-sensed imagery, in order to assess landscape ecological integrity, 3) identify areas with degraded ecological conditions, 4) develop recommendations for ecological restoration, and 5) make data available to decision-makers to aid in setting priorities for non-point source pollution control and wildlife habitat restoration efforts.

1937 aerial photography was obtained, scanned and rectified, and land use / land cover (LULC) polygons were on-screen digitized and converted to a grid (ARC/INFO v. 7.1.2). 1997 LULC data were developed by merging 1992 LULC with 1992 State Wetlands Mapping Program (SWMP) data and 1997 updates mapped from Digital Ortho Quarter Quads (DOQQs). The 1937 and 1997 data sets were compared. Between 1937 and 1997, there was a 12.5% increase in development. As of 1997, developed land represented nearly 22% of the upland portion of the watershed. Cultivated land decreased by 16%, but still accounted for over 47% of the upland portion of the watershed in 1997. Deciduous forest increased by 5%, but accounted for less than 30% of the upland portion of the watershed, with nearly 70% devoted to human uses.

Another change involved the conversion of a large portion of tidal marsh to open water and mud flats, contributing to a 120-ha increase in these classes. Estuarine impoundments increased from 0 to 11 ha, and palustrine ponds and open water impoundments increased by 14 ha. As of 1997 there were at least 116 ha of farmed wetlands.

GIS Landscape metrics were applied to the LULC data in order to demonstrate various approaches to assessing landscape ecological health, and to assess some of the present-day (i.e., 1997) ecological health conditions of the Blackbird Creek watershed, from a remote sensing perspective. Forest interior habitat availability, riparian forest width and degree of forest patch isolation were evaluated, and the results compared with results from bird surveys aimed at detecting forest fragmentation-sensitive birds. The forests of the Blackbird Creek watershed appear to support some fragmentation-sensitive species, but the most sensitive species do not appear to be supported. Forest patch isolation appears to be a limiting factor for at least some rare or endangered species. In addition, 34% of a 30-m zone, along the perimeters of all forest patches, is developed, thus affecting the habitat suitability of the adjacent forest and eliminating opportunities for forest expansion and reduction in fragmentation.

A GIS layer of coastal plain ponds, unique wetland features supporting several rare species, was evaluated in terms of percentage of forest cover within 165 m. This buffer distance is important for the conservation of rare and endangered salamanders. Approximately 51% of the ponds were found to have $\geq$ 75% forest cover within 165 m. Nineteen percent had $\leq$ 50% forest cover within 165 m, and are in need of buffer

restoration. A riparian and wetland buffer restoration targeting tool, which evaluates LULC type within 15 m, 50 m, and 100 m of wetlands or water features, was developed for use in identifying restoration priorities. There appear to be many opportunities for buffer restoration in the Blackbird Creek watershed. For example, development, agriculture and farmed wetlands comprise 43.7% of the land within 15 m of estuarine wetlands.

A qualitative comparison of the wildlife communities of *Phragmites*- and *Spartina*-dominated marshes was undertaken in order to provide information on the ecological conditions of these marsh communities. The *Spartina* areas which were surveyed appeared to support a more native mammal community than that of the *Phragmites* marshes surveyed. In addition, the marsh rice rat (*Oryzomys palustris*), a rare species, appeared to be most abundant in the *Spartina* marshes. A total of 7 bird species and 42 individuals were documented from the *Spartina* sites, versus 5 species and 21 individuals from the *Phragmites* sites.

Chapter 4

WILDLIFE OBSERVATIONS: *PHRAGMITES* AND *SPARTINA* MARSHES

4.1 Background

The overall focus of this project was to identify land use and land cover changes within the Blackbird Creek watershed, and relate these changes to ecological health and habitat restoration needs. One of the changes which has occurred within this watershed and elsewhere on the east coast, is a substantial increase in the areal extent of *Phragmites australis* (common reed). This species has become invasive in fresh and brackish tidal wetlands where it has created vast, monotypic stands where more diverse marsh communities once existed. Despite the difficulty in distinguishing *Phragmites* from other marsh communities through remote sensing techniques, some recent studies (Rice 1996; Bailey 1997) have focused on mapping the areal extent of this invader in mid-Atlantic tidal marshes and developing new remote sensing techniques to accomplish this objective.

No attempt was made, as a part of this study of the Blackbird Creek watershed, to map the distribution of *Phragmites*. This was a significant but unavoidable omission in the land use and land cover change analysis. Due to the poor quality of some of the 1937 photographs covering the tidal marshes of this watershed, it was impossible to identify tidal marsh communities to the species level. Further, there is no way to ground-truth such a classification. However, there is a great deal of interest in learning more about the ecological implications of the spread of this species. It is thought that

the rapid expansion of this species over the past forty years has led to varying degrees of diminished fish and wildlife habitat quality in about one-third of Delaware's tidal wetlands (DNREC 1994), but as *Phragmites* has expanded, the debate over the value of this type of marsh versus the type it replaces (e.g., *Spartina alterniflora-Spartina patens-Distichlis spicata*) has also grown.

It has been suggested that there is a lack of ecological studies to confirm that *Phragmites* invasion leads to a reduction in wetland value (Rooth and Windham 2000), and recent studies comparing *Phragmites* and *Spartina* marshes have found no significant difference in utilization of the two types of marsh by nekton, in terms of abundance and biomass (e.g., Meyer et al., in press). However, bird and vegetation surveys in 40 Connecticut salt and brackish marshes showed that there were significantly fewer species of birds and state-listed species in *Phragmites*-dominated wetlands than in short-grass marshes (Benoit and Askins 1999).

In an attempt to further our understanding of the impacts of *Phragmites* invasion on the wildlife communities of brackish tidal marshes, bird and mammal surveys were conducted in *Phragmites*-dominated marshes and *Spartina*-dominated marshes. Due to time constraints and the addition of this component late in the project, it was not possible to undertake a survey effort which would allow for a statistical comparison of the results. Therefore, the findings of these surveys should be treated simply as observations of the birds and mammals found within a limited number of samples of each marsh community.

4.2 Mammal Survey Methods

A letter permit for small-mammal live-trapping was obtained from the Delaware Division of Fish and Wildlife. Survey transects were established during the early summer of 1999 in four different locations within Blackbird Creek brackish tidal marshes, two of them in *Phragmites*-dominated marshes and two in *Spartina*-dominated marshes (figure 4.1). The effort was temporally divided into two survey periods, the first one starting on 25 May and ending 8 June, and the second period starting on 3 July and ending 24 July. One transect of each marsh type was surveyed during each period. Twenty live-traps of 7 different sizes were placed an average of 15 m apart along each transect. Exact spacing was not possible due to irregular marsh topography which included hummocks and regularly inundated tidal guts and rivulets. No two traps were less than 12.5 m apart. Each transect included the same number of traps of each size and brand. The location of each trap was recorded using a Corvallis MicroTechnology MC-V Global Positioning System (GPS) receiver with a Leica MX 41R Differential GPS (marine) Beacon Receiver connected to it for real-time differential correction.

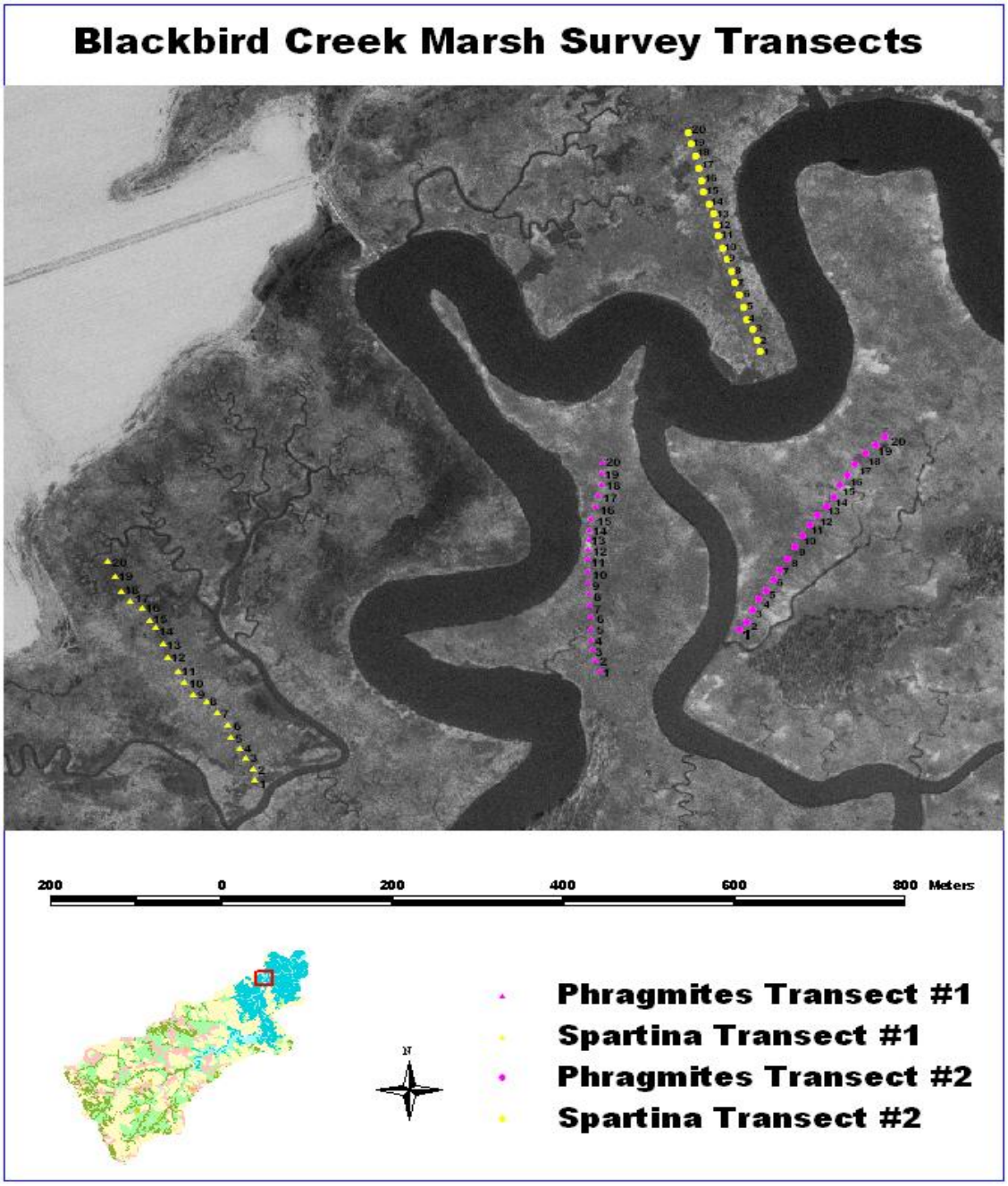

Figure 4.1: 1999 Bird and Mammal Survey Transects

The plant community occurring within a 5 m radius of each trap was documented (tables 4.1 - 4.4). Due to time constraints, stem densities were not measured. Transects were only accessible during high tides. If a plant species appeared to account for at least 50 % areal coverage at the trap location, it was considered dominant or co-dominant. However, at some trap locations the plant community was quite diverse, with 5 or 6 species appearing to be co-dominant, and each species accounting for only 15-20 % areal coverage. Each species was considered co-dominant in these situations.

Phragmites australis was found to have a minor presence at *Spartina* transect number 2. Conversely, two trap stations (13 and 14) along *Phragmites* transect number 1 were dominated by plant species other than *Phragmites* (table 4.2). These other plant communities occurred as small "islands" within an otherwise monotypic stand of *Phragmites*. There were also 2 trap stations (6 and 11) at *Phragmites* transect number 2 which were dominated by species other than *Phragmites*, and other plant species were also found to have a minor presence at 4 other stations along this transect (table 4.4). Skipping these islands of non-*Phragmites* marsh was considered, but it was decided that the standard trap spacing should be maintained.

Table 4.1: *Spartina* transect number 1: Live-trap sizes and plant species found within a 5 m radius of traps. Plant species: Salt-marsh cordgrass, *Spartina alterniflora (Spa_alt)*; Salt-meadow hay, *Spartina patens (Spa_pat)*; Salt grass, *Distichlis spicata (Dis_spi)*; Rose mallow, *Hibiscus moscheutos (Hib_mos)*; Olney three-square, *Scirpus olneyi (Sci_oln)*; Water hemp, *Amaranthus cannabinus (Ama_can)*; Big cordgrass, *Spartina cynosuroides (Spa_cyn)*; Cattail, *Typha* spp. (*Typ_spp)*; Salt-marsh loosestrife, *Lythrum lineare (Lyt_lin*); Marsh elder, *Iva frutescens (Iva_fru).*

Tr. No.	Trap Brand	Trap Size	Dominant Species	Other Species
1	Havahart	7x7x24"	*Spa_alt*	*Ama_can, Typ_spp, Sci_oln*
2	Safeguard	7x8x24"	*Spa_alt*	*Ama_can, Typ_spp, Sci_oln*
3	Havahart	5x5x18"	*Spa_alt*	*Spa_pat, Hib_mos*
4	Havahart	5x5x18"	*Spa_alt, Spa_pat, Dis_Spi, Hib_mos*	*Ama_can, Typ_spp, Sci_oln*
5	Sherman	3x3x10"	*Spa_pat, Dis_spi, Spa_alt, Hib_mos, Sci_oln*	
6	Safeguard	7x8x24"	*Spa_pat, Dis_spi, Spa_alt, Hib_mos, Sci_oln*	*Lyt_lin*
7	Safeguard	5x5x18"	*Spa_alt, Spa_pat, Dis_spi, Hib_mos, Sci_oln*	
8	Sherman	4x4x15"	*Spa_alt*	*Spa_pat, Dis_spi, Hib_mos, Sci_oln, Ama_can, Typ_spp*
9	Safeguard	5x5x18"	*Spa_alt*	*Spa_pat, Dis_spi, Hib_mos, Sci_oln, Ama_can, Typ_spp*
10	Havahart	5x5x18"	*Spa_alt*	*Spa_pat, Dis_spi, Hib_mos, Ama_can, Typ_spp*
11	Sherman	3x3x10"	*Spa_alt, Spa_pat, Dis_spi, Hib_mos, Ama_can, Sci_oln*	*Typ_spp*
12	Sherman	4x4x15"	*Spa_pat, Dis_spi*	*Spa_cyn, Spa_alt, Sci_oln, Ama_can, Typ_spp, Hib_mos*
13	Safeguard	11x12x30"	*Spa_cyn*	
14	Sherman	3x3x10"	*Spa_cyn*	
15	Sherman	3x3x10"	*Spa_alt, Spa_pat, Dis_spi, Spa_cyn, Hib_mos*	
16	Havahart	5x5x18"	*Spa_pat, Dis_spi*	*Spa_alt, Hib_mos, Ama_can*
17	Safeguard	7x8x24"	*Spa_pat, Dis_spi*	*Spa_alt, Hib_mos, Ama_can, Typ_spp, Sci_oln*
18	Havahart	7x7x24"	*Spa_alt*	
19	Safeguard	7x8x24"	*Spa_alt*	*Iva_fru, Hib_mos*
20	Havahart	5 x 5 x 18"	*Spa_cyn, Spa_alt*	

Table 4.2: *Phragmites* transect number 1: Live-trap sizes and plant species found within a 5 m radius of traps. Plant species: Common reed, *Phragmites australist (Phr_aus)*; Olney three-square, *Scirpus olneyi (Sci_oln)*; Salt-marsh cordgrass, *Spartina alterniflora (Spa_alt)*; Salt-meadow hay, *Spartina patens (Spa_pat)*; Salt grass, *Distichlis spicata (Dis_spi)*.

Trap No.	Trap Brand	Trap Size	Dominant Species	Other Species
1	Havahart	7 x 7 x 24"	Phr_aus	
2	Safeguard	5 x 5 x 18"	Phr_aus	
3	Havahart	5 x 5 x 18"	Phr_aus	
4	Havahart	7 x 7 x 24"	Phr_aus	
5	Safeguard	7 x 8 x 24"	Phr_aus	
6	Havahart	5 x 5 x 18"	Phr_aus	
7	Safeguard	5 x 5 x 18"	Phr_aus	
8	Safeguard	7 x 8 x 24"	Phr_aus	
9	Havahart	5 x 5 x 18"	Phr_aus	
10	Safeguard	7 x 8 x 24"	Phr_aus	
11	Havahart	5 x 5 x 18"	Phr_aus	
12	Safeguard	7 x 8 x 24"	Phr_aus	
13	Havahart	5 x 5 x 18"	Sci_oln, Spa_alt, Spa_pat, Dis_spi	Phr_aus
14	Sherman	4 x 4 x 15"	Sci_oln, Spa_alt, Spa_pat, Dis_spi	Phr_aus
15	Sherman	3 x 3 x 10"	Phr_aus	
16	Sherman	3 x 3 x 10"	Phr_aus	
17	Sherman	3 x 3 x 10"	Phr_aus	
18	Safeguard	11 x 12 x 30"	Phr_aus	
19	Sherman	4 x 4 x 15"	Phr_aus	
20	Sherman	3 x 3 x 10"	Phr_aus	

Table 4.3: *Spartina* transect number 2: Live-trap sizes and plant species found within a 5 m radius of traps. Plant species: Salt-meadow hay, *Spartina patens (Spa_pat)*; Salt grass, *Distichlis spicata (Dis_spi)*; Salt-marsh cordgrass, *Spartina alterniflora (Spa_alt)*; Olney three-square, *Scirpus olneyi (Sci_oln)*; Big cordgrass, *Spartina cynosuroides (Spa_cyn)*; Common reed, *Phragmites australis (Phr_aus)*; Cattail, *Typha* spp. (*Typ_spp)*; Salt-marsh fleabane, *Pluchea purpurascens (Plu_pur)*; Walter millet, *Echinochloa walteri (Ech_wal)*; Water hemp, *Amaranthus cannabinus (Ama_can).*

Tr. No.	Trap Brand	Trap Size	Dominant Species	Other Species
1	Safeguard	5x5x18"	Spa_pat, Dis_spi	Spa_alt, Sci_oln
2	Havahart	5x5x18"	Spa_pat	Dis_spi, Sci_oln
3	Safeguard	7x8x24"	Spa_cyn	Spa_pat, Dis_spi, Spa_alt, Sci_oln
4	Safeguard	7x8x24"	Spa_cyn	Sci_oln, Dis_spi, Spa_pat, Spa_alt
5	Sherman	4x4x15"	Spa_pat	Spa_alt, Phr_aus
6	Sherman	3x3x10"	Spa_pat	Sci_oln, Dis_spi
7	Sherman	3x3x10"	Spa_pat	Sci_oln, Phr_aus, Spa_cyn
8	Sherman	4x4x15"	Spa_pat	Sci_oln, Dis_spi, Spa_cyn
9	Sherman	3x3x10"	Spa_pat, Sci_oln	Dis_spi, Spa_cyn
10	Sherman	3x3x10"	Spa_pat	Dis_spi, Sci_oln, Spa_cyn
11	Safeguard	11x12x30"	Spa_pat	Spa_cyn, Spa_alt, Phr_aus, Sci_oln, Dis_spi
12	Havahart	5x5x18"	Spa_cyn	Spa_pat, Dis_spi
13	Havahart	7x7x24"	Spa_cyn	Spa_pat, Dis_spi, Phr_aus
14	Havahart	5x5x18"	Spa_cyn, Spa_pat	Dis_spi, Typ_spp, Phr_aus, Plu_pur
15	Havahart	7x7x24"	Spa_pat	Dis_spi, Spa_cyn, Plu_pur
16	Havahart	5x5x18"	Spa_pat	Dis_spi, Plu_pur, Spa_cyn
17	Safeguard	5x5x18"	Spa_alt	Ech_wal, Plu_pur, Ama_can, Spa_cyn, Dis_spi
18	Safeguard	7x8x24"	Ech_wal	Spa_alt, Plu_pur, Spa_pat, Phr_aus
19	Havahart	5x5x18"	Spa_pat	Phr_aus, Ama_can, Spa_alt, Spa_cyn, Ech_wal, Plu_p
20	Safeguard	7x8x24"	Spa_cyn, Spa_pat	Spa_alt, Sci_oln, Dis_spi

Table 4.4: *Phragmites* transect number 2: Live-trap sizes and plant species found within a 5 m radius of traps. Plant species: Common reed, *Phragmites australist (Phr_aus)*; Olney three-square, *Scirpus olneyi (Sci_oln)*; Salt-meadow hay, *Spartina patens (Spa_pat)*; Salt-marsh cordgrass, *Spartina alterniflora (Spa_alt)*; Salt grass, *Distichlis spicata (Dis_spi)*.

Trap No.	Trap Brand	Trap Size	Dominant Species	Other Species
1	Safeguard	7 x 8 x 24"	Phr_aus	
2	Sherman	3 x 3 x 10"	Phr_aus	
3	Sherman	3 x 3 x 10"	Phr_aus	
4	Sherman	4 x 4 x 15"	Phr_aus	
5	Safeguard	5 x 5 x 18"	Phr_aus	
6	Havahart	5 x 5 x 18"	Spa_pat, Sci_oln	Dis_spi, Spa_cyn
7	Safeguard	11 x 12 x 30"	Phr_aus	
8	Havahart	7 x 7 x 24"	Phr_aus	Sci_oln, Spa_pat
9	Safeguard	5 x 5 x 18"	Phr_aus	Spa_pat, Sci_oln
10	Safeguard	7 x 8 x 24"	Phr_aus	Spa_pat, Sci_oln
11	Sherman	4 x 4 x 15"	Spa_alt, Spa_pat, Dis_spi, Phr_aus	
12	Havahart	5 x 5 x 18"	Phr_aus	
13	Havahart	5 x 5 x 18"	Phr_aus	
14	Havahart	5 x 5 x 18"	Phr_aus	
15	Havahart	7 x 7 x 24"	Phr_aus	
16	Safeguard	7 x 8 x 24"	Phr_aus	
17	Sherman	3 x 3 x 10"	Phr_aus	
18	Safeguard	7 x 8 x 24"	Phr_aus	Spa_alt
19	Sherman	3 x 3 x 10"	Phr_aus	
20	Havahart	5 x 5 x 18"	Phr_aus	

All traps were baited with a mixture of peanut-butter, oatmeal and bacon grease. The peanut-butter and oatmeal combination are commonly used and proven effective in the trapping of most small mammals (Jones 1978; McLaughlin, pers. comm.). The addition of bacon grease was suggested by Dr. Roland Roth, University of Delaware, Department of Entomology and Applied Ecology. To reduce the potential for heat-related trapping mortality, plant debris was loosely placed over traps to provide

shade while ensuring that this did not interfere with the proper functioning of the trap. On several occasions, when weather forecasts predicted very high temperatures (e.g., $\geq$ 93^{o} F), traps were left closed.

Traps were checked and reset on a daily basis, with visitations corresponding with timing of high tides. Traps were not accessible at low tide. The order in which transects were visited was reversed each day in order to avoid a bias. The effort involved a total of 1,040 trap nights ((2 transects x 20 traps/transect x 11 nights) + (2 transects x 20 traps/transect x 15 nights)). Due to the amount of time it took to reach traps on each high tide, and the limited amount of time available to check all traps during the high tide, no attempt was made to age or sex captured individuals, nor was any attempt made to mark captured individuals. Therefore, population estimates were not possible. Instead, for each species, emphasis was placed on the largest number of individuals captured during a single trap night.

4.3 Assumptions Related to Methods and Assessment of Results

There were certain assumptions made which should be considered when viewing the results of this effort:

1) The level of surveyor disturbance (e.g., trail creation, trampling of vegetation) was equal in the two marsh communities. Survey work within both types of marsh involved difficulties and hazards. In general, the *Spartina* marsh included more hummocks, often small and unstable, and muckier conditions, while the *Phragmites* marsh was much more impenetrable and thus required a more obvious trail (i.e.,

movement through the *Phragmites* while carrying trapping equipment was not possible without first making a trail). More hummock-hopping was required in the *Spartina* marsh, which resulted in localized trampling of vegetation and compaction of marsh substrate. There were sections of the *Phragmites* marsh where tidal guts had to be traversed, including one which was approximately 2 m across from top of bank to top of bank. In addition, there were some portions of the *Phragmites* marsh which were regularly inundated. In general, however, the *Spartina* marsh had greater topographic diversity and more areas which were regularly inundated by high tides.

2) There were no significant differences in trap spacing or randomness of trap placement between the two types of marsh. Traps were placed an average of 15 m apart, but it was not possible to precisely space traps given the topographic diversity and presence of regularly inundated areas where traps could not be placed without drowning animals.

4.4 Mammal Survey Results and Discussion

4.4.1 *Spartina* Transect Number 1

Three mammal species, marsh rice rat (*Oryzomys palustris*), Norway rat (*Rattus norvegicus*) and meadow vole (*Microtus pennsylvanicus*), were captured from *Spartina* transect number 1 (table 4.5). The marsh rice rat is listed by the Delaware Natural Heritage Program as a rare (S3) species (DNHP 1997). At least 5 individuals (largest number captured during a single trap night) of this species were captured. This species is closely tied to salt and brackish marshes (Kibbe 1995).

At least 4 meadow vole individuals were captured. This is a common, native mammal of grassy meadows and marshes. A common behavioral characteristic of this species is the construction of runways beneath the matted vegetation (primarily *Spartina patens*) of the high marsh (personal observation). This species was also captured in regularly-flooded, *Spartina alterniflora*-dominated marsh during this study.

Two Norway rat individuals were captured from this marsh transect. This old world rat is an exotic species which can be found in almost any habitat, and is usually associated with areas inhabited by humans.

At least 12 individuals of 3 species were captured from this transect. The ratio of the minimum number of individuals of native species to the minimum number of individuals of exotic species (hereafter referred to as the index of nativeness) was 4.5 ((5 rice rats + 4 meadow voles)/2 Norway rats). In addition, the native species which appeared to be most abundant, the marsh rice rat, is a rare species in Delaware.

Table 4.5: Results of small-mammal live-trapping effort at *Spartina* transect number 1. Species captured: Marsh rice rat, *Oryzomys palustris (O_p)*[r]; Meadow vole, *Microtus pennsylvanicus (M_p)*; Norway rat, *Rattus norvegicus (R_n)*[x].

Tr. No.	5/25	5/26	5/27	5/28	5/29	5/30	5/31	6/1	6/2	6/3	6/4	6/5	6/6	6/7	6/8
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	*O_p*	0	0	0	0	0	0	0	0	0	*O_p*	*M_p*
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*O_p*
8	0	0	0	0	0	0	0	0	0	0	0	0	*O_p*	*O_p*	*O_p*
9	0	0	0	*O_p*	0	0	0	*O_p*	0	0	0	*O_p*	0	*O_p*	*O_p*
10	0	0	0	0	0	0	0	*O_p*	0	*O_p*	0	*O_p*	0	0	*O_p*
11	0	0	0	0	0	0	0	0	0	0	0	0	0	*O_p*	*O_p*
12	0	0	0	0	0	*O_p*	0	0	0	*R_n*	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*M_p*
15	0	0	0	0	0	0	0	0	0	*M_p*	0	0	*M_p*	0	*M_p*
16	0	0	0	0	0	0	0	*M_p*	*M_p*	*M_p*	*M_p*	*M_p*	0	*M_p*	*M_p*
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	*R_n*	0	0	0	*R_n*	0	0	0	0	0

[r] Rare species (ranked S3 by Delaware Natural Heritage Program)
[x] Exotic species (not native to Delaware)

4.4.2 *Phragmites* Transect Number 1

Five species, house mouse (*Mus musculus*), Norway rat, marsh rice rat, meadow vole, and longtail weasel (*Mustela frenata*), were captured from this transect (table 4.6). Although this transect yielded a larger number of species than did the first *Spartina* transect, both of the two additional species are common, and one of them is an exotic

species. The house mouse, like the Norway rat, is an old world rat which is usually closely associated with human habitation. This was the only species captured from the non-*Phragmites* island described in section 4.2.

One longtail weasel was captured. This is a common, but secretive, species which is found in all land habitats near water (Burt and Grossenheider 1976). At least 3 Norway rat individuals were captured, and at least 1 marsh rice rat was captured. Only 1 meadow vole was captured (i.e., only 1 capture). The most abundant species at this transect appeared to be the Norway rat. The index of nativeness for this transect was 0.6 ((1 rice rat + 1 meadow vole + 1 longtail weasel)/(3 Norway rats + 2 house mice)).

Table 4.6: Results of small-mammal live-trapping effort at *Phragmites* transect number 1. Species captured: Norway rat, *Rattus norvegicus (R_n)*[x]; Marsh rice rat, *Oryzomys palustris (O_p)*[r]; Longtail weasel, *Mustela frenata (M_f)*; House mouse, *Mus musculus (M_m)*[x]; Meadow vole, *Microtus pennsylvanicus (M_p).*

Tr. No.	5/25	5/26	5/27	5/28	5/29	5/30	5/31	6/1	6/2	6/3	6/4	6/5	6/6	6/7	6/8
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	R_n	O_p	R_n	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R_n
5	R_n	R_n	0	0	0	0	R_n	0	0	R_n	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	O_p	0
8	0	0	0	0	0	0	0	0	0	R_n	0	M_f	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	R_n	R_n	R_n	R_n	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	R_n	0	R_n	R_n	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	M_m	0	M_m	0	M_m	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	M_m	M_m	0	0	0	0	0	0	0	0	0
16	0	M_m	M_m	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	M_m	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	R_n	0	0	0	0	0	0	0	0	R_n
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	M_m	M_p	0	0	0	0	0	0

[x] Exotic species (not native to Delaware)
[r] Rare species (ranked S3 by Delaware Natural Heritage Program)

4.4.3 *Spartina* Transect Number 2

At least 6 marsh rice rat individuals, 3 meadow vole individuals, and 3 Norway rat individuals were captured from this transect (table 4.7). The species which appeared to be most abundant, the marsh rice rat, is considered rare in Delaware, as previously mentioned. The index of nativeness for this transect was 3.0 (9/3). The

overall index of nativeness for *Spartina* transects 1 and 2 combined was 3.6 (18/5).

Table 4.7: Results of small-mammal live-trapping effort at *Spartina* transect number 2. Species captured: Norway rat, *Rattus norvegicus (R_n)*[x]; Meadow vole, *Microtus pennsylvanicus (M_p)*; Marsh rice rat, *Oryzomys palustris (O_p)*[r].

Trp No.	7/3	7/4	7/5	7/17	7/18	7/19	7/20	7/21	7/22	7/23	7/24
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	*R_n*	*R_n*	*R_n*	0	*R_n*	*R_n*
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	*M_p*	*M_p*	*M_p*	*M_p*	*M_p*
7	0	0	0	0	0	0	0	0	*O_p*	0	0
8	0	0	0	0	*M_p*	*O_p*	*M_p*	*O_p*	*O_p*	*M_p*	*O_p*
9	0	0	0	0	0	*O_p*	0	0	*O_p*	0	0
10	0	0	0	0	*O_p*	*M_p*	0	*M_p*	*M_p*	*M_p*	0
11	0	0	0	0	0	0	0	0	0	0	0
12	*O_p*	*O_p*	*O_p*	0	0	*M_p*	*O_p*	*O_p*	*O_p*	*R_n*	*O_p*
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	*O_p*	0	0	0	0	*O_p*	*O_p*	0
17	*O_p*	0	0	0	0	0	*O_p*	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0
19	0	*O_p*	0	*O_p*	*O_p*	*O_p*	O_p	*M_p*	*O_p*	0	0
20	0	0	0	0	*O_p*	0	*R_n*	*R_n*	0	*R_n*	0

[x] Exotic species (not native to Delaware)
[r] Rare Species (ranked S3 by Delaware Natural Heritage Program)

4.4.4 *Phragmites* Transect Number 2

At least 2 house mouse individuals, 2 Norway rat individuals, and 2 marsh rice rat individuals were captured from this transect (table 4.8). There were 3 marsh rice rat

captures from the non-*Phragmites* (*Spartina*-dominated) stations described in section 4.2, and this was the only species captured from these stations. The index of nativeness was 0.5 (2/4). The index of nativeness for *Phragmites* transects 1 and 2 combined was 0.6 (5/9).

Table 4.8: Results of small-mammal live-trapping effort at *Phragmites* transect number 2. Species captured: House mouse, *Mus musculus (M_m)*[x]; Marsh rice rat, *Oryzomys palustris (O_p)*[r]; Norway rat, *Rattus norvegicus (R_n)*[x].

Trp No.	7/3	7/4	7/5	7/17	7/18	7/19	7/20	7/21	7/22	7/23	7/24
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	*M_m*	0	0	0	*M_m*	0	0	0	0
3	0	0	0	0	0	*O_p*	0	0	0	0	0
4	0	0	0	0	0	0	*O_p*	0	0	*R_n*	0
5	0	0	0	0	0	0	0	0	*R_n*	0	*R_n*
6	0	0	0	0	0	*O_p*	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	*O_p*	0	*O_p*
12	0	0	0	0	0	0	0	*O_p*	*O_p*	*O_p*	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	*R_n*	*R_n*
17	0	0	*M_m*	0	*O_p*	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	*O_p*	0
20	0	0	0	0	0	0	0	0	0	0	0

[x] Exotic Species (not native to Delaware)
[r] Rare Species (ranked S3 by Delaware Natural Heritage Program)

4.4.5 Conclusions

The results of this mammal survey indicate that the *Spartina*-dominated marsh sites supported a more native mammal community than did the *Phragmites* marsh sites. In addition, the *Spartina* sites appeared to support higher densities of marsh rice rats and meadow voles than did the *Phragmites* sites. Considering the marsh rice rat's rare status in Delaware, the conservation of *Spartina*-dominated marsh communities should be a priority. In addition, recognizing the importance of the meadow vole as a prey item for the northern harrier, *Circus cyaneus* (Dunne 1995) and the short-eared owl, *Asio flammeus* (Johnsgard 1988), both listed as endangered species in Delaware, the unchecked spread of *Phragmites* might be expected to threaten the continued persistence of these birds of prey in the state. The short-eared owl feeds primarily on microtine rodents, particularly the meadow vole, *Microtus pennsylvanicus* [(Melvin et al. 1989) In Sutton and Sutton 1995].

4.5 Bird Survey Methods

In addition to the small-mammal live-trapping effort, two 50-m fixed-radius point count surveys (e.g., Heckscher 2000; Ralph et al. 1995; Benoit and Askins 1999) were conducted at each of the four transects, in order to document bird species and numbers of individuals at these sites. The 50 m distance could only be estimated as it was impossible to see for this distance in all directions at the *Phragmites* stations. The distance chosen was based primarily on an assessment of maximum detection (i.e., of bird songs and calls) distance within both marsh types. The point count stations at

Phragmites transect number 1 and *Spartina* transect number 2 each included a small amount of open water within 50 m, with slightly more water included at the *Phragmites* site.

Due to the difficulty in seeing individual birds for a distance of 50 m at the *Phragmites* stations, surveys relied almost exclusively on detection of songs and calls to confirm the presence of a species and document the number of individuals (i.e., visual observations, except for those in close proximity to survey point, were not relied upon for identifying species and numbers of individuals). Therefore, the numbers of individuals are underestimates, as non-singing females were generally overlooked. One exception is the red-winged blackbird (*Agelaius phoeniceus*). Females of this species call often and are easily heard. An assumption was made that surveys were not biased by the difference in vegetation height between the two marsh types, but the density of the *Phragmites* may have reduced the number of songs and calls heard, despite the assertion that singing and calling birds up to 50 m away could be heard.

Each survey was conducted at the location of trap number 10, roughly the center of the transect (figure 4.2). Surveys were conducted between 05:30 hrs and 09:30 hrs on 7 and 8 June (*Spartina* transect number 1 and *Phragmites* transect number 1), and on 3 and 4 July (*Spartina* transect number 2 and *Phragmites* transect number 2). The order in which each transect was surveyed was reversed for the second of each of the two surveys, to avoid temporal bias. Weather conditions were favorable for all surveys (i.e. detection distance was not affected by wind or rain).

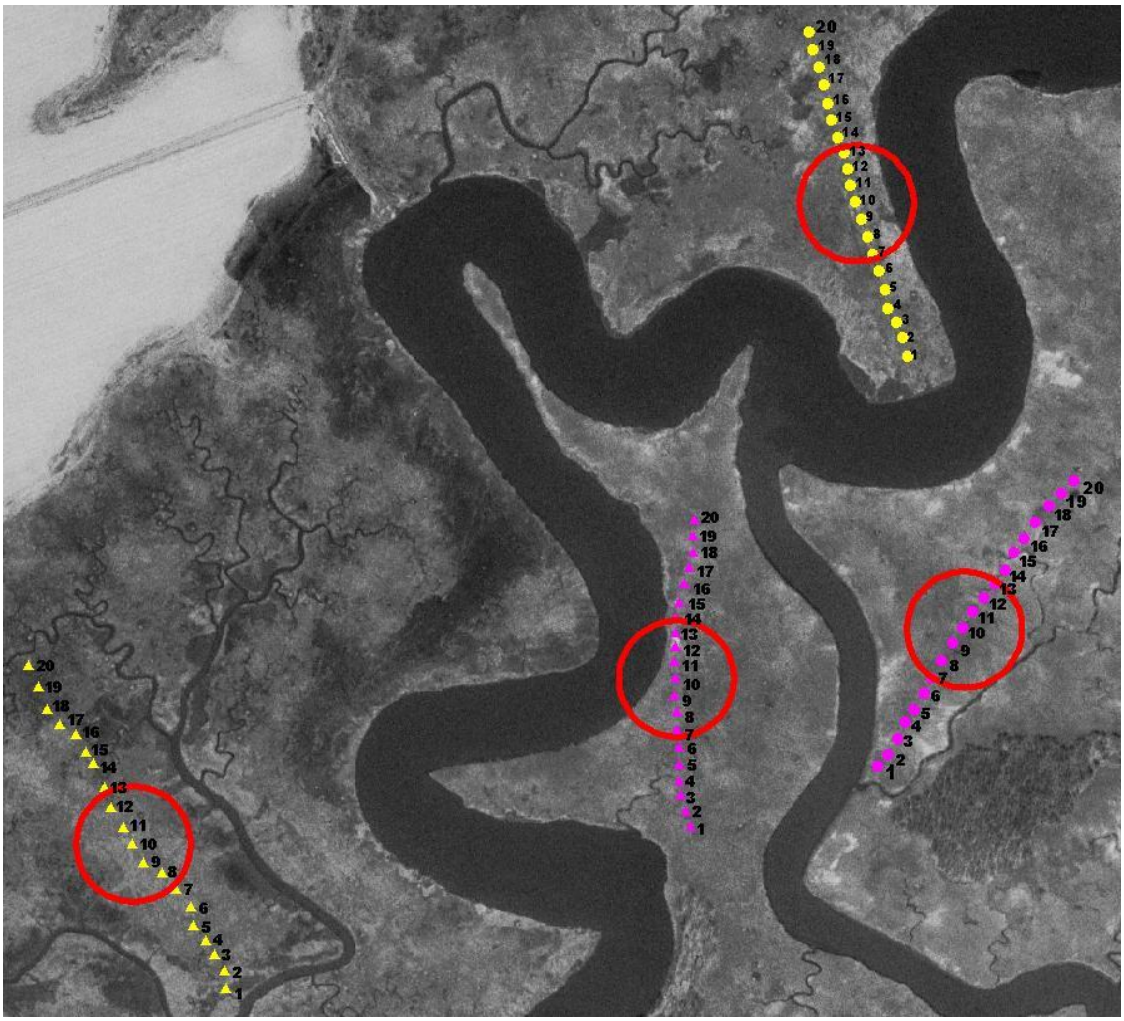

Figure 4.2: 50 m Fixed-Radius Point Count Survey Locations Relative to Transects

Individuals flying over the survey station were not counted. Because the least bittern (*Ixobrychus exilis*), American bittern (*Botaurus lentiginosus*), and rails (*Rallus* spp.) may call very infrequently during the breeding season, a tape playback method (Connors 1986; Benoit and Askins 1999), involving the broadcasting of recorded calls, was used in an effort to detect these species.

4.6 Bird Survey Results and Discussion

4.6.1 *Spartina* Transect Number 1

The two surveys of *Spartina* transect number 1 yielded at least 7 bird species (table 4.9). Despite having recorded vocalizations for comparison, it could not be determined which of the two rail species, clapper rail (*Rallus longirostris*) or king rail (*Rallus elegans*), was present at this transect, or if both species were present. This uncertainty was due to 1) a similarity in vocalizations, 2) a documented overlap in habitat use and distribution within this geographic area (Hess et al. 2000), and 3) documented hybridization between the two species where their ranges overlap (Kerlinger and Widjeskog 1995).

The king rail is considered a very rare species in Delaware (DNHP 1997), whereas the clapper rail is considered common, so it seems more likely that the vocalizations heard during this survey were those of clapper rails. However, these vocalizations seemed to indicate the presence of at least one hybrid individual. For purposes of comparison with results from surveys of the *Phragmites* transects, the rail vocalizations in question will be attributed to the clapper rail only. The wetter marshes characterized by near monocultures of *Spartina alterniflora* are favored by clapper rails (Kerlinger and Widjeskog 1995). One Virginia rail (*Rallus limicola*) was also documented at this site. This species breeds in fresh and brackish marshes and on the drier, fresher edges of transition marshes in reeds near shrubs (Hess et al. 2000).

Table 4.9: Bird species and numbers of individuals documented in *Spartina* transect number 1 marsh surveys. No. = number of individuals; Stat. = status (S3B, rare breeder; Com, common; S2, very rare; S2B, very rare breeder).

Spartina Transect Number 1 - 6/7/99			*Spartina* Transect Number 1 - 6/8/99		
Species	No.	Stat.	Species	No.	Stat.
Coastal plain swamp sparrow, *Melospiza georgiana nigrescens*	3	S3B	Coastal plain swamp sparrow, *Melospiza georgiana nigrescens*	3	S3B
Marsh wren, *Cistothorus palustris*	4	Com	Marsh wren, *Cistothorus palustris*	5	Com
Seaside sparrow, *Ammodramus maritimus*	6	Com	Seaside sparrow, *Ammodramus maritimus*	4	Com
Clapper/King rail, *Rallus longirostris/elegans*	2	Com/ S2	Clapper/King rail, *Rallus longirostris/elegans*	1	Com/ S2
Virginia rail, *Rallus limicola*	1	Com	Common yellowthroat, *Geothlypis trichas*	1	Com
Red-winged blackbird, *Agelaius phoeniceus*	8	Com	Red-winged blackbird, *Agelaius phoeniceus*	8	Com
Great blue heron, *Ardea herodias*	1	S2B			

Three coastal plain swamp sparrow individuals were documented during each of the two surveys at this site (table 4.9). This species is considered a rare breeder in Delaware (DNHP 1997). Another sparrow documented at this site was the seaside sparrow (*Ammodramus maritimus*). This species nests in muddy areas containing patches of medium-height *Spartina alterniflora* (Leukering 1995), and because of its close association with this habitat type, it has been suggested that this species might serve as an indicator species for monitoring marsh health (Conway and Anderson 1996). Six individuals of this species were heard during the first survey and 4 were heard on the second day.

One great blue heron (*Ardea herodias*) was documented foraging at this site. This species is restricted to a small number of breeding colonies in Delaware, and is considered a very rare breeder in the state (DNHP 1997). It may be unfair to include this species in the results, since its detection in *Phragmites* would be difficult.

One warbler species, the common yellow-throat (*Geothlypis trichas*), was documented at this site. This is a common species found in a wide range of habitats. Other species documented at this site included the marsh wren (*Cistothorus palustris*), which is most successful in marshes with comparatively dense vegetation and deep water (Heckscher 1995), and the red-winged blackbird (*Agelaius phoeniceus*) which, in addition to breeding in rank vegetation in a variety of freshwater wetland habitats, breeds most densely in the saltmarsh transition zone containing hightide bush (*Iva frutescens*) and groundsel bush (*Baccharis halimifolia*), whether or not invaded by *Phragmites* (Hess et al. 2000). Red-winged blackbird was the most abundant species at this site, followed by seaside sparrow and marsh wren. Not counting the great blue heron or the possible king rail, 7 bird species and a total of 26 individuals were documented at *Spartina* transect number 1 (table 4.9).

4.6.2 *Phragmites* Transect Number 1

A total of 4 species and 8 individuals were documented at *Phragmites* transect number 1, including the rare coastal plain swamp sparrow (table 4.10). The most abundant species were the marsh wren and red-winged blackbird. One of the species documented in this survey, eastern kingbird (*Tyrannus tyrannus*), was not present at

either of the *Spartina* sites. This species inhabits wood margins, farmsteads, suburbs, roadsides, and lone trees in open areas, frequently near water, particularly salt-marshes (Hess et al. 2000). This species was presumably nesting on a nearby, wooded island. There are two wooded islands within 200 m of the survey point.

Table 4.10: Bird species and numbers of individuals documented in *Phragmites* transect number 1 marsh surveys. No. = number of individuals; Stat. = status (S3B, rare breeder; Com, common).

Phragmites Transect Number 1 - 6/7/99			*Phragmites* Transect Number 1 - 6/8/99		
Species	No.	Stat.	Species	No.	Stat.
Coastal plain swamp sparrow, *Melospiza georgiana nigrescens*	1	S3B	Coastal plain swamp sparrow, *Melospiza georgiana nigrescens*	1	S3B
Marsh wren, *Cistothorus palustris*	3	Com	Marsh wren, *Cistothorus palustris*	3	Com
Red-winged blackbird, *Agelaius phoeniceus*	1	Com	Red-winged blackbird, *Agelaius phoeniceus*	3	Com
			Eastern kingbird, *Tyrannus tyrannus*	1	Com

4.6.3 *Spartina* Transect Number 2

A total of 5 species and 16 individuals were documented at *Spartina* transect number 2 (table 4.11). No new species, compared with *Spartina* transect number 1, were documented. Marsh wren and seaside sparrow were the most abundant species.

Table 4.11: Bird species and numbers of individuals documented in *Spartina* transect number 2 marsh surveys. No. = number of individuals; Stat. = status (S3B, rare breeder; Com, common; S2, very rare).

Spartina Transect Number 2 - 7/3/99			*Spartina* Transect Number 2 - 7/4/99		
Species	No.	Stat.	Species	No.	Stat.
Coastal plain swamp sparrow, *Melospiza georgiana nigrescens*	2	S3B	Coastal plain swamp sparrow, *Melospiza georgiana nigrescens*	1	S3B
Marsh wren, *Cistothorus palustris*	5	Com	Marsh wren, *Cistothorus palustris*	5	Com
Seaside sparrow, *Ammodramus maritimus*	5	Com	Seaside sparrow, *Ammodramus maritimus*	5	Com
Red-winged blackbird, *Agelaius phoeniceus*	3	Com	Red-winged blackbird, *Agelaius phoeniceus*	2	Com
			Clapper/King rail, *Rallus longirostris/elegans*	1	Com/ S2

4.6.4 *Phragmites* Transect Number 2

A total of 4 species and 13 individuals were documented at this transect (table 4.12). No new species, compared with *Phragmites* transect number 1, were documented at this site. The most abundant species were red-winged blackbird and marsh wren.

Table 4.12: Bird species and numbers of individuals documented in *Phragmites* transect number 2 marsh surveys. No. = number of individuals; Stat. = status (S3B, rare breeder; Com, common).

Phragmites Transect Number 2 - 7/3/99			*Phragmites* Transect Number 2 - 7/4/99		
Species	No.	Stat.	Species	No.	Stat.
Coastal plain swamp sparrow, *Melospiza georgiana nigrescens*	2	S3B	Coastal plain swamp sparrow, *Melospiza georgiana nigrescens*	2	S3B
Marsh wren, *Cistothorus palustris*	4	Com	Marsh wren, *Cistothorus palustris*	4	Com
Red-winged blackbird, *Agelaius phoeniceus*	5	Com	Red-winged blackbird, *Agelaius phoeniceus*	1	Com
Common yellowthroat, *Geothlypis trichas*	2	Com	Common yellowthroat, *Geothlypis trichas*	1	Com

4.6.5 Conclusions

A total of 7 species and 42 individuals were documented from the two *Spartina* point count stations, versus 5 species and 21 individuals documented from the *Phragmites* stations. A notable difference between the two types of marsh was the absence of the seaside sparrow from the *Phragmites* sites. This salt and brackish marsh specialist was one of the most abundant species at the *Spartina* sites. Rails were also absent from the *Phragmites* sites. However, a clapper rail was heard calling from the edge of a *Phragmites* marsh during the mammal trapping effort. Also heard in the *Phragmites* marsh during the mammal trapping effort was a green heron (*Butorides virescens*). In addition, a least bittern (*Ixobrychus exilis*) was observed standing at the edge of a *Phragmites* marsh in 1998. This species is considered by the Delaware Natural Heritage Program to be an extremely rare (S1B) species (DNHP 1997). Absent

from all sites was the saltmarsh sharp-tailed sparrow (*Ammodramus caudacutus*), a rare species (S3B) which was documented within the study area during a previous field season, in a *Spartina* marsh (Appendix C, Rock Tract Marshes).

Although no birds of prey were documented in any of the point counts, as stated earlier, there appeared to be a greater abundance of the prey species preferred by the endangered northern harrier and short-eared owl. Further, since the northern harrier requires open ground with low vegetative cover (less than 1 m tall) for hunting (Dunne 1995), the increase in expansive, monotypic stands of *Phragmites* is likely to severely limit the availability of suitable hunting grounds for this species.

Based on the above observations, a prudent approach to coastal marsh management should include *Phragmites* control efforts which substantially limit the expansion of this species but do not eradicate it. Eradication may be unfeasible, and *Phragmites* does appear to provide nesting and escape cover for some marsh birds. This may be attributable, in part, to the loss in many areas of wetland-upland transition zone plant communities (e.g., *Baccharis halimifolia-Iva frutescens*) as a result of agriculture and other human activities.

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