Breeding Bird Use of Salt Marsh Habitat in the Maritime Provinces

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Atlantic Region

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ABSTRACT

Salt marshes and their associated wildlife populations have been identified as priorities for restoration and conservation in north-eastern North America. Three distinct bio-physical regions of salt marshes occur in the Maritime Provinces: Bay of Fundy, Atlantic Coast and Gulf of St. Lawrence. Surveys of salt marsh birds were conducted on 160 marshes located throughout the Maritime Provinces by Canadian Wildlife Service (CWS) staff and volunteer naturalists during 2000-2002. These surveys utilised ten minute point counts spaced 200 m apart, a protocol similar to that used in New England. Information on habitat characteristics such as vegetation type at the point count location, number and total area of salt ponds, marsh area, and presence of dykes or ditches were collected by CWS staff. Landscape-level descriptors of habitat such as proximity to adjacent houses, salt marshes, and dykelands were derived based on air photos and wetland inventory maps.

It was observed that Bay of Fundy study marshes were larger and less isolated compared to study marshes in the Gulf of St. Lawrence or those along the Atlantic Coast. Analysis of Maritime Wetland Inventory data revealed a similar trend. An analysis of study marshes for all biophysical regions showed that species richness was greater on larger salt marshes. Moreover, the density of Nelson's Sharp-tailed Sparrows and Savannah Sparrows was positively correlated with marsh area. This relationship was asyomptotic with no increase in density of Nelson's Sharp-tailed Sparrows for marshes greater than 10 ha. Willet density was not influenced by marsh area but was positively influenced by pond area, which was in turn correlated to marsh area.

Proximity to other marshes, or the number of dwellings within 125 m of the study marsh did not affect any aspect of bird use. Nelson's Sharp-tailed Sparrow density was positively influenced by the presence of adjacent dykeland. *Phragmites* is not widespread in the Maritimes and was therefore not a useful predictor of avian habitat use. A review of findings from studies across north-eastern North America indicates that (1) the size of the marsh is important for many species of salt marsh birds, (2) habitat quality is determined at multiple spatial scales by salt marsh birds and (3) marsh protection policies as well as conservation and restoration activities need to specifically address the collective habitat requirements and conservation concerns for individual bird species and locales.

RÉSUMÉ

Les marais salés et la faune qui leur est associée ont été identifiés comme priorité pour la restauration et la conservation en Amérique du Nord. Les marais salés se catégorisent en trois régions bio-physiques distinctes dans les provinces maritimes: la baie de Fundy, la côte atlantique et le golfe du Saint-Laurent. Le Service canadien de la faune (SCF) a mené avec l'aide de ses employés et de nombreux bénévoles des recensements d'oiseaux de marais salés dans 160 marais des provinces maritimes entre 2000 et 2002. Ces recensements ont été réalisés selon un protocol similaire à celui utilisé en Nouvelle-Angleterre, constitué de points d'écoutes de 10 minutes espacés de 200 mètres. Des données sur les caractéristiques de l'habitat tel que le type de végétation, le nombre et la superficie d'étangs salés, la superficie des marais et la présence de digues et de chenaux ont également été relevées par les employés du SCF. Par ailleurs, des informations supplémentaires sur l'habitat telle que la proximité des habitations, des marais salés et des terres endiguées ont été tirées à partir de photos aériennes et de cartes d'inventaire des marais.

Cette étude a démontré que les marais salés de la baie de Fundy sont plus étendus et moins isolés que ceux du golfe du Saint-Laurent et de la côte atlantique. Les données provenant de l'Inventaire des terres humides des Maritimes (Maritime Wetland Inventory) tendent à appuyer ces observations. L'analyse de la diversité d'espèces dans l'ensemble de ces régions biophysiques a démontré que celle-ci est fonction de la superficie des marais. A cet effet, une corrélation positive a été établie entre la superficie des marais et la densité du Bruant de Nelson et du Bruant des prés. Cette relation devient asymptotique en revanche dans le cas du Bruant de Nelson dont la densité cesse de croître dans les marais dont la taille est supérieure à 10 ha. La densité du Chevalier semipalmé est influencée, elle, par le nombre d'étangs plutôt que par la superficie des marais, bien que la corrélation entre ces deux éléments soit positive.

La proximité d'autres marais ou habitations aux zones d'étude dans un rayon inférieur ou égal à 125 m ne semble pas influencer l'utilisation que font les oiseaux de ces milieux. La densité du Bruant de Nelson augmente en fonction du nombre de digues avoisinantes. Les Phragmites n'ont pu servir d'indicateur pour prédire l'utilisation aviaire de l'habitat en raison de leur faible abondance dans les Maritimes. Une revue des études réalisées dans l'est de l'Amérique du nord démontre que 1) la superficie des marais est un facteur important pour de nombreuses espèces d'oiseaux des marais salés; 2) la qualité de l'habitat est déterminée à différentes échelles par les oiseaux de marais salés; 3) les politiques de protection des marais ainsi que les initiatives de conservation doivent viser spécifiquement les besoins collectifs des oiseaux en matière d'habitat ainsi que les besoins spécifiques des espèces individuelles en matière de conservation.

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INTRODUCTION

Salt marshes are unique ecosystems resulting from complex interactions between hydrology, sedimentation, salinity, tidal amplitude and periodicity, and primary productivity (Bertness 1999). The same physical and biological features that make salt marshes one of the most productive ecosystems in the Temperate Zone, also supported European settlements during colonization of northeastern North America (hereafter Northeast). Human use of salt marshes for agricultural purposes was widespread throughout the Northeast during the 1600s-1900s. Practices ranged from dyking in the Canadian Maritime Provinces (hereafter referred to as the Maritimes) to ditching, draining, and filling in New England. Since European settlement, increasing human populations and expanding cities and towns have resulted in the continued draining, infilling, and alteration of salt marshes. Loss of coastal wetlands in the United States has been substantial, ranging from 30%-40% (Horwitz 1978) with salt marsh habitat in New England being particularly imperiled (Tiner 1984). Upwards of 50% of tidal wetlands have been lost in Connecticut since European settlers arrived (Niering and Bowers 1966). In Canada, the amount of salt marsh lost in some local areas is upwards of 85% (Reed and Smith 1972), although national statistics are not available (Glooschenko *et al.*. 1988).

Despite the magnitude of habitat change, only recently have agencies concerned with wildlife conservation begun to systematically survey salt marsh avifauna in north-eastern North America. Most of the research on the habitat function of salt marshes in eastern North America has focused on fish (*e.g.* Weinstein and Kreeger 2000). Therefore, quantitative information about species occurrence, relative abundance, and density of key wildlife species is unknown. The North American Breeding Bird Survey does not provide adequate coverage for many breeding bird species, especially habitat specialists, such as salt marsh birds with their inherently patchy distributions (Sauer *et al.* 2000). Bird distributions and, most importantly, population trends are poorly estimated by these data. Inadequate information on the status and distribution of salt marsh bird populations limits the utility of North American Bird Conservation Initiative (NABCI) prioritization, and is the primary reason for many salt marsh bird species being listed as species of high conservation concern (Pashley *et al.* 2000). In the Northeast, species such as Nelson's Sharp-tailed Sparrow, Saltmarsh Sharp-tailed Sparrow, and Willet have been identified as species of concern by state, provincial, and federal agencies.

Habitats within landscapes are altered at varying levels of intensity as human demand for space and natural resources increases. This results in reduced habitat area and changes in the spatial arrangement of habitat across the landscape, i.e. fragmentation (Saunders *et al.*. 1991). Habitat fragmentation can be manifest on the landscape via the direct loss of habitat, reduction in size of remaining patches, increased isolation, and loss of habitat diversity (Fahrig 1997; Saunders *et al.*. 1991; Sisk and Battin 2002). Primary influences on avian community diversity include the quality, juxtaposition, and connectivity of suitable habitat on the landscape. Fragmentation of habitat such as: forests (Askins *et al.*. 1987, Fauth *et al.*. 2000, Flather and Sauer 1996, Hannsson and Angelstam 1991, Robbins *et al.*. 1989), grasslands (Johnson and Igl 2001), and freshwater wetlands (Brown and Dinsmore 1986, Fairbairn and Dinsmore 2001, Naugle *et al.*. 2001) has been implicated as a principal threat to most bird species in the temperate zone (Wilcove *et al.*. 1986) and a primary contributor to the population decline of many North American birds (Askins 2000, Askins *et al.*. 1990). Salt marshes are intrinsically patchily distributed across the landscape and hence fragmentation may not have a big influence on habitat suitability compared to loss of habitat.

Saltmarshes provide habitat for a variety of bird species during all stages of their annual cycle (breeding, migration, wintering). Salt marshes are important habitat for many birds in the Northeast because of the continuum from grassland to wetland, the heterogeneous distribution of micro-scale habitat features, and relatively high productivity found within. This importance is despite the tendency of salt marshes to be dominated by relatively few species of emergent vegetation. Differences in species distributions in the Northeast may result in different responses of the bird community to habitat and landscape features among regions (Johnson and Igl 2000). Habitat suitability studies have indicated that for wading and water birds the presence and configuration of open water habitat is important (Burger and Shisler 1978, Erwin *et al.*. 1994, Hansen 1979). Many passerines have been shown to be sensitive to features of the vegetation, such as: species composition, height, and configuration, as well as tidal inundation (DiQuinzio *et al.*. 2002, Marshall and Reinert 1990, Reinert 1995).

A knowledge of habitat requirement of salt marsh birds requires an understanding of both within-patch and landscape configuration of patches. This knowledge is critical in order to evaluate the desired beneficial effects of human activities (e.g. coastal land use policies and regulations, habitat acquisition,

and habitat restoration) as well as potential negative impacts (e.g. infilling, drainage, disturbance) on bird communities. Understanding salt marsh bird habitat requirements is also critical to estimating the effects of long term (sea-level rise) and short term habitat changes (weather, tidal cycles) on breeding bird distribution, abundance, and population trends. The effects of habitat and landscape features on salt marsh bird species richness in one region may not be the same in other regions, making large-scale, multi-region, coordinated studies and syntheses an important component in determining priorities for conservation and management options within regions.

This report summarizes information collected on salt marshes and their bird communities in the Maritime Provinces. The differences in salt marsh distribution and land use among eco-physical regions is described, and patterns of salt marsh habitat area, isolation, human influence, and vegetative characteristics among regions are discussed as well as relationships between bird use and habitat characteristics.

METHODS

Description of Study Area

Within the Maritime Provinces (Figure 1) three different biophysical regions of salt marshes can be recognized: Bay of Fundy, Atlantic Coast, and Gulf of St. Lawrence. (Roberts and Robertson 1986, Wells and Hirvonen 1988). These regions differ substantially in geology, tidal amplitude, latitude, and human impacts on salt marsh habitats. Habitat use by salt marsh birds represents tradeoffs between habitat preferences that have been influenced by natural selection and habitat availability that has been influenced by geophysical processes and human activity.

Bay of Fundy

The Bay of Fundy is the northeastern most extension of the Gulf of Maine. It is located between the Canadian provinces of New Brunswick and Nova Scotia, and covers an area of 16,000 km^2. The Bay of Fundy is a macro-tidal system with a tidal range of 6 m in the outer bay to 16 m at the head of the bay in Cumberland and Minas Basins (Desplanque and Mossman 2000). A single tidal flow into the Bay of Fundy involves 104 km^3 of water. Thus, during a single day, the volume of water moving in an

out of the Bay of Fundy is equivalent to four times the combined discharge of the world's rivers (Desplanque and Mossman 2004). In addition to the huge tidal range, other factors result in the absolute level of mean high water (MHW) to vary by as much as 5 m at a given location (Palmer 1979, Gordon and Desplanque 1983, Desplanque and Mossman 2004. This temporal variation in MHW is greater than tidal amplitude for most other locations in northeastern North America {Gordon *et. al* 1985). Variation in MHW results in high marsh zone elevations to be greater than 1 m above MHW and only flooded by the highest spring tides (Gordon and Cranford 1994).

High water column sediment concentrations are observed in the upper Bay of Fundy, ranging from 50-100 mg/l (Amos 1987, Gordon and Crandford 1994). This combination of high tidal amplitude and sediment concentrations, results in relatively high rates of sediment accretion and elevation change in Bay of Fundy salt marshes (Van Proosdij *et al.* 2000, Schostak *et al.* 2000, Chmura and Hung 2004, Chmura *et al.* 2001).

High marsh in the Bay of Fundy is typically dominated by *Spartina patens* (Ganong 1903, Chapman 1960, Van Zoost 1970, Morantz 1976, Thannheiser 1981, Thomas 1983, Wells and Hirvonen 1988 Chmura *et al.*. 1997, Van Proosdij *et al.* 1999). Only 3% - 4% of the tides per year, for an average duration of 30 minutes, flood the high marsh in the upper Bay of Fundy (Gordon *et al.*. 1985, Van Proosdij *et al.*. 1999). Low marsh is dominated by *Spartina alterniflora* and can be found at elevations between MHW and approximately 1.2 m below MHW (Van Proosdij *et al.*. 1999). A mid-marsh zone which is a transitional zone between high marsh and low marsh has been described (Wells and Hirvonen 1988, Van Proosdij *et al.*. 1999) and can be dominated by *Plantago maritima* in some marshes (Chmura 1997). Another climatic/physical feature of Bay of Fundy salt marshes is the role of ice in creating salt marsh pannes, exporting detritus, and importing sediment (Bleakney and Meyer 1979, Gordon and Desplanque 1983, Gordon and Cranford 1994, Van Proosdij *et al.*. 2000).

Salt marsh plant growth in the Bay of Fundy occurs during May and October (Cranford *et al.*. 1989) and is similar for salt marshes in the other coastal regions in the Maritimes. Latitudinal decline in salt marsh productivity due to decreasing solar radiation has been documented (Turner 1976) and data from the Bay of Fundy conforms to this trend (Gordon *et al.*. 1985). Primary productivity estimates

for Bay of Fundy salt marshes are lower than those for the Atlantic Coast perhaps due to the irregular and brief inundation of the high marsh (Patriquin and McLung 1978, Smith *et al.*. 1980).

European settlement along the shores of the Bay of Fundy began in 1604. The process of dyking and draining salt marsh for conversion to agricultural fields was initiated in the 1630s along the Annapolis River and in the 1670s in the upper Bay of Fundy, with dykes being maintained to this day (Milligan 1987). By 1920, it has been estimated that 80% of all salt marsh in the Maritimes had been converted to agricultural land (Reed and Smith 1972), a major difference in land use patterns compared to other areas in the Northeast.

The draining and utilization of wetlands through the use of dykes and water control structures is very prevalent in Canada with 222,000 ha of argricultural land behind dykes (Papadopoulus 1995). Currently in the Bay of Fundy there are 35,000 ha of dykeland created through conversion from salt marsh. Recently, dykelands have reverted back to salt marsh in the upper Bay of Fundy where dykes and water control structures have failed and not have been repaired or replaced. In the 1980's, less than 65% of original salt marsh area remained behind dykes compared to 80% in the 1920s (Milligan 1987, Austin-Smith 1998). It has been estimated that 35% of New Brunswick's 141 Bay of Fundy salt marshes were formerly dyked (Reed and Smith 1972, Roberts 1993).

The Maritime Wetlands Inventory estimates that in the early 1980s there were 11,599 ha of salt marsh in the Bay of Fundy (Table 1, Hanson and Calkins 1996). In recent years most of the dykeland has been used for forage production or pasture (Collette 1995). This non-intensive agricultural use of the dykeland can provide habitat for grassland birds (Nocera 2002). Based on samples submitted to Saltonstall (2003) both invasive and naturalised forms of Phragmites are found in the Maritimes. Phragmites is not widely distributed or found in large stands (pers obs.).

Nova Scotia Atlantic Coast

The Nova Scotia Atlantic Coast is a high energy system, experiencing the effects of ocean swells, with a tidal range of 2 m (Wells and Hirvonen 1988, Davis and Browne 1996a). Salt marshes along this coastline are most often small protected pocket wetlands or part of a few large complexes associated with estuaries (Scott 1980, Chagué-Goff *et al.*. 2001). The Nova Scotia Atlantic Coast is a drowned coastline and has been subsiding for 7,000 years (Fensome and Williams 2001) and is characterized by drumlins and terminal moraines (Roland 1982).

The productivity of Atlantic Coast salt marshes has been estimated at 429 g dry wt/m^2 (Roberts 1989). The vegetative zones in these marshes have been described as consisting of *Spartina alterniflora* in low marsh, *Spartina patens* in the middle marsh, and *Juncus gerardii*, and sedges in the high marsh (Wells and Hirvonen 1988 Austin-Smith *et al.*. 2000). Although some have reported *Spartina cyanosuroides* in the high marsh (MacKinnon and Scott 1984, Wells and Hirvonen 1988) this may have resulted from a misidentification of *Spartina pectinata* (pers obs., see also Zinc 1998, Hinds 2000, Fleurbec 1985).

Human land use patterns differ between the Bay of Fundy and the Nova Scotia Atlantic Coast. Historically there was little dyking along the Nova Scotia Atlantic Coast (Kuhn-Campbell 1979). In south-western Nova Scotia, where the coastal plain gradually grades to below sea-level, salt marshes were hayed and grazed without the use of dykes. The drowned coastline of the Atlantic Coast results in the land rising steeply from the shoreline in most locales and this has resulted in little infilling of salt marsh for construction of human infrastructure. The Nova Scotia Atlantic Coast is estimated to have 2,285 ha of salt marsh. (Table 1, Hanson and Calkins 1996).

Gulf of St. Lawrence

The Gulf of St. Lawrence is a low energy system compared to the Atlantic Coast and has a much smaller tidal range compared to the Bay of Fundy (Roland 1982). Tidal ranges are 2-4 m with mixed components of semidiurnal and diurnal influences. In the western section the tides are mainly diurnal with a period of 25 hours hence on some days tides can remain high for 12 hours (Davis and Browne

1996b). The Gulf of St. Lawrence coast consists of a low elevation plain (Fensome and Williams 2001) and is influenced by the transport of sandy materials, with many barrier islands, dunes, lagoons and barachois ponds (Reinson 1980). Residential development, resulting in the infilling of salt marshes and alteration of adjacent habitat, is the primary land use alteration affecting salt marsh habitat in the Gulf of St. Lawrence due to the presence of sandy beaches, warm water and flat topography (Roberts 1993, Maillet 2000, Milewski *et al.*. 2001). There has been little dyking and reclamation of salt marsh in the Gulf of St. Lawrence although some old hand dug dikes can still be seen. Coastal marshes were however hayed and grazed and were also considered very important to early agricultural activities (Hatvany 2001). Marshes were ditched to drain ponds and created drier soils for livestock and equipment.

It has also been noted that estuarine productivity is lower when compared to other shallow salt marsh estuaries along the eastern seaboard of the United States (Couture and Sinclair 1982). Hatcher (1977) estimated net aerial production of *S. alterniflora* to be 931 g/m^2/yr and for *S. patens* to be 453 g/m^2/yr. Roberts (1989) estimated low marsh productivity to be 821 g dry wt. m^2 and high marsh to be 345 g dry wt. m^2. Interestingly the pattern for Baie Verte Creek, a nearby marsh, was 536 g dry wt. m ^{2} for low marsh and 765 g dry wt. m ^{2} for high marsh.

The vegetative community has been described as *S. alterniflora* in the low marsh, *S. patens* in the middle marsh and *Juncus gerardii* in the high marsh (Wells and Hirvonen 1988; Roberts 1989). The *Carex palacea* (scaly sedge) and *S. pectinata* (sloughgrass) zones in Gulf of St. Lawrence salt marshes makes them somewhat different than New England salt marshes (Gauvin 1979). The vegetative zones and ecology of Gulf of St. Lawrence marshes have received little study to date compared to the Bay of Fundy. The Gulf of St. Lawrence has 11,878 ha of salt marsh (Table 1, Hanson and Calkins 1996). The combination of relative low land elevations, intensive coastal zone development and erosive soils makes this area highly susceptible to sea-level rise damage (Shaw *et al.*. 1994). Sediment and organic matter accretion rates in relation to apparent sea-level rise remains largely unquantified (Chmura and Hung 2003).

Survey Methods

Data to estimate avian species richness, abundance, dominant vegetation, surface water area, previous human activity, adjacent land use, and proximity to adjacent salt marsh were collected on salt marshes in the Maritimes using techniques similar to those previously used throughout the Northeast (Benoit and Askins 1999, 2002; Shriver 2002).

Aerial photography and Maritime Wetland Inventory maps were used to identify potential salt marsh survey sites (Hanson and Calkins 1996). To survey resident breeding bird communities, 100 m radius point counts (1 - 46 points/marsh) were conducted within each marsh, during 2000-2002. Each point was visited at least two times annually between 10 June – 30 July, with at least 10 days between visits (Ralph *et al.*. 1995). The number of points located in a marsh was determined by marsh size, with more points in larger marshes. All point centers were > 200 m from any other point center and at least 50 m from an upland edge. For small marshes, where the 100-m-radius point extended into adjoining upland habitat, only birds detected within the marsh were counted.

Observers sampled for 10 minutes at each point and recorded all birds seen and heard within 100 m. Surveys were conducted from dawn to 1100 hrs on days with low wind (< 10 km/hr) and clear visibility. All observers were proficient in bird identification (by sight and sound) prior to this study and were trained in identification of salt marsh bird species. Differences among observers in ability to see and hear birds were not quantified.

The vegetative composition of each marsh was characterized by estimating the percent areal cover of each macrophyte species in a 5 m radius centered on the survey point, and a 5 m wide transect between survey points. To reduce inter-observer variation vegetation surveys were conducted by the author in 2001 and 2002 (n=137) and a summer student in 2000 (n=24). The presence of common reed (*Phragmites australis*), old ditches, or dikes were noted if they occurred within the marsh. To summarize the amount of salt marsh meadow vegetation, the variable COVER was calculated by summing the percent cover of *S. patens*, *S. pectinata*, *Carex paleacea*, and *Juncus gerardii*. Wetland inventory maps (Hanson and Calkins 1996), National Topographic Series maps (1:50,000 scale) and the most recent air photos were used to determine landscape level features. Marsh boundaries were

determined by paved roads, or water channels greater than 100 m wide. This definition of marsh boundaries ensured that the salt marsh is a relatively homogeneous patch within the landscape matrix (Forman 1995).

A proximity index was determined using wetland inventory maps and data (Hanson and Calkins 1996). Because the Maritime Wetland Inventory data was point-based, the proximity index was derived by summing the ratio of size (ha) of an adjacent salt marsh divided by its distance (km) to study marsh for all marshes within 1 km of the boundary of the study marsh. This proximity index was based on the total marsh area of adjacent marshes and therefore could be greater than 10, with values of 0 - 131 being derived. Similar to Shriver (2002), a proximity index of 0 represents an isolated marsh with no marshes within 1 km of the marsh boundary, with higher values representing more adjacent marsh habitat. The number of buildings within 125 m, 250 m, and 500 m radii was determined as an index of human disturbance. The number and total area (ha) of ponds in the marsh, the presence of dykes or ditches in the marsh, and the presence of adjacent (25 m) and nearby (250 m) agricultural fields were determined based on air photos.

Species richness in marshes was based on 3 guilds: (1) obligate wetland birds, (2) wading birds, and (3) passerines. Similar to Shriver (2002) these bird species were dependent on salt marshes during the breeding season. Birds that were classified as being infrequent or opportunistic users of salt marsh habitat were not included in calculations of species richness, even though they may have been recorded during the surveys. These species were not assigned a guild in Appendix A. The total number of species detected per marsh was used as an index to species richness (SPP) whereas an area-independent estimate of species richness was the mean number of species detected per survey point in each marsh (RICHNESS).

With the notable exception of Willets, few obligate salt marsh breeding bird species occur throughout the entire Northeast. Saltmarsh Sharp-tailed Sparrows reach their northern limit at the Weskeag Marsh near Thomaston, Maine and Nelson's Sharp-tailed Sparrows reach their southern limit in northern Massachusetts (Hodgman *et al.* 2002). Models were developed to attempt to explain the occurrence and abundance of Willets and Nelson's Sharp-tailed Sparrows in relation to landscape and patch scale variables in the Maritimes because they were observed in many marshes throughout the region, nesting

in or in close proximity to the marsh, and are a conservation priority (Pashley *et al.*. 2000). Models were also developed to attempt to explain the abundance of Savannah Sparrows which are also routinely found in salt marshes in the Maritimes.

Statistical Analysis

General linear models (GLMs) were used to determine which marsh-level and landscape-level features were significantly related to the mean number of birds or number of species observed per survey point in each marsh (SAS 2001). Whereas sample size was relatively small for the Atlantic Coast, and these deterministic models should apply to salt marshes for all study regions, data were pooled for all study regions, and region was not included as a class variable in GLMs. The mean number of individuals per survey point will be referred to as density. Separate models were developed for Nelson's-sharp-tailed Sparrow, Willet, Savannah Sparrow densities as well as species richness. Logistic regression was used to determine the importance of vegetative community on the presence of a given species at a survey point (Proc LOG; SAS 2001). Proportional data were arcsine transformed prior to analysis, count data were square root transformed, and other variables log-transformed prior to statistical analysis (Zar 1999).

RESULTS

Summary data for most of the survey marshes are presented in Appendices A.1 - E.6

The results from bird surveys are provided on the CD in the Excel file entitled 'Avian Survey Results'. The Results Worksheet contains the data, the Metadata Worksheet describes the variables, and the AOU Codes Worksheet provides the American Ornithologist's Union Species Codes.

The results from the vegetation surveys are provided on the CD in the Excel file entitled 'Vegetation Survey Results'. The Results Worksheet contains the data, whereas the Metadata Worksheet describes the variables.

Although care has been taken to ensure the veracity of these data, there may be still be errors in these data. **Please note that no publication or citation of these raw data may be undertaken without the written permission of the Canadian Wildlife Service.**

Salt Marshes in the Maritimes

Surveys were conducted on 160 marshes throughout the Canadian Maritime Provinces. The previously described regions differed in distribution of marsh size, the extent of human disturbance, and vegetation composition. Fewer salt marshes were surveyed along the Atlantic Coast (n = 16) compared to Bay of Fundy (n = 71) or Gulf of St. Lawrence (n = 72; Table 2). Salt marshes surveyed in the Bay of Fundy were larger compared to salt marshes surveyed along the Atlantic Coast, consistent with the size distribution of salt marshes reported by the Maritime Wetlands Inventory (Hanson and Calkins 1996). Old dykes or ditching was present in 36% and 47% of Bay of Fundy salt marshes, respectively. Old dykes or ditching was not present in study marshes along the Atlantic Coast whereas along the Gulf of St. Lawrence they were present in 14% and 17 % of the marshes studied.

Gulf of St. Lawrence salt marshes had a greater number of buildings within 500 m, compared to salt marshes along the Atlantic Coast or Bay of Fundy (Table 2). Gulf of St. Lawrence marshes also had a greater number and greater total area of ponds. Approximately 75% of the surveyed marshes in the Gulf of St. Lawrence had *Spartina pectinata* present (Table 2).

Nelson's Sharp-tailed Sparrow density was similar for study marshes among all three regions (Table 2). The density of Willets was higher for Atlantic Coast marshes compared to Gulf of St. Lawrence marshes, and markedly higher than observed for Bay of Fundy marshes (Table 2). Savannah Sparrow density was lower in Bay of Fundy marshes compared to those along the Gulf of St. Lawrence or Atlantic Coast.

Two salt marshes, Flat island and Sandy Point, were surveyed on the island of Newfoundland (see data on CD). Nelson's Sharp-tailed Sparrows were not recorded on any surveys in these locations in

accordance with reports from breeding bird distributions in Canada. Willets were quite common in both marshes with approximately 6 pairs (Winsor unpubl report).

Landscape and Patch Level Effects

Individual bird species differed in their response to landscape-level and patch level descriptors of habitat. Marsh area was an important determinant of Nelson's Sharp-tailed Sparrows and Savannah Sparrows densities, and species richness (Tables 3-5). The density of Nelson's Sharp–tailed Sparrow increased with increasing marsh size with no further apparent increase in density for marshes > 10 ha (Figure 3). Nelson's Sharp-tailed Sparrow density in marshes < 5.0 ha (0.33 ± 0.07, $\bar{X} \pm$ SE) was less than that for marshes ≥ 5 ha (1.07 ± 0.09, $P = 0.000005$). Willet density was not influenced by marsh area but was positively influenced by pond area. It should be noted that salt marsh area was correlated with pond area ($R^2 = 0.73$) and density of Willets was positively associated with marsh area in models which included marsh area but not pond area (unpubl. data).

The density of Savannah Sparrows was negatively affected by pond area. The average amount of salt marsh meadow vegetation (COVER) in the marsh positively influenced the density of Willets and species richness (Tables 4, 5). The number of dwellings within 500 m also positively influenced species richness. The proximity index or the number of dwellings within 125 m of the study marsh did not affect any of the bird habitat use response variables.

The presence of old dykes and old ditches on the marsh itself, or the presence of dykeland nearby, did not affect the density of Willets or Savannah Sparrows or species richness. The density of Nelson's Sharp-tailed Sparrows per survey point was positively influenced by the presence of adjacent dykeland (Table 6).

Effects of Vegetative Composition

The density of Willets was positively associated with pond area, as previously mentioned, as well as the presence of *Juncus gerardii*, *Spartina alterniflora*, and *Spartina patens* (Table 7). The use of Aikake's Information Criterion (Burnham and Anderson 1998) indicated many potential best models

using various combinations of these variables (Hanson unpubl data). Nelson's Sharp-tailed Sparrows and Savannah Sparrows were not affected by salt marsh meadow cover or individual plant species (Tables 7, 8). For Savannah Sparrows, models which included the amount of *S. patens* and *Carex palacea* as well as marsh and pond area had the lowest AICc scores (Hanson unpubl data).

Species richness was influenced by *S. alterniflora*, *S. patens*, and *S. pectinata* as well as marsh area and dwellings as indicated earlier (Table 8). The model with the lowest AICc score included these four variables (Hanson unpubl data).

Whereas great heterogeneity can be observed in vegetation and the number of birds among survey points within a marsh, an analysis was conducted at the spatial scale of the individual survey point. Variables such as marsh size and pond area have previously been shown to be important and are the same for all survey points within a marsh and hence their significance in logistic models will not be further discussed. The presence of one or more Willets at a given survey point was positively correlated with pond area, *S. patens*, *S. alterniflora*, and *Carex palacea*, and a negative correlation with marsh area, and *S. pectinata* (Table 9). The presence of Nelson's Sharp-tailed Sparrow at a survey point was positively correlated with marsh area, and *S. patens*, as well as negatively associated with *S. pectinata*, and *S. alterniflora*. There was no relationship to the coverage of *Plantago maritima*, *Carex palacea*, or *Scirpus maritimus* (Table 10). The presence of Savannah Sparrows at a survey point was positively influenced by marsh area and *Plantago maritima*, and negatively by pond area, *S. alterniflora*, and *S. patens* (Table 11).

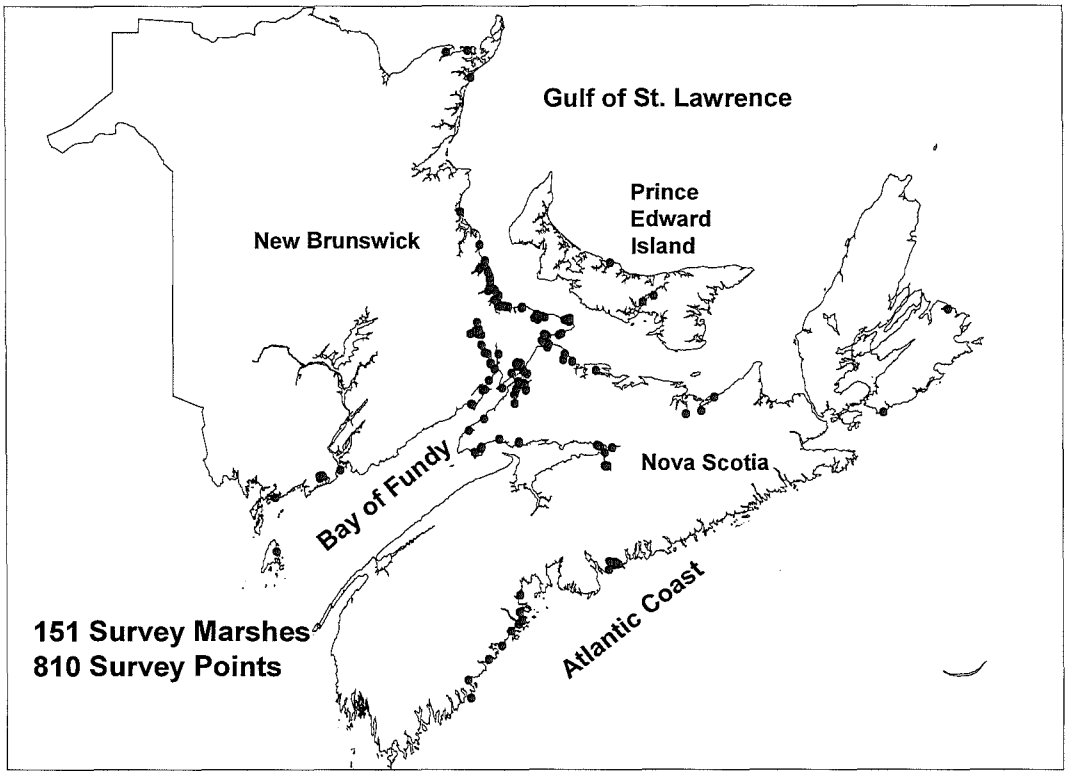

Figure 1- Location of study marshes in the Bay of Fundy, Atlantic Coast and Gulf of St. Lawrence in the Canadian Maritime Provinces.

Marsh Descriptor	Atlantic	Bay of Fundy	Gulf of St. Lawrence
MWI – Number of Salt Marshes	598	574	2106
MWI - Total Marsh Area (ha)	6,075	7,793	11,880
MWI - Median Marsh Size (ha)	4.2	5.9	2.6
MWI - Mean (SE) Marsh Size (ha)	10.2 (0.83)	13.6 (0.91)	5.6 (0.21)
Study Marshes – Total Number	16	72	72
% with Adjacent Dykes	0	29	6
% with Old Dykes in Marsh	0	36	14
% with Old Ditches in Marsh	0	47	37
% with Ponds	69	61	85
% with *Phragmites*	0.0	4.2	5.6

Table 1 - Landscape level descriptors of salt marshes in the Atlantic, Bay of Fundy and Gulf of St. Lawrence Regions. Maritime Wetland Inventory (MWI) data obtained from Hanson and Calkins (1996).

	Atlantic Coast		Bay of Fundy		Gulf of St. Lawrence	
	Mean	SE	Mean	SE	Mean	SE
Marsh Area (ha)	19.98	4.78	52.75	10.97	24.12	4.68
Number of Ponds	9.56	5.08	12.29	2.34	24.88	5.51
Pond Area (ha)	5.41	1.76	5.91	1.08	9.26	1.54
Marsh Area (ha)	19.98	4.78	52.75	10.97	24.12	4.68
Proximity Index	3.00	0.85	19.18	3.19	10.44	1.57
Number of Dwellings 0 - 125m	6.88	2.22	5.21	1.19	8.47	1.93
Number of Dwellings 125 - 250m	7.88	1.90	8.38	2.67	10.56	2.51
Number of Dwellings 250 - 500 m	17.88	3.50	22.51	5.46	31.29	6.74
Total Number of Dwellings < 500m	32.63	5.51	36.10	8.59	50.32	10.03
NSTS per Marsh	6.48	2.35	5.74	0.92	4.74	0.84
NSTS per Point	0.97	0.19	0.85	0.13	0.90	0.09
WILL per Marsh	6.63	2.28	0.63	0.25	2.99	0.62
WILL per Point	1.20	0.22	0.14	0.06	0.69	0.11
SAVS per Marsh	7.53	4.35	3.25	0.71	4.17	1.28
% Cover	33.25	4.99	53.86	2.88	52.59	2.53
No. Passerine Spp.	5.06	0.75	4.19	0.34	5.69	0.40
No. Wetland Spp.	7.13	1.43	2.97	0.40	5.99	0.51
No. Wader Spp.	0.94	0.11	0.49	0.07	0.76	0.07
No. Gull Spp.	1.75	0.17	0.79	0.11	1.18	0.13
Total Spp.	14.88	2.24	8.44	0.79	13.63	0.93
No. Spp per Point	7.32	0.85	3.92	0.29	8.40	0.53

Table 2 – Summary statistics of study salt marshes in the Atlantic, Gulf of St. Lawrence and Bay of Fundy Regions (NSTS – Nelson's Sharp-tailed Sparrow, WILL – Willet; see Methods for full description of variables)

Variable	Class A 1.0 - 2.3 ha (n=20)		Class B 2.7 -5.0 ha (n=21)		Class C 5.1 -10.0 ha (n=29)		Class D 10.1 -18.7 ha (n=24)		Class E 20 -39 ha (n=34)		Class F 41 -89 ha (n=18)		Class G 91 - 435 ha (n=14)	
	X	**SE**	**X**	**SE**	**X**	**SE**	**X**	**SE**	**X**	**SE**	**X**	**SE**	**X**	**SE**
Pond Area	0.35	0.13	2.02	0.96	2.66	0.58	4.21	0.78	9.48	1.50	19.16	3.84	20.43	4.57
Marsh Area	1.55	0.13	3.72	0.19	7.47	0.27	13.96	0.60	28.85	0.85	60.72	3.14	222.85	31.48
Proximity Index	4.28	2.15	4.51	1.85	8.19	2.45	16.14	5.48	18.50	4.34	22.00	5.57	25.05	5.65
Total Number of. Dwellings < 500 m	42.75	11.60	44.43	15.17	43.41	18.36	36.21	12.67	37.62	10.88	27.11	6.46	75.79	35.62
% Cover	59.78	6.64	55.24	7.08	54.86	4.26	53.11	3.57	47.23	3.08	42.43	5.06	43.99	4.55
NSTS per Marsh	0.17	0.08	0.79	0.25	2.00	0.62	3.87	0.88	7.13	1.18	11.85	2.59	16.56	2.36
NSTS per Point	0.17	0.08	0.48	0.11	0.74	0.20	1.14	0.21	1.14	0.18	1.23	0.17	1.30	0.16
WILL per Marsh	0.42	0.19	1.05	0.46	1.36	0.52	1.76	0.35	3.16	1.19	4.87	1.98	4.26	1.69
WILL per Point	0.42	0.19	0.57	0.23	0.56	0.18	0.51	0.10	0.39	0.10	0.68	0.28	0.37	0.17
SAVS per Marsh	0.28	0.13	1.16	0.37	1.88	0.66	1.75	0.53	5.07	1.03	6.51	3.78	17.07	5.92
SAVS per Point	0.28	0.13	0.94	0.31	0.64	0.14	0.62	0.22	0.73	0.13	0.50	0.21	1.06	0.26
No. Passerine Spp.	3.20	0.56	3.19	0.63	4.17	0.46	5.00	0.65	6.50	0.57	5.22	0.64	7.57	0.76
No. Wetland Spp.	2.10	0.62	1.62	0.37	4.52	0.89	4.33	0.66	6.38	0.76	7.39	1.19	7.00	1.24
No. Wader Spp.	0.45	0.11	0.52	0.13	0.62	0.12	0.54	0.12	0.79	0.08	0.83	0.19	0.86	0.18
No. Gull Spp.	0.60	0.18	0.71	0.18	1.07	0.24	0.75	0.15	1.38	0.19	1.17	0.22	1.86	0.25
Total No. Spp. per Marsh	6.35	1.28	6.05	1.10	10.38	1.52	10.63	1.34	15.06	1.30	14.61	1.88	17.29	1.97
Total No. Spp. per Point	6.18	1.26	5.19	0.88	6.86	0.82	6.14	0.74	7.19	0.78	5.41	0.76	5.96	0.69

Table 3 - Summary statistics of study salt marshes according to marsh size. (NSTS – Nelson's Sharp-tailed Sparrow, WILL – Willet; see Methods for description of variables).

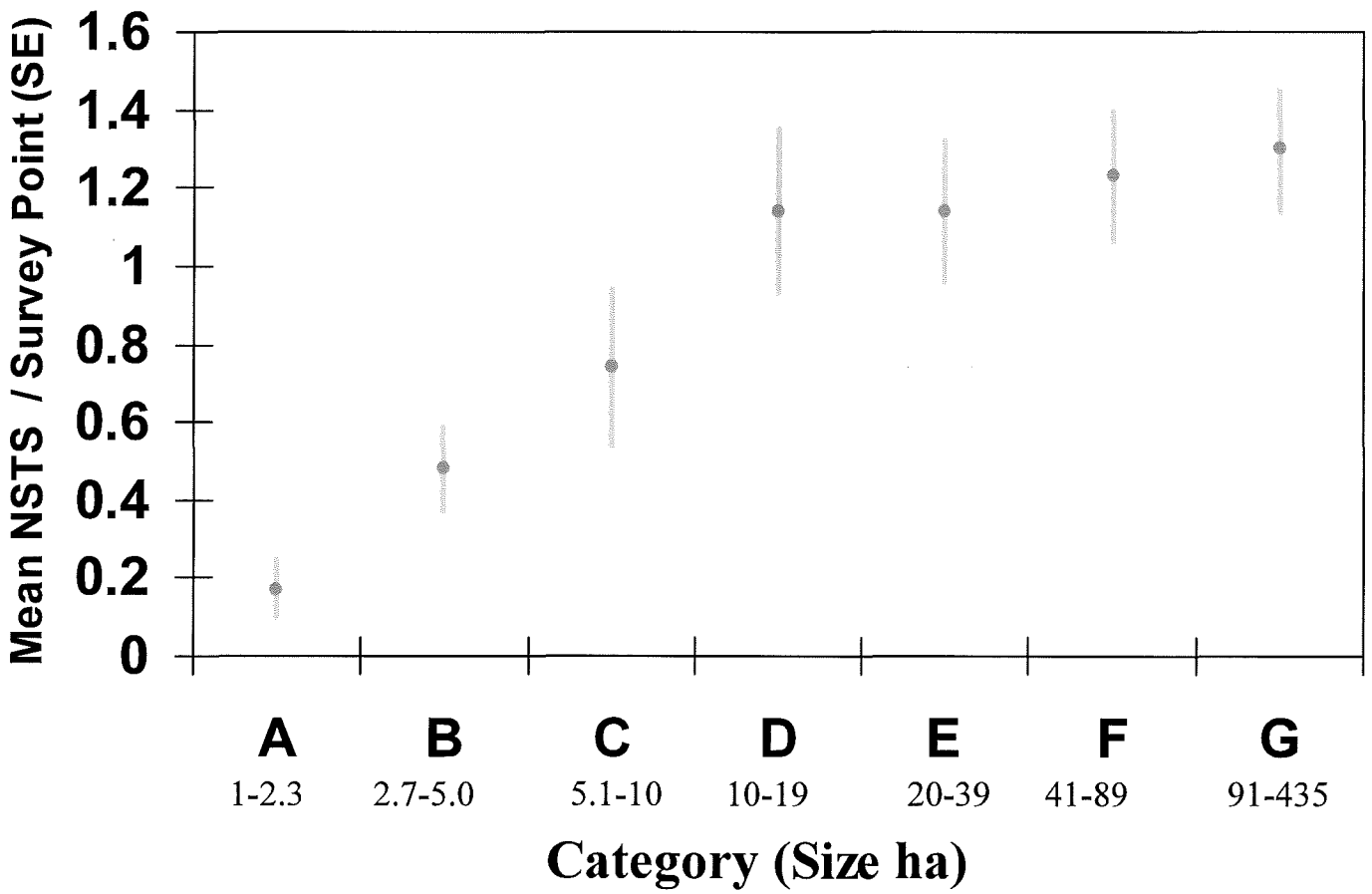

Figure 3 – Mean (± SE) number of Nelson's Sharp-tailed Sparrows (NSTS) per survey point in relation to marsh size.

NSTS	F Value	Parameter Estimate	Pr>F
Model (R^2=0.69)	56.83		0.0001
Marsh Area	27.03	0.151	0.0001
Dwellings <125 m	0.11	0.004	0.7366
Total Dwellings	0.02	0.000	0.8916
Proximity Index	0.05	0.005	0.8318
Pond Area	0.60	0.0249	0.4403
Meadow	1.10	0.0325	0.2966
WILL	**F Value**	**Parameter Est.**	**Pr>F**
Model (R^2=0.37)	15.07		0.0001
Marsh Area	0.22	-0.014	0.6384
Dwellings <125 m	1.26	0.013	0.2627
Total Dwellings	0.17	0.000	0.6829
Proximity Index	0.46	-0.018	0.4974
Pond Area	8.84	0.100	0.0034
Meadow	4.28	0.067	0.0403

Table 4 - Results from GLMs for evaluating the importance of marsh and landscape descriptors on the mean number of Nelson's Sharp-tailed Sparrows (NSTS) and Willets (WILL). See Methods for full description of variables.

SAVS	F Value	Parameter Estimate	Pr>t
Model (R^2=0.49)	23.95		0.0001
Marsh Area	0.0002	0.124	0.0002
Dwellings <125 m	0.0768	0.022	0.0768
Total Dwellings	0.7985	0.001	0.7985
Proximity Index	0.3328	0.0278	0.3328
Pond Area	0.0054	-0.102	0.0054
Meadow	0.9279	0.003	0.9279
Species Richness	**F Value**	**Parameter Estimate**	**Pr>t**
Model (R^2=0.87)	174.42		0.0001
Marsh Area	14.40	0.617	0.0002
Dwellings <125 m	0.06	-0.015	0.8087
Total Dwellings	9.62	0.080	0.0023
Proximity Index	0.02	0.0019	0.8958
Pond Area	0.88	0.169	0.3496
Meadow	66.86	1.419	0.0001

Table 5 - Results from GLMs for evaluating the importance of marsh and landscape descriptors on the mean number of Savannah Sparrows (SAVS), and Species Richness. See Methods for full description of variables.

NSTS	F Value	Pr > F
Model (R^2= 0.26)	46.04	0.0001
Marsh Area	16.98	0.0001
Proximity Index	0.04	0.8344
Pond Area	2.24	0.1362
Salt Meadow Cover	0.17	0.6782
Old Ditching	0.04	0.8346
Old Dykes	2.12	0.1474
Adjacent Dykeland	8.23	0.0047

Table 6 - Result from GLM to evaluate the importance of agricultural land features on the mean number of Nelson's Sharp-tailed Sparrows (NSTS) observed per survey point. See Methods for full description of variables.

WILL	DF	Type III SS	Mean Square	F Value	Pr > F
Marsh Area	1	0.02000000	0.02251795	0.83	0.3629
Dwellings	1	0.09624396	0.09624396	3.56	0.0612
Proximity Index	1	0.02607383	0.02607383	0.96	0.3277
Pond Area	1	0.23312034	0.23312034	8.62	0.0039
D. spicata	1	0.05224722	0.05224722	1.93	0.1666
P. maritima	1	0.03553866	0.03553866	1.31	0.2534
J. gerardii	1	0.14173863	0.14173863	5.24	0.0235
C. palacea	1	0.07133232	0.07133232	2.64	0.1064
S. alterniflora	1	0.11748369	0.11748369	4.35	0.0388
S. patens	1	0.28959725	0.28959725	10.71	0.0013
S. pectinata	1	0.02424354	0.02424354	0.9	0.3452
NSTS	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Marsh Area	1	0.72744938	0.72744938	25.79	0.0001
Dwellings	1	0.00460867	0.00460867	0.16	0.6866
Proximity Index	1	0.00024353	0.00024353	0.01	0.9261
Pond Area	1	0.02084703	0.02084703	0.74	0.3914
D. spicata	1	0.00438813	0.00438813	0.16	0.6938
P. maritima	1	0.00543952	0.00543952	0.19	0.6612
J. gerardii	1	0.03467824	0.03467824	1.23	0.2693
C. palacea	1	0.00174899	0.00174899	0.06	0.8037
S. alterniflora	1	0.07151753	0.07151753	2.54	0.1135
S. patens	1	0.07207637	0.07207637	2.56	0.1121
S. pectinata	1	0.00112439	0.00112439	0.04	0.8420

Table 7 - Results from general linear models to determine the importance of vegetation on the mean number of Willets (WILL) per survey point and Nelson's Sharp-tailed Sparrow (NSTS) per survey point. See Methods for full description of variables.

SAVS	DF	Type III SS	Mean Square	F Value	Pr > F
Marsh Area	1	0.60661269	0.60661269	17.22	0.0001
Dwellings	1	0.23408934	0.23408934	6.64	0.0109
Proximity Index	1	0.01979304	0.01979304	0.56	0.4548
Pond Area	1	0.23693854	0.23693854	6.72	0.0105
D. spicata	1	0.00600342	0.00600342	0.17	0.6804
P. maritima	1	0.00462142	0.00462142	0.13	0.7178
J. gerardii	1	0.00750865	0.00750865	0.21	0.645
C. palacea	1	0.06768736	0.06768736	1.92	0.1679
S. alterniflora	1	0.08940454	0.08940454	2.54	0.1133
S. patens	1	0.08278373	0.08278373	2.35	0.1275
S. pectinata	1	0.04458199	0.04458199	1.27	0.2625
Species Richness	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Marsh Area	1	5.78218811	5.78218811	6.95	0.0093
Dwellings	1	14.09968128	14.09968128	16.94	0.0001
Proximity Index	1	0.00175042	0.00175042	0.00	0.9635
Pond Area	1	0.34621667	0.34621667	0.42	0.5200
D. spicata	1	1.07864300	1.078643	1.3	0.2568
P. maritima	1	0.07899726	0.07899726	0.09	0.7585
J. gerardii	1	0.30427385	0.30427385	0.37	0.5464
C. palacea	1	0.06378908	0.06378908	0.08	0.7823
S. alterniflora	1	7.80757666	7.80757666	9.38	0.0026
S. patens	1	47.26798878	47.26798878	56.79	0.0001
S. pectinata	1	16.11338625	16.11338625	19.36	0.0001

Table 8 - Results from general linear models to determine the importance of vegetation on the mean number of Savannah Sparrows (SAVS) and species richness per survey point. See Methods for full description of variables.

Willet	Present = 318	Absent = 463	R^2= 0.16	
Parameter	**Estimate**	**Error**	**Chi-Square**	**Pr> ChiSq**
Marsh Area	-0.8021	0.1284	39.0554	0.0001
Dwellings	0.0203	0.0178	1.3028	0.2537
Pond Area	0.6898	0.162	18.1428	0.0001
S. patens	0.446	0.1711	6.7915	0.0092
S. pectinata	-1.0398	0.3209	10.4996	0.0012
S. alterniflora	0.5113	0.1895	7.2782	0.007
S.maritimus	-0.8087	0.6918	1.3667	0.2424
P.maritimus	-0.1311	0.4569	0.0824	0.7741
C. palacea	-1.2237	0.5651	4.6887	0.0304

Table 9 - Results from logistic regression to determine which landscape and marsh descriptors of habitat were related to the presence of one or more individuals at a given survey point. See Methods for full description of variables.

Nelson's Sharp-tailed Sparrow	Present = 628	Absent = 153	R^2 = 0.52	
Parameter	**Estimate**	**Error**	**Chi-Square**	**Pr> ChiSq**
Marsh Area	1.122	0.1647	46.405	0.0001
Dwellings	-0.0288	0.0206	1.9593	0.1616
Pond Area	0.0521	0.2023	0.0662	0.7969
S. patens	0.4615	0.2228	4.29	0.0383
S. pectinata	-0.7563	0.3031	6.2247	0.0126
S. alterniflora	-0.82	0.2225	13.5828	0.0002
S.maritimus	-0.5865	0.7049	0.6923	0.4054
P.maritimus	0.2475	0.6264	0.1561	0.6928
C. palacea	0.9004	0.6764	1.772	0.1831

Table 10 - Results from logistic regression to determine which landscape and marsh descriptors of habitat were related to the presence of one or more Nelson's Sharp-tailed Sparrows at a given survey point. See Methods for full description of variables.

Savannah Sparrow Present = 430 Absent = 351 $R^2 = 0.15$				
Parameter	**Estimate**	**Error**	**Chi-Square**	**Pr> ChiSq**
Marsh Area	0.981	0.1343	53.3606	0.0001
Dwellings	0.00337	0.0171	0.0386	0.8442
Pond Area	-1.0471	0.1684	38.6655	0.0001
S. patens	-0.2766	0.1707	2.6252	0.1052
S. pectinata	-0.7177	0.2703	7.0477	0.0079
S. alterniflora	-0.905	0.1965	21.2198	0.0001
S.maritimus	1.1603	0.7142	2.6396	0.1042
P.maritimus	0.9606	0.4814	3.9813	0.046
C. palacea	-0.4757	0.4608	1.0657	0.3019

Table 11 - Results from logistic regression to determine which landscape and marsh descriptors of habitat were related to the presence of one or more Savannah Sparrows at a given survey point. See Methods for full description of variables.

DISCUSSION

Importance of Marsh Area

The density of Nelson's Sharp-tailed Sparrows in a marsh was positively correlated with salt marsh area. These finding are consistent with the findings for other salt marsh specialist bird species such as Seaside Sparrows, and Saltmarsh Sharp-tailed Sparrows in the New England Gulf of Maine and along Long Island Sound (Benoit and Askins 2002; Shriver *et a.*. 2004). The presence of Nelson's Sharp-tailed Sparrows in salt marshes in the New England Gulf of Maine was not influenced by marsh size, although Shriver (2002) did observe that 13 of 14 species detected on greather than 10% of marshes were more likely to be detected on larger marshes compared to smaller marshes. It also should be noted that salt marshes in the New England Gulf of Maine range of Nelson's Sharp-tailed (northern MA – Lubec, ME) are relatively small and patchily distributed which may explain why the occurrence of this species was not sensitive to marsh area in that region. Shriver (2002) did not evaluate the impact of marsh size on density.

The density of Willets was positively correlated with pond area and pond area was highly correlated with marsh area. Hence the results from the Maritimes are consistent with the results from the New England Gulf of Maine and Long Island Sound where the presence and/or density of Willets was positively correlated with marsh area (Benoit and Askins 2002; Shriver *et al.* 2002).

Willets, Nelson's Sharp-tailed Sparrows and Savannah Sparrows were not sensitive to the proximity to other salt marshes, similar to the findings for Nelson's Sharp-tailed Sparrows in the Gulf of Maine (Shriver 2002). The presence of Willets was positively correlated to proximity to other salt marshes in the Gulf of Maine (Shriver 2002).

For species such as Nelson's Sharp-tailed Sparrow, habitat loss may not be as important as fragmentation. This is primarily because these species do not use a mosaic of habitat patches within the landscape. If birds were able to adjust to a reduction in marsh area by using other salt marsh patches within the landscape, then the restrictive definitions of salt marsh boundaries used, *e.g.* a paved road between two adjacent salt marshes, would have obscured the importance of size. Benoit and Askins (2002) observed an effect of marsh size for Willet and Seaside Sparrow using both broad barrier and narrow barrier definitions of marsh boundaries. Radio-telemetry of Nelson's Sharp-tailed Sparrow in Maine did not indicate external marsh movements (Shriver 2002). In the Maritimes, marsh size was not important for facultative or opportunistic users of salt marshes, such as Savannah Sparrow and Great Blue Heron, perhaps because these species are using several habitat patches within the landscape mosaic. Differences among species in the importance of marsh area are consistent with findings for grassland (Bakker *et al.* 2002) and forest birds (Mitchell *et al.* 2001) where individual species demonstrated scale dependent differences in how they perceived habitat and landscape structure, and that no single scale was appropriate for assessing habitat. However the importance of marsh size in results from different studies for different species in north-eastern North America suggest that large coastal marshes should be kept intact and that the wildlife habitat benefits of several small salt marsh restoration projects may not be as great as a single large project.

It is important to consider absolute marsh size, when evaluating the effects of marsh area on bird distribution. For example small marshes were defined as less than 5 ha in the Maritimes whereas Shriver (2002) used 35 ha as a criterion. Willets in Connecticut were not found in marshes less than 138 ha, whereas in Canada, Willets were found in much smaller marshes. This difference may be due to the sizes of marshes present, or low Willet populations. Habitat use does not always equate with habitat selection (Van Horne 1983).

In comparison to eastern forested landscapes or western grassland landscapes, the coastal wetlands of northeastern North America are relatively small discrete habitats patchily distributed along the shoreline. Salt marsh birds are in many locales forced to use only one marsh because others are not available. Hence, the selection pressure for pioneering individuals who investigate several habitats may be small. Larger blocks of salt marsh may be selected because they could potentially have lower predation risk from upland predators, have more foraging areas, or have areas of higher elevation (micro-topography).

The insularity of salt marshes may also explain why the number of dwellings within 125 m of the marsh had no impact on densities of salt marsh birds in the Maritimes. Shriver (2002) did not observe an effect of road density on species richness in either the Connecticut Shore of Long Island Sound or the New England Gulf of Maine. These findings do not minimize the importance of the upland edge boundary as nesting cover for species such as Willet and Nelson's sharp-tailed sparrow in the Maritimes (pers. obs.).

Although proximity to adjacent salt marsh habitat did not influence Sharp-tailed Sparrow densities, the presence of adjacent dykeland habitat did. Nelson's Sharp-tailed Sparrows use tall grass cover in agricultural areas, and riverine floodplain in the Maritimes (Townsend 1912, Nocera 2002, Conner 2002). Willets will also nest in dykeland pasture (pers. obs.) as well as considerable distances from estuarine feeding areas (Hansen 1979).

Species Richness

Data indicate that species richness was greater on larger marshes. This finding is consistent with the Gulf of Maine (Shriver *et al.* 2004). This may reflect different habitat types being present in these larger marshes or a larger habitat target for individuals to discover. In the Maritimes, the Great Blue Heron was the only wading species regularly associated with salt marshes, compared to the many species of waders observed in US salt marshes. Gulls used marshes and associated ponds and lagoons for feeding to various degrees in the Maritimes. Greater Black-backed Gulls were observed nesting in larger salt marshes. The whole concept of species richness for salt marshes becomes confounded by inclusion of breeders and non breeders.

Within Marsh Characteristics

Tidal flooding is an important proximate and ultimate determinant of nest success and hence nest site selection by females (Reinert and Mello 1995, Shriver 2002). Singing male Nelson's Sharp-tailed Sparrows are associated with females who remain relatively close to the nesting area (Shriver 2002). This results in males using the higher elevations of the marsh. In the Maritimes, male Sharp-tailed Sparrows will use old fence posts, bushes or spruce trees as singing perches if available (Hanson pers. obs.). The species of plants associated with higher elevations of the marsh depend on absolute elevations. In some marshes there are only *S. alterniflora* and *S. patens* zones whereas in other marshes there may also be a zone of higher elevation adjacent to the upland that may contain *Juncus gerardii*, *Carex paleacea*, *Juncus balticus* or *S. pectinata*. Hence there was not a strong selection for one species of vegetation over another. The issue of habitat suitability and abundance of birds in Long Island Sound was largely influenced by birds using marshes with *Phragmites* less often compared to marshes with natural vegetation (Benoit and Askins 1999)

The abundance of Willets was positively correlated to pond area and indicators of high marsh. Willets in the Maritimes have been observed to feed intensively on intertidal mudflats (Hansen 1979) as well as saline ponds (Burger and Shisler 1978). Perhaps the correlation to salt marsh meadow vegetation reflects the importance of nesting habitat.

Savannah Sparrows were observed more often in larger salt marshes with fewer ponds. They are usually considered an upland species so perhaps that is why they were negatively associated with ponds as well as *S. alterniflora*, and *S. pectinata*. They were more frequent in survey points adjacent to the upland edge or along adjacent dune ridges (pers. obs).

Conservation of Salt Marsh Habitat

As described earlier there are considerable differences in the nature of salt marshes that naturally occur and remain throughout the Northeast. Salt marshes have been lost due to drainage or infilling and modified by activities such as ditching. The extent and intensity of such activities varies throughout the Northeast. It is important to realize that remaining salt marshes may not be representative of past conditions and that habitat use can only be based on habitat types that are available.

The conservation of salt marshes in New England has been facilitated through the enactment of various federal and state policies and regulations. In Canada, the *Federal Policy on Wetland Conservation* was implemented in 1991 (Government of Canada 1991) and the provincial governments in the Maritimes have recently passed wetland protection policies. Regulations to protect coastal wetlands are forthcoming and much needed. In the Maritimes, coastal wetlands in the Gulf of St. Lawrence are most threatened due to high recreational use of the shoreline. Coastal wetlands may also be threatened in this region due to potential human responses to sea-level rise on this low elevation coastline. Collectively, studies in the Northeast have indicated the importance of wetland size to bird diversity and density in salt marshes. Currently the proportion of salt marshes greater than 5.0 ha is only 54%, 45%, and 31% of the total number in Bay of Fundy, Atlantic and Gulf of St. Lawrence respectively. Because of the steep topography of the Nova Scotia Atlantic coastline there is less pressure to infill salt marshes for residential development. Agricultural demand for dykeland and salt marsh is

declining, so rather than being a reason for further loss there has been an increase in the availability of salt marsh as dykes and aboiteaux have failed.

Implications for Bird Conservation

In the Northeast, Willets were market hunted almost to extirpation by 1910 (Hansen 1979; Tufts 1986). The Willet population north of Virginia was reduced to a small breeding population in southern Nova Scotia. Populations increased throughout Nova Scotia after the 1920s and the passage of the Migratory Bird Convention Act (Erskine 1992). Willets were not reported to be nesting again in New Brunswick until 1966 and for Prince Edward Island it wasn't until 1974.

The absence of Willets from many salt marshes may reflect unsuitable habitat or unused habitat. Regardless of the reason(s), this small population is cause for concern because of low intrinsic capacity for population increase and sensitivity to habitat degradation or environmental catastrophe. The lack of ponds on many salt marshes in the upper Bay of Fundy may be due to vestigial dikes that preclude ice rafting and presence of ditches that promote drainage of ponds. Without an understanding of natural pond formation processes, direct human intervention to create ponds on salt marsh by direct human activity may be considered habitat degradation and not restoration.

Nelson's Sharp-tailed Sparrows seem to be present in all moderately sized marshes in the Maritimes. They have adapted to dykeland habitats and seem to be equally at home in agricultural fields and the floodplain grasslands (Conner 2002; Nocera 2002). Data collected in the Maritime Provinces support the recommendation that Nelson's Sharp-tailed Sparrows be designated as Not at Risk in Canada (Rompre *et al.* 1998). Considering the low numbers of Nelson's Sharp-tailed Sparrows in New England, it becomes apparent that, from a continental perspective, the Maritimes are critical to the protection of salt marsh dwelling Nelson's Sharp-tailed Sparrows.

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Marsh	Region	Veg Pts	Bird Pts	Dyked	Dyke Close	Old Dykes	Old Ditch	No. Ponds	Pond Area
Bas Caraquet	GSL	6	3	n	n	y	y	23	2.74
Inkerman	GSL	19	9	n	n	n	n	30	9.96
Village des Poirier	GSL	10	5	n	n	n	n	40	3.49
Hay Island	GSL	20	10	n	n	y	y	55	7.72
Hay Island11	GSL	2	1	n	n	y	y	28	1.25
Kouchibouguac NP	GSL	5	2	n	n	n	n	0	0.00
Dune de Bouctouche	GSL	46	46	n	n	n	n	24	50.62
Pays de la Saguine (1,2)	GSL	2	2	n	n	n	n	0	0.00
Pays de la Saguine (3)	GSL	1	1	n	n	n	n	0	0.00
Rotary Park	GSL	2	2	n	n	n	y	8	3.89
Surette Island	GSL	1	1	n	n	n	n	1	0.39
Grand Digue	GSL	4	4	n	n	n	n	10	7.78
Bar de Cocagne	GSL	2	2	n	n	n	y	2	1.95
Chockpish	GSL	4	4	n	n	n	n	10	9.34
Cocagne Cove	GSL	4	4	n	n	n	n	1	0.39
Plage Acadie	GSL	0	2	n	n	n	y	0	0.00
Cocagne Hwy(1)	GSL	1	1	n	n	n	n	2	0.78
Cocagne Hwy(2)	GSL	1	1	n	n	n	n	2	0.39
Cocagne Hwy(3)	GSL	1	1	n	n	n	n	0	0.00
La Passe	GSL	3	3	n	y	y	y	2	2.34
Plage Soleil Levant	GSL	6	6	n	n	n	n	9	10.90
Pointe aux Bouleaux	GSL	6	6	n	n	n	y	3	5.06
Pointe-a-Jerome	GSL	1	1	y	y	n	n	7	3.12
Ruisseau Goguen	GSL	1	1	n	y	n	n	7	0.78
Saint Thomas	GSL	1	1	n	n	n	n	2	2.34
Shediac Bridge	GSL	1	1	n	n	n	y	3	1.56
Shediac Island	GSL	3	3	n	n	n	n	2	4.67
Cap Brule	GSL	14	7	n	n	n	y	2	4.67
Pt du Chene	GSL	2	2	n	n	n	n	3	1.17
Belliveau Beach Road	GSL	3	3	n	n	n	n	2	1.95
Cape Bimet East	GSL	18	9	n	n	n	n	3	1.17

Appendix A.1 – Biophysical region (**Region**), number of vegetation survey points (**VegPts**), number of bird survey points (**BirdPts**), presence of adjacent dykeland (**Dyked**), presence of dykeland within 300 m (**DykeClose**), presence of old dykes on marsh (**Old Dykes**), presence of old ditches on marsh (**OldDitch**) number of ponds, (**No.Ponds**), and total pond area (**PondArea**) of study marshes in northern New Brunswick Gulf of St. Lawrence.

Marsh	Region	Veg Pts	Bird Pts	Dyked	Dyke Close	Old Dykes	Old Ditch	No. Ponds	Pond Area
Parc Aboiteaux	GSL	6	3	n	n	n	n	2	1.17
Teddish River	GSL	2	1	n	n	n	n	1	0.39
Aboiteaux Wharf Road	GSL	4	2	n	n	n	n	1	5.06
Friel Brook	GSL	2	1	n	n	n	n	0	0.00
Shemogue - P'tit Cap	GSL	14	7	n	n	n	n	6	5.06
Shemogue - Copp Brook	GSL	14	7	y	n	n	n	60	57.24
Shemogue - Dobson Marsh	GSL	14	7	y	n	n	y	11	17.52
Shemogue - Fox Creek	GSL	26	13	n	n	n	y	8	21.42
Shemogue - Louis Brook	GSL	6	3	n	n	n	n	6	7.01
Shemogue - Duguay Point	GSL	11	5	n	n	n	y	20	11.29
Shemogue Head	GSL	2	1	n	n	n	n	0	0.00
Johnson's Point	GSL	12	6	n	n	n	n	15	15.96
Amos Point	GSL	2	1	n	n	n	n	3	0.78
Peacock Cove	GSL	6	3	n	n	n	n	1	3.89
Annes Acres	GSL	12	5	n	n	n	y	17	31.54
Cape Jourimain	GSL	7	4	n	n	n	n	200	41.24
Bayfield	GSL	8	4	n	n	y	y	200	37.77
Cap St. Laurent	GSL	6	3	n	n	n	y	4	3.89
Ephriam Island	GSL	10	5	n	n	y	y	3	0.75
Bayside	GSL	15	7	n	n	n	y	100	18.30
Arsenault's Marsh	GSL	8	4	n	n	n	n	9	9.73
Harrison's Marsh	GSL	16	8	n	n	y	y	22	23.36
Big Cove	GSL	12	6	n	n	y	y	35	34.27
Siddall Road3	GSL	2	1	n	n	n	y	80	21.42
Siddall Road	GSL	4	2	n	n	n	y	32	12.46

Appendix A.2 – Biophysical region (**Region**), number of vegetation survey points (**VegPts**), number of bird survey points (**BirdPts**), presence of adjacent dykeland (**Dyked**), presence of dykeland within 300 m (**DykeClose**), presence of old dykes on marsh (**Old Dykes**), presence of old ditches on marsh (**OldDitch**) number of ponds, (**No.Ponds**), and total pond area (**PondArea**) of study marshes in southern New Brunswick Gulf of St. Lawrence.

Marsh	Region	Veg Pts	Bird Pts	Dyked	Dyke Close	Old Dykes	Old Ditch	No. Ponds	Pond Area
Beausejour North	BOF	24	11	y	y	y	y	22	12.85
Beausejour - Tongue Island	BOF	30	15	n	y	n	y	11	14.02
Coles Island Centre	BOF	30	15	y	y	y	y	29	33.10
Coles Island 2	BOF	10	5	y	y	y	y	4	24.53
Sackville Town Shed	BOF	7	3	y	y	n	n	0	0.00
Tantramar River - Mouth	BOF	12	6	y	y	n	n	0	0.00
Tantramar River - Strip	BOF	8	3	y	y	n	n	0	0.00
Ram Pasture	BOF	54	27	n	y	y	y	25	24.14
Westcock	BOF	14	7	y	y	y	n	0	0.00
Allen Creek	BOF	35	17	y	y	y	y	0	0.00
Rockport	BOF	6	3	n	n	n	y	5	2.34
Rockland	BOF	24	12	y	y	n	n	0	0.00
Ste. Anselme	BOF	19	10	n	n	y	y	9	12.46
Dieppe Marsh	BOF	11	6	y	y	y	y	1	0.39
Jonathan Creek	BOF	20	10	n	n	n	y	7	12.07
Petitcodiac - Point Park	BOF	30	13	n	n	n	y	5	27.26
Mill Creek1,2	BOF	4	2	n	n	y	n	0	0.00
Mill Creek	BOF	12	6	n	n	y	n	7	7.40
Canadian Brook 1	BOF	2	1	n	n	n	y	0	0.00
Canadian Brook 2	BOF	6	3	n	n	n	n	0	0.00
Stoney Creek	BOF	6	3	n	n	n	n	0	0.00
Minor's Brook1	BOF	2	1	n	n	n	n	0	0.00
Minor's Brook2	BOF	2	1	n	n	n	n	0	0.00
Weldon Creek	BOF	16	8	n	y	y	y	2	5.45
Gray's Island	BOF	22	11	y	y	y	n	0	0.00
Hopewell Rocks	BOF	12	6	n	n	y	y	9	21.81
Daniels Flats	BOF	30	15	n	n	n	y	22	38.16
Mary's Point 2	BOF	20	10	n	n	y	y	34	18.30
New Horton	BOF	20	10	n	n	y	y	20	23.75
Waterside	BOF	22	11	n	n	n	y	85	31.54
NFC1,8	BOF	5	2	n	n	n	n	25	6.62
NF Creek	BOF	12	6	n	n	y	y	20	14.41

Appendix A.3 – Biophysical region (**Region**), number of vegetation survey points (**VegPts**), number of bird survey points (**BirdPts**), presence of adjacent dykeland (**Dyked**), presence of dykeland within 300 m (**DykeClose**), presence of old dykes on marsh (**Old Dykes**), presence of old ditches on marsh (**OldDitch**) number of ponds, (**No.Ponds**), and total pond area (**PondArea**) of study marshes in New Brunswick upper Bay of Fundy.

Marsh	Region	Veg Pts	Bird Pts	Dyked	Dyke Close	Old Dykes	Old Ditch	No. Ponds	Pond Area
St. Rests Marsh	BOF	36	18	n	n	y	y	30	8.10
Musquash	BOF	12	6	n	n	y	y	13	4.30
Board Bridge Creek	BOF	2	1	n	n	n	n	1	0.50
Dunn's Marsh	BOF	2	1	n	n	y	n	85	10.00
Deadman's Harbour	BOF	14	7	n	n	n	n	1	1.00
Castalia	BOF	12	6	n	n	n	n	73	10.00
Five Mile River(1-3)	BOF	6	3	n	y	n	y	23	6.23
Five Mile River (4)	BOF	2	1	n	y	y	y	20	2.24
Five Mile River (5)	BOF	2	1	n	y	y	y	2	1.25
Five Mile River (7,8)	BOF	4	2	n	y	y	y	5	3.24
Five Mile River (6)	BOF	2	1	n	n	n	n	0	0.00
Black Rock	BOF	30	15	n	n	y	y	0	0.00
Lower Debert Marsh - East	BOF	6	3	y	n	n	n	12	2.99
Lwr. Debert Marsh - West	BOF	4	2	y	y	n	y	0	0.00
Little Dyke Marsh	BOF	10	5	y	y	n	y	0	0.00
Fort Belcher	BOF	30	15	y	n	n	n	47	3.74

Appendix A.4 – Biophysical region (**Region**), number of vegetation survey points (**VegPts**), number of bird survey points (**BirdPts**), presence of adjacent dykeland (**Dyked**), presence of dykeland within 300 m (**DykeClose**), presence of old dykes on marsh (**Old Dykes**), presence of old ditches on marsh (**OldDitch**) number of ponds, (**No.Ponds**), and total pond area (**PondArea**) of study marshes in New Brunswick outer Bay of Fundy and Nova Scotia upper Bay of Fundy.

Marsh	Region	Veg Pts	Bird Pts	Dyked	Dyke Close	Old Dykes	Old Ditch	No. Ponds	Pond Area
Parrsboro1	BOF	2	1	n	n	n	n	1	0.25
Parrsboro2	BOF	2	1	n	n	n	n	0	0.00
Parrsboro3	BOF	2	1	n	n	n	n	0	0.00
Fox Creek	BOF	6	3	n	n	y	y	40	11.96
Allenville	BOF	2	1	n	n	n	n	4	0.75
Spencer's Island1	BOF	2	1	n	n	n	y	0	0.00
Spencer's Island2	BOF	2	1	n	n	n	y	0	0.00
Advocate	BOF	4	2	n	n	n	n	27	3.49
Apple River	BOF	4	2	n	n	y	n	24	2.74
Sand River1	BOF	2	1	n	n	n	n	1	0.50
Sand River2	BOF	2	1	n	n	n	n	4	1.00
Sand River3	BOF	2	1	n	n	n	n	5	1.25
Minudie Park	BOF	8	4	y	n	n	n	69	10.21
River Hebert1	BOF	2	1	n	y	n	n	0	0.00
River Hebert2	BOF	2	1	y	y	n	n	2	0.50
Boars Back1	BOF	2	1	n	n	n	y	35	1.74
Boars Back2	BOF	2	1	n	n	n	n	0	0.00
LRH Cemetary	BOF	2	1	n	y	n	n	0	0.00
RH Carters Brook	BOF	2	1	n	n	n	n	0	0.00
Harrison Brook	BOF	2	1	n	y	n	n	0	0.00
Harrison Lake	BOF	2	1	y	n	n	y	0	0.00
Maccan River	BOF	4	1	y	n	n	n	0	0.00
McIver's Marsh	BOF	12	6	y	y	n	n	1	1.00
John Lusby Section 1	BOF	20	10	y	y	y	y	18	6.00

Appendix A.5 – Biophysical region (**Region**), number of vegetation survey points (**VegPts**), number of bird survey points (**BirdPts**), presence of adjacent dykeland (**Dyked**), presence of dykeland within 300 m (**DykeClose**), presence of old dykes on marsh (**Old Dykes**), presence of old ditches on marsh (**OldDitch**) number of ponds, (**No.Ponds**), and total pond area (**PondArea**) of study marshes in Nova Scotia upper Bay of Fundy.

Marsh	Region	Veg Pts	Bird Pts	Dyked	Dyke Close	Old Dykes	Old Ditch	No. Ponds	Pond Area
Tidnish River	GSL	2	1	n	n	n	n	25	2.99
Tidnish River Bridge	GSL	4	2	n	n	y	y	33	2.49
Tidnish - Jackson Point	GSL	4	2	n	n	n	n	36	7.40
Tidnish Purdy Drive	GSL	2	1	n	n	n	n	31	7.79
Mitchell Island	GSL	2	1	n	n	n	n	36	9.73
Shinimicas River	GSL	2	1	n	n	n	n	13	0.75
Shinimicas Estuary	GSL	4	2	n	n	n	y	43	5.23
Wallace River	GSL	5	2	n	n	y	n	200	18.18
McLellan Marsh (1-3)	GSL	6	3	n	n	n	n	15	5.45
McLellan Marsh (4-9)	GSL	12	6	n	n	n	n	18	15.96
Sutherlands River	GSL	2	1	n	n	n	y	0	0.00
Sutherlands River2	GSL	2	1	n	n	n	n	0	0.00
Merigomish Isl	GSL	30	15	n	n	n	n	200	52.18
New London Bay	GSL	10	5	n	n	n	n	12	9.92
Glenfinnan River	GSL	10	5	n	n	n	n	7	3.00
Hillsborough River	GSL	10	5	y	y	n	y	5	3.60
Cow Bay	ATL	14	7	n	n	n	n	0	0.00
Conrad Head - South	ATL	36	18	n	n	n	n	0	0.00
Conrad Head - North	ATL	8	4	n	n	n	n	0	0.00
Fox Point	ATL	10	5	n	n	n	n	1	1.25
Cole Harbour	ATL	8	4	n	n	n	n	1	20.00
Lawrencetown Beach	ATL	8	4	n	n	n	n	31	19.68
Indian Point	ATL	4	2	n	n	n	n	80	8.97
Corkum's Island	ATL	6	3	n	n	n	n	0	0.00
Oler Farm	ATL	0	4	n	n	n	n	8	16.00
Rose Bay - Conrad's Island	ATL	6	3	n	n	n	n	1	3.98
Oxner's Beach	ATL	8	4	n	n	n	n	7	6.22
Crescent Beach	ATL	30	15	n	n	n	n	8	1.99
Beach Meadows	ATL	4	2	n	n	n	n	5	1.99
Cherry Hill Beach	ATL	28	14	n	n	n	n	10	3.98
Port Mouton	ATL	2	1	n	n	n	n	0	0.00
Carter's Beach	ATL	2	1	n	n	n	n	1	2.50

Appendix A.6 – Biophysical region (**Region**), number of vegetation survey points (**VegPts**), number of bird survey points (**BirdPts**), presence of adjacent dykeland (**Dyked**), presence of dykeland within 300 m (**DykeClose**), presence of old dykes on marsh (**Old Dykes**), presence of old ditches on marsh (**OldDitch**) number of ponds, (**No.Ponds**), and total pond area (**PondArea**) of study marshes in Nova Scotia Gulf of St. Lawrence and Atlantic Coast.

Marsh	Marsh Area	NSTS Min	NSTS Max	NSTS Marsh Ave	NSTS Point Ave	Willet Min	Willet Max	Willet Marsh Ave	Willet Point Ave
Bas Caraquet	17.5	0	3	1.83	0.61	0	3	1.17	0.39
Inkerman	51.4	9	18	13.50	1.50	0	12	5.17	0.57
Village des Poirier	21.8	3	7	5.17	1.03	0	2	0.50	0.10
Hay Island	25.8	7	14	10.00	1.00	1	11	5.00	0.50
Hay Island11	7.8	0	0	0.00	0.00	0	0	0.00	0.00
Kouchibouguac NP	12.8	2	4	3.00	1.50	0	0	0.00	0.00
Dune de Bouctouche	211.0	14	35	26.33	0.57	1	13	7.33	0.16
Pays de la Saguine (1,2)	6.6	0	1	0.33	0.17	0	2	1.00	0.50
Pays de la Saguine (3)	1.2	0	0	0.00	0.00	0	0	0.00	0.00
Rotary Park	9.3	0	2	1.33	0.67	2	7	5.33	2.67
Surette Island	1.9	0	2	0.83	0.83	0	4	2.33	2.33
Grand Digue	31.2	2	6	4.00	1.00	1	4	3.00	0.75
Bar de Cocagne	6.2	0	3	1.67	0.83	2	4	2.83	1.42
Chockpish	12.1	2	4	3.00	0.75	0	2	1.00	0.25
Cocagne Cove	9.7	1	5	3.67	0.92	1	2	1.33	0.33
Plage Acadie	10.4	0	2	1.00	0.50	0	4	2.33	1.17
Cocagne Hwy(1)	2.3	0	1	0.33	0.33	0	1	0.50	0.50
Cocagne Hwy(2)	2.3	0	1	0.33	0.33	0	0	0.00	0.00
Cocagne Hwy(3)	3.1	0	1	0.33	0.33	0	0	0.00	0.00
La Passe	4.3	1	3	1.83	0.61	0	3	1.83	0.61
Plage Soleil Levant	31.5	4	6	5.33	0.89	1	1	1.00	0.17
Pointe aux Bouleaux	18.3	1	6	3.67	0.61	2	4	3.33	0.56
Pointe-a-Jerome	3.5	0	1	0.33	0.33	1	4	2.33	2.33
Ruisseau Goguen	2.3	0	2	0.50	0.50	1	4	2.50	2.50
Saint Thomas	1.9	0	0	0.00	0.00	0	7	1.83	1.83
Shediac Bridge	2.7	0	2	1.33	1.33	0	1	0.33	0.33
Shediac Island	5.1	2	2	2.00	0.67	0	0	0.00	0.00
Cap Brule	36.2	6	15	9.60	1.37	0	5	2.00	0.29
Pt du Chene	4.3	0	1	0.67	0.33	8	10	8.67	4.33
Belliveau Beach Road	5.8	0	1	0.33	0.11	0	0	0.00	0.00
Cape Bimet East	28.8	4	5	4.33	0.48	0	6	3.67	0.41

Appendix B.1 – Marsh area in ha(**Marsh Area**), minimum number of Nelson's Sharp-tailed Sparrows observed per survey (**NSTS Min**), maximum number of NSTS observed per survey (**NSTS Max**) average number of NSTS observed per survey (**NSTS Marsh Ave),** average number of NSTS observed per survey point (**NSTS Point Ave**), minimum number of Willets observed per survey (**Willet Min**), maximum number of Willets observed per survey (**Willet Max**), average number of Willets observed per survey (**Willet Marsh Ave)** average number of Willets observed per survey point (**Willet Point Ave**) for northern New Brunswick Gulf of St. Lawrence.

Marsh	Marsh Area	NSTS Min	NSTS Max	NSTS Marsh Ave	NSTS Point Ave	Willet Min	Willet Max	Willet Marsh Ave	Willet Point Ave
Parc Aboiteaux	8.2	2	3	2.33	0.78	0	2	0.67	0.22
Teddish River	7.4	0	1	0.33	0.33	0	0	0.00	0.00
Aboiteaux Wharf Road	9.3	1	2	1.67	0.83	1	2	1.33	0.67
Friel Brook	3.1	0	1	0.33	0.33	0	0	0.00	0.00
Shemogue - P'tit Cap	21.4	8	12	10.33	1.48	0	3	2.00	0.29
Shemogue - Copp Brook	43.6	14	21	18.33	2.62	32	36	33.33	4.76
Shemogue - Dobson Marsh	31.2	9	29	19.00	2.71	8	10	8.67	1.24
Shemogue - Fox Creek	78.7	21	30	25.33	1.95	13	16	14.67	1.13
Shemogue - Louis Brook	15.6	6	8	6.67	2.22	0	1	0.67	0.22
Shemogue - Duguay Point	18.7	19	22	20.00	4.00	2	5	3.33	0.67
Shemogue Head	7.39	0	1	0.33	0.33	0	2	0.67	0.67
Johnson's Point	34.3	0	8	4.33	0.72	3	8	6.83	1.14
Amos Point	2.7	0	1	0.67	0.67	0	0	0.00	0.00
Peacock Cove	6.6	0	1	0.33	0.11	0	0	0.00	0.00
Annes Acres	26.9	3	10	5.67	1.13	1	8	4.33	0.72
Cape Jourimain	68.9	0	1	0.67	0.17	0	1	0.33	0.08
Bayfield	88.8	2	5	3.33	0.83	0	6	3.33	0.83
Cap St. Laurent	6.2	0	4	2.33	0.78	0	6	1.33	0.44
Ephriam Island	18.3	0	2	1.33	0.27	4	4	4.00	0.80
Bayside	22.6	5	9	6.17	0.88	5	16	9.83	1.40
Arsenault's Marsh	11.7	2	4	2.67	0.67	1	2	1.67	0.56
Harrison's Marsh	26.9	13	21	18.00	2.25	12	16	14.67	1.83
Big Cove	41.7	0	8	5.17	1.03	0	10	5.00	1.00
Siddall Road3	33.1	0	0	0.00	0.00	0	0	0.00	0.00
Siddall Road	7.8	0	3	1.00	0.50	0	2	1.00	0.50

Appendix B.2 – Marsh area in ha(**Marsh Area**), minimum number of Nelson's Sharp-tailed Sparrows observed per survey (**NSTS Min**), maximum number of NSTS observed per survey (**NSTS Max**) average number of NSTS observed per survey (**NSTS Marsh Ave),** average number of NSTS observed per survey point (**NSTS Point Ave**), minimum number of Willets observed per survey (**Willet Min**), maximum number of Willets observed per survey (**Willet Max**), average number of Willets observed per survey (**Willet Marsh Ave**) average number of Willets observed per survey point (**Willet Point Ave**) for southern New Brunswick Gulf of St. Lawrence.

Marsh	Marsh Area	NSTS Min	NSTS Max	NSTS Marsh Ave	NSTS Point Ave	Willet Min	Willet Max	Willet Marsh Ave	Willet Point Ave
Beausejour North	61.5	11	13	12.00	1.09	0	0	0.00	0.00
Beausejour - Tongue Island	66.2	15	17	16.33	1.09	0	0	0.00	0.00
Coles Island Centre	145.6	8	30	19.33	1.38	2	24	13.33	0.89
Coles Island 2	29.6	1	12	5.80	1.16	0	6	3.40	0.68
Sackville Town Shed	17.5	6	10	8.00	2.67	2	2	2.00	0.66
Tantramar River - Mouth	55.68	4	4	4.00	0.67	0	1	0.50	0.00
Tantramar River - Strip	37.76	12	12	12.00	4.00	0	2	1.00	0.33
Ram Pasture	164.7	21	30	24.33	0.90	0	20	10.00	0.37
Westcock	25.3	1	8	4.33	0.62	0	0	0.00	0.00
Allen Creek	65.8	9	18	15.20	1.17	0	0	0.00	0.00
Rockport	7.4	0	1	0.33	0.11	0	0	0.00	0.00
Rockland	28.8	4	14	8.00	0.67	0	0	0.00	0.00
Ste. Anselme	172.1	10	14	12.33	1.23	0	0	0.00	0.00
Dieppe Marsh	405	5	15	12.38	2.06	0	0	0.00	0.00
Jonathan Creek	67.4	5	6	5.60	0.56	0	0	0.00	0.00
Petitcodiac - Point Park	141.0	5	12	8.20	0.63	0	0	0.00	0.00
Mill Creek1,2	10.1	2	2	2.00	1.00	0	0	0.00	0.00
Mill Creek	27.6	2	4	3.00	0.50	0	0	0.00	0.00
Canadian Brook 1	5.5	0	0	0.00	0.00	0	0	0.00	0.00
Canadian Brook 2	4.3	1	4	2.33	0.78	0	0	0.00	0.00
Stoney Creek	5.8	6	8	6.67	2.22	0	0	0.00	0.00
Minor's Brook1	0.8	0	0	0.00	0.00	0	0	0.00	0.00
Minor's Brook2	1.2	0	0	0.00	0.00	0	0	0.00	0.00
Weldon Creek	28.8	25	47	36.00	4.50	0	0	0.00	0.00
Gray's Island	26.9	8	15	11.33	1.03	0	0	0.00	0.00
Hopewell Rocks	63.1	8	9	8.50	1.42	0	0	0.00	0.00
Daniels Flats	81.4	28	41	33.33	2.22	0	0	0.00	0.00
Mary's Point 2	373.8	7	23	14.40	1.44	0	0	0.00	0.00
New Horton	35.4	6	10	8.00	0.80	0	0	0.00	0.00
Waterside	91.5	10	23	17.00	1.55	0	0	0.00	0.00
NFC1,8	10.1	1	3	2.00	1.00	0	0	0.00	0.00
NF Creek	28.0	0	1	0.33	0.06	0	0	0.00	0.00

Table B.3 – Marsh area in ha(**Marsh Area**), minimum number of NSTS per survey (**NSTS Min**), maximum number of NSTS per survey (**NSTS Max**) average number of NSTS per survey (**NSTS Marsh Ave**), average number of NSTS per survey point (**NSTS Point Ave**), minimum number of Willets per survey (**Willet Min**), maximum number of Willets per survey (**Willet Max**), average number of Willets per survey (**Willet Marsh Ave**) average number of Willets per survey point (**Willet Point Ave**) for southern New Brunswick upper Bay of Fundy.

Marsh	Marsh Area	NSTS Min	NSTS Max	NSTS Marsh Ave	NSTS Point Ave	Willet Min	Willet Max	Willet Marsh Ave	Willet Point Ave
St. Rests Marsh	119.1	2	11	7.00	0.39	0	0	0.00	0.00
Musquash	30.0	0	0	0.00	0.00	0	0	0.00	0.00
Board Bridge Creek	10.0	0	3	0.75	0.75	0	0	0.00	0.00
Dunn's Marsh	44.0	0	0	0.00	0.00	0	0	0.00	0.00
Deadman's Harbour	9.0	0	0	0.00	0.00	0	0	0.00	0.00
Castalia	30.0	4	11	7.50	1.25	0	0	0.00	0.00
Five Mile River(1-3)	15.0	7	11	9.67	3.22	4	4	4.00	1.33
Five Mile River (4)	10.0	5	6	5.33	5.33	1	5	3.33	3.33
Five Mile River (5)	4.0	0	1	0.33	0.33	0	0	0.00	0.00
Five Mile River (7,8)	10.0	1	7	4.00	2.00	0	0	0.00	0.00
Five Mile River (6)	3.0	1	2	1.33	1.33	0	4	1.33	1.33
Black Rock	435.0	16	22	19.33	1.29	2	4	3.33	0.22
Lower Debert Marsh - East	22.0	0	1	0.67	0.22	0	0	0.00	0.00
Lwr Debert Marsh - West	11.0	0	2	0.67	0.33	0	4	1.67	0.83
Little Dyke Marsh	38.0	6	7	6.67	1.33	0	0	0.00	0.00
Fort Belcher	185.0	14	15	14.50	0.97	0	0	0.00	0.00

Appendix B.4 – Marsh area in ha(**Marsh Area**), minimum number of Nelson's Sharp-tailed Sparrows observed per survey (**NSTS Min**), maximum number of NSTS observed per survey (**NSTS Max**) average number of NSTS observed per survey (**NSTS Marsh Ave),** average number of NSTS observed per survey point (**NSTS Point Ave**), minimum number of Willets observed per survey (**Willet Min**), maximum number of Willets observed per survey (**Willet Max**), average number of Willets observed per survey (**Willet Marsh Ave)** average number of Willets observed per survey point (**Willet Point Ave**) for Bay of Fundy.

Marsh	Marsh Area	NSTS Min	NSTS Max	NSTS Marsh Ave	NSTS Point Ave	Willet Min	Willet Max	Willet Marsh Ave	Willet Point Ave
Parrsboro1	1.0	0	0	0.00	0.00	0	0	0.00	0.00
Parrsboro2	1.0	0	0	0.00	0.00	0	0	0.00	0.00
Parrsboro3	3.0	0	0	0.00	0.00	0	0	0.00	0.00
Fox Creek	57.0	1	2	1.33	0.44	0	0	0.00	0.00
Allenville	5.0	0	0	0.00	0.00	0	0	0.00	0.00
Spencer's Island1	2.0	0	0	0.00	0.00	0	0	0.00	0.00
Spencer's Island2	5.0	0	0	0.00	0.00	0	0	0.00	0.00
Advocate	30.0	0	0	0.00	0.00	0	0	0.00	0.00
Apple River	28.0	0	0	0.00	0.00	0	0	0.00	0.00
Sand River1	2	0	0	0.00	0.00	0	0	0.00	0.00
Sand River2	2	0	0	0.00	0.00	0	0	0.00	0.00
Sand River3	15	0	0	0.00	0.00	0	0	0.00	0.00
Minudie Park	8.0	0	1	0.67	0.17	0	0	0.00	0.00
River Hebert1	1	0	0	0.00	0.00	0	0	0.00	0.00
River Hebert2	1	0	0	0.00	0.00	0	0	0.00	0.00
Boars Back1	5.0	0	0	0.00	0.00	0	0	0.00	0.00
Boars Back2	1.0	0	0	0.00	0.00	0	0	0.00	0.00
LRH Cemetary	1.0	0	0	0.00	0.00	0	0	0.00	0.00
RH Carters Brook	3.0	0	2	1.00	1.00	0	0	0.00	0.00
Harrison Brook	6.0	0	0	0.00	0.00	0	0	0.00	0.00
Harrison Lake	3.0	0	0	0.00	0.00	0	0	0.00	0.00
Maccan River	3.0	0	1	0.33	0.33	0	0	0.00	0.00
McIver's Marsh	13.0	0	8	4.00	0.67	0	0	0.00	0.00
John Lusby Section 1	341.0	10	18	15.33	1.53	0	2	1.33	0.13

Appendix B.5 – Marsh area in ha(**Marsh Area**), minimum number of Nelson's Sharp-tailed Sparrows observed per survey (**NSTS Min**), maximum number of NSTS observed per survey (**NSTS Max**) average number of NSTS observed per survey (**NSTS Marsh Ave),** average number of NSTS observed per survey point (**NSTS Point Ave**), minimum number of Willets observed per survey (**Willet Min**), maximum number of Willets observed per survey (**Willet Max**), average number of Willets observed per survey (**Willet Marsh Ave)** average number of Willets observed per survey point (**Willet Point Ave**) for Nova Scotia upper Bay of Fundy.

Marsh	Marsh Area	NSTS Min	NSTS Max	NSTS Marsh Ave	NSTS Point Ave	Willet Min	Willet Max	Willet Marsh Ave	Willet Point Ave
Tidnish River	5.0	0	2	0.67	0.67	1	2	1.33	1.33
Tidnish River Bridge	7.0	0	0	0.00	0.00	0	0	0.00	0.00
Tidnish - Jackson Point	12.0	2	6	4.33	2.17	0	0	0.00	0.00
Tidnish Purdy Drive	8.0	1	1	1.00	1.00	0	0	0.00	0.00
Mitchell Island	11.0	0	2	0.67	0.67	0	0	0.00	0.00
Shinimicas River	5.0	0	0	0.00	0.00	0	0	0.00	0.00
Shinimicas Estuary	15.0	0	0	0.00	0.00	0	0	0.00	0.00
Wallace River	242.0	2	5	3.33	1.67	4	4	4.00	2.00
McLellan Marsh (1-3)	21.0	8	8	8.00	2.67	0	0	0.00	0.00
McLellan Marsh (4-9)	28.0	2	11	7.00	1.17	0	0	0.00	0.00
Sutherlands River	2.0	0	0	0.00	0.00	0	0	0.00	0.00
Sutherlands River2	1.0	0	3	1.33	1.33	0	0	0.00	0.00
Merigomish Isl	93.0	35	44	38.00	2.53	11	29	20.33	1.36
New London Bay	25.0	0	4	1.70	0.43	0	0	0.00	0.00
Glenfinnan River	18.5	8	9	8.33	1.67	0	4	1.67	0.33
Hillsborough River	13.1	3	5	4.00	0.80	4	4	4.00	0.80
Cow Bay	11.0	0	5	2.75	0.34	5	7	5.67	0.71
Conrad Head - South	49.0	31	41	37.67	2.09	3	18	12.33	0.69
Conrad Head - North	7.0	0	0	0.00	0.00	0	2	1.00	0.25
Fox Point	20.0	9	10	9.67	1.93	2	4	3.33	0.67
Cole Harbour	3	0	0	0.00	0.00	3	6	4.50	1.13
Lawrencetown Beach	30.0	5	5	5.00	1.25	0	1	0.67	0.17
Indian Point	13.0	0	2	1.25	0.63	0	6	3.75	1.88
Corkum's Island	7.0	4	6	5.00	1.67	2	2	2.00	0.67
Oler Farm	51	6	6	6.00	1.50	8	8	8.00	2.00
Rose Bay - Conrad's Island	3	5	5	5.00	1.67	1	2	1.67	0.56
Oxner's Beach	58.0	4	9	7.00	1.75	4	6	5.00	1.25
Crescent Beach	39.0	5	6	5.50	0.37	10	65	37.50	2.50
Beach Meadows	14.3	2	2	2.00	1.00	2	2	2.00	1.00
Cherry Hill Beach	6.4	10	31	16.60	1.11	5	31	14.00	1.00
Port Mouton	2.0	0	1	0.17	0.17	0	4	1.15	1.15
Carter's Beach	6.0	0	0	0.00	0.00	1	8	3.57	3.57

Appendix B.6 – Marsh area (**Marsh Area**), min. number of Nelson's Sharp-tailed Sparrows per survey (**NSTS Min**), maximum number of NSTS per survey (**NSTS Max**) average number of NSTS per survey (**NSTS Marsh Ave),** average number of NSTS per survey point (**NSTS Point Ave**), min. number of Willets per survey (**Willet Min**), maximum number of Willets per survey (**Willet Max**), average number of Willets per survey (**Willet Marsh Ave**) average number of Willets per survey point (**Willet Point Ave**) in salt marshes (NS and PEI Gulf of St. Lawrence and NS Atlantic Coast).

Marsh	SAVS Marsh Ave	SAVS Point Ave	No. Passer Spp	No. Wetland Spp	No. Wader Spp.	No. Gull Spp.	Total No. Spp	Spp. Richness
Bas Caraquet	3.0	1.0	13	8	2	2	25	15.3
Inkerman	13.7	1.5	10	20	3	3	36	15.4
Village des Poirier	5.8	1.2	15	14	2	1	32	16.2
Hay Island	10.7	1.1	10	9	1	3	23	9.1
Hay Island11	1.3	1.3	3	2	1	3	9	9.0
Kouchibouguac NP	2.3	1.2	7	3	1	1	12	10.0
Dune de Bouctouche	86.0	1.9	8	12	1	2	23	6.2
Pays de la Saguine (1,2)	4.7	2.3	3	4	1	2	10	7.5
Pays de la Saguine (3)	0.0	0.0	1	2	1	1	5	5.0
Rotary Park	4.3	2.2	6	7	1	2	16	11.0
Surette Island	2.0	2.0	8	6	1	1	16	16.0
Grand Digue	1.3	0.3	10	10	1	2	23	12.5
Bar de Cocagne	2.2	1.1	7	13	1	3	24	17.5
Chockpish	7.0	1.8	8	10	1	1	20	11.8
Cocagne Cove	2.8	0.7	11	7	1	3	22	12.3
Plage Acadie	0.7	0.3	0	3	1	2	6	7.5
Cocagne Hwy(1)	0.3	0.3	5	10	1	1	17	17.0
Cocagne Hwy(2)	0.3	0.3	7	4	1	1	13	13.0
Cocagne Hwy(3)	3.3	3.3	4	4	1	1	10	10.0
La Passe	5.0	1.7	12	4	1	2	19	12.7
Plage Soleil Levant	5.3	0.9	4	12	1	1	18	11.5
Pointe aux Bouleaux	5.7	0.9	11	10	1	1	23	10.5
Pointe-a-Jerome	2.0	2.0	8	4	1	1	14	14.0
Ruisseau Goguen	1.5	1.5	7	5	1	3	16	16.0
Saint Thomas	0.0	0.0	8	6	1	0	15	15.0
Shediac Bridge	3.0	3.0	4	2	1	1	8	8.0
Shediac Island	1.0	0.3	6	7	1	2	16	8.0
Cap Brule	15.8	2.3	11	11	1	3	26	13.4
Pt du Chene	2.7	1.3	7	5	1	1	14	11.5
Belliveau Beach Road	1.3	0.4	5	6	2	4	17	10.3
Cape Bimet East	21.5	2.4	8	10	1	3	22	9.9

Appendix C.1 – Average number of Savannah Sparrows per survey (**SAVS Marsh Ave**), average number of Savannah Sparrows per survey point (**SAVS Point Ave**), number of passerine species observed (**No. Passer Spp**) number of wetland species observed (**No. Wetland Spp**), number of wading bird species observed, (**No.Wader Spp**), number of gull spp. observed. (**No.Gull Spp**), total number of species (**Total No. Spp**), average number of species per survey point (**Spp. Richness**) in salt marshes (northern New Brunswick Gulf of St. Lawrence).

Marsh	SAVS Marsh Ave	SAVS Point Ave	No. Passer Spp	No. Wetland Spp	No. Wader Spp.	No. Gull Spp.	Total No. Spp	Spp. Richness
Parc Aboiteaux	3.7	1.2	4	1	0	0	5	3.7
Teddish River	1.7	1.7	2	0	0	0	2	3.0
Aboiteaux Wharf Road	5.3	2.7	3	2	0	0	5	4.0
Friel Brook	3.7	3.7	3	2	0	0	5	5.0
Shemogue - P'tit Cap	8.3	1.2	6	6	1	0	13	5.0
Shemogue - Copp Brook	2.0	0.3	6	11	1	0	18	6.0
Shemogue - Dobson Marsh	0.7	0.1	4	7	1	0	12	4.7
Shemogue - Fox Creek	0.7	0.1	5	13	1	0	19	4.8
Shemogue - Louis Brook	0.0	0.0	2	6	0	0	8	4.3
Shemogue - Duguay Point	0.3	0.1	5	4	0	0	9	3.6
Shemogue Head	0.3	0.3	2	4	1	0	7	7.0
Johnson's Point	0.0	0.0	8	7	1	2	18	11.7
Amos Point	4.0	4.0	3	0	0	1	4	4.0
Peacock Cove	2.3	0.8	3	2	0	0	5	3.7
Annes Acres	6.7	1.3	3	7	1	3	14	6.5
Cape Jourimain	0.7	0.2	3	5	1	1	10	4.8
Bayfield	0.0	0.0	2	4	0	0	6	3.3
Cap St. Laurent	0.7	0.2	5	5	0	0	10	3.6
Ephriam Island	1.3	0.3	8	2	0	0	10	4.4
Bayside	0.0	0.0	5	19	1	1	26	12.4
Arsenault's Marsh	0.0	0.0	2	4	0	0	6	2.5
Harrison's Marsh	2.0	0.3	5	8	0	0	13	4.9
Big Cove	1.7	0.3	6	11	1	2	20	6.9
Siddall Road3	0.0	0.0	3	3	1	0	7	3.5
Siddall Road	1.7	0.8	5	7	1	1	14	8.5

Appendix C.2 – Average number of Savannah Sparrows per survey (**SAVS Marsh Ave**), average number of Savannah Sparrows per survey point (**SAVS Point Ave**), number of passerine species observed (**No. Passer Spp**) number of wetland species observed (**No. Wetland Spp**), number of wading bird species observed, (**No.Wader Spp**), number of gull spp. observed. (**No.Gull Spp**), total number of species (**Total No. Spp**), average number of species per survey point (**Spp. Richness**) in salt marshes (southern New Brunswick Gulf of St. Lawrence).

Marsh	SAVS Marsh Ave	SAVS Point Ave	No. Passer Spp	No. Wetland Spp	No. Wader Spp.	No. Gull Spp.	Total No. Spp	Spp. Richness
Beausejour North	4.0	0.4	3	8	0	2	13	3.6
Beausejour - Tongue Island	5.0	0.3	6	7	1	2	16	2.9
Coles Island Centre	0.7	0.0	6	13	1	1	21	4.9
Coles Island 2	4.4	0.9	6	13	1	2	22	6.4
Sackville Town Shed	4.5	1.5	6	7	1	1	15	8.0
Tantramar River - Mouth	3.5	0.6	5	3	0	1	9	5.0
Tantramar River - Strip	0.5	0.2	2	1	0	1	4	1.7
Ram Pasture	9.0	0.3	9	13	2	2	26	5.3
Westcock	5.3	0.8	8	5	1	2	16	8.0
Allen Creek	14.6	0.9	7	7	1	1	16	3.6
Rockport	0.0	0.0	3	4	1	1	9	5.3
Rockland	10.3	0.9	9	6	0	2	17	6.1
Ste. Anselme	29.0	2.9	11	2	1	3	17	6.3
Dieppe Marsh	12.3	2.0	10	6	1	2	19	8.7
Jonathan Creek	0.0	0.0	5	4	2	0	11	4.0
Petitcodiac - Point Park	0.0	0.0	6	7	1	0	14	4.1
Mill Creek1,2	0.7	0.3	2	1	0	0	3	2.0
Mill Creek	1.7	0.3	5	6	0	0	11	2.5
Canadian Brook 1	0.0	0.0	2	0	0	0	2	2.0
Canadian Brook 2	0.0	0.0	1	0	1	0	2	1.3
Stoney Creek	0.0	0.0	2	1	0	0	3	1.7
Minor's Brook1	0.0	0.0	2	0	0	0	2	2.0
Minor's Brook2	0.0	0.0	0	0	0	0	0	0.0
Weldon Creek	0.3	0.0	5	4	0	0	9	2.9
Gray's Island	14.7	1.3	6	2	1	0	9	3.1
Hopewell Rocks	0.0	0.0	3	2	0	2	7	3.3
Daniels Flats	0.3	0.0	8	4	1	1	14	2.5
Mary's Point 2	2.0	0.2	12	12	1	3	28	10.7
New Horton	0.0	0.0	6	4	1	2	13	2.1
Waterside	6.3	0.6	4	3	1	1	9	3.5
NFC1,8	0.0	0.0	1	2	1	0	4	2.5
NF Creek	1.0	0.2	2	2	1	0	5	1.2

Appendix C.3 – Average number of Savannah Sparrows per survey (**SAVS Marsh Ave**), average number of Savannah Sparrows per survey point (**SAVS Point Ave**), number of passerine species observed (**No. Passer Spp**) number of wetland species observed (**No. Wetland Spp**), number of wading bird species observed, (**No.Wader Spp**), number of gull spp. observed. (**No.Gull Spp**), total number of species (**Total No. Spp**), and average number of species per survey point (**Spp. Richness**) in salt marshes (New Brunswick upper Bay of Fundy).

Marsh	SAVS Marsh Ave	SAVS Point Ave	No. Passer Spp	No. Wetland Spp	No. Wader Spp.	No. Gull Spp.	Total No. Spp	Spp. Richness
St. Rests Marsh	15.4	0.9	11	10	2	3	26	9.2
Musquash	3.3	0.6	9	6	1	1	17	6.3
Board Bridge Creek	0.3	0.3	4	7	1	0	12	13.0
Dunn's Marsh	0.0	0.0	0	5	1	1	7	3.0
Deadman's Harbour	0.0	0.0	4	2	0	1	7	1.9
Castalia	16.0	2.7	7	5	1	2	15	8.2
Five Mile River(1-3)	0.0	0.0	5	1	0	0	6	4.7
Five Mile River (4)	0.0	0.0	3	2	0	0	5	5.0
Five Mile River (5)	0.0	0.0	4	3	0	0	7	7.0
Five Mile River (7,8)	0.0	0.0	6	2	0	0	8	6.0
Five Mile River (6)	0.0	0.0	2	1	0	0	3	3.0
Black Rock	8.7	0.6	8	3	0	2	13	3.7
Lower Debert Marsh - East	4.7	1.6	7	1	0	0	8	5.3
Lwr Debert Marsh - West	2.3	1.2	5	2	0	1	8	6.5
Little Dyke Marsh	4.3	0.9	5	2	0	2	9	5.0
Fort Belcher	20.0	1.3	6	3	0	1	10	3.7

Appendix C.4 – Average number of Savannah Sparrows per survey (**SAVS Marsh Ave**), average number of Savannah Sparrows per survey point (**SAVS Point Ave**), number of passerine species observed (**No. Passer Spp**) number of wetland species observed (**No. Wetland Spp**), number of wading bird species observed, (**No.Wader Spp**), number of gull spp. observed. (**No.Gull Spp**), total number of species (**Total No. Spp**), and average number of species per survey point (**Spp. Richness**) in salt marshes (New Brunswick and Nova Scotia Bay of Fundy).

Marsh	SAVS Marsh Ave	SAVS Point Ave	No. Passer Spp	No. Wetland Spp	No. Wader Spp.	No. Gull Spp.	Total No. Spp	Spp. Richness
Parrsboro1	0.3	0.3	3	1	0	0	4	4.0
Parrsboro2	0.0	0.0	1	1	0	1	3	3.0
Parrsboro3	0.0	0.0	0	0	0	1	1	1.0
Fox Creek	0.3	0.1	5	0	0	0	5	3.7
Allenville	0.0	0.0	1	0	0	2	3	1.5
Spencer's Island1	0.0	0.0	2	0	0	0	2	2.0
Spencer's Island2	0.0	0.0	1	0	0	0	1	1.0
Advocate	0.3	0.2	3	0	1	2	6	3.5
Apple River	2.0	1.0	2	1	1	0	4	3.0
Sand River1	0.0	0.0	3	1	0	0	4	4.0
Sand River2	0.0	0.0	2	0	0	0	2	2.0
Sand River3	0.0	0.0	0	0	0	0	0	0.0
Minudie Park	0.0	0.0	4	0	0	0	4	2.5
River Hebert1	1.0	1.0	2	0	1	0	3	3.0
River Hebert2	0.0	0.0	2	0	1	0	3	3.0
Boars Back1	0.0	0.0	3	0	0	0	3	3.0
Boars Back2	0.0	0.0	3	0	0	0	3	3.0
LRH Cemetary	0.0	0.0	0	2	0	1	3	3.0
RH Carters Brook	0.3	0.3	3	0	2	1	6	1.7
Harrison Brook	0.0	0.0	1	0	0	0	1	1.0
Harrison Lake	0.3	0.3	3	1	0	0	4	4.0
Maccan River	0.0	0.0	0	0	1	0	1	4.0
McIver's Marsh	0.5	0.1	5	1	0	1	7	3.0
John Lusby Section 1	23.7	2.4	4	2	0	2	8	3.4

Appendix C.5 – Average number of Savannah Sparrows per survey (**SAVS Marsh Ave**), average number of Savannah Sparrows per survey point (**SAVS Point Ave**), number of passerine species observed (**No. Passer Spp**) number of wetland species observed (**No. Wetland Spp**), number of wading bird species observed, (**No.Wader Spp**), number of gull spp. observed. (**No.Gull Spp**), total number of species (**Total No. Spp**), and average number of species per survey point (**Spp. Richness**) in salt marshes (Nova Scotia upper Bay of Fundy).

Marsh	SAVS Marsh Ave	SAVS Point Ave	No. Passer Spp	No. Wetland Spp	No. Wader Spp.	No. Gull Spp.	Total No. Spp	Spp. Richness
Tidnish River	0.0	0.0	1	1	0	0	2	2.0
Tidnish River Bridge	0.0	0.0	1	0	0	0	1	1.0
Tidnish - Jackson Point	2.0	1.0	4	4	0	1	9	8.0
Tidnish Purdy Drive	0.0	0.0	3	2	1	0	6	6.0
Mitchell Island	0.0	0.0	5	1	0	0	6	6.0
Shinimicas River	0.0	0.0	2	1	0	0	3	3.0
Shinimicas Estuary	0.0	0.0	2	1	0	1	4	3.5
Wallace River	0.0	0.0	3	1	1	1	6	4.0
McLellan Marsh (1-3)	0.0	0.0	12	5	1	2	20	15.3
McLellan Marsh (4-9)	0.0	0.0	10	7	1	3	21	13.0
Sutherlands River	0.0	0.0	1	1	0	1	3	3.0
Sutherlands River2	0.0	0.0	3	0	0	0	3	3.0
Merigomish Isl	26.0	1.7	8	11	0	3	22	9.7
New London Bay	7.3	1.5	12	10	1	3	26	16.8
Glenfinnan River	0.3	0.1	6	8	1	0	15	6.4
Hillsborough River	0.3	0.1	7	8	1	2	18	9.6
Cow Bay	1.0	0.1	7	9	1	2	19	8.0
Conrad Head - South	68.3	3.8	11	15	1	2	29	10.3
Conrad Head - North	1.7	0.4	9	12	1	2	24	13.8
Fox Point	0.0	0.0	1	1	0	1	3	1.6
Cole Harbour	0.0	0.0	1	2	1	1	5	3.3
Lawrencetown Beach	0.0	0.0	4	2	1	1	8	5.8
Indian Point	0.0	0.0	5	2	1	1	9	6.5
Corkum's Island	0.5	0.2	2	6	1	2	11	7.7
Oler Farm	1.0	0.3	3	9	1	2	15	6.3
Rose Bay - Conrad's Island	0.0	0.0	4	4	1	3	12	8.0
Oxner's Beach	1.3	0.3	6	5	0	1	12	8.0
Crescent Beach	18.0	1.2	8	11	1	2	22	5.5
Beach Meadows	10.0	5.0	4	7	1	1	13	2.8
Cherry Hill Beach	18.4	1.3	9	22	2	3	36	13.3
Port Mouton	0.0	0.0	4	3	1	2	10	6.5
Carter's Beach	0.3	0.3	3	4	1	2	10	10.0

Appendix C.6 – Mean number of Savannah Sparrows per survey (**SAVS Marsh Ave**), average number of SAVS per survey point (**SAVS Point Ave**), number of passerine species observed (**No. Passer Spp**) number of wetland species observed (**No. Wetland Spp**), number of wading bird species observed, (**No.Wader Spp**), number of gull spp. observed. (**No.Gull Spp**), total number of species (**Total No. Spp**), and average number of species per survey point (**Spp. Richness**) in salt marshes (Nova Scotia and Prince Edward Island Gulf of St. Lawrence; Nova Scotia Atlantic Coast).

	Spartina alterniflora		Spartina patens		Spartina pectinata	
Marsh	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**
Bas Caraquet	1.00	20	0.67	37	0.83	12
Inkerman	0.11	8	0.68	31	0.26	12
Village des Poirier	0.40	10	0.80	32	0.40	15
Hay Island	0.40	13	0.70	31	0.00	0
Hay Island11	1.00	30	1.00	33	0.00	0
Kouchibouguac NP	0.20	5	1.00	26	1.00	36
Dune de Bouctouche	0.00	0	0.54	75	0.26	19
Pays de la Saguine (1,2)	0.50	24	0.50	63	0.00	0
Pays de la Saguine (3)	0.00	0	1.00	100	0.00	0
Rotary Park	1.00	15	1.00	73	0.00	0
Surette Island	0.00	0	0.00	0	1.00	1
Grand Digue	0.50	6	1.00	67	0.25	15
Bar de Cocagne	0.50	25	1.00	88	0.00	0
Chockpish	0.25	1	0.75	49	0.25	10
Cocagne Cove	0.00	0	0.50	77	0.00	0
Cocagne Hwy(1)	0.00	0	1.00	100	0.00	0
Cocagne Hwy(2)	1.00	20	1.00	40	0.00	0
Cocagne Hwy(3)	1.00	34	0.00	0	1.00	1
La Passe	0.00	0	0.67	63	0.67	53
Plage Soleil Levant	0.00	0	0.50	9	0.17	29
Pointe aux Bouleaux	0.17	5	0.50	43	0.50	1
Pointe-a-Jerome	0.00	0	1.00	100	0.00	0
Ruisseau Goguen	0.00	0	1.00	95	0.00	0
Saint Thomas	1.00	25	1.00	45	0.00	0
Shediac Bridge	0.00	0	1.00	29	0.00	0
Shediac Island	0.67	37	1.00	75	0.00	0
Cap Brule	0.43	12	1.00	42	0.71	18
Pt du Chene	0.50	40	0.50	60	0.50	10
Belliveau Beach Road	0.33	20	1.00	86	0.33	1
Cape Bimet East	0.22	49	0.33	23	0.83	38

Appendix D.1 – Frequency of occurrence and average percentage cover of *Spartina* species in salt marshes (northern New Brunswick Gulf of St. Lawrence).

	Spartina alterniflora		Spartina patens		Spartina pectinata	
Marsh	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**
Parc Aboiteaux	0.17	5	1.00	43	0.50	10
Teddish River	0.00	0	1.00	30	1.00	10
Aboiteaux Wharf Road	0.00	0	1.00	26	1.00	16
Friel Brook	1.00	5	1.00	30	1.00	15
Shemogue - P'tit Cap	0.50	21	0.93	29	0.29	38
Shemogue - Copp Brook	0.93	19	1.00	50	0.07	5
Shemogue - Dobson Marsh	0.71	34	0.93	45	0.14	41
Shemogue - Fox Creek	0.35	12	1.00	42	0.27	20
Shemogue - Louis Brook	0.33	20	1.00	42	0.17	20
Shemogue - Duguay Point	0.73	19	0.82	34	0.36	35
Shemogue Head	0.50	10	1.00	18	0.50	24
Johnson's Point	0.67	34	0.75	34	0.50	14
Amos Point	0.50	10	1.00	73	0.50	10
Peacock Cove	0.33	35	0.67	9	1.00	55
Annes Acres	0.42	7	0.75	20	0.42	23
Cape Jourimain	1.00	77	0.29	15	0.14	20
Bayfield	1.00	91	0.25	13	0.00	0
Cap St. Laurent	0.33	43	0.67	65	0.50	64
Ephriam Island	0.50	18	1.00	50	0.20	30
Bayside	0.93	51	0.93	29	0.33	13
Arsenault's Marsh	0.25	7.5	0.75	68	0.00	0
Harrison's Marsh	0.94	25	1.00	39	0.00	0
Big Cove	0.92	47	0.92	27	0.08	20
Siddall Road3	1.00	39	0.00	0	1.00	20
Siddall Road	1.00	66	0.75	24	0.00	0

Appendix D.2– Frequency of occurrence and average percentage cover of *Spartina* species in salt marshes (southern New Brunswick Gulf of St. Lawrence).

	Spartina alterniflora		Spartina patens		Spartina pectinata	
Marsh	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**
Beausejour North	0.75	32	0.88	45	0.04	5
Beausejour - Tongue Island	0.73	21	1.00	50	0.07	4
Coles Island Centre	0.87	21	1.00	42	0.27	8
Coles Island 2	0.80	31	1.00	57	0.00	0
Sackville Town Shed	0.29	15	1.00	56	0.43	18
Tantramar River - Mouth	0.50	18	1.00	47	0.00	0
Tantramar River - Strip	0.00	0	0.88	67	0.13	5
Ram Pasture	0.54	18	1.00	56	0.06	12
Westcock	0.86	24	0.86	43	0.86	17
Allen Creek	0.60	49	0.51	28	0.03	20
Rockport	0.50	21	0.83	70	0.17	20
Rockland	0.92	14	0.96	41	0.92	19
Ste. Anselme	0.68	11	0.84	29	0.58	10
Dieppe Marsh	0.91	16	1.00	31	0.91	23
Jonathan Creek	0.00	0	0.15	51	0.85	74
Petitcodiac - Point Park	0.57	26	0.70	22	0.80	49
Mill Creek1,2	0.25	65	0.75	37	0.00	0
Mill Creek	0.42	14	0.33	56	0.42	28
Canadian Brook 1	0.50	20	1.00	23	1.00	33
Canadian Brook 2	0.17	5	1.00	25	0.17	40
Stoney Creek	0.00	0	0.50	37	0.50	25
Minor's Brook1	0.00	0	1.00	15	1.00	23
Minor's Brook2	0.00	0	1.00	20	1.00	10
Weldon Creek	0.63	31	0.38	63	0.06	10
Gray's Island	0.64	84	0.59	48	0.00	0
Hopewell Rocks	0.67	26	0.92	40	0.00	0
Daniels Flats	0.27	18	1.00	52	0.07	5
Mary's Point 2	0.65	12	0.95	70	0.05	10
New Horton	0.55	22	1.00	53	0.05	10
Waterside	0.86	29	0.09	27	0.00	0
NFC1,8	0.00	0	0.20	10	0.80	18
NF Creek	1.00	39	0.00	0	0.25	17

Appendix D.3 – Frequency of occurrence and average percentage cover of *Spartina* species in salt marshes (New Brunswick upper Bay of Fundy).

	Spartina alterniflora		Spartina patens		Spartina pectinata	
Marsh	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**
St. Rests Marsh	0.78	40	0.50	39	0.14	21
Musquash	1.00	18	0.00	0	1.00	51
Board Bridge Creek	0.50	5	1.00	40	0.00	0
Dunn's Marsh	1.00	25	1.00	32	0.50	25
Deadman's Harbour	0.86	23	0.86	32	0.00	0
Castalia	0.92	56	0.58	21	0.00	0
Five Mile River(1-3)	0.33	12.5	1.00	35	0.50	8
Five Mile River (4)	0.50	5	0.50	50	1.00	18
Five Mile River (5)	0.50	30	1.00	70	1.00	8
Five Mile River (7,8)	0.00	0	0.00	0	1.00	23
Five Mile River (6)	1.00	80	0.00	0	0.00	0
Black Rock	0.60	224	0.90	41	0.17	9
Lower Debert Marsh - East	0.50	37	1.00	57	0.00	0
Lwr Debert Marsh - West	0.25	5	1.00	68	0.00	0
Little Dyke Marsh	0.40	20	0.90	56	0.00	0
Fort Belcher	0.67	26	0.83	26	0.07	4

Appendix D.4 – Frequency of occurrence and average percentage cover of *Spartina* species in salt marshes (New Brunswick and Nova Scotia Bay of Fundy).

	Spartina alterniflora		Spartina patens		Spartina pectinata	
Marsh	**Freq**	**Cover**	**Freq**	**Cover**	**Freq**	**Cover**
Parrsboro1	0.00	0	1.00	65	0.00	0
Parrsboro2	1.00	30	0.00	0	0.00	0
Parrsboro3	1.00	8	1.00	62	0.00	0
Fox Creek	0.50	32	0.67	41	0.50	30
Allenville	0.50	20	1.00	23	0.00	0
Spencer's Island1	1.00	95	0.00	0	0.00	0
Spencer's Island2	1.00	75	0.50	10	0.00	0
Advocate	0.75	37	1.00	29	0.00	0
Apple River	0.75	25	0.75	38	0.00	0
Sand River1	0.50	25	1.00	64	0.00	0
Sand River2	1.00	43	1.00	49	0.00	0
Sand River3	1.00	43	1.00	44	0.00	0
Minudie Park	0.88	13	0.88	28	0.00	0
River Hebert1	0.00	0	0.50	15	1.00	35
River Hebert2	0.00	0	0.50	5	1.00	74
Boars Back1	0.00	0	0.00	0	1.00	98
Boars Back2	0.00	0	0.00	0	1.00	99
LRH Cemetary	0.50	100	0.00	0	0.50	100
RH Carters Brook	0.00	0	0.50	39	0.50	40
Harrison Brook	0.00	0	0.00	0	1.00	50
Harrison Lake	0.00	0	0.00	0	0.00	0
Maccan River	0.00	0	0.00	0	1.00	88
McIver's Marsh	0.42	10	0.50	37	1.00	63
John Lusby Section 1	0.50	15	0.85	40	0.15	17

Appendix D.5 – Frequency of occurrence and average percentage cover of *Spartina* species in salt marshes (Nova Scotia upper Bay of Fundy).

Marsh	Spartina alterniflora		Spartina patens		Spartina pectinata	
	Freq	Cover	Freq	Cover	Freq	Cover
Tidnish River	1.00	53	1.00	18	0.50	5
Tidnish River Bridge	0.50	40	1.00	45	0.50	10
Tidnish - Jackson Point	1.00	51	1.00	35	0.25	10
Tidnish Purdy Drive	1.00	35	1.00	30	0.50	20
Mitchell Island	0.50	10	0.50	35	0.50	25
Shinimicas River	1.00	23	1.00	35	0.50	35
Shinimicas Estuary	1.00	48	1.00	35	0.25	5
Wallace River	0.80	29	1.00	57	0.40	10
McLellan Marsh (1-3)	0.00	0	0.00	0	1.00	50
McLellan Marsh (4-9)	0.33	11	0.00	0	1.00	39
Sutherlands River	0.50	30	0.00	0	0.50	30
Sutherlands River2	0.50	5	0.00	0	1.00	8
Merigomish Isl	0.70	35	0.83	26	0.20	25
New London Bay	0.80	14	0.80	38	0.60	41
Glenfinnan River	0.70	46	0.80	34	0.20	35
Hillsborough River	1.00	46	1.00	41	0.10	10
Cow Bay	0.21	15	0.29	39	0.36	45
Conrad Head - South	0.47	17	0.25	15	0.42	15
Conrad Head - North	0.75	10	0.00	0	0.25	10
Fox Point	0.90	23	1.00	40	0.10	15
Cole Harbour	0.88	72	0.38	2	0.00	0
Lawrencetown Beach	0.63	32	0.63	38	0.38	27
Indian Point	1.00	67	1.00	31	0.00	0
Corkum's Island	1.00	58	1.00	32	0.00	0
Rose Bay - Conrad's Island	1.00	17	1.00	64	0.17	30
Oxner's Beach	0.75	46	1.00	36	0.00	0
Crescent Beach	1.00	70	0.50	34	0.13	9
Beach Meadows	0.50	18	0.75	30	0.00	0
Cherry Hill Beach	0.61	46	0.57	28	0.00	0
Port Mouton	1.00	30	1.00	20	1.00	25
Carter's Beach	1.00	40	1.00	30	0.00	0

Appendix D.6 – Frequency of occurrence and average percentage cover of *Spartina* species in salt marshes (Nova Scotia and Prince Edward Island Gulf of St. Lawrence; Nova Scotia Atlantic Coast). Coast).

Marsh	Total COVER	Juncus gerardii		Carex scaleacea		Plantago maritima	
		Freq	Cover	Freq	Cover	Freq	Cover
Bas Caraquet	41	0.17	25	0.17	10.00	0.83	22
Inkerman	28	0.05	10	0.21	16.25	0.16	12
Village des Poirier	54	0.80	28	0.00	0.00	0.40	10
Hay Island	23	0.10	18	0.00	0.00	0.00	0
Hay Island11	33	0.00	0	0.00	0.00	0.00	0
Kouchibouguac NP	65	0.00	0	0.40	7.50	0.00	0
Dune de Bouctouche	53	0.15	35	0.02	75.00	0.00	0
Pays de la Saguine (1,2)	44	0.50	25	0.00	0.00	0.00	0
Pays de la Saguine (3)	100	0.00	0	0.00	0.00	0.00	0
Rotary Park	73	0.00	0	0.00	0.00	0.00	0
Surette Island	46	1.00	45	0.00	0.00	0.00	0
Grand Digue	71	0.00	0	0.00	0.00	0.00	0
Bar de Cocagne	88	0.00	0	0.00	0.00	0.00	0
Chockpish	46	0.00	0	0.25	25.00	0.00	0
Cocagne Cove	38	0.00	0	0.00	0.00	0.00	0
Cocagne Hwy(1)	100	0.00	0	0.00	0.00	0.00	0
Cocagne Hwy(2)	40	0.00	0	0.00	0.00	0.00	0
Cocagne Hwy(3)	1	0.00	0	0.00	0.00	0.00	0
La Passe	77	0.00	0	0.00	0.00	0.00	0
Plage Soleil Levant	22	0.17	46	0.17	29.00	0.00	0
Pointe aux Bouleaux	25	0.00	0	0.17	19.00	0.00	0
Pointe-a-Jerome	100	0.00	0	0.00	0.00	0.00	0
Ruisseau Goguen	95	0.00	0	0.00	0.00	0.00	0
Saint Thomas	45	0.00	0	0.00	0.00	0.00	0
Shediac Bridge	34	0.00	0	1.00	5.00	0.00	0
Shediac Island	75	0.00	0	0.00	0.00	0.00	0
Cap Brule	57	0.00	0	0.07	25.00	0.14	4
Pt du Chene	52	0.50	34	0.00	0.00	0.00	0
Belliveau Beach Road	86	0.00	0	0.00	0.00	0.00	0
Cape Bimet East	41	0.06	10	0.06	10.00	0.28	30

Appendix E.1 – Frequency of occurrence and average percentage cover of *Juncus gerardii*, *Carex scaleacea* and *Plantago maritima* and average percent cover of salt meadow species (**Total Cover**) in salt marshes (northern New Brunswick Gulf of St. Lawrence).

Marsh	Total Cover	Juncus gerardii		Carex scaleacea		Plantago maritima	
		Freq	Cover	Freq	Cover	Freq	Cover
Parc Aboiteaux	62	0.83	16	0.17	5.00	0.83	8
Teddish River	55	1.00	15	0.00	0.00	0.00	0
Aboiteaux Wharf Road	50	0.75	10	0.00	0.00	0.50	8
Friel Brook	60	1.00	15	0.00	0.00	0.00	0
Shemogue - P'tit Cap	53	0.64	24	0.00	0.00	0.21	8
Shemogue - Copp Brook	55	0.21	20	0.00	0.00	0.43	7
Shemogue - Dobson Marsh	49	0.07	20	0.00	0.00	0.50	27
Shemogue - Fox Creek	71	0.73	31	0.08	10.00	0.27	23
Shemogue - Louis Brook	62	0.50	35	0.00	0.00	0.00	0
Shemogue - Duguay Point	51	0.18	33	0.27	16.67	0.36	14
Shemogue Head	80	0.50	70	0.50	30.00	0.00	0
Johnson's Point	45	0.67	18	0.00	0.00	0.33	11
Amos Point	78	0.00	0	0.00	0.00	0.00	0
Peacock Cove	61	0.00	0	0.00	0.00	0.00	0
Annes Acres	45	0.33	6	1.00	18.33	0.00	0
Cape Jourimain	10	0.14	20	0.00	0.00	0.00	0
Bayfield	3	0.00	0	0.00	0.00	0.00	0
Cap St. Laurent	81	0.00	0	0.17	30.00	0.00	0
Ephriam Island	69	0.60	14	0.30	15.00	0.00	0
Bayside	39	0.47	14	0.13	5.00	0.13	10
Arsenault's Marsh	58	0.38	18	0.00	0.00	0.13	5
Harrison's Marsh	54	0.63	22	0.19	8.33	0.06	10
Big Cove	39	0.25	30	0.17	28.50	0.42	5
Siddall Road3	48	0.00	0	1.00	27.50	0.50	2
Siddall Road	27	0.75	12	0.00	0.00	0.00	0

Appendix E.2 – Frequency of occurrence and average percentage cover of *Juncus gerardii*, *Carex scaleacea* and *Plantago maritima* and average percent cover of salt meadow species (**Total Cover**) in salt marshes (southern New Brunswick Gulf of St. Lawrence).

Marsh	Total Cover	Juncus gerardii		Carex scaleacea		Plantago maritima	
		Freq	Cover	Freq	Cover	Freq	Cover
Beausejour North	43	0.25	14	0.00	0.00	0.13	4
Beausejour - Tongue Island	52	0.17	5	0.00	0.00	0.17	3
Coles Island Centre	47	0.17	15	0.00	0.00	0.07	2
Coles Island 2	57	0.00	0	0.00	0.00	0.00	0
Sackville Town Shed	66	0.14	10	0.14	10.00	0.00	0
Tantramar River - Mouth	47	0.00	0	0.00	0.00	0.00	0
Tantramar River - Strip	65	0.38	15	0.00	0.00	0.13	5
Ram Pasture	58	0.13	8	0.02	4.00	0.07	9
Westcock	52	0.07	5	0.00	0.00	0.00	0
Allen Creek	18	0.06	18	0.09	20.00	0.11	9
Rockport	66	0.33	13	0.00	0.00	0.00	0
Rockland	58	0.13	13	0.00	0.00	0.00	0
Ste. Anselme	33	0.16	10	0.05	15.00	0.00	0
Dieppe Marsh	53	0.00	0	0.00	0.00	0.00	0
Jonathan Creek	71	0.00	0	0.00	0.00	0.00	0
Petitcodiac - Point Park	59	0.17	20	0.20	5.00	0.00	0
Mill Creek1,2	45	0.00	0	0.50	35.00	0.00	0
Mill Creek	92	0.00	0	0.83	73.70	0.08	5
Canadian Brook 1	85	0.50	20	0.50	40.00	0.00	0
Canadian Brook 2	85	0.83	26	1.00	31.67	0.00	0
Stoney Creek	60	0.50	15	0.67	32.50	0.00	0
Minor's Brook1	83	1.00	18	1.00	27.50	0.00	0
Minor's Brook2	90	1.00	40	1.00	20.00	0.00	0
Weldon Creek	24	0.00	0	0.00	0.00	0.00	0
Gray's Island	28	0.09	2	0.00	0.00	0.05	1
Hopewell Rocks	36	0.00	0	0.00	0.00	0.58	19
Daniels Flats	67	0.27	20	0.43	21.15	0.23	6
Mary's Point 2	68	0.05	10	0.05	20.00	0.55	4
New Horton	68	0.15	43	0.35	21.71	0.25	2
Waterside	15	0.41	26	0.09	14.00	0.82	19
NFC1,8	40	0.60	18	0.40	31.50	0.40	10
NF Creek	12	0.33	13	0.17	20.00	0.08	5

Appendix E.3 – Frequency of occurrence and average percentage cover of *Juncus gerardii*, *Carex scaleacea* and *Plantago maritima* and average percent cover of salt meadow species (**Total Cover**) in salt marshes (New Brunswick upper Bay of Fundy).

Marsh	Total Cover	Juncus gerardii		Carex scaleacea		Plantago maritima	
		Freq	Cover	Freq	Cover	Freq	Cover
St. Rests Marsh	25	0.11	15	0.06	10.00	0.44	25
Musquash	54	0.33	10	0.00	0.00	0.00	0
Board Bridge Creek	55	0.50	10	0.50	20.00	0.00	0
Dunn's Marsh	60	0.50	30	0.00	0.00	0.00	0
Deadman's Harbour	64	0.93	28	0.50	20.71	0.43	8
Castalia	16	0.17	15	0.08	10.00	0.33	25
Five Mile River(1-3)	81	1.00	42	0.00	0.00	0.00	0
Five Mile River (4)	43	0.00	0	0.00	0.00	0.00	0
Five Mile River (5)	78	0.00	0	0.00	0.00	0.00	0
Five Mile River (7,8)	53	0.75	40	0.00	0.00	0.00	0
Five Mile River (6)	0	0.00	0	0.00	0.00	0.00	0
Black Rock	46	0.13	21	0.17	28.00	0.17	3
Lower Debert Marsh - East	67	0.67	15	0.00	0.00	0.00	0
Lwr Debert Marsh - West	75	0.50	14	0.00	0.00	0.25	2
Little Dyke Marsh	70	0.30	66	0.00	0.00	0.60	3
Fort Belcher	22	0.00	0	0.00	0.00	0.03	2

Appendix E.4 – Frequency of occurrence and average percentage cover of *Juncus gerardii*, *Carex scaleacea* and *Plantago maritima* and average percent cover of salt meadow species (**Total Cover**) in salt marshes (New Brunswick and Nova Scotia Bay of Fundy).

Marsh	Total Cover	Juncus gerardii		Carex scaleacea		Plantago maritima	
		Freq	Cover	Freq	Cover	Freq	Cover
Parrsboro1	65	0.00	0	0.00	0.00	1.00	8
Parrsboro2	0	0.00	0	0.00	0.00	1.00	50
Parrsboro3	72	1.00	10	0.00	0.00	0.50	10
Fox Creek	57	0.33	18	0.33	27.50	0.50	12
Allenville	53	1.00	28	0.50	5.00	0.50	5
Spencer's Island1	0	0.00	0	0.00	0.00	0.00	0
Spencer's Island2	5	0.00	0	0.00	0.00	1.00	8
Advocate	48	0.25	25	0.75	16.67	0.50	13
Apple River	31	0.25	10	0.00	0.00	1.00	16
Sand River1	64	0.00	0	0.00	0.00	0.50	1
Sand River2	54	0.50	10	0.00	0.00	0.00	0
Sand River3	44	0.00	0	0.00	0.00	0.00	0
Minudie Park	31	0.25	25	0.00	0.00	0.25	8
River Hebert1	55	0.50	25	0.00	0.00	0.00	0
River Hebert2	77	0.00	0	0.00	0.00	0.00	0
Boars Back1	98	0.00	0	0.00	0.00	0.00	0
Boars Back2	99	0.00	0	0.00	0.00	0.00	0
LRH Cemetary	50	0.00	0	0.00	0.00	0.00	0
River Hebert - Carters Brook	75	0.50	20	1.00	25.00	0.00	0
Harrison Brook	98	1.00	30	1.00	17.50	0.00	0
Harrison Lake	45	0.50	10	1.00	40.00	0.00	0
Maccan River	93	0.50	10	0.00	0.00	0.00	0
McIver's Marsh	84	0.25	10	0.08	5.00	0.00	0
John Lusby Section 1	37	0.10	8	0.00	0.00	0.00	0

Appendix E.5 – Frequency of occurrence and average percentage cover of *Juncus gerardii*, *Carex scaleacea* and *Plantago maritima* and average percent cover of salt meadow species (**Total Cover**) in salt marshes (Nova Scotia upper Bay of Fundy).

Marsh	Total Cover	Juncus gerardii		Carex scaleacea		Plantago maritima	
		Freq	Cover	Freq	Cover	Freq	Cover
Tidnish River	30	0.50	20	0.00	0.00	0.00	0
Tidnish River Bridge	60	0.50	20	0.00	0.00	0.00	0
Tidnish - Jackson Point	45	0.25	30	0.00	0.00	0.00	0
Tidnish Purdy Drive	40	0.00	0	0.00	0.00	0.00	0
Mitchell Island	82	1.00	52	0.00	0.00	0.00	0
Shinimicas River	58	0.50	10	0.00	0.00	1.00	9
Shinimicas Estuary	36	0.00	0	0.00	0.00	0.75	7
Wallace River	68	0.40	18	0.00	0.00	0.00	0
McLellan Marsh (1-3)	50	0.00	0	0.00	0.00	0.00	0
McLellan Marsh (4-9)	39	0.00	0	0.00	0.00	0.00	0
Sutherlands River	45	0.00	0	1.00	30.00	0.00	0
Sutherlands River2	34	0.00	0	0.50	53.00	0.00	0
Merigomish Isl	33	0.37	17	0.03	5.00	0.53	31
New London Bay	67	0.60	20	0.00	0.00	0.60	9
Glenfinnan River	54	0.40	20	0.40	28.50	0.30	5
Hillsborough River	43	0.10	5	0.00	0.00	0.10	5
Cow Bay	27	0.00	0	0.00	0.00	0.14	10
Conrad Head - South	14	0.17	21	0.00	0.00	0.00	0
Conrad Head - North	3	0.00	0	0.00	0.00	0.00	0
Fox Point	52	0.60	17	0.10	5.00	0.60	22
Cole Harbour	1	0.13	2	0.00	0.00	0.00	0
Lawrencetown Beach	36	0.00	0	0.13	20.00	0.00	0
Indian Point	31	0.00	0	0.00	0.00	0.00	0
Corkum's Island	34	0.17	10	0.00	0.00	0.00	0
Rose Bay - Conrad's Island	69	0.00	0	0.00	0.00	0.00	0
Oxner's Beach	51	0.63	24	0.00	0.00	0.75	8
Crescent Beach	22	0.30	12	0.00	0.00	0.03	10
Beach Meadows	54	0.75	42	0.00	0.00	0.50	4
Cherry Hill Beach	21	0.32	15	0.00	0.00	0.07	10
Port Mouton	55	1.00	10	0.00	0.00	1.00	5
Carter's Beach	30	0.00	0	0.00	0.00	0.00	0

Appendix E.6 – Frequency of occurrence and average percentage cover of *Juncus gerardii*, *Carex scaleacea* and *Plantago maritima* and average percent cover of salt meadow species (**Total Cover**) in salt marshes (Nova Scotia and Prince Edward Island Gulf of St. Lawrence; Nova Scotia Atlantic Coast).