Botanical Survey of Musquash Marsh

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1. Background

The Musquash Estuary, located in southwest New Brunswick, contains a mix of intertidal saltmarsh habitat, some of which has been sequestered from tidal influence by dykes for more than half a century. An area of previously dyked agricultural land adjacent to Highway 1 (Fig. 1.1) represents an opportunity for restoration of a saltmarsh habitat under controlled and monitored conditions that will help understand the successional processes involved in salt marsh restoration. A preliminary botanical survey of the existing agricultural dykeland and salt marsh in the area was conducted by Acadia University personnel in 2003 (Newell, 2003) to document the vegetation present prior to the initiation of the restoration process. A more comprehensive survey was carried out during the late summer of 2004 with the following primary objectives:

(1) to establish permanent plots in the marshland habitats present at the unaltered salt marsh and the flooded agricultural dykeland,
(2) to characterise these plots in terms of: plant species and composition, seasonal biomass production, soil characteristics and elevation*, and
(3) to establish a protocol for future annual monitoring based upon Neckles et al. (2002).

It is anticipated that this survey will be repeated on a yearly basis during late August/early September.

* The soil characteristics and elevation studies are being carried out by Dr. Jeff Ollerhead of Mount Alison University.

Fig. 1.1. Overview of study area.

2. Approach and Methodology

The site to be restored is composed of two areas, one located north of the railway embankment (approximately 24 ha), and one located south of the embankment (approximately 98 ha). A total of eight permanent plots were established; three north of the embankment, and five south of the embankment (Fig. 2.1). The south plots represent sites which had previously been dyked but are now subject to flooding due to breaches in the dyke. The tidal energy this area experiences, however, may be somewhat reduced as a result of the remnant dykes still present. The north sites are similar, but two breaches in the dykes have occurred much more recently (within the last two years). The location of each plot on the south side of the embankment was originally to be determined partly on the basis of elevation, and partly to ensure equidistant spacing along an east-west course. The results of a topographic survey, however, indicated little variation in elevation so the plots wee chosen mainly on the basis of spacing. Each plot was one square metre in area. Table 2.1 lists the location of each plot.

Table 2.1. Location of sample plots.

Plot	Easting	Northing
1	710149	5007689
2	709942	5007648
2	709752	5007568
4	710020	5007091
5	710305	5007259
6	710148	5007337
7	710252	5007484
8	709481	5007057

Within each sample plot, three randomly chosen one-quarter square meter plots were selected for determination of species composition and percent cover of each species. Quantitative measurements of plant height were also made by determining the mean height of the three tallest individuals of the most abundant species within each sampling quadrate.

In addition to percent cover and plant height measurements, a one-quarter square meter plot located immediately adjacent to the northeast corner of the main sample plot was clipped of all above ground vegetation for laboratory determination of above ground biomass of the most dominant species. Biomass determinations were made after oven drying the plants to a constant dry weight at 70 ºC.

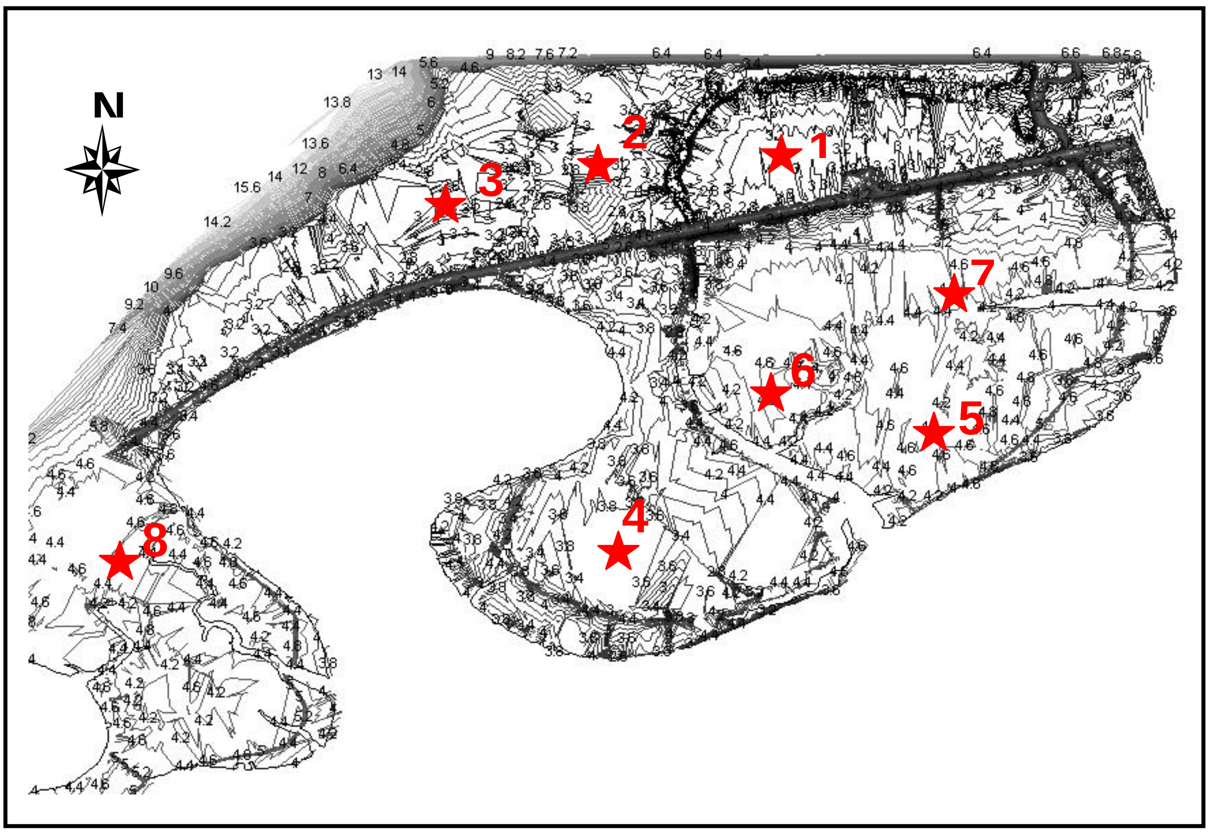

Fig. 2.1. Topographic map showing location of sample plots (map provided by Dr. Jeff Ollerhead of Mt. Allison University).

Photographic records of each sampling plot, as well as the harvested plots, were also made prior to sampling in order to provide a visual record of changes in vegetation over time. Additional photographs were also made showing panoramic views of numerous areas of the marsh. These are contained in Appendix II.

3. Results

A summary of the species present, percent species composition and height of the dominant species at each sample plot is contained in Appendix I. A total of 14 species of plants were identified. About half of these seldom constituted more than a few per cent of the total plant cover. Most plots contained relatively high percentages of dead vegetation[1]. The most common plant species was *Carex paleacea*. *Carex paleacea* and *Spartina pectinata* were the most dominant plant species within the north plots, and *Carex paleacea* and *Spartina patens* dominated the south plots. *Spartina alterniflora* was only present at the most southern plots (4 and 5).

The three species of *Spartina* showed the zonation pattern typical of each species. *S. pectinata* is typically found in areas at the very highest margins of salt marshes where soils are relatively free of salts, and was present only in plots located the north of the embankment. *S. patens*, or high marsh grass, is most characteristic of areas that tend to be flooded only during spring tides. It was present in three of the four plots on the south side of the embankment suggesting that this area is only flooded during spring tides. *S. alterniflora*, or low marsh grass, is typical of salt marsh zones that are flooded on most tides and was present in the two most southern plots (4 and 5). *S. patens* was also present at these plots and the presence of both *S. alterniflora* and *S. patens* indicates that these plots were probably located in the transitional zone between high and low salt marsh.

Fig. 3.1 illustrates the percent cover of each species at each sample plot. Plant biomass, as grams dry weight per m^2, is summarized in Table 3.1 and Fig. 3.2.

[1] The ground surface of all plots was always completely covered by dead vegetation. The live plants grew up through this dead vegetation.

Table 3.1. Biomass of dominant plants at each plot (units are gms dry wt per sq m).

Plot	***Carex paleacea***	***Spartina pectinata***	***Spartina patens***	***Spartina alterniflora***	***Aster novi-belgii***	***Argentina egedii***	***Agrostis stolonifera***	***Solidago sempervirens***	***Glaux maritima***	***Triglochin maritima***	***Calystegia sepium***	***Ranunculus cymbalaria***	**Unknown grass**	**Total Biomass**
1	284.4	179.6											6.5	470.5
2	51.1	152.4												203.5
3	264.7	74.4												339.1
4			110.5	51.3		0.4	9.0			0.2				171.4
5	3.2	3.0	66.4	93.4		6.5		0.6		41.4		0.2		214.7
6	266.2	44.3	98.2		1.6	8.8		12.4	7.6	1.7			3.2	444.0
7	315.3		57.5			4.4	5.8		14.6	52.9				450.5
8	421.0	90.4			27.8			5.3			1.8			546.3

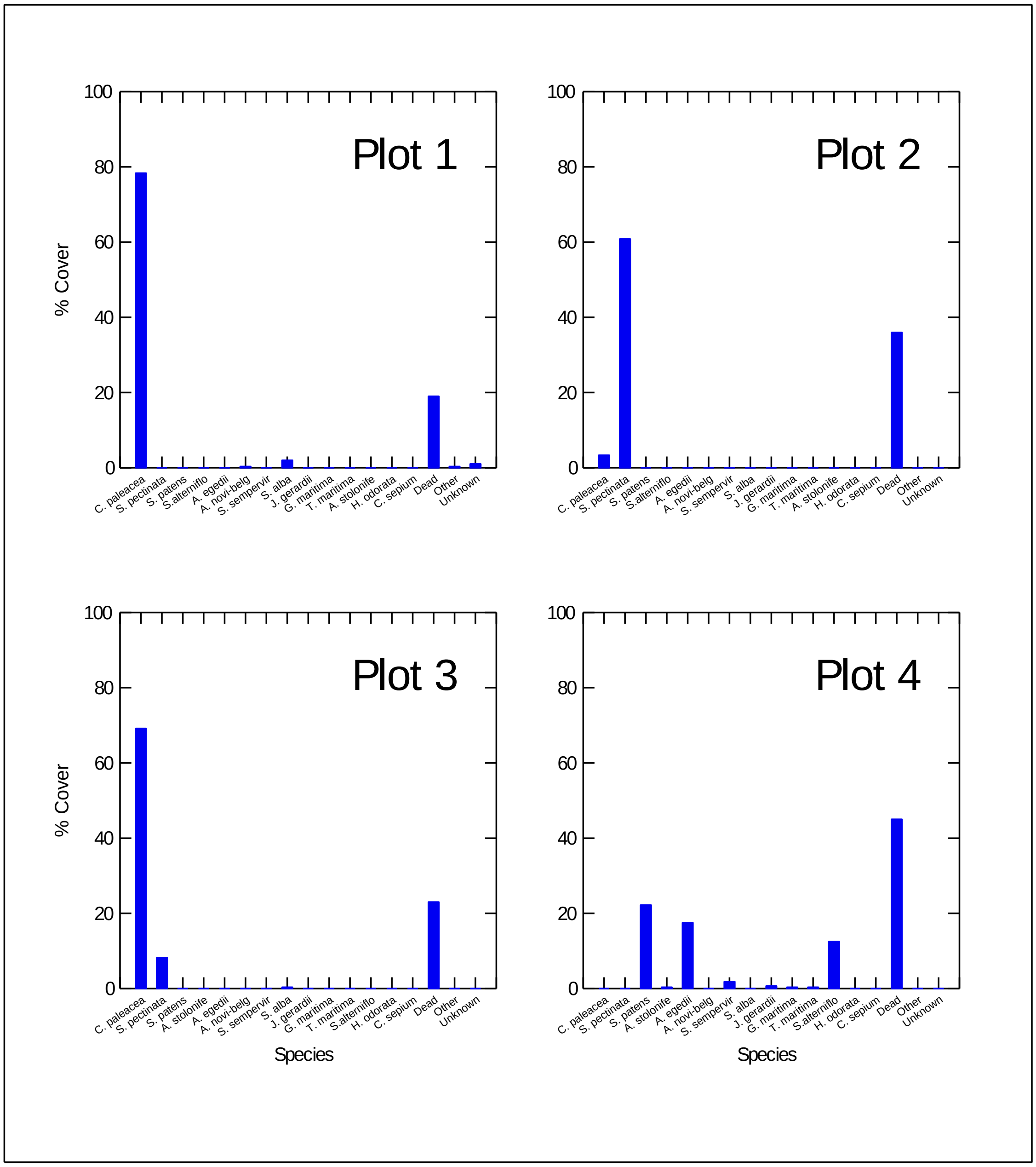

Fig. 3.1 Percent cover of each species at each sample plot.

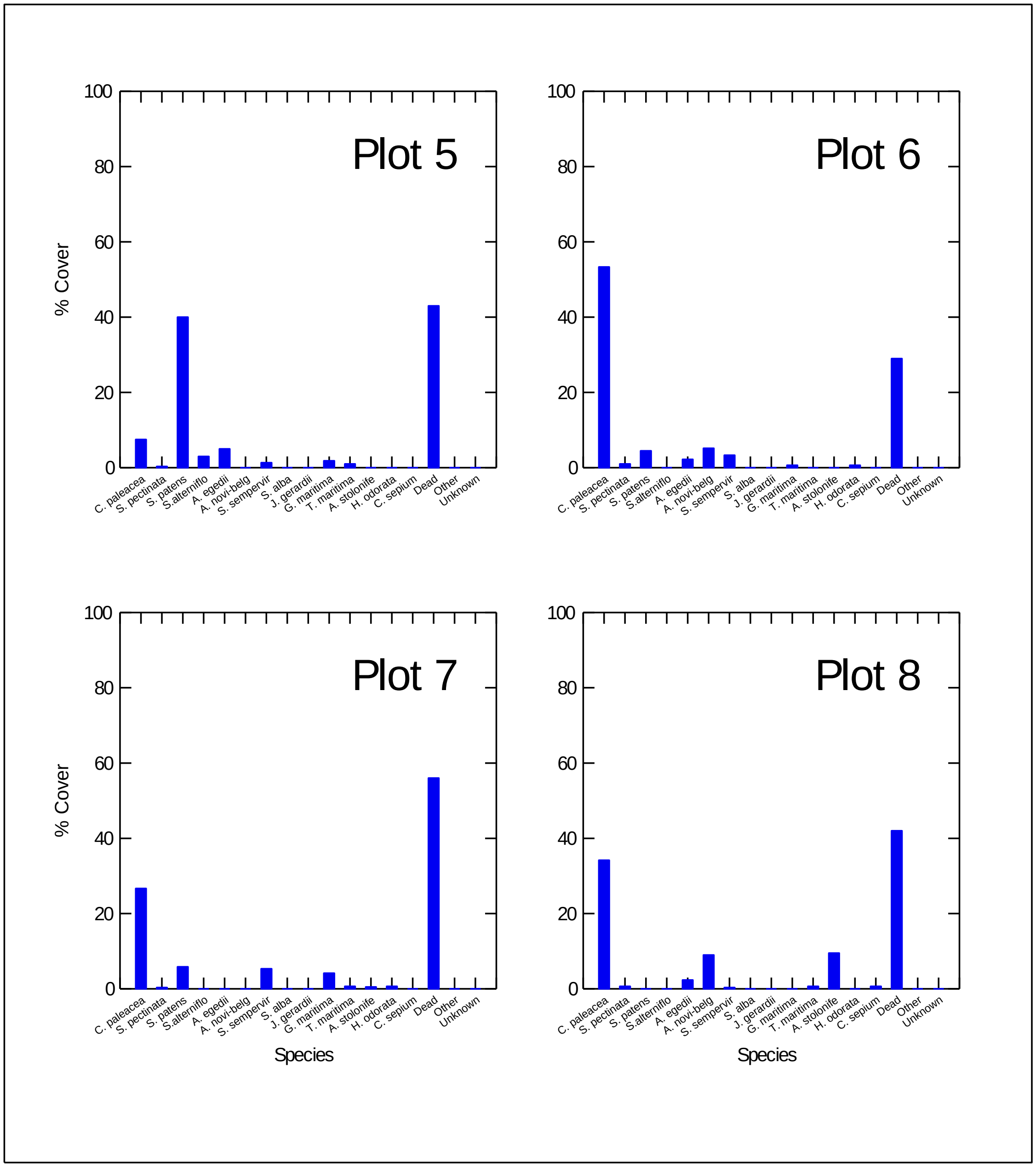

Fig. 3.1 (continued). Percent cover of each species at each sample plot.

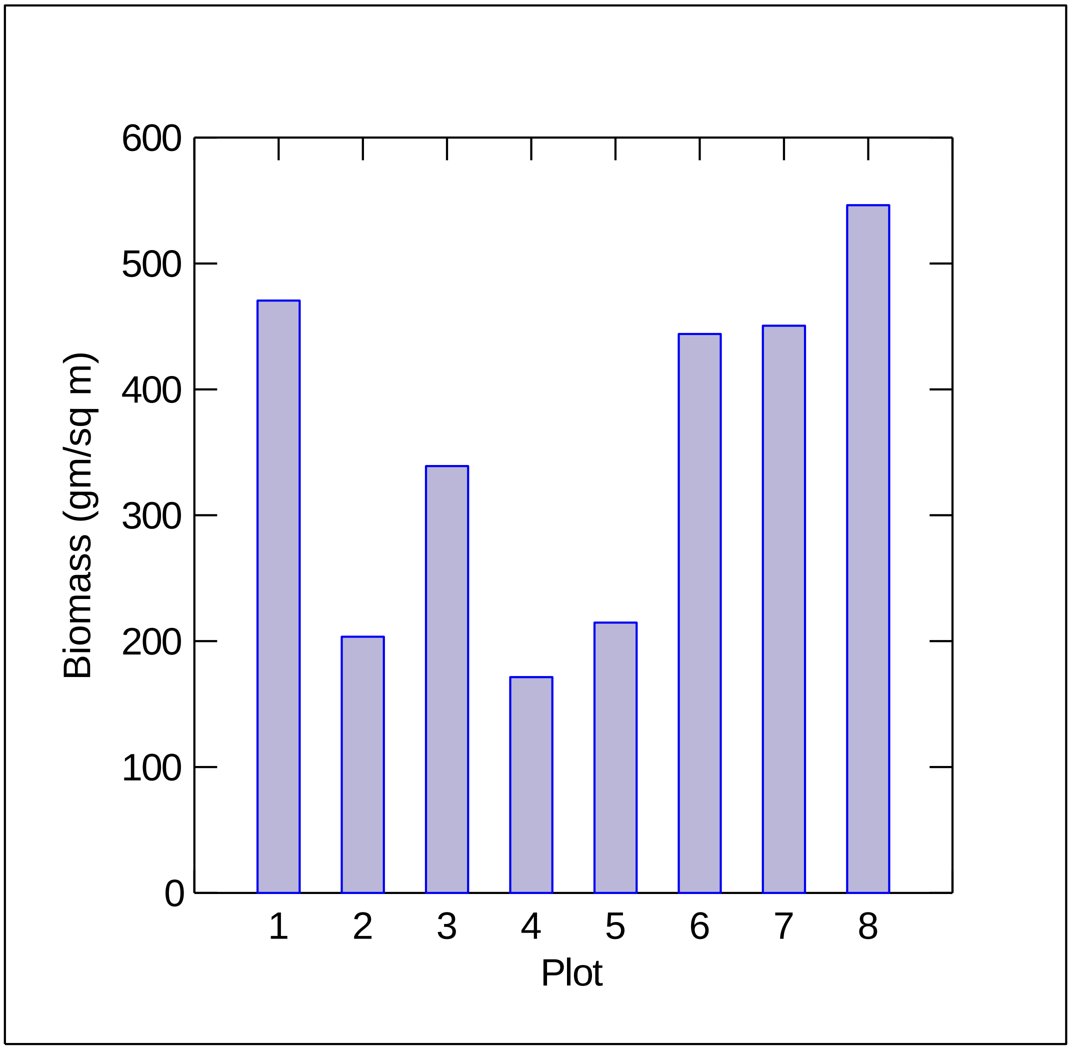

Fig 3.2. Total plant biomass at each sample plot.

4. Discussion

As is generally typical of salt marsh environments, species diversity was quite low. Only 14 plant species were identified from all of the sample plots. *Carex paleacea* dominated almost all plots. On the north side of the railway embankment *Spartina pectinata* was the second most abundant species. On the south side of the embankment, *Spartina patens* was the second most dominant species. All of the plant species observed are typical of those present in salt marsh systems. Some, such as *Spartina patens*, *S. alterniflora*, *Glaux maritima* and *Solidago sempervirens* are typically found only in salt marsh environments, while others, such as *Aster novi-belgii*, *Calystegia sepium*, *Agrostis stolonifera* and *Spartina pectinata* are also found in environments other than salt marshes.

For plots located both north and south of the railroad embankment, the cumulative number of species observed did not increase substantially as the number of sample plots increased. This suggests that an increase in the number of plots sampled would unlikely result in a significant increase in the number of species observed.

Plant biomass did not show any consistent trends among sample plots. The ranges in biomass of plots north and south of the railway embankment were similar. On the south side of the embankment there appears to be a slight trend of increasing biomass from south to north.

5. Recommendations for a Future Sampling Protocol

Neckles et al. (2002) suggests the following as a monitoring protocol when documenting vegetation changes in impacted salt mashes that are undergoing restoration:

- Sample plots
  - Establish permanent plots along transects at intervals necessary to maintain independence (>10m-20m)
  - Suggests 20 plots is adequate to describe most New England salt marshes
- Frequency of sampling
  - Once at time of maximum biomass (mid-July through August)
- Determine Species Composition
  - Identify all plants species occurring per m^2 in each sample plot
- Plant Abundance
  - Percent cover per m^2 by species in each sample plot
- Plant Height
  - Determine mean height of three tallest individuals of each species of concern per m^2 in each sample plot
- Density
  - Determine number of shoots per m^2 in each sample plot
- Photography
  - Panoramic views of entire marsh from several compass bearings
  - Close ups of permanent plots

The protocol followed in this study was essentially the same as that described above with the exception that (1) only eight plots were established and, (2) density was determined as biomass per m^2 rather than number of shoots per m^2.

The decision as to the number of permanent plots to establish was based on the resources available for the survey. More plots would certainly increase the power of any statistical analyses used to detect significant changes over time. It would, however, also require additional resources. In order to determine the degree of change that could be detected based on the current level of sampling effort, an analysis of the absolute and relative changes that would be detectable in plant height (Table 7.1) was carried out according to the procedure described in Krebs (1989). The level of difference that could be detected ranged from 2.2 to 5.4 % with seems quite acceptable.

Table 7.1 Determination of difference in plant heights detectable based on data collected for the three most abundant plant species.

Species	Number of Observations	Mean Height (cm)	Standard Deviation*	Detectable Difference**	
				Absolute (cm)	Relative (%)
Carex paleacea	77	106.7	2.74	2.3	2.2
Spartina pectinata	18	103.6	6.64	5.6	5.4
Spartina patens	24	53.9	3.25	2.7	5.0

* Mean of standard deviations for each quadrate.
** Based on 95% confidence interval.

With respect to estimating biomass as opposed to plant stem density, we consider biomass to be a better parameter to estimate since it better reflects changes in the growth and productivity of the plants.

6. Acknowledgements

Funding for this study was provided by Ducks Unlimited Canada. Evan Fairn assisted with the field and laboratory work. Dr. Jeff Ollerhead of Mount Alison University provided the topographic map and assisted in providing coordinates for the sampling plots. Peter Romkey and Dr. Graham Daborn of Acadia University provided advice on various aspects of the project.

7. References

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Neckles, H.A., M. Dionne, D.M. Burdick, C.T. Roman, R. Buchsbaum and E. Hutchins 2002. A monitoring protocol to assess tidal restoration of salt marshes on local and regional scales. Restoration Ecology. 10(3):556-563.

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Appendix I. Summary of vegetation survey data.

PLOT	Quadrate*	*Carex paleacea*		*Aster novi-belgii*		*Spartina pectinata*		*Spartina patens*		*Argentina egedii*		*Spartina alterniflora*		*Solidago sempervirens*		*Agrostis stolonifera*		*Hierchloe odorata*	*Calystegia sepium*	*Juncus gerardii*	*Glaux maritima*	*Triglochin maritima*	*Spiraea alba*
		% Cover	Height (cm)	% Cover	Height (cm)	% Cover	Height (cm)	% Cover	Height (cm)	% Cover	Height (cm)	% Cover	Height (cm)	% Cover	Height (cm)	% Cover	Height (cm)	% Cover	% Cover	% Cover	% Cover	% Cover	% Cover
1	2	90	136/136/134																				5
1	3	90	133/138/137	1	46																		1
1	4	60	118/128/132																				
2	2					75	110/103/101																
2	3	10	102/100/81			25	100/101/107																
2	4					85	107/104/101																
3	2	80	125/103/110			2	124/102/100																
3	3	50	107/107/104			10	106/107/100																<1
3	4	80	122/109/108			15	91/103/98																
4	1							20	49/45/46	15	20/17/22	5		4						<1			
4	2							12		20	25/28/22	25	55/55/49	1		1					<1	<1	
4	3							35	49/57/58	20	26/25/18	5								<1			
5	2	8	86/67/77					45	38/38/38	5		2		<1							1	<1	
5	3	10	77/79/79			1		20	38/52/44	5		5		1							4	<1	
5	4	5	76/63/73			<1		55	37/43/44	5	24/27/19	2		2		5					1	<1	
6		50	115/108/107	7	62/52/47	<1		5						5				1			1		
6		80	115/104/100	5		<1		10	64/79/81					5				1			1		
6		30	103/97/99	5	50/38/39	<1		1															
7	1	30	8495/93					10	68/67/69	5								<1			3		
7	2	30	94/94/85					10	65/63/63	1				<1							10	<1	
7	3	25	101/92/87			<1		10		1				15	74/81/73			1			2	<1	
8	1	30	130/120/120	5		<1										20	67/81/91		<1			<1	
8	2	50	131/134/135	5	83/80/66									<1		<1							
8	3	30	129/131/130	20	68/77/75	<1										10			<1			<1	

*Quadrate numbers are as follows: 1 - Northwest; 2 - Northeast; 3 – Southwest; 4 – Southeast.

APPENDIX II
Images of Marsh and Survey Plots

Key to Panoramic Images

Panoramic No. 1

Panoramic No. 2

Panoramic No. 3

Panoramic No. 4

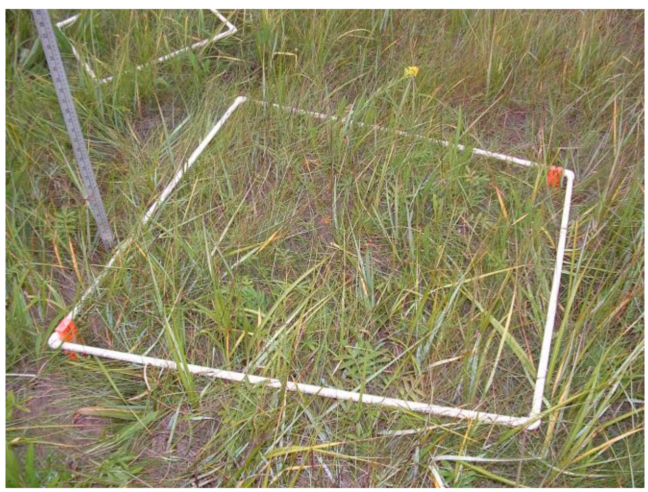
Panoramic No. 5

Images of Sample Plots

Site 1

Site 2

Site 3

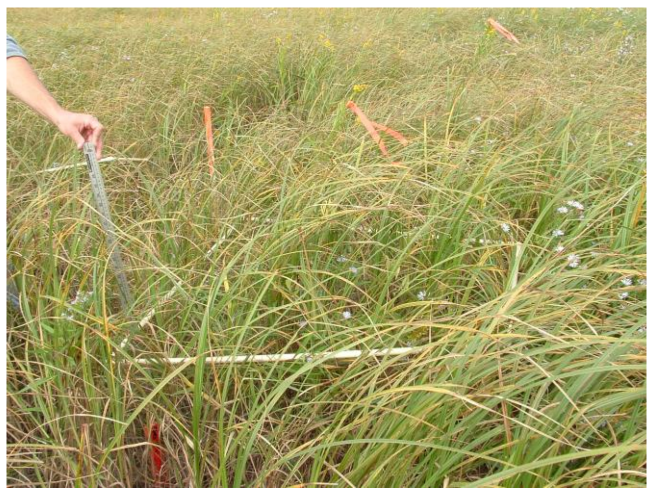


Site 4

Site 5

Site 6

Site 7



Site 8