Assessment of Littoral Vegetation at Cove Point from Shoreline Transects

Final Report To:

Cove Point Natural Heritage Trust
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INTRODUCTION

Cove Point is a unique geomorphic feature on the western shore of the Maryland portion of the mainstem of Chesapeake Bay, just south of Calvert Cliffs State Park. Despite the small area of the spit (>100 acres), almost 400 species of plants have presently been found there with 41 listed as threatened, or endangered (Steury 1997). Although Cove Point may be an ephemeral feature over geological time, it has existed more or less intact since settlement in the late 17th Century (Stevenson and Sundberg 1997). However, there is evidence of recent changes which may need to be addressed in managing this system in the future. Among the most striking change in vegetation is the increasing dominance of *Phragmites australis*, a species which has been aggressively invading many marshes in the Chesapeake Bay Region since 1938 (Rice and Stevenson 1996). There has been serious concern in the marsh management community, that if left unchecked, this *Phragmites* might significantly reduce the species diversity of comparatively small isolated systems like Cove Point. *Phragmites australis* has invaded many wetland environments, resulting in pure stands. Not only does this lessen the overall plant diversity, but some have suggested that *Phragmites*-dominated marshes also have less wildlife value than other saltmarsh types (Haslam 1971). Thus, large scale aerial applications of the wide spectrum herbicide, Rodeo (a formulation of glyphosate), have been proposed for the Cove Point marsh. However, due to environmental concerns aerial applications have been delayed until baseline vegetation data could be collected.

The littoral area between the beach and the marsh is of special significance since it is critical to the maintenance of the shoreline as well as the integrity of the marsh systems behind it. Major breaks in this community might jeopardize the stability of the marshes behind if they were to be flooded with salt-water. Also the presence of a rare and endangered species of tiger beetle, is also a consideration in managing the Cove Point system. The purpose of this study was to obtain baseline information on vegetation occurring along transects laid out perpendicular to the shoreline of Cove Point. This effort will be part of a longer term one designed to quantitatively assess vegetation changes in the marsh at Cove Point.

METHODS

Transects

Fourteen line transects were laid out 100 meters apart along the beach from approximately 120 m above the boardwalk to the end of the Cove Point LNG facility near the lighthouse. Five of the transects started near the benchmarks that were surveyed by the laboratory for Coastal Research at University of Maryland (Beardsley et al. 1996). Transect benchmarks were initiated on the berm at the sand/vegetation interface. All transects proceeded perpendicular to the beach, in a southwesterly direction. Sample sites were established at 10-m intervals. The distance to each sampling site was determined using 100-m fiberglass survey tapes. Survey flags were placed at each sample site and were labeled with the site location (in meters from the beach benchmark).

Vegetation Surveys

Vegetation surveys took place on May 20-21, 1996 and September 25, 1996. At each sample site a 1-m^2 quadrat was laid out, and all species present in the quadrat were identified using a combination of Silberhorn (1982), and Brown and Brown (1984) with nomenclature in accordance with Cronquist's latest edition. The composition of each quadrat was recorded (to the nearest 1%) as percentages of each species present. Canopy height (cm) was also recorded by measuring the height of the tallest representative macrophyte in the plot. The transects continued until the *P. australis* density dropped to less than 50% in two successive quadrats along the transect. All data were recorded on appropriate data sheets in the field, and eventually transferred to QuattroPro spreadsheets. Two voucher specimens of all major species present were collected and pressed and are currently retained at Horn Point Environmental Laboratory.

Nitrogen and Phosphorus and Salinity in the Cove Point Ponds

When we recognized that the remnants of hurricane Fran had breached the berm and flooded the ponds in early September, water quality background data was collected on September 25, 1996 to see the potential effects. For reference the water column of the ponds was compared to the adjacent bay waters (off the pier). The samples were collected and filtered immediately in the field with Whatman GFF filters (0.7 µm nominal pore size) and transported on ice to Horn Point where they were frozen before further analysis by HPEL Analytical Services following protocols described in Stevenson et al. (1993).

RESULTS

Spring and Fall Vegetation Surveys

During the May 1996 survey, twenty-nine macrophytes (Table 1a) were identified from within the quadrats using Silberhorn (1982) and/or Brown and Brown (1984). In some cases, vegetation could not be identified to species as it hadn't yet developed enough definitive characteristics. Additional visits were made to the marsh on June 6 and 8, 1996 to monitor development of these species and begin collecting and pressing voucher specimens.

On September 25, 1996, we re-surveyed the line transects that had been established in May. The shoreline had been markedly changed by erosion of the beach resulting from the remnants of a hurricane Fran on September 6. A comparison of the actual tide record at Solomons with the predicted amplitude indicates that late on September 6 there was 2.5 ft more tide than usual (Figures 1 & 2). In addition, the wind was out of the east with several miles of fetch which caused extensive damage to the pier at Chesapeake Biological Laboratory at Solomons (Figure 2). At Cove Point, approximately 5 to 10 meters of vegetation had been washed away. We were able to locate all fourteen transects. However, in September, the beginning points of all transects except CP6, CP7, CP8, and CP13 were located on sandy beach whereas in May all transects began at the interface between sandy beach and dune, where vegetation began. Potential water quality issues relevant to hurricane Fran are discussed below.

We followed the same protocol used in May, examining each 1-m^2 quadrat that had been previously surveyed for total percent cover, canopy height (in cm), and composition (Table 1b). It does not appear as though *Phragmites australis* has expanded its range (Figure 3) at the Cove Point Marsh during the 1996 growing season (Table 2).

Additional plant specimens were collected and pressed. To date, 39 macrophytes (Table 3) have been identified from within the quadrats using Silberhorn (1982) and/or Brown and Brown (1984). There are still several "unknown species" which will have to be annotated by others. Currently, all voucher specimens are located at Horn Point Environmental Laboratory.

Water Quality

The salinity was measured in the ponds with a refractometer and found to be consistently 4 ‰ on the interior of transects 1, 3 and along 8. The salinity at the end of

the pier in the Bay was then 11 ‰ (Table 4). Thus, about a third by volume of the water in the ponds was now from the adjacent bay, confirming that significant intrusion had occurred most likely over the past weeks. (There were two other events between May and late September-- but these do not appear to be significant enough to cause the observed erosion-- see Figure 2). Phosphorus (PO_4) was remarkably stable in each of the five samples ranging from 0.06 to 0.10 µM. In contrast, dissolved inorganic nitrogen (DIN) was much lower in the ponds than the adjacent bay (Table 4). The low DIN is especially significant due to the low ammonium (NH_4) concentrations, suggesting nitrification and possibly denitrification had taken place in the intervening period (in addition to dilution with fresh water). Although the data are admittedly sparse, they suggest that in late summer, nitrogen most likely is the limiting nutrient in the ponds.

DISCUSSION

Disturbed marsh areas around Chesapeake Bay are increasingly vulnerable to invasion by *Phragmites australis*. Although supposedly native to North America, it seems to have been restricted to disturbed areas around the piers of Baltimore prior to the 20th Century (Shreve et al. 1910). Most likely, the invasive biotype(s) we now have in the region are derived from European imports which are now more aggressively colonizing disturbed wetland areas. Rice and Stevenson (1996) have carefully documented the advance of *P. australis* in six tidal marshes in Maryland using aerial photography dating from 1938. They concluded that while many brackish and fresh water marshes are now largely dominated by *Phragmites*, it appears to be slowing down in these situations. However, high salinity marshes are now being invaded at increasingly higher rates. Although often considered a noxious weed in the U.S., this is not the case elsewhere. In Europe this species is considered important, not only because of its high productivity and ability to protect shorelines from erosion, but also because of the high algal productivity associated with epiphytes on the middle sections of submerged parts (Muller 1995). Thus there is concern in Europe about the consequences of losing *Phragmites* there. To some degree this argument should have some resonance in the U.S. How much effort should we spend on eradication of *Phragmites*-- especially if it can protect shorelines from erosion?

One interesting by-product of the present study has been the assessment of the ability of *Phragmites* to withstand a significant erosion event--i.e hurricane Fran. However, our data indicated that there was little correlation between the percentage of Phragmites (in May) and the amount of erosion at that location (Fig. 4). Admittedly this was an a-posteriori analysis and somewhat crude, but it does suggest that *Phragmites* may not be an adequate buffer to significant storm events such as Fran. Whether it can withstand lesser events is of course open to question. The overall conclusion that might be drawn here is that extermination of *Phragmites* might not be detrimental to shoreline stability. However, the interdispersed nature of the *Phragmites* among other desirable vegetation in the littoral zone indicates the need for a very selective approach such as back pack spraying rather than aerial spraying of herbicides in this area.

Another aspect of hurricane Fran that should be considered is the intrusion of saltwater into the ponds. The concern here is that when saltwater containing sulfate comes into contact with rich organic substrates in the ponds, large amounts of hydrogen sulfide are produced. As well as having a noxious odor, this gas is highly toxic to many plants (with the exception perhaps of a few halophytes (e.g. *Spartina*, Eelgrass, and etc.). This could adversely affect biodiversity in these systems and efforts should be made to monitor intrusions and keep them to a minimum in the future.

CONCLUSIONS

• The beach erosion at Cove Point was far faster in 1996 than historical rates would have indicated.

• This erosion appears to have been mostly due to the remnants of hurricane Fran, but there were two other smaller "high tide/wind" events between May and September which may have contributed to beach loss.

• The ponds at Cove Point had elevated salinity of at least 4‰ in early fall due to intrusions of bay water over the summer.

• The ponds lost nitrogen relative to phosphorus-- suggesting the former is the limiting nutrient and/or the ponds have substantial rates of denitrification (and nitrification).

• There is a significant percentage of *Phragmites* along the beach vegetation at Cove Point on some transects but there is no correlation between *Phragmites* and erosion on the transects.

• Because it is often in low percentages and mixed with other vegetation, *Phragmites* may be affected by aerial spraying. A better method for many transects appears to be back-pack spraying.

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FIGURE 1.

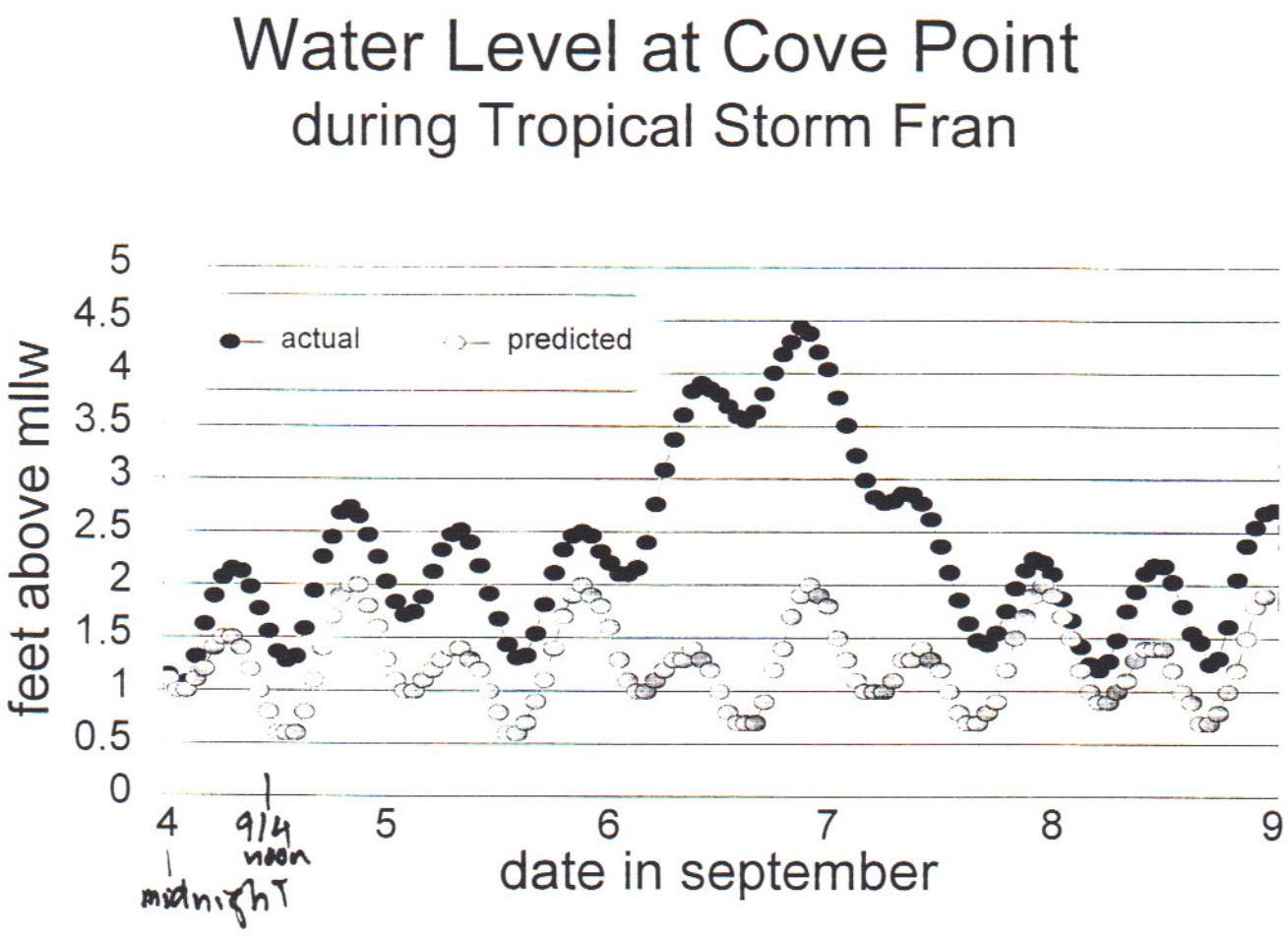
Water Level at Cove Point
during Tropical Storm Fran
feet above mllw
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
actual
predicted
4
9/4
noon
midnight
5
6
7
8
9
date in september

FIGURE 2

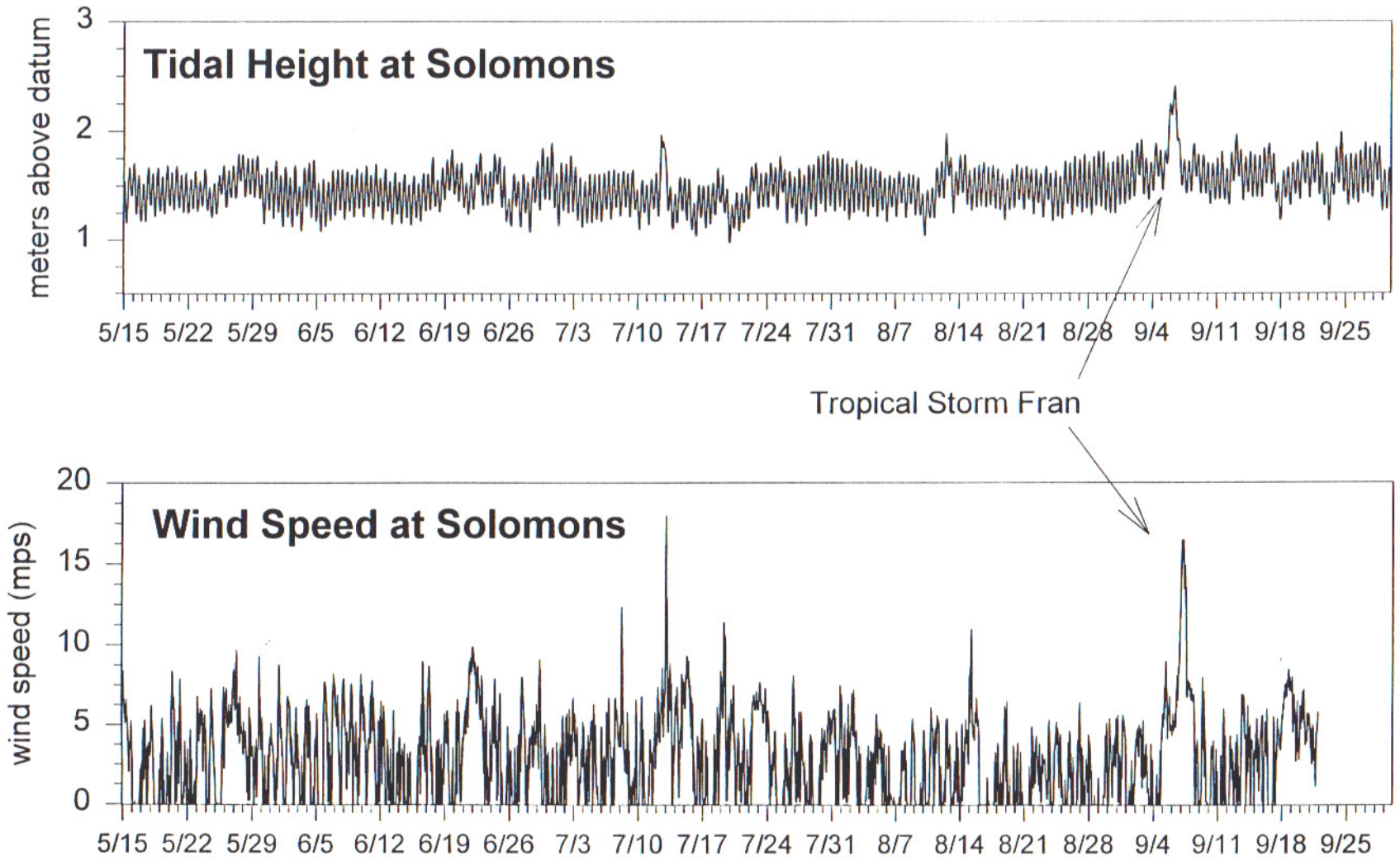
Tidal Height at Solomons
meters above datum
3
2
1
5/15 5/22 5/29 6/5 6/12 6/19 6/26 7/3 7/10 7/17 7/24 7/31 8/7 8/14 8/21 8/28 9/4 9/11 9/18 9/25
Tropical Storm Fran
Wind Speed at Solomons
wind speed (mps)
20
15
10
5
0
5/15 5/22 5/29 6/5 6/12 6/19 6/26 7/3 7/10 7/17 7/24 7/31 8/7 8/14 8/21 8/28 9/4 9/11 9/18 9/25

FIGURE 3 *Phragmites australis* distributions at Cove Point Marsh. Each bar graph represents the percent of *P. australis* present in 1-m^2 quadrats located at 10-m intervals along a transect (cp0-cp13) running from the beach/marsh interface (0m) into the marsh. See graph cp7 for axis labels.

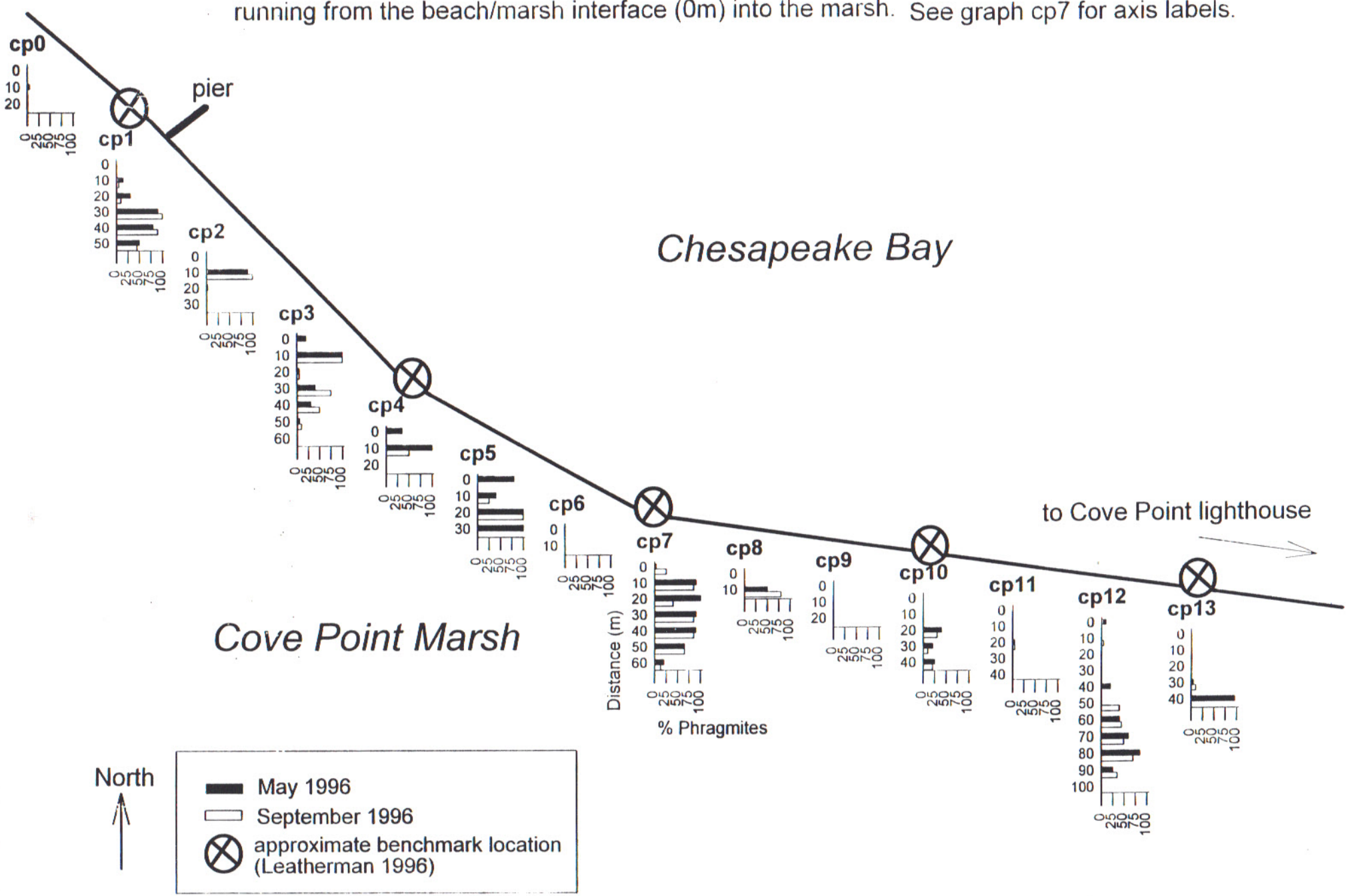

FIGURE 4.

Shoreline Erosion from May to Sept. 1996 at Cove Point Marsh compared to Phragmites Densities

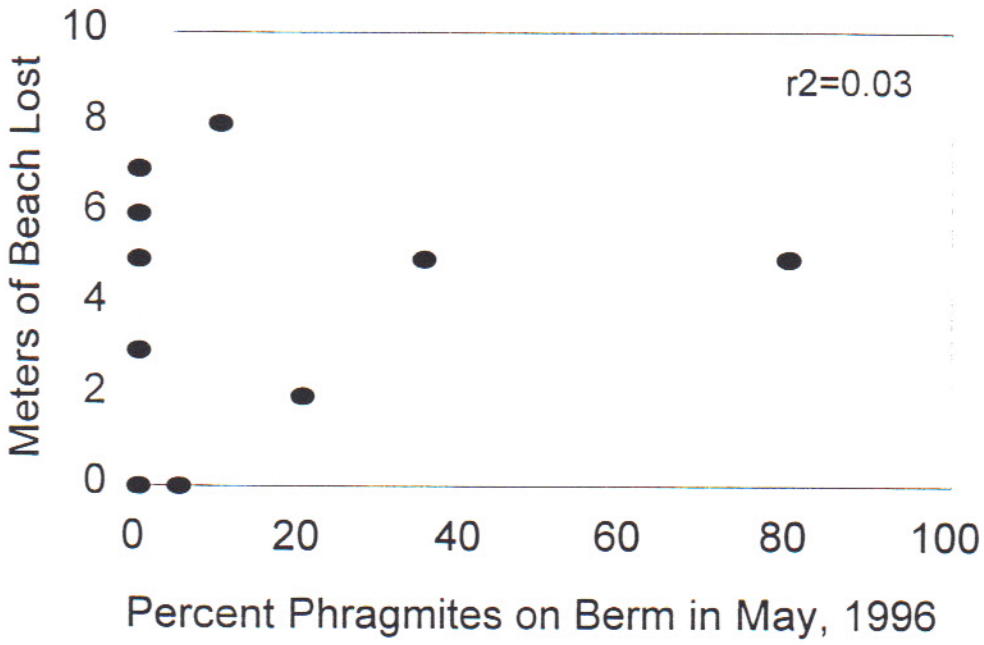

Table 1a. Species distributions along transects at Cove Point Marsh, May 1996.

transect	distance	total %cover	canopy height	species	% composition
CP0	0	60	75	Ammophila breviligulata	40
				Galium aparine	4
				Lonicera sempervirens	40
				unknown #1	4
				Robinia pseudo-acacia	7
				Diospyros virginiana	5
	10	20	310	Robinia pseudo-acacia	20
				Galium aparine	40
				Lonicera sempervirens	20
				Phragmites australis	5
				Campsis radicans	10
				Panicum sp.	5
	20	50	155	Hydrocotyle sp.	30
				Hibiscus moscheutos	10
				Typha angustifolia	60
CP1	0	15	60	Galium aparine	50
				Phragmites australis	<1
				Ammophila breviligulata	50
				unknown #2	<1
	10	15	45	Hydrocotyle sp.	30
				Apocynum cannabinum	5
				Phragmites australis	15
				Galium aparine	40
				unknown #3	10
	20	10	180	Hibiscus moscheutos	10
				Typha angustifolia	60
				Phragmites australis	30
	30	5	120	Phragmites australis	90
				Hydrocotyle sp.	10
	40	20	150	Phragmites australis	80
				Hibiscus moscheutos	7
				Hydrocotyle sp.	7
				Alisma sp.	<1
				Polygonum sp.	7
	50	15	140	Phragmites australis	50
				Peltandra virginica	5
				Hibiscus moscheutos	10
				Alisma sp.	2
				Typha angustifolia	30
				Polygonum sp.	3

Table 1a. Species distributions along transects at Cove Point Marsh, May 1996.

transect	distance	total %cover	canopy height	species	% composition
CP2	0	75	225	Ammophila breviligulata	100
	7.5	100	167	Phragmites australis	90
				Ammophila breviligulata	4
				Galium aparine	3
				mint sp.	3
	17.5	65	280	Hibiscus moscheutos	2
				Phragmites australis	2
				Ammophila breviligulata	2
				Eleocharis sp.	94
	27.5	65		Hibiscus moscheutos	5
				Ammophila breviligulata	5
				Eleocharis sp.	86
				Alisma sp.	2
				Polygonum sp.	2
CP3	0	10	40	Phragmites australis	20
				Ammophila breviligulata	50
				Calystegia sepium	25
	10	30	220	Phragmites australis	100
	20	5	140	Typha angustifolia	45
				Eleocharis sp.	45
				Phragmites australis	5
				Hibiscus moscheutos	5
	30	30	170	Phragmites australis	40
				Hibiscus moscheutos	20
				Typha angustifolia	20
				Hydrocotyle sp.	10
				Eleocharis sp.	5
				Eleocharis sp.	5
	40	25	170	Phragmites australis	30
				Typha angustifolia	30
				Hydrocotyle sp.	10
				Hibiscus moscheutos	10
				Eleocharis sp.	15
				Polygonum sp.	5
	50	15	100	Hibiscus moscheutos	40
				Typha angustifolia	30
				Hydrocotyle sp.	20
				Eleocharis sp.	5
				Phragmites australis	5
	60	25	110	Typha angustifolia	75
				Hibiscus moscheutos	10
				Hydrocotyle sp.	10
				Eleocharis sp.	5

Table 1a. Species distributions along transects at Cove Point Marsh, May 1996.

transect	distance	total %cover	canopy height	species	% composition
CP4	0	50	140	Phragmites australis	35
				Calystegia sepium	10
				Ammophila breviligulata	55
	10	100	200	Phragmites australis	100
	20	40	80	Ammophila breviligulata	60
				Scirpus olneyi	30
				Hibiscus moscheutos	10
CP5	0	10	58	Phragmites australis	80
				Ammophila breviligulata	20
	10	25		Phragmites australis	40
				Ammophila breviligulata	30
				Calystegia sepium	30
	20	90	250	Phragmites australis	100
	30	10	85	Phragmites australis	100
		open water			
CP6	0	5	60	Ammophila breviligulata	100
	5	90	200	Phragmites australis	75
				Calystegia sepium	25
	10	20	180	Typha angustifolia	98
				Hydrocotyle sp.	2
				Hibiscus moscheutos	<1
CP7	0	100		Ammophila breviligulata	95
				Phragmites australis	3
				Calystegia sepium	2
	10	90	205	Phragmites australis	90
				Hydrocotyle sp.	10
				unknown #6	<1
	20	50	210	Phragmites australis	100
	30	100	210	Phragmites australis	90
				unknown #6	10
	40	100	160	Phragmites australis	90
				Typha angustifolia	10
	50	100	225	Hydrocotyle sp.	5
				Typha angustifolia	30
				Phragmites australis	65
	60	90	130	Typha angustifolia	80
				Phragmites australis	20

Table 1a. Species distributions along transects at Cove Point Marsh, May 1996.

transect	distance	total %cover	canopy height	species	% composition
CP8	0	50	50	Apocynum cannabinum	50
				Ammophila breviligulata	50
	10	65	210	Phragmites australis	50
				Apocynum cannabinum	20
				Galium aparine	20
				Calystegia sepium	5
				Ammophila breviligulata	5
	20	open water			
CP9	0	90	70	Galium aparine	5
				Vitis labrusca	3
				Parthenocissus quinquefolia	60
				Ammophila breviligulata	30
				Rhus radicans	2
	8		75	Phragmites australis	
	10	95	160	Rubus pensilvanicus	50
				Solidago sempervirens	20
				Typha angustifolia	20
				Vitis labrusca	5
				Lonicera sempervirens	3
				Galium aparine	2
	20	75	180	Hydrocotyle sp.	80
				Typha angustifolia	10
				Hibiscus moscheutos	10

Table 1a. Species distributions along transects at Cove Point Marsh, May 1996.

transect	distance	total %cover	canopy height	species	% composition
CP10	0	10	60	Ammophila breviligulata	40
				Apocynum cannabinum	20
				Vitis labrusca	20
				Cakile edentula	20
	10	70	55	Rhus radicans	50
				Vitis labrusca	20
				Parthenocissus quinquefolia	5
				Ammophila breviligulata	20
				Galium aparine	5
	20	15	165	Typha angustifolia	30
				Phragmites australis	40
				Hydrocotyle sp.	20
				Polygonum sp.	10
	30	60	200	Typha angustifolia	65
				Phragmites australis	20
				Hibiscus moscheutos	4
				Hydrocotyle sp.	10
				Rumex verticillatus	1
	40	50	220	Typha angustifolia	60
				Phragmites australis	25
				Hibiscus moscheutos	5
				Hydrocotyle sp.	10
CP11	0	80	80	Ammophila breviligulata	94
				Galium aparine	2
				Apocynum cannabinum	2
				Solidago sempervirens	2
	10	20	38	Vitis labrusca	80
				Parthenocissus quinquefolia	13
				Rhus radicans	3
				Ammophila breviligulata	5
	20	100	143	Calystegia sepium	5
				Rhus radicans	70
				Phragmites australis	5
				Vitis labrusca	10
				Rubus pensilvanicus	10
	30	90	100	Thelypteris thelypteroides	40
				Carex sp.	60
	40	85	185	Typha angustifolia	85
				Hydrocotyle sp.	15

Table 1a. Species distributions along transects at Cove Point Marsh, May 1996.

transect	distance	total %cover	canopy height	species	% composition
CP12	0	30	60	Ammophila breviligulata	85
				Phragmites australis	10
				Unknown #7 (fleshy lobed)	5
	10	5	60	Ammophila breviligulata	98
				unknown #8 (tiny ground cover)	2
	20	15	45	Ammophila breviligulata	20
				Parthenocissus quinquefolia	40
				Rhus radicans	40
	30	100	approx 180	Rhus radicans	
		thicket observed		Smilax rotundifolia	
		from distance		Diospyros virginiana	
				Phragmites australis	
	40	80	140	Phragmites australis	20
				Typha angustifolia	25
				Hibiscus moscheutos	5
				Thelypteris thelypteroides	50
	50	60	175	Hydrocotyle sp.	5
				Hibiscus moscheutos	10
				Typha angustifolia	80
				Rumex verticillatus	5
	60	60	180	Phragmites australis	40
				Typha angustifolia	40
				Hibiscus moscheutos	5
				Hydrocotyle sp.	5
				Lemna sp.	5
				Rumex verticillatus	5
	70	80	200	Phragmites australis	60
				Typha angustifolia	10
				Apocynum cannabinum	20
				Lemna sp.	5
				Hydrocotyle sp.	5
	80	75	200	Phragmites australis	85
				Hibiscus moscheutos	5
				Lemna sp.	5
				Rumex verticillatus	5
	90	20	170	Phragmites australis	25
				Hibiscus moscheutos	25
				Thelypteris thelypteroides	50
	100			Acer rubrum, phrag, fern mix	
CP13	0	75	75	Ammophila breviligulata	100
	10	50	60	Apocynum cannabinum	15
				Ammophila breviligulata	75
				Calystegia sepium	10
	20	65	60	Parthenocissus quinquefolia	80
				Ammophila breviligulata	20
	30	100	185	Rhus radicans	95
				Phragmites australis	5
	40	50	250	Phragmites australis	95
				Rhus radicans	5

Table 1b. Species distributions along transects at Cove Point Marsh, Sept. 1996.

transect	distance	total %cover	canopy height	species	% composition
CP0	0	0		beach 0-7 m	
	10	40	310	Robinia pseudo-acacia	10
				Ammophila breviligulata	60
				Lonicera sempervirens	30
	20	70	210	Typha angustifolia	50
				Hibiscus moscheutos	30
				Hydrocotyle verticillata	20
	30	90	220	Typha angustifolia	60
				Hibiscus moscheutos	20
				Hydrocotyle verticillata	40
CP1	0	0		beach	
	10	25	145	Panicum virgatum	50
				Hydrocotyle verticillata	40
				Phragmites australis	5
				Typha angustifolia	5
	20	50	165	Hibiscus moscheutos	30
				Phragmites australis	10
				Typha angustifolia	60
	30	5	150	Phragmites australis	100
	40	80	230	Phragmites australis	90
				Typha angustifolia	5
				Hibiscus moscheutos	5
	50	100	150	Phragmites australis	45
				Typha angustifolia	5
				Peltandra virginica	50
CP2	0	0		beach	
	7.5	80	35	Phragmites australis	100
	17.5	80	100	Ammophila breviligulata	85
				Scirpus americanus	5
				unknown cp2	5
				Hibiscus moscheutos	5
	27.5	100	110	Hydrocotyle verticillata	1
				unknown cp2	5
				Ammophila breviligulata	74
				Phragmites australis	10
				Panicum virgatum	5
				Hibiscus moscheutos	5

Table 1b. Species distributions along transects at Cove Point Marsh, Sept. 1996.

transect	distance	total %cover	canopy height	species	% composition
CP3	0	0		beach 0-2m	
	10	85	310	Phragmites australis	100
	20	60	270	Phragmites australis	5
				Spartina patens	65
				Typha angustifolia	20
				unknown cp2	2
				Panicum virgatum	5
				Hydrocotyle verticillata	3
	30	50	255	Hibiscus moscheutos	5
				Phragmites australis	75
				Typha angustifolia	10
				Spartina patens	10
	40	60	175	Polygonum sp.	10
				Echinoclea sp.	5
				Spartina patens	20
				Hydrocotyle verticillata	5
				Hibiscus moscheutos	10
				Phragmites australis	50
	50	30	120	Phragmites australis	10
				Hibiscus moscheutos	40
				Echinoclea sp.	5
				Spartina patens	30
				Polygonum sp.	5
				Hydrocotyle verticillata	10
	60	85	160	Hibiscus moscheutos	10
				Juncus effusus	25
				Typha angustifolia	55
				Hydrocotyle verticillata	5
				Polygonum sp.	5
CP4	0	0		sand	
	10	80	200	Phragmites australis	50
				Typha angustifolia	50
	20	15	100	Scirpus americana	20
				Ammophila breviligulata	80
CP5	0	0		beach	
	10	10	70	Ammophila breviligulata	75
				Phragmites australis	25
	20	90	270	Phragmites australis	100
	30	10	120	Typha angustifolia	100

Table 1b. Species distributions along transects at Cove Point Marsh, Sept. 1996.

transect	distance	total %cover	canopy height	species	% composition
CP6	0	15	50	unknown cp6	50
				Ammophila breviligulata	50
	5	100	260	Phragmites australis	100
				Calystegia sepium	1
	10	75	190	Typha angustifolia	85
				Hibiscus moscheutos	10
				Phragmites australis	5
CP7	0			Ammophila breviligulata	
				Phragmites australis	
				unknown cp7	
	10	50	320	Phragmites australis	85
				unknown cp2	5
				Hydrocotyle verticillata	5
				Hibiscus moscheutos	2.5
				Lemna sp.	2.5
	20	80	340	Phragmites australis	40
				unknown cp2	10
				Polygonum sp.	40
				Typha angustifolia	10
	30	90	300	Phragmites australis	85
				unknown cp2	10
				Pluchea foetida	5
	40	90	300	Phragmites australis	85
				Typha angustifolia	10
				Hibiscus moscheutos	2.5
				Hydrocotyle verticillata	2.5
	50	90	320	Phragmites australis	65
				Typha angustifolia	30
				Hydrocotyle verticillata	5
	60	90	200	Phragmites australis	13
				Typha angustifolia	80
				Hydrocotyle verticillata	5
				Polygonum sp.	2
CP8	0	50	65	Ammophila breviligulata	100
	10	70	250	Phragmites australis	80
				Apocynum sp.	10
				Matelea sp.	10
	20	0		open water	

Table 1b. Species distributions along transects at Cove Point Marsh, Sept. 1996.

transect	distance	total %cover	canopy height	species	% composition
CP9	0	0		beach	
	10	100	160	unknown cp9	5
				Typha angustifolia	35
				Phragmites australis	1
				Lonicera sempervirens	5
				Solidago sempervirens	10
				Rubus pennsylvanicus	35
				unknown cp2	5
				Hydrocotyle verticillata	5
	20	80	190	Typha angustifolia	90
				Polygonum sp.	2.5
				unknown cp2	2.5
				Hibiscus moscheutos	2.5
				Hydrocotyle verticillata	2.5
CP10	0	0	70	beach	
	10	80	80	Vitis labrusca	30
				Parthenocissus quinquefolia	30
				Ammophila breviligulata	30
				Rhus radicans	10
	20	50	175	Typha angustifolia	50
				Hibiscus moscheutos	5
				Phragmites australis	30
				unknown cp2	5
				Hydrocotyle verticillata	10
	30	80	320	Typha angustifolia	75
				Phragmites australis	10
				Polygonum sp.	5
				unknown cp10	10
	40	90	310	Typha angustifolia	60
				Phragmites australis	20
				Hydrocotyle verticillata	5
				Polygonum sp.	5
				unknown cp10	5
				Hibiscus moscheutos	5

Table 1b. Species distributions along transects at Cove Point Marsh, Sept. 1996.

transect	distance	total %cover	canopy height	species	% composition
CP11	0	0		beach 0-6m	
	10	20	80	Parthenocissus quinquefolia	10
				Ammophila breviligulata	30
				Vitis labrusca	10
				Rhus radicans	50
	20	100	100	Phragmites australis	5
				Rhus radicans	50
				Lonicera sempervirens	20
				Calystegia sepium	5
				Vitis rotundifolia	5
				Parthenocissus quinquefolia	5
				Rubus pennsylvanicus	10
	30	50	100	Carex sp.	90
				Thelypteris palustris	10
	40	75	190	Typha angustifolia	85
				Hydrocotyle verticillata	5
				Polygonum sp.	10
CP12	0	0		beach 0-8m	
	10	20	80	Phragmites australis	5
				Spartina patens	30
				Euphorbia polygonifora	5
				unknown cp12	60
	20	25	75	Ammophila breviligulata	50
				Parthenocissus quinquefolia	5
				Euphorbia polygonifora	5
	30	100	approx 180	Rhus radicans	30
		thicket observed		Smilax rotundifolia	
		from distance		Diospyros virginiana	
				Phragmites australis	
	40	80	200	Typha angustifolia	30
				Hibiscus moscheutos	30
				Thelypteris palustris	40
	50	60	220	Lemna sp.	5
				Hibiscus moscheutos	10
				Typha angustifolia	75
				Phragmites australis	10
	60	50	330	Phragmites australis	40
				Typha angustifolia	10
				Hibiscus moscheutos	5
				Lemna sp.	40
				Rumex verticillatus	5
	70	85	320	Phragmites australis	45
				Lemna sp.	50
				Ludwigia sp.	5
	80	80	240	Phragmites australis	50
				Lemna sp.	45
				Ludwigia sp.	5
	90			Rumex verticillatus	5
	90	40	240	Phragmites australis	70
				Lemna sp.	10
				Thelypteris palustris	20
	100			Acer rubrum	40
				Phragmites australis	35
				Hibiscus moscheutos	5
				Rumex verticillatus	5
				Lemna sp.	5
				Thelypteris palustris	10

Table 1b. Species distributions along transects at Cove Point Marsh. Sept. 1996.

transect	distance	total %cover	canopy height	species	% composition
CP13	0	80	75	Ammophila breviligulata	90
				Apocynum sp.	5
				Xanthium pennsylvanicum	5
	10	75	60	Ammophila breviligulata	90
				Apocynum sp.	10
	20	75	95	Ammophila breviligulata	85
				Parthenocissus quinquefolia	15
	30	30		Phragmites australis	10
				Lonicera sempervirens	5
				Rhus radicans	80
				Apocynum sp.	5
	40	10	0	Lemna sp.	100

Table 2. Percentage of each sampling quadrat covered by Phragmites australis in May and September, 1996.

transect	distance	% P. australis	
		May	Sept.
CP0	0	0	0
	10	5	0
	20	0	0
CP1	0	<1	0
	10	15	5
	20	30	10
	30	90	100
	40	80	90
	50	50	45
CP2	0	0	0
	10	90	100
	20	2	0
	30	0	10
CP3	0	20	0
	10	100	100
	20	5	5
	30	40	75
	40	30	50
	50	5	10
	60	0	0
CP4	0	35	0
	10	100	50
	20	0	0
CP5	0	80	0
	10	40	25
	20	100	100
	30	100	0
CP6	0	0	0
	10	0	0
CP7	0	3	25
	10	90	85
	20	100	40
	30	90	85
	40	90	85
	50	65	65
	60	20	13

transect	distance	% P. australis	
		May	Sept.
CP8	0	0	0
	10	50	80
	20	0	0
CP9	0	0	0
	10	0	1
	20	0	0
CP10	0	0	0
	10	0	0
	20	40	30
	30	20	10
	40	25	20
CP11	0	0	0
	10	0	0
	20	5	5
	30	0	0
	40	0	0
CP12	0	10	0
	10	0	5
	20	0	0
	30	0	0
	40	20	10
	50	0	40
	60	40	45
	70	60	50
	80	85	70
	90	25	35
CP13	0	0	0
	10	0	0
	20	0	0
	30	5	10
	40	95	0

Table 3. A partial species list for Cove Point Marsh.

species	common name
Ammophila breviligulata	dune grass
Galium aparine	cleavers
Lonicera sempervirens	honeysuckle
Robinia pseudo-acacia	black locust tree
Diospyros virginiana	persimmon tree
Phragmites australis	phrag
Campsis radicans	trumpet creeper
Panicum virgatum	switch grass
Hydrocotyle verticillata	pennywort
Hibiscus moscheutos	hibiscus
Typha angustifolia	narrow leaf cattail
Apocynum cannabinum	dog bane
Alisma subchordatum	water plantain
Peltandra virginica	arrow arum
Eleocharis sp.	
Spartina patens	salt hay
Pluchea foetida	marsh fleabane
Matelea sp.	
Ludwigia sp.	
Euphorbia polygonifora	seaside spurge
Juncus effusus	soft rush
Echinoclea sp.	
Rumex verticillatus	swamp dock
Xanthium pennsylvanicum	cockle-burr
Calystegia sepium	bindweed
Polygonum punctatum	water smart weed
Vitis labrusca	fox grape
Vitis rotundifolia	Muscadine grape
Parthenocissus quinquefolia	Virginia creeper
Rhus radicans	poison ivy
Rubus pensilvanicus	blackberry
Solidago sempervirens	seaside goldenrod
Thelypteris palustris	marsh fern
Carex sp.	
Smilax rotundifolia	catbrier or greenbrier
Lemna sp.	duckweed
Acer rubrum	red maple
Scirpus americanus	three-square
Cakile edentula	sea rocket

Table 4.

Water Quality Parameters at Five Sites at Cove Point Marsh
September 25, 1996

Site	Salinity	PO4	NO3	NH4	DIN	N:P
	ppt	uM	uM	uM	uM	
PIER (BAY)	11	0.10	2.70	2.09	4.79	47.9
UNDER BOARDWALK	4	0.13	2.09	0.03	2.12	16.3
CP1*	4	0.12	1.10	BD	1.10	9.2
CP3*	4	0.12	1.64	0.17	1.81	15.1
CP8*	4	0.06	1.94	BD	1.94	32.3

*samples were taken from the ponds located along the given transect
BD=below detection