



## **The Swales of Sandy Neck**

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## ABSTRACT

Low elevation interdunal swales on Sandy Neck, Barnstable, MA were surveyed in an attempt to devise a classification scheme based on vegetative characteristics. Species abundance was determined by measuring frequency of occurrence and relative abundance in over 20 different swales. Water table depth and pore water conductivity were measured for 11 swales as possible correlates to swale vegetation type. Species abundance data was used to classify swales into one of 8 distinct swale types that differ from one another in species composition and species diversity.

## INTRODUCTION

Dune swales, also known as dune slacks (Ranwell 1972), are depressions located between coastal sand dunes. They are common features of extensive sand dune systems characterized by both primary and secondary dunes, such as at Sandy Neck in Barnstable, MA. One of the most striking features of the swales on Sandy Neck is that they are fundamentally different from the surrounding dunes: they are flat, at low elevation, have wet soil, and support a very different and much denser assemblage of plant species. Similar characteristics are cited for North Carolina swales by Evans (1992). Swales separated from one another by a single sand dune or a few tens of meters may have very different vegetation characteristics. This immediately raises the question of why are these areas different from one another? Followed by how do they change over time? And do the vegetation differences between swales reflect different stages of swale succession? Before any of these questions can be answered, the differences between swales needs to be characterized. The goal of this study is to characterize the different types of swales found on the extensive barrier beach system of Sandy Neck and to provide a vegetation-based classification scheme for differentiating between different types of swales. This

information may then be used as a baseline for addressing the previous questions and for planning the conservation of these unique habitats.

### STUDY SITE DESCRIPTION

All research was conducted at Sandy Neck in Barnstable, MA, USA on the North side of Cape Cod (41°43' N Lat, 70°22' W Long). Sandy Neck is a 14.5 km barrier beach bordered on the North by Cape Cod Bay and on the South by an extensive salt marsh (the Great Marsh) and Barnstable Harbor (Redfield 1972). The site supports several distinct habitats. The North side has extensive beach front and foredunes that serve as important nesting grounds for shorebirds (Strauss 1990). The Great Marsh to the South borders one of the largest salt marshes in Massachusetts (Redfield 1972). Between these two areas are extensive sand dunes. The dune vegetation is dominated by natural and replanted stands of American Beachgrass, *Ammophila breviligulata*. Low elevation swales are common throughout the sand dune ecosystem. The dunes are interspersed with patches of maritime forest dominated by *Pinus rigida* (Pitch Pine). There are also occasional stands of low lying forests that support dense growth of oaks and other hardwoods. The sand dunes are traversed by a small number of jeep trails and horse trails that receive low usage. Depending on their proximity to the beach and local camps dunes also receive a small amount of foot traffic. Historically Sandy Neck has experienced moderate anthropogenic disturbance from ORVs, pedestrians, and sport fisherman. Stricter conservation efforts since the early 1980's have reduced the degree of anthropogenic disturbance at the site.

Twenty-three swales were examined as part of this study (Fig. 1). A swale was defined as a low elevation area surrounded by sand dunes. The elevation was estimated to be close to sea level in the swales studied. Swales could also be

identified by an abrupt change from the *Ammophila breviligulata* dominated vegetation characteristic of the surrounding dunes to vegetation usually dominated by dense growth of rushes and sedges. Higher elevation depressions between dunes are common (usually dominated by *Hudsonia tomentosa*), but were not included in this study. The soil in the study swales was either noticeably wet to the touch or discolored, usually red or gray, from previous wet periods. The exceptions were located at the end of Trail 6 which had dry soils and were dominated by *Hudsonia tomentosa*. Similar depressions, commonly referred to as cranberry bogs, occur throughout the maritime forest patches. These are surrounded by Pitch Pine forest and not by Beachgrass dominated sand dunes and will not be considered in this study, although they may support similar species.

## METHODS

Frequency of occurrence was used to quantify the species abundance in each swale (N=17). Three parallel transects were established along the long axis of each swale. In general swales tended to be elliptical in shape. The first transect was positioned along the center of the swale while the other two were positioned halfway between the center transect and the right and left outside edges. A .5 X .5 m<sup>2</sup> quadrat was placed at 5 m intervals along each transect and the presence of each species in the quadrat was recorded. The number of times that a species was observed in a quadrat was divided by the total number of quadrats surveyed to determine the frequency of occurrence of each species in the swale. Due to variation in swale size, the number of quadrats surveyed varied for each swale. A minimum of 20 quadrats were sampled per swale. These data were then used to identify indicator species that could be used to distinguish differences between swales. Most of the swales were surveyed from mid-July to mid-August 1994 and two were

surveyed in early October 1994.

The relative abundance of all species found in 23 swales was estimated visually using the DAFOR abundance rating described by Mueller-Dombois and Ellenberg (1974). According to this system each species receives an abundance rating relative to the abundance of the other species in the swale: Dominant > Abundant > Frequent > Occasional > Rare. An attempt was made to identify every plant species in each swale and to assign it an abundance rating. Swales were surveyed several times during the study period from June-October 1994 and again in August and September 1995.

Plants were identified using Newcomb, L. 1977. Newcomb's Wildflower Guide. Little, Brown, & Co.: Boston; Svenson, H.K. and Pyle, R.W. 1979. The Flora of Cape Cod. Cape Cod Natural History Museum: Brewster; Demoranville, I.E. 1984. Weeds of Massachusetts Cranberry Bogs. Part I. University of Massachusetts, U.S. Department of Agriculture and County Extension Services, J1824:11/84-2M; and Demoranville, I.E. 1986. Weeds of Massachusetts Cranberry Bogs. Part II. University of Massachusetts, U.S. Department of Agriculture and County Extension Services, J2591:2/86-2M.

The differences in vegetation observed between swales may possibly be correlated with physical conditions of the soil. Proximity to the water table and pore water salinity and conductance were measured as possible correlates to swale vegetation characteristics. A soil auger (7 cm diam) designed for sand coring (AMS soil auger with sand auger head) was used to excavate a hole deep enough to intersect with the soil water table. The distance to the water table was determined by measuring the distance from the soil surface to standing water in the test hole. Water was then extracted from the hole and measured for conductivity using a portable Conductivity Meter (YSI 33 S-C-T Meter). Because coastal ground water levels are known to change with tides, all measurements were conducted during slack tide on

August 9 and 10, 1994 when tidal amplitude was at its monthly low.

## RESULTS AND DISCUSSION

### *Species abundance*

Frequency of occurrence of each species (number of quadrats in which it was found and the percentage of quadrats in which it occurred) is reported for each swale in Table 1. *Vaccinium macrocarpon*, *Juncus canadensis*, *Juncus pelocarpus*, *Juncus greenii*, *Cyperus dentatus*, *Solidago tenuifolia*, *Solidago sempervirens*, *Scirpus americanus*, *Myrica pensylvanica*, *Agrostis* sp., *Xyris torta* were the most abundant species encountered in the transect surveys.

A list of all species identified in each swale and their relative abundances may be found in Table 2.

### *Swale classification*

The results from the frequency of occurrence and relative abundance surveys indicate that swales differ from one another in terms of their species composition and species abundance. These results were used to generate a swale classification scheme based upon the vegetation characteristics of the swales. Different swale types were distinguished by the presence or absence of unvegetated soil, the presence or absence of dicot adults, the presence of indicator species such as *Myrica pensylvanica*, *Vaccinium macrocarpon*, *Hudsonia tomentosa*, and *Phragmites communis*, and by the diversity of species (richness) occurring in the swale. Using these characteristics swales were classified as young swales with wet soil and sparse vegetation, young swales supporting monocots only, young swales supporting monocots and adults of *Myrica pensylvanica*, cranberry swales with low species diversity, cranberry swales with high species diversity, high species diversity swales

with low cranberry cover, *Phragmites* swales, and *Hudsonia* swales. Descriptions and examples of each swale type are presented below.

## Young Swales

### Wet Soil with Sparse Vegetation

Support sparse growth of sedges and rushes, few or no dicots present. Soil may be damp to the touch and often reddish in color, with sparse vegetation cover and appreciable bare ground.

Common species: *Cyperus dentatus*, *Juncus canadensis*, *Juncus pelocarpus*. May also include seedlings of *Myrica pensylvanica*.

Examples: Wet spot near dead center, Wet spot parallel to High Diversity, Horse Trail # 1

### Swales Supporting Monocots Only

Support sparse to dense growth of sedges and rushes, but few or no dicot adults. No appreciable bare ground visible (< 100 cm sq.).

Common species: *Cyperus dentatus*, *Juncus canadensis*, *Juncus pelocarpus*.

Examples: Tadpole Swale

### Swales Supporting Monocots with *Myrica* adults

Supports sparse to dense growth of sedges and rushes. Dicots are rare with the exception of *Myrica pensylvanica* which may be found in the swale or more commonly ringing the perimeter of the swale.

Common species: *Cyperus dentatus*, *Juncus canadensis*, *Juncus pelocarpus*, *Myrica pensylvanica*.

Examples: Ugly Swale, Garbage Dump Swale, Rectangle Swale

## Cranberry Swales

### Low Diversity Cranberry Swales

Supports a near 100% cover of *Vaccinium macrocarpon* in addition to a handful of other species, mostly sedges and rushes. *Myrica pensylvanica* may be growing at the perimeter of the swale. Standing water is common for part or all of the growing season.

Common species: *Vaccinium macrocarpon*, *Scirpus americanus*, *Cyperus dentatus*, *Juncus canadensis*, *Juncus pelocarpus*, *Myrica pensylvanica*.

Examples: Small Cranberry Swale

### High Diversity Cranberry Swales

Support a very dense growth of *Vaccinium macrocarpon*, sedges, rushes, and dicot species. *Myrica pensylvanica* may be common throughout as well as at the perimeters. This type of swale is represented by some of the largest swales included in this study, except for the *Hudsonia* swales. Small clones of *Phragmites communis* or *Lythrum salicaria* may be present and may have the potential to spread throughout the swale.

Common species: *Vaccinium macrocarpon*, *Cyperus dentatus*, *Juncus canadensis*, *Juncus pelocarpus*, *Solidago tenuifolia*, *Myrica pensylvanica*.

Examples: House Swale, Gentian Swale, high Diversity Swale, Dead Center Swale, Gatehouse Swale, Airdown Swale, Horse Trail # 2.

### High diversity Swales with low (<20%) cranberry cover

Similar to high diversity swales, but have lower cranberry cover.

Examples: Large low Bayberry Swale



### ***Phragmites* Swales**

Support a high density and high (>50%) cover of *Phragmites communis* stems. May contain many of the same species as the high diversity swales. It is hypothesized that these swales were once one of the above swale types, but were colonized by the aggressive invader *Phragmites communis* which competitively displaced the previous occupants.

Common species: Similar to other swales but in lower abundance, *Phragmites communis*, *Rhus radicans*.

Examples: Dumpster swale.

### ***Hudsonia* Swales**

These swales are fundamentally different in species composition from the other types and are characterized by virtual monocultures of *Hudsonia tomentosa*. The second major difference is that the soil in these swales is very dry whereas the soil of other swales is characteristically moist during most of the growing season. On Sandy Neck low lying *Hudsonia* swales may be found at the Eastern tip near the lighthouse at the end of trail 6. Higher elevation *Hudsonia* "swales" are also common between dunes throughout Sandy Neck, but were not included in this study.

Common species: *Hudsonia tomentosa*, *Deschampsia flexuosa*, *Ammophila breviligulata*, *Polygonella articulata*, *Cladonia* spp.

Examples: Trail 6 Swales

#### *Physical characteristics*

The depth to the water table ranged from an average of 20.2-48.6 cm for the 11 swales where water table depth was measured (Table 3). There was no clear

relationship between swale type and water table depth. In general cranberry (*Vaccinium macrocarpon*) was associated with swales 30 cm or less from the water table. The greatest cranberry abundance was found in the swale (Small Cranberry) with the water table closest to the surface. Swales classified as "young" due to the sparseness of vegetation, low species diversity, and paucity of dicots had the greatest water table depth (>40 cm).

Conductivity averaged from 58-1140  $\mu\text{mhos/cm}$  with all but Gatehouse Swale averaging below 258  $\mu\text{mhos/cm}$  (Table 3). There was no clear relationship between conductivity and swale type.

Future attempts to correlate swale type with physical traits such as water table depth and conductivity should examine these parameters over an entire growing season, as they may be of greater importance at different times in the life cycle of the plant species. The results reported in this study were obtained from a single set of measurements taken during the middle of the growing season.

#### *Rare plant species and animal interactions with swales*

The only "listed" rare species discovered in the swales of Sandy Neck is Plymouth Gentian, *Sabatia kennedyana*. Listed as a species of Special Concern, Plymouth Gentian is normally found growing along the shores of coastal kettle hole ponds (Svenson and Pyle 1979). It was present in large numbers in a single swale and absent elsewhere on Sandy Neck. Why it is found in this location, but not in swales 10's of meters away is not known. The Plymouth Gentian Swale also supports several clones of *Phragmites* and a single clone of *Lythrum*. In several cases these aggressive invaders have Plymouth Gentian as in immediate neighbor. This close association between two aggressive invaders and a rare species may have negative effects on the future of *Sabatia kennedyana* on Sandy Neck and should be

monitored more closely in the future.

Several animal species also depend upon swales for their survival. Mammals, such as white tailed deer, coyote, red fox, and skunks frequently dig holes to the freshwater table in swales or drink from holes excavated by others (Peter Auger, personal communication). These watering holes also serve as the sites for egg laying and tadpole development for Fowler's Toads (personal observation). They may also be used by other amphibians, such as the rare Spadefoot Toad (Peter Auger, personal communication). Burrowing by animals may bring buried dormant seeds to the surface and their footprints may serve as safe sites for seed germination and seedling recruitment (personal observation).

#### *Threats from aliens*

The occurrence of *Phragmites communis* and *Lythrum salicaria* in several swales has the potential to drastically alter the future species composition and abundance in these swales. *Phragmites* and *Lythrum* are aggressive alien species that can quickly colonize and dominate wetland habitats. The dominance of *Phragmites* in the Dumpster swale may be an indication of the future for other swales currently supporting small, but spreading clones of *Phragmites* (House, Gentian, High Diversity swales). The three swales with small *Phragmites* populations also support plant species that are either uncommon or absent from other swales that were studied. For example, *Spiranthes cernua* was found only in the House and High Diversity Swales, while *Sabatia kennedyana* (SC) was found only in the Gentian Swale. *Phragmites* stands are scattered throughout the swales, cranberry bogs (natural and abandoned cultivated), and salt marsh edges throughout Sandy Neck. In many places it is the dominant species in these habitats.

*Lythrum salicaria* was found in only a few neighboring swales with only one or

two small individuals per swale. The threat from *Lythrum* comes once it begins to set seed, as the plants produce large numbers of seeds (O'Neil 1992). I did not observe any evidence of seed shadows around the established plants. The tristylous flowers of *Lythrum* are designed to promote outcrossing between flowers with different length styles. Of the three plants observed, one in Gentian, Airdown, and Dumpster swales, two had long style length and one had mid-length style flower morphologies. It is possible that successful cross pollination may occur between the mid- and long-styled flowers. The plants are located within 100-200 m from one another which does not seem like an unreasonable distance for insect pollinators to travel and may lead to successful seed set in these individuals. While self pollination is possible in this species, the effects of inbreeding depression are reported to be high (O'Neil 1994).

#### *Future studies*

Little ecological work appears to have been done on swales and the species that inhabit them (Ranwell 1972, for exceptions see Evans 1992, 1988, Silander 1979a, 1979b, 1982). Future studies should attempt to determine the factors responsible for the differences in species composition and abundance between swales, population dynamics of swale species, the effects of alien species on swales, and ecological succession of swale communities.

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## Figure Legends

Figure 1. USGS map segment of Sandy Neck showing locations of study swales. The four circled areas, from West to East (left to right), include the following swales (listed roughly in order of occurrence from West to East): circle 1: house swale of Sandwich, circle 2 is bordered by the Sandy Neck Road and old Trail 1: small cranberry, garbage dump, gatehouse, dumpster, airdown, gentian, tadpole, large bayberry, rectangle, dead center, high diversity, wet spot parallel to high diversity, wet spot near dead center, small, and ugly; circle 3 encompasses the Trail 4 swales: middle of trail 4, horse trail 1, and horse trail 2; and circle 4 encompasses the *Hudsonia* swales at the end of trail 6: mini-*Hudsonia*, *Hudsonia* 1, *Hudsonia* 3, and rock.

Figure 1.

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Table 1. Frequency of occurrence of species in transect surveys (see methods for details) of 17 swales. Columns represent the number (N) of .25 m<sup>2</sup> quadrats that a species was found in and the frequency (F) of occurrence of that species in the quadrats sampled for that swale.

Table 1. Frequency Data

Swale	Airdown		Dead Center		Dumpster		Garbage Dump		Gatehouse	
	N	F	N	F	N	F	N	F	N	F
Bare Soil	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
<i>Acer rubrum</i>	0	0.00	0	0	0	0.00	0	0	0	0
<i>Agrostis sp.</i>	2	8.70	7	22.58	0	0.00	1	5.56	4	16.00
<i>Ammophila breviligulata</i>	2	8.70	11	35.48	0	0.00	7	38.89	4	16.00
<i>Carex sp.</i>	0	0.00	2	6.45	0	0.00	0	0.00	3	12.00
<i>Cyperus dentatus</i>	8	34.78	21	67.74	0	0.00	14	77.78	12	48.00
<i>Deschampsia flexuosa</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
<i>Drosera intermedia</i>	0	0.00	0	0.00	0	0.00	1	5.56	0	0.00
<i>Hudsonia tomentosa</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
<i>Hypericum mutilum</i>	1	4.35	0	0.00	1	3.70	0	0.00	0	0.00
<i>Juncus canadensis</i>	7	30.43	7	22.58	1	3.70	1	5.56	10	40.00
<i>Juncus greenei</i>	0	0.00	14	45.16	0	0.00	15	83.33	3	12.00
<i>Juncus pelocarpus</i>	2	8.70	11	35.48	0	0.00	5	27.78	15	60.00
<i>Lycopodium inundatum</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
<i>M. pennsylvanica seedling</i>	0	0.00	0	0.00	0	0.00	0	0.00	1	4.00
<i>Myrica pennsylvanica adult</i>	6	26.09	4	12.90	4	14.81	10	55.56	10	40.00
<i>Panicum ararum</i>	1	4.35	0	0.00	0	0.00	0	0.00	0	0.00
<i>Panicum lanuginosum</i>	8	34.78	23	74.19	0	0.00	1	5.56	8	32.00
<i>Phragmites communis</i>	0	0.00	0	0.00	19	70.37	0	0.00	0	0.00
<i>Polygonella articulata</i>	0	0.00	0	0	0	0.00	0	0.00	0	0.00
<i>Rhus radicans</i>	2	8.70	0	0.00	20	74.07	0	0.00	0	0.00
<i>Sabatia kennedyana</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
<i>Sabatia kennedyana rosette</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
<i>Salix sp.</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
<i>Scirpus americanus</i>	5	21.74	0	0.00	0	0.00	0	0.00	6	24.00
<i>Scirpus cyperinus</i>	0	0.00	0	0	1	3.70	0	0	0	0
<i>Solidago sempervirens</i>	2	8.70	1	3.23	0	0.00	5	27.78	7	28.00
<i>Solidago tenuifolia</i>	1	4.35	2	6.45	1	3.70	1	5.56	14	56.00
<i>Spirea tomentosa</i>	0	0.00	0	0	2	7.41	0	0	0	0
<i>Typha sp</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
<i>Vaccinium macrocarpon</i>	13	56.52	7	22.58	0	0.00	0	0.00	10	40.00
<i>Viola lanceolata</i>	4	17.39	8	25.81	0	0.00	0	0.00	0	0.00
<i>Xanthium echinatum</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
<i>Xyris torta</i>	0	0.00	0	0.00	0	0.00	7	38.89	0	0.00
Number of quadrats	23	100.00	31	100.00	27	100.00	18	100.00	25	100.00

Table 1. Frequency Data

Swale	Gentian		High Diversity		Horse Trail 1		Horse Trail 2		House	
	N	F	N	F	N	F	N	F	N	F
Bare Soil	0	0.00	0	0.00	1	2.78	0	0.00	0	0.00
<i>Acer rubrum</i>	0	0.00	0	0	0	0.00	0	0	1	3.23
<i>Agrostis sp.</i>	0	0.00	1	2.33	0	0.00	0	0.00	0	0.00
<i>Ammophila breviligulata</i>	5	11.36	2	4.65	5	13.89	0	0.00	0	0.00
<i>Carex sp.</i>	1	2.27	0	0.00	0	0.00	0	0.00	0	0.00
<i>Cyperus dentatus</i>	25	56.82	18	41.86	33	91.67	11	20.00	4	12.90
<i>Deschampsia floxuosa</i>	0	0.00	0	0.00	0	0.00	3	5.45	0	0.00
<i>Drosera intermedia</i>	1	2.27	21	48.84	0	0.00	4	7.27	0	0.00
<i>Hudsonia tomentosa</i>	0	0.00	0	0.00	0	0.00	8	14.55	0	0.00
<i>Hypericum mutilum</i>	0	0.00	2	4.65	0	0.00	0	0.00	0	0.00
<i>Juncus canadensis</i>	9	20.45	22	51.16	9	25.00	3	5.45	4	12.90
<i>Juncus greenii</i>	9	20.45	5	11.63	2	5.56	3	5.45	1	3.23
<i>Juncus pelocarpus</i>	17	38.64	5	11.63	29	80.56	13	23.64	1	3.23
<i>Lycopodium inundatum</i>	0	0.00	14	32.56	0	0.00	4	7.27	0	0.00
<i>M. pennsylvanica seedling</i>	1	2.27	1	2.33	1	2.78	0	0.00	0	0.00
<i>Myrica pennsylvanica adult</i>	18	40.91	15	34.88	0	0.00	20	36.36	12	38.71
<i>Panicum ararum</i>	1	2.27	0	0.00	0	0.00	0	0.00	0	0.00
<i>Panicum lanuginosum</i>	8	18.18	0	0.00	0	0.00	8	14.55	1	3.23
<i>Phragmites communis</i>	1	2.27	4	9.30	0	0.00	0	0.00	14	45.16
<i>Polygonella articulata</i>	0	0.00	0	0	0	0.00	0	0.00	0	0.00
<i>Rhus radicans</i>	5	11.36	2	4.65	0	0.00	1	1.82	4	12.90
<i>Sabatia kennedyana</i>	8	18.18	0	0.00	0	0.00	0	0.00	0	0.00
<i>Sabatia kennedyana rosette</i>	9	20.45	0	0.00	0	0.00	0	0.00	0	0.00
<i>Salix sp.</i>	0	0.00	3	6.98	0	0.00	0	0.00	0	0.00
<i>Scirpus americanus</i>	16	36.36	22	51.16	0	0.00	2	3.64	0	0.00
<i>Scirpus cyperinus</i>	0	0.00	0	0	0	0.00	0	0	0	0
<i>Solidago sempervirens</i>	8	18.18	0	0.00	0	0.00	0	0.00	0	0.00
<i>Solidago tenuifolia</i>	25	56.82	38	88.37	0	0.00	3	5.45	1	3.23
<i>Spirea tomentosa</i>	0	0.00	0	0	0	0.00	0	0	0	0
<i>Typha sp</i>	1	2.27	0	0.00	0	0.00	0	0.00	0	0.00
<i>Vaccinium macrocarpon</i>	14	31.82	24	55.81	0	0.00	44	80.00	30	96.77
<i>Viola lanceolata</i>	0	0.00	3	6.98	0	0.00	0	0.00	5	16.13
<i>Xanthium echinatum</i>	2	4.55	0	0.00	0	0.00	0	0.00	0	0.00
<i>Xyris torta</i>	3	6.82	34	79.07	0	0.00	2	3.64	0	0.00
Number of quadrats	44	100.00	43	100	36	100.00	55	100.00	31	100.00

Table 1. Frequency Data

Swale	Large Bayberry		Rectangle		Small Cranberry		Tadpole		Ugly	
	N	F	N	F	N	F	N	F	N	F
Bare Soil	0	0	0	0.00	0	0.00	0	0.00	0	0
<i>Acer rubrum</i>	0	0	0.00	0.00	0	0	0.00	0.00	0	0
<i>Agrostis sp.</i>	0	25.00	6	15.79	0	0.00	10	47.62	2	6.25
<i>Ammophila breviligulata</i>	4	26.67	6	15.79	0	0.00	7	33.33	18	56.25
<i>Carex sp.</i>	0	3.33	4	10.53	0	0.00	0	0.00	2	6.25
<i>Cyperus dentatus</i>	2	53.33	33	86.84	2	10.00	21	100.00	15	46.88
<i>Deschampsia floeuvosa</i>	0	5.00	0	0.00	0	0.00	0	0.00	0	0
<i>Drosera intermedia</i>	0	3.33	0	0.00	0	0.00	0	0.00	0	0
<i>Hudsonia tomentosa</i>	1	1.67	0	0.00	0	0.00	0	0.00	0	0
<i>Hypericum mutilum</i>	0	0	0	0.00	0	0.00	0	0.00	0	0
<i>Juncus canadensis</i>	3	35.00	28	73.68	0	0.00	16	76.19	3	9.375
<i>Juncus greenei</i>	4	43.33	12	31.58	1	5.00	11	52.38	14	43.75
<i>Juncus pelocarpus</i>	3	40.00	0	0.00	0	0.00	0	0.00	2	6.25
<i>Lycopodium inundatum</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0
<i>M. pennsylvanica seedling</i>	0	5.00	5	13.16	0	0.00	6	28.57	0	0
<i>Myrica pennsylvanica adult</i>	5	40.00	1	2.63	8	40.00	0	0.00	4	12.5
<i>Panicum ararum</i>	0	0.00	0	0.00	1	5.00	0	0.00	0	0
<i>Panicum lanuginosum</i>	3	16.67	0	0.00	0	0.00	0	0.00	0	0
<i>Phragmites communis</i>	0	0.00	0	0.00	0	0.00	0	0.00	5	15.63
<i>Polygonella articulata</i>	0	0	0	0.00	0	0.00	0	0.00	1	3.125
<i>Rhus radicans</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0
<i>Sabatia kennedyana</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0
<i>Sabatia kennedyana rosette</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0
<i>Salix sp.</i>	0	0	2	5.26	0	0.00	0	0.00	1	3.125
<i>Scirpus americanus</i>	1	10.00	5	13.16	15	75.00	4	19.05	0	0
<i>Scirpus cyperinus</i>	0	0	0.00	0.00	0	0	0.00	0.00	0	0
<i>Solidago sempervirens</i>	1	10.00	6	15.79	1	5.00	10	47.62	2	6.25
<i>Solidago tenuifolia</i>	2	43.33	6	15.79	0	0.00	3	14.29	0	0
<i>Spirea tomentosa</i>	0	0	0.00	0.00	0	0	0.00	0.00	0	0
<i>Typha sp</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0
<i>Vaccinium macrocarpon</i>	2	11.67	0	0.00	19	95.00	0	0.00	0	0
<i>Viola lanceolata</i>	0	5.00	0	0.00	0	0.00	0	0.00	0	0
<i>Xanthium echinatum</i>	0	0.00	0	0.00	0	0.00	0	0.00	0	0
<i>Xyris torta</i>	0	10.00	0	0.00	0	0.00	0	0.00	0	0
Number of quadrats	60	100	38	100.00	20	100.00	21	100.00	32	100

Table 1. Frequency Data

Swale	Wet Spot Near Dead Ctr		Wet Spot Near Hi Diversity	
	N	F	N	F
Bare Soil	4	11.43	8	12.90
<i>Acer rubrum</i>	0	0	0	0
<i>Agrostis sp.</i>	2	5.71	15	24.19
<i>Ammophila breviligulata</i>	2	5.71	16	25.81
<i>Carex sp.</i>	0	0.00	0	0.00
<i>Cyperus dentatus</i>	31	88.57	53	85.48
<i>Deschampsia floerxiosa</i>	0	0.00	0	0.00
<i>Drosera intermedia</i>	0	0.00	0	0.00
<i>Hudsonia tomentosa</i>	0	0.00	0	0.00
<i>Hypericum mutilum</i>	0	0	0	0.00
<i>Juncus canadensis</i>	5	14.29	7	11.29
<i>Juncus greenei</i>	5	14.29	10	16.13
<i>Juncus pelocarpus</i>	16	45.71	23	37.10
<i>Lycopodium inundatum</i>	0	0.00	0	0.00
<i>M. pennsylvanica seedling</i>	1	2.86	2	3.23
<i>Myrica pennsylvanica adult</i>	0	0.00	0	0.00
<i>Panicum ararum</i>	0	0.00	0	0.00
<i>Panicum lanuginosum</i>	0	0.00	0	0.00
<i>Phragmites communis</i>	0	0.00	0	0.00
<i>Polygonella articulata</i>	0	0	0	0
<i>Rhus radicans</i>	0	0.00	0	0.00
<i>Sabatia kennedyana</i>	0	0.00	0	0.00
<i>Sabatia kennedyana rosette</i>	0	0.00	0	0.00
<i>Salix sp.</i>	0	0	1	1.61
<i>Scirpus americanus</i>	0	0.00	2	3.23
<i>Scirpus cyperinus</i>	0	0	0	0
<i>Solidago sempervirens</i>	0	0.00	2	3.23
<i>Solidago tenuifolia</i>	0	0.00	1	1.61
<i>Spiraea tomentosa</i>	0	0	0	0
<i>Typha sp</i>	0	0.00	0	0.00
<i>Vaccinium macrocarpon</i>	0	0.00	0	0.00
<i>Viola lanceolata</i>	0	0.00	0	0.00
<i>Xanthium echinatum</i>	0	0.00	0	0.00
<i>Xyris torta</i>	0	0.00	0	0.00
Number of quadrats	35	100	62	100.00

Table 2. Relative abundance of all species in each swale studied. In the abundance scale Dominant > Abundant > Frequent > Occasional > Rare. Survey dates, swale type, and brief descriptions are also provided for each swale.

Table 2.1

**HORSE TRAIL # 1**

4 Aug 1994, 7 Aug 1995

Type: Wet soil with sparse vegetation

Young swale along horse trail off of trail 4; mostly sedges and rushes; dense clusters of seedlings emerging in depressions from footprints and digging; some bare space; 65 m X 32 m.

<i>Ammophila breviligulata</i>	Beachgrass	Frequent
<i>Cyperus dentatus</i>	Nut sedge	Dominant
<i>Juncus canadensis</i>	Canada rush	Abundant
<i>Juncus greenii</i>		Frequent
<i>Juncus pelocarpus</i>	Mud rush	Dominant
<i>Myrica pensylvanica</i> seedlings	Northern bayberry	Occasional
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Rare

Table 2.2

**WET SPOT NEAR DEAD CENTER**

2 Aug 1994, 7 Aug 1995

Type: Wet soil with sparse vegetation

Large amount of open sand; Nut sedge is the only species present in over 60% of the swale; more developed at end near Dead Center Swale; 60 m X 15 m.

<i>Agrostis</i> sp.		Rare
<i>Ammophila breviligulata</i>	Beachgrass	Rare
<i>Cyperus dentatus</i>	Nut sedge	Dominant
<i>Juncus canadensis</i>	Canada rush	Frequent
<i>Juncus greenei</i>	Greene's rush	Frequent
<i>Juncus pelocarpus</i>	Mud rush	Abundant
<i>Myrica pensylvanica</i>	Northern bayberry	Rare (seedlings only)
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Rare



Table 2.3

## WET SPOT PARALLEL TO HIGH DIVERSITY

2 Aug 1994, 7 Aug 1995

Type: Wet soil with sparse vegetation

Long and narrow with large amount of bare sand; 105 m X 20 m.

<i>Agrostis</i> sp.		Dominant
<i>Ammophila breviligulata</i>	Beachgrass	Rare
<i>Carex</i> sp.	"One way" sedge	Rare
<i>Cyperus dentatus</i>	Nut sedge	Abundant
<i>Juncus canadensis</i>	Canada rush	Common
<i>Juncus greenii</i>		Dominant
<i>Juncus pelocarpus</i>	Mud rush	Abundant
<i>Myrica pensylvanica</i>	Northern bayberry seedlings	Abundant
<i>Salix</i> sp.	Willow w/ singed stipules	Rare
<i>Solidago sempervirens</i>	Seaside goldenrod	Rare
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Rare

Table 2.4

## TADPOLE SWALE

27 July 1994, 7 Aug 1995

Type: Monocots only

35 m long

<i>Agrostis</i> sp.		Dominant
<i>Ammophila breviligulata</i>	Beachgrass	Occasional
<i>Carex</i> sp.	"One sided" sedge	Rare
<i>Cyperus dentatus</i>	Nut sedge	Occasional
<i>Hypericum mutilum</i>	Dwarf St. Johnswort	Rare
<i>Juncus canadensis</i>	Canada rush	Abundant
<i>Juncus greenei</i>		Abundant
<i>Juncus pelocarpus</i>	Mud rush	Abundant
<i>Myrica pensylvanica</i>	Northern bayberry - small	Abundant
<i>Phragmites communis</i>	Reed grass	Rare (1-3 stems/clone)
<i>Rhus radicans</i>	Poison ivy	Rare
<i>Salix</i> sp.	Willow w/ winged stipules	Rare
<i>Scirpus americanus</i>	Three-square	Occasional
<i>Scirpus cyperinus</i>	Wool grass	Rare
<i>Solidago sempervirens</i>	Seaside goldenrod	Frequent
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Occasional
<i>Typha</i> sp.	Cat-tail	Rare
<i>Xyris torta</i>	Slender yellow-eyed grass	Rare

Table 2.5

**GARBAGE DUMP SWALE**

3 Aug 1994, 7 Aug 1995

Type: Monocots with *Myrica* adults.

Named for the collection of trash (glass fragments and metal cans) next to the swale; young swale, not well developed; 35 m long.

<i>Agrostis</i> sp.		Occasional
<i>Ammophila breviligulata</i>	Beachgrass	Occasional
<i>Aster dumosus</i>		Rare
<i>Cyperus dentatus</i>	Nut sedge	Abundant
<i>Drosera intermedia</i>	Spatulate sundew	Rare
<i>Juncus canadensis</i>	Canada rush	Rare
<i>Juncus greenei</i>	Greene's rush	Dominant
<i>Juncus pelocarpus</i>	Mud rush	Occasional
<i>Myrica pensylvanica</i>	Northern bayberry	Abundant (15 cm tall)
<i>Panicum lanuginosum</i>	Hairy panic grass	Rare
<i>Solidago sempervirens</i>	Seaside goldenrod	Rare
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Occasional
<i>Xyris torta</i>	Slender yellow-eyed grass	Abundant

Table 2.6

## RECTANGLE SWALE

27 July 1994, 7 Aug 1995

Type: Monocots with *Myrica* adults

65 m long.

<i>Agrostis</i> sp.		Dominant
<i>Ammophila breviligulata</i>	Beachgrass	Occasional
<i>Carex</i> sp.	one way sedge	
<i>Cyperus dentatus</i>	Nut sedge	Abundant
<i>Juncus canadensis</i>	Canada rush	
<i>Juncus greenei</i>		Occasional
<i>Juncus pelocarpus</i>	Mud rush	Abundant
<i>Myrica pensylvanica</i>	Northern bayberry	Frequent
<i>Populus</i> sp.	Aspen - single seedling	Rare
<i>Salix</i> sp.	Willow w/ winged stipules	Occasional
<i>Scirpus americanus</i>	Three square	Frequent
<i>Scirpus cyperinus</i>	Wool grass	Rare
<i>Solidago sempervirens</i>	Seaside goldenrod	Occasional
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Abundant

Table 2.7

## SMALL SWALE

7 Aug 1995

Type: Monocots with adult *Myrica*

Small swale along way from Large Bayberry to High Diversity swales; reddish soil; 35 m X 15 m.

<i>Cyperus dentatus</i>	Nut sedge	Abundant
<i>Juncus canadensis</i>	Canada rush	Dominant
<i>Juncus greenii</i>		Frequent
<i>Juncus pelocarpus</i>	Mud rush	Dominant
<i>Myrica pennsylvanica</i>	Northern bayberry	Occasional

Table 2.8

## UGLY SWALE NEAR TRAIL 1

2 Aug 1994, 7 Aug 1995

Type: Monocots with *Myrica* adults

Located just West of Trail 1; 55 m in length.

<i>Agrostis</i> sp.		Occasional
<i>Ammophila breviligulata</i>	Beachgrass	Abundant
<i>Carex</i> sp.	One way sedge	Rare
<i>Cyperus dentatus</i>	Nut sedge	Abundant
<i>Hudsonia tomentosa</i>	Poverty "grass"	Rare
<i>Juncus canadensis</i>	Canada rush	Abundant
<i>Juncus greenii</i>		Dominant
<i>Juncus pelocarpus</i>	Mud rush	Occasional
<i>Myrica pennsylvanica</i>	Northern bayberry	Abundant
<i>Phragmites communis</i>	Reed grass	Abundant
<i>Polygonella articulata</i>	Jointweed	Rare
<i>Salix</i> sp.	Willow w/ winged stipules	Rare
<i>Scirpus cyperinus</i>	Wool grass	Rare
<i>Solidago sempervirens</i>	Seaside goldenrod	Occasional
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Rare
<i>Vaccinium macrocarpon</i>	Cranberry	Rare
<i>Xyris torta</i>	Slender yellow eyed grass	Rare

Table 2.9

**MIDDLE OF TRAIL 4 SWALE**

4 Aug 1994

Type: Low diversity cranberry

Small swale located adjacent to trail 4.

<i>Cyperus dentatus</i>	Nut sedge	Dominant
<i>Drosera filiformis</i>	Thread leaved sundew	Abundant
<i>Juncus greenii</i>		Frequent
<i>Juncus pelocarpus</i>	Mud rush	Frequent
<i>Myrica pensylvanica</i>	Northern bayberry	Occasional
<i>Panicum lanuginosum</i>	Hair grass	Rare
<i>Pinus rigida</i>	Pitch pine	Rare
<i>Rhus radicans</i>	Poison Ivy	Rare
<i>Solidago tenuifolia</i>	Narrow-leaved goldenrod	Occasional
<i>Vaccinium macrocarpon</i>	Cranberry	Dominant
<i>Xyris torta</i>	Slender yellow-eyed grass	Occasional

Table 2.10

**SMALL CRANBERRY SWALE**

27 July 1994, 7 Aug 1995

Type: Low diversity cranberry

Small swale dominated by very dense growth of cranberry; 35 m long.

<i>Juncus canadensis</i>	Canada rush	Frequent
<i>Myrica pensylvanica</i>	Northern bayberry	Dominant (2 m tall)
<i>Panicum ararum</i>		Rare
<i>Panicum lanuginosum</i>	Hairy panic grass	Rare
<i>Rhus radicans</i>	Poison ivy	Occasional
<i>Salix</i> sp.	Willow	Rare (4 m tall)
<i>Scirpus americanus</i>	Three-square	Dominant (1 m tall)
<i>Scirpus cyperinus</i>	Wool grass	Rare
<i>Typha</i> sp.	Cat tail (single plant)	Rare
<i>Vaccinium macrocarpon</i>	Cranberry	Dominant



Table 2.11

## AIRDOWN SWALE

15 June 1994, 7 Aug 1995

Type: High diversity cranberry

Located North of the beach access road near Dumpster swale; persistent wet center with some standing water; contains single clone of *Lythrum* with 8 stems and mid-length style flower morphology; 40 m X 25 m.

<i>Agrostis</i> sp.		Abundant
<i>Carex</i> sp.	"One way" sedge	Rare
<i>Cyperus dentatus</i>	Nut sedge	Frequent
<i>Juncus canadensis</i>	Canada rush	Frequent
<i>Juncus greenei</i>		Rare
<i>Lythrum salicaria</i>	Purple loosestrife	Rare
<i>Myrica pensylvanica</i>	Northern bayberry	Abundant
<i>Panicum ararum</i>		Rare
<i>Panicum lanuginosum</i>	Hairy panic grass	Rare
<i>Rhus radicans</i>	Poison Ivy	Frequent
<i>Salix</i> sp.	Willow w/ singed stipules	Rare
<i>Scirpus americanus</i>	Three-square	Abundant
<i>Solidago sempervirens</i>	Seaside goldenrod	Occasional
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Frequent
<i>Spirea tomentosa</i>	Steeplebush	Occasional
<i>Vaccinium macrocarpon</i>	Cranberry	Dominant
<i>Viburnum recognitum</i>		Rare

Table 2.12

**DEAD CENTER SWALE**

2 Aug 1994, 7 Aug 1995

Type: High diversity cranberry swale

Relatively dry swale; the illusion of a dead center is due to persistent dead vegetation (rushes and bayberry) at the center; 55 m X 35 m.

<i>Ammophila breviligulata</i>	Beachgrass	Occasional
<i>Aster dumosus</i>		Rare
<i>Carex</i> sp.	"One way" sedge	Rare
<i>Cyperus dentatus</i>	Nut sedge	Frequent
<i>Drosera intermedia</i>	Spatulate sundew	Rare
<i>Hudsonia tomentosa</i>	Poverty "grass"	Rare
<i>Hypericum</i> sp.		Rare
<i>Juncus canadensis</i>	Canada rush	Abundant
<i>Juncus greenei</i>		Abundant
<i>Juncus pelocarpus</i>	Mud rush	Abundant
<i>Myrica pensylvanica</i>	Bayberry	Abundant
<i>Panicum ararum</i>		Rare
<i>Panicum lanuginosum</i>	Hairy panic grass	Abundant
<i>Pinus rigida</i>	Pitch pine	Rare
<i>Rhus radicans</i>	Poison Ivy	Rare
<i>Scirpus cyperinus</i>	Wool grass	Rare
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Occasional
<i>Vaccinium macrocarpon</i>	Cranberry	Frequent
<i>Viola lanceolata</i>	White violet	Abundant

Table 2.13

## GATEHOUSE SWALE

27 July 1994, 7 Aug 1995

Type: High diversity cranberry

Located along beach access road near old gate house; 40 m X 18 m.

<i>Agrostis</i> sp.		Abundant
<i>Ammophila breviligulata</i>	Beachgrass	Rare
<i>Carex</i> sp.	one way sedge	Rare
<i>Cyperus dentatus</i>	Nut sedge	Abundant
<i>Drosera intermedia</i>	Spatulate sundew	Frequent
<i>Hudsonia tomentosa</i>	Poverty "grass"	Rare
<i>Juncus canadensis</i>	Canada rush	Abundant
<i>Juncus greenei</i>	Greene's rush	Abundant
<i>Myrica pensylvanica</i>	Northern Bayberry	Abundant
<i>Rhus radicans</i>	Poison ivy	Occasional
<i>Salix</i> sp.	Willow	Rare
<i>Scirpus americanus</i>	Three square	Abundant
<i>Scirpus cyperinus</i>	Wool grass	Rare
<i>Solidago sempervirens</i>	Seaside goldenrod	Rare
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Abundant
<i>Spirea tomentosa</i>	Steeplebush	Rare
<i>Vaccinium macrocarpon</i>	Cranberry	Dominant

Table 2.14

## GENTIAN SWALE

27 July 1994, 7 Aug 1994

Type: High diversity cranberry

Plymouth gentian is found in 25% of the swale and was in full bloom on 27 July 1994; there are also many non-flowering Plymouth gentian rosettes. This swale is in danger of being overrun by *Phragmites* (4 clones). A single clone of *Lythrum salicaria* was found with 10 stems in 1994 and 26 stems in 1995. No *Lythrum* seedling shadow was observed. The clone has mid-length style flower morphology. 65 m long.

<i>Agrostis</i> sp.		Occasional
<i>Ammophila breviligulata</i>	Beachgrass	Occasional
<i>Aster pilosus</i>		Rare
<i>Cyperus dentatus</i>	Nut sedge	Abundant
<i>Drosera intermedia</i>	Spatulate sundew	Abundant
	Fern	Rare
<i>Juncus canadensis</i>	Canada rush	Frequent
<i>Juncus greenei</i>		Occasional
<i>Myrica pensylvanica</i>	Northern bayberry	Dominant
<i>Panicum ararum</i>		Occasional
<i>Phragmites communis</i>	Reed grass	Frequent
<i>Rhus radicans</i>	Poison ivy	Occasional
<i>Sabatia kennedyana</i>	Plymouth gentian	Abundant
<i>Salix</i> sp.	Willow	Rare
<i>Scirpus americanus</i>	Three-square	Abundant
<i>Solidago sempervirens</i>	Seaside goldenrod	Occasional
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Abundant
<i>Typha</i> sp.	Cat-tail	Rare
<i>Vaccinium macrocarpon</i>	Cranberry	Dominant
<i>Xanthium echinatum</i>	Cocklebur	Rare
<i>Xyris torta</i>	Slender yellow eyed grass	Abundant

Table 2.15

## HIGH DIVERSITY SWALE

6 June 1994, 7 Aug &amp; 27 Sept 1995

Type: High diversity cranberry

Large swale with at least 4 clones of *Phragmites* in 1995; 65 m long.

<i>Agrostis</i> sp.		Rare
<i>Drosera intermedia</i>	Spatulate sundew	Abundant
	Fern	Rare
<i>Juncus canadensis</i>	Canada rush	Abundant
<i>Juncus greenei</i>		Frequent
<i>Lycopodium inundatum</i>	Bog club moss	Abundant
<i>Myrica pennsylvanica</i>	Northern bayberry	Abundant
<i>Panicum lanuginosum</i>	Hairy panic grass	Rare
<i>Phragmites communis</i>	Reed grass	Frequent
<i>Prunus</i> sp.	seedling	Rare
<i>Rhus radicans</i>	Poison ivy	Frequent
<i>Salix</i> sp.	Willow w/ winged stipules	Occasional
<i>Scirpus americanus</i>	Three square	Frequent
<i>Scirpus cyperinus</i>	Wood grass	Rare
<i>Solidago sempervirens</i>	Seaside goldenrod	Rare
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Abundant
<i>Spiranthes cernua</i>	Nodding ladies tresses	Abundant (175 plants)
<i>Vaccinium macrocarpon</i>	Cranberry	Dominant
<i>Viola lanceolata</i>	White violet	Occasional
<i>Xyris torta</i>	Slender yellow-eyed grass	Abundant

Table 2.16

## HORSE TRAIL SWALE # 2

4 Aug 1994, 7 Aug 1995

Type: High diversity cranberry swale

Large swale surrounded by extensive dunes; 105 m long. There is a 10 m X 5 m depression with standing water at one edge of the swale.

<i>Ammophila breviligulata</i>	Beach grass	Occasional
<i>Andropogon scoparius</i>		Rare
<i>Aster linariifolius</i>	Stiff leaved aster	Rare
<i>Cyperus dentatus</i>	Nut sedge	Occasional
<i>Deschampsia flexuosa</i>	Common hairgrass	Occasional
<i>Drosera intermedia</i>	Spatulate sundew	Occasional
<i>Hudsonia tomentosa</i>	Poverty grass	Occasional
<i>Hypericum</i> sp.		Rare
<i>Juncus canadensis</i>	Canada rush	Rare
<i>Juncus pelocarpus</i>	Mud rush	Frequent
<i>Lechea maritima</i>	Pinweed	Rare
<i>Lycopodium inundatum</i>	Bog club moss	Occasional
<i>Myrica pensylvanica</i>	Bayberry	Abundant
<i>Panicum lanuginosum</i>	Hair grass	Occasional
<i>Pinus rigida</i>	Pitch pine	Rare
<i>Rhus radicans</i>	Poison Ivy	Frequent
<i>Salix</i> sp.	Willow	Rare
<i>Scirpus americanus</i>	Three-square	Occasional
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Occasional
<i>Vaccinium macrocarpon</i>	Cranberry	Dominant
<i>Vaccinium</i> sp.	Blueberry	Rare
<i>Xyris torta</i>	Slender yellow-eyed grass	Occasional

Table 2.17

## HOUSE SWALE OF SANDWICH

7 July 1994, 27 Sept 1995

Type: High diversity cranberry

In danger of becoming dominated by *Phragmites*; 60 m long.

<i>Acer rubrum</i>	Red maple	Rare
<i>Andropogon scoparius</i>		Rare
<i>Cyperus dentatus</i>	Nut sedge	Occasional
<i>Juncus canadensis</i>	Canada rush	Frequent
<i>Juniperus virginiana</i>	Red Cedar	Rare
<i>Lycopodium inundatum</i>	Bog club moss	Occasional
<i>Myrica pensylvanica</i>	Northern bayberry	Abundant
<i>Phragmites communis</i>	Reed grass	Abundant
<i>Pinus rigida</i>	Pitch pine	Occasional
<i>Rhus radicans</i>	Poison ivy	Frequent
<i>Salix</i> sp.	Willow w/ winged stipules	Occasional
<i>Scirpus cyperinus</i>	Wool grass	Occasional
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Occasional
<i>Spiranthes cernua</i>	Nodding ladies tresses	Rare (7 plants in 1995)
<i>Vaccinium macrocarpon</i>	Cranberry	Dominant
<i>Vaccinium</i> sp.	Blueberry	Occasional
<i>Viola lanceolata</i>	White violet	Occasional
<i>Xyris torta</i>	Slender yellow eyed grass	Rare

Table 2.18

**LARGE BAYBERRY SWALE**

27 July 1994

Type: High diversity cranberry

Large swale with diverse topography; dominated by *Myrica*; a stand of *Phragmites* is located just outside the border of this swale; 145 m X 45 m

<i>Agrostis</i> sp.		Abundant
<i>Ammophila breviligulata</i>	Beachgrass	Occasional
<i>Carex</i> sp.	"One way" sedge	Rare
<i>Cyperus dentatus</i>	Nut sedge	Occasional
<i>Drosera intermedia</i>	Spatulate sundew	Frequent
<i>Hudsonia tomentosa</i>	Poverty "grass"	Rare
<i>Hypericum</i> sp.		Rare
<i>Juncus canadensis</i>	Canada rush	Occasional
<i>Juncus greenei</i>	Greene's rush	Abundant
<i>Juncus pelocarpus</i>	Mud rush	Frequent
<i>Myrica pennsylvanica</i>	Northern bayberry	Dominant
<i>Panicum ararum</i>		Rare
<i>Rhus radicans</i>	Poison ivy	Occasional
<i>Scirpus americanus</i>	Three-square	Occasional
<i>Scirpus cyperinus</i>	Wool grass	Rare
<i>Solidago sempervirens</i>	Seaside goldenrod	Occasional
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Abundant
<i>Vaccinium macrocarpon</i>	Cranberry	Frequent
<i>Xyris torta</i>	Slender yellow-eyed grass	Frequent



Table 2.19

## DUMPSTER SWALE

15 June 1994, 7 Aug 1995

Type: *Phragmites*

Dominated by dense stand of *Phragmites*; located next to trash dumpster at beginning of beach access road near old gatehouse; contains a single clone of *Lythrum salicaria* (long style flower morph) with 2 stems in 1995; 10 m long.

<i>Agrostis</i> sp.		Rare
<i>Aster pilosus</i>		Rare
<i>Carex</i> sp.	"One way" sedge	Rare
<i>Cyperus dentatus</i>	Nut sedge	Rare
	Fern	Rare
<i>Juncus canadensis</i>	Canada rush	Rare
<i>Lythrum salicaria</i>	Purple loosestrife	Rare
<i>Myrica pensylvanica</i>	Northern bayberry	Occasional
<i>Phragmites communis</i>	Reed grass	Dominant
<i>Rhubus</i> sp.	Bramble	Occasional
<i>Rhus radicans</i>	Poison ivy	Abundant
<i>Scirpus americanus</i>	Three square	Rare
<i>Scirpus cyperinus</i>	Wool grass	Rare
<i>Solidago sempervirens</i>	Seaside goldenrod	Rare
<i>Solidago tenuifolia</i>	Narrow leaved goldenrod	Occasional
<i>Spiraea tomentosa</i>	Steeplebush	Rare
<i>Vaccinium macrocarpon</i>	Cranberry	Frequent
<i>Viola lanceolata</i>	White violet	Occasional

Table 2.20

**HUDSONIA SWALE # 1 AT END OF TRAIL 6**

27 July 1994

Type: *Hudsonia*Large swale dominated by *Hudsonia*

<i>Aster linariifolia</i>	Stiff aster	Frequent
<i>Cladonia</i> spp.	Lichens - 5 spp.	Abundant
<i>Deschampsia flexuosa</i>	Common hairgrass	Abundant
<i>Hudsonia tomentosa</i>	Poverty "grass"	Dominant
<i>Lechea maritima</i>	Pinweed	Frequent
<i>Myrica pensylvanica</i>	Northern bayberry	Rare
<i>Polygonella articulata</i>	Jointweed	Frequent
<i>Solidago sempervirens</i>	Seaside goldenrod	Frequent

Table 2.21

**HUDSONIA SWALE # 3 AT END OF TRAIL 6**

28 July 1994

Type: *Hudsonia**Hudsonia* monoculture; cobbles and bare sand at Eastern end

<i>Ammophila breviligulata</i>	Beachgrass	Occasional
<i>Cyperus</i> sp.	Sedge	Occasional
<i>Hudsonia tomentosa</i>	Poverty "grass"	Dominant
<i>Lechea maritima</i>	Pinweed	Frequent
<i>Polygonella articulata</i>	Jointweed	Frequent

Table 2.22

## MINI-HUDSONIA SWALE AT END OF TRAIL 6

27 July 1994

Type: *Hudsonia*

*Hudsonia* monoculture in 75% of swale, 25% is mix of *Ammophila* and *Deschampsia*

<i>Ammophila breviligulata</i>	Beachgrass	Abundant
<i>Aster linariifolius</i>	Stiff aster	Frequent
<i>Cyperus</i> sp.	Sedge	Occasional
<i>Deschampsia flexuosa</i>	Common hairgrass	Abundant
<i>Hudsonia tomentosa</i>	Poverty "grass"	Dominant
<i>Lechea maritima</i>	Pinweed	Occasional

Table 2.23

## ROCK SWALE AT END OF TRAIL 6

28 July 1994

Type: *Hudsonia*

Approximately 50% bare cobbles and sand.

<i>Ammophila breviligulata</i>	Beachgrass	Dominant
<i>Carex</i> sp.	"One way" sedge	Rare
<i>Cyperus</i> sp.	Sedge	Common
<i>Hudsonia tomentosa</i>	Poverty "grass"	Dominant
<i>Lathyrus japonicus</i>	Beach pea	Rare
<i>Myrica pensylvanica</i>	Northern bayberry	Occasional
<i>Polygonella articulata</i>	Jointweed	Frequent
<i>Solidago sempervirens</i>	Seaside Goldenrod	Frequent

Table 3. Average (N=5) water table depth, conductivity, and swale type for 12 swales listed from shallowest to deepest water table depth.

Swale	Water Table Depth (Cm)		Conductivity ( $\mu$ mhos/cm)		Swale Type
	Mean	S.D.	Mean	S.D.	
Sm. Cranberry	20.2	1.6	166	45.1	Lo Div. Cranberry
Airdown	24.8	13.6	258	251.4	Hi Div. Cranberry
Gatehouse	28.4	6.3	1140	577.1	Hi Div. Cranberry
Gentian	30.8	3.0	232	95.2	Hi Div. Cranberry
Tadpole	32.8	5.9	84	27.0	Monocots only
High Diversity	34.8	3.2	88	16.4	Hi Div. Cranberry
Garbage Dump	35.6	4.3	186	148.6	Monocots w/ <i>Myrica</i>
Lg Bayberry	40	6.0	118	60.2	Hi Div. Cranberry
Rectangle	40	4.8	200	163.7	Monocots w/ <i>Myrica</i>
Wet Spot -					
Hi Diversity	44.8	3.5	88	53.6	Wet soil & sparse veg.
Ugly	48.4	5.7	78	19.2	Monocots w/ <i>Myrica</i>
Wet Spot -					
Dead Center	48.6	5.4	58	4.5	Wet soil & sparse veg.