Virginia Journal of Science
Volume 41, Number 4A
Winter 1990

Plant Associations on the Virginia Barrier Islands

Cheryl A. McCaffrey, 7425 Earlwood Road NE
Newberg, Oregon 97132, and **Raymond D. Dueser**[1]
Department of Environmental Sciences,
University of Virginia,
Charlottesville, Virginia 22903

ABSTRACT

Vegetation maps (1:20000 scale) and descriptions of plant associations were compiled for 16 barrier and marsh islands on the seaward margin of the Delmarva Peninsula (USA): Metompkin, Cedar, Parramore, Revel, Crescent, Chimney Pole Marsh, Hog, Rogue, Cobb, Little Cobb, Wreck, Ship Shoal, Godwin, Myrtle, Mink and Smith. These maps were based on photointerpretation of false-color infrared aerial photography taken in 1974. Extensive ground-truthing revealed 26 mapping units based on botanical, topographic and edaphic attributes. Each unit represents a distinctive plant association, ecotone or non-vegetated surface. Most associations exhibit relatively low plant species diversity, high consistency in species composition and strong dominance by one or a few plant species. Variation among communities reflects the effects of location, topography, edaphic factors, consumer influence and disturbance history. With periodic resurvey, these maps will be useful for describing site-specific vegetation dynamics and succession on this rapidly-changing landscape.

Key Words: barrier island, Delmarva Peninsula, landscape, plant association, succession, vegetation

INTRODUCTION

The islands located on the seaward margin of the southern Delmarva Peninsula (USA) are among the least disturbed and most dynamic coastal landscapes remaining in North America (Hayden *et al.*, in press). Although relatively free of recent human activity, these islands are subject to the effects of recurrent coastal storms (Dolan *et al.*, 1988), the continuing secular rise in sea level (Aubrey and Emery 1983), and the effects of landward migration across the coastal margin (Dolan *et al.*, 1979). These islands thus offer the potential to study the ecosystem effects of climate change and climate variation on a coastal system that is relatively free from the effects of other, confounding sources of influence. As background for such studies, McCaffrey (1975, 1976) prepared vegetation maps and accompanying descriptions of plant associations for 16 barrier and marsh islands in 1975.

---

1 Present address: Department of Fisheries and Wildlife, College of Natural Resources, Utah State University, Logan, Utah 84321.

The present paper describes these plant associations and presents detailed (1:20000 scale) vegetation maps. This information provides an historical baseline for studies of vegetation change and landscape dynamics in this rapidly-changing coastal environment. This paper and the attached maps are a companion to the floristic information reported by McCaffrey and Dueser (1990)

STUDY AREA

The 16 islands are, from north to south: Metompkin, Cedar, Parramore, Revel, Crescent, Chimney Pole Marsh, Hog, Rogue, Cobb, Little Cobb, Wreck, Ship Shoal, Godwin, Myrtle, Mink and Smith (Fig. 1). These islands are centered on latitude 37° 30′ north and longitude 75° 40′ west. With the exception of Wreck Island, which is owned by the Commonwealth of Virginia, most of the acreage of these islands is owned The Nature Conservancy and managed as the Virginia Coast Reserve. This region comprises one of the last stretches of undeveloped coastline on the mid-Atlantic seaboard. Graham (1976) and McCaffrey and Dueser (1990) discuss pertinent aspects of the history of the study area.

METHODS AND MATERIALS

Vegetation maps were prepared from 1:20000-scale false-color aerial infrared transparencies (cf. Holman 1974). The photography was flown by the National Aeronautics and Space Administration, Wallops Island, Virginia during the late morning of June 4, 1974, at 2-2.5 hours before low tide (Roll W 2710101, frames 83-127).

Variation within and between plant associations was identified in the transparencies from different tones and textures of red and black. Non-vegetated features such as open water, submerged sand and mudflats also were delineated. Vegetated and non-vegetated features are referred to collectively as "mapping units." Distinctions between units were based on species composition, growth form, leaf and stem density, tidal influence, substrate mobility, elevation and soil type. Narrow ecotones and small patches of "included" associations were visible in the photography, but were combined with the most similar adjacent mapping unit.

Field maps at 1:6500 scale were prepared by magnifying the transparencies using a reflecting projector. Differences in photo-appearance were traced onto acetate overlays and labeled with preliminary mapping unit interpretations. Blueprints of these overlays were field-checked in 43 days between early March and late July, 1975. Variations in photo-appearance portrayed on the field maps were inspected along multiple transects across and along each island. At several stops in each preliminary mapping unit, a number was recorded on the map and keyed to a brief site description. Each description included percent cover (visual estimation), species relative abundances, canopy height and relative leaf or stem density, salinity and edaphic factors, topography, dune height and other observations.

Relative abundances of conspicuous species were estimated visually as follows: Dominant - most abundant plant species characterizing the mapping unit; Abundant - plants found in quantity essentially throughout the mapping unit; Frequent - plants scattered throughout the mapping unit; and Occasional - individuals or colonies observed infrequently and usually noted simply as "present" in a unit. Characteristic species composition and relative abundances for each mapping unit

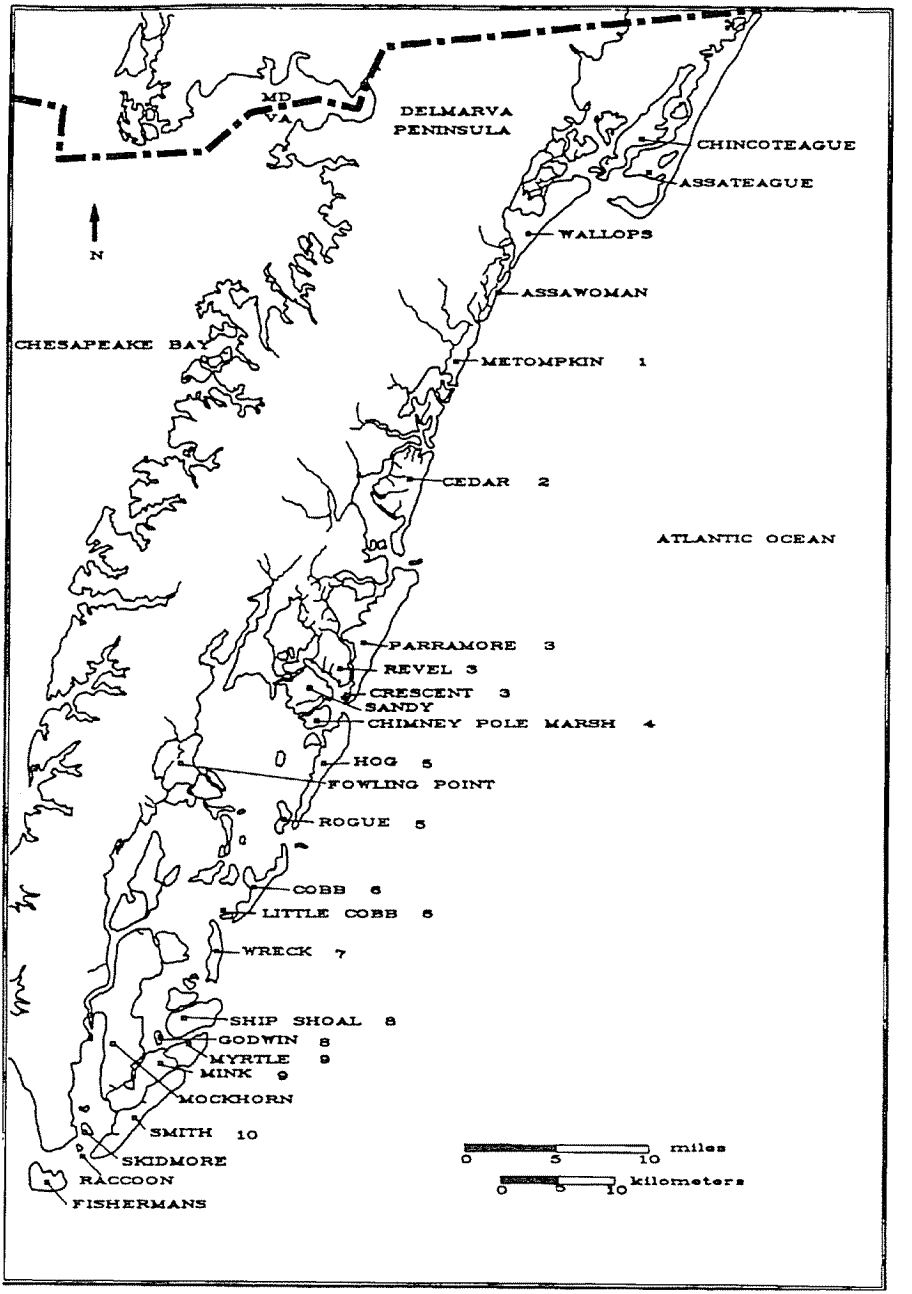

FIGURE 1. The Virginia barrier islands extend the length of the seaward margin of the southern Delmarva Peninsula. Number after island name refers to vegetation map for that island.

are indicated below and in Appendix 1. Relative abundances of species in each mapping unit on each island are available from the second author upon request.

Field data formed the basis for revised photointerpretation, for written descriptions of mapping units, and for description of variations among units and islands. Final photointerpretation was recorded on acetate overlays directly from the 1:20000-scale transparencies. Minimum mapping unit size was determined by the smallest area which could be enclosed by a "00" drafting pen, approximately 30 x 30 m on the ground. Extreme portions of some islands were not covered by the photographs. To complete the bayshore outline of the salt marsh west of Cedar Island, the northeastern beach and bayshore salt marsh of Parramore Island, and the western sides of Godwin and Mink Islands, the maps published here were prepared by merging the vegetation photo- interpretation with the water boundary shown on island basemaps provided by The Nature Conservancy (Dueser *et al.*, 1976).

MAPPING UNIT DESCRIPTIONS

Twenty-six mapping units were identified. These included sparsely vegetated sand and salt flats; sparse and dense grasslands; shrub thickets; upland forests of pine and hardwood species; fresh, brackish and salt marshes; and a variety of unvegetated surfaces. The characteristic plant species for each mapping unit are listed in Appendix 1. Conspicuous inter-island variation in the composition of plant associations is discussed below. Inter-island variation in the number and types of plant associations is illustrated on the attached vegetation maps: Map 1 (Metompkin), Map 2 (Cedar), Map 3 (Parramore, Revel and Crescent), Map 4 (Chimney Pole Marsh), Map 5 (Hog and Rogue), Map 6 (Cobb and Little Cobb), Map 7 (Wreck), Map 8 (Ship Shoal and Godwin), Map 9 (Myrtle and Mink), and Map 10 (Smith).

1) Xeric-Mesic Herbaceous Mapping Units

Herbaceous associations dominated by *Ammophila breviligulata* or *Spartina patens* on xeric or mesic soils are found in the seaward and interior portions of the islands. These units are separated by location, origin, topographic position, species composition and plant density.

Foredune Grassland (A). Xeric foredunes 0.6-1.8 m high parallel the upper beach on most islands, and are sparsely vegetated (5-20% cover) with *A. breviligulata.* In some locations this grassland extends inland into mesic interdunal swales densely vegetated (75-100% cover) with *A. breviligulata* mixed with *S. patens, Panicum amarum* and *Strophostyles helvola*. Swale grasslands behind foredunes breached by overwash typically have less than 20% cover. This unit occasionally includes small patches of *Juncus roemerianus* and *Phragmites communis*, as well as scattered small shrubs and vines.

Sparse Grassland (g). Dry, sandy grassland with 5-20% cover occurs above the upper beach on overwash areas having a surface of shell material. Dominant species include *A. breviligulata, Cakile edentula,* and *Spartina patens* or *Solidago sempervirens*. Dunes up to 0.6 m high and intermittent foredunes protecting small areas of denser grassland occur in this unit. On the lee side of the southern end of Smith Island the sparse grassland occurs at 1.5-2.4 m in elevation above the surrounding surface, and is dominated by *Andropogon scoparius, S. sempervirens,*

moss and scattered *Myrica cerifera.* Sparse grassland typifies Metompkin Island and the narrow, low-lying portions of several other islands.

Foredune-Sparse Grassland Complex (Ag). *Ammophila breviligulata* foredunes, 1.2-3.0 m in elevation above the surrounding surface, and sparse grassland often are interspersed and inseparable. This unit occurs primarily on narrow, overwash- influenced islands such as Metompkin, Cedar and the northern end of Smith Island.

Open Dunes-Thicket Complex (At). This interior unit is sparsely vegetated (10-50% cover) with grasses (particularly *A. breviligulata*), forbs, and scattered shrubs and small trees. In places there are *M. cerifera* thickets and extensive non-vegetated dunes ("blowouts"). This association occurs only on Revel Island and on the northern end and one-third of the eastern length of Parramore Island. It was mapped as part of the dominant woody vegetation on tops of the "Parramore Mounds" (i.e., scattered low, sandy interior dunes on Parramore Island).

Beach (B). The tidal margin of the ocean beach is non- vegetated. The beach above the berm is sparsely vegetated (0-10% cover) with *A. breviligulata, C. edentula* and other herbaceous species, and includes scattered low (1.2 m) primary dunes and drift material. Beach accretion is evident on the northern ends of Hog, Cobb, Myrtle and Ship Shoal Islands and on the southern end of Parramore Island. On the eroding northern ends of Cedar and Parramore Islands, storm overwash has penetrated into woody plant associations, leaving dead shrubs and trees on the beach.

Dense Grassland (G). Dense grassland (50-100% cover) is dominated by erect *Spartina patens* with numerous other herbaceous species. *Ammophila breviligulata* is a frequent component. This unit usually occurs in the interior or bayshore portions of the islands. Its several forms include disturbed areas (*e.g.*, lawns of U.S. Coast Guard facilities); xeric or mesic areas with flat or rolling topography and vegetation transitional to thicket (0- 50% shrub cover); flat, mesic grassland with tall, erect *S. patens* between foredunes and salt marshes; drift line and *Iva frutescens* borders between brackish and salt marshes and adjacent narrow foredunes or patches of sparse grassland too small to map. Mesic grasslands characterize Hog, Cobb, Wreck and Ship Shoal Islands, whereas dense grasslands on Smith Island are on xeric dune ridges. Ponds of water on Cobb Island and salt flats on Hog Island are notable inclusions in this mapping unit.

Beachgrass Dunes-Dense Grassland Complex (AG). *Ammophila breviligulata* dunes alternate with and often are inseparable from dense *S. patens* grasslands. Beachgrass dunes are taller (0.3-3.0 m) and more densely vegetated (10-50% cover) than is typical, and *Andropogon scoparius* is more abundant. Dense grassland is usually mesic and includes species characteristic of moist sites (*Fimbristylis spadicea, Scirpus americanus, Juncus* spp.). This unit occurs on Revel, Hog and Cobb Islands. On Hog Island, it includes small salt flats in various stages of succession.

2) Woody Mapping Units

Associations characterized by the occurrence of shrub or tree species usually occupy upland locations. Where beach erosion is pronounced, woody associations occur adjacent to the seaside beach. Shrub associations are dominated by

M. cerifera. Forests vary among islands, but generally are composed of *Juniperus virginiana, M. cerifera, Persea palustris, Pinus taeda* and *Prunus serotina*. Woody units are distinguished by vegetation height and species composition.

An unusual arrangement of scattered low dunes occurs on the central third of Parramore Island and on northern Cedar Island. The "Parramore Mounds" vary in diameter from 7.6-61.0 m and are elevated less than 1.5 m above the surrounding marsh. Vegetation varies in concentric bands from brackish marsh on the periphery to low thicket, to tall thicket, to pine or pine-hardwood forest on the interior. The apex is open sand (0-15% cover), with trees, shrubs and grasses similar to the open dunes-thicket complex of northern Parramore Island.

Tall Thicket (T). Impenetrable *M. cerifera* greater than 3.0 m tall dominate elevated portions of several islands. The canopy is closed, producing a dense herbaceous layer composed chiefly of lianas. There is dense herbaceous ground cover on mesic sites with an open canopy. Thickets are shorter in stature along the borders of fresh, brackish and salt marshes, and *M. cerifera* is replaced here by *Baccharis halimifolia* and *I. frutescens,* with herbaceous species characteristic of the adjacent association.

On Cedar Island *M. pensylvanica* is more abundant than *M. cerifera. Rhus radicans* and *Parthenocissus quinquefolia* are abundant on thicket edges. In the hardwood forest of Parramore Island, *Persea palustris* gradually declines in stature toward the edge of the unit and is mixed with tall (4.6 m) *M. cerifera* and scattered pines and cedars, creating an unusual tall thicket composition. Tall thickets on parallel secondary dune ridges on southern Smith Island have *M. cerifera* interspersed with *Smilax bona-nox* and *R. radicans. Ilex vomitoria,* near the northern end of its range, is frequent on Smith Island, but *J. virginiana* occurs very infrequently. The only insular location of *Quercus virginicus* is in a tall thicket near Smith Island beach.

Open Dunes-Tall Thicket Complex (AT). Large patches of tall (3.0-4.6 m) *M. cerifera* thicket alternate with open, sparsely vegetated dunes along the bayshore marshes on the northern end of Hog Island. This unit has the composition of typical tall thicket (T). The dune portion (A) of the complex has sparse herbaceous vegetation (5-20% cover) dominated by *A. breviligulata.* Livestock grazed this island, resulting in thickets relatively clear of dead branches and with dense, varied and well-cropped herbaceous vegetation.

Low Thickets (t). Dense stands of *Iva frutescens, B. halimifolia* and *M. cerifera* less than 3.0 m tall are typical components, with occasional *J. virginiana. Spartina patens* is the usual herbaceous component. This unit includes patches of shrubs in marshes and grasslands having greater than 50% shrub cover. Low thicket varies in species composition, plant density and edge. Where it grades into taller woody units, and in areas subject to occasional flooding, low thicket may have 100% canopy closure. Dense *I. frutescens* 1.0-1.2 m tall, with *S. patens* and *Borrichia frutescens*, form low thickets on sand or drift deposits perched above normal high tide within brackish and salt marshes.

Living shrubs near the ocean are 1.2-2.4 m tall and exhibit the effects of salt-pruning. In places on Cedar, Parramore and Ship Shoal Islands, the seaward edge of low thicket is subjected to erosion, overwash and salt-water flooding, leaving only dead shrubs and trees with an understory of herbaceous dune species.

Myrica pensylvanica and *M. cerifera* are co-dominants with an unusally high abundance of *R. radicans* in low thicket on Cedar Island. Low thicket extends the gradient of decline in plant stature at the edge of the hardwood forest on Parramore Island. In other places on Parramore a narrow north-south line of low thicket has grown in an abandoned roadbed. *Quercus falcata, Q. nigra* and *Ilex vomitoria* occur occasionally in low thickets on Smith Island. A narrow, unmapped band of low *M. cerifera, Baccharis halimifolia* and *Iva frutescens* surrounds the grassland on Mink Island, and with the grassland, is the only upland vegetation on the island.

Juniper Thicket (J). Juniper thickets are dominated by 3.0-4.5 m tall *J. virginiana* with an abundance of shrubs typical of tall thickets (T). On the northern ends of Cedar and Parramore Islands, juniper thicket is separated from bayshore marshes by a narrow band of low shrubs. *M. pensylvanica* is absent, and *M. cerifera, R. radicans* and *Parthenocissus quinquefolia* are uncharacteristically sparse in only one patch of juniper thicket isolated in a salt marsh on Cedar Island. Dead junipers occur along the beach of Cedar Island and near the bayshore marshes of Parramore Island. Juniper thicket on the southern end of Revel Island has an open canopy and merges with the adjacent grassland.

Pine Forest (P). *Pinus taeda* forest occurs only on the interior dune ridges of Parramore Island (Italian Ridge). The understory is sparse under the closed pine canopy. *Myrica cerifera* and *Persea palustris,* with a sparse herbaceous layer, occupy canopy gaps. This forest was estimated to be 65-85 years old in 1968 (O'Neal 1969). In 1975, vast areas of pine had been killed by the southern pine bark beetle and by a rising water table. Some logging occurred in the 1960s (Graham 1976). Many of the Parramore Mounds, mentioned above, had pine canopy and *M. cerifera* understory, and were inter-connected by low shrub thickets of *B. halimifolia, I. frutescens* and *M. cerifera.*

Hardwood Forest (H). This forest has essentially 100% cover of medium-small hardwood trees or tall shrubs intertwined with lianas forming a dense, nearly impenetrable woodland. This association occurs only on Parramore and Smith Islands, where it often occurs in wet, low-lying locations.

Myrica cerifera, P. palustris, Smilax bona-nox, R. radicans and *Parthenocissus quinquefolia* are the most abundant species. *Juniperus virginiana* is a dominant species on Parramore Island, and *Acer rubrum, Ilex* spp., *Liquidambar styraciflua* and *Prunus serotina* occur occasionally. *Prunus serotina* is a dominant component on Smith Island. *Robinia pseudo-acacia* and *I. vomitoria* are abundant on Smith, while *Sassafras albidum, J. virginiana, L. styraciflua, Q. falcata, Q. stellata* and *Q. nigra* occur only infrequently. In some locations, as in the southern extension of this unit on Parramore Island, there is a gradual decline in plant stature and canopy closure; the edge of the forest in such locations was mapped as tall thicket.

Pine-Hardwood Forest Complex (PH). Hardwood forest on old dune ridges on Parramore, Revel and Smith Islands includes scattered *Pinus taeda. Juniperus virginiana* is more abundant on Revel Island than on the other two islands. Open areas of dead pines and fallen logs have an understory of *M. cerifera, Persea palustris, Prunus serotina* and, on Smith Island, *I. vomitoria.* Herbaceous components include *Andropogon scoparius, A. virginicus, Festuca rubra, Opuntia com-*

pressa, *Spartina patens* and *Uniola laxa*. The edges of this association grade into pine forest, hardwood forest, tall thicket or marsh.

3) Hydric-Halophytic Herbaceous Mapping Units

Water- or salt-related units include marshes, open water and virtually bare areas affected by storm overwash and occasional tidal flooding. Marsh communities are separated by species composition, topographic position and tidal influence.

Low Salt Marsh (m). Bayshore marshes have 75-100% cover of *S. alterniflora*, frequently with the macroalgae *Ulva lactuca* and *Fucus vesiculosus* also abundant. Although not mapped separately, short (17-25 cm), medium (26-91 cm) and tall (92-167 cm) height classes of *S. alterniflora* were observed. The taller *S. alterniflora* was less dense than the shorter, as has been reported elsewhere by Holman (1974). The daily tidal range of 1.0-1.4 m floods most marsh areas twice a day. Sinuous creeks dissect the marsh surface. Low marsh comprises most of Chimney Pole Marsh and Ship Shoal, Godwin, Myrtle and Mink Islands.

Marsh substrate changes along a gradient from upland to open water. Higher elevations in low marsh usually have firm organic sediments and support short, often dense, *S. alterniflora*. Lower elevations have fine-grained, mucky sediments which are inundated several hours per day and which support tall *S. alterniflora*. Driftlines of *Borrichia frutescens* and *Iva frutescens* usually separate low marsh and upper low marsh from other herbaceous mapping units.

Upper Low Salt Marsh (Mm). A halophytic association (50-100% cover), usually flooded to a depth of < 10 cm, occupies the higher elevations of low marsh. It is dominated by *Salicornia virginica* and short *Spartina alterniflora*, often with a layer of unicellular algae and sulfur bacteria. A border of *Distichlis spicata, B. frutescens, I. frutescens, S. patens* and drift material usually separates it from upland grassland or woody associations. Upper low marsh includes small mudflats, salt flats, salt ponds, *Juncus roemerianus* colonies, drift mats and some scattered elevated patches of shrubs. This mapping unit is referred to by some authors (Levy 1983, Harvill 1965, Clovis 1968) as tidal flats or salt flats with various combinations of dominant species and by other authors (Martin 1959, Higgins *et al.*, 1971, Klotz 1986) as part of the salt marsh.

Brackish Marsh (M). Brackish marsh has 100% cover of dense, typically decumbent, *D. spicata* and *S. patens* with numerous salty-to-brackish pools. This association fringes the edges of salt flats. Salinity varies with the frequency of precipitation and saltwater flooding. Due to the range of salinity, brackish marshes may gradually merge with upper low marsh, fresh marsh or dense grassland. Higher elevations include small areas of shrub thicket, such as on the Parramore Mounds. The presence of *D. spicata, S. patens* or *I. frutescens* distinguishes brackish from fresh marsh, and the drift line separates brackish from salt marsh. Dense grassland is usually drier than brackish marsh and has erect *S. patens*.

Salt Flat (s). Salt flats are intermittently flooded areas of firm sand with a high salt concentration and a surface layer of unicellular algae and sulfur bacteria. The edges have less than 15% cover of halophytic species (typically *Salicornia virginica, S. bigelovii* and *S. europaea*), with individual plants scattered sparsely elsewhere. Salt flats are differentiated from mud flats and wash flats by the algal layer, a gray-caked surface appearance and the sparse halophytic vegetation. Salt flats are

found on all islands, most commonly associated with former drift mat locations on the upper edge of the upper low marsh.

Fresh Marsh (F). Fresh marsh is dominated by *Spartina patens,* and on Parramore Island, by *Panicum dichotomiflorum* and *Typha angustifolia*. Fresh marshes occupy wet soil or standing fresh-to-slightly brackish water, and often encircle open water. They include scattered *Baccharis halimifolia* and occasional shrub thickets, and they may extend beneath adjacent wooded canopies. Fresh marshes occur only on Parramore, Hog and Smith Islands.

Open Water (w). Ephemeral or permanent ponds with filamentous algae are found on most islands. Those nearest the ocean or creeks are salty, while those further inland are brackish or fresh. They are usually surrounded by a marsh or flooded grassland with *S. patens, S. alterniflora* and other species. Halophytic species characteristic of salt flats and upper low marsh surround salt ponds located near low marshes.

4) Other Mapping Units

Several essentially bare or submerged mapping units were recognized on the basis of location, origin, substrate composition and plant species composition.

Drift (dr). Extensive areas of drift material composed chiefly of dead stems of *S. alterniflora* and flotsam are found on the higher elevations of salt marshes, typically bordering grassland. Drift mats are transported by storm tides; their deposition may produce essentially non-vegetated mud flats or salt flats. They are recognized as a unit because of their occasional large area and their role in substrate stabilization and plant propagation. The sparse vegetation associated with the edges of the driftline included *C. edentula, Borrichia frutescens, Calystegia sepium, D. spicata, I. frutescens, S. patens, Solidago sempervirens,* and numerous other species typical of beaches and brackish wetlands.

Submerged Sand (b). Contiguous with some islands are submerged accumulations of sand near a spit or inlet. Under a regime of sediment accretion, submerged sand having primarily oceanic influence may emerge and join an island beach. With accumulation of fine sediments in the lee of an island, and with establishment of *S. alterniflora*, low marshes may develop.

Underwater Flora (or Fauna) (uw). Underwater features that were visible on the aerial photographs include oyster beds, patches of dense algal growth and human artifacts.

Peat Outcrop (Peat). Outcrops of marsh peat are found on seaside and inlet beaches. The outcrops contain roots of *S. alterniflora* and *S. patens,* but occasional *Ulva lactuca* is the only living vegetation. These features change with short-term erosion and storm activity. They are found on Metompkin, the southern end of Cobb, Ship Shoal, Myrtle and Smith Islands.

Wash Flat (wf). Wash flats appear as bayshore beaches. They occur above buried low marsh in overwash areas and in ephemeral inlets. Portions of a wash flat may receive tidal flooding. There is sparse (0-10%) *S. alterniflora* near tidal creeks and elsewhere occasional inclusions of *S. alterniflora* with 10-50% cover and sparse halophytic vegetation. Wash flats may be separated from the ocean by sparse grasslands, or they may be continuous with the beach. This "rear beach" lacks the abundance of shell material found on the ocean beach and sparse

grasslands. Wash flats lack the algae and the salt-caked surface characteristic of salt flats, although wash flats appear to be transitional to salt flats. Wash flats are found primarily on narrow parts of islands such as Crescent Island, southern Hog Island and northern Smith Island.

Mud Flat (mf). Mud flats have a "muddy" surface and little vegetation except for occasional *U. lactuca, S. alterniflora* and other halophytes. Mud flats form where there recently was a drift mat (0-20% cover) or where accumulations of fine estuarine sediments accrete onto a marsh. They are successional to salt marsh and occur in three types of locations: as shallowly-flooded extensions of marsh islands, within low marsh or upper low marsh, and as leeward extensions of overwash fans.

DISCUSSION

The surfaces of the islands and marshes are conspicuously patchy, with distinct zonation and sharp transitions between patches. Twenty-six mapping units were identified, including 19 vegetated units. Although the Virginia barrier islands support a rich diversity of plant species (McCaffrey and Dueser 1990), most vegetated units exhibit dominance by only one or a few species:

A, g, Ag, At, B, G, AG - *Ammophila breviligulata, Spartina patens*

T, AT - *Myrica cerifera*

t - *Iva frutescens, Baccharis halimifolia, Myrica cerifera*

J - *Juniperus virginiana*

P - *Pinus taeda*

H - *Myrica cerifera, Persea palustris, Juniperus virginiana, Acer rubrum* (Parramore Island); *Prunus serotina, Robinia pseudoacacia, Ilex vomitoria* (Smith Island)

PH - *Pinus taeda, Juniperus virginiana, Myrica cerifera, Persea palustris, Prunus serotina, Ilex vomitoria*

m, Mm, M - *Spartina alterniflora, Spartina patens*

s - *Salicornia* spp.

F - *Spartina patens, Panicum dichotomiflorum, Typha angustifolia*

Altogether, then, fewer than 20 vascular plant species dominate the 19 vegetated units. Only the relatively uncommon hardwood (H) and pine-hardwood (PH) forest units typically exhibit inter- island variation in gross composition and appearance.

In addition to compositional differences, mapping units are distinguished from one another by their physical attributes (*e.g.*, location on the island, topographic position, depth and frequency of salt water flooding). Some units appear to exhibit greater variation (*i.e.*, amplitude) in site attributes than others. For example, pine forest (P) typically occurs on xeric sites and hardwood forest (H) on mesic sites. Low thicket (t), by contrast, occurs in fresh, brackish and saline environments and on xeric, mesic and flooded sites. This unit appears to arise through a variety of successional pathways, including from xeric or mesic grassland, from brackish or fresh marsh, and from heavy drift deposits in saline areas. Variability exhibited by a unit must reflect variability in the requirements and tolerances of its component species.

Boulé (1979) identified 14 "natural communities" on Fishermans Island, at the southern end of the Delmarva Peninsula. He used different terminology to describe these communities, but his botanical and physical descriptions identify 12 synonymies with mapping units described here: pioneer beach (B), foredune (A), low dune (g or Ag), backdune (AG), low marsh (m), high marsh (Mm), upper marsh (M), panne (s), marsh transition (t), thicket (T), woodland (H) and fresh marsh (F). Only Boule' 's "old dune" and "dune-marsh boundary" units are not readily identified with one of the units reported here. This cross-classification attests to the regional applicability of the units described here.

The islands discussed here range in area and elevation from 29 ha and 0.9 m (Little Cobb) to 2,197 ha and 9.1 m (Parramore). There is a direct relationship between island area, maximum elevation and vegetation complexity, measured as the observed number of mapping units (Dueser and Brown 1980). Larger islands tend to have a greater variety of plant associations ($r = +0.74$), particularly woody associations ($+0.84$), than smaller islands. Similarly, elevated islands tend to have a greater variety of plant associations ($r = +0.60$), particularly woody associations ($+0.78$), than low-lying islands. These patterns of variation must reflect the greater substrate diversity, the more reliable supply of fresh groundwater, and the reduced frequency of overwash and flooding associated with larger area and higher elevation.

Barrier islands frequently exhibit pronounced shore-parallel zonation of plant associations, from barrier beach to bayshore (Dolan *et al.*, 1973 and references therein). Because of the effects of erosional and accretional processes on the Virginia barrier islands, and because these islands are relatively low- lying (0.9-9.1 m), substantial variation on this pattern is evident. This is particularly well-illustrated on Parramore Island, where several thicket (t, T, At) and forest (H, PH) units occur immediately inland from seaside beach (B), and where brackish marsh (M) occurs adjacent to at least 14 other units, including all eight of the units having a conspicuous woody component. Interspersion of mapping units is the rule rather than the exception on these islands.

The mapping units identified here are subject to change through accretion, deposition, erosion and subsidence. These processes may produce transitions from one type of unit to another. For example, low marsh may eventually become upper low marsh through accretion or deposition, or upper low marsh may become low marsh through erosion or subsidence. Both salt marsh units might become mud flat or wash flat through the effects of deposition or erosion produced by overwash. Similarly, shore-front forest might become shrub thicket, foredune grassland, and eventually even beach, through beach erosion. The superficial simplicity suggested by few-species dominance and sharp zonation belies the actual complexity of the types, frequencies and rates of changes which may occur within mapping units. As in other coastal systems (Tyndall and Levy 1978), plant succession is likely to be both relatively rapid and highly stochastic on the Virginia barrier islands.

A sequence of vegetation maps comparable to those presented here is potentially available through the interpretation of historical (post-1933) aerial photography for the islands. Although these photographs vary in type, quality and resolution, it should be possible to produce a decadal sequence of maps from the

1930s through the 1980s. Such maps would support a "time lapse" study of major surficial and vegetation changes on the islands since the historic storm of 1933. It would be possible, for example, to detect temporal changes which have occurred at selected points on the islands and to estimate the probability of a given mapping unit changing into any of the other units through time (Horn 1976). Presumably, most of the transition probabilities are close to zero, while a few are close to one. Nevertheless, because of the strong interplay between biological and physical processes, it is expected that vegetation dynamics will be quite complex despite the superficial simplicity of vegetation structure.

ACKNOWLEDGEMENTS

The data and maps presented here were prepared for and are published with the permission of the Virginia Coast Reserve of The Nature Conservancy. Maps 1-10 were prepared originally for the Conservancy, and have been redrafted for inclusion in this paper. The authors deeply appreciate the many hours dedicated to drafting by Ms. Linda Tolan and Ms. Beth Walton. Editorial assistance by Beth Walton, Jonathan P. Evans and an anonymous reviewer is gratefully acknowledged. This work would never have been possible were it not for the dedication of The Nature Conservancy to the preservation of ecosystems and knowledge about them. Publication of this paper was supported by the Virginia Coast Reserve Long-Term Ecological Research Program of the University of Virginia (NSF BSR-8702333).

LITERATURE CITED

Aubrey, D. G. and K. O. Emery. 1983. Eigenanalysis of recent United States sea levels. Continental Shelf Res. 2:21-33.

Boulé, M. E. 1979. The vegetation of Fisherman Island, Virginia. Castanea 44:98-108.

Clovis, J. F. 1968. The vegetation of Smith Island, Virginia. Castanea 33:115-121.

Dolan, R., P. J. Godfrey and W. E. Odum. 1973. Man's impact on the barrier islands of North Carolina. Amer Sci. 61:152-162.

Dolan, R., B. P. Hayden and C. Jones. 1979. Barrier island configuration. Science 204:401-403.

Dolan, R., H. Lins and B. Hayden. 1988. Mid-Atlantic coastal storms. J. Coastal Res. 4:417-433.

Dueser, R. D. and W. C. Brown. 1980. Ecological correlates of insular rodent diversity. Ecology 61:50-56.

Dueser, R. D., M. A. Graham, G. J. Hennessey, C. A. McCaffrey, A. W. Niedoroda, T. E. Rice, E. Thomas and B. Williams. 1976. Virginia Coast Reserve Study: Ecosystem Description. The Nature Conservancy. Arlington, Virginia. 568 pp.

Graham, M.A. 1976. Land use history. A study of man's influence on Virginia's barrier islands:1-86. *In* Dueser, R.D., M.A. Graham, G.J. Hennessey, C.A. McCaffrey, A.W. Niedoroda, T.E. Rice, E. Thomas and B. Williams. Virginia Coast Reserve Study: Ecosystem Description. The Nature Conservancy. Arlington, Va.

Harvill, A.M., Jr. 1965. The vegetation of Parramore Island, Virginia. Castanea 30: 220-228.

Hayden, B. P., R. D. Dueser, J. T. Callahan and H. H. Shugart, Jr. In press. The Virginia barrier islands, LTER and MAB. BioScience.

Higgins, E. A. T., R. D. Rappleye and R. G. Brown. 1971. The flora and ecology of Assateague Island. Bull. A-172. Univ. Maryland Agric. Exper. Sta., College Park, Md. 70 pp.

Holman, R. E., III. 1974. The use of color infrared aerial photography in determining salt marsh vegetation and delimiting man-made structures of Lynnhaven Bay, Virginia. NASA Contractor Report 62099. Wallops Flight Center, Va. 47 pp.

Horn, H. S. 1976. Markovian properties of forest succession: 187- 204. *In* May, R.M. (ed.). Theoretical Ecology: Principles and Applications. Saunders, Philadelphia.

Klotz, L. H. 1986. The vascular flora of Wallops Island and Wallops mainland, Virginia. Castanea 51: 306-326 .

Levy, G.F. 1983. A study of vegetational dynamics on Parramore Island, Virginia. Castanea 48: 32-36.

Martin, W.E. 1959. The vegetation of Island Beach State Park, New Jersey. Ecol. Monogr. 29:1-46.

McCaffrey, C. A. 1975. Major vegetation communities of the Virginia barrier islands: Metomkin through Smith Island inclusive. Technical Report. The Nature Conservancy. Arlington, Va. 197 pp.

McCaffrey, C. A. 1976. The major vegetation communities of the Virginia Coast Reserve:385-437. *In* Dueser, R. D., M.A. Graham, G. J. Hennessey, C. A. McCaffrey, A. W. Niedoroda, T. E. Rice, E. Thomas and B. Williams. Virginia Coast Reserve Study: Ecosystem Description. The Nature Conservancy. Arlington, Va.

McCaffrey, C. A. and R. D. Dueser. 1990. Preliminary vascular flora for the Virginia barrier islands. Va. J. Sci. 41(4A):259-281

O'Neal, W. S. 1969. Virginia Division of Forestry cultural report, Accomac County. Unpublished report, Virginia Division of Forestry Office, Accomac, Va.

Tyndall, R. W. and G. F. Levy. 1978. Plant distribution and succession within interdunal depressions on a Virginia barrier dune system. J. Elisha Mitchell Sci. Soc. 94: 1-15.

APPENDIX 1: Relative abundances of plant species recorded in each of the 26 mapping units described in the text. Abundance classes are D - dominant (most abundant or characteristic species found in unit), A - abundant (occurs in quantity throughout unit), F - frequent (scattered plants occurring regularly throughout unit), and O - occasional (infrequent individuals or groups). Prefix "1" indicates local abundance in a particular portion of a mapping unit. For complex mapping unit, abundance in first unit is indicated above the "/" and abundance in the second is below the "/." Absence in a unit is denoted by "-."

Plant Species	Xeric-Mesic Herbaceous[1]								Woody[2]							Hydric-Halophytic[3]						Other[4]				
	A	g	Ag	At	B	G	AG	dr	T	AT	t	J	P	H	PH	m	Mm	M	s	F	w	dr	uw	Peat	wf	mf
Achillea millefolium L.	.	.	.	.	.	O	.	.	.	F/lF	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ammophila breviligulata Fernald	D	D	D/A	D/-	A	F	D/-	.	.	D/-	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.
Andropogon scoparius Michx.	.	.	.	.	.	.	F/-	.	.	A/-	.	.	F	lF	lO	.	.	.	.	.	.	.	.	.	.	.
Andropogon virginicus L.	.	.	.	.	.	F	F/F	.	O	A/A	F	lF	F	lF	lF	.	.	.	.	.	.	.	.	.	.	.
Andropogon virginicus var. *abbreviatus* (L.) Fern. & Grisc.	.	.	.	.	.	F	-/F	.	.	O/A	F	lF	O	lF	.	.	.	.	.	.	.	.	.	.	.	.
Apocynum cannabinum L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	.	.	.	.	.	.
Aristida tuberculosa Nuttall	.	.	.	A-	.	.	.	.	O/-	.	.	F	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Atriplex arenaria Nuttall	.	O	F/-	.	O	.	.	.	.	.	.	.	.	.	.	.	O	.	O	.	.	O	.	.	.	F	O
Atriplex patula L.	.	.	.	.	.	.	.	F	.	.	.	.	.	.	.	.	O	.	.	.	.	O	.	.	.	.	.
Baccharis halimifolia L.	lO	.	.	.	.	F	F/F	F	A	-/A	A	A	.	lA	lA	.	.	lA	.	lD	.	A	.	.	.	.	.
Bassia hirsuta (L.) Ascherson	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	O	.	.	.	.	.	.	O	.
Berchemia scandens (Hill) Koch.	.	.	.	.	.	.	.	.	.	.	.	.	.	lF	lA	.	.	.	.	.	.	.	.	.	.	.	.
Boehemeria cylindrica (L.) Swartz	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.
Borrichia frutescens (L.) DC.	.	.	.	.	.	.	.	A	.	.	A	.	.	.	.	.	A	lA	O	.	.	A	.	.	.	O	A
Cakile edentula (Bigel.) Hooker	F	D	A/-	.	D	.	.	F	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	O	O
Calystegia sepium (L.) R.Br.	F	F	-/F	.	.	F	.	A	F	.	F	.	.	.	.	.	.	.	.	.	.	O	.	.	.	.	.
Campsis radicans (L.) Seemann	.	.	.	.	.	.	.	.	A	.	.	.	.	F	F	.	.	.	.	.	.	.	.	.	.	.	.
Carduus spinosissimus Walter	F	.	.	.	.	F	F/-	.	F	A/A	O	.	O	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex festucacea Schkuhr	lO	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	.	.	.	.	.	.

	A	g	Ag	At	B	G	AG	dr	T	AT	t	J	P	H	PH	m	Mm	M	s	F	w	dr	b	uw	Peat	wf	mf
Cenchrus tribuloides L.	F	.	.	A/-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cerastium glomeratum Thuillier	.	.	.	.	.	.	.	.	.	-/IF	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodium ambrosiodes L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	.	.	.	.
Distichlis spicata (L.) Greene	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	.	A	D	F	.	D	A	.	.	.	O	.
Eleocharis acicularis (L.) R.&S.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	F	.	.	.	.	.	.	.
Eleocharis palustris (L.) R.& S.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.
Erigeron canadensis var. *canadensis* (L.) Britton	O	.	-/A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eupatorium capillifolium var. *capillifolium* (Lam.) Small	.	.	.	O/-	.	O	.	.	.	.	.	.	F	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eupatorium hyssopifolium L.	.	.	.	.	.	O	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eupatorium rotundifolium L.	.	.	.	.	.	O	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia polygonifolia L.	O	O	O/-	O/-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca rubra L.	F	.	.	.	.	A	-/F	.	F	F/F	O	F	.	IAA	.		.	IA	.	.	.	.	.	.	.	.	.
Festuca sciurea Nuttal	.	.	.	.	.	.	.	.	.	O/-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fimbristylis spadicea (L.) Vahl	IF	.	.	.	.	F	-/F	A	O	-/A	O	.	.	.	.	.	O	.	.	.	.	A	.	.	.	O	.
Geranium carolinianum L.	.	.	.	.	.	.	.	.	.	-/IF	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gnaphalium obtusifolium L.	F	.	.	.	.	O	.	.	.	O/-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gnaphalium purpureum var. *purpureum* L.	O	.	.	.	.	O	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus moscheutos ssp. *moscheutos* L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	F	.	O	O	.	.	.	.	.	.
Hydrocotyle verticillata Thunberg	.	.	.	.	.	.	.	.	.	-/F	.	.	.	.	.	.	.	.	.	F	.	.	.	.	.	.	.
Ilex opaca (L.) Aiton	.	.	.	-/O	.	.	.	.	O	.	.	.	F	O	F	.	.	.	.	.	.	.	.	.	.	.	.
Ilex vomitoria Aiton	.	.	.	.	.	.	.	.	.	.	.	.	.	IA	IA	.	.	.	.	.	.	.	.	.	.	.	.
Iva frutescens L.	.	.	.	.	.	F	F/F	D	A	.	A	A	.	IA	.		A	A	O	IO	.	A	.	.	.	.	A
Juncus bufonius L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.
Juncus dichotomus Ell.	.	.	.	IO	.	O	O/-	.	.	F/F	.	.	.	.	.	.	.	F	.	.	.	.	.	.	.	.	.
Juncus gerardi Loisel.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	F	.	.	.	.	.	.	.	.	.

	A	g	Ag	At	B	G	AG	dr	T	AT	t	J	P	H	PH	m	Mm	M	s	F	w	dr	b	uw	Peat	wf	mf
Juncus roemerianus Scheele	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	F	.	O	.	.	.	.	.	.	.
Juncus scirpoides Lam.	O	.	.	lO	.	O	-/O	.	.	F/-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Juniperus virginiana L.	.	.	.	-/D	.	.	.	.	O	-/O	F	D	F	lD	lD	.	.	.	.	.	.	.	.	.	.	.	.
Kosteletskya virginica (L.) Presl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	F	.	A	O	.	.	.	.	.	.
Lepidium virginicum L.	F	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limonium nashii var. *nashii* Small	.	.	.	.	.	.	.	F	.	.	.	.	.	.	.	.	.	F	.	F	.	F	.	.	.	.	.
Lippia lanceolata Michx.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.
Liquidambar styraciflua L.	.	.	.	.	.	.	.	.	.	.	.	.	lO	lO	lF	.	.	.	.	.	.	.	.	.	.	.	.
Mikania scandens (L.) Willd.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	F	.	F	.	.	.	.	.	.	.
Mitchella repens L.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Monarda punctata L.	.	.	.	.	.	O	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Myrica cerifera L.	.	.	.	-/D	.	F	F/F	.	D	-/D	D	A	D	D	D	.	.	.	.	lF	.	.	.	.	.	.	.
Myrica pensylvanica Loisel.	.	.	.	-/O	.	.	.	.	lA	.	.	lA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oenothera laciniata Hill	.	.	.	.	.	O	F/-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Opuntia compressa (Salisbury) Macbride	.	.	.	.	.	.	.	.	O	.	.	lF	O	.	F	.	.	.	.	.	.	.	.	.	.	.	.
Panicum amarulum Hitchc. & Chase	F	.	.	.	.	.	O	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panicum amarum Ell.	A	O	F/-	.	O	O	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panicum dichotomiflorum Michx.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	lD	.	.	.	.	.	.	.
Panicum virgatum L.	.	.	.	.	.	O	.	.	.	.	.	.	.	O	.	.	.	.	.	.	.	.	.	.	.	.	.
Parthenocissus quinquefolia (L.) Planchon	.	.	.	.	.	.	.	.	D	-/A	F	lA	.	A	lA	.	.	.	.	.	.	.	.	.	.	.	.
Persea palustris (Raf.) Sarg.	.	.	.	-/F	.	.	.	.	.	.	.	lF	D	D	lD	.	.	.	.	.	.	.	.	.	.	.	.
Phragmites communis Trinius	.	.	.	.	.	.	.	.	.	.	O	lF	.	.	.	.	.	F	.	F	.	.	.	.	.	.	.
Pinus taeda L.	.	.	.	-/F	.	.	.	.	O	-/O	.	lO	D	.	D	.	.	.	.	.	.	.	.	.	.	.	.
Pluchea purpurascens (Swartz). DC.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.	A	.	A	A	.	.	.	.	O	.
Poa annua L.	.	.	.	.	.	.	.	.	.	-/lF	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prunus serotina Ehr.	.	.	.	-/O	.	.	.	.	F	-/O	.	.	.	lD	lD	.	.	.	.	.	.	.	.	.	.	.	.
Ptilimnium capillaceum (Michx.) Raf.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	.	.	.	.	.	.

	A	g	Ag	At	B	G	AG	dr	T	AT	t	J	P	H	PH	m	Mm	M	s	F	w	dr	b	uw	Peat	wf	mf
Quercus falcata Michx.	.	.	.	.	.	.	.	.	.	.	.	.	.	lO	lO	.	.	.	.	.	.	.	.	.	.	.	.
Quercus laurifolia Michx.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	lO	.	.	.	.	.	.	.	.	.	.	.	.
Quercus nigra L.	.	.	.	.	.	.	.	.	.	.	.	.	.	lO	lO	.	.	.	.	.	.	.	.	.	.	.	.
Quercus stellata Wang.	.	.	.	.	.	.	.	.	.	.	.	.	.	lO	lO	.	.	.	.	.	.	.	.	.	.	.	.
Rhus radicans L.	.	.	.	.	.	.	.	.	D	-/F	F	lD	.	A	A	.	.	.	.	.	.	.	.	.	.	.	.
Robinia pseudo-acacia L.	.	.	.	.	.	.	.	.	.	.	.	.	.	lD	lA	.	.	.	.	.	.	.	.	.	.	.	.
Rubus argutus Link	.	.	.	.	.	.	.	.	O	-/F	O	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex acetosella L.	.	.	.	.	.	.	.	.	.	-/lF	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ruppia maritima L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.
Salicornia bigelovii Torrey	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	A	.	.	O	.	.	.	O	O
Salicornia europaea L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	F	.	A	.	.	.	.	.	.	F	F
Salicornia virginica L.	.	.	.	.	.	.	.	F	.	.	.	.	.	.	.	lD	D	.	D	.	.	F	.	.	.	F	.
Salix nigra Marshall	.	.	.	.	.	.	.	.	.	-/O	.	.	.	O	.	.	.	.	.	.	.	.	.	.	.	.	.
Salsola kali L.	O	O	O/O	.	F	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	.	.	.	.
Samolus parviflorus Raf.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	F	.	O	O	.	.	.	.	.	.
Sassafras albidum (Nutt.) Nees	.	.	.	.	.	.	.	.	.	.	.	.	F	lF	F	.	.	.	.	.	.	.	.	.	.	.	.
Scirpus americanus Persoon	lF	F	.	.	.	F	-/F	.	.	.	O	.	.	.	.	.	O	F	.	.	F	O	.	.	.	.	.
Scirpus robustus Pursh	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	F	.	.	.	.	.	.	.	.	.
Setaria geniculata (Lam.) Beauvois	lF	.	.	.	.	F	-/F	F	A	-/A	F	lF	.	.	.	.	.	lA	.	.	.	F	.	.	.	.	.
Smilax bona-nox L.	.	.	.	.	.	.	.	.	A	.	.	lF	F	D	F	.	.	.	.	.	.	.	.	.	.	.	.
Smilax glauca Walter	.	.	.	.	.	.	.	.	.	.	.	.	.	lF	lF	.	.	.	.	.	.	.	.	.	.	.	.
Smilax rotundifolia L.	.	.	.	.	.	.	.	.	.	.	.	.	.	F	A	.	.	.	.	.	.	.	.	.	.	.	.
Solanum carolinense L.	.	.	.	.	.	.	.	.	.	O/-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solidago microcephala (Greene) Bush	.	.	.	.	.	.	.	.	.	O/-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solidago sempervirens L.	F	D	A/A	.	F	F/-	F	A	.	.	O	.	.	.	.	.	O	.	O	.	.	A	.	.	.	.	.
Spartina alterniflora Loisel.	.	.	.	.	.	.	.	F	.	.	.	.	.	.	.	.D	D	.	F	.	.	F	.	.	.	lD	D
Spartina patens (Ait.) Muhl.	A	D	F/D	F/-	F	D/D	D	D	D	A/A	A	A	A	lA	lA	.	.	D	O	D	D	A	.	.	.	O	A
Spergularia marina (L.) Grisebach	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	F	.	.	.	.	.	.	O	.
Strophostyles helvola (L.) Ell.	A	A	-/F	.	O	.	F/-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

	A	g	Ag	At	B	G	AG	dr	T	AT	t	J	P	H	PH	m	Mm	M	s	F	w	dr	b	uw	Peat	wf	mf
Suaeda linearis (Ell.) Moq.	.	.	.	.	.	.	.	F	.	.	.	.	.	.	.	.	O	.	O	.	.	F	.	.	.	F	.
Teucrium canadense L.	.	.	.	.	.	F	.	F	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	.	.	.	.
Typha angustifolia L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	lA	.	lD	.	.	.	.	.	.	.
Typha latifolia L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	lO	.	.	.	.	.	.	.
Uniola laxa (L.) BSP.	.	.	.	.	.	.	.	.	.	.	.	.	A	lF	A	.	.	.	.	.	.	.	.	.	.	.	.
Vitis aestivalis Michx.	.	.	.	.	.	.	.	.	F	-/F	.	.	A	lF	A	.	.	.	.	.	.	.	.	.	.	.	.
Vitis rotundifolia Michx.	.	.	.	.	.	.	.	.	.	.	.	.	.	lF	lA	.	.	.	.	.	.	.	.	.	.	.	.
Xanthium strumarium L.	.	O	-/F	.	O	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	.	.	.	.
Zanthoxylum clava-hercules L.	.	.	.	-/F	.	.	.	.	.	O/-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Zostera marina L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	lF	.	.	.

[1]Xeric-mesic herbaceous mapping units: A = foredune grassland; g = sparse grassland; Ag = beachgrass dunes-sparse grass- land complex; At = open dunes-thicket complex; B = beach; G = dense grassland; AG = open dunes-dense grassland complex; dr = bayshore drift material deposited on dense grassland.

[2]Woody mapping units: T = tall thicket; AT = open dunes-tall thicket complex; t = low thicket; J = juniper thicket; P = pine forest; H = hardwood forest; PH = pine-hardwood forest.

[3]Hydric-halophytic mapping units: m = low salt marsh; Mm = upper low salt marsh; M = brackish marsh; s = salt flat; F = fresh marsh; w = open water.

[4]Other mapping units: dr = drift material deposited on unvegetated surface; b = submerged sand; uw = underwater; peat = peat outcrop; wf = wash flat; mf = mud flat.