ISSN-0095-0157

FLORIDA MARINE RESEARCH PUBLICATIONS

A Survey of Selected Coastal Vegetation Communities of Florida

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Florida Department of Natural Resources
Marine Research Laboratory
Number 30 **December 1977**

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ABSTRACT

Carlton, J. M. 1977. A Survey of Coastal Vegetation Communities of Florida. Fla. Mar. Res. Publ. No. 30. 40 pp. A survey of coastal vegetation around Florida was conducted during 1973 and 1974. Seventeen sites were selected and sampled using the transect method to determine species occurrence, relative densities, and habitat development and structure. Sites were sampled quarterly except where high tides prevented data gathering. Species occurrence was compared within and between sites using Sørensen's Index of Similarity (IS_s) as a basis for determining similarity of species inhabiting selected sites. Indices ranged from 4 to 61%, the former representing only one plant common to two sites. Results show environmental factors acting upon species alter species composition in seemingly similar habitats. Instead of the term "community", the term "association" is used to better reflect the concept of a taxonomically unrelated group of plants occupying a particular habitat.

Contribution No. 297, Florida Department of Natural Resources Marine Research Laboratory

This public document was promulgated at an annual cost of $1542 or $.77 to provide the scientific data necessary to preserve, manage and protect Florida's marine resources and increase public awareness of the detailed information needed to wisely govern our marine environment.

INTRODUCTION

Florida's coastline of more than 12,000 kilometers encompasses a variety of climatic and temperature regimes, soil types, tidal amplitudes, wave energy levels, and other environmental factors. Consequently, it is vegetated by several diverse plant communities. Mangrove, salt marsh, and sand dune communities dominate these saline habitats. Florida's temperate to tropical climate supports growing seasons ranging from eleven months per year in the south to eight or more months in most northerly counties. Tidal heights vary considerably statewide, ranging from less than 0.3 m in the Keys to nearly 2.1 m at the Florida-Georgia border. The state's coastline consists of several substrate types, primarily: quartz sand; coquina and other shell fragments; calcium carbonate in the form of marl or coral reefs; and various combinations of silt, sand, and clay deposited where wave action is insufficient to sort the various particles (Martens, 1931; Tanner, 1960). Wave energy levels around the state vary greatly (Figure 1) and are an important factor in determining eventual success of coastal vegetation communities. Salt spray is another factor limiting plant growth and development in dunes (Oosting, 1945, 1954) and marshes (Adams, 1963).

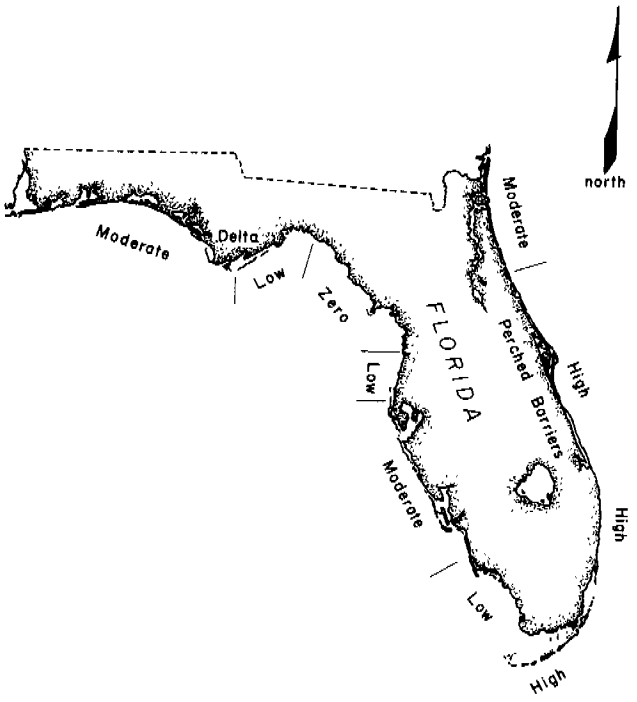

Figure 1. Wave energy levels around Florida, categories separated at 10 and 50 cm average breaker heights (Redrawn from Tanner, 1960).

A survey of representative mangrove, salt marsh, and sand dune communities was undertaken during 1973 and early 1974 to describe plant composition and habitat development around the Florida coast. Sampling sites are listed in Table 1. Figure 2 provides an outline map of Florida indicating vegetation inventory study sites. An alphabetical checklist, including common and scientific names of species encountered in this survey, is presented in Appendix I. Representative sites were located primarily in federal, state, or other governmental areas to insure the relatively undisturbed nature and continued establishment of each site.

HISTORICAL RESUME

MANGROVE SWAMPS

Lower and middle Florida coastlines are fringed by one or more species of woody plants known as mangroves. The three plants most often referred to as mangroves in Florida are *Rhizophora mangle* L. (red mangrove), *Avicennia germinans* (L.) L. (black mangrove), and *Laguncularia racemosa* Gaertn. f. (white mangrove). *Conocarpus erectus* L., (buttonwood or button mangrove), is often found in association with these three species and may also be found in areas away from salt water.

Mangroves extend from the Cedar Keys region (Levy County) along the Gulf Coast, and from just north of St. Augustine (St. Johns County) on the Atlantic Coast, southward into the Keys. Their distribution seems to be limited by periodic freezes in northern Florida (Davis, 1940; Chapman, 1944; Moldenke, 1960; Graham, 1964). The best developed mangrove stands are in the Ten Thousand Islands area of the southwest coast of Florida, where individual trees of *Rhizophora mangle* to 19 m and *Avicennia germinans* up to 24 m tall are common. McNulty, et al. (1972) recently inventoried estuarine and coastal areas of Florida's Gulf coast, reporting that 13.1% or 159,112 hectares are covered by mangroves.

MANGROVE TAXONOMY

The unique ability of mangroves to exist in salt water and their unique root systems, composed of prop roots and pneumatophores, brought them early attention. Naturalists, writers, and travelers first noted these plants during the time of Alexander the Great (Bowman, 1917; Davis, 1940; Gill, 1969). Subsequent descriptive accounts have

TABLE 1. LIST OF COASTAL VEGETATION INVENTORY SAMPLING SITES, NEAREST GEOGRAPHIC AREA, AND SAMPLING DATES.

Site		Association	Dates 1973			1974
A	Fort Clinch State Park	Dune	1/30	5/9	8/27	1/7
	Fernandina Beach	Salt marsh	1/30	5/9	8/27	1/7
B	Fort Matanzas National Mont.	Dune	1/31	5/10	8/28	1/8
	Crescent Beach-Marineland	Mangrove-marsh	1/31	5/10	8/28	1/8
C	Apollo State Park (Canaveral	Dune	2/2	5/11	8/31	1/8
	National Seashore)	Mangrove-marsh	2/2	5/11	8/31*	1/9
	New Smyrna Beach					
D	Sebastian Inlet State Park	Strand	2/3	5/12	9/2	1/9
	Sebastian Inlet	Mangrove	2/4	5/13	9/2	1/9
E	St. Lucie Inlet State Park	Strand	2/6	5/13	9/4	1/10
	Hobe Sound					
F	Elliott Key (Biscayne National	Strand	2/12	5/15	9/5	1/11
	Monument)					
	Homestead					
G	Bahia Honda State Park	Strand	2/11	5/17	9/7	1/15
	Bahia Honda Key					
H	Flamingo (Everglades	Strand	2/13	5/18	9/20	1/15
	National Park)					
I	Wiggins Pass State Park	Strand	2/15	5/25	9/21	1/16
	Naples					
J	Manasota Key State Park	Strand	2/15	5/25	9/21	1/16
	Englewood Beach					
K	Beacon Key (Cockroach Bay)	Strand	1/2	5/22	9/12	3/6
	Ruskin					
L	Hammock Key	Mangrove-marsh	1/4	4/18	9/1*	3/11
	Aripeka					
M	Atsena Otie Key	Mangrove-marsh	1/3	4/19	9/13	3/7
	Cedar Key					
N	Rocky Creek	Salt marsh	1/24	5/24	10/5	12/7
	Steinhatchee					
O	St. George Island	Dune	1/22	5/2	10/4	12/6
	Apalachicola-East Point					
P	W. T. Stone State Park-Cape	Dune	1/21	5/1	10/3	12/5
	San Blas	Salt marsh	1/22	5/2	10/3	12/5*
	Port St. Joe					
Q	Fort Pickens-Gulf Islands	Dune	1/20	5/1	10/3	12/5
	National Seashore					
	Pensacola Beach					

*Station not sampled due to high tides covering marsh; year average based only on three quarterly samples.

been thoroughly reviewed by Bowman (1917), Davis (1940), Macnae (1968), Gill (1970), Savage (1972a), and Walsh (1974).

Few major botanical works on Florida plant communities existed prior to 1900. Since then, mangroves have been studied because of their contribution to shoreline stabilization (Savage, 1972b; Carlton, 1974), and to nursery areas and food webs for Florida's rich finfish and shellfish populations (Heald, 1970, 1971; Robas, 1970), and their overall contribution to the state's coastal ecosystems.

Chapman (1883) was one of the first to include descriptions of mangrove and shore plant species in Florida. John K. Small's books (1913a, b, c), and manual (1933), and numerous reports and articles in *Journal of the New York Botanical Garden* (Craighead, 1971), have made him one of Florida's outstanding botanists. Since Small's contributions, several floristic and taxonomic treatments of mangroves have been produced, the most recent by Long and Lakela (1971) and Humm (1973).

Reviews and monographs of mangrove families and genera have been provided by Hou (1960), Graham (1964), and Breteler (1969). However, taxonomic uncertainties have persisted in the Avicenniaceae. This family has been considered a member of the Lamiaceae (Britton and Millspaugh, 1920; Wilcox, et al., 1971) or Verbenaceae (Sargent, 1933; West and Arnold, 1946; Lawrence, 1951; Little, 1953; Compere, 1963). Moldenke's monograph (1960) placed *Avicennia* in its own family. Most recent authors follow this taxonomic treatment (Long and Lakela, 1971; Adams, 1972; Correll and Correll, 1972; Savage, 1972a; Carlton, 1975). Problems with family taxonomy have been compounded by

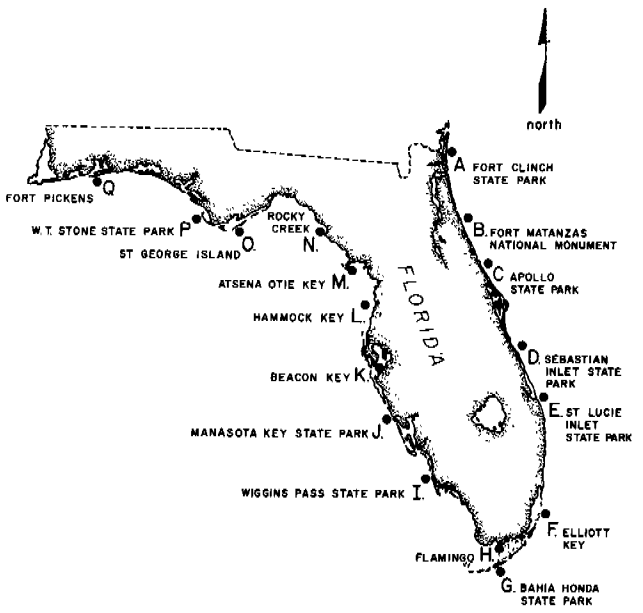

Figure 2. Vegetation inventory study sites.

synonymy at the specific level. For example, Moldenke (1960) referenced Stearn (1958) on West Indian mangroves, using the epithet *Avicennia germinans* (L.) Stearn. However, the most frequently used synonym has been *A. nitida* Jacq. Recent nomenclatural studies by Stearn (personal communication, 1973) indicate that *A. germinans* (L.) L. has priority. Therefore, it will be used in this text.

The Combretaceae (=Terminaliaceae), the white mangrove family, includes *Laguncularia racemosa* and *Conocarpus erectus*. Sargent (1903) was one of the first to discuss Combretaceae species in Florida. His work was updated by Small (1913a, b, c; 1933). Recent reviews of this family are given in Lawrence (1951), Graham (1964), and Long and Lakela (1971). Stearn (1958) and Graham (1964) postulated that the silver form of *Conocarpus erectus* L. var. *sericea* Forst. ex DC., did not deserve varietal status but was only a form. Semple (1970) agreed with this conclusion based on studies of leaf characteristics and pubescence.

MANGROVE PHYTOGEOGRAPHY

Reports on various south Florida plant communities have included some discussion of mangroves if coastal plants were described. Shore plants of the Sand Keys, an island chain west of Key West, were described by Millspaugh (1907) and Davis (1942), while the Dry Tortugas flora were covered by Bowman (1918). Plants of the Florida Keys were listed by Small (1913c); number of species on Big Pine Key were expanded by Dickinson, et al. (1953).

Harshberger (1914) limited his studies to Everglades and shore plants south of 27°30′N, exclusive of the Keys, while Small (1913a) gave a taxonomic account of plants in the Miami area. Additional descriptions of south Florida's resources are found in Harper's (1927) paper on natural vegetation, and in those by Davis (1940) and Fuller (1941) on mangrove distribution and ecology. Egler (1952) and Loveless (1959) reported on community structure, taxonomy, natural history and ecology of plants found in saline marshes and everglades of south Florida. Penfound (1952) included mangroves and associated species in his work describing southern swamp and marsh plant ecology.

Plants of shorelines and islands on Florida's Gulf coast have been described by Thorne (1954), Cooley (1955), Laessle and Wharton (1959), Lakela and Long (1970), Fowler (1974), and Hilsenbeck and Hilsenbeck (1974).

SALT MARSHES

Salt marshes extend unbroken along Florida's east coast from the Florida-Georgia border to near Daytona Beach, and then continue farther south as scattered clumps. Northwest Florida marshes occur infrequently and are scattered due to large volumes of freshwater discharge into bays and estuaries and to the more steeply sloping shorelines. From St. Joseph Bay, Port St. Joe, and the Apalachicola River south to Tampa Bay, there are extensive salt marshes, often facing directly into open Gulf waters. Due to a broad and gently sloping shelf along that coast and consequent reduction in wave energy, broad marshes have developed. South of Tampa Bay, competition with mangroves for suitable substrate occurs similar to the competition on the east coast, thus limiting marsh development. McNulty, et al. (1972), in their inventory of Florida's Gulf coast marshes, determined that 17.6%, or 213,892 hectares were covered by salt marshes. Provost (1973) presented evidence that changing sea levels along Florida's coast have a decisive effect on coastal vegetation and that a high water line might be drawn using marsh vegetation which has adapted to these conditions as a biological indicator of the environment.

SALT MARSH TAXONOMY

Identification manuals by Chapman (1883), Small (1933), Long and Lakela (1971), Radford, et al. (1968), Correll and Correll (1972), and Duncan

(1974) deal with salt marsh species in Florida and the southeast. Identification guides to important marsh species include those by Hotchkiss (1970), Ursine (1972), and Carlton (1975).

SALT MARSH PHYTOGEOGRAPHY

Few papers are available concerning Florida salt marsh communities. Harshberger (1914), Harper (1927), Davis (1943), and Thorne (1954) described salt marshes and salt flats along the Gulf coast and noted species composition and community structure in a variety of marsh sites. Jackson (1952) discussed factors affecting plant zonation in Florida salt marshes, particularly chlorinity and soil characteristics. The most thorough study of salt marsh communities in Florida is by Kurz and Wagner (1957). This paper describes ecology, soil relationships, elevations and other factors leading to vegetation establishment and development of marshes in Florida's panhandle. Kurz and Wagner were among the first to correlate zonation of *Spartina alterniflora* Loisel. (smooth cordgrass) to high tide levels, showing that plants grow from mean sea level to the level of highest tides. Coultas' (1969, 1970) analyses of marsh soils in the Florida panhandle included particle size distribution, pH, organic carbon, total nitrogen, salinity, bulk density, and exchangeable cations at all substrate horizons.

SAND DUNES

Along the east coast, sand dunes extend from the Florida-Georgia border southward into Broward County and scattered dune-strand systems extend into the Florida Keys. The Gulf coast has well-developed dunes west of St. George Island to Alabama, with dune-strand areas located on several of the offshore islands extending south to Cape Romano. Some of the tallest dunes in the state are on Cape San Blas, which separates St. Joseph Bay from the Gulf, and also between Destin and Ft. Walton Beach.

SAND DUNE TAXONOMY

Dune plants of Florida and the southeast have been described in the manuals of Chapman (1883), Small (1913c, 1933), Long and Lakela (1971), Correll and Correll (1972), and Radford, et al. (1972). Graetz (1973) and Stalter (1974) reported on dune plants of the Carolinas, while Craig (1974) listed plants of Florida's dune communities. Specific genera and families have been more thoroughly studied [e.g., the works of de Lisle (1963) on *Cenchrus*, Parks (1973) on *Melanthera*, and Rodman (1974) on *Cakile*].

SAND DUNE PHYTOGEOGRAPHY

Early papers on Florida dune and strand communities include works on strand plants of the Sand Keys by Millspaugh (1907), Davis (1942), and most recently, Teas and Schroeder (1971). Harper discussed dune species and dune formation in north (1914), central (1921), and south Florida (1927).

Perhaps the most extensive dune studies in Florida were by Kurz (1940, 1942). His early paper dealt with dune plants of northwestern Florida and their reaction to shifting sand and other environmental factors. Kurz later noted ecological parameters, species, and habitats at nine sites around Florida, comparing species and floristic composition with inland sand-scrub communities. Dune-strand species along the Gulf coast were listed by Thorne (1954); those on offshore islands also received attention [e.g. Sanibel (Cooley, 1955); Caladesi (Fowler, 1974); Mullet Key (Hilsenbeck and Hilsenbeck, 1974)].

METHODS

Seventeen sites selected as typical of distinct Florida coastal regions were investigated for floristic composition and community structure. The "line intercept method", or transect, (Canfield, 1941; Bauer, 1943) was used. Transects extended landward from the lowest reaches of shoreline vegetation to areas of non-shoreline plants or to where no appreciable change in community structure could be detected. Transects, stretched above the surface of the herb-shrub layer in each community, were divided into 19 m segments for ease of reference and field handling. Branches or limbs of arborescent species perpendicular to the plane of the transect were included if they crossed the transect. Grasses, vines or other trailing herbs were included as often as their parts crossed the line.

Sampling dates are indicated in Table 1 and at the top of each column in Tables 2-23. Each station was sampled quarterly. Exact times of visitation vary due to weather, tides, or other circumstances. Identification of known species was made in the field. Other species were pressed and placed in the laboratory herbarium for later determination. Principal taxonomic references were Small (1933), Long and Lakela (1971), and

Radford, et al. (1968), supplemented with revisions by others where applicable.

Indices of Similarity (IS_s), the presence-community coefficients, were derived using Sørensen's formula, expressed as follows:

$$IS_s = \frac{2c}{A + B} \times 100$$

where c = number of species shared by both sites; A and B = total number of species present at site A and site B, respectively (in Mueller-Dombois and Ellenberg, 1974). Plants listed in the "Results" section may not necessarily be present in Tables 2-23, if they did not occur on the transect. Similarly, plants in the tables may not be listed in the "Results" if they were not observed to dominate the flora.

RESULTS

SITE A

Fort Clinch State Park (Nassau County: 30°42′N, 81°27′W) is located approximately 6.5 km east of downtown Fernandina Beach off Florida Highway A1A. The park occupies a narrow peninsula between the Atlantic Ocean to the east and Egans Creek with its marshes and mud flats bordering the Intracoastal Waterway to the west. The salt marsh study site is located on the northwest side of the bridge over Egans Creek. The dune study site is situated 0.8 km below the St. Mary's River south jetty. Transect length in the salt marsh was 35 m, in the dune, 57 m.

Substrate in the marsh is sand with thick deposits of organic sediments and mud. Dune composition is chiefly quartz sand with minor amounts of shell fragments. Mean range of tides in Amelia River (Fernandina Beach) is 2.0 m (NOAA Chart 841-SC).

SALT MARSH (A1)

Intertidal marshes of Florida's northeast coast (Figure 3) consist of many species found in marshes along the east coast of the United States. Dominant species include *Batis maritima* (saltwort), *Iva frutescens* (marsh elder), *Limonium carolinianum* (sea lavender), *Salicornia virginica* (perennial glasswort), *Spartina alterniflora* (smooth cordgrass), and *Spartina patens* (marsh hay cordgrass). The most conspicuous plant appears to be *Spartina alterniflora*, especially since plants remain green all year. Proceeding from the water toward the uplands, high salt marsh species,

Figure 3. Intertidal marsh study site at Fort Clinch State Park.

including *Aster tenuifolius* (salt marsh aster), *Borrichia frutescens* (sea oxeye daisy), and *Juncus roemerianus* (black needlerush), extend up to and above high tide line. Above the tide line *Sporobolus virginicus* (Virginia dropseed) covers the ground and merges into the *Serenoa-Pinus-Quercus* (palmetto-pine-oak) forest which dominates this section of the Florida coast. Table 2 presents the relative density of salt marsh plants at Ft. Clinch State Park.

DUNE (A2)

Dunes at Fort Clinch, as in most of the study sites, are dominated by *Uniola paniculata* (sea oats) (Figure 4). This hardy perennial grass acts as an efficient sand binder and stabilizer of dunes. However, if *Uniola paniculata* is damaged by storms, disease, insects, or people, erosion of dunes may result. Understory plants at Fort Clinch include *Cenchrus tribuloides* (sandspur), *Cirsium horridulum* (purple thistle), *Heterotheca subaxillaris* (camphor weed), *Hydrocotyle bonariensis* (water pennywort), *Ipomoea stolonifera* (goatsfoot morning glory), *Spartina patens*, and others. Most species exist at, or just above the sand, from dune crest inland, protected by *Uniola paniculata*. Creeping or prostrate plants contribute little to overall dune buildup, but help catch sand drift missed by other dominant species. They also contribute to litter production on dunes,

TABLE 2. RELATIVE DENSITY IN PERCENTAGES OF SALT MARSH PLANTS AT FORT CLINCH STATE PARK, SITE A_1.

Species	Dates 1/30	5/9	8/27	1/7	Yearly Average
Aster tenuifolius var. *aphyllus*	x				.05
Batis maritima	12.1	6.4	7.9	7.4	8.45
Borrichia frutescens	44.2	30.9	56.1	39.5	42.67
Iva frutescens	x	x	x		.30
Juncus roemerianus	8.4	3.9	4.5	3.2	5.00
Physalis viscosa var. *maritima*		x			.15
Polygala grandiflora var. *grandiflora*		x	x		.12
Salicornia virginica	10.8	3.8	2.0	3.0	4.90
Spartina alterniflora	16.5	9.8	20.3	22.2	17.2
Spartina patens	4.1	3.5	3.3	3.7	3.65
Sporobolus virginicus	3.1	39.5	3.5	20.6	16.67
Suaeda maritima			1.6		.40

x = species present, constituting less than 1% relative density.

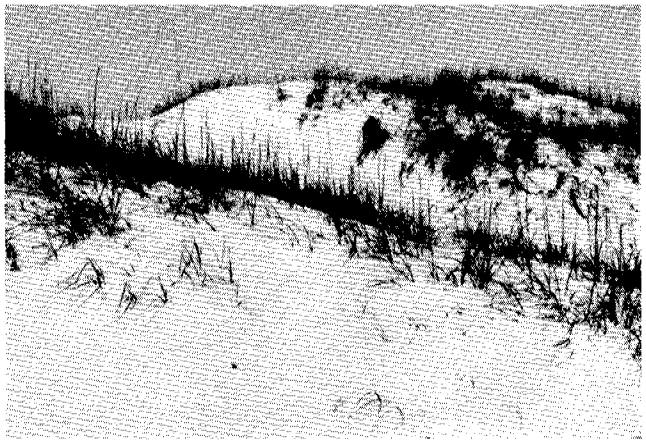

Figure 4. *Uniola paniculata* dominates dunes at Fort Clinch State Park.

gradually changing composition of dunes for future plant communities. Behind the fore dunes, herbs such as *Hydrocotyle bonariensis*, *Oenothera humifusa* (seaside evening primrose), and *Lippia nodiflora* (capeweed), carpet the surface, especially in swales where moisture persists. Table 3 presents the relative density of dune species at Site A.

SITE B

Fort Matanzas National Monument (St. Johns County: 29°43′N, 81°14′W) lies 22.5 km south of St. Augustine off Florida Highway A1A. The mangrove-marsh study site, northwest of the visitors center, is on a small peninsula separating Matanzas River and a small, man-made canal leading to a former pompano culture farm. The dune site is east of Highway A1A, 0.8 km south of the beach access road opposite the park's main entrance. Transect length in the dune was 38 m, and in the mangrove-marsh, 29 m.

Substrate in Fort Matanzas is chiefly quartz sand overlying coquina with oyster shells and mud in the intertidal zone along Matanzas River. Beach sand is predominantly coquina-sand mixture. Dunes are almost pure quartz sand with little shell material. Tidal amplitude at Matanzas River (St. Augustine Inlet) is 1.3 m (NOAA 843-SC).

MANGROVE-MARSH (B1)

Avicennia germinans (Figure 5) is the only mangrove existing this far north due to periodic freezes which kill other species. Salt marsh vegetation is predominant, with *Batis maritima*, *Borrichia frutescens*, *Juncus roemerianus*, *Salicornia virginica*, *Spartina alterniflora*, and *Sporobolus virginicus* dominating tide-influenced areas of the shore. *Iva frutescens* (marsh elder), *Lycium carolinianum* (Christmas berry), *Serenoa repens* (saw palmetto), *Solidago sempervirens* var. *mexicana* (seaside goldenrod), plus numerous herbs and grasses occupy elevated areas of the marsh.

Spartina alterniflora occupies the shoreline from mean sea level to the zone of highest predicted tides. *Avicennia germinans* grows as scattered clumps or individuals frequently surrounded by, or existing on, crests of oyster bars prevalent in the area. Mangroves are found on the shores of the man-made canal and also along the Matanzas River, sheltered by a submerged bar visible during spring low tide. Between these two bodies of water is a succession of vegetation, with the crest of the peninsula dominated by plants flooded only during extreme storm tides. Relative

TABLE 3. RELATIVE DENSITY IN PERCENTAGES OF DUNE PLANTS AT FORT CLINCH STATE PARK, SITE A_2.

Species	Dates 1/30	5/9	8/27	1/7	Yearly Average
Cakile edentula ssp. *Harperi*		x			.07
Cenchrus tribuloides		2.49	x	1.06	1.05
Chamaesyce blodgetii		6.23	1.81		2.01
Chloris petraea		4.36			1.09
Cirsium horridulum	6.84	1.86	6.57	14.43	7.43
Conyza ramosissima			13.15		3.28
Croton punctatus		x	x		.21
Distichlis spicata	x		13.15		3.35
Heterotheca subaxillaris	8.68	4.98	6.34	7.48	6.87
Hydrocotyle bonariensis	6.05		2.26	6.41	3.68
Ipomoea stolonifera	8.94	9.96	17.46	5.88	10.56
Oenothera humifusa	11.31	15.57	6.80	13.36	11.76
Opuntia stricta			2.49	1.60	1.02
Panicum amarulum	x	x			.20
Physalis viscosa var. *maritima*		4.36			1.09
Schizachyrium maritimum		4.04	x		1.12
Spartina patens		13.39			3.34
Uniola paniculata	57.36	31.46	28.57	49.73	41.78

x = species present, constituting less than 1% relative density.

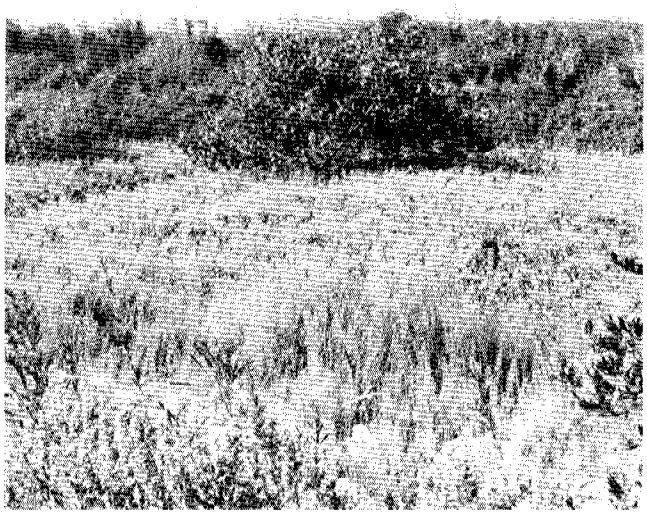

Figure 5. *Avicennia germinans* among salt marsh plants, Fort Matanzas National Monument.

density of mangrove-marsh plants at Site B is presented in Table 4.

DUNE (B2)

Dunes at Fort Matanzas typically form series like those found elsewhere in the state, second and third rows being tallest. Fore dunes and newly accreting areas are covered by such plants as *Cakile edentula* ssp. *Harperi* (sea rocket), *Ipomoea pes-caprae* (railroad vine), *I. stolonifera*, and *Iva imbricata*, which combine to temporarily stabilize the sand-shell substrate. On mature dunes, *Panicum amarulum* (dune panic grass) and *Uniola paniculata* together stabilize these structures. The oldest dunes are covered by *Serenoa repens* succeeding into a *Juniperus-Persea-Quercus* (cedar-bay-oak) coastal forest. Common understory plants include *Cnidoscolus stimulosus* (tread softly), and *Hydrocotyle bonariensis*, along with *Helianthus debilis* (dune sunflower), *Heterotheca subaxillaris*, and *Oenothera humifusa*. *Cassia fasciculata* (partridge pea) is prevalent between dunes, especially in swales where *Opuntia stricta* (prickly pear cactus), *Spartina patens*, and other grasses and herbs also occur. Table 5 shows the relative density of dune plants at Site B.

SITE C

Apollo Beach State Recreation Area (Volusia County: 28°53′N, 80°48′W) is approximately 19 km south of New Smyrna Beach on a barrier island separating the Atlantic Ocean and Indian River. The southern terminus of Apollo Park abutts the northern limit of Merritt Island National Wildlife Refuge. These two public areas, the former Apollo Park now combined into the Canaveral National Seashore by the U. S. Department of the Interior, preserve and protect the longest stretch of remaining natural beachfront on Florida's east coast. The two study areas in Apollo Park are both located near the southern boundary, adjacent to the graded road. Transect length in the dune was 48 m, in the mangrove-marsh, 33 m.

TABLE 4. RELATIVE DENSITY IN PERCENTAGES OF MANGROVE-MARSH PLANTS AT FORT MATANZAS NATIONAL MONUMENT, SITE B_1.

Species	Dates 1/30	5/10	8/28	1/8	Yearly Average
Avicennia germinans	5.13	2.94	1.78	3.29	3.28
Batis maritima	15.75	15.47	12.79	13.47	14.37
Borrichia frutescens	5.13	1.96	1.48	4.49	3.26
Iva frutescens	x	x	3.27	1.19	1.38
Portulaca pilosa	1.54	x	1.48	2.09	1.33
Salicornia virginica	3.08	x	4.16	1.19	2.29
Sesuvium portulacastrum	25.51	34.15	25.59	23.35	27.15
Solidago sempervirens var. *mexicana*	5.82	2.45	8.03	2.69	4.74
Spartina alterniflora	20.89	14.00	16.96	15.56	16.85
Sporobolus virginicus	16.78	27.27	24.40	32.63	25.27

x = species present, constituting less than 1% relative density.

TABLE 5. RELATIVE DENSITY IN PERCENTAGES OF DUNE PLANTS AT FORT MATANZAS NATIONAL MONUMENT, SITE B_2.

Species	Dates 1/31	5/10	8/28	1/8	Yearly Average
Atriplex arenaria			x		.12
Cakile edentula ssp. *Harperi*	1.39	2.22		2.54	1.53
Cassia fasciculata		5.18	5.91		2.55
Cenchrus tribuloides		2.96	x	2.54	1.49
Chloris petraea		2.22	3.44	1.69	1.83
Galactia sp.			17.73		4.43
Helianthus debilis	4.89	2.22			1.77
Heterotheca subaxillaris		1.48		x	.58
Hydrocotyle bonariensis	2.79	9.62	4.43	16.10	8.23
Ipomoea pes-caprae var. *emarginata*	2.09	1.48	7.38		2.73
Ipomoea stolonifera		3.70	13.79	3.38	5.21
Oenothera humifusa	1.39	2.22	3.94	x	2.09
Opuntia stricta		x	x		.30
Panicum amarulum	13.28	7.40	2.95	10.16	8.44
Rumex hastatulus		2.96		14.40	4.34
Salsola kali			x		.24
Sesuvium portulacastrum		2.96	x	x	1.19
Smilax auriculata	11.88	8.88	x	x	5.49
Solidago sp.			1.97		.49
Spartina patens	2.09	x	x		.95
Uniola paniculata	60.13	42.96	33.49	45.76	45.58

x = species present, constituting less than 1% relative density.

Substrate consists of sand and fine coquina fragments along the beach, with thick layers of fine mud and organic debris along Indian River shores. Tidal range in the Indian River is approximately 0.3 m. However, along the beach and at Ponce de Leon Inlet (Daytona Beach) mean range is 0.7 m (NOAA 843-SC).

MANGROVE-MARSH (C1)

All three Florida mangroves—*Avicennia germinans*, *Laguncularia racemosa*, and *Rhizophora mangle*—are present, intermixed with more northerly salt marsh species. Overall, this site is similar to that at Fort Matanzas, except for additional mangrove species.

Dense beds of *Batis maritima* and *Salicornia virginica* and extensive stands of *Juncus roemerianus* dominate the understory (Figure 6). The presence of another more tropical species, *Acrostichum aureum* (mangrove fern), indicates higher average annual temperatures than those occurring at Sites A and B. *Borrichia frutescens* appears among the *Juncus*, adjacent to an upland vegetation zone marked by extensive populations of *Serenoa repens* and species of oak. *Amyris elemifera* (torchwood), *Chiococca alba* (snowberry), *Myrcianthes fragrans* (nakedwood), and *Zamia pumila* (coontie) occur in adjacent ham-

Figure 6. *Batis maritima*, *Juncus roemerianus*, and *Salicornia virginica* dominate the mangrove-marsh site at Apollo State Park.

mocks and also indicate increased temperature regimes. The relative density of mangrove-marsh plants is presented in Table 6.

DUNE (C2)

Extensive erosion in Apollo Park has caused reduction of beachfront, including loss of all fore dunes. A steep scarp currently present along the shore averages 1.2-1.8 m high and effectively limits seaward extension of most dune species. *Uniola paniculata* along the scarp continues shoreward for a short distance. *Coccoloba uvifera* (sea grape), to 0.6 m tall and *Serenoa repens*, with twisted trunks and spiny fronds, become evident landward. Infrequent winter freezes effectively limit growth and natural range extension of *Coccoloba uvifera* to beaches of New Smyrna. Numerous woody shrubs occur on the dunes, including *Erythrina herbacea* (coral bean), *Lantana camara* (shrub verbena), *Myrica cerifera* (wax myrtle), and *Myrsine guianensis* (myrsine). Herbaceous plants, some also found on deep sands of inland Florida, include *Bidens pilosa* (beggar tick), *Cnidoscolus stimulosus*, *Gilia rubra* (standing cypress), *Licania michauxii* (gopher apple), *Physalis viscosa* (ground cherry), *Verbena maritima* (seaside verbena) and others. Vines, such as *Canavalia maritima* (beach bean) and *Chiococca alba*, are common. Relative density of dune plants at Apollo State Park is presented in Table 7.

SITE D

Sebastian Inlet State Park (Brevard-Indian River Counties: 27°51′N, 80°27′W) covers 260 hectares at Sebastian Inlet midway between Melbourne and Vero Beach on Florida Highway A1A. Extending north and south of the inlet the park fronts the Atlantic to the east and Indian River to the west. Two sites were selected for study in the park: a mangrove site northwest of the highway A1A bridge over the inlet, off an unused shell road leading to Indian River; and a strand site approximately 1.3 km north of McClarity Museum, a historical museum adjacent to the park's southern boundary. Transect length in the mangrove site was 38 m, in the strand site, 57 m.

Substrate around Sebastian Inlet, created by dredging through the sandy barrier island, is chiefly quartz sand and broken shell fragments. Below the mangroves, thick mud and organic debris predominate upper layers of sediment. Along the seaward edge of the beach are coquina-like outcrops extending below low tide line. Mean range of tide at Sebastian Inlet is approximately 0.7 m (NOAA 845-SC).

TABLE 6. RELATIVE DENSITY IN PERCENTAGES OF MANGROVE-MARSH PLANTS AT APOLLO STATE PARK, SITE C_1.

Species	Dates 2/2	5/12	8/31*	1/8	Yearly Average
Acrostichum aureum	1.38	x	—	x	.87
Avicennia germinans	2.22	2.75	—	1.81	2.26
Batis maritima	43.33	35.51	—	40.45	39.76
Borrichia frutescens	1.38	1.03	—	1.36	1.25
Juncus roemerianus	43.05	54.13	—	50.00	49.06
Salicornia virginica	8.61	6.20	—	5.45	6.75

*Note: station not sampled on date scheduled due to high tides in the marsh.
x = species present, constituting less than 1% relative density.

TABLE 7. RELATIVE DENSITY IN PERCENTAGES OF DUNE PLANTS AT APOLLO STATE PARK, SITE C_2.

Species	Dates 2/2	5/11	8/31	1/9	Yearly Average
Baccharis halimifolia var. *angustior*	x	x	x		.39
Bidens pilosa		x	1.23		.42
Canavalia maritima		4.78	14.04		4.70
Cenchrus tribuloides	x	1.43	2.06		1.04
Chiococca alba	9.09	5.26	3.71	3.84	5.48
Cnidoscolus stimulosus		1.43	x	1.09	.73
Coccoloba uvifera	13.28	10.52	12.80	17.03	13.41
Erythrina herbacea		x	x		.32
Gilia rubra			x		.10
Helianthus debilis		5.74	3.30	4.39	3.36
Heterotheca subaxillaris	8.39				2.10
Indigofera leptosepala	x	2.39	2.06		1.28
Ipomoea pes-caprae var. *emarginata*	2.09				.52
Ipomoea stolonifera			x		.10
Lantana camara	1.39	x	x		.56
Licania michauxii	2.79	3.82	x		1.76
Myrica cerifera	4.89	3.82	6.19	6.04	5.26
Myrsine guianensis	12.58	7.64	4.95	6.04	7.80
Oenothera humifusa		x			.12
Opuntia stricta	1.39	x	1.23	1.64	1.18
Panicum amarulum		x			.12
Passiflora suberosa			x	x	.34
Physalis viscosa var. *maritima*	2.09	1.43			.88
Sabal palmetto	.69	.47	.41	.54	.53
Serenoa repens	18.18	36.36	35.53	50.00	35.02
Spartina patens	5.59	3.34	1.23		2.54
Uniola paniculata	11.88	7.65	6.61	7.69	8.46
Verbena maritima	.69			.54	.31
Vigna luteola	2.79				.70
Zanthoxylum clava-herculis		x	x	x	.36

x = species present, constituting less than 1% relative density.

MANGROVE (D1)

The Sebastian Inlet area, with temperatures modified by both the Atlantic Ocean and Indian River, is vegetated by dense, nearly solid stands of mangroves and *Conocarpus erectus*. Hardwood hammocks dominate interior sections. All three species of mangroves occur here. Herbaceous perennials such as *Batis maritima*, *Borrichia frutescens*, *Limonium carolinianum*, and *Salicornia virginica* dominate ground level. *Schinus terebinthifolius* (Brazilian pepper), some to 7.5 m high, marks a transition between saline and coastal hammock vegetation. Table 8 presents relative density of mangrove plants at Site D.

STRAND (D2)

South of Sebastian Inlet, Highway A1A separates a small bay from the rest of Indian River. A narrow shore community exists landward from the ocean beach, followed by a hammock and shell mound flora extending to the bay. Fringing the ocean shore above storm tide level are succulents such as *Cakile lanceolata* (sea rocket), *Sesuvium portulacastrum* (sea purslane), and *Iva imbricata*. Most of the shoreline is dominated by a forest of *Coccoloba uvifera* ranging to 7.5 m or higher. Small trees and shrubs, including *Bursera simaruba* (gumbo limbo), *Forestiera segregata* var. *segregata* (Florida privet), *Randia aculeata* (white indigo berry), and young *Casuarina equisetifolia* (Australian pine) are sheltered from constant salt-laden winds under and behind the *Coccoloba uvifera*. A rarely used shell trail divides the community almost equally. Plants such as *Dalbergia ecastophyllum* (coin vine), *Helianthus debilis*, *Lantana camara*, *Poinsettia cyathophora* (painted leaf), *Portulaca pilosa* (pink purslane), and *Zanthoxylum fagara* (wild lime) either invade the trail or are adjacent to it.

A shore hammock westward of the trail is dominated by *Bumelia tenax* (tough buckthorn), *Coccoloba diversifolia* (tie tongue), *Ficus aurea* (strangler fig), and *Sabal palmetto* (cabbage palm), with an understory of herbaceous species including *Cnidoscolus stimulosus*, *Physalis viscosa*, *Rivina*

TABLE 8. RELATIVE DENSITY IN PERCENTAGES OF MANGROVE PLANTS AT SEBASTIAN INLET STATE PARK, SITE D_1.

Species	Dates 2/3	5/12	9/2	1/9	Yearly Average
Avicennia germinans	11.41	9.19	9.82	4.34	8.69
Batis maritima	x	1.14	x	x	.65
Conocarpus erectus	5.88	8.04	12.71	4.15	7.70
Laguncularia racemosa	45.32*	46.55	52.02	79.05	55.73
Limonium carolinianum var. *carolinianum*	33.56	28.16	17.34	8.10	21.79
Monarda punctata	x				.08
Rhizophora mangle	2.07	4.59	6.93	3.55	4.29
Salicornia virginica	x	1.72		x	.75
Schinus terebinthifolius		.57			.14
Verbesina virginica var. *laciniata*			.57		.14

x = species present, constituting less than 1% relative density.

humilis (rouge plant), *Rumex hastatulus* (sorrell), and others. Numerous woody vines include *Chiococca alba*, *Dalbergia ecastophyllum*, *Parthenocissus quinquefolia* (Virginia creeper), and *Pisonia aculeata* (devil's claw). *Sabal palmetto* dominates the crest of a small shell mound surrounded by *Ficus aurea* and *Yucca aloifolia* (Spanish bayonet). Bay shores are dominated by grasses and halophytes, especially *Batis maritima*, *Distichlis spicata* (seashore saltgrass), *Paspalum vaginatum* (salt joint-grass), and *Sesuvium portulacastrum*. Table 9 presents relative density of strand vegetation at Site D.

SITE E

St. Lucie Inlet State Park (Martin County: 27°08′N, 80°09′W) is located on the northern end of Jupiter Island, a barrier island stretching from St. Lucie Inlet on the north to Jupiter Inlet on the south. The park extends south of St. Lucie Inlet to the northern boundary of Hobe Sound National Wildlife Refuge, facing the Atlantic to the east and the Intracoastal Waterway-Hobe Sound system to the west. Extensive erosion along the northern third of the island has resulted in loss of large sections of beach-front and inland mangrove areas, evidenced by many mangrove trunks in the surf zone. Transect length in the strand site was 38 m.

Substrate of Jupiter Island consists of quartz sand and broken shell. No well-developed dunes are present. The study site, approximately 16 m north of the park's southern boundary, stretches from the surf zone westward to mangroves bordering Steamboat Creek and Hobe Sound. Tidal amplitudes in St. Lucie Inlet average 0.5 m (NOAA 845-SC).

STRAND

Many of the interior mangrove swamp communities face open Atlantic waters due to erosion (Figure 7). At low tide dead mangroves, some with trunks 0.6 m in circumference, can be seen along a narrow beach. From tide line to the mangroves a few herbs and grasses have become established, including *Distichlis spicata*, *Iva imbricata*, *Panicum amarulum*, and *Spartina patens*. *Casuarina equisetifolia* dominates the vegetation between beach and mangroves but is often washed out of the ground by the advancing sea. The interior mangrove swamp is sometimes as close as 30 m to the surf line. *Rhizophora mangle* predominates here and extends to Steamboat Creek as an almost continuous canopy. These trees, to 10 m or taller, are characterized by scraggly growth, long prop roots, branching aerial roots, and numerous knots on main branches and trunks (Figure 8). Table 10 presents relative density of strand vegetation at St. Lucie Inlet State Park.

SITE F

Elliott Key (Dade County: 25°27′N, 80°11′W) lies approximately 40 km southeast of Miami, or nearly 12.5 km east of Homestead's Bayfront Park. Elliott Key, accessible only by boat, is one of about thirty islands forming the area known as "Islandia", recently incorporated into Biscayne National Monument by the U.S. Department of the Interior. The key, longest in the chain, fronts 12.8 km on both the Atlantic Ocean and Biscayne Bay. A diversity of plant communities there includes hardwood hammocks as well as shoreline and strand plants. The study site is 0.8 km north of the east-west bearing road across the key, on the Atlantic. Transect length at the site was 38 m.

TABLE 9. RELATIVE DENSITY IN PERCENTAGES OF STRAND PLANTS AT SEBASTIAN INLET STATE PARK, SITE D_2.

Species	Dates 2/4	5/13	9/2	1/9	Yearly Average
Ardisia escallonioides	15.38	6.36	8.97	3.70	8.60
Bursera simaruba	x	x	2.56	1.48	1.33
Cakile edentula ssp. *Harperi*	1.28				.32
Chiococca alba	2.56	6.36	7.69	4.44	5.26
Chrysobalanus icaco	5.12	2.54	4.48	7.40	5.01
Cissus incisa		8.28	6.41	1.48	4.04
Cnidoscolus stimulosus				.74	.18
Coccoloba diversifolia	1.28	1.27	1.28	1.48	1.33
Coccoloba uvifera	12.82	12.73	14.10	10.37	12.50
Dalbergia ecastophyllum	7.05	10.19	12.82	9.62	9.92
Erythrina herbacea	1.92		1.92	2.22	1.52
Ficus aurea		1.27	1.28	x	.82
Forestiera segregata var. *segregata*	1.92	1.91	3.20	4.44	2.87
Helianthus debilis		x	x	x	.50
Heliotropium curassavicum	1.28	1.91	1.28	x	1.30
Ipomoea triloba	1.28	3.18	2.56	2.22	2.31
Iva imbricata	4.48	5.09	4.48	9.62	5.92
Limonium carolinianum var. *carolinianum*		3.18			.79
Opuntia stricta	4.48	5.09	4.48	9.62	5.92
Parthenocissus quinquefolia		5.09			1.27
Physalis viscosa var. *maritima*	2.56	5.09	x	x	2.26
Pisonia aculeata	1.28	1.27	1.28	1.48	1.33
Poinsettia cyathophora			1.28	1.48	.69
Portulaca pilosa	5.12	x		1.48	1.81
Randia aculeata	7.69	1.27			2.24
Rivina humilis	7.69	4.45	6.41	12.59	7.78
Rumex hastatulus		1.91		.74	.64
Sabal palmetto	x	x	x	1.48	.66
Sesuvium portulacastrum	x	2.54	3.84		1.76
Sporobolus poiretti			.64		.16
Toxicodendron radicans ssp. *radicans*				2.96	.74
Yucca aloifolia	4.48	4.45	6.41	6.66	5.50
Zanthoxylum fagara	5.76	3.18	5.12	5.18	4.81

x = species present, constituting less than 1% relative density.

Composed of coral limestone in a "Key Largo" formation, the key is pockmarked with numerous pits or solution holes. These pits, often filled with a thin layer of sand and soil produced by decayed vegetation, provide an excellent habitat for plant growth. Tidal amplitude in Biscayne Bay (Elliott Key) is approximately 0.4 m (NOAA 141-SC).

STRAND

On the eastern shore of Elliott Key the strand community is a narrow band of vegetation consisting of clumps of mangroves living in solution holes and cracks in the limestone. *Laguncularia racemosa* occurs frequently; other mangroves occur infrequently. Mangroves, although facing open Atlantic waters, can exist here since offshore reefs reduce wave action. Succulents are prevalent and grow in the substrate created by dense mats of beached seagrass leaves (Figure 9). *Borrichia arborescens* (sea oxeye daisy), *B. frutescens*, *Heliotropium curassavicum* (seaside heliotrope), and *Sesuvium portulacastrum* are most numerous. A ridge of porous coral sand and debris, which was probably created by previous hurricanes along this coast, is dominated by arborescent species, including *Bursera simaruba*, *Casasia clusiifolia* (seven-year apple), *Casuarina equisetifolia*, *Coccoloba uvifera*, *Forestiera segregata* var. *segregata*, and *Suriana maritima* (bay cedar). *Casuarina equisetifolia* and *Coccoloba uvifera* are tallest and shelter other plants from constant salt-laden winds, particularly *Chamaesyce mesembryanthemifolia* (beach spurge), *Hymenocallis latifolia* (Keys spider lily), and *Rivina humilis*.

Figure 7. Dead mangroves along the ocean beach, St. Lucie Inlet State Park.

An extensive growth of the vine *Gouania lupuloides* (chew stick) marks a dry zone behind the first ridge. Another ridge follows about 6 m inland, dominated by *Coccoloba uvifera* to 9.5 m or higher. The lee side of the second ridge drops nearly a meter to solid limestone, pockmarked with solution holes full of decaying vegetation. *Conocarpus erectus* dominates in the lower elevations behind this ridge. *Avicennia germinans* and *Rhizophora mangle* exist along a small tidal creek leading to Biscayne Bay. *Forestiera segregata* var. *segregata* (forming small trees), *Chiococca alba* and *Pithecellobium keyense* (cat claws) inhabit the understory and contribute to the extensive leaf litter on the rock surface. Table 11 presents relative density of strand vegetation at Elliott Key.

SITE G

Bahia Honda State Park (Monroe County: 24°40′N, 81°15′W), located approximately 65 km north of Key West on U.S. Highway 1, covers the lower end of Bahia Honda Key. Substrate is coral sand, shell fragments, and calcified algal debris.

Figure 8. *Rhizophora mangle* at St. Lucie Inlet State Park showing growth habit, prop roots, and numerous knots along main branches and trunks.

The key is generally circular in outline with several embayments surrounded by mangroves as well as tropical hammock and strand communities. Transect length at the site was 19 m. Mean range of tides at Bahia Honda is 0.3 m (NOAA 141-SC).

STRAND

Beaches on Bahia Honda, as on Elliott Key, are coral rock with almost no quartz sand present. Mangroves are generally restricted to shores of Florida Bay and to several interior bays. A few *Laguncularia racemosa*, however, are present on the ocean side of the key. There are numerous

TABLE 10. RELATIVE DENSITY IN PERCENTAGES OF STRAND PLANTS AT ST. LUCIE INLET STATE PARK, SITE E.

Species	Dates 1/6	5/13	9/4	1/10	Yearly Average
Casuarina equisetifolia	21.29	20.37	24.28	28.00	23.49
Chamaesyce mesembryanthemifolia	9.25				2.31
Iva imbricata	2.77				.69
Laguncularia racemosa	4.62		1.42	10.66	4.17
Panicum amarulum	1.85		4.28	1.33	1.86
Rhizophora mangle	56.48	79.62	65.71	60.00	65.45
Sabal palmetto	1.85				.46
Schinus terebinthifolius	x				.23
Spartina patens	x		4.28		1.30

x = species present, constituting less than 1% relative density.

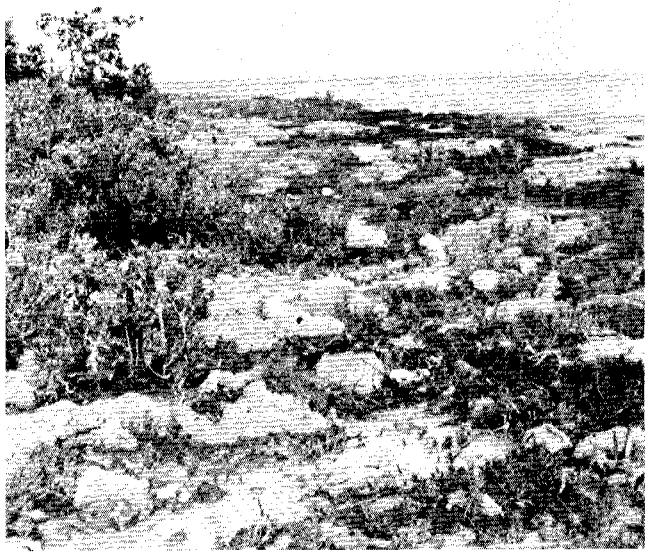

Figure 9. Atlantic shore of Elliott Key with mangroves and strand plants growing in solution holes and in dense beds of beached seagrass leaves.

tropical plants here. Beach species include shrubs [*Casasia clusiifolia*, *Suriana maritima*, *Tournefortia gnaphalodes* (sea lavender)], and vines (*Canavalia maritima*, *Ipomoea pes-caprae*). *Philoxerus vermicularis* (marsh samphire) and *Sesuvium portulacastrum* cover broad areas of shore, while *Rhabdadenia biflora* (rubber vine) and *Smilax laurifolia* (bamboo vine) occur further landward. *Ernodea littoralis* (ernodea) creates a dense cover, allowing only a few plants to penetrate, [*Bidens pilosa*, *Cordia sebestena* (geiger tree), *Hymenocallis latifolia*, *Lantana camara*, *Panicum amarulum*, *Uniola paniculata*]. Relative density of strand plants at Site G is presented in Table 12.

SITE H

Located at the southern terminus of Florida Highway 27, the city of Flamingo (Monroe County: 25°09′N, 80°55′W) is in Everglades National Park. The park, established in 1947, contains a variety of plant communities, including sawgrass marsh, hardwood hammocks, cypress stands, pinelands, salt flats and mangroves. Trails have been established by the Park Service through many of these communities. One, along the shore of Florida Bay called Strand Trail, 3.2 km west of Flamingo beyond the public camping area, was chosen for the study site. Transect length was 38 m.

Miami limestone forms the underlying base of Florida Bay and the mainland. Bay bottoms are overlain by deep layers of precipitated calcium carbonate (marl). The adjacent mainland is overlain by variously formed deposits of peat and thick layers of Florida Bay marl shaped into a ridge 0.8-1.3 m or thicker along bay shores (Craighead, 1971). Mean range of tide at Flamingo is approximately 0.4 m (NOAA 141-SC).

STRAND

The shore community along Strand Trail exists mostly as a thin fringe seaward of the

TABLE 11. RELATIVE DENSITY IN PERCENTAGES OF STRAND PLANTS AT ELLIOTT KEY, SITE F.

Species	Dates 2/12	5/14	9/5	1/11	Yearly Average
Borrichia frutescens	50.50	21.73	22.22	21.64	29.02
Bursera simaruba	x	x	x		.49
Caesalpinia bonduc			x	x	.34
Casasia clusiifolia	1.50	x	1.23	1.49	1.27
Chamaesyce mesembryanthemifolia	4.00	8.69	7.40	5.22	6.32
Chiococca alba		x		x	.40
Chrysobalanus icaco	1.50				.38
Coccoloba uvifera	9.00	13.04	16.04	14.17	13.06
Conocarpus erectus	4.50	5.21	4.93	3.73	4.59
Cyperus sp.			x		.15
Forestiera segregata var. *segregata*	2.00	6.95		5.22	3.54
Gouania lupuloides	6.00	29.56	24.69	38.80	24.76
Hymenocallis latifolia	x		6.79	2.98	2.57
Laguncularia racemosa	8.00	7.82	5.55	4.47	6.46
Pithecellobium keyense	x	x	x	x	.68
Rivina humilis	2.00		4.93		1.73
Rumex hastatulus	3.00	1.73			1.18
Suaeda linearis	6.50	1.73	3.70		2.98

x = species present, constituting less than 1% relative density.

TABLE 12. RELATIVE DENSITY IN PERCENTAGES OF STRAND PLANTS AT BAHIA HONDA STATE PARK, SITE G.

Species	Dates 2/11	5/17	9/7	1/15	Yearly Average
Bidens pilosa		x		4.18	1.22
Canavalia maritima	9.68	8.45	4.56	14.79	9.37
Casasia clusiifolia	x	x	x	x	.35
Chamaesyce mesembryanthemifolia		x	1.14	x	.53
Ernodea littoralis var. *littoralis*	28.37	51.05	52.85	29.58	40.46
Ipomoea pes-caprae var. *emarginata*			x	x	.17
Panicum amarulum	6.92	3.87	4.56	2.25	4.40
Paspalum vaginatum	x	1.40	1.14	x	.88
Philoxerus vermicularis	41.17	21.12	28.89	41.47	33.09
Sesuvium portulacastrum	4.84	6.69	3.04	2.89	4.37
Smilax laurifolia		x		x	.17
Suriana maritima	8.30	5.63	3.04	2.57	4.82

x = species present, constituting less than 1% relative density.

hurricane-created marl ridge or levee (Flamingo Embankment, Figure 10); (Craighead, 1971). *Batis maritima* dominates behind the embankment above the *Avicennia germinans*, *Laguncularia racemosa*, and *Rhizophora mangle* association and is succeeded by a community of *Philoxerus vermicularis*, *Salicornia virginica*, *Sesuvium portulacastrum*, and *Suaeda maritima* (sea blite) further inland. *Borrichia frutescens*, sometimes 0.9 m or higher, tallest noted in this state-wide survey, dominates broad sections of coast above tide-influenced areas. A low-salinity ruderal community (Figure 11) dominated by *Sporobolus virginicus* and several shrubs, including *Baccharis halimifolia* var. *angustior* (groundsel) and *Randia aculeata*, extends to an adjacent hammock. Herbs, such as *Alternanthera ramosissima* (chaff flower), *Momordica charantia* (wild balsam apple), *Pluchea purpurascens* (camphorweed) and *Sida cordifolia* (sida) also inhabit this region. Table 13 presents relative density of strand vegetation at Site H.

SITE I

Wiggins Pass State Recreation Area (Collier County: 26°17′N, 81°50′W), about 24 km north of Naples off Florida Highway 865, is a narrow, sandy peninsula extending between the Gulf of Mexico and the mangrove-lined waters of the Cocohatchee

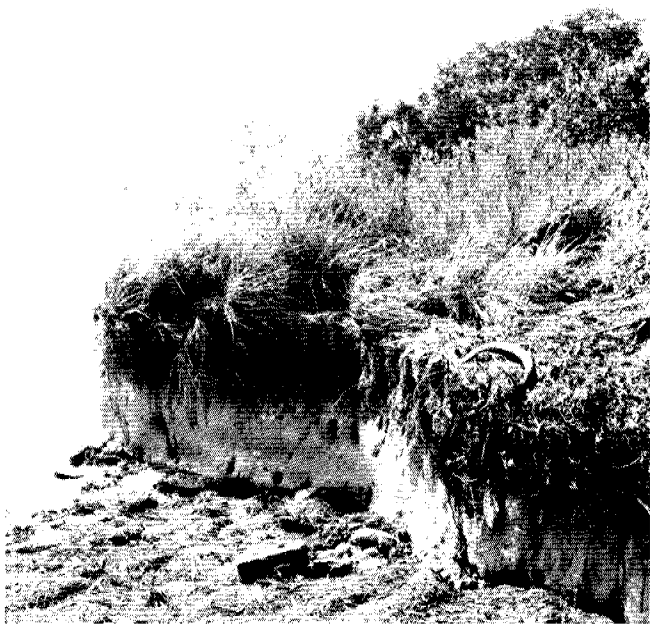

Figure 10. A section of the Flamingo Embankment (Craighead, 1971) along northern shores of Florida Bay near Flamingo, Everglades National Park.

Figure 11. The low salinity, ruderal community extending landward from the strand site, Flamingo, Everglades National Park.

TABLE 13. RELATIVE DENSITY IN PERCENTAGES OF STRAND PLANTS AT STRAND TRAIL, FLAMINGO, SITE H.

Species	Dates 2/13	5/18	9/20	1/15	Yearly Average
Alternanthera ramosissima				6.12	1.53
Andropogon virginicus	1.31	1.03			.59
Avicennia germinans	1.31	1.29	1.81	4.45	2.22
Baccharis halimifolia var. *angustior*	2.36	1.80	1.81	1.67	1.91
Batis maritima	18.37	8.26	9.87	13.64	12.54
Borrichia frutescens	19.94	18.86	15.32	25.90	20.00
Chamaesyce hirta			5.71	3.89	2.40
Chrysobalanus icaco	x	x	x	x	.52
Cyperus retorsus		x	1.29	1.39	.79
Ipomoea acuminata			x		.13
Laguncularia racemosa	x	x	x	x	.52
Mikania cordifolia		x	x		.12
Momordica charantia			x		.13
Monarda punctata			5.97		1.49
Philoxerus vermicularis	16.53	39.53	17.66	8.07	20.45
Pluchea purpurascens				2.22	.56
Portulaca pilosa			x		.06
Randia aculeata	2.62			6.96	2.40
Rhizophora mangle	x	x	x	x	.39
Rumex pulcher	1.83		10.64	x	3.19
Salicornia virginica	19.42	14.47	15.84	11.97	15.43
Sesuvium portulacastrum	12.07	9.04	9.35	8.91	9.84
Sida cordifolia				x	.21
Solidago sempervirens var. *mexicana*	2.36	x	x	1.39	1.13
Sporobolus virginicus	x	3.10	1.03		1.16
Suaeda maritima				x	.21

x = species present, constituting less than 1% relative density.

River. Local citizens often utilized the area prior to recent state ownership, traveling the narrow, sandy, non-maintained road which winds the length of the park.

The study site is located approximately 1.6 km north of the park's southern boundary. Transect length was 57 m. Substrate is deep quartz sand with numerous shell fragments. Tidal amplitudes average 0.8 m at Naples (NOAA 856-SC).

STRAND

Wiggins Pass, an area largely unaffected by most freezes, contains a number of tropical and subtropical species almost equally divided into three communities: strand, *Casuarina equisetifolia*, and *Sabal palmetto*. Even though the sandy beach has no dunes, it is dominated from above high tide by *Uniola paniculata* (Figure 12). Seasonally, many herbs and vines such as *Canavalia maritima*, *Cenchrus incertus*, and *Ipomoea pes-caprae*, are present. A thick growth of *Casuarina equisetifolia*, some to 12 m or taller, extends as close as 16 m from tide line. Weedy species, including *Bidens pilosa*, *Chamaesyce hirta* (spurge), *Desmodium canum* (tick trefoil), *Sporobolus poiretii* (smutgrass) and others, were probably introduced via use of the sand-shell road.

Figure 12. *Uniola paniculata* and *Casuarina equisetifolia* dominate the strand at Wiggins Pass State Recreation Area.

Sabal palmetto forms the overstory east of the road (Figure 13), and continues toward mangroves bordering the Cocohatchee River. On or beneath these trees grow a number of plants, such

Figure 13. *Sabal palmetto* forms the overstory east of the road in Wiggins Pass State Recreation Area.

as *Phlebodium aureum* (golden polypody fern), *Toxicodendron radicans* ssp. *radicans* (poison ivy), and *Vittaria lineata* (shoestring fern). The herb-shrub layer contains such plants as *Commelina diffusa* (dayflower), *Galium hispidulum* (bedstraw), *Rumex hastatulus*, and *Tradescantia ohiensis* (spiderwort). Near the river shore, *Agave americana* (century plant), *Coccoloba uvifera*, *Dalbergia ecastophyllum*, *Schinus terebinthifolius* and *Yucca aloifolia* are present, along with *Casuarina equisetifolia*. Other plants which are usually found farther south were noted in the park, but not within the study site (*Casasia clusiifolia*, *Ernodea littoralis*, *Lantana involucrata*, *Suriana maritima*). Table 14 presents the relative density of strand plants at Site I.

SITE J

Manasota Key State Recreation Area (Sarasota County: 26°56′N, 82°21′W) is located south of Venice at Englewood Beach, on a sandy peninsula separating Lemon Bay and the Gulf of Mexico. This area, like Wiggins Pass, was used extensively by the public prior to its recent purchase by the state. The study area, approximately 1.6 km south of the park's northern boundary, extends from the Gulf to Lemon Bay. Transect length was 52 m.

Substrate of Manasota Key Park is quartz sand with extensive deposits of shell fragments. Mean tide range in Stump Pass, located at the south end of the park, is approximately 0.6 m (NOAA 857-SC).

STRAND

Erosion of Manasota Key is progressing rapidly. Consequently, the park may soon become a sand bar visible only at low tide. Erosion here, as at St. Lucie Inlet, is severe and could create new, isolated islands. The barrenness of the Gulf beach for some distance back from high tide line and gullies spanning the peninsula indicate storm waves have crossed this area before. Several *Casuarina equisetifolia* stumps in the surf, similar to those of *Rhizophora mangle* at St. Lucie Inlet, are also indicative of high wave energetics and erosion along this coast (Figure 14).

Plants closest to the shoreline include *Iva imbricata*, *Scaevola plumieri* (ink berry), and *Uniola paniculata* along with the vines *Canavalia maritima* and *Ipomoea pes-caprae*, pioneer plants of coasts. *Casuarina equisetifolia* and *Coccoloba uvifera* dominate interior sections of the park. *Avicennia germinans* and *Rhizophora mangle* as well as *Conocarpus erectus* occur along the shores of Lemon Bay. Grasses and succulents, especially *Paspalum vaginatum*, *Sesuvium portulacastrum*, *Suaeda linearis* (sea blite), and *Sporobolus virginicus* are common near shore and extend to slightly below high tide line. Table 15 presents relative density of strand plants at Site J.

SITE K

Beacon Key (Hillsborough County: 27°40′N, 82°31′W), approximately 56 km south of Tampa, west of U.S. Highway 41, is the southern peninsula of Cockroach Bay and separates that bay from Tampa Bay. The key, which is most accessible by boat, along with numerous offshore islands protect oyster bars and mangrove islands which dot the bay. The study site is approximately 90 m south of the tip, extending from Tampa Bay across into mangroves fronting Cockroach Bay. Transect length was 35 m.

Beacon Key is composed of deep quartz sand overlying Tampa limestone with deep layers of mud and organic matter along shores of Cockroach Bay. Windrows of algae and seagrass leaves, to 0.6 m or deeper, seasonally line much of the Tampa Bay shoreline. Tide range in Tampa Bay averages 0.6 m (NOAA 586).

STRAND

The tip of Beacon Key is surrounded by a mangrove fringe which is widest along the sheltered shore of Cockroach Bay. Along Tampa Bay deep windrows of seagrass leaves and algae shelter

TABLE 14. RELATIVE DENSITY IN PERCENTAGES OF STRAND PLANTS AT WIGGINS PASS STATE PARK, SITE I.

Species	Dates 2/15	5/25	9/21	1/16	Yearly Average
Agave americana		x	x		.20
Andropogon capillipes				1.17	.29
Bidens pilosa	5.28	4.24	6.55	2.94	4.75
Canavalia maritima	5.72	2.70	3.05		2.86
Casuarina equisetifolia	2.20	3.89	5.24	7.64	4.73
Cenchrus incertus	1.32	6.17	7.42	5.29	5.05
Chamaesyce hirta			1.31	1.17	.62
Chamaesyce mesembryanthemifolia		.38	1.31	1.17	.71
Chloris petraea	4.40	2.31	3.05	1.76	2.88
Coccoloba uvifera	10.57	9.65	7.86	8.23	9.07
Commelina diffusa	1.32		8.73	x	2.65
Cyperus sp.			1.31	1.17	.62
Dalbergia ecastophyllum		x	x	x	.34
Desmodium canum		2.31			.57
Distichlis spicata	3.52				.88
Forestiera segregata var. *segregata*		1.54			.38
Galium hispidulum	14.97	17.37	6.11	11.76	12.55
Monarda punctata			.43		.10
Opuntia stricta	x	x	x	1.76	.86
Physalis viscosa var. *maritima*	x		2.18	3.52	1.64
Pithecellobium keyense		x		1.17	.38
Poinsettia cyanthophora		.38	1.31	4.11	1.45
Polygala grandiflora var. *grandiflora*		.38			.09
Rumex hastatulus	3.52	3.08	4.80	3.52	3.73
Sabal palmetto	18.50	15.83	8.73	13.52	14.14
Schinus terebinthifolius				.58	.14
Solanum aculeatissimum		.77			.19
Toxicodendron radicans ssp. *radicans*	2.20	2.31	3.05	2.94	2.62
Uniola paniculata	23.78	20.46	14.84	21.76	20.21
Verbesina virginica var. *laciniata*	x	2.312	3.49	1.17	1.96
Vigna luteola	x	1.54	6.55	1.76	2.57
Yucca aloifolia		x	x	x	.55

x = species present, constituting less than 1% relative density.

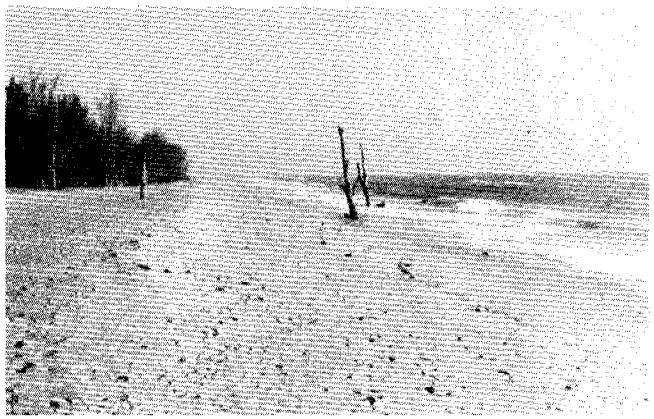

Figure 14. Stumps of *Casuarina equisetifolia* in the surf zone, and the broad, unvegetated beach, indicate high erosion rates at Manasota Key State Recreation Area.

seedlings of *Avicennia germinans* and *Laguncularia racemosa*, which are further protected from waves by wide offshore sandflats. A number of woody plants, several with tropical affinities, line the Tampa Bay shoreline and include *Coccoloba uvifera*, *Eugenia axillaris* (white stopper), *Ficus aurea*, *Forestiera segregata* var. *segregata*, *Schinus terebinthifolius*, *Sophora tomentosa* (necklace pod), and several palms (e.g., *Sabal palmetto* and *Serenoa repens*). Grasses, especially *Distichlis spicata*, *Spartina patens* and *Uniola paniculata*, contribute to shoreline vegetation along Tampa Bay.

A central ridge of sand divides Beacon Key into halves. On the Tampa Bay side *Chenopodium ambrosioides* (Mexican tea) and *Sesuvium portulacastrum* occur in addition to the woody plants listed above. *Chiococca alba* and *Sabal palmetto* dominate in the center. Vines, including spiny

TABLE 15. RELATIVE DENSITY IN PERCENTAGES OF STRAND PLANTS AT MANASOTA KEY STATE PARK, SITE J.

Species	Dates 2/15	5/25	9/21	1/16	Yearly Average
Avicennia germinans			1.06	1.45	.63
Cakile lanceoloata ssp. *fusiformis*	3.33				.83
Casuarina equisetifolia	3.33	2.66			1.50
Coccoloba uvifera	6.66	2.66			2.33
Conocarpus erectus	21.66	14.66	9.57	2.91	12.20
Ipomoea pes-caprae var. *emarginata*	8.33	1.33	52.12	16.78	19.64
Iva imbricata	5.00	36.00		8.75	12.44
Paspalum vaginatum	8.33	6.66	15.95	45.98	19.23
Scaevola plumieri	3.33	16.00	7.44		6.69
Sesuvium portulacastrum	5.00	1.33	2.12	x	2.29
Sporobolus virginicus			4.25	16.05	5.07
Suaeda linearis				2.18	.54
Uniola paniculata	35.00	18.66	7.44	5.10	16.56

x = species present, constituting less than 1% relative density.

Caesalpinia crista (gray nicker bean), *Chiococca alba* and *Dalbergia ecastophyllum*, as well as spiny *Bumelia tenax* (tough buckthorn), make this area almost impenetrable. This thick vegetation continues into a predominantly *Avicennia germinans* and *Rhizophora mangle* community extending into open waters of Cockroach Bay. Relative density of strand plants at Site K is presented in Table 16.

SITE L

Hammock Key (Hernando-Pasco Counties: 28° 26′ N, 82° 40′ W) is located in Hammock Creek at Aripeka on the Hernando-Pasco county line. A narrow, spring-fed creek flows around the island. A northern channel has been dredged for boat traffic. The island is comma-shaped with a central elevated area surrounded by mangroves as a "head" and salt marsh plants extending westward as a "tail". Transect length was 38 m.

Substrate of Hammock Key is thin sand overlying limestone. Rock forms the surface of nearby islands and the mainland. Mud and organic debris are present in the intertidal area. The creek bottom is vegetated by dense beds of *Ruppia maritima* (widgeon grass), suggesting lower salinities. Tide range at Aripeka is approximately 0.8 m (NOAA 1258).

MANGROVE MARSH

Hammock Key, with elevations barely above storm tide levels, contains a number of euryhaline species. Grasses and sedges dominate the flora,

TABLE 16. RELATIVE DENSITY IN PERCENTAGES OF STRAND PLANTS AT BEACON KEY, COCKROACH BAY, SITE K.

Species	Dates 1/2	5/22	9/12	3/6	Yearly Average
Avicennia germinans	10.82	13.85	16.00	20.00	15.17
Batis maritima	1.91				.48
Bumelia tenax	1.91	1.80	1.71	3.33	2.19
Chenopodium ambrosioides		1.20	2.85	x	1.22
Chiococca alba	17.83	7.22	37.14	10.00	18.05
Coccoloba uvifera		5.42	1.71		1.78
Dalbergia ecastophyllum	5.09		2.28	4.16	2.88
Forestiera segregata var. *segregata*			x		.14
Ipomoea pes-caprae var. *emarginata*			x		.14
Iva frutescens	11.46	4.21	1.14	2.50	4.83
Rhizophora mangle	12.10	18.67	17.14	28.33	19.06
Sabal palmetto	1.91	1.20	4.56	10.00	4.41
Salicornia virginica	2.54				.64
Sesuvium portulacastrum	34.39	46.38	14.28	20.83	28.97

x = species present, constituting less than 1% relative density.

particularly *Distichlis spicata*, *Juncus roemerianus*, *Spartina alterniflora* and *S. patens*. A variety of succulents, such as *Aster tenuifolius*, *Batis maritima*, *Borrichia frutescens*, *Limonium carolinianum*, *Philoxerus vermicularis* and *Suaeda linearis*, are intermixed among the grasses and sedges.

Trees, representing only a few genera, are numerous and *Sabal palmetto* dominates this vegetation. A single *Juniperus silicicola* (southern red cedar) was noted. Common shrubs include *Baccharis halimifolia* var. *angustior*, *Bumelia tenax* and *Sophora tomentosa*. Mangroves, particularly *Avicennia germinans* and *Rhizophora mangle*, line the eastern shore of the island, with *Conocarpus erectus* forming small clumps in the center. Mangroves also form small scattered colonies in the *Juncus* marsh which covers the island's western "tail". Table 17 presents relative density of mangrove-marsh plants at Site L.

SITE M

Atsena Otie Key (Levy County: 29°27'N, 83°02'W) lies approximately 1.6 km off Cedar Key on Florida's west coast, east of Cedar Key's National Wildlife Refuge. Due to its relative inaccessibility, the key seems to have been undisturbed in recent years, although red cedars were cleared off the island in the late 1800's. The study site on Atsena Otie Key is along the island's eastern shore and extends across a narrow beach into mangroves bordering a small embayment. Transect length was 38 m.

Substrate of Atsena Otie Key, as for most adjacent islands, is sand overlying limestone with relatively small amounts of mud or organic debris in the mangrove zone. Average tidal range at Cedar Key is 0.9 m (NOAA 1259).

MANGROVE MARSH

Atsena Otie Key is surrounded by warm Gulf waters which allow plants of the island to exist in a more favorable climate than that of the nearby mainland. Numerous dead mangrove trunks seen in all directions from Cedar Key are evidence of previous freezes. The only living mangrove this far north on the mainland is *Avicennia germinans*, but it too has suffered periodically. On warmer offshore islands, however, plants with tropical affinities have become established (Laessle and Wharton, 1959), e.g., *Laguncularia racemosa* and *Rhizophora mangle*, but few reach more than 3 m high.

The study site extends from the exposed beach over a storm-washed berm into the mangroves. The shore community appears similar to that at Fort Matanzas, split between the salt marsh and *Avicennia germinans* communities. Grasses and sedges [*Chloris petraea* (finger grass), *Distichlis spicata*, *Fimbristylis spathacea* (sedge), *Spartina alterniflora*, *S. patens*, *Stenotaphrum secundatum* (St. Augustine grass)] dominate these

TABLE 17. RELATIVE DENSITY IN PERCENTAGES OF MANGROVE-MARSH PLANTS AT HAMMOCK KEY, ARIPEKA, SITE L.

Species	Dates 1/4	4/18	9/11*	3/7	Yearly Average
Aster tenuifolius var. *aphyllus*	x	2.75	—	2.35	1.94
Avicennia germinans			—	.26	.08
Baccharis angustifolia		3.48	—	2.09	1.86
Baccharis halimifolia var. *angustior*	1.35	2.75	—	3.14	2.41
Borrichia frutescens	8.95	19.26	—	23.29	17.16
Bumelia tenax	x	1.65	—	2.35	1.61
Chloris petraea		x	—		.06
Conocarpus erectus	x	1.10	—	x	.60
Distichlis spicata			—	x	.17
Iva frutescens	x		—		.03
Juncus roemerianus	57.08	33.94	—	36.12	42.38
Limonium carolinianum var. *carolinianum*	4.16	14.67	—	2.09	6.97
Lycium carolinianum	x	x	—	x	.46
Sabal palmetto	x	x	—	1.04	.50
Samolus ebracteatus		1.10	—	.78	.63
Sophora tomentosa	x		—		.03
Spartina patens	26.14	17.79	—	25.13	23.02

*Note: station not sampled on date scheduled due to high tides in the marsh.
x = species present, constituting less than 1% relative density.

shores. A specimen of *Juniperus silicicola* was present on the crest of the site where no other trees were observed.

Numerous succulents encountered near the mangroves include *Batis maritima*, *Borrichia frutescens*, *Limonium carolinianum*, *Philoxerus vermicularis* and *Sesuvium portulacastrum*. Between this section of shore plants and open waters of the embayment is an almost solid stand of *Avicennia germinans* ranging from 0.6-4.6 m or higher. Table 18 presents relative density of mangrove-marsh plants at Site M.

SITE N

Rocky Creek Marsh (Dixie County: 29°33'N, 83°25'W), south of Steinhatchee at the terminus of Florida Highway 361, is an area of extensive salt marshes and coastal palm hammock communities. The study site is located approximately 0.8 km west of the road and begins at one edge of the marsh, crosses a former hammock which is now marked by stumps of *Juniperus silicicola*, and reaches into the marsh community (Figure 15). Transect length was 76 m.

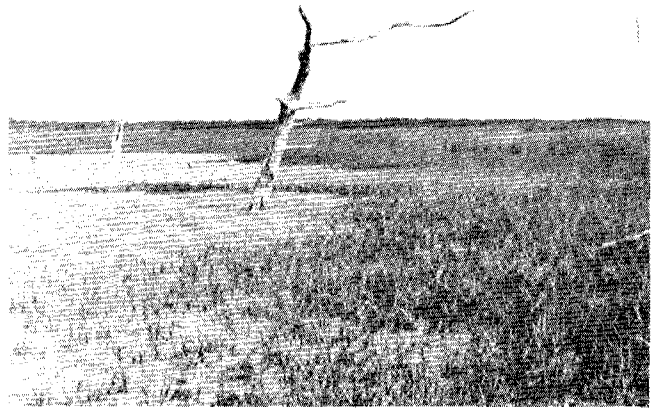

Figure 15. *Juniperus silicicola* stumps mark a former hammock, now salt marsh and salt flat, at the Rocky Creek marsh site.

Substrate around Rocky Creek is limestone rock with a thin layer of limestone sand. Occasionally an organic peat soil lies below marsh plants. This type of rocky substrate creates high salinity salt flats between areas of deeper sediments where visibly increased vegetative growth occurs. Highest salinity values noted during this survey were taken at this site. Tide range in Steinhatchee River is approximately 0.9 m (NOAA 1260).

TABLE 18. RELATIVE DENSITY IN PERCENTAGES OF MANGROVE-MARSH PLANTS AT ATSENA OTIE KEY, SITE M.

Species	Dates 1/4	4/18	9/11	3/11	Yearly Average
Andropogon virginicus			2.73		.68
Aster tenuifolius var. *aphyllus*		4.24	x	1.80	1.73
Avicennia germinans	x	x	x	x	.68
Batis maritima	1.29	1.92	2.00	1.52	1.68
Borrichia frutescens	2.76	8.22	3.10	8.06	5.53
Bumelia tenax		x		x	.13
Chloris petraea		x	x	x	.28
Commelina diffusa			x		.04
Fimbristylis spathacea	2.50				.62
Juniperus silicicola	x	x	x	x	.12
Limonium carolinianum var. *carolinianum*	8.28	1.67	4.37	5.56	4.97
Mikania cordifolia		1.79	5.10		1.72
Opuntia stricta	x	x		x	.19
Panicum repens			x		.18
Philoxerus vermicularis	4.65	12.46	13.32	20.59	12.75
Salicornia virginica	1.63	1.67	1.27	x	1.35
Sesuvium portulacastrum		x			.06
Solidago sempervirens var. *mexicana*	1.63		x		.49
Spartina alterniflora	16.39	4.11	6.38	5.14	8.00
Spartina patens	48.57	22.87	28.64	18.08	29.54
Sporobolus virginicus	11.21	35.60	21.53	31.15	24.87
Stenotaphrum secundatum		3.08	8.02	5.70	4.20
Suaeda linearis		x			.03

x = species present, constituting less than 1% relative density.

SALT MARSH

Plants of the Rocky Creek marsh site are subject to a wide range of temperatures and salinities. Where adequate soil depth exists, plant growth is profuse. Storm tides or high spring tides flood the marsh, thus increasing soil salinities when tide waters evaporate.

Plants of this area, with few exceptions, are similar to those in salt marshes elsewhere in this survey. Grasses and sedges predominate, especially *Distichlis spicata*, *Spartina alterniflora*, *S. patens*, and *Sporobolus virginicus*. *Juncus roemerianus* covers broad areas of marsh where slight elevations favor its establishment. Grading from the solid grass-rush zone into the salt flats are common succulents such as *Aster tenuifolius*, *Batis maritima*, *Borrichia frutescens*, *Limonium carolinianum*, *Salicornia bigelovii* (annual glasswort), and *S. virginica*. *Monanthochloë littoralis* (key grass) is prevalent in the marsh but becomes dominant toward the barren salt flats.

Numerous hammocks in or on the edge of the marsh are dominated by *Juniperus silicicola*, *Lycium carolinianum*, and *Sabal palmetto*. Dead trunks of these and other species are seen far into the marsh, indicative of the advance of salt marsh vegetation inland. Table 19 presents relative density of salt-marsh plants at Rocky Creek.

SITE O

Saint George Island (Franklin County: 29°41′N, 84°48′W) lies approximately 3.2 km off the northwest Florida mainland, across St. George Sound from Apalachicola. Nearly 24 km long, this barrier island protects numerous oyster bars and rich nursery areas of the Apalachicola Bay and River. The island, composed of quartz sand, is less than 0.8 km wide in several places. Evidence indicates that storm tides have crossed it.

The study site is opposite a washout created by Hurricane Agnes (1972), east of the beach community (Figure 16). The survey begins on the Gulf beach and extends into the secondary dune field; transect length was 38 m. Tide range in St. George Sound is approximately 0.6 m (NOAA 865-SC).

Figure 16. Dune fields developed since Hurricane Agnes (1972) along Gulf shores of St. George Island.

DUNE

Two plant communities dominate the flora: the sand dune-strand and a pine-oak forest. Dunes extend the length of the island and inland for more than half its width. Dune heights vary from 0.3 m or less in developing dune fields along the shore to over 6 m for older, vegetated dunes. Newly established dunes, such as those created since Hurricane Agnes, are vegetated primarily by grasses and vines; older dunes are dominated by

TABLE 19. RELATIVE DENSITY IN PERCENTAGES OF SALT MARSH PLANTS AT ROCKY CREEK, SITE N.

Species	Dates 1/24	5/24	10/5	12/7	Yearly Average
Aster tenuifolius var. *aphyllus*	10.64	1.51	x	x	3.37
Batis maritima	5.08	9.96	11.36	9.10	8.87
Borrichia frutescens	9.94	7.25	5.16	7.04	7.32
Juncus roemerianus	15.17	1.70	1.77	1.05	4.93
Limonium carolinianum var. *angustatum*	3.31	2.08	3.27	1.55	2.56
Monanthochloë littoralis	34.59	47.44	37.19	41.89	40.28
Salicornia bigelovii		x			.22
Salicornia virginica	17.27	25.48	33.46	30.98	26.79
Spartina alterniflora	3.96	3.65	6.83	7.91	5.59

x = species present, constituting less than 1% relative density.

herbs and woody plants. Dominant grasses are *Schizachyrium maritimum* (seacoast bluestem) and *Uniola paniculata*. *Hydrocotyle bonariensis* and *Ipomoea stolonifera*, with runners as long as 4.5 m, are prevalent. In spring, species of *Atriplex* (*A. arenaria*: beach orach) and *Cakile* (*C. edentula* ssp. *Harperi*) appear.

Shore plants are subject to frequently shifting sands and annual freezes. During Hurricane Agnes severe wash-over occurred on the island, flooding interior areas and destroying dunes. Many of the trees in the coastal pine-oak forests were killed due to standing salt water. During subsequent trips, we observed natural revegetation. Relative density of dune plants at Site O is presented in Table 20.

SITE P

W.T. Stone State Park (Gulf County: 29°46′N, 85°25′W), on the uppermost section of Cape San Blas, the J-shaped peninsula separating St. Joseph's Bay from the Gulf of Mexico, is opposite Port St. Joe. Several diverse plant communities occur in the park: tall, well-developed dune fields; broad salt marshes; and extensive pine-oak scrub forests on relict dunes in the center of the Cape. One of the two sites selected for study is a salt marsh along the shore of St. Joseph Bay adjacent to Eagle Cove. The other is a dune site located between two boardwalks which provide access to the beach while limiting foot traffic and resultant damage to dunes. Transect length in the salt marsh was 38 m, in the dune, 57 m.

Substrate is primarily sand with a thin layer of mud and organic debris along bay shores. A unique substrate, pine bark and large pine chips, refuse from a local pulp mill, extensively covers intertidal shorelines and adjacent bay bottoms. Tidal amplitudes in the bay are approximately 0.5 m (NOAA 867-SC).

DUNE (P1)

Dunes at Stone State Park represent the tallest studied during this statewide survey and range to 9 m or higher. The dominant plant, as on most Florida dunes, is *Uniola paniculata* (Figure 17). Ground-clinging plants or sub-shrubs, including *Cnidoscolus stimulosus*, *Croton punctatus* (beach tea), *Heterotheca subaxillaris*, *Hydrocotyle bonariensis*, *Ipomoea stolonifera*, and *Schizachyrium maritimum*, are common on dunes and between dune crests. Dunes out of the wind are overgrown with *Ceratiola ericoides* (rosemary) and *Serenoa repens* (Figure 18). Between the dunes and salt marshes is an extensive pine forest, dominated by *Pinus clausa* (sand pine) and *Pinus elliottii* (slash pine), plants typical of deep, well-drained sandy soils. Table 21 shows relative density of dune plants at W.T. Stone State Park.

Figure 17. *Uniola paniculata* covers most dunes in Florida, intermixed with *Panicum amarulum* and *Schizachyrium maritimum* at W. T. Stone State Park.

SALT MARSH (P2)

The salt marsh site faces open waters of St.

TABLE 20. RELATIVE DENSITY IN PERCENTAGES OF DUNE PLANTS AT ST. GEORGE ISLAND, SITE O.

Species	Dates 1/24	5/1	10/3	12/5	Yearly Average
Hydrocotyle bonariensis	x	2.30	x	1.37	1.05
Oenothera humifusa	x		x		.29
Panicum amarulum	x	1.15			.44
Schizachyrium maritimum	82.62	87.30	92.76	92.32	88.75
Uniola paniculata	16.15	9.23	6.17	6.29	9.46

x = species present, constituting less than 1% relative density.

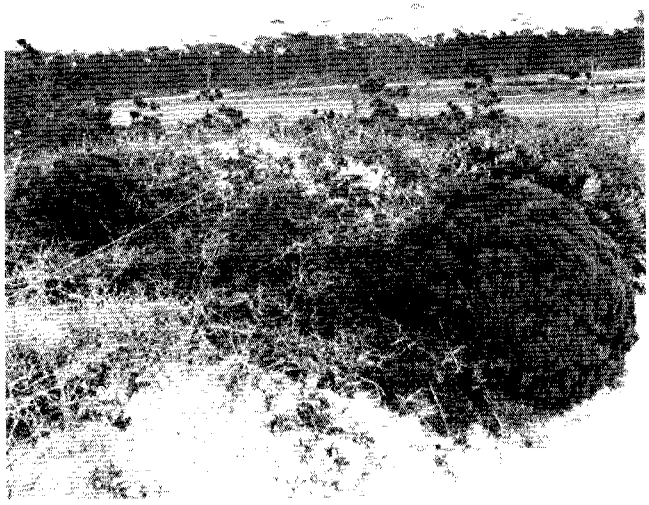

Figure 18. Dunes protected from direct salt spray covered with *Serenoa repens* and *Ceratiola ericoides*, W. T. Stone State Park.

Figure 19. *Juncus roemerianus* and *Spartina alterniflora* dominate intertidal shorelines at W. T. Stone State Park. Substrate consists of mud, decayed seagrass leaves, and variously sized pine bark chips.

Joseph Bay to the northeast. Seagrass flats and broad shallows enable marsh plants to extend some distance into bay waters. *Spartina alterniflora* and *Juncus roemerianus* dominate intertidal and above-tide levels, respectively (Figure 19). Succulents include *Batis maritima*, *Borrichia frutescens*, *Philoxerus vermicularis*, *Salicornia virginica* and *Sesuvium portulacastrum*. Upper shorelines are covered by *Sporobolus virginicus*; a zone of *Baccharis halimifolia* var. *angustior* and *Iva frutescens* marks a transition to higher, dry sand.

Clumps of *Croton punctatus*, *Hydrocotyle bonariensis*, *Iva imbricata* and *Uniola paniculata* along with several species of *Cenchrus* live in the marsh's sandy soil. These plants normally establish on dunes and beaches. Table 22 presents relative density of dune plants at Site P.

SITE Q

Fort Pickens (Escambia County: 30°19′N, 87°14′W), now part of the Gulf Islands National Seashore, lies at the western end of Santa Rosa Island, separating Pensacola Bay and Santa Rosa Sound from the Gulf of Mexico. The Seashore

TABLE 21. RELATIVE DENSITY IN PERCENTAGES OF DUNE PLANTS AT W. T. STONE STATE PARK, PORT ST. JOE, SITE P_1.

Species	Dates 1/21	5/2	10/3	12/5	Yearly Average
Bidens pilosa	2.36				.59
Cenchrus tribuloides			x		.13
Chamaesyce bombensis	x		5.49	1.85	1.93
Cnidoscolus stimulosus		1.64	1.64		.82
Conyza ramosissima			7.14		1.78
Croton punctatus			x	1.23	.44
Heterotheca gossypina			x		.13
Heterotheca subaxillaris	x		x		.23
Hydrocotyle bonariensis	4.72	10.98	7.14	11.11	8.48
Panicum amarulum	2.36	1.64	1.64		1.41
Polygala grandiflora var. *grandiflora*			x	x	.28
Quercus virginiana var. *geminata*	x	1.09	1.09	1.23	1.04
Schizachyrium maritimum	1.96	6.04	x	16.04	6.14
Serenoa repens	x	x	2.19	1.23	1.09
Smilax laurifolia	1.18	2.19			.84
Solidago paucifloscula	2.36	3.29	5.49	3.70	3.71
Uniola paniculata	83.07	72.52	64.83	62.96	70.85

x = species present, constituting less than 1% relative density.

TABLE 22. RELATIVE DENSITY IN PERCENTAGES OF SALT MARSH PLANTS AT W. T. STONE STATE PARK, PORT ST. JOE, SITE P_2.

Species	Dates 1/22	5/1	10/3	12/5*	Yearly Average
Atriplex pentandra			x	—	.04
Baccharis halimifolia var. *angustior*	x	1.29		—	.73
Chloris petraea	2.77	1.51		—	1.42
Galactia volubilis			8.40	—	2.80
Heterotheca subaxillaris			1.47	—	.49
Hydrocotyle bonariensis	1.69	3.45	3.53	—	2.89
Juncus roemerianus	38.21	3.88	2.50	—	14.86
Mikania cordifolia		4.53	5.16	—	3.23
Physalis viscosa var. *maritima*		1.51	x	—	.55
Salicornia virginica		1.72	x	—	.67
Sesuvium portulacastrum	x	x		—	.40
Smilax auriculata			1.17	—	.39
Spartina alterniflora	31.27	27.42	31.26	—	29.98
Sporobolus virginicus	21.72	52.05	41.88	—	38.55
Suaeda linearis			x	—	.04
Uniola paniculata	2.61	2.15	3.83	—	2.86

*Note: station not sampled on date scheduled due to high tides in the marsh.
x = species present, constituting less than 1% relative density.

includes the barrier island's western end, several smaller sections, and several offshore islands extending to the Mississippi coast. The study site is approximately 1.5 km east of park headquarters and stretches from the wave-cut beach (Figure 20) toward Pensacola Bay. Transect length was 76 m. Tide range in Pensacola Bay is approximately 0.5 m (NOAA 867-SC).

Figure 20. The wave-cut beach at Fort Pickens, with *Heterotheca gossypina* and *Uniola paniculata* dominating the flora.

Santa Rosa Island is generally very narrow, often less than 0.8 km wide. Elevations along the western half of the island seldom reach 4.6 m above sea level. As on St. George Island and Cape San Blas, sand dune and pine-oak scrub forests dominate. *Pinus clausa*, the major pine species here, is found throughout the state on sandy scrub communities of relict dunes and sand ridges. Abundant *Ceratiola ericoides* is another indicator of deep, well-drained, sandy soils.

DUNE

Uniola paniculata dominate park dunes, with *Heterotheca gossypina* (hairy camphorweed), *H. subaxillaris*, *Hydrocotyle bonariensis*, *Ipomoea stolonifera*, *Schizachyrium maritimum* and *Solidago pauciflosculosa* (woody goldenrod) contributing significantly to overall community structure. Along the road through the park occur *Bidens pilosa* and species of *Cenchrus*. Clumps of *Quercus virginiana* var. *geminata* (sand live oak) are often found entwined by woody stems of *Smilax laurifolia* on dunes further removed from direct salt spray.

Older, well-developed dunes east of the park, as well as along many areas of the northern Gulf coast, are crowned by specimens of *Magnolia grandiflora* (southern magnolia) and *Pinus palustris* (southern long-leaf pine). Numerous dead trunks confirm Kurz's (1940) observations on the deleterious effects of dune movement on plants of west Florida. Table 23 presents relative density of dune plants at Fort Pickens State Park.

DISCUSSION AND CONCLUSIONS

Early surveyors of Florida's coastal plant communities gave the impression that sections of the state's coastal shorelines were covered by only one of three vegetation types: sand dune, salt marsh, and mangrove (Harper, 1914; Bowman, 1918; Davis, 1943; Egler, 1952). However, during

TABLE 23. RELATIVE DENSITY IN PERCENTAGES OF DUNE PLANTS AT FORT PICKENS, SITE Q.

Species	Dates 1/24	5/1	10/3	12/5	Yearly Average
Cenchrus longispinus	x		x		.26
Chamaesyce ammannioides			4.90	3.39	2.07
Conyza ramosissima			11.69		2.92
Helenium amarum		x	1.50		.51
Heterotheca gossypina	5.78	4.37	x	x	2.84
Heterotheca subaxillaris	14.12	8.74	6.03	18.44	11.83
Hydrocotyle bonariensis	2.54	10.92	4.15	4.85	5.61
Helianthemum corymbosum		3.27	8.67		2.98
Oenothera humifusa	4.16	3.27	4.90	6.31	4.66
Panicum adspersum			1.50		.37
Panicum amarulum	x				.23
Physalis viscosa var. *maritima*		2.18	x	x	.88
Polygala grandiflora var. *grandiflora*			1.50		.37
Quercus virginiana var. *geminata*	x	1.09	x	x	.81
Rumex hastatulus	x	x		1.45	.73
Schizachyrium maritimum	24.30	15.84	21.14	40.29	25.39
Smilax laurifolia	x				.06
Solidago pauciflosculosa	2.77	14.75	12.45		7.49
Uniola paniculata	43.05	34.42	19.24	22.81	29.88

x = species present, constituting less than 1% relative density.

our field work and later analysis, exceptions to these restricted categories became obvious. These exceptions have not been thoroughly explored or discussed by previous workers. This paper attempts to elucidate differences in this flora and define diversity or similarity of species comprising these communities.

Relative density of plants, based on a survey of seventeen selected coastal sites around Florida is reported (Tables 2-23). Percent similarity of communities, or Sørensen's "presence-community coefficient" (IS_s) values are presented in Tables 24 and 25. The higher the Index of Similarity the greater the similarity between communities. Indices ranged from 4 to 61%, the former representing only one plant common to two sites.

The frequent occurrence of plants in a particular location has led to a variety of terms and phrases coined to describe these observed assemblages. Plant community, stand, sociation, association, type, and formation are but a few of a long series of attempts to analyze an abstract, often unrelated taxonomic group of plants inhabiting a particular niche or habitat. Further community definitions include: "a spatial and temporal organization of organisms"; "a combination of plants that are dependent on their environment and influence one another and modify their own environment"; and a "mixed population stand" (Mueller-Dombois and Ellenberg, 1974). A "true" community (Pielou, 1975) is "one whose member individuals interact, either directly or through a chain of other individuals, in a way that affects their individual lifetimes and chances of reproduction and survival."

Originally, this paper was to have surveyed apparent communities of coastal vegetation around Florida. The low Index of Similarity data produced (Tables 24 and 25) reveal the wide diversity of species contained in this flora. Differences in environment were noted broadly, e.g.: sandy ocean beaches; muddy intertidal bay or river shores; coral sand and rock shores. This wide diversity of habitats and environmental factors, acting upon species occupying a particular location, alters species composition and thus our concept of communities. A better term might be "association"—"a more flexible term . . . where community types can be recognized by one or more dominant species . . ." (Mueller-Dombois and Ellenberg, 1974). Index of Similarity values would then report similarity of associations occupying a habitat, e.g., dune habitat, marsh habitat. The habitat generally affects what types of plants can occur there. However, species occurrence is a variable depending on many factors, including wind and ocean currents, nearness of seed sources, and soil types. Plants characterizing Florida coastal habitats are listed and can be used to define similar habitats.

Similarity indices have been used to compare individuals, communities or habitats based on a readily available analysis of occurrence data. These indices have been important in defining apparent associations or non-associations. Use of intuitive

TABLE 24. INDEX OF SIMILARITY (IS_s) VALUES FOR FLORIDA COASTAL VEGETATION INVENTORY.* VALUES ROUNDED TO NEAREST WHOLE NUMBER.

Site	A_2	B_1	B_2	C_1	C_2	D_1	D_2	E	F	G	H	I	J	K	L	M	N	O	P_1	P_2	Q
A_1	13	54	6	44	9	18	4	9	6	—	26	9	8	23	34	40	57	—	7	36	13
A_2		—	56	—	38	—	16	15	—	7	—	20	6	—	17	10	—	43	46	29	43
B_1			6	50	—	30	9	—	7	9	44	—	26	42	22	48	42	—	—	31	—
B_2				—	39	—	19	13	5	18	4	15	18	11	11	14	—	31	26	32	30
C_1					—	38	—	—	8	—	25	—	10	30	26	28	53	—	—	18	—
C_2						—	25	15	8	19	36	26	14	18	13	8	—	17	30	17	20
D_1							5	32	14	—	33	14	17	33	22	24	21	—	—	8	—
D_2								10	27	4	14	31	13	25	8	11	—	—	4	8	8
E									15	19	11	20	18	17	15	6	—	—	8	—	7
F										13	9	20	19	19	11	10	7	—	—	6	—
G											11	14	24	15	—	11	—	12	14	7	6
H												7	15	25	14	41	17	—	—	24	—
I													13	17	12	8	—	5	8	13	16
J														30	13	22	—	—	7	28	6
K															19	22	17	—	—	13	—
L																35	23	—	—	18	—
M																	31	—	—	36	—
N																		—	—	24	—
O																			36	19	42
P_1																				18	23
P_2																					61

*After Sørenson, in Mueller-Dombois and Ellenberg, 1974.

Legend:
A_1 = salt marsh (Fort Clinch)
A_2 = dune (Fort Clinch)
B_1 = mangrove-marsh (Ft. Matanzas)
B_2 = dune (Ft. Matanzas)
C_1 = mangrove-marsh (Apollo)
C_2 = dune (Apollo)
D_1 = mangrove (Sebastian Inlet)
D_2 = strand (Sebastian Inlet)
E = strand (St. Lucie Inlet)
F = strand (Elliott Key)
G = strand (Bahia Honda Key)
H = strand (Flamingo)
I =strand (Wiggins Pass)
J =strand (Manasota Key)
K =strand (Beacon Key)
L =mangrove-marsh (Hammock Key)
M =mangrove-marsh (Atsena Otie Key)
N =salt marsh (Rocky Creek)
O =dune (St. George Island)
P_1 =salt marsh (W. T. Stone State Park)
P_2 =dune (W. T. Stone State Park)
Q =dune (Ft. Pickens)

judgement in data analysis has led to differing interpretations of similar indices and their applicability (Morisita, 1959; Mueller-Dombois and Ellenberg, 1974). This paper uses Sørenson's index as a technique for reporting differences in floristic composition and species similarity/dissimilarity around Florida. I originally selected sites to characterize plant communities consistent with adjacent habitats; however, subsequent low similarity indices (Table 24) suggest that this initial judgement represented habitat regimes and not necessarily plant communities.

For this paper arbitrary "similarity limits" were established as follows:

0-10 percent	almost no similarity
11-25 percent	very low similarity
26-50 percent	low similarity
51-75 percent	moderate similarity
76-100 percent	high similarity

Grouping of percent similarities as they occur in Table 24 according to the above similarity limits is as follows:

0-10 percent	104 entries
11-25 percent	80 entries
26-50 percent	42 entries
51-75 percent	5 entries
76-100 percent	0 entries

On a percent total entry level, these groups represent 45.0, 34.6, 18.2, and 2.2 percent total entries in Table 26. Nearly 97 percent of IS_s values reported from all sites fall below the "low similarity" levels established above. This data reflects the diversity of plant life of coastal Florida, broadens the concepts of restrictive community definitions, and opens avenues for further research into comparisons between similar sites, some of which are discussed below.

TABLE 25. INDEX OF SIMILARITY VALUES (IS_s) OF PARALLEL ASSOCIATIONS DERIVED FROM TABLE 24.

Associations	Sites						
Mangrove-Marsh		M	L	D	C		
	B	48	15	30	50		
	C	28	26	33			
	D	24	22				
	L	35					
Dune		Q	P	O	C	B	
	A	43	46	43	38	56	
	B	30	26	31	39		
	C	20	30	17			
	O	42	36				
	P	61					
Salt Marsh		P	N				
	A	36	57				
	N	24					
Strand		K	J	I	H	G	F	E
	D	25	13	31	14	4	27	10
	E	17	18	20	11	19	15	
	F	19	19	20	9	13		
	G	15	24	14	11			
	H	25	15	7				
	I	17	13					
	J	30						
Mangrove		D						
	A	18						
	B	30						
	C	38						
	L	22						
	M	24						
	N	21						
	P	—						

TABLE 26. ARBITRARY SIMILARITY LIMITS, NUMBER OF IS_s VALUES, AND PERCENT TOTAL ENTRIES OF VEGETATION INVENTORY SITES SHOWN IN TABLE 24.

Associations	Similarity Limits	Number of IS_s Values	Percent of Total Values
Mangrove-Marsh	0- 10 percent	—	0
	11- 25 percent	2	20
	26- 50 percent	8	80
	51- 75 percent	—	0
	76-100 percent	—	0
Dune	0- 10 percent	—	0
	11- 25 percent	2	13.4
	26- 50 percent	12	80.4
	51- 75 percent	1	6.7
	76-100 percent	—	0
Salt Marsh	0- 10 percent	—	0
	11- 25 percent	1	33.3
	26- 50 percent	1	33.3
	51- 75 percent	1	33.3
	76-100 percent	—	0
Mangrove	0- 10 percent	1	14
	11- 25 percent	4	57
	26- 50 percent	2	29
	51- 75 percent	—	0
	76-100 percent	—	0
Strand	0- 10 percent	4	14.4
	11- 25 percent	21	75.6
	26- 50 percent	3	10.2
	51- 75 percent	—	0
	76-100 percent	—	0
Total from Table 24.	0- 10 percent	104	45
	11- 25 percent	80	34.6
	26- 50 percent	42	18.2
	51- 75 percent	5	2.2
	76-100 percent	—	0

SALT MARSH

Salt marsh and mangrove-marsh sites were arbitrarily delimited by presence or absence of any of the three Florida mangroves. On this basis, three sites were defined as salt marsh— Site A, Ft. Clinch (Table 2); Site N, Rocky Creek (Table 19); and Site P, W.T. Stone State Park (Table 22). Table 25 presents IS_s values for these sites. Between Sites A and N, IS_s values were relatively high (57% = moderate similarity), but decreased for Sites A and P (36% = low similarity). Only six species were shared between Sites A and N, five between A and P. Comparison of Site P and N reveals an IS_s value of 24% (= very low similarity), with three species shared.

From this survey, Florida salt marsh habitats are frequently covered by an association of *Batis maritima*, *Borrichia frutescens*, *Juncus roemerianus*, *Monanthochloë littoralis*, *Salicornia virginica*, *Spartina alterniflora*, and *Sporobolus virginicus*.

DUNE

Highest IS_s values obtained (Table 25) were collected from dune sites. Values from Site P, W.T. Stone State Park (Table 21), and Site Q, Ft. Pickens (Table 23), were the highest (61% = moderate similarity), closely followed by a value of 56% (moderate similarity) for dune Sites A, Ft. Clinch (Table 3) and B, Ft. Matanzas (Table 5). Eighty percent of dune IS_s values fall into the "low similarity" category, ranging from 26 to 46% (Table 26). Two values (17% and 20%) represent very low similarity between sites. When east coast and west coast sites are compared, IS_s values are lowest, reflecting differences in plants occupying

apparently similar habitats. The lowest value, 17%, reflects only two species shared between sites.

Plants of Florida's dune habitat are principally an association of *Heterotheca subaxillaris*, *Panicum amarulum*, *Schizachyrium maritimum*, and *Uniola paniculata*.

STRAND

Strand plants (shore plants not readily described as dune, marsh or mangrove) occupy much of Florida's coast. A widely diverse assemblage comprises the segment of Florida coastal vegetation from Site D, Sebastian Inlet (Table 9), to Site K, Beacon Key (Table 16). Index of Similarity values calculated for strand habitats were never above the "low similarity" category, with 75% ranging between 11-25%. Highest IS_s values were 27, 30, and 31%, in the "low similarity" class, representing 10% of total entries (Table 26). The highest value (31%) represented Site D, Sebastian Inlet (Table 9) when compared to Site I, Elliott Key (Table 11), with nine common species. Overall, strand IS_s values were low, reflecting a different halophytic flora; few species are represented at more than one or two sites.

MANGROVE

Although the three mangrove species were found at various sites, only Site D, Sebastian Inlet (Table 8) was considered an exclusive mangrove site. Upon comparison with salt marsh and mangrove-marsh communities (Table 25), higher IS_s values than expected were obtained. Index of Similarity values ranged from 18 to 38 percent, comparing Site D to Site A (Ft. Clinch) and Site C (Apollo), respectively. Fifty-seven percent of the IS_s values (Table 26) are in the "low similarity" category, 29% in the "very low similarity" class, and 14% (Site P and Site D) in the "almost no similarity" category. Salt marsh grasses and succulents contribute significantly in raising IS_s values above expected values.

MANGROVE-MARSH

Mangrove-marsh sites, areas not dominated by either mangroves or salt marsh associations, are present by Site B, Ft. Matanzas (Table 4) and Site C, Apollo (Table 6) on Florida's east coast, and by Site L, Hammock Key (Table 17) and Site M, Atsena Otie Key (Table 18) on the Gulf. Index of Similarity values ranged from 15% (sites B and L) to 50% (sites B and C), indicating considerable species variation between sites. Eighty percent of IS_s values were in the "low similarity" class, with 20% in the "almost no similarity" group (Table 26).

Common dominant species of the mangrove-marsh habitat are *Avicennia germinans*, *Aster tenuifolius*, *Batis maritima*, *Borrichia frutescens*, *Juncus roemerianus*, *Limonium carolinianum*, *Spartina alterniflora*, and *S. patens*. *Avicennia* is found at all four sites, no doubt due to its ability to withstand periodic freezes. Winter cold fronts and a relatively broad and shallow continental shelf along the Gulf coast favor development of broad salt marshes and cause a displacement of mangroves further south than along the Atlantic coast.

ACKNOWLEDGEMENTS

A survey of this size required the assistance of a number of persons, to whom I extend my thanks. Appreciation is extended to herbaria directors and their assistants at the following institutions, gardens, and laboratories: Gulf Coast Research Laboratory, Ocean Springs, Mississippi; University of West Florida, Pensacola; Florida State University, Tallahassee; University of Florida, Gainesville; University of South Florida, Tampa; Florida Atlantic University, Boca Raton; University of Miami, Coral Gables; Fairchild Tropical Garden, Miami; and Florida Keys Community College, Key West.

Various persons in the Division of Recreation and Parks, especially Park Superintendents and Managers, offered much help and encouragement. Thanks are also due to the District Naturalists, under the direction of Chief Naturalist, Major Jim Stevenson, for assistance and advice. Personnel of the National Park Service at Everglades, Fort Matanzas, Elliott Key and Gulf Islands National Seashore were also helpful and supportive.

I wish to extend thanks to Messrs Edwin A. Joyce, Jr., and Dale Beaumariage, and Ms. Karen A. Steidinger for their encouragement and assistance. Appreciation is expressed to Mr. Terry Pulver, staff biologist, for his assistance in the actual fieldwork for this survey. Grateful acknowledgement is extended to Ms. Rena B. Futch, Ms. Jennifer W. Smith, the late Dr. Robert W. Long, Jr. (University of South Florida), Dr. Robert K. Godfrey (Tall Timbers Research Station), and Ms. Cynthia Carter and Mr. Charles Futch for their editorial assistance.

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APPENDIX I

LIST OF COMMON AND SCIENTIFIC NAMES, AND FREQUENTLY ENCOUNTERED SYNONYMS OF PLANTS FOUND IN THE SURVEY OF COASTAL VEGETATION IN FLORIDA.

Scientific Name	Common Name	Family
Acrostichum aureum L.	Mangrove fern Leather fern	Pteridaceae
Agave americana L.	Century plant	Agavaceae
Alternanthera ramosissima (Mart.) Chodat (*A. floridana* Small) (*Achyranthes ramosissima* (Mart.) Standl.)	Chaff flower	Amaranthaceae
Amyris elemifera L.	Torchwood	Rutaceae
Andropogon capillipes Nash (*A. glaucus* Muhl.)	Beardgrass	Poaceae (Graminae)
Andropogon virginicus L. (*A. glomeratus* (Walt.) BSP.)	Broomsedge	Poaceae
Ardisia escallonioides Schlect. (*Icacorea paniculata* (Nutt.) Sudw.)	Marlberry	Myrsinaceae
Aster tenuifolius L. (includes var. *aphyllus* R. W. Long and var. *tenuifolius*)	Salt marsh aster	Asteraceae (Compositae)
Atriplex arenaria Nutt.	Sand atriplex Orach	Chenopodiaceae
Atriplex pentandra (Jacq.) Standl.	Crested atriplex	Chenopodiaceae
Avicennia germinans (L.) L. (*A. germinans* (L.) Stearn) (*A. nitida* Jacq.)	Black mangrove Honey mangrove	Avicenniaceae
Baccharis angustifolia Michx.	False willow	Asteraceae
Baccharis halimifolia L. var. *angustior* DC.	Groundsel Silverling	Asteraceae
Batis maritima L.	Saltwort	Bataceae
Bidens pilosa L. (includes var. *pilosa* and var. *radiata* Sch.-Bip.) (*B. leucantha* L.)	Beggar tick	Asteraceae
Borrichia arborescens (L.) DC.	Sea oxeye daisy	Asteraceae
Borrichia frutescens (L.) DC.	Sea oxeye daisy	Asteraceae
Bumelia tenax (L.) Willd.	Tough buckthorn	Sapotaceae
Bursera simaruba (L.) Sarg. (*Elaphrium simaruba* (L.) Rose)	Gumbo limbo	Burseraceae
Caesalpinia bonduc (L.) R. Br. (*C. crista* L.) (*Guilandina crista* (L.) Small)	Gray nickerbean	Fabaceae (Leguminosae)
Cakile edentula (Bigel.) Hook ssp. *Harperi* (Small) Rodman (*C. Harperi* Small)	Sea rocket	Brassicaceae (Cruciferae)
Cakile lanceolata (Willd.) O. E. Schulz ssp. *fusiformis* (Greene) Rodman (*C. fusiformis* Greene)	Sea rocket	Brassicaceae

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Scientific Name	Common Name	Family
Cakile lanceolata (Willd.) (Continued) (*C. lanceolata* var. *fusiformis* (Greene) Patman) (*C. Chapmanii* Millsp.)		
Canavalia maritima (Aubl.) Urban (*C. obtusifolia* (Lam.) DC.) (*Canavali lineata* (Thunb.) DC.)	Beach bean June bean	Fabaceae
Casasia clusiifolia (Jacq.) Urban (*Genipa clusiaefolia* (Jacq.) Griseb.)	Seven-year apple	Rubiaceae
Cassia fasciculata Michx. (*Chamaecrista fasciculata* (Michx.) Greene	Partridge pea	Fabaceae
Casuarina equisetifolia Forst.	Australian pine	Casuarinaceae
Cenchrus incertus M.A. Curtis	Sandspur	Poaceae
Cenchrus longispinus (Hackl.) Fern.	Sandspur	Poaceae
Cenchrus tribuloides L.	Sandspur	Poaceae
Ceratiola ericoides Michx.	Rosemary	Empetraceae
Chamaesyce ammannioides (HBK) Small	Spurge	Euphorbiaceae
Chamaesyce blodgettii (Engelm.) and Hitch.) Small (*Euphorbia blodgettii* Engelm. and Hitch.)	Spurge	Euphorbiaceae
Chamaesyce bombensis (Jacq.) Dugand	Spurge	Euphorbiaceae
Chamaesyce hirta (L.) Millsp. (*C. pilulifera* (L.) Small) (*Euphorbia hirta* L.)	Spurge	Euphorbiaceae
Chamaesyce mesembryanthemifolia (Jacq.) Dugand (*C. buxifolia* (Lam.) Small)	Spurge	Euphorbiaceae
Chenopodium ambrosioides L. (*Ambrina ambrosioides* (L.) Spach.)	Mexican tea	Chenopodiaceae
Chiococca alba (L.) Hitch.	Snowberry	Rubiaceae
Chloris petraea Swartz (*Eustachys petraea* Desv.)	Finger grass	Poaceae
Chrysobalanus icaco L. (*C. pellocarpus* Meyer) (*C. interior* Small)	Coco plum	Chrysobalanaceae
Cirsium horridulum Michx. (*Carduus spinosissimus* Walter) (*Carduus smallii* (Britt.) Ahles.)	Purple thistle	Asteraceae
Cissus incisa (Nutt.) Des Moulins	Marine ivy	Vitaceae
Cnidoscolus stimulosus (Michx.) Engelm. and Gray (*Bivonia stimulosus* (Michx.) Raf.) (*Jatropha stimulosus* Michx.)	Tread softly	Euphorbiaceae

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Scientific Name	Common Name	Family
Coccoloba diversifolia Jacq. (*C. laurifolia* Jacq.) (*C. floridana* Meissner)	Tie tongue	Polygonaceae
Coccoloba uvifera (L.) Jacq. (*Coccolobis uvifera* (L.) Jacq.)	Sea grape	Polygonaceae
Commelina diffusa Burm. f. (*C. longicaulis* Jacq.)	Dayflower	Commelinaceae
Conocarpus erectus L. (*C. erecta* L.)	Buttonwood Button mangrove	Combretaceae
Conocarpus erectus L. var. *sericea* Forst. ex DC.	Silver buttonwood	Combretaceae
Cordia sebestena L. (*Sebesten sebestena* (L.) Britt.)	Geiger tree	Boraginaceae
Conyza ramosissima Cronquist (*Erigeron divaricatus* Michx.) (*Leptilon divaricatum* (Michx.) Raf.)	Dwarf horseweed	Asteraceae
Croton punctatus Jacq.	Beach tea	Euphorbiaceae
Cyperus retrorsus Chapm. (*C. Torreyi* Small)	Nut sedge	Cyperaceae
Dalbergia ecastophyllum (L.) Taub. (*Ecastophyllum ecastophyllum* (L.) Britt.)	Coin vine	Fabaceae
Desmodium canum (Gmel.) Schinz and Thellund (*Meibomia cana* (Gmel.) Blake)	Tick trefoil	Fabaceae
Distichlis spicata (L.) Greene	Seashore saltgrass	Poaceae
Ernodea littoralis Sw. var. *littoralis* R. W. Long (includes *E. angusta* Small)	Ernodia	Rubiaceae
Erythrina herbacea L.	Coral bean	Fabaceae
Eugenia axillaris (Sw.) Willd. (*E. monticola* DC.)	White stopper	Myrtaceae
Ficus aurea Nutt.	Strangler fig	Moraceae
Fimbristylis spathacea Roth	Fringed rush	Cyperaceae
Forestiera segregata (Jacq.) Krug and Urban var. *segregata* (*F. porulosa* (Michx.) Poir.) (*Adelia segregata* Jacq.)	Florida privet	Oleaceae
Galactia volubilis (L.) Britt.	Milk pea	Fabaceae
Galium hispidulum Michx. (*G. bermudense* L.)	Bedstraw	Rubiaceae
Gilia rubra (L.) Heller (*Ipomopsis rubra* (L.) Wherry)	Standing cypress	Polemoniaceae
Gouania lupuloides (L.) Urban	Chew stick	Rhamnaceae
Helenium amarum (Raf.) H. Rock (*H. tenuifolium* Nutt.)	Sneezeweed	Asteraceae

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Scientific Name	Common Name	Family
Helianthemum corymbosum Michx. (*Crocanthemum corymbosum* (Michx.) Britt.)	Rock rose	Cistaceae
Helianthus debilis Nutt. (including ssp. *debilis* and ssp. *vestitus* (E. E. Watson) Heiser)	Dune sunflower	Asteraceae
Heliotropium curassavicum L.	Seaside heliotrope	Boraginaceae
Heterotheca gossypina (Michx.) Shinners (*Chrysopsis gossypina* Nutt.)	Golden aster Hairy camphorweed	Asteraceae
Heterotheca subaxillaris (Lam.) Britt. and Rusby	Camphorweed	Asteraceae
Hydrocotyle bonariensis Lam.	Water pennywort	Apiaceae
Hymenocallis latifolia (Mill.) Roem. (*H. keyensis* Small) (*H. collieri* Small)	Keys spider lily	Amaryllidaceae
Indigofera leptosepala Nutt. ex Torr. and Gray	Indigo	Fabaceae
Ipomoea acuminata (Vahl.) R. and S. (*I. cathartica* Poir.) (*Pharbitis cathartica* (Poir.) Choisy)	Morning glory	Convolvulaceae
Ipomoea pes-caprae (L.) Sweet (includes var. *emarginata* Hallier f.)	Railroad vine	Convolvulaceae
Ipomoea stolonifera (Cyrill) J. F. Gmel. (*I. littoralis* (L.) Boiss.)	Goats-foot morning glory Beach morning glory	Convolvulaceae
Ipomoea triloba L.	Morning glory	Convolvulaceae
Iva frutescens L.	Marsh elder	Asteraceae
Iva imbricata Walt.	Beach elder Marsh elder	Asteraceae
Juncus roemerianus Scheele	Black needlerush	Juncaceae
Juniperus silicicola (Small) Bailey	Southern red cedar	Cupressaceae
Laguncularia racemosa Gaertn. f.	White mangrove	Combretaceae
Lantana camara L. (*L. aculeata* L.)	Shrub verbena	Verbenaceae
Licania michauxii Prance (*Chrysobalanus oblongifolius* Michaux)	Gopher apple	Chrysobalanaceae
Limonium carolinianum (Walt.) Britt. var. *angustatum* (Gray) Blake) (*L. Nashii* Small var. *angustatum* (Gray) Ahles) (*L. angustatum* (Gray) Small)	Sea lavender	Plumbaginaceae

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Scientific Name	Common Name	Family
Limonium carolinianum (Walt.) Britt. var. *carolinianum* (*L. Nashii* Small)	Sea lavender	Plumbaginaceae
Lippia nodiflora L. (*Phyla nodiflora* (L.) Greene)	Cape weed	Verbenaceae
Lycium carolinianum Walt.	Christmas berry	Solanaceae
Magnolia grandiflora L. (*M. foetida* (L.) Sarg.)	Southern magnolia	Magnoliaceae
Melanthera spp.	Melanthera	Asteraceae
Mikania cordifolia (L.) Willd.	Climbing hempweed	Asteraceae
Momordica charantia L.	Wild balsam apple	Cucurbitaceae
Monanthochloë littoralis Engelm.	Key grass	Poaceae
Monarda punctata L.	Horsemint	Lamiaceae
Myrcianthes fragrans (Sw.) McVaugh (includes var. *simpsonii* (Small) R. W. Long) (*Anamomis simpsonii* Small)	Nakedwood	Myrtaceae
Myrica cerifera L. (*Cerothamus ceriferus* (L.) Small)	Wax myrtle	Myricaceae
Myrsine guianensis (Aubl.) Kuntze (*M. rapanea* R. and S.) (*Rapanea guayanensis* Aubl.) (*R. guianensis* Aubl.)	Myrsine	Myrsinaceae
Oenothera humifusa Nutt. (*Raimannia humifusa* (Nutt.) Rose)	Seaside evening primrose	Onagraceae
Opuntia stricta Haw. (includes var. *stricta* and var. *dillenii* (Ker.) L. Benson)	Prickly-pear cactus	Cactaceae
Panicum adspersum Trin.	Panic grass	Poaceae
Panicum amarulum Hitch. and Chase	Dune panic grass	Poaceae
Panicum repens L.	Torpedo grass	Poaceae
Parthenocissus quinquefolia (L.) Planchon	Virginia creeper	Vitaceae
Paspalum vaginatum Sw. (possible synonym of *P. distichum* L.)	Salt jointgrass	Poaceae
Passiflora suberosa L. (*P. pallida* L.)	Corky stem	Passifloraceae
Persea borbonia (L.) Spreng. var. *borbonia* (*P. littoralis* Small) (*Tamala borbonia* (L.) Raf.) (*T. pubescens* (Pursh) Small)	Red bay	Lauraceae
Philoxerus vermicularis (L.) R. Br. (*Iresine vermicularis* (L.) Moq.)	Marsh samphire	Amaranthaceae

APPENDIX I

LIST OF COMMON AND SCIENTIFIC NAMES, AND FREQUENTLY ENCOUNTERED SYNONYMS OF PLANTS FOUND IN THE SURVEY OF COASTAL VEGETATION IN FLORIDA (Continued).

Scientific Name	Common Name	Family
Phlebodium aureum (L.) J. Smith (*Polypodium aureum* L.)	Golden polypody fern	Polypodiaceae
Physalis viscosa L. (includes var. *maritima* (M.A. Curtis) Waterfall)	Groundcherry	Solanaceae
Pinus clausa (Chapm. ex Engelm.) Vasey ex. Sarg.	Sand pine	Pinaceae
Pinus elliottii Engelm. (includes var. *elliottii* and var. *densa* Little and Dorman) (*P. caribaea* sensu Small) (*P. palustris* sensu Small)	Slash pine	Pinaceae
Pinus palustris Mill. (*P. australis* Michx. f.)	Southern long-leaf pine	Pinaceae
Pisonia aculeata L.	Devil's claws	Nyctaginaceae
Pithecellobium keyense Britt ex Coker (*P. guadelupense* Chapm.)	Cat claws Black-bead	Fabaceae
Pluchea purpurascens (Sw.) DC.	Camphor weed	Asteraceae
Poinsettia cyathophora (Murr.) Small	Painted leaf	Euphorbiaceae
Polygala grandiflora Walt. var. *grandiflora* (*P. cumulicola* Small) (*P. miamiensis* Small) (*Asemeia grandiflora* (Walt.) Small)	Polygala	Polygalaceae
Portulaca pilosa L.	Pink purslane	Portulacaceae
Quercus virginiana Miller var. *geminata* Sarg. (*Q. geminata* Small) (*Q. virginiana* Miller var. *maritima* (Chapm.) Sarg.)	Sand live oak	Fagaceae
Randia aculeata L.	White indigo berry	Rubiaceae
Rhabdadenia biflora (Jacq.) Muell. Arg. (*R. paludosa* (Vahl.) Miers) (*Echites biflora* Jacq.)	Rubber vine	Apocynaceae
Rhizophora mangle L.	Red mangrove	Rhizophoraceae
Rivina humilis L.	Rouge plant Rouge berry	Phytolaccaceae
Rumex hastatulus Baldw. ex Ell.	Sorrell Common dock	Polygonaceae
Rumex pulcher L.	Fiddle dock	Polygonaceae
Ruppia maritima L.	Widgeon grass	Ruppiaceae
Sabal palmetto (Walt.) Lodd. and Schultes (*S. jamesiana* Small) (*Inodes palmetto* O. F. Cook)	Cabbage palm	Arecaceae (Palmae)

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LIST OF COMMON AND SCIENTIFIC NAMES, AND FREQUENTLY ENCOUNTERED SYNONYMS OF PLANTS FOUND IN THE SURVEY OF COASTAL VEGETATION IN FLORIDA (Continued).

Scientific Name	Common Name	Family
Salicornia bigelovii Torr. (*S. mucronata* Bigel.)	Annual glasswort	Chenopodiaceae
Salicornia virginica L. (*S. perennis* Standl.)	Perennial glasswort	Chenopodiaceae
Salsola kali L. (*S. kali* var. *caroliniana* (Walt.) Nutt.) (*S. kali* var. *tenuifolia* Tausch)	Saltwort	Chenopodiaceae
Samolus ebracteatus HBK. (*Samodia ebracteata* (HBK.) Baudoin)	Water pimpernel	Primulaceae
Scaevola plumieri (L.) Vahl. (*S. plumierii* Vahl.)	Inkberry	Goodeniaceae
Schinus terebinthifolius Raddi (*Rhus terebinthifolius* Schlecht. and Cham.)	Brazilian pepper	Anacardiaceae
Schizachyrium maritimum (Chapm.) Nash in Small (*Andropogon littoralis* Nash) (*A. maritimus* Chapm.)	Seacoast bluestem	Poaceae
Serenoa repens (Bartr.) Small (*S. serrulata* (Michy.) Hook)	Saw palmetto	Arecaceae
Sesuvium portulacastrum L.	Sea purslane	Aizoaceae
Sida cordifolia L.	Sida	Malvaceae
Smilax auriculata Walt.	Greenbrier	Smilacaceae
Smilax laurifolia L.	Bamboo vine	Smilacaceae
Solidago pauciflosculosa Michx. (*Chrysoma pauciflosculosa* (Michx.) Greene)	Woody goldenrod	Asteraceae
Solidago sempervirens L. var. *mexicana* (L.) Fern. (*S. mexicana* L.)	Seaside goldenrod	Asteraceae
Solanum aculeatissimum Jacq.	Soda apple	Solanaceae
Sophora tomentosa L.	Necklace pod	Fabaceae
Spartina alterniflora Loisel.	Smooth cordgrass	Poaceae
Spartina patens (Ait.) Muhl.	Marsh hay cordgrass	Poaceae
Sporobolus poiretii (R. and S.) Hitchc. (*S. berteroanus* (Trin.) Hitchc. and Chase)	Smutgrass	Poaceae
Sporobolus virginicus (L.) Kunth	Virginia dropseed	Poaceae
Stenotaphrum secundatum (Walt.) Kuntze	St. Augustine grass	Poaceae
Suaeda linearis (Ell.) Moq. (*Dondia linearis* (Ell.) Millsp.)	Sea blite	Chenopodiaceae
Suaeda maritima (L.) Dum. (*Dondia maritima* (L.) Druce)	Sea blite	Chenopodiaceae
Suriana maritima L.	Bay cedar	Surianaceae

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LIST OF COMMON AND SCIENTIFIC NAMES, AND FREQUENTLY ENCOUNTERED SYNONYMS OF PLANTS FOUND IN THE SURVEY OF COASTAL VEGETATION IN FLORIDA (Continued).

Scientific Name	Common Name	Family
Tournefortia gnaphalodes (L.) R. Br. (*Mallotonia gnaphalodes* (Jacq.) Britt.)	Sea lavender	Boraginaceae
Toxicodendron radicans (L.) ssp. *radicans* (*Rhus radicans* L.)	Poison ivy	Anacardiaceae
Tradescantia ohiensis Raf. (*T. canaliculata* Raf.) (*T. incarnata* Small)	Spiderwort	Commelinaceae
Uniola paniculata L.	Sea oats	Poaceae
Verbena maritima Small	Seaside verbena	Verbenaceae
Verbesina virginica L. var. *laciniata* (Poir.) Gray (*V. laciniata* (Poir.) Nutt.)	Crownbeard	Asteraceae
Vigna luteola (Jacq.) Benth. (*V. repens* (L.) Kuntze	Cow peas	Fabaceae
Vittaria lineata (L.) J. Smith	Shoestring fern	Vittariaceae
Yucca aloifolia L.	Spanish bayonet	Agavaceae
Zamia pumila L.	Coontie	Cycadaceae
Zanthoxylum clava-herculis L. (*Z. carolinianum* Lam.)	Hercules club	Rutaceae
Zanthoxylum fagara (L.) Sarg.	Wild lime	Rutaceae