SECTION I.

SYNOPSIS OF COASTAL
PLANT COMMUNITIES OF FLORIDA
BEACH AND DUNE COMMUNITIES

The beach/dune community is a hostile environment to all but the hardiest species of plants and animals. High summer temperatures, drought conditions, low nutrient levels, unstable sands, saltwater intrusion, and occasional inundation severely limit the kinds of plants and animals that can live here. In fact, many species have developed special attributes to help them survive in this harsh environment. For instance, dune plants have high growth rates, dense root systems, low profiles, and profuse flower and seed production to compensate for restrictions imposed by severe growth conditions.

The beach/dune environment varies geographically and temporally and can be characterized as low, moderate, or high energy, depending upon the relative magnitude of wave and wind forces acting on the shoreline. The high-energy Atlantic coast of north Florida has extensive dunes (see profile in Figure 1). Dunes along the lower Atlantic coast, which is also high energy, lack the breadth of the northern dunes. Florida's Gulf coast (excluding the Panhandle region) is lower energy, and dunes have rarely formed, except for the central region from Anclote Key to Marco Island where sand deposits can be found fronting the barrier islands. The Panhandle Gulf coast is moderately high energy, and the sands are well sorted, resulting in nutrient- and organic-poor "sugar sands."

Because of the forces generated by breaking waves, beaches do not support vegetation. Immediately landward of the beach above the highest tides, pioneer dune areas are colonized by low herbs (e.g., sea-rockets, sand atriplex, seaside evening-primrose) that become established in the organic debris deposited by wind and waves. As sand accumulates around these plants, the dune feature increases in height, forming the primary, or fore dune. Fore dunes increase in size when low, tough, rhizomatous plants -- such as sea-oats or bitter panicum -- trap and stabilize the shifting sands. Dune fields are a series of older dunes that are more stable and have higher organic content. In areas where dune erosion is extensive or offshore sand sources are limited, dune fields may be narrow or completely absent. When dune soils accumulate sufficient organic material, colonizing woody vegetation (e.g., groundsel-bush, wax-myrtle, or cabbage palm) forms the dense scrub/shrub zone. Upon further development, the oldest dunes may be colonized by trees
Figure 1. Typical Florida sand dune showing common vegetation patterns.
and shrubs, forming the maritime forest. Distinctive communities, called "hammocks," may form on deeper, organic soils. Hammocks often contain tropical species, even as far north as the Cedar Keys on the west coast and Cape Canaveral on the east coast.

Approximately 800 miles of the more than 1300 miles of linear coastline of Florida fronting the Atlantic Ocean and Gulf of Mexico are sandy beaches. These beaches are a primary contributor to the economy of the state. A 1986 Sea Grant study determined that the combined resident and tourist use of the beaches accounted for sales of $4.5 billion, with $164 million collected as state taxes (3). Our fragile beach/dune habitats are constantly assaulted by severe weather; rising sea level may also be cause for future concern. Also, human activities encroach upon the system and interfere with natural cycles of erosion and accretion. In a report published in April 1989 by the Florida Department of Natural Resources' Division of Beaches and Shores, 218 miles of beach were estimated to be in a critical state of erosion (12). Hopefully, educational efforts that promote wise management practices and improve awareness of beach/dune values will help to ensure that this natural resource is available to future generations.
MARINE WETLANDS COMMUNITIES

Plant species growing in coastal wetlands must tolerate inhospitable conditions such as variable tides, high salinity, oxygen-poor sediments, and wave and current damage. Along Florida's coastline, the three most widespread and commonly recognized wetlands plant communities are sea-grass beds, salt marshes, and mangrove forests. Sea-grasses usually occur below mean low water; salt marshes and mangrove forests are principally intertidal but may extend substantial distances landward of mean high water in gently sloping areas.

Sea-grass beds occur in estuarine systems such as the Indian River Lagoon, Biscayne Bay, Charlotte Harbor, Tampa Bay, and Apalachicola Bay. Large offshore beds occur in Florida Bay and from Anclote Key north through Apalachee Bay. Extensive salt marshes are found in, but are not limited to, the Big Bend region on the Gulf coast and the St. Johns River estuary on the Atlantic coast. Large expanses of mangroves occur from Naples south through the Everglades and northward on the Atlantic coast into Biscayne Bay. Less extensive mangrove forests are found in the Florida Keys and most estuarine systems in south Florida.

Sea-grasses are not true grasses but are actually more closely related to lilies. The most common species in Florida's waters are turtle-grass (*Thalassia testudinum*), shoal-grass (*Halodule wrightii*), manatee-grass (*Syringodium filiforme*), star-grass (*Halophila engelmannii*), and widgeon-grass (*Ruppia maritima*). Although sea-grasses are important to marine productivity, the technology to establish them is undeveloped compared to marsh and mangrove species. Because of the complex culture and planting requirements for sea-grasses, nursery-grown stock is virtually nonexistent. For this reason, specific information on sea-grasses has not been included in this publication.

Salt marshes are dominated by grasses and grass-like species (Figure 2). At lower elevations, smooth cordgrass (*Spartina alterniflora*) is more abundant, but as elevation increases slightly, needle rush (*Juncus roemelianus*) becomes dominant. Needle rush is more widespread on the Gulf coast, and smooth cordgrass is more extensive on the Atlantic coast. Salt marshes are common in the northern half of Florida, but because marsh species
Figure 2. Typical Florida salt marsh. Mangroves displace marsh vegetation at lower elevations in southern regions of the state.
are easily shaded out by cold-sensitive mangroves, they are usually found only in patches along deeper mangrove margins in the southern half of the state.

Mangroves are cold-sensitive trees that grow along saline, tidally influenced shores of the tropics and subtropics. The word "mangrove" is an ecological term and does not imply a taxonomic relationship among the various species. In Florida, three species of mangroves are commonly recognized: red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove (*Laguncularia racemosa*). A fourth species, buttonwood (*Conocarpus erecta*), is often accepted as a mangrove because of its regular occurrence at the landward margin of the mangrove community and its close relationship to the white mangrove. Under appropriate conditions (e.g., lack of disturbance, gradual slopes, etc.), mangrove species may occur in distinct zones. Red mangrove usually occurs on the seaward margin, followed by black mangrove, white mangrove, and the most landward species, buttonwood (Figure 3).

In infrequently flooded, gentle-slope areas transitional to uplands, mangroves and salt marshes may give way to salt flats. Salt flats, also known as salterns, salt barrens, or salinas, are characterized by high-salinity substrates (90 parts per thousand [ppt] up to 125 ppt or higher) devoid of vegetation except for patches of low-growing forbs, grasses, and occasionally, stunted mangroves around the margin. During certain times of the year, salt flats are critical feeding areas for important commercial and sport-fish species. Water salinity in salt flats may vary from nearly fresh during rainy periods to highly saline (greater than 70 ppt) during spring tides. At the other salinity extreme (annual average water salinity of 0.5 to 5 ppt) where substantial freshwater input occurs, oligohaline marshes dominated by brackish-water species (e.g., saw-grass, cat-tails) develop. Oligohaline marshes are important year-round habitats for many animal species.

Coastal plants provide shelter for juvenile and adult animals, contribute nutritional energy sources that enhance marine productivity, aid in protecting uplands from varying degrees of wave damage, assist in improving and maintaining water quality, and provide complex aesthetic benefits. An estimated 383,000 acres of salt marshes and 674,000 acres of mangroves occur in Florida (17). Although salt marshes and mangrove forests cover large areas in some places, severe local destruction has depleted these resources such that decreased fisheries productivity is becoming evident.
Figure 3. Typical Florida fringe mangrove showing the commonly recognized zonation pattern.
SECTION II.

PLANTING AND MAINTENANCE GUIDELINES
GUIDELINE CATEGORY DESCRIPTIONS

The 17 plant species discussed in this guide were selected primarily because they are readily available from most commercial salt-tolerant vegetation sources. In addition, these species are relatively easily transplanted, exhibit rapid growth patterns, and/or encourage development of plant community diversity by propagule (including seeds, fruits, etc.) entrapment. An abbreviated list of other potentially useful salt-tolerant species can be found in Section IV.

Because appropriate plant species must be selected to encourage development of the desired habitat, correct identification is crucial. Therefore, both close-up and habit photographs are provided, as well as line drawings showing unique plant characteristics. However, substantial variability in appearance, influenced by environment (such as water, nutrients, and light) and by genetic makeup, occurs within each species. For example, some species grow in both sand dunes and marsh habitats and may have coarse, thick leaves in one habitat and fine, thin leaves in the other. Accordingly, presentation of the total range of field variability is not practical in a publication of this scope, and species identification by a professional may be desirable.

Habitat requirements and horticultural information for each species are presented under four headings: Plant Characteristics, Plant Availability, Planting Guidelines, and Maintenance Guidelines. Subheadings within each major heading further distinguish individual species. Each of these headings and subheadings is described on the following pages.

Plant Characteristics

The plant characteristics described below are generalizations especially pertinent to habitat creation projects. Other less obvious characteristics may modify habitat quality as well (e.g., long-term soil maturation).
Ecological Function/User Application - This category describes natural and human-oriented values supplied by the plant's community. Commonly recognized values are erosion control, sediment stabilization, wildlife habitat (shelter and food), water quality improvement, or aesthetic contributions. Frequently, government agencies establish specific planting requirements to attempt to achieve these values.

Natural Geographic Distribution/Cold Hardiness - Although all of the plants described in this publication are native to Florida, many of them cannot be grown statewide. Therefore, each species' geographic distribution and resistance to low temperature are included and keyed to a map of Florida's temperature zones (Figure 4). These zones are modified by year-to-year climatic differences and local topography. Genetic variability of plant populations can modify cold tolerance as well.

Optimum Soil Type - This category provides information on clay/organic content and drainage characteristics of the substrate. Dune soils are generally well-drained sands. Marsh soils, which contain fine-grained clays and organics, retain more water than dune soils.

Resistance to Erosion - Although planting vegetation does not guarantee complete erosion control, many species have shoots that slow down wind-blown sand or water-borne sediments and dense root systems that bind the soil and sediments. In general, dense grass stands are better suited for erosion control than low, vine-like vegetation or shrubs and trees.

Related to erosion resistance by shoreline plants is the "fetch" of the site. Fetch is the longest stretch of unobstructed, open water facing the planting. Fetch and water depth largely determine wave height and, in turn, the magnitude of erosive forces acting on the shoreline. Some plants, such as smooth cordgrass, can tolerate longer fetches during establishment than other plants, such as mangrove propagules.
Figure 4. Average annual low temperature zones in Florida (after Bradley, 1972) (4).
Although plants in dune systems are less subject to wave damage, many states have laws to help reduce beach and dune erosion. For instance, the Florida Department of Natural Resources (FDNR) Division of Beaches and Shores has established the Coastal Construction Control Line (CCCL) along the state’s sandy beach shorelines. This line identifies the beach/dune zone that would be subjected to 100-year storm surges. A permit must be obtained from the Division before any construction, change of grade, alteration of contours, or destruction of vegetation can occur seaward of this line.

**Potential Growth Rate** - This category provides a relative estimate of how quickly the plant will spread laterally. Plant growth rates are strongly affected by local environmental conditions. For instance, growth rates are higher in areas where regular input of fresh water dilutes salinity. Nevertheless, growth rates may be slowed more by severely fluctuating salinity than by constantly low or moderately high salinities. Optimum growth-promoting salinities for many coastal species are between 10 and 15 parts per thousand.

**Plant Availability**

The success of any planting project is largely dependent on the availability of the desired plant during its optimum planting period. Plants may be nursery grown or harvested from natural populations. The Association of Florida Native Nurseries’ annual **Plant and Service Locator** is a comprehensive guide to sources of salt-tolerant vegetation. Copies may be obtained by contacting the association (see Commercial Sources insert for the address).

**Nursery Sources** - Descriptions in this subheading refer to plants that are propagated and grown in a nursery (greenhouse or field). Because certain species require longer culture periods, they may be available only if the grower is given adequate advance notification; contractual agreements are
usually required in this case. Various types and sizes of pots and planting units are usually available for most plants. However, because of growth characteristics and production costs, some species are available only in limited quantities and sizes. Units are usually produced in liners, two-inch, four-inch, one-gallon, and three-gallon pots; larger sizes are rare at this time but are becoming available. Larger units are more expensive and the probability of survival may not be enhanced.

**Natural Sources** - This subheading describes planting units obtained from natural populations; these units may be cuttings, plugs, sods, bare-root, or seed/propagule sources. In general, plants obtained from local natural populations may represent the better management practice. Plants transplanted directly from the field may be available on relatively short notice, but suppliers are required to obtain permits from the Florida Department of Environmental Regulation (FDER) and FDNR to remove plants from jurisdictional waters. Mangrove propagules and seeds/fruit of many species are not currently under restriction, but State of Florida regulations prohibit the transport of certain species (usually nuisance species) between bodies of water without a permit (Bureau of Aquatic Plant Research and Control, FDNR).

Unpermitted destruction or alteration of wetlands is prohibited by Section 404 of the federal Clean Water Act and the Warren S. Henderson Wetland Protection Act, Section 403, Part VIII, Florida Statutes (F.S.). Mangroves are specifically protected by FDER Chapter 17-27, Florida Administrative Code (FAC), with general protection under FDER Chapters 17-3, 17-4 and 17-12, FAC and Section 403.061, F.S. Harvesting seeds of some sensitive dune plants may also be restricted. For example, sea-oats and sea-grape seeds are protected on public lands and seaward of the CCCL under Sections 161.053(2) and 370.041, F.S.
**Planting Guidelines**

This section addresses some of the more critical concerns regarding the establishment of plant habitats. The categories listed below have interacting effects, so that changing one variable often requires adjustment of the others to maximize survival of planted units. Additionally, because of unforeseen events, some sites may require replanting over a period of time.

**Elevation** - Information provided under this category refers to planting elevation relative to tide range. Elevation is often referenced to the National Geodetic Vertical Datum (NGVD), a survey reference plane established in 1929 that approximates mean sea level in some areas. Because tidal range varies with location, its relationship to NGVD may differ as well. Also, some local benchmarks have changed elevation since their installation and may be unreliable.

Absolute planting elevations cannot be specified for a particular species because of the above limitations. However, tidal range during the optimum planting window (see p. 14) can be estimated for a given site, and plants can be placed at elevations that increase their chances of survival. Although elevations of nearby plants can be used as a planting guide, propagules and seedlings may not have as broad a physical tolerance as older, established plants.

**Ground Slope** - This term refers to the change in elevation over a given distance; for example, a one-foot vertical change over five feet of horizontal distance is a 1 to 5 slope. Slope may also be expressed as a percentage (e.g., 1 to 5 is a 20% slope) or in degrees (e.g., 1 to 5 is approximately a 10° slope). Wetlands plants characteristically colonize gentle slopes, but steeper slopes can support many of the species described in this publication. However, steeper slopes contain much less area for plant colonization and provide less habitat value, partly because of complete surface drainage (some intertidal animals survive only in water films at low tide). In low-slope areas, minor
elevation that cause permanent ponding -- while providing habitat for some creatures -- often cause death of installed plants.

**Depth** - This category refers to the depth at which the root-ball is planted relative to the substrate surface. For example, dune soils are subject to drying at the surface; therefore, planting the root-ball deeper ensures a moist soil environment for root initiation. Some plants are adversely affected by deep planting and must be installed at a shallower depth. These plants often require watering during the establishment phase if planted in soils subject to drying conditions.

**Planting Window** - Optimum planting periods for a species differ geographically. Therefore, a general time-frame (window) is suggested that takes into account optimum temperature and natural geographic distribution.

**Density** - This category refers to the spacing between plants that provides a reasonable vegetative cover in the shortest time. Plant species differ in growth form and growth rate and, consequently, the time needed to provide a desired cover or density. For example, grass species generally exhibit more rapid lateral growth than woody species and have historically been planted at densities that provide total cover in two to three years. However, mangroves planted at these same densities have often proven to take longer for their leaves and branches to form a continuous canopy. Planting mangroves at higher densities should provide better habitat values sooner.

**Maintenance Guidelines**

Because the plants in this guide are native to Florida and are adapted for survival under natural conditions, they should require little maintenance. However, several maintenance practices that may ensure the rapid establishment of these plants are
suggested. This does not imply that such practices are necessary or even desirable over the long term.

**Watering** - Occasionally, some form of irrigation is needed. Because other variables may be critical, certain species must be planted during a dry portion of the year and must be watered when installed. However, continued watering may allow invasion by undesirable plants that interfere with establishment of the desired species and the quality of the habitat. All plant species subject to saline field conditions at planting may require saline acclimation in the nursery prior to planting. Although little is known regarding the influence of freshwater culture on plants installed in saline conditions, some evidence indicates a long-term negative influence on plant survival.

**Fertilization** - Fertilization may be desirable to promote rapid shoot growth. However, long-term use of fertilizer or high application rates may encourage invasion by undesirable species and may inhibit root production. Incorporation of a time-release fertilizer in the planting hole is preferred. Broadcast fertilizer is not acceptable for wetlands species at any time.

**Weeding** - Some weeding and removal of debris can be beneficial during the establishment phase. Over the long term, removal and continued control of habitat-damaging exotic vegetation (e.g., Brazilian-pepper and Australian-pine) is essential for maintenance of habitat quality.

**Pruning** - Cutting, clipping, or mowing improves growth of some plants but can seriously damage others. Before pruning is undertaken, relevant species-specific state and local government restrictions must be considered. For example, pruning of sea-grapes is addressed in Sections 161.053(2) and 370.041, F.S.
In addition to restrictions on sea-grape pruning, current FDER mangrove-protection rules limit pruning of mangroves (Chapter 17-27, FAC). Other state laws prohibit all unpermitted pruning within boundaries of Aquatic Preserves and would supersede the FDER rule. City and county mangrove laws must be at least as restrictive as FDER and FDNR regulations and are occasionally more restrictive. Concerns about pruning effects on mangroves extend beyond the immediate, individual plant response. Complex ecosystem properties such as habitat quality and quantity are influenced by mangrove stand-structure, and long-term studies are required before an adequate understanding of these properties is realized.

**Relevant Literature** - Additional information about each species is available from a number of sources. Particularly helpful literature is listed here and keyed to the reference list that begins on p. 51.