AN INTRODUCTION TO PLANTING AND MAINTAINING SELECTED COMMON COASTAL PLANTS IN FLORIDA

PRINCIPAL EDITORS:
MICHAEL R. BARNETT & DAVID W. CREWZ
AN INTRODUCTION TO PLANTING AND MAINTAINING
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PRODUCED BY

THE FLORIDA SEA GRANT
SALT-TOLERANT VEGETATION ADVISORY PANEL

PRINCIPAL EDITORS:

MICHAEL R. BARNETT
FLORIDA SEA GRANT EXTENSION PROGRAM

DAVID W. CREWZ
FLORIDA MARINE RESEARCH INSTITUTE
FLORIDA DEPARTMENT OF NATURAL RESOURCES

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PREFACE

In 1983, the Florida Sea Grant Extension Program organized salt-tolerant vegetation experts from industry, government, and the extension program into a working panel. Since then, the members of the Salt-Tolerant Vegetation Advisory Panel have worked diligently to improve communications between the various agencies and industries involved in efforts to restore coastal habitats in Florida. This publication represents the fulfillment of one of the advisory panel's major goals — to produce an introductory guide to habitat design, planting, and maintenance of selected marsh, mangrove, and dune plant species.

This publication consists of four sections. The first section provides a brief summary of coastal habitats in Florida. The second section contains the planting and maintenance guidelines. Illustrations and color plates are provided in the third section to aid in species identification and differentiation. A glossary of terms is provided in an appendix along with information on other coastal plant species not detailed in this report.

Substantial variation exists in the style in which the common names of many coastal plant species are presented in publications. To maintain consistency throughout this publication, the common names used follow the rules set forth in the Council of Biological Editors Style Manual. For instance, sea-oats is hyphenated since it is not a true "oat."

Although the information in this publication should be very helpful to readers who have had limited experience with salt-tolerant vegetation, simply following the guidelines presented here will not guarantee a successful planting. In fact, some guidelines may need to be modified to meet differences in plant community structure or the desired plant application. The inexperienced planter should always contact an accredited consultant before planning or beginning a planting of salt-tolerant vegetation.

A list of commercial establishments that stock coastal plant species is included at the end of this publication. However, this list is not a complete compilation of all the sources of these species, and a periodic update of this list will be prepared by the Florida Sea Grant Program. Inquiries or comments about the list may be addressed to the Florida Sea Grant Program, Building 803, University of Florida, Gainesville, FL 32611. The inclusion of a commercial source on this list does not constitute an endorsement of the firm by the Florida Sea Grant Program or the Florida Cooperative Extension Service.
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Members of the Florida Sea Grant Salt-Tolerant Vegetation Advisory Panel include those persons named above, as well as A. Gail Boorman (A. Gail Boorman & Associates), Joseph L. Gilio (Wetlands Management, Inc.), William E. Hoffman (Associated Marine Institutes), and Dan Stankey (U.S.D.A. Soil Conservation Service). Past members include Robert Glennon (U.S.D.A. Soil Conservation Service) and Larry Rabinowitz (private consultant). This publication could not have been produced without the invaluable advice, critical reviews, and comments provided by these dedicated professionals.

Final editing of this publication was performed by Michael R. Barnett, Sydney T. Bacchus, David W. Crewz, Jay Humphreys (Florida Sea Grant), and John M. Stevely. Outside review was provided by Dr. David W. Hall (Herbarium, University of Florida), Dr. Margaret O. Hall (Florida Marine Research Institute), Dr. Robin B. Huck (Division of Recreation and Parks, Florida Department of Natural Resources), and Paden E. Woodruff III (Division of Beaches and Shores, Florida Department of Natural Resources). Marilyn L. Little (Florida Sea Grant) assisted with final text preparation.

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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 roemerianus*) 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/fruits 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.
GUIDELINES
*Avicennia germinans* (L.) L. - Black Mangrove

(Figures 6, 9; Plate II)

**PLANT CHARACTERISTICS**

Ecological Function/User Applications - shoreline protection and sediment stabilization; nursery habitat for birds and marine life; contribution to detrital-based food web; aesthetics; water-quality maintenance.

Natural Geographic Distribution/Cold Hardiness - low-energy, coastal wetlands; throughout southern Florida and American tropics, north on the Atlantic coast to Matanzas Inlet vicinity and on the Gulf coast to Cedar Key; least cold-sensitive of the three mangrove species; freezes only in coldest winters in northern parts of its range; zones 3-7.

Optimum Soil Type - saturated organic soils with periodic tidal inundation.

Resistance to Erosion - good in older plants; rapid sediment buildup may eventually kill larger plants; protect young plants from wave action; initial use of smooth cordgrass to stabilize shorelines may encourage establishment of naturally colonized and broadcast propagules.

Potential Growth Rate - In early years, two to two and one-half feet or more per year in nutrient-rich, protected areas.

**PLANT AVAILABILITY**

Nursery Sources - liner size up to one-gallon pots; limited availability of larger plants.

Natural Sources - transplants rare due to governmental regulations regarding natural populations; propagules available in early fall (floating or removed from trees). Cannot be propagated by cuttings or air-layering.

**PLANTING GUIDELINES**

Elevation - small plants and propagules at approximate MHW (except during highest spring tides); larger plants may tolerate elevations lower than MHW, but specific site characteristics will modify survival.

Ground Slope - up to 30° (1 to 2) for larger plants, but less than 10° (1 to 5) is preferable; protected, wet ground with no slope for propagules.
**Avicennia germinans** (continued)

**Depth** - top of root-ball even with soil surface.

**Planting Window** - in the spring, after danger of frost has passed, through November; planting in the northernmost part of its range is not recommended (zones 3-4); rainy periods better if plants have been grown in fresh water.

**Density** - historically, three feet on center (O.C.) or less for one-gallon plants (legal requirements will dictate maximum distances); denser plantings emulate natural recruitment and should improve overall quality of planting.

**MAINTENANCE GUIDELINES**

**Watering** - not required.

**Fertilization** - for small plants, a teaspoon of time-release, nitrogenous fertilizer incorporated when planted; responds well to higher nutrients in culture.

**Weeding** - control flotsam and jetsam until plants are fully established; some sea-grass wrack desirable.

**Pruning** - may tolerate various pruning techniques if done properly; see state and local restrictions in Guideline Category Descriptions (pp. 15-16).

[Relevant Literature - 10, 11, 13-15, 21, 27, 39, 42, 47, 48-54, 57, 62, 65, 66, 74, 77, 78, 80, 85-91, 96]
Borrichia frutescens (L.) DC. - Sea Ox-eye Daisy

(Figures 15, 16; Plate V)

PLANT CHARACTERISTICS

Ecological Function/User Applications - sediment stabilization; seed source for birds and small mammals; aesthetics.

Natural Geographic Distribution/Cold Hardiness - coastal high marshes and dunes; Virginia to Florida and Gulf states; tolerates lowest temperatures throughout Florida; zones 2-7.

Optimum Soil Type - saturated, silty sands.

Resistance to Erosion - good; tolerates sediment buildup.

Potential Growth Rate - rapid spread through rhizomes.

PLANT AVAILABILITY

Nursery Sources - liners, four-inch pots, occasionally one-gallon pots.

Natural Sources - seeds prolifically; does not transplant well.

PLANTING GUIDELINES

Elevation - high-marsh areas above mean high water.

Ground Slope - up to 45° (1 to 1), but less than 10° (1 to 5) is preferable.

Depth - top of root-ball slightly below soil surface.

Planting Window - March through November south of Tampa Bay/Cape Canaveral and April through October northward.

Density - as desired to fill in between principal planted species (e.g., sea-oats or marsh-hay).
Borrichia frutescens (continued)

MAINTENANCE GUIDELINES

Watering - when planted, and periodically for first few weeks if rain or tidal inundation is lacking.

Fertilization - light fertilization may be helpful in high pH soils/dredge spoil.

Weeding - remove and control exotics.

Pruning - tolerates limited top cutting.

[Relevant Literature - 11, 26, 27, 45, 67, 68]
Distichlis spicata (L.) Greene - Saltgrass

(Figures 21, 22, 30, 33; Plate VII)

PLANT CHARACTERISTICS

Ecological Function/User Applications - sediment stabilization; food source for birds and small mammals; habitat.

Natural Geographic Distribution/Cold Hardiness - coastal high marsh and inland saline wetlands; Canada to Florida and Gulf states; tolerates lowest temperatures throughout Florida; zones 2-7.

Optimum Soil Type - wet to saturated silty sands.

Resistance to Erosion - fair; tolerates slow sedimentation.

Potential Growth Rate - rapid; dense cover in second year in some sites.

PLANT AVAILABILITY

Nursery Sources - liners, two- and four-inch pots.

Natural Sources - bare-root, plugs, seeds; vegetative state easily confused with some growth forms of Sporobolus virginicus and Paspalum vaginatum.

PLANTING GUIDELINES

Elevation - from just below MHW to highest spring-tide levels; best with infrequent inundation but withstands frequent inundation.

Ground Slope - up to 30° (1 to 2), but less than 10° (1 to 5) is preferable.

Depth - top of root-ball approximately two inches below soil surface at higher elevations.

Planting Window - March through November south of Tampa Bay/Cape Canaveral and April through October northward.

Density - bare-root one foot O.C., two-inch plugs two feet O.C., four- and six-inch plugs three feet O.C.
*Distichlis spicata* (continued)

**MAINTENANCE GUIDELINES**

**Watering** - not required in moist soils subject to inundation.

**Fertilization** - responds well to one teaspoon per plant of a time-release, nitrogenous fertilizer when planted.

**Weeding** - remove and control exotics.

**Pruning** - mowing can stimulate vegetative growth.

[Relevant Literature - 8, 9, 11, 18, 26, 27, 30, 36, 44, 45, 73, 96]
Helianthus debilis Nutt. - Dune Sunflower; Beach Sunflower

(Figures 13, 14; Plate V)

Note: Two subspecies of interest to planters occur in Florida: Helianthus debilis subspecies debilis occurs along the Atlantic coast, and Helianthus debilis subspecies vestitus (E.E. Wats) Heiser occurs only along the central peninsular Gulf coast. These subspecies differ somewhat in stem color, hairiness, leaf margins, and flower size. Because of this differentiation, care should be taken not to transport the subspecies between coasts. Preservation of these subspecies should be of concern to growers because introduction of plants of the Atlantic coast subspecies could dilute the genetic composition of the threatened Gulf coast subspecies.

PLANT CHARACTERISTICS

Ecological Function/User Applications - food source for birds, small mammals, and insects; minor role in dune stabilization; aesthetics.

Natural Geographic Distribution/Cold Hardiness - see note above; throughout peninsular Florida dunes; subject to cold damage in northern parts of its range in colder winters; zones 4-7.

Optimum Soil Type - well-drained sandy and calcareous dune soils.

Resistance to Erosion - fair; usually found in sheltered, stable dunes.

Potential Growth Rate - rapid with moderate water but slow in less stabilized, drier sands.

PLANT AVAILABILITY

Nursery Sources - liners, two- and four-inch pots.

Natural Sources - cuttings, seeds.

PLANTING GUIDELINES

Elevation - behind fore dune or on stabilized slopes above erosional forces.

Ground Slope - up to 30° (1 to 2), but less than 10° (1 to 5) in unstable sands.

Depth - top of root-ball approximately two inches below soil surface.
**Helianthus debilis** (continued)

**Planting Window** - March through November south of Tampa Bay/Cape Canaveral.

**Density** - as desired to fill in between principal planted species (e.g., sea-oats).

**MAINTENANCE GUIDELINES**

**Watering** - when planted and every five days for one month if heavy rainfall does not occur.

**Fertilization** - approximately one teaspoon per plant of balanced, time-release fertilizer (14-14-14), incorporated when planted, aids root establishment; too much fertilizer may inhibit root growth.

**Weeding** - remove and control exotics.

**Pruning** - withstands heavy clipping once established.

[Relevant Literature - 2, 18, 22, 46, 64, 84]
*Ipomoea imperati* (Vahl) Griseb. - Beach Morning-glory

(Figures 11, 12; Plate IV)

Note: Recent taxonomic revision has placed *Ipomoea stolonifera* (Cyrillo) J.F. Gmel. in synonymy with *Ipomoea imperati*.

**PLANT CHARACTERISTICS**

Ecological Function/User Applications - soil stabilization; aesthetics.

Natural Geographic Distribution/Cold Hardiness - coastal dunes and sandy shores; Florida and Gulf states north to South Carolina; tolerates lowest temperatures throughout Florida; zones 2-7.

Optimum Soil Type - well-drained sandy soils.

Resistance to Erosion - fair, once established.

Potential Growth Rate - rapid but uneven; dense cover possible in two to three growing seasons.

**PLANT AVAILABILITY**

Nursery Sources - liners, two- and four-inch pots, one-gallon pots.

Natural Sources - cuttings, seeds.

**PLANTING GUIDELINES**

Elevation - upper high marsh and dune areas; withstands infrequent inundation.

Ground Slope - up to 20° (1 to 3); grows on steeper slopes if stable.

Depth - top of root-ball slightly below soil surface.

Planting Window - March through November south of Tampa Bay/Cape Canaveral and April through October northward.

Density - small plants one and one-half feet O.C., large plants three feet O.C., or intermittent among principal dune species (e.g., sea-oats).
Ipomoea imperati (continued)

MAINTENANCE GUIDELINES

Watering - when planted and periodically during the first few weeks if heavy rainfall does not occur.

Fertilization - responds well to light application of a time-release fertilizer (14-14-14).

Weeding - remove and control exotics; shaded out by dense grasses.

Pruning - tolerates clipping for landscape purposes.

[Relevant Literature - 2, 18, 22, 46, 96]
Ipomoea pes-caprae (L.) R. Br. - Railroad-vine

(Figures 10, 12; Plate IV)

PLANT CHARACTERISTICS

Ecological Function/User Applications - soil stabilization; aesthetics.

Natural Geographic Distribution/Cold Hardiness - dune swales, high beaches, and coastal wetlands margins; central and south Florida, further north on the Atlantic coast; sensitive to freezing temperatures; zones 5-7.

Optimum Soil Type - moist sandy or calcareous soils.

Resistance to Erosion - fair, once established.

Potential Growth Rate - rapid but uneven; dense cover possible in two to three growing seasons (more rapid in moister soils).

PLANT AVAILABILITY

Nursery Sources - liners, two- and four-inch pots, one-gallon pots.

Natural Sources - cuttings, seeds.

PLANTING GUIDELINES

Elevation - above MHW to limits of high marsh and in low dune areas; withstands infrequent inundation.

Ground Slope - up to 20° (1 to 3); grows on steeper slopes if stable.

Depth - top of root-ball slightly below soil surface.

Planting Window - April through October south of Tampa Bay/Cape Canaveral; planting in the northernmost part of its range is not recommended.

Density - smaller units one and one-half feet O.C., larger units three feet O.C.
Ipomoea pes-caprae (continued)

MAINTENANCE GUIDELINES

Watering - when planted and periodically during the first few weeks if heavy rainfall does not occur.

Fertilization - responds to a light application of balanced, time-release fertilizer (14-14-14).

Weeding - remove and control exotics.

Pruning - tolerates clipping for landscape purposes.

[Relevant Literature - 2, 18, 22, 46, 62, 79, 94, 96]
*Iva frutescens* L. - Marsh-elder

(Figures 17, 19; Plate VI)

**PLANT CHARACTERISTICS**

Ecological Function/User Applications - seed source for birds and small mammals; planted to retard exotic plant invasion.

Natural Geographic Distribution/Cold Hardiness - coastal high-marsh margins; Canada to Florida and Gulf states; tolerates lowest temperatures throughout Florida; zones 2-7.

Optimum Soil Type - moist, low-salinity soils; tolerant of high-pH soils.

Resistance to Erosion - moderate; offers protection against rainfall-induced erosion.

Potential Growth Rate - rapid in better soils.

**PLANT AVAILABILITY**

Nursery Sources - four-inch pots, one-gallon pots.

Natural Sources - cuttings, seeds.

**PLANTING GUIDELINES**

Elevation - above MHHW.

Ground Slope - up to 20° (1 to 3).

Depth - top of root-ball even with soil surface.

Planting Window - March through November south of Tampa Bay/Cape Canaveral and April through October northward.

Density - intermittently with other plants.
*Iva frutescens* (continued)

**MAINTENANCE GUIDELINES**

**Watering** - when planted, unless heavy rainfall occurs.

**Fertilization** - responds well to balanced fertilizers (e.g., 14-14-14).

**Weeding** - remove and control exotics.

**Pruning** - response not documented, but probably survives.

[Relevant Literature - 11, 26, 96]
Iva imbricata Walt. - Beach-elder, Dune-elder

(Figures 18, 19; Plate VI)

PLANT CHARACTERISTICS

Ecological Function/User Applications - food source for birds and small mammals; secondary component of dunes and high marsh; traps sand.

Natural Geographic Distribution/Cold Hardiness - coastal dunes and high-marsh margins; Virginia to Florida and Gulf states; tolerates lowest temperatures throughout Florida; zones 2-7.

Optimum Soil Type - sandy soils.

Resistance to Erosion - poor to fair; tolerates sand accretion.

Potential Growth Rate - moderate; shrubby habit.

PLANT AVAILABILITY

Nursery Sources - four-inch pots, one-gallon pots.

Natural Sources - cuttings, seeds.

PLANTING GUIDELINES

Elevation - above MHHW.

Ground Slope - up to 30° (1 to 2).

Depth - top of root-ball four inches below soil surface in dunes; in heavier soils, root-ball even with soil surface.

Planting Window - March through November south of Tampa Bay/Cape Canaveral and April through October northward.

Density - intermittently with other plants (e.g., sea-oats).
Iva imbricata (continued)

MAINTENANCE GUIDELINES

Watering - when planted (especially in dunes) unless heavy rainfall occurs.

Fertilization - responds to balanced, time-release fertilizer (14-14-14) incorporated when planted.

Weeding - remove and control exotics.

Pruning - does not tolerate severe clipping.

[Relevant Literature - 2, 6, 11, 15, 16, 18, 22, 46, 64, 96]
**Juncus roemerianus** Scheele - Needle Rush; Black Rush

(Figure 20; Plate VII)

**PLANT CHARACTERISTICS**

Ecological Function/User Applications - shoreline protection and sediment stabilization; contribution to detrital-based food web; habitat for marine organisms; water-quality maintenance.

Natural Geographic Distribution/Cold Hardiness - low-energy, coastal marshes; Maryland to Florida and Gulf states; rarer in south Florida; tolerates lowest temperatures throughout Florida; zones 2-7.

Optimum Soil Type - saturated organic muck or sandy clay loam.

Resistance to Erosion - fair; waterward edge subject to undermining.

Potential Growth Rate - slow; several growing seasons required to attain coalescence of a fairly dense planting.

**PLANT AVAILABILITY**

Nursery Sources - limited availability in two- and four-inch pots, one-gallon pots.

Natural Sources - bare-root, plugs.

**PLANTING GUIDELINES**

Elevation - MHW to high spring-tide levels.

Ground Slope - up to 10° (1 to 5).

Depth - top of root-ball two inches below soil surface.

Planting Window - March through November south of Tampa Bay/Cape Canaveral and April through October northward.

Density - one foot O.C. for coalescence within one growing season; two feet O.C. will require considerably longer to coalesce.
Juncus roemerianus (continued)

MAINTENANCE GUIDELINES

Watering - not required.

Fertilization - some response to time-release, nitrogenous fertilizer incorporated when planted.

Weeding - not required.

Pruning - clipping results in temporary stand of green plants, reverting to grey-brown colors, mixed with green, within one to two months.

[Relevant Literature - 8, 11, 13, 14, 24-27, 28, 31, 39, 45, 47, 48-52, 56, 85-91, 96]
Laguncularia racemosa (L.) Gaertn. f. - White Mangrove

(Figures 7, 9; Plate III)

PLANT CHARACTERISTICS

Ecological Function/User Applications - shoreline protection and sediment stabilization; nursery habitat for birds and marine life; contribution to detrital-based food web; aesthetics; water-quality maintenance.

Natural Geographic Distribution/Cold Hardiness - low-energy, coastal wetlands; throughout southern Florida and American/African tropics north to Brevard County on the Atlantic coast and Tampa Bay area on the Gulf coast; most cold-sensitive of the three Florida mangrove species and may suffer severe freeze damage as far south as Naples; zones 5-7.

Optimum Soil Type - moist, sandy, organic sediments.

Resistence to Erosion - good for adult plants; rapid sediment buildup may eventually kill adults; protect young plants from wave action; initial use of smooth cordgrass to stabilize shorelines may encourage establishment of natural-colonized and broadcast propagules.

Potential Growth Rate - very rapid, shrubby growth in protected areas.

PLANT AVAILABILITY

Nursery Sources - smaller containers (one gallon down to liner size); limited availability of larger plants.

Natural Sources - transplants rare due to governmental regulations regarding natural populations; propagules available in early fall (floating or removed from trees); can be air-layered.

PLANTING GUIDELINES

Elevation - small plants and collected propagules at approximate MHW (except during highest spring tides); larger plants may tolerate elevations lower than MHW, but specific site characteristics will modify survival.

Ground Slope - up to 30° (1 to 2) for larger plants, but less than 10° (1 to 5) is preferable; protected, wet ground with no slope for propagules.

Depth - top of root-ball even with soil surface.
Laguncularia racemosa (continued)

Planting Window - in the spring, after danger of frost has passed, through November; planting in the northernmost part of its range is not recommended (zone 5).

Density - historically, three feet O.C. or less for small plants (legal requirements will dictate maximum distances); denser plantings emulate nature and may improve overall quality of planting.

MAINTENANCE GUIDELINES

Watering - not required.

Fertilization - one teaspoon per plant of a time-release, nitrogenous fertilizer incorporated when planted; responds well to higher nutrients in culture.

Weeding - control flotsam and jetsam until plants are fully established; some sea-grass wrack desirable.

Pruning - plants may tolerate various pruning techniques if done properly; see state and local restrictions in Guideline Category Descriptions (pp. 15-16).

[Relevant Literature - 10, 11, 13, 14, 21, 27, 39, 40, 47, 51-54, 57, 62, 65, 66, 74, 77, 78, 80, 82, 84-91, 96]
*Panicum amarum* Ell. - Bitter Panicum; Beach Panicgrass

(Figures 27, 32; Plate X)

Note: Recent taxonomic revision has placed *Panicum amarullum* Hitchc. and Chase in synonymy with *Panicum amarum*. Differences in seed production result from differences in the number of sets of chromosomes; *Panicum amarum* has six sets (hexaploid) and *Panicum amarullum* has four sets (tetraploid). The form with six sets of chromosomes should be avoided because of low seed set; it is recognizable by being more prostrate and open-growing, and the inflorescence is narrower and sparsely flowered. Northern populations of *P. amarum* are more erect and clumpy and have probably crossed with *Panicum virgatum* L.

**PLANT CHARACTERISTICS**

Ecological Function/User Applications - sand trapping and stabilization; food source and cover for birds and small mammals.

Natural Geographic Distribution/Cold Hardiness - coastal dunes; Connecticut to Florida and Gulf states; tolerates lowest temperatures throughout Florida; zones 2-7.

Optimum Soil Type - well-drained, sandy soils.

Resistance to Erosion - good, once established.

Potential Growth Rate - rapid (dense coverage in two to three growing seasons).

**PLANT AVAILABILITY**

Nursery Sources - liners, two- and four-inch pots; advance notice of plant quantities and/or a growing contract is necessary for the hexaploid form.

Natural Sources - cuttings, seeds (tetraploid form only).

**PLANTING GUIDELINES**

Elevation - above limit of wave uprush and highest spring tides.

Ground Slope - up to 30° (1 to 2).

Depth - top of root-ball four inches below sand surface.
Panicum amarum (continued)

Planting Window - March through November south of Tampa Bay/Cape Canaveral and April through October northward.

Density - small plants one and one-half feet O.C., large plants three feet O.C.

MAINTENANCE GUIDELINES

Watering - when planted, and during the first month unless heavy rainfall occurs.

Fertilization - incorporate one teaspoon per plant of a balanced, time-release fertilizer (14-14-14) when planted.

Weeding - remove and control exotics.

Pruning - lateral spread improved by clipping.

[Relevant Literature - 6, 18, 20, 22, 46, 59, 64, 81, 92]
*Paspalum vaginatum* Sw. - Salt Jointgrass; Seashore Paspalum

(Figures 23, 30, 34; Plate VIII)

Note: One recent taxonomic revision placed *Paspalum vaginatum* in synonymy with *Paspalum distichum* L. However, further study supported maintaining *P. vaginatum* as a distinct species.

**PLANT CHARACTERISTICS**

Ecological Function/User Applications - soil stabilization; food source and cover for some birds and small mammals.

Natural Geographic Distribution/Cold Hardiness - coastal plain freshwater and saltwater high marshes; North Carolina to Florida and Gulf states and south to Argentina; tolerates lowest temperatures throughout Florida; zones 2-7.

Optimum Soil Type - moist, silty sands.

Resistance to Erosion - excellent, once established.

Potential Growth Rate - rapid; dense cover possible in one to two growing seasons.

**PLANT AVAILABILITY**

Nursery Sources - liners, two-inch pots.

Natural Sources - bare-root, plugs, cuttings; vegetative state can be confused with some forms of *Sporobolus virginicus* and *Distichlis spicata*.

**PLANTING GUIDELINES**

Elevation - above MHW and in low dune areas; withstands some flooding.

Ground Slope - up to 30° (1 to 2), but plants will grow on steeper slopes.

Depth - top of root-ball slightly below soil surface.

Planting Window - March through November south of Tampa Bay/Cape Canaveral and April through October northward.

Density - two-inch plants one and one-half feet O.C., larger plants three feet O.C.
**Paspalum vaginatum** (continued)

**MAINTENANCE GUIDELINES**

**Watering** - not required in moist soils, but periodically during the first few weeks in drier soils if rain is lacking.

**Fertilization** - responds well to balanced fertilizers.

**Weeding** - remove and control exotics.

**Pruning** - mowing results in a low, dense mat.

[Relevant Literature - 11, 18, 40]
Rhizophora mangle L. - Red Mangrove

(Figures 5, 9; Plate I)

PLANT CHARACTERISTICS

Ecological Function/User Applications - shoreline protection and sediment stabilization; nursery habitat for birds and marine life; contribution to detrital-based food web; aesthetics; water-quality maintenance.

Natural Geographic Distribution/Cold Hardiness - low-energy, coastal wetlands; throughout southern Florida and tropics north on the Atlantic coast to Ponce de Leon Inlet and on the Gulf coast to Cedar Key; difficult to establish north of Melbourne on the Atlantic coast and north of Tampa Bay on the Gulf coast, due to freeze damage in colder winters; zones 4-7.

Optimum Soil Type - mixture of sand and organics inundated regularly by tides.

Resistance to Erosion - poor for propagules and small plants; large plants more resistant. Initial use of smooth cordgrass to stabilize shorelines may encourage establishment of naturally colonized and broadcast propagules.

Potential Growth Rate - shoot-length increase of six to twelve inches per year in nutrient-rich soils; moderate-nutrient substrates promote branching; low-nutrient substrates promote flower production.

PLANT AVAILABILITY

Nursery Sources - readily available in two-inch pots up to three-gallon containers; availability decreases as plant size increases.

Natural Sources - transplants rare due to government regulations regarding natural populations; propagules available in early fall (floating or removed from trees). Vegetative propagation possible, but difficult.

PLANTING GUIDELINES

Elevation - just below MHW to summer spring-tide elevations for smaller plants; check local elevation range for naturally established propagules to confirm optimum elevation range.

Ground Slope - up to 30° (1 to 2), but less than 10° (1 to 5) is preferable.
**Rhizophora mangle** (continued)

**Depth** - insert propagules two to three inches into soil surface; for rooted propagules and large plants, root-ball even with soil surface.

**Planting Window** - propagules August through November (corresponds to natural availability); nursery plants after the last frost of the winter, and no later than November; planting in the northernmost part of its range is not recommended (zone 4).

**Density** - historically, three feet O.C. or less for small plants (legal requirements will dictate maximum distance); denser plantings emulate natural recruitment and may improve overall quality of planting.

**MAINTENANCE GUIDELINES**

**Watering** - not required.

**Fertilization** - top growth increased by light application of time-release, nitrogenous fertilizer incorporated when planted.

**Weeding** - remove accumulated drift material during the first year following planting; some sea-grass wrack is desirable.

**Pruning** - does not survive severe pruning; even regular long-term clipping can cause death of plants; see state and local regulations in Guideline Category Descriptions (pp. 15-16).

[Relevant Literature - 10, 11, 13, 14, 21, 27, 32-35, 39, 41, 47-54, 57, 58, 62, 65, 66, 74, 76-78, 80, 85-91, 96]
Spartina alterniflora Loisel. - Smooth Cordgrass

(Figures 25, 31; Plate IX)

PLANT CHARACTERISTICS

Ecological Function/User Applications - shoreline protection and sediment stabilization; contribution to detrital-based food web; nursery habitat; water-quality maintenance.

Natural Geographic Distribution/Cold Hardiness - low-energy, coastal low marshes; Canada south to Florida and Gulf states, although rarer in south Florida; tolerates lowest temperatures throughout Florida; zones 2-7.

Optimum Soil Type - regularly inundated, silty sediments.

Resistance to Erosion - generally good once established.

Potential Growth Rate - rapid; dense cover possible in two growing seasons.

PLANT AVAILABILITY

Nursery Sources - two- and four-inch pots.

Natural Sources - bare-root, plugs; short form occurs in poorly flushed areas and tall form occurs on creek banks.

PLANTING GUIDELINES

Elevation - upper one-third of the tide range and slightly above MHW; can occupy a zone slightly lower than red mangrove by 0.2 - 0.3 ft.

Ground Slope - up to 15° (1 to 4).

Depth - top of root-ball two inches below soil surface.

Planting Window - March through November south of Tampa Bay/Cape Canaveral and April through October northward; no later than July for erosion-prone areas where dense growth is needed to provide shoreline protection during first winter season; planting season can be extended by using natural stock.

Density - one foot O.C. for bare-root, one and one-half feet O.C. for two-inch plugs, two feet O.C. for four-inch plugs, three feet O.C. for six-inch plugs.
Spartina alterniflora (continued)

MAINTENANCE GUIDELINES

Watering - not required.

Fertilization - responds well to time-release, nitrogenous fertilizer incorporated when planted.

Weeding - remove accumulated drift material during the first six months following planting.

Pruning - careful clipping can stimulate vegetative growth and spread of rhizomes; pruning while the plant is in flower can extend the period of vegetative growth into late autumn and early winter; pruning during late winter or early spring to remove frost-killed material can stimulate spring growth by reducing the shading of new tillers.

[Relevant Literature - 7, 8, 11, 13, 14, 26, 27, 28, 31, 39, 45, 47-53, 55, 56, 61, 66, 73, 75, 78, 85-91, 96]
Spartina patens (Ait.) Muhl. - Marsh-hay; Saltmeadow Cordgrass

(Figures 26, 31; Plate IX)

PLANT CHARACTERISTICS

Ecological Function/User Applications - shoreline protection and soil stabilization; forage.

Natural Geographic Distribution/Cold Hardiness - coastal high-marsh margins and dunes; Canada to Florida and Gulf states, but less common in south Florida; tolerates lowest temperatures throughout Florida; zones 2-7.

Optimum Soil Type - loose, sandy soils; tolerates a wide range of soils (except very fine-grained soils such as clay, mud and muck).

Resistance to Erosion - good, once established.

Potential Growth Rate - moderately rapid but tends to clump in wet soils; dense cover possible in two growing seasons.

PLANT AVAILABILITY

Nursery Sources - two- and four-inch pots.

Natural Sources - bare-root, plugs, larger transplants; may be mistaken vegetatively for Spartina spartinae (Grin.) Merr.

PLANTING GUIDELINES

Elevation - above MHW to highest spring-tide elevation in marsh areas; on upland side of primary dune and in swales between dunes.

Ground Slope - up to 15° (1 to 4).

Depth - top of root-ball slightly below soil surface.

Planting Window - March through November south of Tampa Bay/Cape Canaveral and April through October northward.

Density - small plants one foot O.C., increased spacing with plant size up to two and one-half feet O.C. for four-inch plugs.
Spartina patens (continued)

MAINTENANCE GUIDELINES

Watering - when planted in dune areas and until plants are established; not generally required in high-marsh areas.

Fertilization - in dunes, one teaspoon per plant of a balanced, time-release fertilizer (e.g., 14-14-14), incorporated when planted; in marsh, incorporate one teaspoon per plant of a nitrogenous, time-release fertilizer when planted.

Weeding - remove accumulated drift material during the first six months following planting in marsh areas; remove and control exotics in dune areas.

Pruning - responds well to clipping or mowing, when done properly.

[Relevant Literature - 2, 6, 11, 18, 26, 27, 30, 39, 46, 70-72, 81, 96]
Sporobolus virginicus (L.) Kunth - Seashore Dropseed

(Figures 24, 30, 35; Plate VIII)

PLANT CHARACTERISTICS

Ecological Function/User Applications - soil stabilization; food source for birds and small mammals.

Natural Geographic Distribution/Cold Hardiness - coastal dunes, high marsh, and transition areas; Virginia to Florida and Gulf states, and south to Brazil; tolerates lowest temperatures throughout Florida; zones 2-7.

Cold Hardiness - very good.

Optimum Soil Type - moderately well-drained, silty sand.

Resistance to Erosion - very good, once established.

Potential Growth Rate - rapid; dense cover possible in two growing seasons (provided initial spacing is not greater than two feet O.C.).

PLANT AVAILABILITY

Nursery Sources - limited availability in two- and four-inch pots.

Natural Sources - bare-root, plugs, seeds; vegetative state may be confused with some growth forms of Paspalum vaginatum and Distichlis spicata.

PLANTING GUIDELINES

Elevation - above MHW; tolerates occasional inundation, but may suffer with regular inundation.

Ground Slope - up to 30° (1 to 2), but plants will grow on steeper slopes.

Depth - root-ball approximately two inches below soil surface in moist soil, deeper in dry soil; larger plants slightly deeper.

Planting Window - March to November south of Tampa Bay/Cape Canaveral and April to October northward.
**Sporobolus virginicus** (continued)

Density - bare-root six inches O.C., increased spacing for larger plants up to two feet O.C. for six-inch plugs.

**MAINTENANCE GUIDELINES**

Watering - when planted and periodically for the first few weeks in dry soils, unless heavy rainfall occurs; not required in moist soils.

Fertilization - incorporate one teaspoon per plant of a time-release, balanced fertilizer (e.g., 14-14-14) in dunes and nitrogenous fertilizer in wet soils.

Weeding - remove and control exotics.

Pruning - clipping or mowing stimulates vegetative growth and controls exotics.

[Relevant Literature - 2, 5, 8, 11, 18, 23, 29, 39, 81, 92]
Uniola paniculata L. - Sea-oats

(Figures 28, 29, 32; Plate X)

PLANT CHARACTERISTICS

Ecological Function/User Applications - sand stabilization; food source and cover for birds and small mammals; aesthetics.

Natural Geographic Distribution/Cold Hardiness - coastal dunes; Virginia to Florida and Gulf states; tolerates lowest temperatures throughout Florida; zones 2-7.

Optimum Soil Type - well-drained, sandy or calcareous soils.

Resistance to Erosion - good, once established; withstands wind erosion well, but waves wash away soil and plants.

Potential Growth Rate - highly dependent on environmental conditions and maintenance; plants can grow laterally up to four feet per year after establishment; dense cover possible in three growing seasons; flowers in second or third year.

PLANT AVAILABILITY

Nursery Sources - liners, two- and four-inch pots, one- and three-gallon pots.

Natural Sources - generally not available in large quantities; protected by law. Available as seeds or transplants on private property behind the CCCL.

PLANTING GUIDELINES

Elevation - above limits of wave uprush.

Ground Slope - up to 30° (1 to 2).

Depth - top of root-ball four inches below soil surface (many planting failures have been attributed to not planting deeply enough).

Planting Window - March through November south of Tampa Bay/Cape Canaveral and April through October northward.

Density - one- and two-inch pots one and one-half feet O.C., increased spacing to three feet O.C. for large plants (three-gallon).
Uniola paniculata (continued)

MAINTENANCE GUIDELINES

Watering - when planted, and weekly for first few months depending on rainfall.

Fertilization - one teaspoon per plant of a balanced, time-release fertilizer (e.g., 14-14-14), incorporated when planted.

Weeding - remove and control exotics.

Pruning - after establishment may respond to careful clipping by producing more tillers.

[Relevant Literature - 1-3, 15, 18-20, 22, 37, 38, 46, 64, 69, 81, 83, 92, 93, 95-97]
RELEVANT LITERATURE

The following references represent a variety of technical reports, agency publications, conference proceedings, journal articles, and other reports of relevance to salt-tolerant vegetation. This list should not be considered a complete collection of reference materials; rather, it is a representative compilation of works pertaining to various facets of plant taxonomy, functional relationships, and habitat restoration efforts that address many of the species discussed in this guide.


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SECTION III.

PLANT ILLUSTRATIONS AND COLOR PLATES
Figure 5. *Rhizophora mangle* - Red Mangrove; fruiting branch (see also Figure 9, Plate I).
Figure 6. *Avicennia germinans* - Black Mangrove
(see also Figure 9, Plate II).
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Reference only, not in guidelines
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PLATE I. *Rhizophora mangle* - Red Mangrove

a = habit, b = habit, c = propagules/fruit, d = inflorescence.
PLATE II. *Avicennia germinans* - Black Mangrove

a = habit, b = pneumatophores, c = propagule/fruit, d = inflorescence.
PLATE III. *Laguncularia racemosa* - White Mangrove

a = habit, b = germinating fruit, c = propagule/fruit, d = inflorescence.
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PLATE VII. *Juncus roemerianus* - Needle Rush: a = habit, b = inflorescence; 
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PLATE X. *Panicum amarum* - Bitter Panicum: a = habit, b = inflorescence;

*Uniola paniculata* - Sea-oats: c = habit, d = inflorescence.
# PHOTO CREDITS

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Cover photograph by Wendy Wilson
SECTION IV.

APPENDIX
ADDITIONAL COASTAL PLANT SPECIES

Included in the following list are some additional common species useful in habitat creation projects in Florida. To provide a detailed description of the over 500 plant species found in coastal Florida is beyond the scope of this publication. The information in this section should be regarded only as a general guide. Common names vary among geographic locations, taxonomy of scientific names is always in flux, and habitat ranges may extend beyond what is presented here.

Many coastal plant species occur across a broad range of environmental conditions and are often found in a number of community associations. Because of variable habitat tolerance, many species cannot be pigeonholed into specific habitats. In particular, describing where vegetation occurs using the vegetation itself as a category leads to a circular description. For instance, while bay-bean (Canavalia) may be conveniently described as occurring in mangrove fringes, can red mangrove (Rhizophora) be said to occur in mangrove fringes as well?

Therefore, to avoid a circular description, we have adopted a system of habitat description based on three main tidal-related ranges: supratidal, intertidal, and subtidal. Each of these tidal ranges is followed by specific modifiers in parentheses. A supratidal range may be dry and/or wet, and intertidal/subtidal ranges may be fresh.brackish/saline or a combination of these. Plants may also range across more than one category, and if so, the principal range is given first. For instance, sea-purslane (Sesuvium) has a habitat range of "Supratidal (wet or dry); Intertidal (saline to brackish)" which implies that this species is principally supratidal but may be found intertidally; in addition, it is found in dry areas (for example, dunes) and wet areas (tidal shores) and can tolerate high salinity substrates as well as less saline areas. Tidal-range classes are presented in order of decreasing elevation, with the highest elevations listed first and followed through successively lower elevations. Plant species within each range are listed alphabetically by common name.
Supratidal (dry)

Beach-creeper (*Ernodea littoralis* Sw., Rubiaceae)

Beach-tea (*Croton punctatus* Jacq., Euphorbiaceae)

Beachberry; Inkberry (*Scaevola plumieri* (L.) Vahl, Goodeniaceae)

Blanket Flower; Fire-wheel (*Gaillardia pulchella* Foug., Asteraceae)

Coral Foxtail (*Setaria macrosperma* (Scribn. & Merr.) Schlum., Poaceae)

Groundsel-bush; Sea-myrtle (*Baccharis glomeruliflora* Pers., Asteraceae)

Groundsel-bush; Sea-myrtle (*Baccharis halimifolia* L., Asteraceae)

Hercules'-club (*Zanthoxylum clava-herculis* L., Rutaceae)

Little Bluestem (*Schizachyrium scoparium* (Michx.) Nash, Poaceae)

Live Oak (*Quercus virginiana* Mill., Fagaceae)

Myrtle Oak (*Quercus myrtifolia* Willd., Fagaceae)

Necklace-pod (*Sophora tomentosa* L., Fabaceae)

Pink Purslane (*Portulaca pilosa* L., Portulacaceae)

Purple Sandgrass (*Triplasis purpurea* (Walt.) Chapm., Poaceae)

Sand Atriplex (*Atriplex pentandra* (Jacq.) Standl., Chenopodiaceae)

Sand Live Oak (*Quercus gaminata* Small, Fagaceae)

Sand Pine (*Pinus clausa* (Chapm. ex Engelm.) Vasey ex Sarg., Pinaceae)

Sea-grape (*Coccoloba uvifera* (L.) L., Polygonaceae)

Seaside Evening-primrose (*Oenothera humifusa* Nutt., Onagraceae)

Sisal; Century-plant (*Agave* spp., Agavaceae)

Southern Red Cedar (*Juniperus silicicola* (Small) Bailey, Cupressaceae)

Spanish-dagger; Spanish-bayonet (*Yucca aloifolia* L., Agavaceae)

Tall Threeawn (*Aristida patula* Chapm. ex Nash, Poaceae)
Supratidal (wet)
Annual Marsh Aster (*Aster subulatus* Michx., Asteraceae)
Bay-bean (*Canavalia rosea* (Sw.) DC., Fabaceae)
Chestnut Sedge (*Fimbristyris castanea* (Michx.) Vahl, Cyperaceae)
False Willow; Saltmarsh-willow (*Baccharis angustifolia* Michx., Asteraceae)
Galingale; Flat Sedge (*Cyperus odoratus* L., Cyperaceae)
Gulf Cordgrass (*Spartina spartinae* (Trin.) Merr. ex Hitche., Poaceae)
Hairgrass; Muhly Grass (*Muhlenbergia capillaris* (Lam.) Trin., Poaceae)
Hairy Chestnut Sedge (*Fimbristyris caroliniana* (Lam.) Fern, Cyperaceae)
Keygrass; Shoregrass (*Monanthochloë littoralis* Engelm., Poaceae)
Perennial Saltmarsh Aster (*Aster tenuifolius* L., Asteraceae)
Samphire; Beach-carpet (*Blutaparon vernaliculare* (L.) Mears, Amaranthaceae)
Trailing Cow-pea (*Vigna luteola* (Jacq.) Benth., Fabaceae)
Yellow-top (*Flaveria* spp., Asteraceae)

Supratidal (wet or dry)
Bay-cedar (*Suriana maritima* L., Surianaceae)
Buttonwood; Button Mangrove (*Conocarpus erecta* L., Combretaceae)
Cabbage Palm; Palmetto (*Sabal palmetto* (Walt.) Lodd. ex Schultes, Areaceae)
Coco-plum (*Chrysobalanus icaco* L., Chrysobalanaceae)
Florida-privet (*Forestiera segregata* (Jacq.) Krug & Urban, Oleaceae)
Gray-nicker (*Caesalpinia bonduc* (L.) Roxb., Fabaceae)
Hurricane-grass (*Fimbristyris spathacea* Roth., Cyperaceae)
Pigeon-plum; Tie-tongue (*Coccoloba diversifolia* Jacq., Polygonaceae)
Purple Sedge (*Cyperus ligularis* L., Cyperaceae)
Sand Cordgrass; Baker's Cordgrass (*Spartina bakeri* Merr., Poaceae)
Saw Palmetto (*Serenoa repens* (Bartr.) Small, Areaceae)
Southern Sea-blite (*Suaeda linearis* (Ell.) Moq., Chenopodiaceae)
Thin Paspalum (*Paspalum setaceum* Michx., Poaceae)
Woody Sea Ox-eye Daisy (*Borrachia arborescens* (L.) DC., Asteraceae)
Supratidal (wet or dry); Intertidal (saline to brackish)
Horse-purslane (*Trianthema portulacastrum* L., Aizoaceae)
Sea-purslane (*Sesuvium portulacastrum* L., Aizoaceae)

Intertidal (fresh to brackish)
Bull-tongue; Lanceleaf Arrowhead (*Sagittaria lancifolia* L., Alismataceae)
Saw-grass (*Cladium jamaicense* Crantz., Cyperaceae)

Intertidal (brackish)
Common Three-Square Bulrush (*Scirpus americanus* Pers., Cyperaceae)
Golden Leather Fern (*Acrostichum aureum* L., Pteridaceae)
Giant Leather Fern (*Acrostichum danaeifolium* Langsd. & Fisch., Pteridaceae)
Saltmarsh Bulrush (*Scirpus robustus* Pursh., Cyperaceae)

Intertidal (saline to brackish)
Annual Glasswort (*Salicornia bigelowii* Torr., Chenopodiaceae)
Perennial Glasswort (*Salicornia virginica* L., Chenopodiaceae)
Saltwort (*Batis maritima* L., Bataceae)

Subtidal; Intertidal (saline to brackish)
Shoal-grass (*Halodule wrightii* Aschers., Cymodoceaceae)
Widgeon-grass (*Ruppia maritima* L., Ruppiaceae)

Subtidal (saline)
Turtle-grass (*Thalassia testudinum* Koenig, Hydrocharitaceae)
Star-grass (*Halophila engelmannii* Aschers., Hydrocharitaceae)
GLOSSARY

BALANCED FERTILIZER - fertilizer containing the same percentage of nitrogen (N), phosphorus (P), and potassium (K). For example, N-P-K is 6-6-6 or 20-20-20, etc.

BARE-ROOT - single planting units with roots and/or rhizomes, taken from the field and lacking a soil ball; must be protected from drying and heat damage.

BROADCAST FERTILIZER - fertilizer spread by hand or mechanical means; not incorporated into soil at planting time.

CANOPY - leafy component of a plant. The canopy layer is the tallest leafy layer in an area.

CLONAL PLANT - plants able to reproduce vegetatively by producing tillers, rhizomes, or stolons that produce additional shoots; the shoots are usually considered genetically identical.

COALESCENCE - the growing together of two or more separate units, as in grass plugs or mangrove canopies.

COASTAL CONSTRUCTION CONTROL LINE (CCCL) - an imaginary jurisdictional line of variable location (determined by the Florida Department of Natural Resources’ Division of Beaches and Shores) delineating the 100-year storm impact zone on sandy beaches. See Section 161.053, F.S., for details.

DENSITY - the number of individuals per unit area (usually per m²); for clonal organisms (e.g., smooth cordgrass), the individual is usually regarded as the stem, not the clump of genetically related stems.

DETRITUS - free, disintegrating dead organic tissue (mostly of plant origin) and the associated microorganisms engaged in the decomposition of the material.

DRIFT MATERIAL - predominantly plant material in varying stages of decay that is moved about by currents; flotsam and jetsam.

EXOTIC - not indigenous to a region; intentionally or accidentally introduced and often persisting, occasionally in epidemic proportions; alien.

FORB - short, leafy, herbaceous plants other than grasses and grass-like plants.

HABIT - the appearance or makeup of an organism.

HABITAT - the environment occupied by individuals of a particular species, population, or community.
INDIGENOUS SPECIES - native to a region.

INFLORESCENCE - the basic presentation of the flowering structure of plants. After seed set, known as an infructescence.

INTERTIDAL - sediment surface between mean low water and mean high water.

INUNDATION - a condition in which water from any source temporarily or permanently covers a land surface.

LIGULE - a structure of membranes, hairs, or a combination of both that occurs at the juncture of the leaf blade and leaf sheath of grasses.

LINER - in practice, the smallest container-grown planting unit available; usually consists of multiple units in a tray.

MAINTENANCE - any follow-up activities necessary to assure successful long-term goals after a project is completed (e.g., erosion control, water-level manipulations).

MANGROVE - an ecological grouping for woody plants that inhabit marine intertidal shorelines, principally along tropical shores.

MEAN HIGH WATER (MHW) - the average maximum elevation above mean sea level reached by a rising tide and is the average of all high tides of each tidal day (24.84 hours) over the National Tidal Datum Epoch (19 years).

MEAN HIGHER HIGH WATER (MHHW) - the 19-year average of only the highest high tide of each tidal day; this is higher than MHW (see above).

MEAN SEA LEVEL (MSL) - a datum, or "plane of zero elevation," established by averaging hourly tidal elevations over a 19-year tidal cycle or "epoch." This plane is corrected for curvature of the earth and is the standard reference for elevations on the earth's surface.

MITIGATION - attempting to offset wetlands losses through restoration, creation, or enhancement of wetlands at other locations.

MONITORING - periodic evaluation of a site to determine its status relative to specific predetermined goals.

NATIONAL GEODE蒂IC VERTICAL DATUM (NGVD) - an imaginary fixed-reference plane relative to Mean Sea Level in 1929. The relationship between MSL and NGVD is site-specific.

NITROGENOUS FERTILIZER - a fertilizer that has only nitrogen and lacks other components such as potassium and phosphorus (e.g., 19-0-0).
NUISANCE SPECIES - a species (usually exotic) that becomes abundant by virtue of fast growth and reproduction and that can exclude desirable species.

NURSERY HABITAT - the complex environmental area for maturation of young organisms that may migrate out of the habitat at maturity; nutrition and protection from predators are afforded by plants and their by-products.

ON CENTER (O.C.) - spacing between centers of planting units.

PERCENT COVER - the amount of vegetated versus unvegetated substrate (expressed as a percentage of the whole) in a given area.

PLANT COMMUNITY - all of the plant populations occurring in a shared habitat or environment and recognizable as being differentiated from adjacent communities.

PROPAGULE - generally, the dispersable "offspring" of a plant (e.g., seeds, fruits, vegetative units). Mangrove offspring are called propagules because seeds are never formed in these plants.

RHIZOME (RHIZOMATOUS) - an underground plant stem that can form shoots above and roots below and results in lateral spread of the plant.

ROOT-BALL - the roots of a plant and the associated soil volume; may be dug from the ground or cultured in containers.

SALT-TOLERANT - having the physiology necessary to cope with the stresses resulting from exposure to fluctuating levels of salts in the growing medium.

SPIKELET - the basic unit of a grass or sedge inflorescence; composed of one or more small flowers (florets).

SPRING TIDE - a tide that occurs at or near the time of a new or full moon and rises higher and falls lower relative to mean sea level than tides at other moon phases (neap tides).

SUBSTRATE - the base or substance on or into which an organism is attached or rooted.

SUBTIDAL - sediment surface below mean low water.

SUPRATIDAL - soil surface above mean high water.

SYNONYMY - taxonomic revision by which scientific names become outdated and the new name becomes preferred over the former name(s).

TAXONOMY - the classification of organisms using Latin terminology.
TILLER - a lateral, leafy stem originating from the stem base of a clonal grass plant.

TIME-RELEASE FERTILIZER - encapsulated fertilizer that absorbs water and gradually leaches nutrients.

TRANSITION ZONE - an ill-defined zone in which gradation occurs between two distinct habitats; may be narrow or broad; ecotone.

UPLAND - land not inundated at any time by normal tidal cycles (may be flooded during storm episodes).

WAVE UPRUSH - the rush of water up onto the beach following the breaking of a wave.

WETLANDS - areas which are permanently saturated or permanently or periodically inundated by surface or groundwater at a frequency and duration sufficient to support vegetation typically adapted for life in saturated soil conditions (e.g., estuaries, rivers, swamps, marshes, and bogs).