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# Beach Dune, Coastal Strand and Maritime Hammock

<b>FNAI Global Rank:</b>	<b>G3/4</b>
<b>FNAI State Rank:</b>	<b>S1/2</b>
<b>Federally Listed Species in S. FL:</b>	<b>16</b>
<b>State Listed Species in S. FL:</b>	<b>50</b>

## Beach dune/coastal strand.

Original photograph by Ann Johnson.



The beach dune and coastal strand communities in South Florida are the closest communities to the high-energy shoreline. Within this high-energy zone, there are a number of daily, naturally occurring events such as: wave action, sand burial, and salt spray. Closest to the coast, the upper beach is regularly disturbed by waves of high tides or storms and regularly recolonized by driftline annuals and trailing perennials such as railroad vine (*Ipomoea pes-caprae*). Above the reach of annual wave action is the foredune, built by coarse, rhizomatous grasses; primarily sea oats (*Uniola paniculata*), that thrive under constant burial from sand blown off the beach. Beyond the zone of constant sand burial are the dwarfed trees and shrubs of the coastal strand. The species growing in this zone are kept at a low stature by salt spray, which kills the upward-growing leader shoots. Species composition within the coastal strand communities that are located on the Gulf and Atlantic coasts differ. These differences need to be taken into account prior to restoration plantings.

Maritime hammocks are low forests of evergreen broadleaved trees found inland from coastal strand communities on the Atlantic coast and from coastal grassland communities on the Gulf coast. The canopy may be composed of trees with either temperate affinities (*Quercus virginiana*, *Sabal palmetto*, *Persea borbonia*) or (usually on more calcareous substrates) of trees with tropical affinities (*Bursera simarouba*, *Ficus aurea*, *Coccoloba uvifera*). In both cases in South Florida the understory is composed primarily of tropical shrubs and small trees. Although they share some widespread coastal tree species, forests on nearby tropical coasts of the Bahamas, Cuba, and the Yucatan Peninsula do not appear to have the same structure and composition as tropical maritime hammocks in South Florida (Correll and Correll 1982, Sauer 1967, Moreno-Casasola and Espejel 1986).

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### Synonymy - Beach Dune/Coastal Strand

This description also includes several other coastal communities of lesser extent, *i.e.*, coastal grassland, coastal interdunal swale, and coastal rock barren (FNAI 1990 and Federal Department of Natural Resources (FDNR) 1990). These communities are mapped under “coastal strand” and “barren and urban land” categories on the Florida Land Cover map (GFC 1992); in the latest draft of The Nature Conservancy’s classification (Weakley *et al.* 1998) they are subsumed under the following alliances: *Uniola paniculata* subtropical herbaceous alliance, *Muhlenbergia filipes* herbaceous alliance, *Fimbristylis castanea-Scirpus pungens* seasonally flooded herbaceous alliance, *Coccoloba uvifera* shrubland alliance, *Sophora tomentosa-Forestiera segregata* shrubland alliance, *Serenoa repens* wooded shrubland alliance. The FLUCCS codes for beach dune and coastal strand include: 310 (herbaceous), and 720 (sand other than beaches), respectively.

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### Synonymy - Maritime Hammock

This description includes the shell mound community (FNAI 1997 and FDNR 1990). The FLUCCS codes for this community include: 425 (tropical hardwoods), and 427 (live oak). In the most recent draft of The Nature Conservancy classification (Weakley *et al.* 1998) they are found under the following alliances: *Quercus virginiana-Sabal palmetto* forest alliance; *Bursera simarouba-Coccoloba diversifolia-Ocotea coriacea-Eugenia axillaris* forest alliance; *Sabal palmetto-Coccoloba uvifera* forest alliance.

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### Distribution - Beach Dune/Coastal Strand

The beach dune community occurs on the first dunes above the beach, which are most often built by sea oats. This herbaceous zone is found on sandy shores around the Gulf of Mexico from eastern Mexico north of the Yucatan Peninsula (Sauer 1967, 1982) to Florida, including Cuba and the Bahamas (Correll and Correll 1982), and extending northward up the Atlantic coast to Virginia (Stalter and Lamont 1997). In South Florida, the herbaceous zone and sandy coasts are continuous along the Atlantic coast from the Sebastian Inlet, Indian River County, south to Cape Florida, Miami-Dade County, and along the Gulf coast from Lido Key, Sarasota County, south to Cape Romano, Collier County (Johnson *et al.* 1992, Johnson and Muller 1992). Between Collier and Miami-Dade counties, beaches are discontinuous, being found at two sites on the Florida Keys (Kruer 1992), four sites on the islands west of Key West, including the Marquesas (Kruer 1992) and the Dry Tortugas (Davis 1942), on Cape Sable, and on a few of the larger outer islands of the Ten Thousand Islands (Johnson and Muller 1992).

The zone immediately inland from the herbaceous zone may be occupied by shrubs (coastal strand community), grasses (coastal grassland and coastal interdunal swale communities), or by a sparse stand of stunted shrubs and cacti on bare limestone substrate (coastal rock barren community). Coastal strand is found along both the Atlantic and Gulf coasts of South Florida, but is most

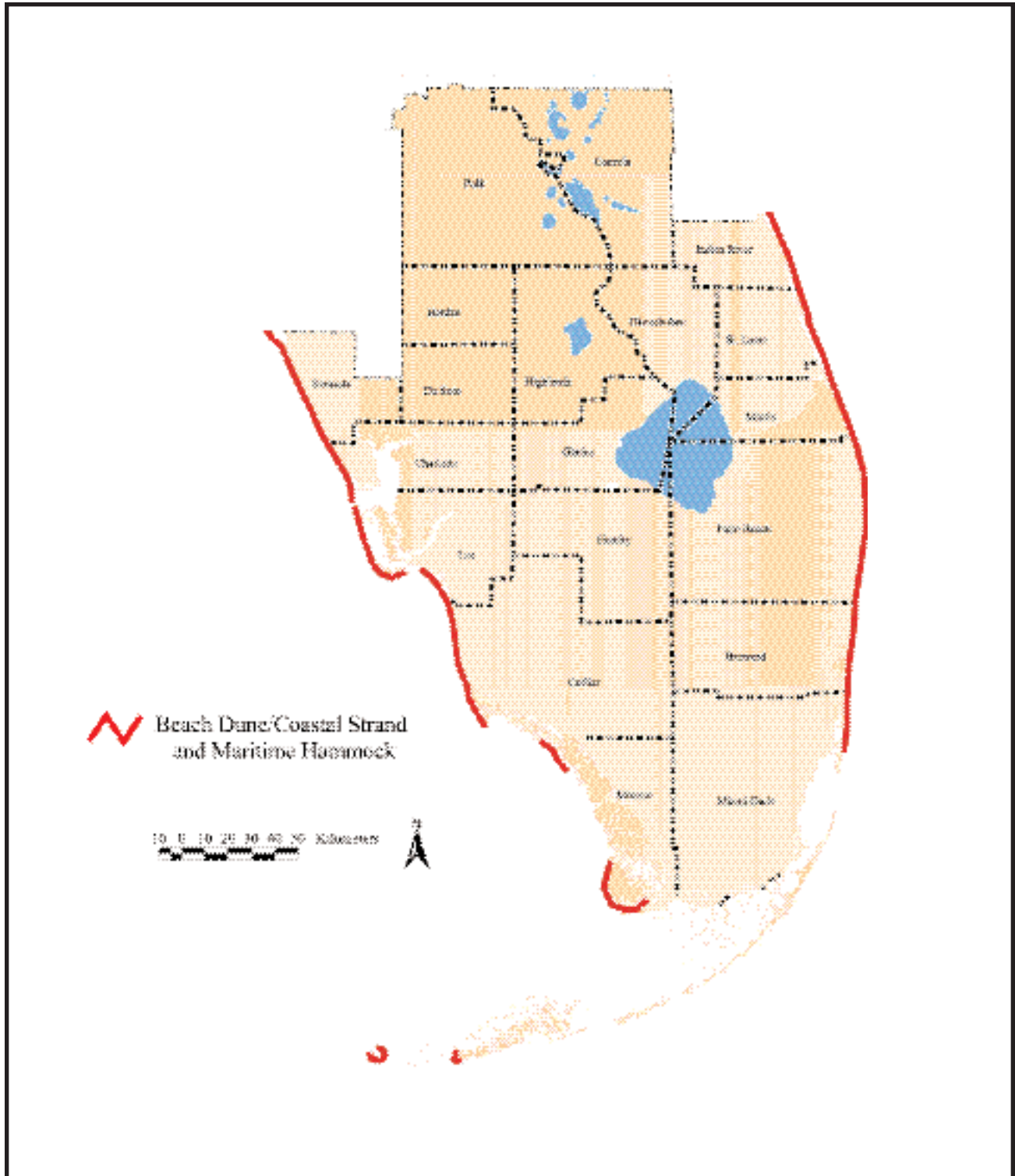


Figure 1. The distribution of beach dune, coastal strand and maritime hammock in South Florida (adapted from Myers and Ewel 1990).

common and continuous along the Atlantic coast; coastal grassland and coastal interdunal swale communities are found primarily on Cape Sable and the broader barrier islands of the Gulf coast, *i.e.*, Cape Romano, Canon, Keewaydin, North Captiva, Cayo Costa, Don Pedro and Knight Islands (Johnson and Muller 1992, Herwitz 1977, Morrill and Harvey 1980), and formerly on Sanibel, Captiva, Little Gasparilla, and Gasparilla Islands (Cooley 1955, Morris *et al.* 1979). The coastal rock barren community is known from four sites in the Florida Keys (Kruer 1992).

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### Distribution - Maritime Hammock

Maritime hammocks characterized by a canopy of Virginia live oak (*Quercus virginiana*) occur north along the Atlantic coast to Virginia, and west along the Gulf coast to Texas (Bellis 1995, Weakely *et al.* 1998). On the east coast, tropical species appear in the understory of these oak-dominated forests in Florida around the latitude of Daytona Beach, Volusia County, and on the west coast at Tarpon Springs, Pasco County. On calcareous substrates, such as shell mounds, tropical species may form the canopy of coastal forests as far north as Levy and Volusia counties on the west and east coasts of Florida, respectively. In South Florida, maritime hammocks extend south on the sandy barrier islands to Cape Florida, Miami-Dade County on the Atlantic side, and Cape Romano, Collier County, on the Gulf side. They may also occasionally be found along the mainland shores of the lagoons and bays separating the barriers from the mainland. In Monroe County they are also found in scattered locations on Ten Thousand Islands and Cape Sable. In the Florida Keys they are replaced by the more diverse tropical hardwood hammock community (refer to the tropical hardwood hammock account) including coastal berms or limestone substrate.

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### Description - Beach Dune

The beach dune community is a predominantly herbaceous community of wide-ranging coastal specialists. It occurs on the upper beach and foredune, or first dune above the beach, which is built by perennial rhizomatous grasses growing upward from year to year as they are buried by sand blown inland off the beach. Sea oats is the most commonly encountered dune-former, a tall coarse grass capable of rapid lateral spread, forming a relatively sparse stand of tillers with internodes up to one foot apart (Wagner 1964). Two less common dune-forming grasses are beach cordgrass (*Spartina patens*) and bitter panicum (*Panicum amarum* var. *amarulum*). Several shrubs (*Helianthus debilis*, *Croton punctatus*, *Scaevola plumieri*, and *Iva imbricata*) can often be found growing between the widely spaced leaves in a patch of sea oats, along with two less frequent coastal shrubs, *Argusia gnaphalodes* and *Suriana maritima*. The upper beach in front of the sea oats foredune is a less stable habitat, being disturbed by seasonal or storm high tides annually or at least every few years, and is colonized by trailing vines: *Ipomoea pes-caprae*, *I. imperati*, *Canavalia rosea*, and on the Atlantic coast: *Alternanthera maritima* and *Okenia hypogaea*, by low, spreading, halophytic grasses: *Paspalum distichum*, *Sporobolus virginicus*, and by driftline annuals: *Cakile lanceolata*, *Salsola kali* and *Atriplex pentandra* (Johnson and Muller 1993).

The discontinuous beaches of the Keys, the islands west of Key West, and the Ten Thousand Islands, which tend to be formed largely of shell fragments rather than quartz sands, have the same set of species as the mainland beaches, with a higher representation of the more tropical component, *i.e.*, *Suriana maritima*, *Argusia gnaphalodes*, *Ambrosia hispida*, *Hymenocallis latifolia*, and *Sesuvium portulacastrum* (Kruer 1992, Davis 1942).

### Wildlife Species of Concern

Federally listed animal species that depend upon or utilize the beach dune community in South Florida include: southeastern beach mouse (*Peromyscus polionotis nivieventris*), roseate tern (*S. dougallii dougallii*), piping plover (*Charadrius melodus*), loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), Kemp's ridley sea turtle (*Lepidochelys kempii*), and hawksbill sea turtle (*Eretmochelys imbricata*). Biological accounts and recovery tasks for these species are included in "The Species" section of this recovery plan. In addition, other species use the beach dune community in South Florida for loafing, foraging, and nesting (refer to Appendix C).

The endemic **southeastern beach mouse** which is restricted to sea oats dunes, was formerly abundant from Ponce (=Mosquito) Inlet, Volusia County to Hollywood Beach, Broward County. In South Florida, it is now restricted to scattered localities in Indian River and St. Lucie counties, although it still has stable populations in the northern portion of its range, and is federally listed as threatened (FWS 1998). On the Gulf coast, the Chadwick Beach cotton mouse (*Peromyscus gossypinus restrictus*), described from the dunes near Englewood in Charlotte County, has been determined to be extinct (Repenning and Humphrey 1986).

The Caribbean population of the federally threatened **roseate tern** nests on limestone or shell rubble in the lower Keys and the Dry Tortugas. The species has an unstable breeding site distribution that is dependent on islands with open sandy or broken coral nesting areas, a lack of mammalian and avian predators, and minimal disturbance by humans. Roseate terns are also known to nest on roofs of buildings in Florida (Smith 1996). A moderate amount of suitable natural breeding habitat remains in the Caribbean population range; however, much of the Florida Keys' natural habitat has been greatly reduced or degraded by natural or anthropogenic factors.

Many shorebirds use beaches in South Florida for nesting or wintering or both. Florida is the main wintering ground of the federally threatened **piping plover** which breeds in northern North America. Formerly seen wintering in all South Florida counties except Martin, this species is now absent from Indian River, Palm Beach, and Broward counties and has become rare in Miami-Dade and Sarasota counties (FWS 1998).

The **southeastern snowy plover** (*C. alexandrinus tenuirostris*), which is State-listed as threatened (GFC 1997), both breeds and winters along the Gulf coast of Florida and the larger Caribbean islands, and in South Florida breeds from Charlotte to Collier counties (Gore and Chase, 1989).

**Least tern.** Original photograph by Barry Mansell.



**American oystercatchers** (*Haematopus palliatus*) are State-listed as species of special concern. They inhabit the Atlantic coast of Florida from the north Florida line south to Palm Beach County. Oystercatchers are also found on the Florida Gulf coast from Collier County north to the Suwannee River. They utilize beach, sandbar, mudflat, and mollusk beds for feeding and roosting. They feed on small fish and a variety of marine invertebrates. Oystercatchers prefer large, sparsely vegetated sand areas for nesting, but will also nest in wrack and marsh grass. They are vulnerable to human disturbance, habitat loss, and mammalian predation.

The **least tern** (*Sterna antillarum*) is state-listed as threatened. It nests throughout Florida's coasts except for the salt marshes of the Big Bend area and the mangrove-lined southwestern coast. Historically, least tern nesting took place on the ground, in open sandy places where vegetation covered less than 20 percent of the area. Shoreline development and human disturbance have altered much of the natural least tern nesting habitat. Least terns have been sighted nesting on roofs of buildings in Palm Beach County (P. Davis, Palm Beach County, personal communication 1998).

**Black skimmers** (*Rynchops niger*) are State-listed as a species of special concern. They nest along the coastal areas of Florida from Escambia to Collier County on the Gulf coast and from Nassau to Broward County on the Atlantic coast. Nesting colonies are located on dredge-material islands, natural sandbars, small coastal islands, and beaches with little vegetation, generally within sight of open water. They usually feed in estuary areas, with small fish being the predominant prey. Black skimmers need undisturbed, sandy beaches and islands for nesting and rearing their young. Least terns and black skimmers that formerly nested on bare sand beaches have turned to rooftops and spoil islands for nesting as increased human use has rendered the mainland beaches in South Florida unsuitable.

Bare sand beaches are utilized for nesting by **sea turtles**. Four federally listed species of sea turtles nest on South Florida beaches. These include: **loggerhead, green, hawksbill, and leatherback** sea turtles. The **Kemp's ridley** sea turtle has nested once in Lee County, and has had a few false crawls in Palm Beach County. The most frequent nester in South Florida, the loggerhead, has a worldwide distribution with three major nesting areas: in the Arabian Sea, in Australia, and in the southeastern United States. Although turtles nest on beaches from North Carolina to the Florida panhandle, during the 1997 nesting season, roughly 84 percent of the 66,445 nests recorded throughout Florida were found from Brevard to Broward counties (DEP 1998). Of this total, Brevard County had the highest overall nesting activity at 38 percent, with the second highest occurring in Palm Beach County at 18 percent (DEP 1998). Major nesting beaches in South Florida include: Hutchinson Island, Jupiter Island, and northern Palm Beach County (from Tequesta to Singer Island) (P. Davis, Palm Beach County, personal communication 1998). South Florida (Indian River to Sarasota counties) accounted for approximately 56 percent of the loggerhead sea turtle nesting during the 1997 season (DEP 1998). Sea turtles typically nest at night from March through November, with incubation lasting approximately 55 days. Although not all beaches are monitored 7 days a week, sea turtle nest densities in South Florida during the 1997 season were approximately 1 nest per 117 km of beach surveyed. Threats to sea turtle nests in this region are both man-made (physical disturbance, including burial by beach nourishment projects; high raccoon predator populations; lights near the coast which disorient hatchlings) and natural (coastal erosion causing cliffing and invasion by the exotic Australian pine whose root mats interfere with nest excavation) (FWS 1998).

### Plant Species of Concern

Federally listed species that depend upon or utilize the beach dune community in South Florida include the beach jacquemontia (*Jacquemontia reclinata*). The biological account and recovery tasks for this species are included in "The Species" section of this recovery plan. Refer to Appendix C for a list of other plant species that utilize the beach dune community in South Florida.

**Sanibel lovegrass** (*Eragrostis tracyi*) is a state endangered, delicate annual grass that occasionally reaches a height of 40 cm (16 inches) (usually less). It occurs on the Florida coast southwest in Lee County northward to Mound Key, and found nowhere else in the world. Habitat requirements for this grass are flexible and can be found in many disturbed or pioneering sites including coastal dune, coastal strand, and maritime hammock environments.

**Sea lavender** (*Tournefortia gnaphalodes*) is a shrub which reaches 2 m (6.6 ft) in height. The plant has many dense, fleshy branches which often give it a clumped appearance. It has slender light gray leaves from 4 to 12 cm (1.6 to 4.8 inches) long. This shrub occurs throughout the Caribbean, but in Florida is found only along the east coast from Brevard County southward to the Keys. Coastal construction has extirpated this plant at many previously documented sites. The State of Florida has designated the sea lavender as an endangered species.

***Remirea maritima* (beachstar.)**  
Original photograph courtesy of  
Florida Natural Areas Inventory.



The state endangered **burrowing four-o'clock** (*Okenia hypogaea*) is an annual with deep taproots and stems that spread out over the soil surface. It is often found with sand covering the plant in a thick coat. In Florida, burrowing four-o'clock is found in only a few locations along the southeast coast, but is also found on the Mexican Gulf coast. The plant is restricted to the ocean side of coastal dunes, often being the closest plant to the water's edge.

The **beach-star** (*Remirea maritima*) is a small perennial herb with stems arising at intervals along the elongated stolon. Its numerous leaves, overlapping at the base with recurved leaf blades, give this plant a star-like appearance. Although widely distributed in the tropics, it is found in Florida only along the southeastern coast (especially south of Martin County). The plant's former range was from Vero Beach southward to Miami-Dade County, but beach development has extirpated this plant from former sites, especially in Miami-Dade County. This species has been designated as an endangered species by the State of Florida.

The **bay cedar** (*Suriana maritima*) is a densely branched shrub or small tree which reaches a height of 8 m. Its leaves are fleshy blades from 1 to 4 cm (0.4 to 1.6 inches) in length. The state endangered bay cedar is found in coastal beaches, sand dunes and sandy thickets throughout South Florida, including the keys of Florida Bay and the lower Florida Keys.

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### Description - Coastal Strand

The most commonly encountered community behind the herbaceous dune zone is a shrubby community known as coastal strand. On the Atlantic coast, coastal strand occurs as a dense, flat-topped (salt spray-pruned) community of evergreen shrubs which shows increasing abundance of tropical species as one goes south along the coast. The zone nearest the beach is usually occupied by a mixture of saw palmetto (*Serenoa repens*) and a shrubby form of sea grape (*Coccoloba*



*wifera*). As one goes inland, the canopy grades upward and is formed by a mixture of shrubs, usually including *Sabal palmetto* (dwarfed), *Forestiera segregata*, *Persea borbonia*, *Chrysobalanus icaco*, and *Rapanea punctata*. The associates of these widespread species change as one goes southward. From Indian River to St. Lucie County their common associates are *Sideroxylon tenax*, *Myrcianthes fragrans*, and *Quercus virginiana* (dwarfed); from Martin to Miami-Dade County their associates change to tropical species, such as *Eugenia foetida* and *Pithecellobium keyense* (Johnson and Muller 1993).

On the Gulf coast, the area behind the foredune is usually occupied by an open stand of grasses or trailing shrubs with scattered islands of taller shrubs surrounding a few cabbage palms in their center. These shrub islands of the coastal strand community are composed of many of the same tropical species found on the Atlantic coast (*Forestiera segregata*, *Rapanea punctata*, *Randia aculeata*, *Chiococca alba*, *Lantana involucrata*), plus several shrubs or small trees more commonly, if not exclusively, found on the Gulf coast and the Florida Keys, i.e., *Jacquinia keyense*, *Pithecellobium unguis-cacti*, *Sideroxylon celastrina*, and *Piscidia piscipula*. Coastal shrubs with a low trailing growth habit [*Ernodea littoralis*, *Ambrosia hispida*, *Chiococca parvifolia* = *C. alba*, Wunderlin (1996)] are also more abundant in the open backdune communities on the Gulf than they are in the denser, shrubby backdune thicket communities on the Atlantic coast of South Florida (Johnson and Muller 1992, Cooley 1955, Herwitz 1977).

The coastal grassland community in which these shrub islands occur is generally of two types: on newer sand deposits it is composed of a variety of tall grasses (*Muhlenbergia capillaris*, *Spartina patens*, *Schizachyrium semiberbe*, *Andropogon glomeratus*, *Aristida patula*, etc., plus occasional remnant patches of *Uniola paniculata*). This type is well developed on Cape Sable and the newer southern part of Cannon Island. In older, more stable portions of the broad barrier islands fronting Pine Island Sound, e.g., Cayo Costa, North Captiva, and formerly Captiva and Sanibel (Cooley 1955), coastal grassland consists of a short, dense sward of hairy grama grass, *Bouteloua hirsuta*, a western disjunct which is also a dominant species in Texas and on the western high plains (Kuchler 1964). This community is well preserved on state-owned land on Cayo Costa and North Captiva islands.

The coastal interdunal swale community is associated with the newer type of coastal grassland which develops on the ridges as a barrier island accretes as a series of low ridges and swales. It generally consists of graminoid species such as *Fimbristylis castanea*, *F. spathacea*, *Spartina patens*, and *Paspalum distichum*, with occasional halophytic species (*Juncus roemerianus*, *Avicennia germinans*) if tidal influence is present (Johnson and Muller 1992).

The coastal rock barren community occurs on Key Largo limestone and is marked by an abundance of spiny species including, *Acanthocereus pentagonus*, *Opuntia stricta*, and *Agave decipiens*, plus a great variety of other weedy herbs and shrubs (Kruer 1992). It appears to develop after disturbance, whether man-made or natural, and probably would not be recognized as a separate community except for the presence of several rare plants, notably *Chamaesyce garberi*, *Opuntia triacantha*, and *Indigofera mucronata* var. *keyensis*.

### Wildlife Species of Concern

Federally listed animal species that depend upon or utilize the coastal strand community in South Florida include: Lower Keys rabbit (*Sylvilagus palustris hefneri*), southeastern beach mouse, eastern indigo snake (*Drymarchon corais couperi*), and Kirtland's warbler (*Dendroica kirtlandii*). Biological accounts and recovery tasks for these species are included in "The Species" section of this recovery plan.

**Gopher tortoise** (*Gopherus polyphemus*), a species State-listed as threatened, may form dense populations in coastal grassland (Johnson and Muller, 1992). Gopher tortoises are large terrestrial turtles, averaging 23 to 28 cm (9.2 to 11.2 inches) in carapace length. In Florida, the gopher tortoise occurs in all 67 counties, but its distribution in the southern peninsula is limited and increasingly fragmented by unsuitable habitat and urbanization. They require well-drained loose soil for burrowing, adequate low-growing herbs for foraging, and open sunlit sites for nesting. Gopher tortoise populations are declining primarily due to urbanization and other habitat-altering land uses.

### Plant Species of Concern

Federally listed plant species that depend upon or utilize the coastal strand community in South Florida include: Garber's spurge (*Chamaesyce* (= *Euphorbia*) *garberi*), and Key tree-cactus (*Pilosocereus* (= *Cereus*) *robinii*). The biological accounts and recovery tasks for these species are included in "The Species" section of this recovery plan.

The endemic **Atlantic coast Florida lantana** (*Lantana depressa* var. *floridana*) occurs in the coastal strand community. This species is a low-growing shrub that occurs in the natural (storm overwash) or man-made openings in the dense shrub layer. The Atlantic coast Florida lantana is a small shrub with prostrate or erect branches, and leaves up to 3.5 cm (1.4 inches) long. The State of Florida has classified *Lantana depressa* var. *floridana* as an endangered species.

The **coastal vervain** (*Verbena* (= *Glandularia*) *maritima*) is a endangered perennial with rose-purple flowers, nearly hairless creeping stems, and deeply incised or toothed leaves from 2 to 4 cm (0.8 to 1.6 inches) in length. In addition to the coastal strand community, it also occurs in the coastal dune and pine rockland communities.

The **Florida semaphore cactus** (*Opuntia corallicola* (= *spinosissima*)) is an endemic, distinct species (Austin *et al.* 1998, Gordon and Kobisiak 1998) presently known from a single remaining wild population of fewer than 15 mature plants at The Nature Conservancy's Torchwood Hammock Preserve on Little Torch Key. According to Small (1930), it formerly occurred on Big Pine Key and Key Largo; neither the number of individuals nor the size of those populations were described. Cactus hobbyists were thought to have eliminated this species in the late 1970s, but it was rediscovered at the Torchwood Hammock Preserve site during the mid 1980s (Austin *et al.* 1998). The State of Florida has listed the Florida semaphore cactus as an endangered species.

Coastal grassland on Cayo Costa and North Captiva islands are home to some of the few populations of non-hybridized, state endangered **Gulf coast Florida**

**lantana** (*Lantana depressa* var. *sanibelensis*) (Johnson and Muller 1992, Sanders 1987). Similar in appearance to the Atlantic coast Florida lantana (*Lantana depressa* var. *floridana*), this coastal shrub, is highly endemic to southwestern Florida.

The coastal rock barren community supports the growth of the state endangered **Key's Joe-jumper** (*Opuntia triacantha*). This species has nearly prostrate, irregularly branched stems, with loosely attached joints 4 to 8 cm (1.6 to 3.2 inches) long and 3 to 4 cm (1.2 to 1.6 inches) wide. Spines vary from one to six in number and are 4 cm (1.6 inches) long. It is distributed from Florida to the West Indies, including Puerto Rico and the Virgin islands.

The **Key's indigo** (*Indigofera mucronata* var. *keyensis*) is an endemic herbaceous perennial vine currently known only from the upper Florida Keys (Isley 1990). This species is shade intolerant and requires periodic burning to reduce competition from woody vegetation. Its historic distribution once included Lower and Upper Matecumbe keys where it is now extirpated. Threats to the Key's indigo include loss of habitat as a result of development, fire suppression, and exotic plant invasion. The plant can be identified as having five leaflets opposite on its leaf stalk; pink to salmon flowers and stems with small appressed, straight hairs.

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### Description - Maritime Hammock

Maritime hammocks with a temperate canopy are generally short forests (10 to 12 m) with a monotonous canopy of *Quercus virginiana*, *Sabal palmetto*, and *Persea borbonia*, plus a structurally diverse understory of woody species including small trees and tall and short shrubs which do not form clear layers. Commonly encountered species include *Ardisia escallonioides*, *Rapanea punctata*, *Myrcianthes fragrans*, *Zanthoxylum fagara*, *Z. clava-herculis*, *Eugenia axillaris*, *E. foetida*, *Psychotria nervosa*, and *Serenoa repens* (Johnson *et al.* 1992). South of northern Palm Beach County most maritime hammocks have a tropical canopy composed of a greater variety of trees, including the three most common mentioned above plus: *Mastichodendron foetidissimum*, *Guapira discolor*, *Coccoloba diversifolia*, *Simarouba glauca*, and *Metopium toxiferum*. *Sabal palmetto* continues south as an important component of the canopy and subcanopy; the understory shrubs are also the same southward, except for *Myrcianthes fragrans* which does not continue south of St. Lucie County. As one goes southward in Palm Beach County more tropical species appear, including silver palm (*Coccothrinax argentata*) and blackbead (*Pithecellobium keyense*). The barrier islands of southern Palm Beach, Broward, and Miami-Dade counties were developed early in the century and Alexander (1958), in describing a soon-to-be-destroyed hammock near Pompano Beach containing 21 species of tropical trees, referred to the hammock community in this region as essentially "extinct". The best remaining examples of this community can be found at JD MacArthur Beach State Park, Ocean Hammock Park, and Gumbo Limbo Nature Center in Palm Beach County (P. Davis, Palm Beach County, personal communication 1998), and at the Bartlett Estate (Bonnet House) south of Hugh Taylor Birch State Park in Broward County.

On the Gulf coast of South Florida maritime hammocks with a temperate canopy of live oak and cabbage palm may be found from Sarasota to Collier counties. As on the east coast, maritime hammocks with tropical canopies occur on calcareous substrates. Composition of canopy and understory of temperate hammocks on the Gulf coast is similar to hammocks on the Atlantic coast; composition of tropical maritime hammock canopies is also similar to those on the Atlantic, but somewhat less diverse. Although one species, *Piscidia piscipula*, is found on the Gulf and not on the Atlantic coast, six tree species found on the Atlantic are not found on Gulf coast: *Amyris elemifera*, *Guapira discolor*, *Krugiodendron ferreum*, *Metopium toxiferum*, *Ocotea coriacea*, and *Zanthoxylum coriaceum* (Wunderlin *et al.* 1996; Table 1). Two Atlantic species are replaced on the Gulf by related species in the same genus. *Pithecellobium unguis-cati* replaces *P. keyense* and *Harrisia aboriginum* replaces *Harrisia simpsonii* from Lee County northward (Wunderlin *et al.* 1996). Another difference, noted by Harper (1927), is that west coast hammocks tend to have more spiny species (*Acanthocereus pentagonus*, *Agave decipiens*, *Yucca aloifolia*, *Opuntia stricta*) in the understory than do east coast hammocks. The best examples of maritime hammocks are found on the inland side of Cayo Costa and North Captiva Islands just above the mangrove fringe. Other good examples of temperate maritime hammock are found on “inner barrier islands” that characterize this coast. These develop when an inlet severs the tip of an island from the remainder and subsequent coastwise growth of outer barrier causes it to overlap its former tip, allowing the development of hammock on the now protected inner island. Such hammock development has occurred on Petersen Island and Whiddon Key at Port Charlotte State Recreation Area in Charlotte County and on Cannon and Johnson Islands at the south end of Keewaydin in Collier County. One of the best developed tropical hammocks in the Gulf coast is found on a shell mound on Josselyn Island in Pine Island Sound, Lee County (Johnson and Muller 1992).

Among animals dependent on maritime hammocks, populations of the insular cotton rat (*Sigmodon hispidus insulicola*), found in tidal marshes and on hammock edges on Captiva, Sanibel, and Pine Islands in Lee County, are apparently secure enough not to require state-listing as are populations of the lower Keys cotton rat (*S. h. exputus*) which is found in similar coastal habitats (Humphrey 1992). Migrating songbirds that funnel down the Atlantic coast of Florida on their way to South America use the coastal hammock and strand communities for food and shelter. The northern prairie warbler (*Dendroica discolor*) and indigo bunting (*Passerina cyanea*) are declining species that use the peninsular migration route (Enge *et al.* 1997).

### Wildlife Species of Concern

Federally listed species that depend upon or utilize the maritime hammock community in South Florida include: Florida panther (*Puma (=Felis) concolor coryi*), eastern indigo snake, bald eagle (*Haliaeetus leucocephalus*), and Kirtland’s warbler. Biological accounts and recovery tasks for these species are included in “The Species” section of this recovery plan. For a list of other species that utilize the maritime hammock community please refer to Appendix C.

**Florida prairie warblers** (*Dendroica discolor paludicola*) utilize the maritime hammock community. They are approximately 12 cm (4.72 in) long overall, and

weigh about 6 to 8 grams (0.21-0.28 oz). There is no overall population estimate for the Florida prairie warbler. Its local abundance ranges from rare to common. Because the species nests almost entirely in mangroves, it is reasonable to infer that its numbers have declined somewhat as mangroves have been cleared or otherwise rendered unusable for nesting. Development pressures continue to be strong in the high-growth coastal zone of the southern peninsula.

The **peregrine falcon** (*Falco peregrinus*) is federally listed as endangered due to its similarity of appearance with the endangered *Falco peregrinus anatum*. *Falco peregrinus* can be found utilizing the maritime hammock community while migrating through Florida. The species feeds primarily on birds, and rarely on small mammals, fish, lizards, and insects. Threats include: falconers robbing nests, shooting by hunters, and food chain contamination from use of persistent pesticides. Peregrine falcon reintroductions have been fairly successful in the United States. Populations of peregrine falcons are estimated to be 1,593 breeding pairs in the United States and Canada. In recognition of this species' recovery, the FWS has proposed to remove *Falco peregrinus anatum*, and consequently *Falco peregrinus* from the endangered and threatened species list (63 FR 45446). A final decision will be made following the receipt of public comments.

### Plant Species of Concern

Although there are no federally listed plant species that utilize the maritime hammock community, this community is utilized by other species, including State-listed species (Appendix C).

The **small-flowered lily-thorn** (*Catesbaea parviflora*) is a state endangered shrub that can utilize the maritime hammock community in South Florida. The species has few known occurrences, low abundance at each occurrence, and is subject to overcollection and habitat destruction. In Florida, this species only occurs on Big Pine Key and Bahia Honda Key in Monroe County.

The **west coast prickly-apple** (*Cereus gracilis* var. *simpsonii*) is an endemic cactus that can be found utilizing the maritime hammock community in Collier, Indian River, Monroe, and St. Lucie counties. The species is columnar with 9 to 11 ridged stems, red fruit, and whitish flowers. Other ecological communities where it can be found include: shell mounds, and rockland hammocks.

The maritime hammock community is utilized by the state endangered **aboriginal prickly-apple** (*Cereus gracilis* var. *aboriginum*). While similar to the west coast prickly apple, this species also has whitish flowers but produces a yellow fruit and occurs in Lee, Manatee, and Sarasota counties.

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### Ecology

In terms of natural disturbances, coastal communities are mainly influenced by intermittent severe storm disturbances and by constant or predictable coastal stresses such as seasonal high tides, winter storms, sand burial and abrasion, and salt spray deposition. Fires occasionally occur in these communities, but it seems likely that natural fires were less frequent on barrier islands than on the

mainland, since there are fewer compass directions from which fire could spread to any given area of barrier island compared to a similar area of mainland by virtue of the island's being surrounded by water. Frost occasionally kills back the tropical species of coastal strand and maritime hammocks in the northern portion of the South Florida coast, with the notable exception of *Myrcianthes fragrans* which survived the December 1989 freeze on the Atlantic coast unscathed.

The zonation of coastal communities at right angles to the shore reflects the decrease in type and intensity of coastal stresses as one moves away from the coast. Plants of the upper beach must be able to rapidly re-colonize this habitat after frequent periodic destruction by seasonal high tides or storm waves. They are all herbaceous and either complete their life cycle in one growing season or colonize vegetatively by sending out low, wide-ranging runners from rooted rosettes in safe sites higher up on the foredune. Most upper beach colonists can withstand inundation by salt water. Beyond the annual reach of the waves, the wind constantly piles sand from the beach around plant stems to create a foredune. This habitat may persist for many years between major storms and favors perennial rhizomatous grasses whose upward growth can keep pace with sand burial and build up the height of the foredune. Aside from sand burial, plants on the foredune must be able to tolerate salt spray blown off the water. Salt from droplets deposited on the foliage may enter the cells through cuts in the cuticle (produced by sand abrasion) and kill the growing buds (Boyce 1954). Plants avoid the entrance of salt into the cells by having a tough cuticle (e.g., *Uniola paniculata*), or by growing low to the ground out of the path of the wind (e.g., *Chamaesyce bombensis*), or they tolerate the entrance of salt by diluting it, producing succulence (e.g. *Iva imbricata*). As the foredune grasses intercept sand, they allow species less tolerant of burial such as the shrubby species of coastal strand, or the less specialized grasses of the coastal grassland, to survive landward of them. The influence of salt spray continues the farthest inland of the coastal stresses, producing the low evenly pruned canopies of coastal strand and maritime hammock communities. Their canopies gradually become taller with increasing distance from the coast as the twigs of the seaward plants comb the salt droplets out of the windstream, allowing the terminal twigs to reach progressively greater heights inland before being killed by salt (Boyce 1954). In order to produce spray-pruning, of course, the wind must blow across water. Low spray-pruned canopies are much more frequently encountered along the Atlantic coast, where the prevailing easterly winds blow across the ocean, rather than on the Gulf coast, where the prevailing easterlies blow across land (Johnson and Barbour 1990).

Waves breaking at other than right angles to the beach tend to move sand along the coast, a process called longshore drift. The prevailing direction of longshore drift in South Florida is southward. If a jetty interrupts this wave conveyor belt, sand will accumulate on the updrift side of the obstruction and be carried away from the downdrift side, producing erosion, especially when storms occur. Coastal erosion has been prevalent in recent years on the Atlantic coast of South Florida (Pilkey *et al.* 1984), where all inlets are "hardened" by jetties, whereas accretion or build-up of new barrier islands from underwater bars has

occurred in the same period in many places on the Gulf coast (Johnson 1994), where many inlets are natural. Although only one hurricane has directly struck South Florida in the last three decades, winter storms called nor'easters have struck the Atlantic coast from Palm Beach County north. Recent erosion has forced relocation of bathhouses and dune overpasses in parks south of Sebastian Inlet in Indian River County and caused overwash of beach sand into mangrove forests along Hutchinson Island south of St. Lucie Inlet. Beach renourishment projects at both these inlets have pumped sand from inside the inlets onto beaches to the south of them. Erosion in this high-density sea turtle nesting area may interfere with nesting by producing a cliff above the beach which blocks the turtles from nesting out of reach of the regular high tides. Accretion on the Gulf coast, on the other hand, has provided new nesting sites for southeastern snowy plovers and least terns (e.g. Lido Key, Estero Island, Keewaydin, and Marco Island). The main threat in this case in an area of such high population density is disturbance by boaters, beach strollers, and their dogs.

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### Status and Trends

Much of the narrow fringe of South Florida's sandy shoreline has been developed into cities and resorts. From Indian River to northern Miami-Dade County only about 56 km of a total 267 km (35 of 160 miles) of coast (22 percent) are not developed; from Sarasota to northern Collier county only 72 km of a total 206 km (45 of 128 miles) of coast (35 percent) remain undeveloped (Johnson *et al.* 1992, Johnson and Muller 1992).

Development is not evenly distributed along the coast. From Sebastian Inlet to Cape Florida, the number and size of sites in natural vegetation on the barrier islands diminishes sharply south of MacArthur Beach State park in northern Palm Beach County. The 121 km (75 miles) of coastline north of MacArthur Beach contains 32 sites in natural vegetation, comprising a total of approximately 1,133 ha (2,800 acres); the 137 km (85 miles) of coastline south of MacArthur Beach contains only 15 sites in natural vegetation totaling approximately 202 ha (500 acres) (Johnson *et al.* 1992). Virtually all of the suitable natural acreage remaining on barrier islands in Palm Beach, Broward, and Miami-Dade counties is already in public ownership, but approximately 65 percent of the remaining natural acreage on barriers in the three northern counties is in private ownership (Johnson *et al.* 1992). About one-fourth of this remaining acreage (all of it in Indian River County) is proposed for state acquisition as part of the Archie Carr NWR in the state (CARL) program. This project would protect the highest-density nesting beaches for sea turtles in Indian River and southern Brevard counties, of which approximately 81 ha (200 acres) in Indian River County has been purchased to date (DEP 1997). Scattered natural hammocks on both the mainland and barrier island shores of Indian River Lagoon are also proposed for state acquisition as part of the Indian River Lagoon Blueway CARL project.

In the 209 km (130 miles) of Gulf coast from Lido Key to Cape Romano, there are 24 sites in natural vegetation comprising a total of approximately 1,214 ha (3,000 acres). Some of these are large sites comprising almost all of certain barrier islands such as Cayo Costa, North Captiva, and Keewaydin Islands. Most of the suitable natural land remaining is in public ownership or

is proposed for public acquisition by the state including Buck Key and portions of Cayo Costa Island as part of the Cayo Costa Island CARL project in Lee County, and Keewaydin, Little Marco, Cannon, and Johnson Islands as part of the Rookery Bay CARL project in Collier County (DEP 1997).

Aside from real estate development, displacement by the exotic Australian pine (*Casuarina equisetifolia*), a coastal tree native to Australia and islands in the Pacific, is the greatest threat to coastal communities in South Florida. It invades bare sand beaches, whether newly deposited or denuded of natural vegetation by storm overwash, as well as spoil deposits produced by dredging the intracoastal waterway. Since *C. equisetifolia* tolerates inundation by seawater and deposition of salt spray on its foliage better than do native woody species, its seedlings can colonize and grow into forests closer to the coast than can native trees, displacing not only native coastal forest, but also coastal grassland and coastal strand along with their associated rare endemic plants, all of which are adapted to a high-light environment (Johnson 1994). Australian pines form tall, shady, monospecific forests with a deep litter layer of “needles” (actually branchlets) that appears to preclude germination of most native understory species, although these will grow in the understory when planted as seedlings or saplings (Fernald and Barnett 1991).

Dense Australian pine forests are found along 44 percent [32/72 km (20/45 miles)] of undeveloped coast from Sarasota to Collier counties and 46 percent [26/56 km (16/35 miles)] of undeveloped coast between Indian River and Miami-Dade counties. Much of the mature Australian pine forests in South Florida are within state parks or preserves including Port Charlotte Beach SRA, Don Pedro Island SRA, Cayo Costa Island SRA (including portions of North Captiva Island), Lovers Key SRA, and Delnor Wiggins SRA along the Gulf coast, and St. Lucie Inlet SRA and John U. Lloyd SRA on the Atlantic. Mature forests of Australian pine also occur on many spoil islands in the intracoastal waterway (FDNR 1990). Mature Australian pine forests formerly occurred on state-managed land at Cape Florida SRA, Miami-Dade County and Keewaydin Island, Collier County. The Cape Florida forest was blown down by Hurricane Andrew in 1992; the trees were chipped and the area re-planted to native hammock.

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## Management

The chief management concern in coastal communities of South Florida is exotic plant control, primarily of Australian pine, but also of Brazilian pepper (*Schinus terebinthifolius*), beach naupaka (*Scaevola taccada* var. *sericea*), latherleaf (*Colubrina asiatica*) and carrotwood (*Cupaniopsis anacardioides*). One of the most important and effective steps to take with Australian pine is to pull seedlings that are invading new areas. Once a mature forest of *Casuarina* is established, it presents an expensive problem to eradicate all at once and replace with native species. This has been done where funds were made available: at The Nature Conservancy’s Blowing Rocks Preserve in Martin County [approximately 5.6 ha (14 acres) cleared and re-planted for about \$300,000; Jensen 1994], at Cape Florida SRA in Miami-Dade County after the Australian pine forest was flattened by Hurricane Andrew in 1992 [approximately 121 ha (300 acres) chipped, graded,



and re-planted for about \$4 million; P. Schroeder, Cape Florida SRA, personal communication 1994], Palmer Dunes, Sarasota County [ 3.2 ha (8 acres) cleared and to be re-planted for a proposed \$300,000; R. Patten, Coastal Dunes Inc., personal communication 1998] and on Keewaydin Island (part of the Rookery Bay National Estuarine Research Reserve) in 1998 [approximately 182 ha (450 acres) cleared, not re-planted, for unknown amount; D. Addison, The Nature Conservancy Inc., personal communication 1998]. Once the initial money is spent, little is usually allocated for the follow-up jobs of monitoring, re-planting of natives, and pulling of re-invading *Casuarina* seedlings, which tasks have fallen to volunteer labor, at least at the first two sites (Jensen 1994; E. Golden, Cape Florida SRA, personal communication 1998).

While the mature Australian pine forest remains, its shade can skew the gender of loggerhead hatchlings toward males, its root mat can interfere with the female turtle's nest excavation, and it can narrow the zone of bare sand and pioneer sea oats dunes used by beach mice and nesting shorebirds. In addition, beach visitors come to enjoy its shade and will protest a too rapid and complete removal program, even though the tree creates problems for the human population as well. Its wind-dispersed pollen can cause respiratory distress and its shallow root system makes it likely to topple during hurricanes, blocking evacuation routes.

Due to its popularity, as well as financial constraints, the state parks have adopted a program of gradual removal of large Australian pines by girdling and herbiciding the trees and allowing them to die and decay in place (Glisson 1994). Control of seedling invasion in the parks is on a casual basis. Systematic control would require manpower with boat access to monitor newly deposited or eroded beaches annually or semi-annually and pull the invading seedlings, which can grow up to 1.5 to 3m (5 to 10) feet per year (Morton 1980). This could be accomplished by coordination of volunteer efforts and by forming partnerships with interested non-profit groups, such as the Audubon Society. An example of the effectiveness of following up removal of mature pines by pulling seedlings is the experience of Everglades NP which managed to prevent the development of a mature Australian pine forest on Cape Sable by annually pulling up the seedlings that came in after Hurricane Donna in 1960 (Klukas 1969).

Other exotics pose a continuing, if not yet as severe, problem for coastal communities. Beach naupaka naturalizes from landscaped areas into the beach dune community, possibly displacing the native inkberry, *Scaevola plumieri*. *Lantana camara*, the common shrub used in landscaping, naturalizes in disturbed areas and will hybridize with the native endemic varieties of *L. depressa* (Sanders, 1987); Brazilian pepper has seeded into the understory of most maritime hammocks and may become so dense as to exclude seedling regeneration of native species after storms open up the canopy; also common in the understory of maritime hammocks in the Keys and Ten Thousand Islands are the exotics, *Agave sisalana* and *Sansevieria hyacinthoides*. Latherleaf, a woody vine from Asia, occupies the ecotone between the beach and hammock zones and has formed dense populations on some beaches in the Ten Thousand Islands NWR (D. Addison, Nature Conservancy Inc., personal communication

1998). Carrotwood, a common landscape tree, naturalizes on the fringes of maritime hammocks on both coasts (Austin 1994).

Plants may be impacted in several ways. Cutting down of coastal strand and maritime hammock for parking lots or beach structures may allow salt spray to penetrate further inland and kill the canopies of trees in the remaining hammock, since the salt droplets are no longer combed out of the windstream by the seaward twigs in a continuous canopy that slants uniformly upward away from the coast. Raking of seaweed drift off the beach removes a source of fertilizer, as well as the seeds of pioneer species, both of which may be especially needed after storms for rapid recolonization and growth, to help stabilize the sand and restore the elevation of the foredune.

**Table 1. Plant species of beach dune, coastal strand, and maritime hammock communities found only on the east or west coast of South Florida (Wunderlin *et al.* 1996).**

Species	FLORIDA ENDEMIC	EAST COAST	WEST COAST	Keys
<i>Alternanthera maritima</i>	X	X		
<i>Amyris elemifera</i>		X		X
<i>Argusia gnaphalodes</i>		X		X
<i>Coccothrinax argentata</i>		X		X
<i>Chamaesyce cumulicola</i>	X	X		
<i>Glandularia maritima</i>	X	X		
<i>Guapira discolor</i>		X		X
<i>Harrisia simpsonii</i>	X	X		X
<i>Harrisia aboriginum</i>	X	X	X	
<i>Helianthus debilis ssp. debilis</i>	X			
<i>Helianthus debilis ssp. vestitus</i>	X	X	X	
<i>Jacquinia keyensis</i>			X	X
<i>Krugiodendron ferreum</i>		X		X
<i>Lantana depressa var. sanibelensis</i>	X		X	
<i>Lantana depressa var. floridana</i>	X	X		
<i>Metopium toxiferum</i>		X		X
<i>Okenia hypogaea</i>		X		
<i>Pithecellobium keyense</i>		X		X
<i>Pithecellobium unguis-cati</i>			X	X
<i>Piscidia piscipula</i>			X	X
<i>Remirea maritima</i>		X		
<i>Tephrosia angustissima var. curtissii</i>	X	X		
<i>Zanthoxylum coriaceum</i>		X		

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**Literature Cited**

- Addison, D. 1998. Telephone communication. April 3, 1998.
- Alexander, T. R. 1958. Ecology of Pompano Beach hammock. *Quarterly Journal of the Florida Academy of Sciences* 21:299-304.
- Austin, D. F. 1994. The invasion of our coasts. Pages 119-120 in D.C. Schmitz and T.C. Brown, eds., *An assessment of invasive non-indigenous species in Florida's public lands*. Technical report no. TSS-94-100, Bureau of Aquatic Plant Management, Division of Environmental Resource Permitting, Florida Department of Environmental Protection; Tallahassee, Florida.
- Austin, D.F., D.M. Binniger, and D.J. Pinkiva. 1998. Uniqueness of the endangered Florida semaphore cactus (*Opuntia corallicola*). *SIDA* 18(2):151-158.
- Bellis, V.J. 1995. Ecology of maritime forests of the southern Atlantic coast: a community profile. U.S. Department of Interior, National Biological Service, Biological Report 30; Washington, D.C.
- Boyce, S.G. 1954. The salt spray community. *Ecological Monographs* 24:29-67.
- Coile, N. 1998. Notes on Florida's endangered and threatened plants. Florida Department of Agriculture and Consumer Services, Division of Plant Industry; Gainesville, Florida.
- Cooley, G.R. 1955. The vegetation of Sanibel Island, Lee County, Florida. *Rhodora* 57:269-289.
- Correll, D.S. and H. B. Correll. 1982. *Flora of the Bahama archipelago*. J. Cramer; Vaduz, Germany.
- Davis, J.H. Jr. 1942. The ecology of the vegetation and topography of the sand keys of Florida. *Carnegie Institution of Washington Publication* 524:113-195.
- Davis, P. 1998. Comments on technical/agency draft multi-species recovery plan for South Florida. September 30, 1998.
- Enge, K.M., B.A. Millsap, T. J. Donovan, J.A. Gore, N. J. Douglas, M.S. Robson, and G. L. Sprandel. 1997. Conservation plans for biotic regions in Florida that contain multiple rare or declining wildlife taxa. Draft technical report, Florida Game and Fresh Water Fish Commission; Tallahassee, Florida.
- Fernald, R.T., and B.S. Barnett. 1991. Establishment of native hammock vegetation on spoil islands dominated by Australian pine (*Casuarina equisetifolia*) and Brazilian pepper (*Schinus terebinthifolius*). Pages 131-150 in T. D. Center, R. F. Doren, R. L. Hofstetter, R. L. Myers, and L. D. Whiteaker, eds., *Proceedings of the symposium on exotic pest plants*. Technical report NPS/NREVER/NRTR-91; National Park Service, P.O. Box 25287, Denver, Colorado.
- Florida Department of Environmental Protection [DEP]. 1997. Conservation and Recreation Lands (CARL) annual report 1997. Office of Environmental Services, Division of State Lands; Tallahassee, Florida.
- Florida Department of Natural Resources [FDNR]. 1990. Indian River Lagoon spoil island management plan. Florida Inland Navigation District; Jupiter, Florida.
- Florida Game and Fresh Water Fish Commission [GFC]. 1992. Map entitled "Florida Land Cover" from Landsat Thematic Mapper Satellite Imagery (1985-1989); Tallahassee, Florida.

- Florida Game and Fresh Water Fish Commission [GFC]. 1997. Florida's endangered species, threatened species, and species of special concern. Official lists; Tallahassee, Florida.
- Florida Natural Areas Inventory [FNAI] and Florida Department of Natural Resources [FDNR]. 1990. Guide to the natural communities of Florida. Florida Department of Environmental Protection; Tallahassee, Florida.
- Glisson, M. 1994. Invasive non-indigenous species in Florida's state parks. Pages 132-138 *in* D. C. Schmitz and T. C. Brown, eds. An assessment of invasive non-indigenous species in Florida's public lands. Technical report no. TSS-94-100, Florida Department of Environmental Protection; Tallahassee, Florida.
- Golden, E. 1998. Telephone communication. April 2, 1998.
- Gordon, D.R. and T.L. Kubisiak. 1998. RAPD analysis of the last populations of a likely Florida Keys endemic cactus. *Florida Sci.* 61:203-210.
- Gore, J.A. and C. A. Chase III. 1989. Snowy plover breeding distribution. Final performance report, Nongame Wildlife Section, Florida Game and Fresh Water Fish Commission; Tallahassee, Florida.
- Harper, R. 1927. Natural resources of southern Florida. Florida State Geological Survey, 18th Annual Report; Tallahassee, Florida.
- Herwitz, S. 1977. The natural history of Cayo Costa Island. New College Environmental Studies Program Publication No. 14; Sarasota, Florida.
- Humphrey, S.R. 1992. Introduction. Pages 1-10 *in* S. R. Humphrey, ed. Rare and endangered biota of Florida volume I: mammals. The University Presses of Florida; Gainesville, Florida.
- Isley, D. 1990. Vascular flora of the southeastern United States. Volume 3, part 2 Leguminosae. The University of North Carolina Press; Chapel Hill, North Carolina.
- Jensen, D. B. 1994. Statement of Dr. Deborah B. Jensen, Director of Conservation Science and Stewardship for The Nature Conservancy, before the Senate Governmental Affairs Committee, March 11, 1994. The Nature Conservancy; Arlington, Virginia.
- Johnson, A. F. 1994. Coastal impacts of non-indigenous species. Pages 119-125 *in* D.C. Schmitz and T.C. Brown, eds., An assessment of invasive non-indigenous species in Florida's public lands. Technical report no. TSS-94-100, Bureau of Aquatic Plant Management, Division of Environmental Resource Permitting, Florida Department of Environmental Protection; Tallahassee, Florida.
- Johnson A. F. and M. G. Barbour. 1990. Dune and maritime forests. Pages 429-473 *in* R.L. Myers and J.J. Ewel, eds., *Ecosystems of Florida*. University Presses of Florida; Gainesville, Florida.
- Johnson, A.F. and J.W. Muller 1992. An assessment of Florida's remaining coastal upland natural communities: southwest Florida. Unpublished report, Florida Natural Areas Inventory; Tallahassee, Florida.
- Johnson, A.F. and J.W. Muller. 1993. An assessment of Florida's remaining coastal upland natural communities: final summary report. Unpublished report, Florida Natural Areas Inventory; Tallahassee, Florida.
- Johnson, A.F., J.W. Muller and K.A. Bettinger. 1992. An assessment of Florida's remaining coastal upland natural communities: southeast Florida. Unpublished report, Florida Natural Areas Inventory; Tallahassee, Florida.

- Klukas, R.W. 1969. The Australian pine problem in Everglades National Park, Unpublished report, Everglades National Park; Homestead, Florida.
- Kruer, C.R. 1992. An assessment of Florida's remaining coastal upland natural communities: Florida Keys. Unpublished report, Florida Natural Areas Inventory; Tallahassee, Florida.
- Kuchler, A.W. 1964. Potential natural vegetation of the conterminous United States. American Geographic Society special publication no. 36.
- Moreno-Casasola, P. and I. Espejel. 1986. Classification and ordination of coastal sand dune vegetation along the Gulf and Caribbean Sea of Mexico. *Vegetatio* 66:147-182.
- Morrill, S. and J. Harvey. 1980. An environmental assessment of North Captiva Island, Lee County, Florida. New College Environmental Studies Program publication no. 23; Sarasota, Florida.
- Morris, J., J. Miller, W. K. Byle, Jr., and J. B. Morrill. 1979. Survey of the natural systems of Gasparilla Island, Florida. Unpublished report submitted to The Conservation Foundation; Washington, D.C.
- Morton, J. 1980. The Australian pine or beefwood (*Casuarina equisetifolia*), an invasive "weed" tree in Florida. *Proceedings of the Florida Horticultural Society* 93:87-95.
- Myers, R.L. and J.J. Ewel. 1990. *Ecosystems of Florida*. University of Central Press; Orlando, Florida.
- Patten, R. 1998. Telephone communication. April 2, 1998.
- Pilkey, O.H. Jr., D.C. Sharma, H. R. Wanless, L.J. Doyle, O. H. Pilkey Sr., W. J. Neal, and B. J. Gruver. 1984. *Living with the east Florida shore*. Duke University Press; Durham, North Carolina.
- Repenning, R.W. and S.R. Humphrey. 1986. The Chadwick beach cotton mouse (Rodentia: *Peromyscus gossypinus restrictus*) may be extinct. *Florida Scientist* 49:259-262.
- Sanders, R.W. 1987. Identity of *Lantana depressa* and *L. ovatifolia* (Verbenaceae) of Florida and the Bahamas. *Systematic Botany* 12:44-60.
- Sauer, J.D. 1967. Geographic reconnaissance of seashore vegetation along the Mexican Gulf coast. Louisiana State University coastal studies series no. 21, Louisiana State University Press; Baton Rouge, Louisiana.
- Sauer, J.D. 1982. Cayman Islands seashore vegetation: a study in comparative biogeography. University of California publications in geography volume 25, University of California Press; Los Angeles, California.
- Schoeder, P. 1994. Telephone communication. October 1994.
- Small, J.K. 1930. *Consolea corallicola*, Florida semaphore cactus. *Addisonia*. 15:25-26.
- Smith, H. T. 1996. Threatened: roseate tern (*Sterna dougallii*). Pages 247-257 in J. A. Rogers Jr., H. W. Kale II, and H. T. Smith, eds. *Rare and endangered biota of Florida volume 5: birds*. The University Presses of Florida; Gainesville, Florida.
- Stalter, R. and E.E. Lamont. 1997. Flora of North Carolina's outer banks, Ocracoke Island to Virginia. *Journal of the Torrey Botanical Club* 124:71-88.
- U.S. Fish and Wildlife Service [FWS]. 1998. Multi-species recovery plan for the threatened and endangered species of South Florida. Volume 1 of 2, The species. technical/agency draft; Vero Beach, Florida.

- Wagner, R.H. 1964. The ecology of *Uniola paniculata* in the dune-strand habitat of North Carolina. *Ecological Monographs* 34:79-95.
- Weakley, A. S., K. D. Patterson, S. Landaal, and M. Pyne. 1998. International classification of ecological communities: terrestrial vegetation of the southeastern United States. Working draft of March 1998. Unpublished manuscript, The Nature Conservancy, Southeast Regional Office; Chapel Hill, North Carolina.
- Wunderlin, R.P., B. F. Hansen, and E. L. Bridges. 1996. Atlas of Florida vascular plants CD-ROM. Institute of Systematic Botany, University of South Florida; Tampa, Florida.





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# Restoration of Beach Dune, Coastal Strand and Maritime Hammock

**Restoration Objective:** Maintain the structure, function, and ecological processes of beach dune, coastal strand and maritime hammocks, and prevent any further loss or degradation of these communities in South Florida.

## Restoration Criteria

This restoration objective will be achieved when: (1) beach dune/coastal strand/maritime hammock communities are protected from further destruction and degradation; (2) areas dominated by the exotic Australian pine (*Casuarina equisetifolia*) are replaced with native coastal vegetation; (3) invasion of newly created coastal habitat by this exotic is prevented; (4) endemic, rare, and imperilled species that use these communities have self-sustaining populations in the wild; and (5) natural successional processes following storm destruction or beach accretion are allowed to occur.

## Community-Specific Actions

1. **Prevent further destruction or degradation of existing beach dune/coastal strand/maritime hammock communities.** Acquire remaining natural coastal areas identified on the state (CARL) list. Prevent colonization by Australian pine of newly deposited or storm-denuded coastal areas in public ownership by regularly scheduled pulling of Australian pine seedlings.
2. **Restore existing degraded beach dune/coastal strand/maritime hammock communities.**
  - 2.1. **Restore native maritime hammock communities** at coastal areas dominated by invasive exotic species, such as Australian pine forests, by introducing seeds or seedlings of native woody species in the understory if they are not already present, and by killing the exotic species with hand-administered herbicide application.
  - 2.2. **Restore coastal strand communities** in areas dominated by invasive exotic species exposed to salt spray by applying herbicide to kill the canopy of exotics and reduce shading, and then planting seeds or seedlings of native strand species behind the foredune, if plants of the strand community are not already present.
  - 2.3. **Within their known ranges, introduce rare endemic species**, such as *Jacquemontia reclinata*, into natural openings in the appropriate coastal community which they may be unable to colonize naturally due to fragmentation of the natural linear coastal vegetation by development. Factors to consider in siting such plantings for each species are its tolerance of sand burial, salt spray on its foliage, and saltwater inundation of its root zone.

- 2.4. **Remove the naturalized landscape ornamentals in the genus *Lantana*** before planting the endemic varieties of *Lantana depressa*; the ornamentals tend to hybridize with the native species.
- 2.5. **Use a mix of native species in replantings** based on nearest natural coastal communities, bearing in mind that some species are native only to the east or west coast of South Florida (Table 1).
3. **Maintain existing natural communities in a natural condition.**
  - 3.1. **Permit native coastal species to successfully colonize or re-colonize coastal beach areas** following natural storms or beach accretion by controlling colonization by competing exotics. Introduce native seeds, seedlings, or cuttings to areas that may be too distant from natural seed sources (due to intervening development along the coast) for dispersal to occur.
  - 3.2. **Leave seaweed wrack on the upper beach** to be buried by sand and form a natural fertilizer and seed bed for colonization of the beach.
  - 3.3. **Monitor populations of rare species**, both plant and animal and control overuse by humans of parts of the beach needed for nesting or feeding of turtles and shorebirds.
4. **Conduct community-level research.**
  - 4.1. **Conduct research on cost-efficient methods of removing Australian pine**, both as mature forest and as colonizing seedlings.
  - 4.2. **Conduct research on best methods of re-establishing native vegetation** of the beach dune, coastal strand, and maritime hammock communities once exotic species have been removed. This would include supporting basic research into the factors influencing the process of natural dune succession in South Florida.
  - 4.3. **Provide a regular forum to encourage sharing of information** on techniques and case histories for dealing with exotic species such as Australian pine removal and subsequent re-vegetation efforts between public agencies at all levels and between private contractors and public agencies.
5. **Monitor land management actions.**
  - 5.1. **Once cleared of exotic species, monitor coastal areas at least semi-annually** to determine the rate and sequence of natural revegetation and to be sure exotics are not re-invading.
  - 5.2. **Monitor plantings of native species (including rare species) following exotic plant removal** to follow success and to re-plant or modify planting scheme if necessary.
6. **Increase public awareness.**
  - 6.1. **Provide pamphlets, information billboards, and guided walks to inform the public** on the effects of invasive exotic vegetation on native plant and animal communities along the coast, as well as the need to avoid disturbing nesting birds during some seasons.
  - 6.2. **Enlist the aid of volunteer groups and nonprofit organizations** to aid in annual or semi-annual pulling of exotic plant seedlings on newly formed or overwashed beaches.