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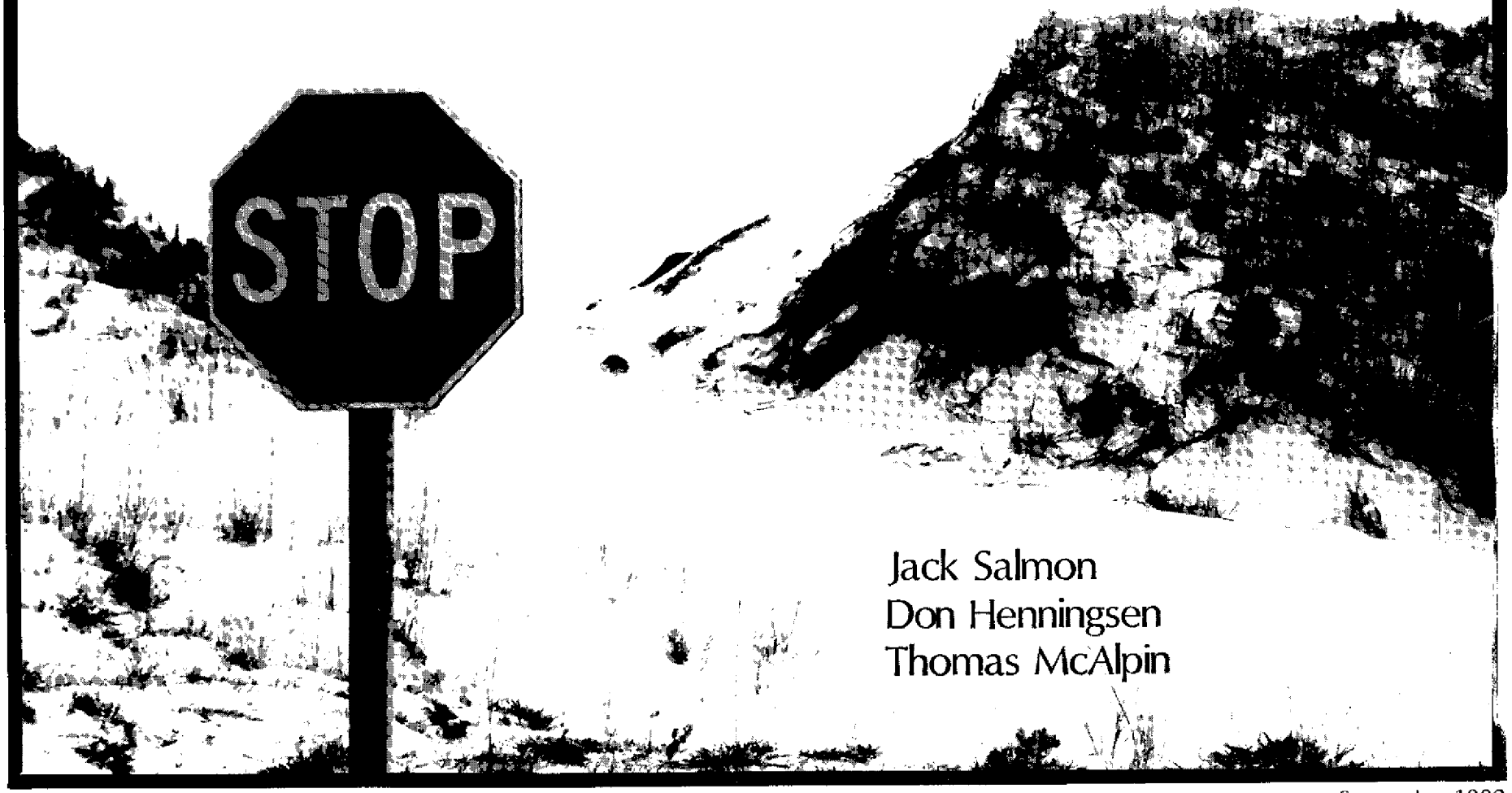
DUNE RESTORATION AND REVEGETATION MANUAL



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FLORIDA SEA GRANT COLLEGE

September 1982

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Table of Contents

Introduction

Beaches and sand dunes confront tremendous energies from storm waves, tides and winds. They act as shock absorbers to protect the coastal environment and buildings behind them. Dunes can also be looked upon as sand stockpiles, accumulating sand in normal conditions and releasing it to the beach during major storms. This sand reserve helps beaches resist wave energy and provides material to help rebuild the beach after the storm.

In many coastal areas dunes have been removed to allow construction of buildings or severely damaged by foot or vehicle traffic. Destruction of dunes reduces the beach's ability to absorb energy and break up waves, thus increasing vulnerability to storm water damage, with potential devastating effects on both the natural environment and man-made structures.

A basic conflict exists between "developing" coastal property and the natural processes at work where sea meets land. The conflict is between the dynamic natural system, constantly changing the position of the beaches and dunes, and man's unmoving structures, which demand a more stationary topography. The natural beach-dune ecosystem is flexible enough to move and adjust to storm and hurricane conditions and absorb their tremendous forces while preserving the productivity of the coastal environment. Human structures are not.

Man's inability to artificially duplicate the flexible resilience of the natural beach system or control the actions of the oceans has confounded him for centuries. Jetties, sea walls, rip-rap and other methods have very definite limits to their effectiveness. Often attempts to artificially stabilize the beach have actually resulted in increased erosion, either at the stabilization site or down the beach, sometimes miles away.

Dunes are also valued for aesthetic reasons. The attractive qualities of beach-dune areas have made them highly sought-after for homes, tourist attractions, and recreational purposes. Projections show a continuing increase in population and construction in coastal areas, with consequent pressure on the coastal barrier dune systems. If dunes are damaged or destroyed, the natural system is less able to absorb storm energies. The result may be greater damage to the entire barrier ecosystem, increased danger to island and coastal homeowners, and higher cost to all--including the general taxpayer who subsidizes coastal development in several ways.

Five of the major hurricanes which hit the US since 1965 (Eloise, Frederic, Agnes, Camille, Betsy) caused damages estimated at $8.5 billion. Fortunately, these hurricanes missed those coastal areas experiencing the most dramatic growth. Preservation or restoration of dunes will not infallibly protect against damage by major storms or hurricanes, but their value in at least reducing the level of damage is widely accepted.

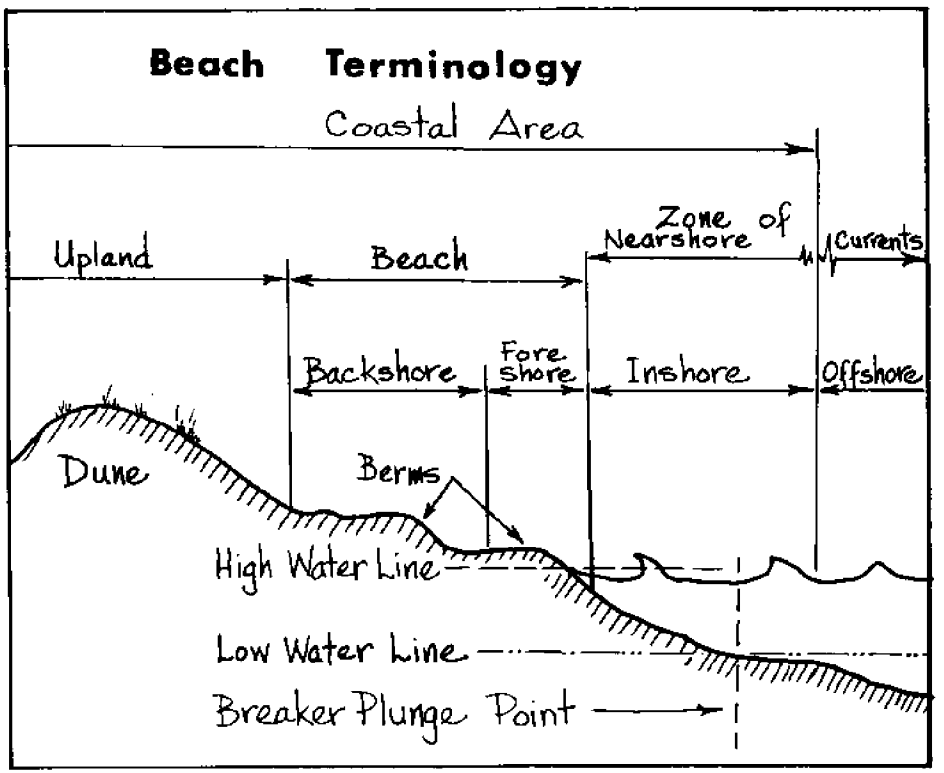
Integrity of the dune line is important for proper functioning of all ecosystems on an island. These ecosystems (tidal and salt marshes, freshwater ponds, maritime forests, dune and dune swale communities) are dependent upon dune protection against storm seas. Marshes and estuaries protected by the barrier system

provide nutrients and shelter for spawning, nursery, and feeding grounds for fish. An estimated 90 percent of all fish caught on the coast, for food and sport, depend on estuaries and marshes behind the barrier island chain at some stage in their life cycle. Breaches in the dune system may lead to a breach in the island, threatening island ecosystem survival and allowing saltwater intrusion into the backbay estuary.

Sand dunes are the natural forward defense works for the coastal environment. Careful development can preserve the primary dune systems, maintaining this aesthetic, economic and protective resource. Where dune damage occurs, under the right conditions we can repair or re-establish a dune system protecting both the natural and the built environment behind the dune lines.

To build dunes, we do what nature would do if left alone -- we merely help speed the process. Sand fences create more rapid sand deposition; dune grass planting greatly speeds the natural revegetation process. Fertilizing and watering (if needed) decreases plant mortality and encourages rapid growth. Preserving healthy dunes (maintenance), is also important: it is cheaper and easier than rebuilding an already damaged dune or creating a new one from scratch.

Although details of dune reconstruction may become complex, basic principles are simple: fit the dune into the natural dune pattern in the area; allow room for the dune to adjust naturally to the energy regime; prevent man-caused damage wherever possible; help nature without completely replacing it. Individuals can do these



things on their own land. Government can help by enacting and enforcing policies to prevent dune damage, by monitoring dune fields and "patching" as needed, by creating dune management areas, and by encouraging property owners to preserve or restore the natural system.

Purpose and Limitations of this Manual

Our concern here is with sand dunes, not with the larger topic of beaches generally. We focus on dunes in the pioneer or sea oat zone closest to the waves, since these are the dunes most often damaged or destroyed, and hence most in need of attention.

This manual is generally applicable to the Gulf of Mexico and Southeastern Atlantic states. Florida is used as a model for regulatory and institutional illustrations. Our purpose is to provide pragmatic, clear instructions for making good decisions and doing the job well. This is not a research report, but an operating tool for the private property owner or busy government official. In fact, we have found a surprising amount of conflict among the experts on some practical matters such as best use of sand fencing, although they tend to agree on the scientific questions. We have tried to sort out those areas in which there is general agreement and to present them as "fact." On some other points we offer either our own best judgment or a choice of two or three alternatives--an indication we could not find agreement on the "one best way."

Because we are attempting to serve both the private property owner and the local government official, both large projects and small, each user should be aware that not every item in the Manual will apply to their particular case. Much of the "public involvement" section, for example, will be useful only in large projects run by government. But even the private property owner concerned with one small dune on his beachfront lot may find that public involvement methods could help develop public understanding, reduce trampling of the dune or vandalism of the sand fences, etc.

How to Use this Manual

Chapter One introduces the terminology which applies to dunes and describes the natural processes which form, build, destroy and rebuild dunes. Knowing the terminology will help in filing for permits or talking to engineers, biologists or other expert consultants. Understanding how the natural process works may provide a clue to the answer when you confront some situation not adequately treated by the Manual, or when the advice of the Manual is not quite clear.

Chapter Two provides a guide to help answer intelligently what must be the first question: is it worth your while to embark upon a dune restoration project? By pursuing the question as recommended you may save a great deal of effort and money. If the answer is positive and you decide to begin a dune project, you will know that you have a good chance of success and you will have clarified the nature of your problems, perhaps leading to an improved project.

Getting organized to do the job and then actually doing it is the topic of the third chapter, containing

most of the detail of the Manual. But when your dune is emplaced and beginning to grow, or when you are concerned with keeping intact and healthy the existing dunes, chapter four on dune maintenance should be consulted. Maintenance is less complex and difficult or expensive than dunebuilding, but is no less vital. As a long term, continuing responsibility, the requirement is chiefly that the status of the dunes be monitored and corrective action taken quickly when problems develop.

Obtaining one or more permits from state or local agencies will be necessary for almost any dune project. Various regulations either require or prohibit certain kinds of actions. The Manual gives some guidance on how to deal with permitting requirements.

A Reference section concludes the Manual. It contains the footnotes, provides a selection of literature on dunes and vegetation, and reproduces key sections of the Florida statutes related to beaches and dunes. If your questions are not answered in the text of the Manual, we hope the References will provide a starting point that will lead quickly to the answer.

Sea Oats

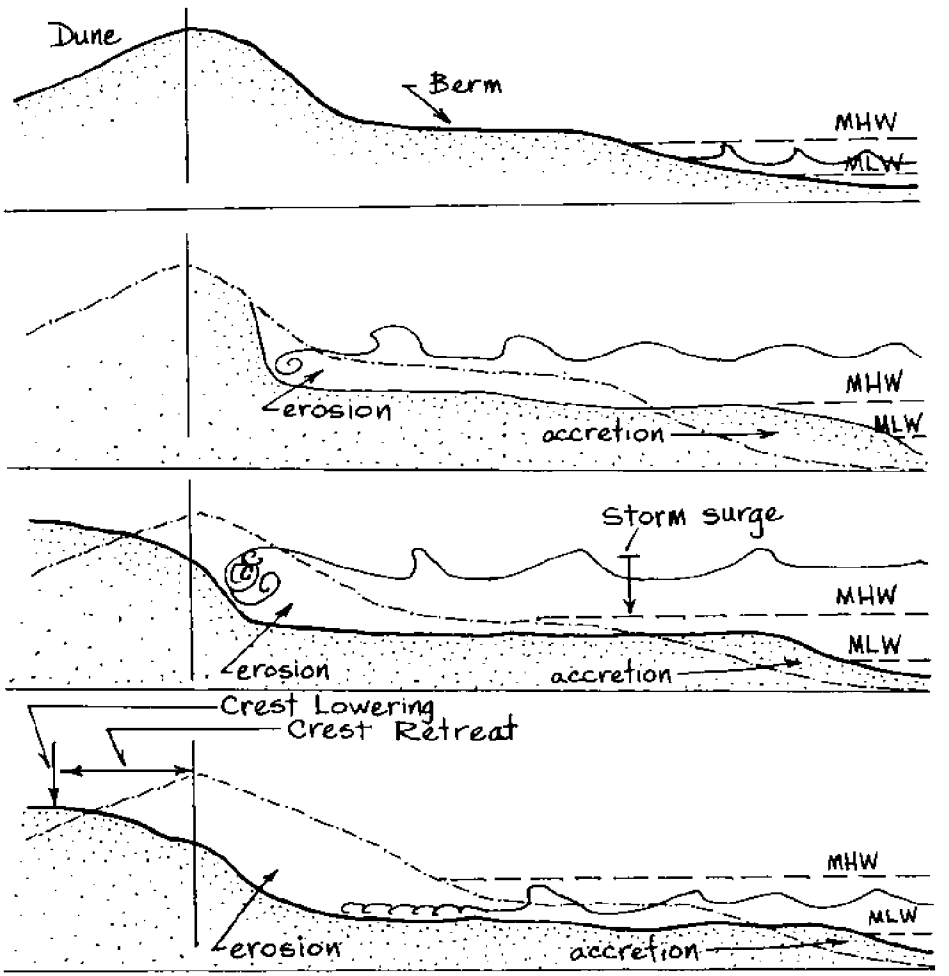
Chapter 1 The Natural Cycle

Beach Dynamics

Atlantic and Gulf coast beaches of the southeastern United States vary in tidal action, wave energy, climate, plant life, sand consistency, geomorphology, and rates of erosion or accretion. But they are alike in being dynamic, changing systems, reacting to the constant impact of waves and wind upon the loose beach sand and shell fragments. Most plants and animals cannot survive in this habitat; those that can are important in the life of the beaches and dunes.

The beach/dune system adjusts flexibly to constantly changing beach energy levels. Sand is stored in off shore bars, the tidal beach, the back beach above normal high tide, and in the dunes. During the stormy winter season storm waves drive high onto the beach and pull sand off the foreshore and back beach, depositing it on enlarged offshore bars. These storm bars absorb wave energy, thus reducing the energy actually reaching the back beach. During lengthy storms, sand will be removed from the beach and an equilibrium profile reached; the larger a storm, the more sand removed. During more severe storms, waves may reach the foredune area and remove sand from the dunes. This scouring of the foredunes by wave action may leave a scarp in the dune or even breach and remove a portion of the dune line. During calmer periods, the large offshore sand bar loses some volume as lower energy waves slowly push some of the

Storm Effect On Dunes



sand back onto the beach, although there is usually a net loss of sand. For this reason, beaches are usually narrower in the winter (stormy season) and wider in the summer (calmer season).

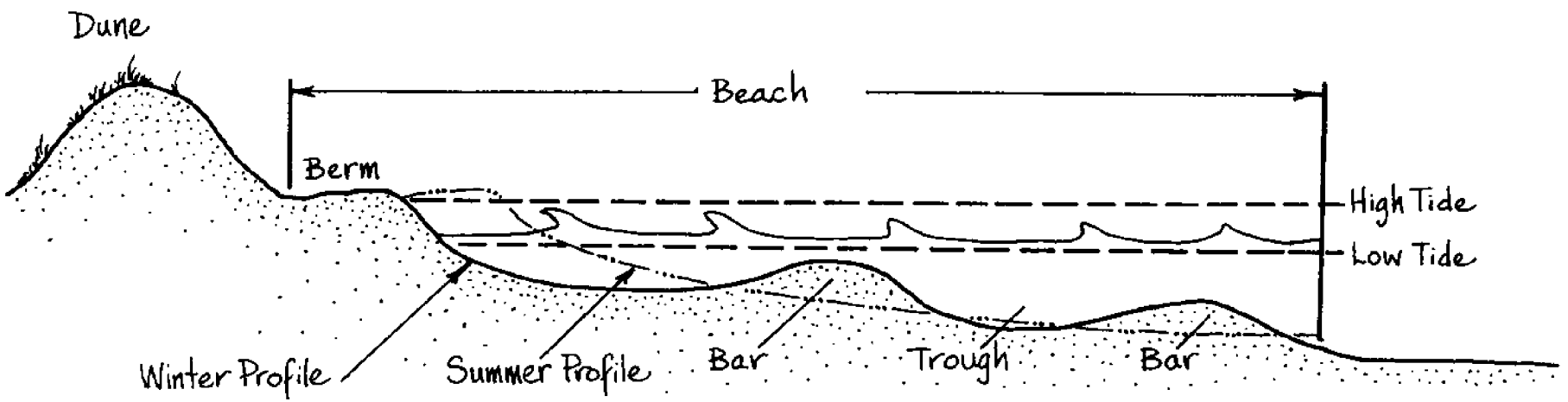
As the sand migrates back onto the beach, wind picks it up and blows it across the beach and onto the dunes. The dune zone may consist of a single dune or of several dune ridges that are usually in lines parallel to the shoreline. The orientation of the coastal land or barrier island to the prevailing winds and waves is important in the development of sand dunes. This relationship between prevailing wind directions and land orientation will be important in determining the height and shape of the dunes or dune lines.

Dune Development

Dunes act as a reservoir of sand for the beach, but first the sand must be accumulated. Dunes develop through the interaction of three major beach resources: wind, sand and plants.

Winds are turbulent: they have both vertical and horizontal components of motion, and therefore can not only push sand along the ground, but pick it up and carry it. Near to the ground the vertical component averages one-fifth the velocity of the horizontal component. To pick up and move much sand, the wind must be blowing at least 4-5 meters per second (10-12 mph). After sand has been moved up onto the beach by wave action, winds will dry the sand and selectively pick up the smaller

Summer & Winter Beach Profiles



grains of sand (diameter of dune sands ordinarily ranges from .08 mm to .5 mm with the average in the range .15-.3 mm). Winds move the fine sand either back into the water or across the beach and towards the dunes. Thus prevailing onshore winds expedite dune formation, and the sand grain size in dunes is normally smaller than that of the foreshore or offshore areas. This is important because water holding ability and suitability for vegetation growth is greater for fine sands than for coarse sand.

The amount of sand available to the beach will be a controlling factor in natural dune formation. Beaches can be categorized as stable, eroding, or accreting. A beach which has a relatively constant profile is termed a stable beach. Stable beaches occur where the sand brought up on the beach is nearly equal to the amount of sand removed from the beach (man or nature can change this balance). An eroding beach has a negative sand budget, as opposed to an accreting beach which has a positive sand budget. Note that a beach can be eroding during the winter storm season, but have an overall yearly positive sand budget (accreting beach). Because of variations in sand, wind, and plant availability, some areas of the southeast U.S. will build up a sizable dune in a relatively short time compared to other areas.

Onshore winds of sufficient velocities will blow sand inland until the wind currents are slowed or obstructed and the sand is dropped. Vegetation growing close to the water will reduce wind velocity and trap the sand, keeping much of it in the immediate vicinity of the beach. If the plants have the ability to grow upward while being partially buried by sand, the sand-catching process will continue and a dune will develop. If vegetation is destroyed or absent, winds will blow the sand inland. Eventually, at some distance inland the sand may be effectively removed from the beach (e.g., carried into a forest zone from which offshore winds could not return the sand to the beach).

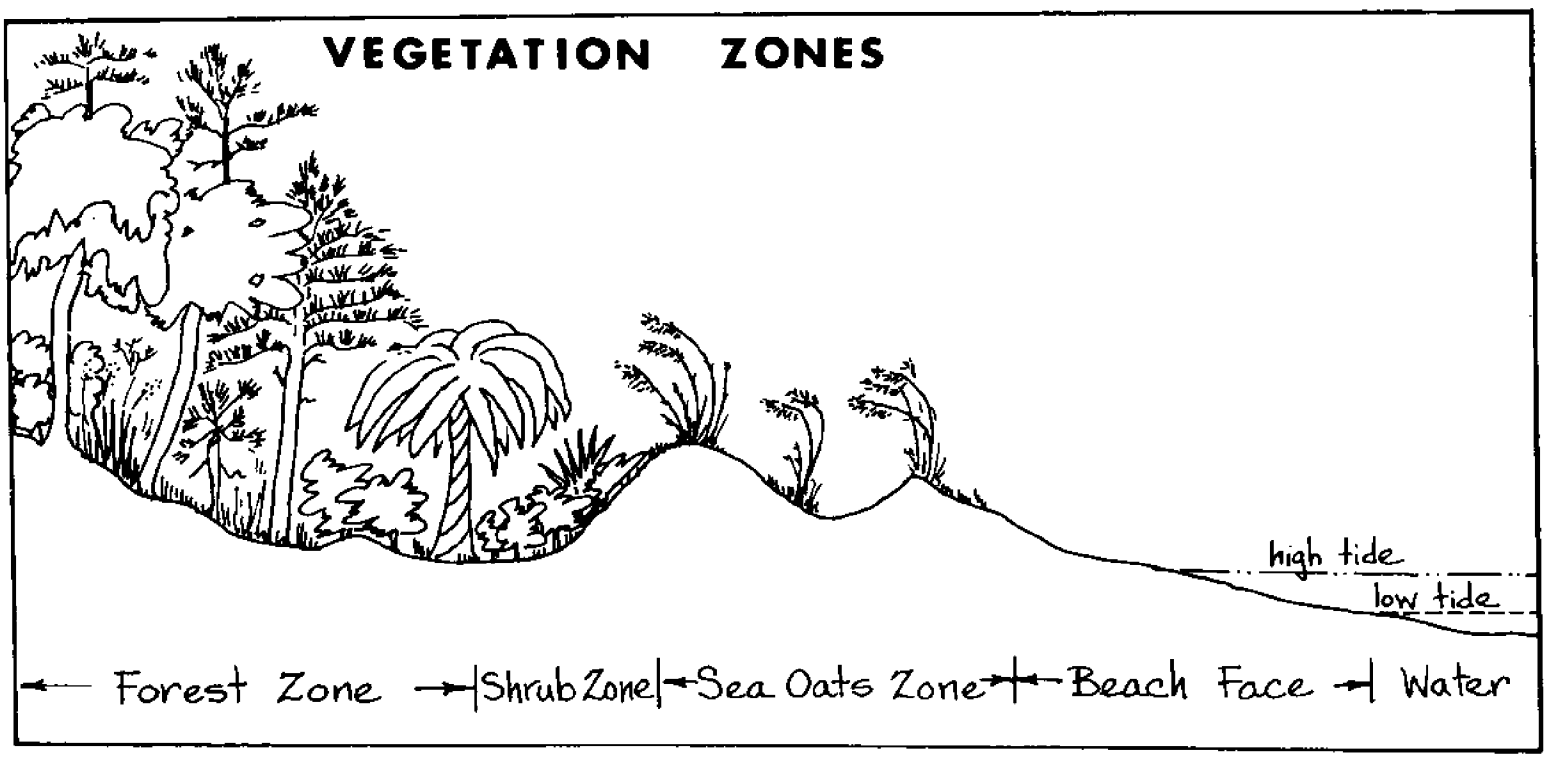
Since the mist of suspended salt water (salt spray) caused by breaking waves is greatest near the surf, vegetation that grows close to the water must be salt tolerant. Compounding this problem is the frequent drought condition on beaches, due to sand's poor moisture retention capability. It is not unusual to find grasses in this stressful "pioneer" zone of vegetation. Among the hardy dune grasses are sea oats (Uniola paniculata), marsh hay (also called salt meadow) cord grass (Spartina patens), and dune panic grass (Panicum amarum). For the southeastern U.S., sea oats are the dominant dune building plant. This plant is protected by law in several states and localities in the southeast and has been used extensively in revegetation projects.

Sea oats reproduce both by seed and by lateral spread of rhizomes (underground stems). The plant has an ability to grow upward as sand accumulates around it. Roots develop along the stem as it is progressively buried. A dune stabilized by sea oats will have an extensive root system that may have roots running all the way down to the base of the dune. This growth pattern will stabilize a mound of sand, and the plants will

continue to propagate, catch sand, and build dunes.

As the sea oats plants provide organic material to the soil and vegetational coverage of the dune increases, several changes may occur. Increasing vegetation will shade the dune, decreasing soil temperatures and loss of water by evaporation (from the soil and the plants). These events gradually change the physical and chemical conditions of the dune and may allow survival of species unable to tolerate the intial rigorous environment. This sequence of events is known as plant succession. In some areas plant succession will not occur, leaving sea oats the dominant (climax) species on the foredune.

Salt spray, drought conditions, heat, and soil conditions may create different zones of vegetation. The first zone we have labeled the sea oats zone (or pioneer zone). As one moves further inland, away from the intense salt spray area, there is often a zone characterized by the presence of woody shrubs, referred to in this Manual as the shrub zone (or scrub zone). Still further inland is the forest zone in which trees are the dominant species. In some regions all three zones are found on the first dune (often called the primary dune or foredune), but this is not usually the case. Depending on local conditions, particularly the width and intensity of the salt spray area, these zones will vary in width or be altogether absent. Often it is difficult to make sharp distinctions between zones.



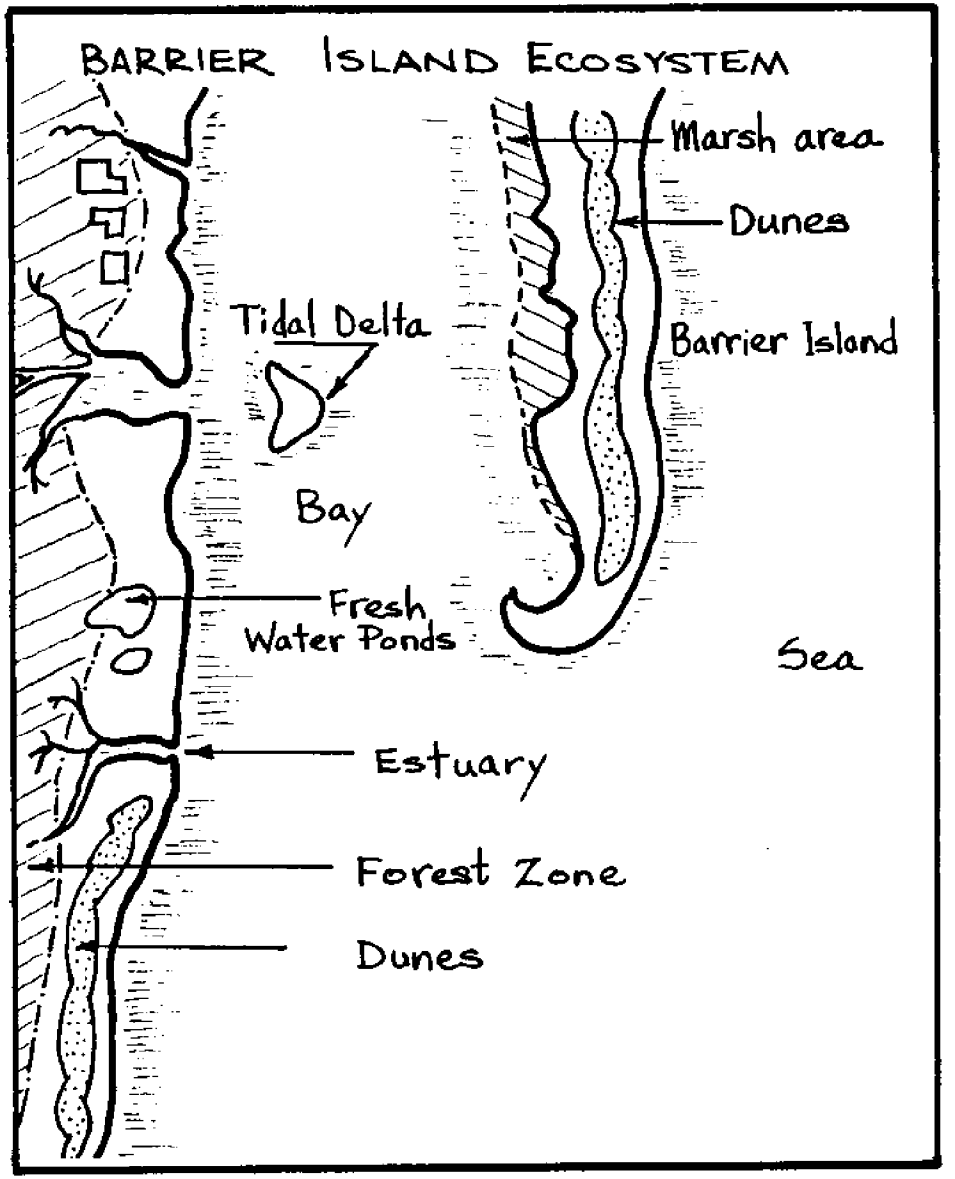
Coastal forests and shrub areas are significant coastal features but beyond our concern in this Manual.

The Case of Barrier Islands

Barrier islands along the southeast U.S. are unique ecosystems with a strong appeal to man. They are a valuable asset and are now the focus of considerable legislative and regulatory activity intended to better protect them from damage by man's actions (1). Barrier islands are subject to large energy stresses due to periodic fluctuations in tides, wave patterns and intensities, storms and hurricanes. By confronting these energy forces and responding to them, barrier islands provide protection for many natural habitats and human settlements in coastal and inland areas behind the islands, including estuarine zones, lagoons, sounds and wetlands upon which fish depend for survival.

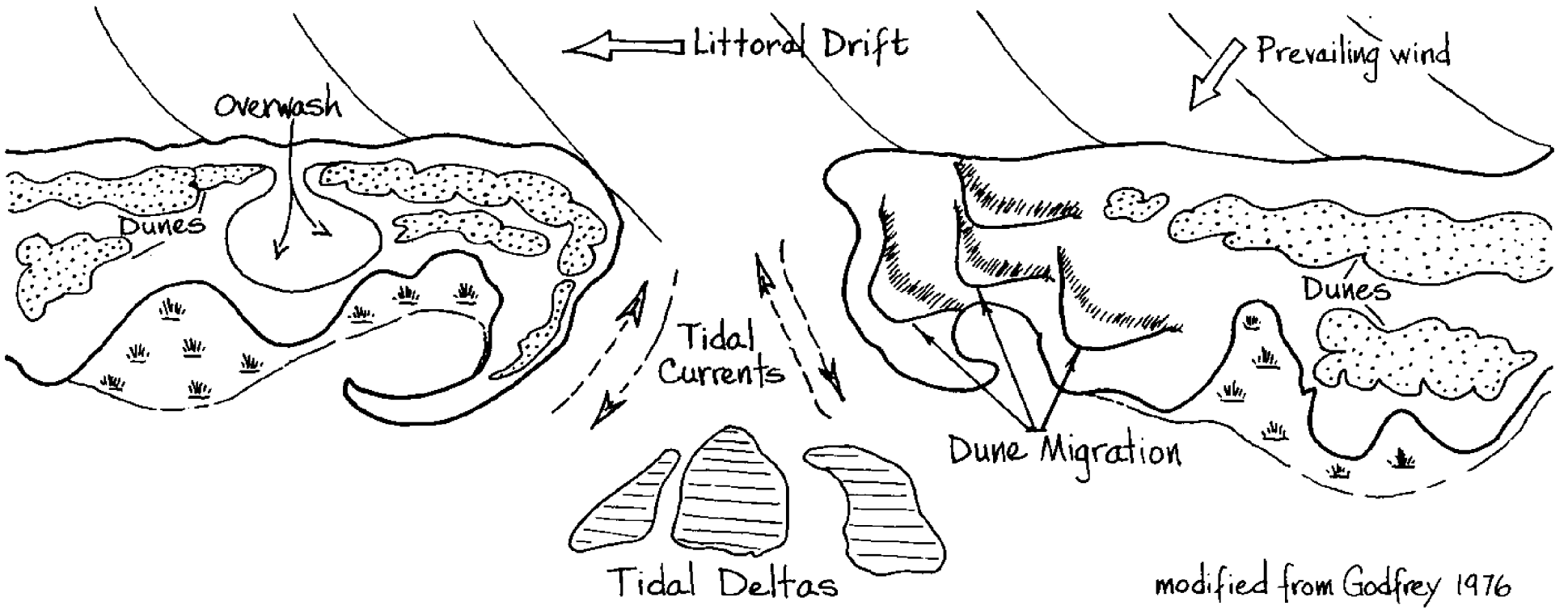
The natural response of barrier islands faced with the tremendous energies of coastal storms, hurricanes and relentless waves and wind, is to yield, flex and retreat. It is an established fact that most Atlantic and Gulf barriers are retreating towards the mainland, and that sea levels are rising by about 1 foot per century.

There are three related mechanisms by which barrier islands retreat: inlet dynamics, overwash, and dune migration. Inlets carry sand from the ocean by littoral currents to shoals on the interior side of the island. These shoals will build up and become land forms if the inlet finally closes. Overwash occurs when storm waters

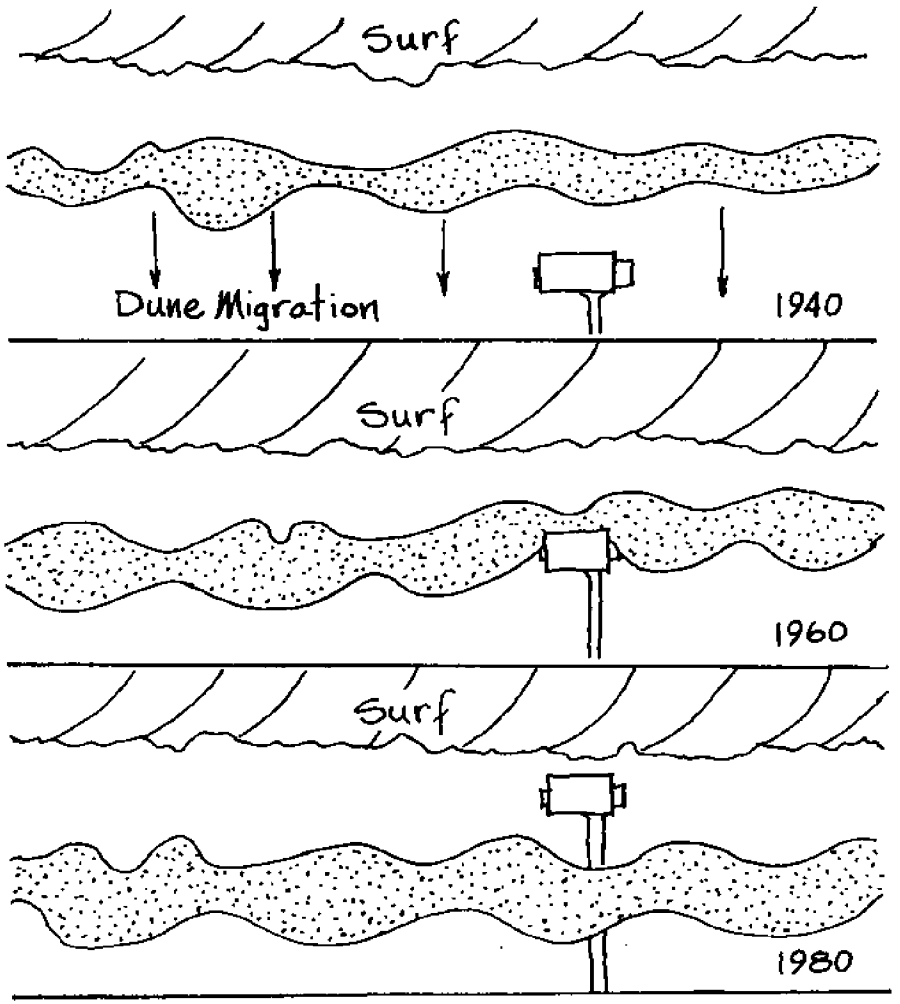


break through the dunes and deposit sand as "washover fans" or terraces behind the dune line. When a dune line is breached by wind, the gap is called a "blowout". Extensive breaches may be widened and deepened by severe storms, penetrating the island and forming a new inlet. When tidal ranges are low, as is the case in the southeastern U.S., and storm frequency is high (varies from place to place), overwash is a common occurrence. Limited overwash is useful in helping dissipate high storm energies, but major overwash may breach the island and will certainly impact the natural or built environment behind the protective dunes.

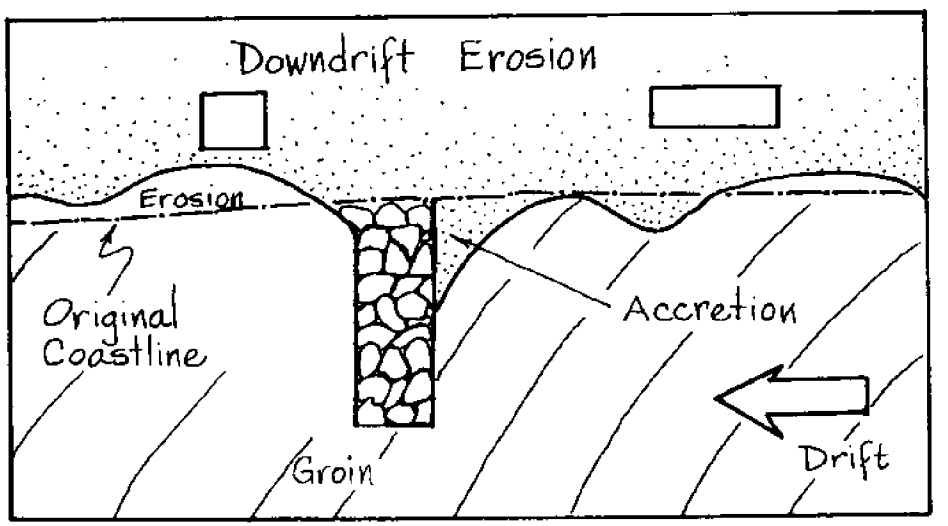
Sand dunes retard the retreat of the island by holding back storm waters but contribute to overall island migration in their own way - dune migration. Wind causes dunes to move slowly downwind - generally landward. Speed and exact direction of migration will depend upon the direction and intensity of winds, the sand supply in the area, and the amount of vegetation on the dunes.



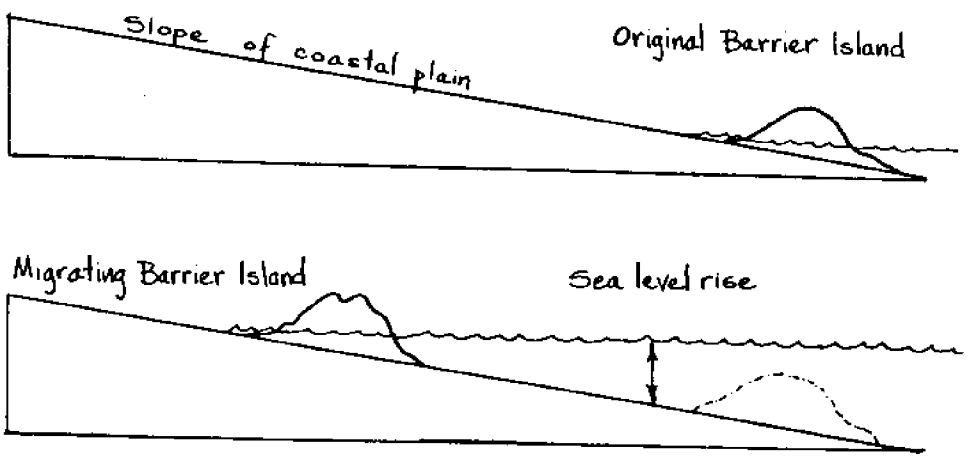
Both dunes and beaches need room to move. If construction does not take the natural adjustment process into consideration there will be severe problems - evidence of which can be found on most developed barrier islands and beaches. If construction destroys the dunes or does not allow sufficient room for migration, there may develop a situation with only three alternatives, none appealing. One is to let nature take its course, with possible loss of structures and distress to property owners. A second option is "beach armor" with seawalls, groins, etc. This solution is expensive, not always successful, and reduces beach attractiveness. A third option is beach nourishment, pumping offshore sand back on the beach. Nourishment is expensive and usually temporary: if the beach is eroding it will probably continue to do so and will require repeated renourishment.



Dune Migration



Survival of the dune system under natural conditions depends upon the relative rates of shoreline retreat and dune migration. Dune migration occurs in inland areas also, and should be allowed for. If vegetation on dunes is destroyed, the dune may begin rapid movement, around or over anything in its path. If the sand movement is too rapid, even sea oats cannot adapt fast enough to avoid deep burial and death. Human intervention to protect existing dunes or build and vegetate new ones must consider the natural cycle, including the rate and direction of movement, to assure that location of dunes or structures will leave room for the dune system to adjust over time. Gares et al. (1979) tried to find an acceptable setback distance between dunes and construction sites, and developed the useful concept of dune management zones.



modified from Leatherman 1980

Preventing Dune Damage

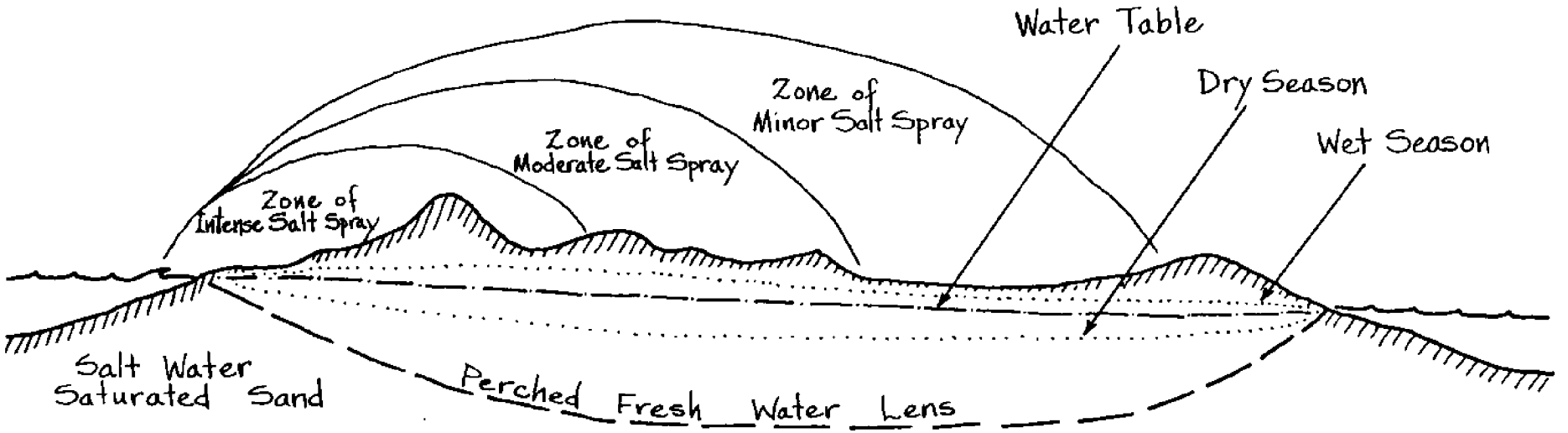
It is the vegetative cover on dunes which holds them together, producing a stabilized dune from what would otherwise be a mobile pile of sand. Plants can be found anywhere from the mean high water line (MHW) landward, with the seaward boundary set by the amount of salt spray and the tidal and storm surge ranges. Local conditions vary greatly, even yard by yard along a beach.

Sea oats (Uniola paniculata) is the dominant dune grass from Mexico east to Florida and north to southeastern Virginia (Cape Henry). At Cape Henry American Beachgrass (Ammophila breviligulata) the ecological equivalent of sea oats, becomes the dominant dune grass.(2)

We have discussed some circumstances of nature that inhibit dune growth, but man-related factors also must be mentioned. One potential threat to dune vegetation is excessive removal of ground water by local communities. The supply of fresh water for vegetation on barrier islands is entirely dependent on rainfall, which replenishes the fresh water lens. The lens floats above the salt water, and is held within the boundaries of the island by pressure from the denser salt water. Dunes are elevated above the fresh water lens; unless the plant roots go all the way down to the water table they will be subject to periodic drought conditions. Excessive withdrawal from the freshwater lens or coastal aquifers lowers the island water table, intensifying drought conditions. A reduction in the fresh water table will be reflected in the health of the plant communities.

In addition to lowering of the fresh water lens, other "people" factors influence the health of the dunes. Off-road vehicles (ORVs) and the uncontrolled crossing of dunes by pedestrians have tremendous impact on dune grasses. Despite their resilience in the face of storms and hurricanes, dunes can be seriously damaged by repeated localized impacts. ORV's will completely destroy the sand dune vegetation and alter the dune profile. Pedestrian traffic damage is more subtle but can be equally damaging. Visitors usually take the shortest and easiest path to the beach, often following an existing trail over dunes. There may be many of these "pig trails," one next to the other, whenever pedestrian traffic over the dunes is uncontrolled. Devegetated foot paths and the effects of the wind funnelling along these bared strips through the dunes may produce large breachways through the foredune. These breaches will allow storm overwash surges passage to the interior environments, subjecting them to excessive salt-water flooding. Numerous studies have documented the inability of the dune grasses to tolerate trampling by pedestrians, or vehicles. Protection from traffic damage cannot be overemphasized.

Barrier Island Fresh Water Lens & Salt Spray



Should Dunes Be Restored?

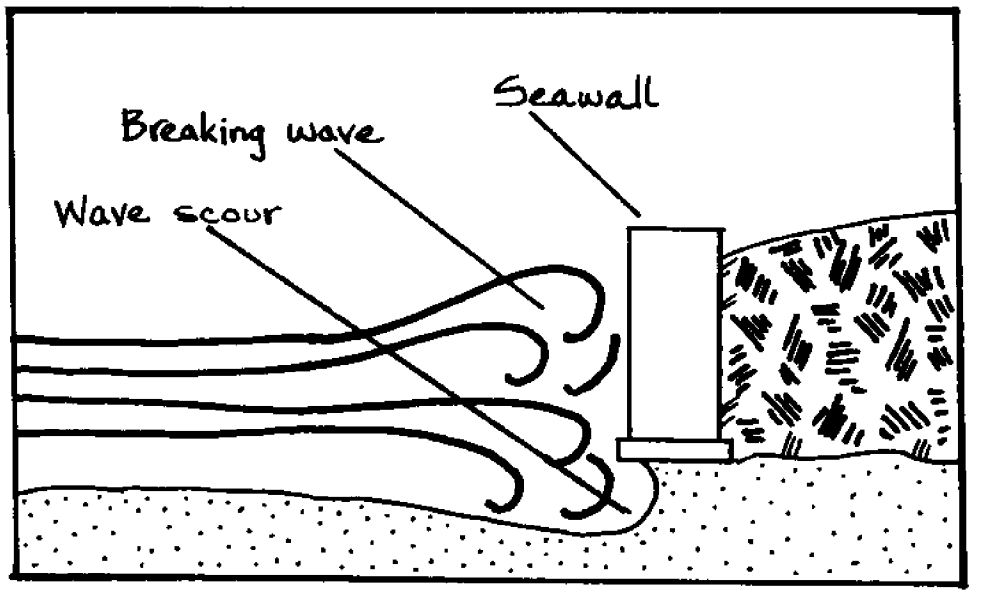
If natural processes or human actions destroy or seriously damage beaches and dunes, the choices are:

1) Do nothing; let natural processes work
2) "Beach armor:" seawalls, rip-rap, groins
3) Rebuild the dune
4) Renourish the beach
5) Combinations (2 & 3; 2 & 4; 3 & 4)

Option #1 is not necessarily a choice to despair. Natural processes do sometimes rebuild beaches and dunes. Regulatory action may help prevent further damage if gaps in dune lines attract vehicle and foot traffic. But if dunes were removed as part of a construction project, new structures and secondary effects from them (e.g., wind erosion due to reflected or channeled winds, foot traffic, etc.) may prevent formation of new dunes.

Artificial replacements for dunes are sometimes the best solution, but costly both to construct and to maintain. Seawalls, for example, may cost up to several hundred dollars per linear foot. Sea walls, groins and rip-rap will create new patterns of erosion and deposition, and often effectively prevent use of the beach for swimming, boating, surfing, etc. near the area of the "armor." To build dunes where you want them, it may be necessary to extend the beach (nourishment) forward of the present location, an expensive process. Permits for armoring and nourishment may be difficult to obtain.

Waves Undermining Seawall



This Manual focuses on dune restoration, an option with important advantages. Building a dune is much cheaper than almost any armoring process and need not block access to or cause erosion of the wet sand beach. Beach armor, or the unrelieved flat and bare appearance of a duneless area, is less pleasing aesthetically than a dune field. As long-term protection, in some cases dunes can can be as effective as many sea walls.

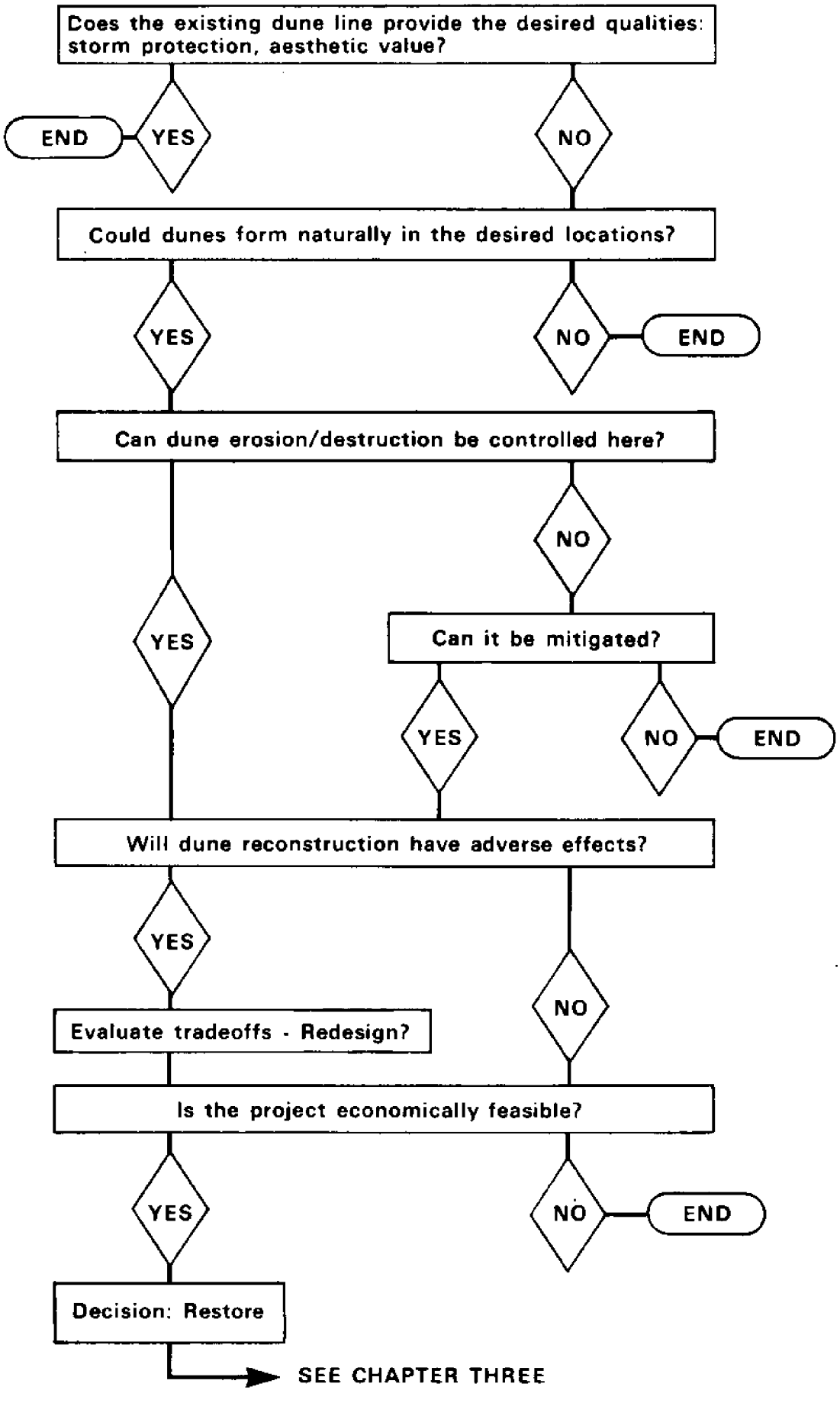
Sometimes it is neither possible nor sensible to build dunes. The only realistic options may be either do-nothing or beach armoring. If the dunes have

disappeared from a lengthy, largely uninhabited, highly mobile stretch of shoreline the option of do-nothing may be the best choice: restoration of a large area will be expensive, no essential structure needs protection, and in any case the shoreline may be so mobile dunes do not have time to form near the beach. Perhaps nature is best left alone. In some cases where coastal structures are threatened, the only feasible choice may be between armoring and allowing the structure to fall into the sea. Given the cost of adequate protection through beach armor, the latter is sometimes the economically-sensible choice. Nor is it always possible to build dune systems to provide the protection or aesthetic value desired. If a beach is eroding rapidly, building a dune may not provide protection for very long. There may be insufficient room between structure and wave reach to build a dune. Wind patterns, human traffic on the beach, or combinations of several factors may make construction of a dune in the required location simply infeasible.

The chart following this page is intended to help focus attention on the right questions at the right time in any decision on whether to build or rebuild a dune. First, does the existing dune (if any) serve as desired? If not, is it because the particular location is unsuited to dune formation (due to traffic, lack of wind-blown sand, wind erosion caused by nearby structures, space between structure and wave range inadequate, etc.)? If a dune can exist in this location but perhaps only with some protection, is it technically and economically feasible to undertake the work required to halt or reverse damage, or perhaps merely to slow the rate of damage and decay? It could be that building a dune in this location will cause offsetting injury elsewhere, as by blocking foot traffic and displacing it onto a nearby area which is currently in good shape. If so it may be better to live with the situation.

By subjecting a possible dune restoration project to examination we may avoid discovering too late that the economic cost will be too high, that a dune simply will not form/stay in the desired location, or that the solution to one problem creates another problem elsewhere. The wide variety of possible cases prevents cataloguing all potential dune restoration problems, but the decision model presented here is general enough to help identify problems and possible solutions. Chapter 3 of this Manual will help you develop the specific data you will need to answer these questions.

Deciding: To Restore, or Not To Restore?



Chapter 3 Dune Reconstruction Planning and Implementation

Introduction

This chapter is the "how to do it" section of the Manual. Information presented here will help you decide whether you want to build a dune (Chapter 2), and goes on to describe methods to use in doing the work.

Both man and nature help make dune reconstruction a rather lengthy process. Before erecting a sand fence or implanting the first sea oat, you must meet a number of human requirements: to obtain the funds, the permits, whatever public support is needed or can be gained, and to develop a work program. For a small, one-little-dune-by-the-house project on private property this entire process may take 15 minutes; major projects may take several months. The human lead-time requirements must be meshed with natural ones. For best results, sand-gathering and planting need to be done at the right time in the annual beach cycle. You may want to wait six months or more in order to catch the vegetation cycle at the best time or you may find that by working rapidly you could be ready to plant at the optimum time of year.

In either case, you need to be sure that your plan will fit into its natural and/or man-made context. Conducting an inventory of the area's biological and geological content is essential to detailed planning and proper choice between alternatives. With this information in hand, you can then determine if any permits are required and proceed to obtain them. Raising the money and working to obtain whatever degree and kind of public support you deem necessary or useful can begin early and be continued throughout the process. Only after all this preliminary work are you ready to implement dune reconstruction.

One essential requirement in dune building is patience: the natural process requires several years. It can be speeded up somewhat by measures recommended here, but there is no miraculous short-cut to a well-established dune. It is therefore important to get started as soon as possible, but to expect the project to take several years before large dunes with adequate vegetation are established.

The following sections are presented in a logical sequence paralleling normal steps in a dune project:

(1) Conceptual planning

(2) Biological and geological inventory

(3) Permitting: an inventory and guide

(4) Funding sources

(5) Public involvement: organization and support

(6) Implementation

Conceptual Planning

Before ordering sand fencing and sea oats to build a dune, you should know what dunes are and what they can do--and are not and cannot do.

Sand dunes should be considered fragile, dynamic systems. Sound dunes well-stabilized with vegetation are attractive and effective defenses against most storms, but not all. A major hurricane can destroy any dune. It is the nature of dunes to retreat before powerful winds and waves, giving up some of their substance. Major storms may drive some water over and around dunes, with consequent effect upon the ecosystems, homes and property sheltered behind the dunes. The sea oat's rapid growth and ability to root at stem nodes is illustrative of the workings of the natural system: yield stubbornly, adapt, and then rebuild. Still, a stabilized dune can reduce damage levels a major storm might otherwise inflict, and can offer almost complete protection from minor storms.

Once wind starts to funnel through a break in vegetation, further erosion can develop rapidly. Unless such breaks are "patched," dune structure may break down and the dune may either disappear or become migratory. For example, dune buggies destroyed vegetation on a large dune on Dauphin Island, Alabama and the dune began to migrate. Before Hurricane Frederic devastated the island in 1979 this dune had moved across a school playground, through a pine forest, and was threatening homes. Dunes sometimes do repair themselves naturally, but human intervention may be necessary or may speed the process.

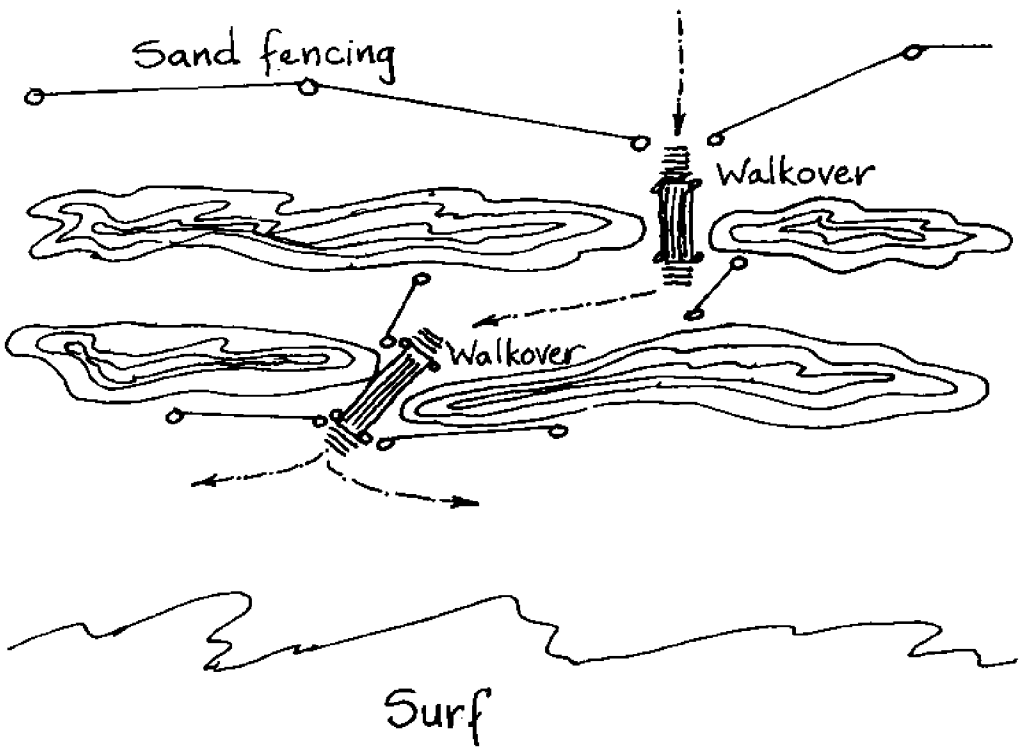
Plans for dune rebuilding must include protection of the growing dune. Vehicles of all types must be kept off the site. Foot traffic should be prevented or its impact minimized by such devices as dune walkovers, required in some areas (e.g., in Cocoa Beach, FL all beach structures larger than a triplex must have a walkover). Public recreation areas near dunes should provide walkovers, observation decks, etc. designed so that beach access is easy if the walks are followed, difficult if not.

If beach armoring is to be combined with dunes, careful planning is needed to minimize conflicts. Any solid structure will reflect wind or wave energy onto nearby dunes and increase their erosion rate. There is no fully satisfactory substitute for keeping all structures, including dunes, well back from the surf zone.

Dune reconstruction should generally follow the model of natural dunes in the area. It is not necessary to develop unbroken, even ridges. Occasional swales (low areas) in barrier dunes can channel storm waves into "buffer zones" between ridges. These dune swale areas can be marked and walkovers erected for use as pathways to the beach.

In conducting a dune planning and building project, the following information and suggestions should be very helpful. But the key fact, which must be kept constantly in mind, is that dunes are natural structures responsive to natural forces. They must fit into the environment. When in doubt about a particular dune placement or the feasibility of combining dunes with other measures, refer again to this section of the Manual.

Dune Swale Beach Entries



Biological and Geological Inventory

The existence and rate of growth of sand dunes is dependent upon:

(1) The type of vegetation and its density on the dunes
(2) The amount of sand moving on the beach
(3) Intensity, frequency and direction of winds capable of carrying sand
(4) The frequency and intensity of storms

All of the above factors will vary over both area and time, but patterns can usually be found.

Area climate largely determines the survival of a particular plant species, although soil conditions (pH, sand grain size, moisture content, etc.) are also important. In South Atlantic and Gulf of Mexico coastal areas, winter temperatures and annual rainfall patterns are the main factors influencing survival of plants.

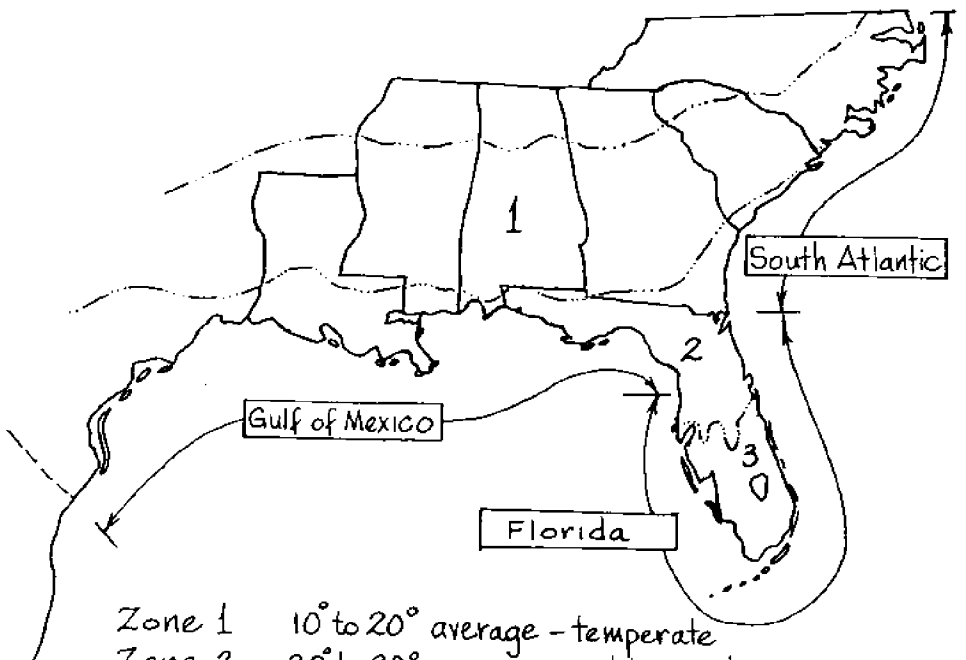
The southeastern U.S. coast can be divided into three climatic regions, although beach conditions can vary considerably within each region.

Southern Atlantic - North Carolina south to the Florida border. This region is characterized by mild winters with very little ice. Summers are long and usually wet.

Florida - Florida east and west coasts to Cedar Key. Long summers, mild winters, variable rainfall. Southern-areas are tropical; remainder are subtropical.

Gulf of Mexico - Cedar Key, Florida to Mexican border. Variable rainfall, subtropical conditions.

SOUTHEASTERN REGION ZONES & COLDEST WINTER TEMPERATURES



Zone 1 10° to 20° average - temperate
Zone 2 20° to 30° average - subtropical
Zone 3 30° to 40° average - tropical

modified from Southern Living

Beach Conditions

Florida is used here as a general model of beach conditions. NE Florida is similar to the Southern Atlantic Region; NW Florida is part of the Gulf of Mexico Region.

Northeast Florida Region (Georgia to Cape Canaveral) - Shore materials mostly sand; strong wind, wave, and tidal action, especially during northeast storms; sea oats zone often narrow or absent as a result of severe erosion; low dune ridges, upon which pioneer plants can germinate and initiate embryo dunes, are usually absent.

Southeast Florida Region (Cape Canaveral to the Keys) - Shore materials composed of sand and shell; intense wind, wave, and tidal action; proportion of tropical plant cover increases further south; development has left only short strips of natural vegetation.

Southwest Florida Region (Keys to Clearwater area) - Shore materials mostly shell; low to moderate wave energy area; few, low dunes; broad pioneer zone; high shell content of soil favors alkali-tolerant species of grasses, shrubs, and trees (cabbage palms); many introduced ornamental plants have crowded out native plants.

Northwest Florida Region (Apalachicola area to Alabama) - Shore material almost pure quartz sand; moderate wind, wave, and tidal action. Sea oats common in broad pioneer zone.

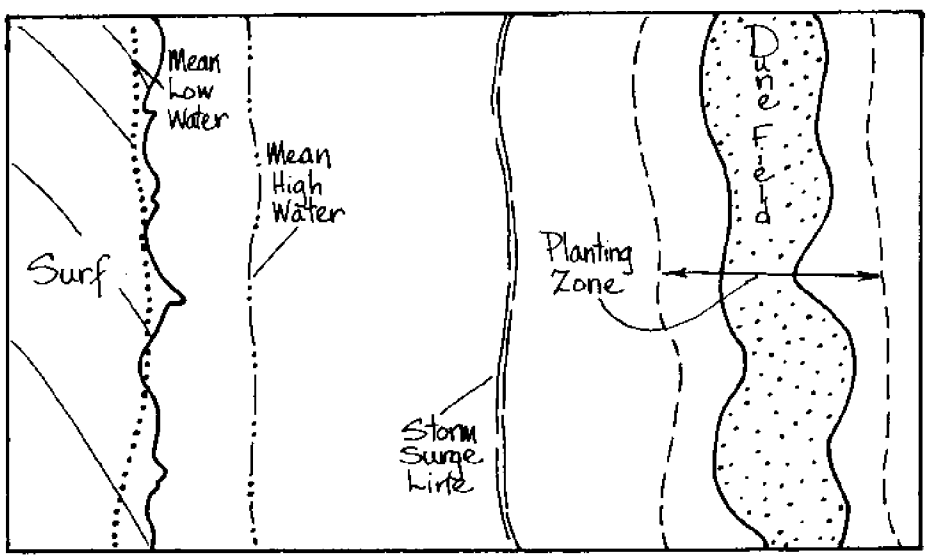
The dynamics of any particular beach can be extremely variable and complex. Coastal habitats are very fragile ecosystems. Working successfully within the ecological limits of a particular dune system requires harmonizing many factors. A good dune restoration project will make use of expert advice, where available, on the best way to handle local beach conditions and problems. Someone with dune revegetation experience can help identify the specific needs of a particular dune site. Your local Marine or Agriculture Extension Agent, or the area DNR agent, may be able to assist you.

But even if expert advice is not available, it is possible to do a good job by carefully studying the nearby natural dunes in the same beach zone and conditions as your project area. Dune orientation (angle to the wind and water), distance from the tide line, and general width and shape will probably be good guides for your efforts. The plant species growing there will probably do equally well on your dune. Do remember that a young dune needs pioneer plants first, but pattern additional plantings after the neighboring plant communities.

The next two pages of this Manual are a Dune Inventory checklist, to take to the project site as an aid to efficient and complete inventory work.

Dune Positioning

Storm frequency and intensity, tidal ranges, and the amount of sand migrating inland will be major determining factors in positioning of the primary dune line. To attempt to revegetate or restore a dune line that is within reach of the tide or seasonal storms would be futile. The optimal location for plantings will probably be the site of the old dune line or, alternatively, parallel to adjacent surviving dune lines. Plantings should be beyond range of seasonal storms and behind a beach area broad enough for onshore winds to pick up a good load of sand. The direction of prevailing winds and of normal storm waves will help determine both orientation of the dune line and its distance from the water.



DUNE INVENTORY CHECKLIST

Purpose: For use as a guide in information collection for dune reconstruction projects

Significance: Information collected here may assist in deciding whether to conduct a project, planning for it, estimating costs, obtaining funding and permits, and will be of value if professional assistance is required.

Outline: First, read the Manual carefully.
Second, use this Checklist, record notes, make sketches.
Take a copy of this Checklist into the field with you.
Third, if necessary, seek expert advice
Fourth, update information

I. Do you need a dune here? What difference will it make?
1. Is there a gap in the dune line? How wide?
2. Does the gap expose homes, roads, commercial facilities or utilities to storm damage? (important for permits, funding)
3. How many families, businesses would be affected? Who owns affected properties? (important for funding, support, and possible transplant materials)

II. Site characteristics:
1. Determine storm or hurricane surge heights likely at the site (Federal Insurance Administration publishes flood zone maps--your County Engineer should have them).
2. Is the beach area generally eroding, accreting or stable? (County Engineer, US Army Corps of Engineers maps)
3. Will your site be subject to the Coastal Construction Control Line? (County Engineer)
4. Is there evidence of foot or vehicle traffic near or across your site? Could it be controlled (fencing, walkovers)?
5. Are there structures (buildings, highway, etc.) nearby? Measure the high water-to-structure distance and direction.
6. Are such structures significant wind or water erosion factors at the site? (Observe beach, dune, wind, plant patterns in the area. Professional advice may be needed.)
7. How far inland does the intense salt spray zone extend? (Observe beach plant growth patterns as an indicator)
8. Is there an adequate water source within "hose range" or will tank trucks be needed?
9. In what political jurisdictions is the site located? (Needed for permitting purposes)

III. Dune reconstruction data base:
1. If there are natural dunes adjoining your site, use three or four of them as examples to gather the following data:

A. Measure from high water mark (beach debris line) to the front slope of the dunes.
B. Inspect dune faces. Steep slopes and lack of vegetation indicate recent erosion. You should plan your dune site further from the water.
C. Measure the dune width, front to back.
D. Measure or estimate the average height of dune crests above high water.
E. Measure or estimate the angle of the dune crests to the beach line (normally they are about parallel).
F. Observe vegetation on nearby dunes:
   a) plant varieties, especially most numerous variety
   b) where do the plants grow on the dunes--front, sides, back? Which variety grows where?
G. On a breezy day, is there much sand movement? (This is a judgment call--can you see and feel sand moving, observe accumulations around plants and structures? If not, consult a professional about feasibility).
H. Is the terrain behind your site higher or lower than the elevation of the site? Measure or estimate.
I. Measure the length of your tentative dune site, end to end along the beach.

TRANSFER THE ABOVE INFORMATION TO A SKETCH OF THE SITE AND A SKETCH OF AN "AVERAGE" DUNE PROFILE (cross section)

2. If there are no natural dunes nearby, find an area similar to your site and conduct observations there on dune size, shape, vegetation, etc. Information from this distant site may not translate directly to your site, but can still be useful for general information purposes.

3. Soil information:
   A. If wind-blown sand is plentiful (see III-1-G above) and plants are growing well on nearby dunes, your site will very probably support good plant growth with normal care.
   B. If you answered III-1-G with "no," professional consultants should be consulted for optional actions.
   C. If you will be using graded or imported sand, take samples to your County Agricultural Service for tests of salinity, composition, grain size--and get advice. Your local government may prohibit use of "staining" sands (e.g., "red clay") in the beach area. Check.

Plants for Your Area

Dune grasses stabilize sand dunes by increasing resistance to wind and water erosion. Sea oats have very extensive root or runner systems, with rapid vertical and horizontal growth patterns. This allows them to survive in an environment of constantly shifting sand. Another important feature of these grasses is their ability to root at the nodes (joints along the stem). Many plants have these characteristics, but to qualify as a successful dune grass the plant must also be salt tolerant and drought tolerant. These plants are commonly found in dune habitats in the southeastern United States:

Common Names	Scientific Name	Potential for dune plantings
Sea Oats	Uniola paniculata	very good
Salt-meadow grass	Spartina patens	low, moist areas
Dune panic grass	Panicum amarum	good
Marsh elder	Iva imbricata	fair
Railroad vine	Ipomea Pes-caprae	OK
European beach grass	Ammophila arenaria	OK for some areas

In the regions covered by this Manual, sea oats are usually the best choice for dune building: salt and drought tolerant, densely rooted, rapidly spreading. Commercial beach plant nurseries usually have sea oats, or local transplants can be used. In the North Carolina area other plants begin to serve as pioneers, but in the southern regions sea oats are the most appropriate and effective plant for dune-building. Other plants (e.g., dune panic grass) can be mixed with sea oats, and plantings of several species may be more successful than those using sea oats only. But sea oats will be the predominant plant used and is the plant that will be doing the actual "work" of building the dunes.

The vegetational community in any particular area will vary by type of vegetational zone (sea oats or scrub). For purposes of this Manual we focus on situations that normally exist in the sea oats zone. We stress again our recommendations for careful local observation of existing similarly located plant communities.

If you are planning a major project it may be helpful to test your planned dune shape and vegetation pattern on a trial location in the project area. Since useful results may not appear for several months, this approach is probably best suited to large projects which take months, perhaps a year or more, to organize and implement. Long term maintenance programs may also use test dunes as a means of improving future restoration project methods.

Whatever species are chosen, care taken in transportation and planting will have a favorable impact on survival rates.

Planning the Job

Once you have decided to restore an area or to build a dune (Chapter 2), there is planning to be done. The major organizing factor is time: time to plan and organize, lead time to obtain any needed permits and public support, time for funding sources to consider your request and provide funds, and of course time to order materials and arrange your work force.

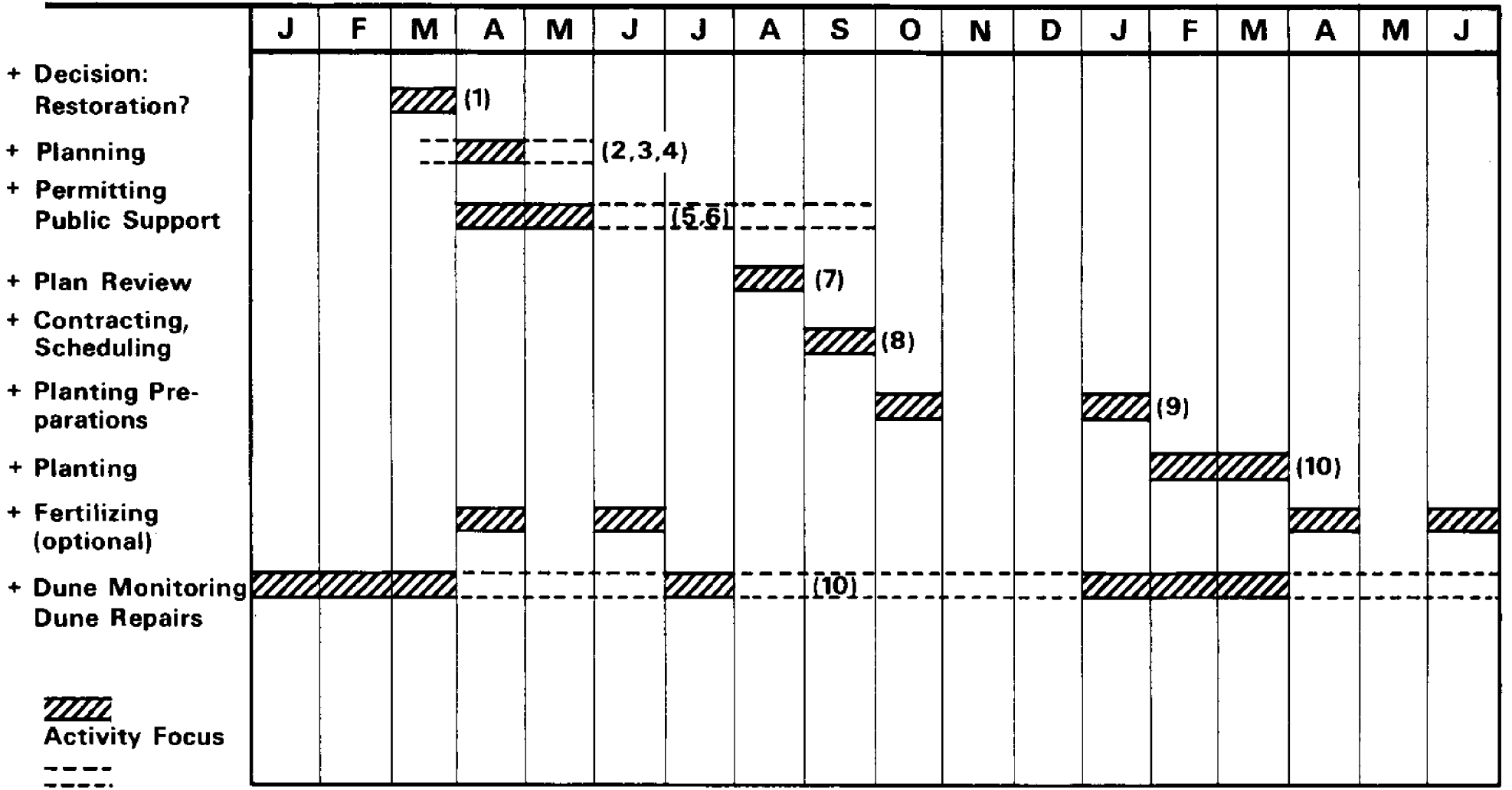
"Time Zero" for a major project will be sometime in February or March of next year: the day when transplanting begins on the beach. By starting with that date and backing up toward the present it is possible to develop a good idea of what should be done when in order for all the pieces to be in place at planting time.

Following is a step-by-step management program. A "Dune Restoration Work Cycle" chart keyed by number to the management steps and the calendar provides guidance for problems of lead time and scheduling. The sequence illustrated here spreads work over nearly a year in order to reduce the stress of "crash programs" and to allow time to overcome the inevitable problems and snags.

Management Program	Timing (general)
*Step 1: Decision-making Process, Chapter 2.	Whenever dune damage becomes of concern
*Step 2: Determine and clarify responsibility for project direction, funding, general planning, public support.	As soon as Step 1 is completed and the decision made to restore
*Step 3: Develop funding plan. Complete/update data acquisition begun in Step 1.	Upon completion of Step 2.
*Step 4: Determine permits needed, begin applications	Six months before starting beach work
*Step 5: Develop compliance plan for permit requirements	Continuing
*Step 6: Refine public support program and begin to implement	As required by support plan
*Step 7: Major review and update of all elements of plan in light of permits, data, funds, etc.	Minimum of one month before planned beginning of beach work
*Step 8: Schedule work, hire or secure volunteer commitments. Order plants, fence, etc.	Upon conclusion of Step 7
*Step 9: Begin beach work. Begin developing long-range maintenance plan	Fall, early spring--to catch sand moving in winter winds
*Step 10: Planting. Begin maintenance plan.	Time zero. All time scheduling backs up from this date

Dune Restoration Work Cycle

* Generalized time schedule, by calendar months, planning steps, and activities.



* This schedule assumes an optimal beach planting time about February 15. Most of the northern Gulf coast would fit this schedule; other areas should adjust to meet local climate conditions.

Permitting: An Inventory and Guide

Any beach or dune restoration or modification is likely to require obtaining one or more permits from governmental agencies having jurisdiction. Individual property owners, associations, cities or counties should conduct a thorough review of all applicable regulations and required permits, and must obtain agency approval prior to initiation of any work. Experience shows that beach project sponsors underestimate both the amount of detailed data required to satisfy governmental agency requirements, and the amount of time required to collect the data. The skills of a surveyor or engineer may be necessary in some cases. Often the permitting agency will find the data supplied inadequate and return the application for further elaboration.

Since the permitting process alone may require six months to a year, project planners must allow for adequate lead time. Alternative starting dates should be developed, incorporating both permitting lead time and predictable seasonal variations which encourage/discourage planting. As soon as the general scope and methods of the dune or beach project have been determined, this permitting and regulatory review should begin. Any project revisions required in order to comply with regulations can then be built into the plan at an early date, with minimal adverse effects.

Three State of Florida Statutes apply directly to beach restoration (administering agency shown in parends):

Chapter 161 - Beach and Shore Preservation
(DNR - Division of Beaches and Shores)

Chapter 16B-23 - Rules and Procedures for Disbursement of Erosion Control Trust Funds
(DNR - Division of Beaches and Shores)

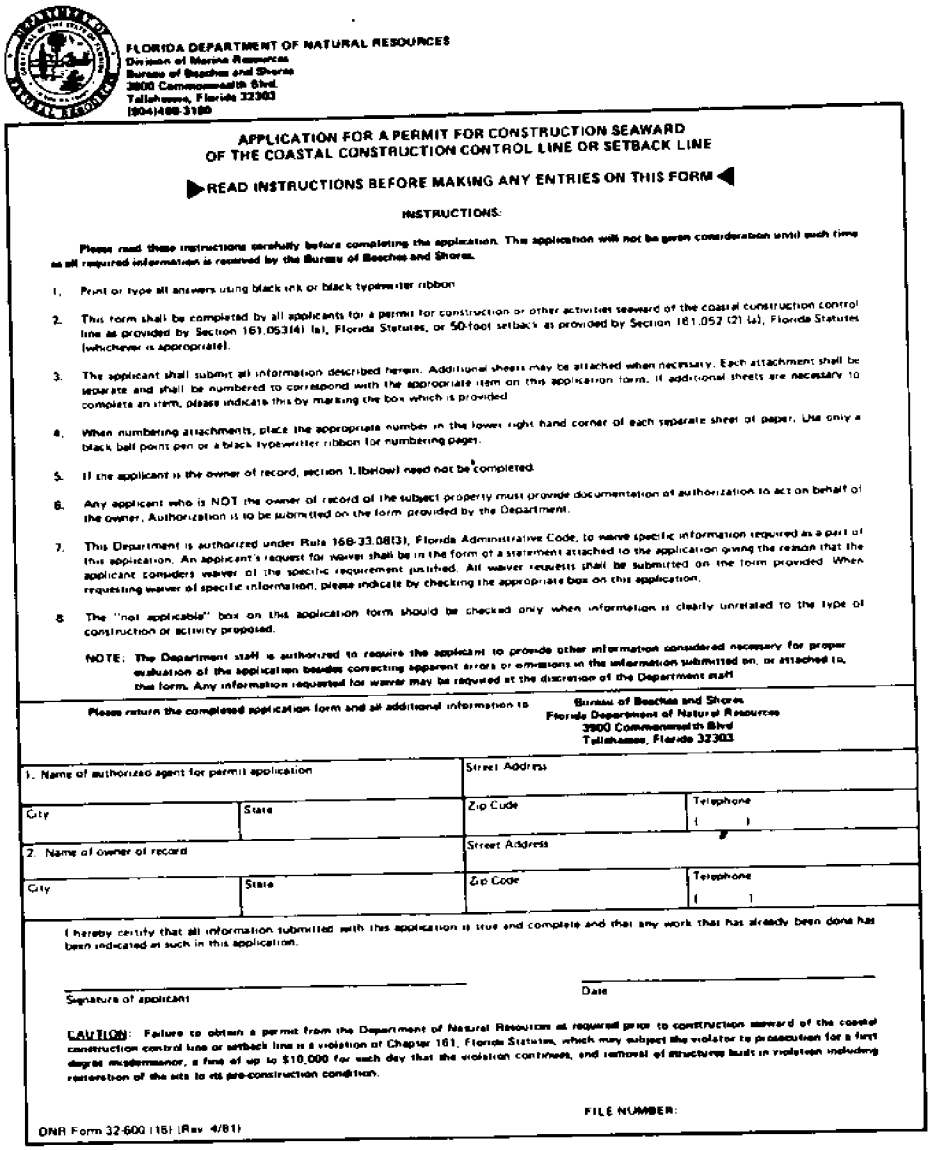
Chapter 370 - Saltwater Fisheries
(DNR - Division of Beaches and Shores)
Despite its title, this Statute includes major points of beach construction and the harvesting of beach plants

Very important for all coastal construction in Florida is the state-designated Coastal Construction Control Line (CCCL), which parallels the sandy beaches, usually between the mean high water line and any existing line of construction. In some areas it is located inland from the existing homes, motels or road. All excavation, beach material removal (including plants) or construction seaward of this line requires a permit approved by the Governor and Cabinet sitting as directors of DNR. They receive recommendations for approval or disapproval from DNR, based on Division of Beaches and Shores research.

The Beach and Shore Preservation Act, Chapter 161 Florida Statutes and Chapter 16B-33.05 Florida Administrative Code are key elements in the state effort to protect beaches, people and property from coastal storms and hurricanes. Counties and cities also have restrictions which may apply to your dune project.

Page one of a Florida permit application (opposite) indicates the format and requirements. Projects for revegetation-only require minimal information; complex projects may require more data and detailed drawings. Projects such as dune walkovers and sand fencing should be placed landward of the control line or approval should be received prior to beginning physical work on the beach. If DNR approves work seaward of the CCCL, they encourage transplanting of native plants rather than their destruction. Work sites may therefore be a useful source of plants for your project.

Local government rules and regulations vary greatly and change over time. State laws also vary, from state to state and over time. We provide in the Reference section information on current Florida statutory and administrative rules, for illustration. Check that no recent rule changes affect your project. We have condensed the statutes and deleted non-applicable materials for simplicity. After carefully reviewing current statutes, noting any changes, these summaries may be used for working purposes. But there is no substitute for personal inquiry at all concerned local and state offices, asking the direct question: for what we want to do, must we obtain any permits or comply with any regulation?



FLORIDA DEPARTMENT OF NATURAL RESOURCES
Division of Marine Resources
Bureau of Beaches and Shores
3900 Commonwealth Blvd.
Tallahassee, Florida 32303
[904]488-3180

APPLICATION FOR A PERMIT FOR CONSTRUCTION SEAWARD OF THE COASTAL CONSTRUCTION CONTROL LINE OR SETBACK LINE

▶READ INSTRUCTIONS BEFORE MAKING ANY ENTRIES ON THIS FORM◀

INSTRUCTIONS:

Please read these instructions carefully before completing the application. This application will not be given consideration until such time as all required information is received by the Bureau of Beaches and Shores.

1. Print or type all answers using black ink or black typewriter ribbon.
2. This form shall be completed by all applicants for a permit for construction or other activities seaward of the coastal construction control line as provided by Section 161.053(4) (a), Florida Statutes, or 50-foot setback as provided by Section 161.052 (2) (a), Florida Statutes (whichever is appropriate).
3. The applicant shall submit all information described herein. Additional sheets may be attached when necessary. Each attachment shall be separate and shall be numbered to correspond with the appropriate item on this application form. If additional sheets are necessary to complete an item, please indicate this by marking the box which is provided.
4. When numbering attachments, place the appropriate number in the lower right hand corner of each separate sheet of paper. Use only a black ball point pen or a black typewriter ribbon for numbering pages.
5. If the applicant is the owner of record, section 1.(below) need not be completed.
6. Any applicant who is NOT the owner of record of the subject property must provide documentation of authorization to act on behalf of the owner. Authorization is to be submitted on the form provided by the Department.
7. This Department is authorized under Rule 16B-33.08(3), Florida Administrative Code, to waive specific information required as a part of this application. An applicant's request for waiver shall be in the form of a statement attached to the application giving the reason that the applicant considers waiver of the specific requirement justified. All waiver requests shall be submitted on the form provided. When requesting waiver of specific information, please indicate by checking the appropriate box on this application.
8. The "not applicable" box on this application form should be checked only when information is clearly unrelated to the type of construction or activity proposed.

NOTE: The Department staff is authorized to require the applicant to provide other information considered necessary for proper evaluation of the application besides correcting apparent errors or omissions in the information submitted on, or attached to, this form. Any information requested for waiver may be required at the discretion of the Department staff.

Please return the completed application form and all additional information to: Bureau of Beaches and Shores, Florida Department of Natural Resources, 3900 Commonwealth Blvd, Tallahassee, Florida 32303

1. Name of authorized agent for permit application		Street Address	
City	State	Zip Code	Telephone ( )
2. Name of owner of record		Street Address	
City	State	Zip Code	Telephone ( )

I hereby certify that all information submitted with this application is true and complete and that any work that has already been done has been indicated as such in this application.

Signature of applicant _____ Date _____

CAUTION: Failure to obtain a permit from the Department of Natural Resources as required prior to construction seaward of the coastal construction control line or setback line is a violation of Chapter 161, Florida Statutes, which may subject the violator to prosecution for a first degree misdemeanor, a fine of up to $10,000 for each day that the violation continues, and removal of structures built in violation including restoration of the site to its pre-construction condition.

FILE NUMBER:

DNR Form 32-600 (16) (Rev. 4/81)

Funding Sources

Large dune restoration projects normally require considerable labor and funding. Recruitment of people to provide labor is generally easier than acquiring money for the project.

Several types of local, county and state organizations, government and private, can be requested to provide funds and technical support. Included in this section is an illustrative list of organizations that have often contributed to local projects. The list indicates types of organizations that might provide funding; it does not include all the clubs and organizations that can be solicited. Where specific neighborhoods or housing tracts benefit, these organizations may provide funding for a private project. Where a single property owner will benefit, securing outside funding is likely to be difficult.

In most cases where public funds are available for enhancement or restoration of privately owned beach areas, the law usually requires that the public must benefit by the expenditure. Most often this benefit will be obtained by the property owner agreeing to increase public access through his property to the beach or donating some land to public ownership or use.

Organizations usually use their purposes and goals as criteria in choosing projects to support. If you seek funding from a community organization it is helpful to know those purposes and be able to show how your project helps fulfill them. Few are likely to support projects which benefit only an individual or some private group.

(1) Kiwanis
(2) Rotary
(3) Civitan
(4) Lions Club
(5) Optimists Club
(6) garden clubs
(7) Sierra Club
(8) Nature Conservancy
(9) League of Woman Voters
(10) merchant or store owner organizations
(11) economic development groups
(12) Chamber of Commerce
(13) community and neighborhood associations
(14) hotel-motel associations
(15) boating-surfing clubs
(16) recreation industries
(17) YMCA - YWCA
(18) boys club
(19) Boy Scouts - Girl Scouts
(20) high school clubs
(21) university clubs

Individual property owners can organize cooperative neighborhood dune restoration projects. Usually, one individual takes the lead in convincing others to join the effort and functions as project "foreman." It is normally much easier for ten contiguous beachfront neighbors to share the costs and workload than for each to operate independently. One individual can buy sand fencing for

nine neighbors while the others share various responsibilities for obtaining sea oats, fertilizer, and equipment.

Erosion Control Districts may be established by county commissioners. A District can collect an ad valorem tax not to exceed 1 mill per year on all non-exempt taxable property within the erosion control district for up to 2 years to pay for organizational and administrative costs. Citizens looking for a way to raise beach restoration funds may find an erosion control district a suitable vehicle, and may request county government to create one. Once established, the district can negotiate with county or state agencies and the U.S. Army Corps of Engineers.

Depending on the size, location, purpose and beneficiaries of the dune restoration or revegetation project, county commissioners or a city council may be the best place to begin looking for support. In addition to or instead of money, government may be able to provide assistance such as equipment loan of trucks, bulldozers, posthole diggers, planting tools or perhaps the services of personnel with beach restoration training. Evidence of support by local citizens, such as donation of labor or money, can be a point in favor of government cooperation.

Most coastal state governments have funds designated for beach restoration projects. In Florida the Department of Natural Resources is authorized (F.S. Ch. 161) to pay 75 percent of the cost of (1) biological monitoring (2) revegetation, providing the project sponsors pay for:

(1) project engineering, supervision and inspection;

(2) all required construction easements, rights-of-way, public access easements, and required vehicle parking spaces;

(3) obtaining all required permits;

(4) the costs of establishing erosion control line;

(5) all other costs.

There are specific requirements that the local government or sponsor must accept to obtain state funding in Florida. These requirements are found in the section titled References under Chapter 16 B - 23, Rules and Procedures for Disbursement of Erosion Control Trust Fund Funds, which explains how to fill out the application to DNR - Division of Beaches and Shores for a beach restoration, revegetation or dune walk-over project.

Action Summary for Funding Support

* First action - Check with U.S. Army Corps of Engineers in your district.

* Second action - (1) Check with the state agency responsible for beaches (in Florida, DNR's Division of Beaches and Shores) (2) Check with state agency responsible for coastal permits (in Florida, DER's Permitting office)

* Third action - Contact civic organizations dealing with environmental issues

* Fourth action - Solicit neighborhood or beach area dwellers for support

* Fifth action - Contact county commissioners

* Sixth action - Contact city or district officials.

Public Involvement

Public involvement can be an important part of dune restoration efforts. When public funds are to be spent there are often legal requirements for public hearings, but even entirely private projects may benefit from public participation. The public can be a source of labor and/or funds, which may be the only economically feasible way to conduct some projects. Public comments may provide information or perspectives not otherwise available. But the most important reason for seeking public involvement is that people are most likely to support or cooperate with projects to which they have personally contributed. Signs asking people to "stay off the baby dunes" are likely to be more effective if people think of the dunes as their babies.

People need a sound, well-developed proposal before them in order to react constructively, but it should be made clear that suggestions for improvements are very welcome. Managers should be prepared to modify, add or delete parts of the plan to increase public support--and should credit public comment as the source of the change. The style of the manager's reaction may be nearly as important as the substance. Wide dissemination of information about dunes and proposed projects is essential: informed public comment is not possible otherwise. People sometime oppose vague programs because of fear that change may be injurious to their interests. Clear, complete information helps reduce that kind of opposition.

The most effective method of increasing public participation is to actively involve individuals.

Commitment is strengthened by such things as writing letters, selling T-shirts, or planting sea oats--and should be built into the planning for the project. Psychologically, citizens feel good about being involved and identified with programs viewed as "in the public interest." They may go to other community groups in which they participate and help obtain volunteer labor or statements of endorsement, which can be of help in seeking both private and government funding.

Because people have different time budgets and interests, it is best to plan several participation opportunities. The following list is neither complete nor presented in any recommended order, but may serve to illustrate the possibilities for giving people useful, important project responsibilities suited to their individual time and talents.

Public Support and the Role of Government:

(1) check the state coastal management program for application to your situation and general use.

(2) read the applicable state statute covering beach regulations (Ch. 161 Florida Statutes)

(3) Write for information from lead agency (Florida DNR, Division of Beaches and Shores or DER's Permitting Office).

(4) Check to see if a local resident is a member of a coastal advisory committee.

(5) Check with nearby universities for sources of information and people with experience.

(6) Contact Sea Grant Marine Advisory Agency in your region for information and assistance.

(7) Contact local representatives of the State permitting agency.

Media exposure and education:

(8) Draft newspaper articles or ask for coverage

(9) Prepare a statement and request TV coverage

(10) Check on audio-visual presentations on dunes or develop your own presentation.

(11) Write articles for magazines or newsletters

(12) Involve state legislators by sending information that supports coastal issues.

(13) Select someone qualified to speak about dune reconstruction to local civic organizations.

(14) Advertise in an effective manner - newspaper, radio, TV, billboard, T-shirts, brochures, etc.

(15) Address City Council or County Commissioners, requesting their public support of dune programs.

Recruitment and Promotion

(16) Develop a contact list of supporters and neutral groups. Attempt to understand opposition groups and look for compromises.

(17) Organize support groups.

(18) Involve high school groups as well as universities in dune ecology projects, fencing, planting, etc.

(19) Encourage letter writing to responsible agencies.

(20) Program a "Save Our Dunes" week, month, year in your county or city.

(21) Observe state coastal actions involving dunes and notify constituents.

(22) Request assistance of the U.S. Army Corps of Engineers: information, advice, local experience

(23) Locate other areas where public involvement projects have been successful and analyze why.

(24) Identify economic benefits and safety margins augmented by development of natural dune barriers. Focus on public safety, welfare, protection of public and private investments.

(25) Promote the self-help spirit and the sharing of the benefits. Community pride and increased aesthetic values are also very important.

(26) Monitor public involvement and feedback information so program can be tailored to local concerns.

(27) Keep the county, state and federal agencies updated on your progress and public sentiment.

(28) Encourage groups to visit the area before work begins and to observe changes as they develop.

(29) Conduct a public hearing, with assistance from local agencies and individuals qualified to discuss pros and cons of a dune restoration project.

(30) Organize groups to work on specific phases of a self-help project. Example - civic organizations supply sand fencing, posts, etc.; garden clubs supply sea oats grasses; boy scouts/girl scouts plant sea oats; high school clubs erect sand fencing.

(Sample logo used in promotion of public support for dune restoration)

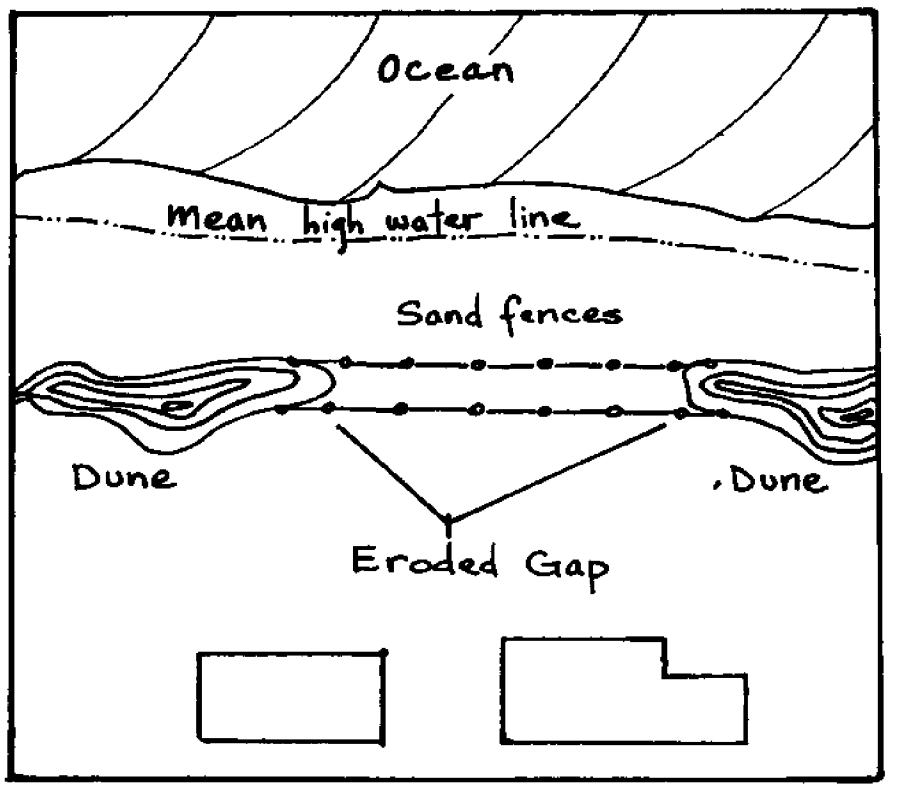
Implementation

With all preparations made and permits in hand, it's time to get started on the beach. Recommendations in this section are for "typical" dune restoration projects; adapt them to your particular needs. Refer to the Work Cycle chart on page 26 for time sequence.

Sand fencing should be put up far enough in advance of plantings to allow sand build-up to about two-thirds the height of the fences. (Note: sand fence suppliers may not be easy to find. Allow ample lead time). The advance time needed varies from a few months to a year, depending upon the amount of sand being transported by winds. Erecting fences early can provide important information by allowing time to note public reaction to the structures and to monitor foot traffic. If problems of pedestrian flow exist some measures must be taken. Signs prohibiting walking through the area, or explaining the project and asking for public cooperation, may be enough. If not, dune walkovers in the project area or nearby can be planned or, alternatively, the decision to rebuild the dune may be reconsidered.

Graded artificial dunes often have sand grain size different than or of a less uniform texture than is required for good plant growth. With such mechanically placed materials, there will be some period of time during which beach processes work to recast them into a natural slope and shape. Sand fences placed on the graded area can help accumulate sand of the proper size for plant growth and simultaneously speed the adjustment period.

Since plantings need water and will do best if they can tap the fresh water lens, dunes--graded or accumulated by fencing--should not be very high when planted. Sand fencing about two feet high is probably a good choice: sand can accumulate to 12-18 inches, enough for a good planting depth but shallow enough that roots may be able to reach water tables. Commercially-available fencing often comes in 4-foot height, but can be easily cut into two strips.



Sand fencing methods

Sand fencing works by simply slowing down the wind, which allows wind-borne sand grains to drop out and collect around the fence. Almost any kind of "fence" can be used, provided that it slows but does not completely block the wind.

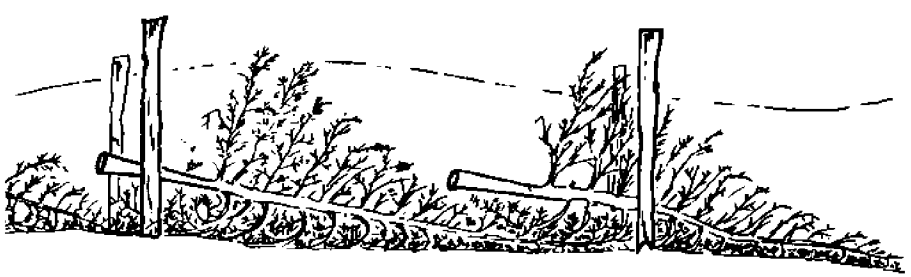
Brush fences - a low budget technique

Christmas trees and other brush material can be used to trap sand as the foundation for dunes. Trees may be loosely piled in rows and pegged down with light rope or twine, or may be held more securely between two rails on posts. The trees should be placed end to end one or two trees wide, in a long row. If more than one row is used, the rows should be around 15 feet apart, measured from edge to edge of the brush pile. This is not a magic measurement essential to success, rather a rule of thumb.

If Christmas trees will be needed in large quantities, an excellent opportunity for public involvement exists. Public announcements could explain how the trees would be used, the importance of dunes, etc., not only to secure Christmas trees but to increase public awareness and support for dune work. Christmas tree dealers might be persuaded to hand out informational flyers with each Christmas tree sold. The public should be told when, where and how the trees will be collected by the project operators. Alternatively, the local refuse collection system may be willing to cooperate. Another source of brush material would be the local dumping area. Note that governmental permission and cooperation may be essential to brush fence plans.

An additional benefit of brush fences as sand-gatherers is the organic material of the trees, which provides water-holding capacity and nutrients for the new plantings. A disadvantage is that picnickers may use the brush for firewood.

Discarded Christmas Trees



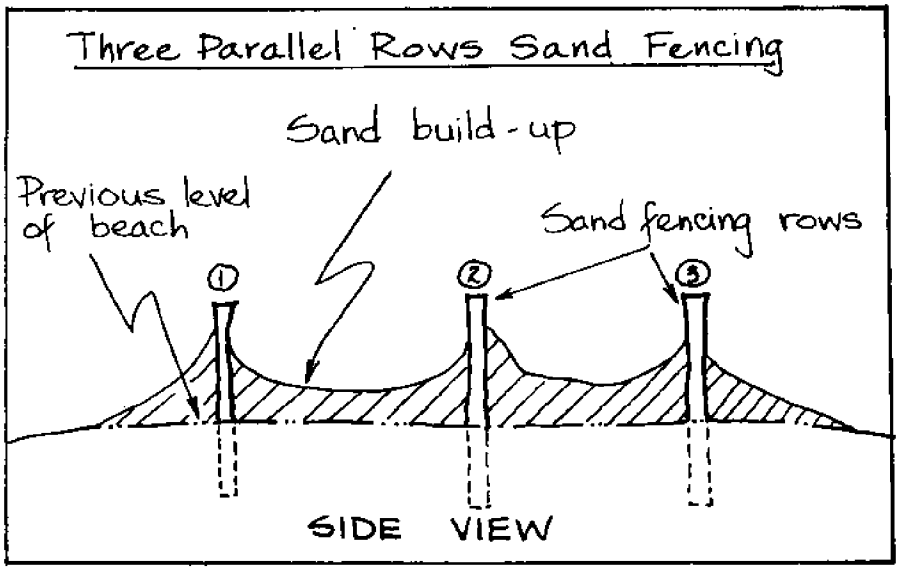
Sand fences - commercially available products

Commercial sand fencing is available in several forms: common wood-and-wire "snow fence," fabric or plastic. Price and local availability are probably the most important reasons for choosing between the types. Do not use either completely solid fencing (e.g. plastic sheets) or such "open" types as chicken wire. Around 50% solid material seems to work well.

Placement of sand fencing

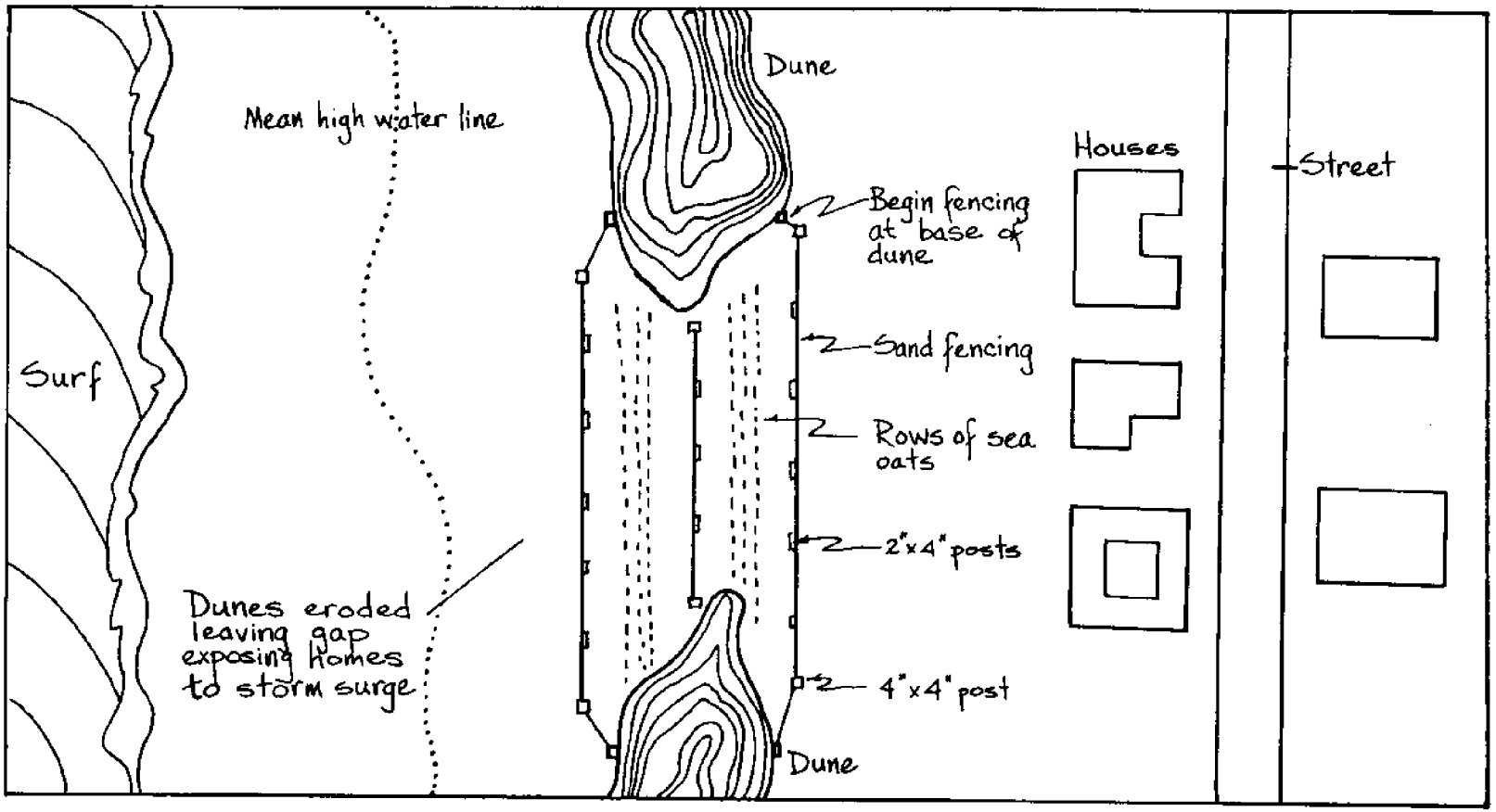
The function of sand fencing is to speed accumulation of sand in the location chosen for dune reconstruction. Fencing should be placed within the outline of the planned dune, following the rules for dune location: roughly perpendicular to the prevailing winds, not within range of seasonal storm waves, aligned with any neighboring dune. Three rows of fencing about 15 feet apart give a sand trap area some 50 feet across. Greater width is not necessary; less is acceptable, but a dune less than 30 feet in width is less resistant to erosion by moderate storms and other forms of injury.

Arrangements of fencing within the dune shape seem to follow individual taste more than scientific evidence. Parallel fences have the virtue of being usually simpler to construct. Among the possible fence geometries are parallel lines, zig-zags, "chain links," and others.



Where possible, fence ends should be tied in with a neighboring dune. If the fence end is "open," it may be helpful to put short (10-15 ft) over-lapping lengths of fencing between the ends of longer rows, to catch sand which would otherwise blow around the fence ends. Iron pipes or wooden posts anchor the fences, driven into the sand deeply enough to secure it under a load of sand which may gather primarily on one side.

Damaged fences should be repaired as soon as possible to prevent wind or foot traffic from being channeled through the hole, eroding the new dune.



Are sand fences essential?

Low areas such as washover channels benefit from sand fencing, especially if a saline water table exists in the area. By catching enough sand to provide initial elevation, fencing can raise the plants above the high salinity level. Fences can also help reduce wind erosion and impede traffic through the area.

In most other situations sand fencing is recommended but not a necessity. If there is enough sand movement on the beach, a good stand of plants will begin the dune building process. Do use some method to keep traffic off the plants. Otherwise, tend the plants carefully and be prepared to wait a year or two for your dune to catch up with dune growth in areas using sand fence.

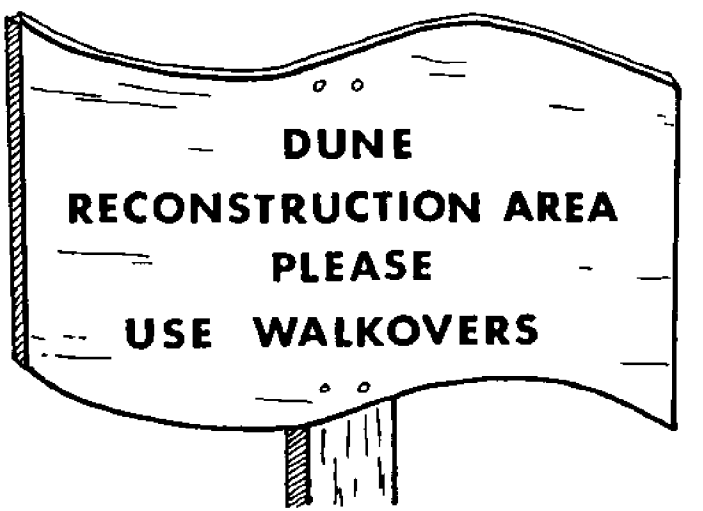
Dunes and 'Dozers

There are situations in which it will be necessary to build dunes by mechanical grading, often using imported sand. Low energy beaches with minimal sand movement build dunes slowly by natural means. Severe storm or construction damage may require extensive, rapid dune work. Many such projects have been successful, but special conditions apply.

First, use of machinery on the beach will almost certainly require one or more permits from one or more agencies, state and local. Such permits are often given with conditions attached. For example, the permit may require that all machinery on the beach use extra-wide rubber tires and may control access point(s) or hours of operation. Second, it is often necessary to import sand to the site. Permits will require that the imported sand be an acceptable match (color, grain size, composition) with native sand. Since even a small project may require several hundred cubic yards of imported sand it will be important to find a local sand source at an affordable price. Sometimes sand can be obtained from nearby dredging sites. Commercial dealers may have suitable sand sources.

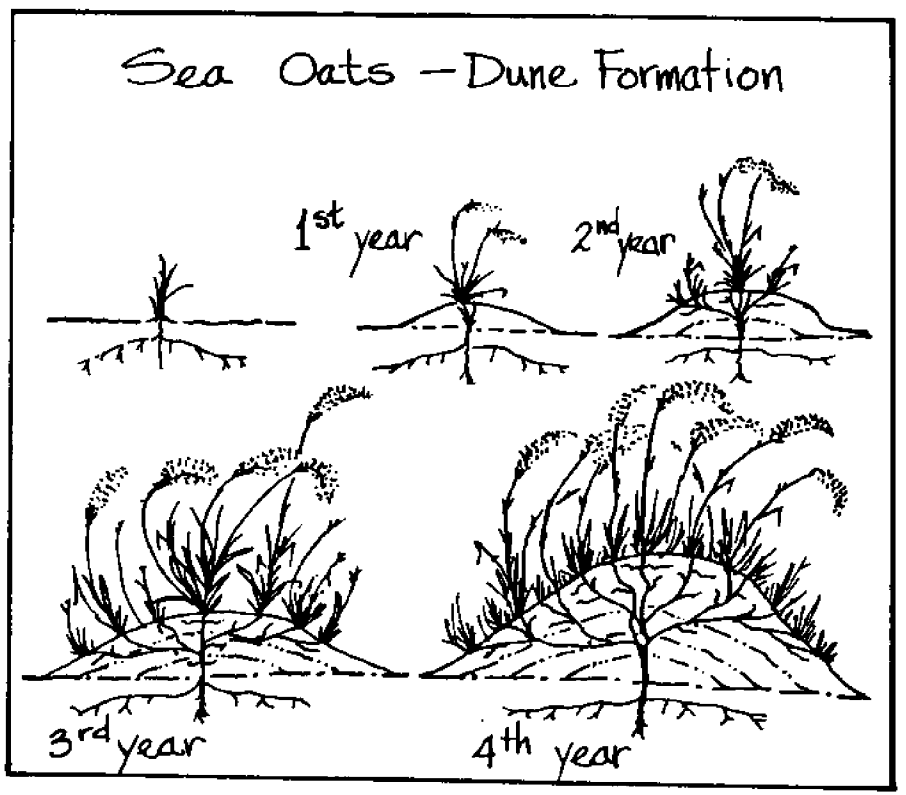
It is obvious that mechanical dune building will be relatively expensive, which makes funding a central problem. Professional advice should be sought on proper placement and shape of dunes. On-site monitoring will probably be needed, to guard against violation of permit conditions by workmen or inexperienced helpers and to assure that the project is conducted properly.

After the graded material has settled in place and been well washed by irrigation or several rainstorms, vegetation should be planted to stabilize the dune. The graded material is likely to be more coarse than wind-blown sand and may be poor in plant nutrients. Irrigation and fertilizing should be regularly conducted for the first several months of the project, after which natural processes should be sufficient.



Planting

Revegetation of a dune is the most labor-intensive and delicate part of the entire dune-building process. Care should be taken to allow enough lead time to obtain the needed plants, arrange for the needed labor, and be sure that the beach is prepared for planting. Before sending the troops forth armed with plants and spades, it is adviseable to hold a demonstration session on "how to plant." Allow plenty of time for planting.



modified from Leatherman 1980

Obtaining the plants

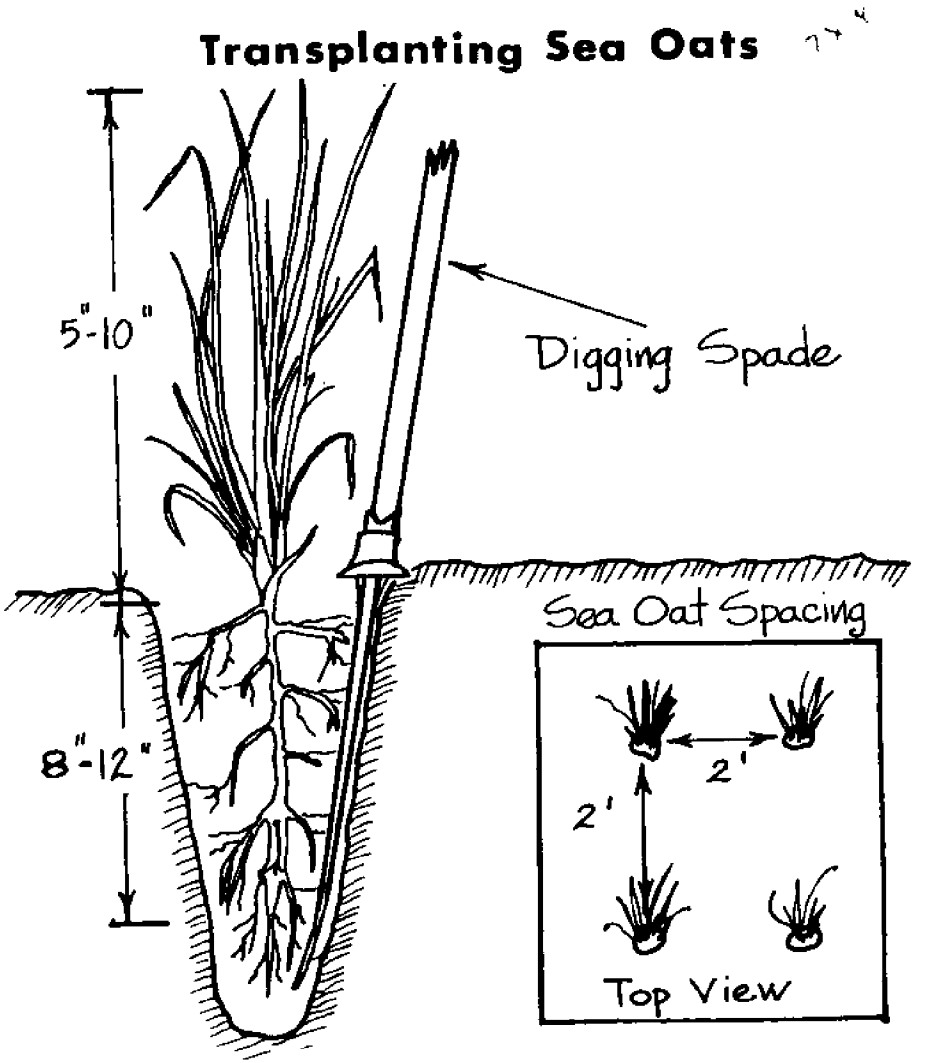
Dune revegetation rarely works well if one begins with seeds. Many seeds will be non-viable or slow to germinate, and seedlings grow slowly. As a result, vegetation on the dune would be likely to emerge slowly and with random bare patches. Transplantation is definitely the superior method of revegetation. Plants for transplanting can be obtained in three ways: transplant from vegetation on nearby dunes, buy seedlings from a nursery, or build your own nursery.

Obtaining stock from nearby dunes is clearly cheaper than purchasing or developing a nursery, but caution should be used. First, sea oats and other beach plants are legally protected in many areas and cannot be transplanted from wild colonies on public land. In Florida a land owner can transplant from one portion of his land to another, or may obtain another land owner's permission to take some of his plants, provided the plants are not seaward of the Coastal Construction Control Line. It is adviseable to inform local law enforcement officials of your plans, to carry identification and (if needed) a signed permit from the donating land owner. This may save delays and aggrevation if law enforcement officials become interested in your activities (personal experience). Second, plants should be carefully selected and cropped over a wide area rather than all in one place, to avoid weakening a healthy dune by either digging up too many plants or trampling an area and injuring the plants.

If you are going to transplant from neighboring areas, choose from younger, lower dunes that are not yet mature. Harvesting from large, densely-vegetated dunes is difficult, takes too much time and may damage the dune. Dig carefully around the plant base, deep enough to recover as much of the root as possible, at least one main root node. Clusters can be separated by hand into individual plants and the tops trimmed to a length of 5-10 inches, then bound into bundles of convenient size for handling. The bundles can be packed roots down into laundry baskets, garbage cans or some other container and immersed in freshwater for movement and brief storage--not more than three or four days. For overnight storage, a good covering of wet sand or a wet bag/tarp should be adequate.

Plants purchased from a commercial nursery should be handled as recommended by the nursery. Obtain this advice far enough ahead of time to fit any special handling requirements into your planning.

Establishing your own nursery is a good idea for purposes of routine maintenance, or perhaps to provide large numbers of plants for a long-term dune building program. But it takes at least one and usually two years for a nursery to produce large annual crops for transplanting. If you need the plants soon, you'll have to either transplant from nearby dunes or buy from a commercial nursery. See Chapter 4 for instructions on establishing a nursery.



Transplanting

Use plants with a sound stem and intact root node. The sand into which you are transplanting must be wet (rain or non-saline irrigation water) and should have a salinity of less than 2000 micromhos per square centimeter--preferrably less than 1000. Your local agricultural service may be able to test the site. However, if there are plants growing well in the immediate area, or if you are planting in the sand accumulated by a sand fence, salinity is probably within acceptable limits. If the area is low and flat, fairly close to the beach, salinity may be too high. In such areas use of sand fencing to accumulate an initial 18-24 inches of sand is desireable. Temporary inundation by salt water (waves or spray from a large storm) will not kill the plantings, but continued severe exposure (several days) will kill them.

Insert the transplants eight to 12 inches deep. If sand is rapidly accumulating use six inches; if accumulation is slow or wind scour removal of sand is possible, go deeper. Drifting sand may bury the plant as much as six inches before harmful effects become noticeable; burial to 20 inches or more has been observed to cause total failure. Planting one or two plants in each hole, with holes on approximately two-foot centers, gives generally good results. Sand accumulation by the second year should be very effective.

Use of paper mesh, sand or mulch netting has been recommended for areas with high average winds and a tendency to scour. Dahl et al. report good results with open-weave (0.5 x 2.5 inch) netting laid loosely over the planted areas. If used, the netting should be spread and staked securely. It is unlikely that such measures will be needed except in high wind areas, and then only on exposed dune faces.

There is no agreement on exactly how wide to make the planting field, or precisely where to place plants within the field. A width of about 50 feet seems to be the general practice, with plants on about two-foot centers uniformly through the area. Other alternatives include planting more densely in the center of the field, with the aim of producing higher accumulation rates in the center and thus a "rounded" dune form, or planting more densely at the back of the field since less sand should have migrated that far to be trapped. Observation suggests that plants should not be placed within about two feet of the sand fencing because of the danger of burial on one side or scour on the other; natural spread will fill in the gap. However, inventive variations on a standard grid pattern seem not to be demonstrably superior and do introduce complications in the planting process, particularly with volunteer labor.

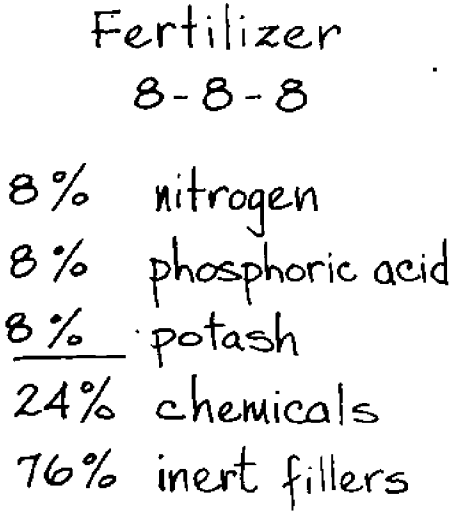
Post-planting care

Watering will certainly increase survival rates, especially during any extended dry periods. Be sure the irrigation water is not saline. A good soaking every two weeks is better than constant watering. After the first dry season irrigation is less important, although watering during the second growing season would speed development of dense cover.

Fertilizing during the first growing season will probably increase growth rates. Experience suggests use of a balanced fertilizer (8-8-8) applied at a rate of about 150 lbs. of nitrogen per acre. (Note: 100 lbs. of 8-8-8 would contain only 8 lbs of nitrogen). The fertilizer should be spread mechanically or by hand in two or three applications, four to six weeks apart.

A late spring storm, sand burial, or other disasters may wipe out portions of the planting area. Filling the gaps with new transplants is possible at once, or in the next planting season. If the transplant occurs late in the planting season, especial care with irrigation and fertilization should be taken in the re-planted area.

Over the next several years the beach may change (erosion, accretion). You may want to add and vegetate a second line of dunes, either behind or in front of the first dune, or to broaden the new dune or established ones nearby. Use the same general methods of dune positioning, fencing, and planting, adapted to the new shape of the beach.



Conclusion

Remember that this chapter is intended for the non-professional who wants good results without courting bankruptcy or spending all of his time working on the beach. Additional effort and money--for more elaborate irrigation, more sand fence, denser plantings, professional help, etc.--will probably produce better and faster results. However, if the guidelines in this Manual are followed there is a high probability of satisfactory results.

Chapter 4: Dune Maintenance

Introduction:

Previous sections of this Manual have focused on reconstruction of damaged dunes, beginning with more or less flat, unvegetated sand and building a "new dune". But it is at least equally important to monitor existing dunes, help them grow and prevent damage or repair minor damage as soon as it can be spotted.

Automobile manufacturers provide a suggested schedule of routine maintenance, advising the owner that careful adherence to the routine will minimize the probability of major breakdowns and consequent major costs. Dune maintenance operates on a similar principle. Development of a routine monitoring program allows the manager to spot trouble early in its development, when repair is likely to be easiest and cheapest. Adherence to the monitoring routine over the long term is important: Murphy's Law tells us that just when we slacken our vigilence, the damage will begin.

An important element of a dune maintenance program is development of good public support, with the objective of low-level but continuing public awareness and cooperation. It may be possible to integrate this effort into the monitoring program: members of the public may observe the beginning of dune damage, or its cause (e.g., beach buggy vandalism or the start of picnic trails) and report it to a designated office. Further, if continuing low-level public awareness is maintained, it will be easier to generate larger-scale support when needed. With the exception of major storms, it is human activity which is the greatest threat to dunes. If public awareness of the role of dunes and their fragility can help reduce the rate or amount of damage, maintenance is simplified. This chapter is divided into sections for convenience in exposition, but part of the dune manager's routine should be to check on how the total maintenance function is proceeding: the effort must be integrated.

Monitoring

Scheduling a weekly or bi-monthly visit to the dune reconstruction location by a project team member is necessary. If at all possible daily inspections are desirable, especially when weather conditions are abnormal. This would include storms, high winds, very hot or cold temperatures which might affect newly planted vegetation, drought conditions and high spring tides.

Monitoring should also be especially intense during and after heavy tourist influx at peak holiday periods. Once sand fencing is broken down, permitting more direct beach access, pedestrian damage to dunes may become severe. Daily inspections permit quick remedies and repairs to fencing on the spot, channeling pedestrian travel to controlled access points. Inspections should verify that posted signs are still in place, warning against picking sea oats and identifying access points. Experience indicates that wooden slats from sand fencing are often used for beach fires (illegal in most areas) It may be necessary to post metal or plastic signs warning beach users not to remove fencing materials.

Major items to check periodically are the dune walk-overs. When properly constructed these structures should not require frequent maintenance. However, minor damage to the walking surface must be corrected immediately to preclude injury and the occasional law suit. During your periodic checks closely inspect all parts of the dune walk-over system, including fencing channeling beach users toward the walk-overs.

Planted dune vegetation and the sand buildup from both the sand fences and vegetation are the primary reasons periodic monitoring is important. Adjustments might have to be made in sand fencing location or a second layer of fencing may have to be added, or the sea oats may require watering. These decisions can only be made at the dune reconstruction area. Where strong winds occur over several days the young sea oats may be completely buried with newly accumulated sand, requiring additional plantings.

Periodic monitoring also allows the project team to introduce the project to interested groups, such as school clubs, garden clubs and realtors/construction companies. Of significant interest to these groups is the rate of growth of the dune. Periodic visits permit daily or weekly recording of changes. Photographs are particularly valuable for newspaper and professional journal use, to illustrate and document changes. Dated photos and records of prevailing weather/wind conditions serve as evidence to support subsequent planning, showing how dune growth was more successful during some weather and wind conditions than others.

Management

Although it is simple to say that a team member will monitor the project, management planning is required. The monitoring provides information, but does not determine when work must be done or organize the effort. Aligning tasks requires scheduling, especially if specific equipment, vehicles or personnel are required--it can be very frustrating to try to load several hundred feet of sand fencing into the trunk of a Corvette. Before the team arrives at the dune location informal meetings or phone conversations organizing the overall effort are necessary.

Perhaps the most efficient method is to develop a management plan which programs dates, people, and work to be accomplished, on a quarterly or semi-annual schedule. This simple diagram, which will be driven by weather factors and the biological cycle of the plants, can be plotted by work tasks assigned to members (the "work cycle" chart in Chapter 3 may be used as an example). For instance, if one half-mile of a one mile project is to be done first, followed by the second half-mile, you will find it necessary to carefully plot and organize the work effort with estimated start and completion dates.

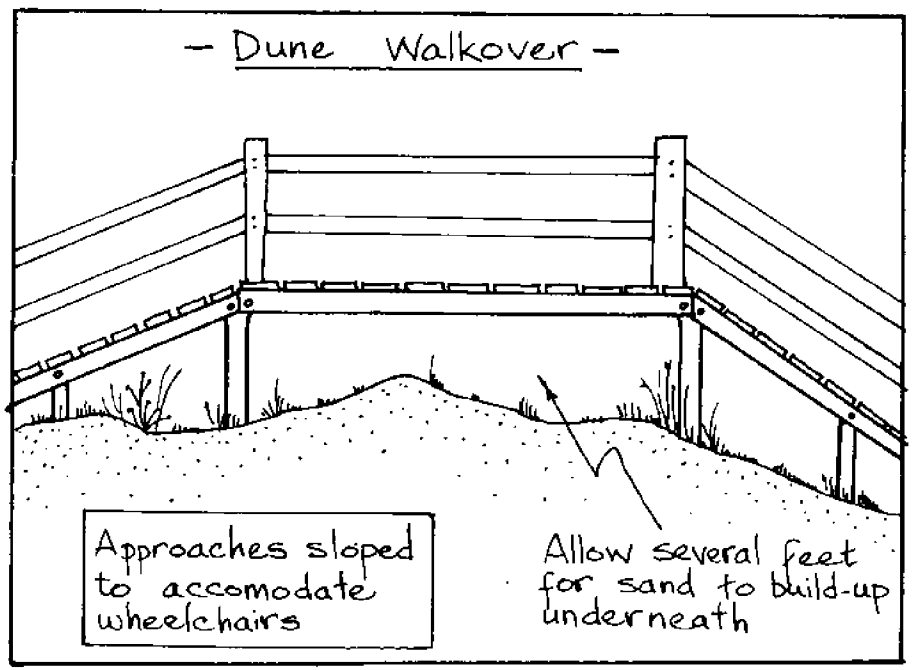
If your efforts include a nursery obviously this must be part of the management plan as well. Plants must be of adequate maturity before transplanting into the beach environment. A key management consideration is that they must be ready during the most suitable time for transplanting (usually the winter-spring season) to assure

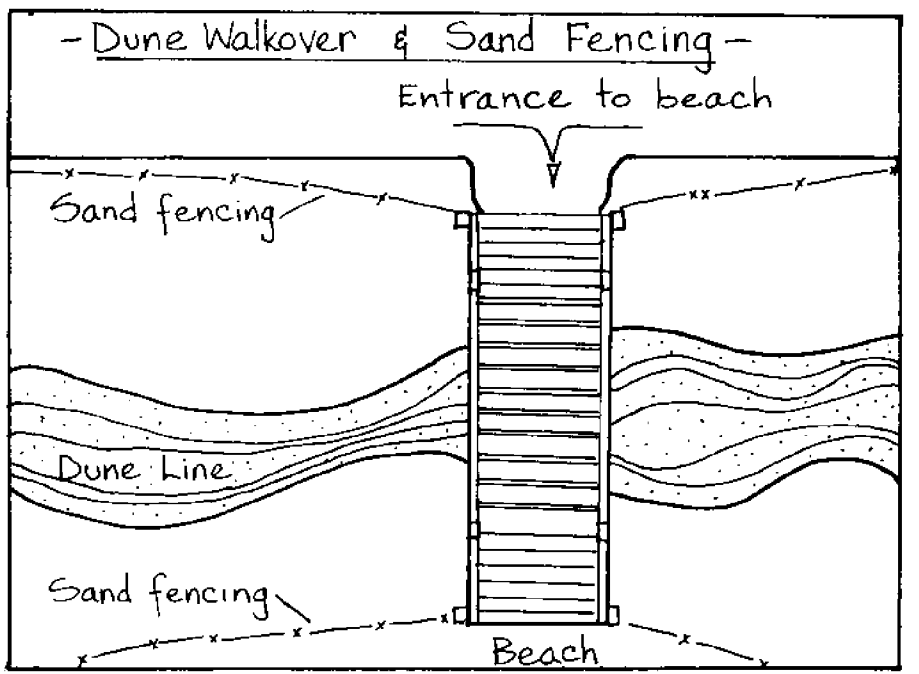
maximum survivability. Responsibility for care of the nursery, expenditure of funds and maintenance of equipment are management decisions that must be made in advance.

One of the management actions that normally must be decided before dune restoration begins is where, how, and who will construct dune walkovers. Usually it will take at least a year for a major dune to grow to about the "normal" height of neighboring dunes, after which it will increase very slowly. If a walkover is necessary the time for construction is before the vegetation is planted. Walkovers are virtually essential if the dune will obstruct an established beach access way. Construction should be elevated to permit dune buildup and vegetation growth underneath.

Controlling dune damage is a major management problem that must be worked on constantly. Man-induced damage can be eliminated or at least reduced if state and local laws are enforced. You may have to bring to the enforcement agency's attention some failures to enforce the rules.

Some activities that often will cause damage are dune buggies driven over the dunes, foot traffic, construction, picknickers and fire, either campfire or





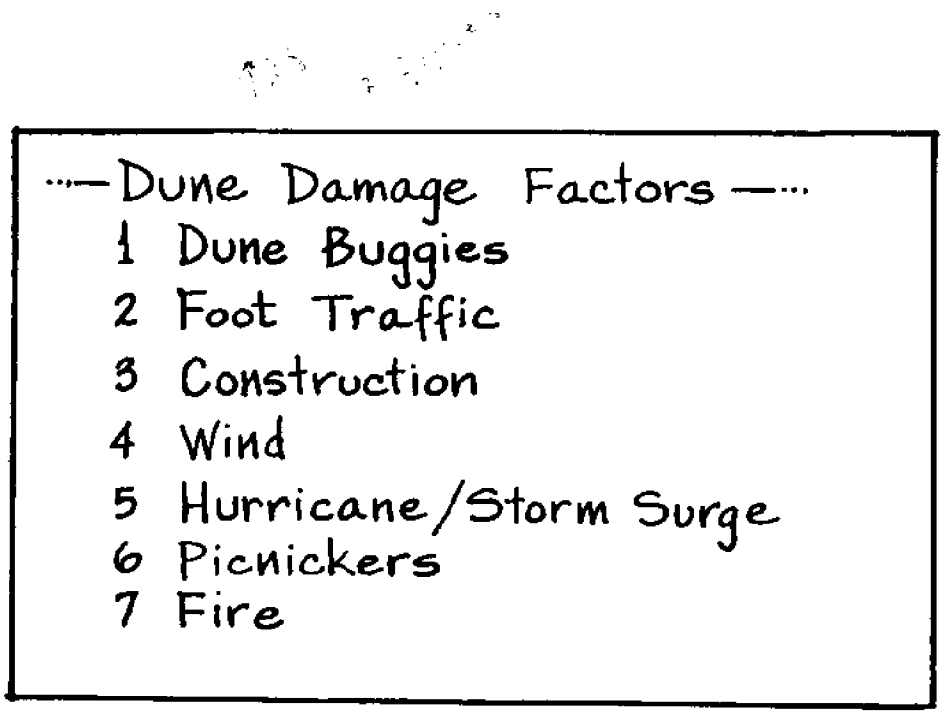
controlled burning. Natural conditions generally viewed as damage factors are hurricanes and storms, wind, severe cold and drought. In addition, any beach construction or development that significantly lowers the fresh water table may eliminate desirable species of vegetation.

Routine Maintenance

Watering of the sea oats during the first six months is often necessary when rainfall is sparse and the stimulation of root growth is critical. This may be done with a temporary sprinkler system or hand watering from a backpack tank. Commercial water trucks with 500 gallon tanks and long hoses can be hired to water the new plants.

Fertilizing during and after planting is beneficial in the first year or two, as discussed above. If growth is poor a light annual feeding may help.

Routine maintenance of dune walk-overs, fencing and signs will be necessary. Installation of new rows of fencing on top of rapidly accreting dunes is possible when previously installed fencing is buried. There will also be occasional vandalism to fencing and sea oat plantings, which should be repaired quickly. Only a consistent, organized routine will assure that such needs will be discovered early and dealt with in a timely fashion.



Establishing a Nursery for Beach Plants

For periodic plant replacement, especially in large project areas, a nursery program may be useful. Nurseries are good public involvement projects, perhaps in continuing cooperation with local schools or service clubs. A joint public-private nursery might be established with local or state agencies having similar needs.

A nursery usually needs a year or two for the plants to become established. Thereafter it should provide vigorous young plants, easily dug and transplanted.

Sea oats can be grown in greenhouses, but for large supplies at low cost the beach itself is the best site. Nursery sites should be located in flat areas with minimal blowing sand, accessible to machinery (for cultivation) and irrigation water. Barren areas require minimal site preparation or weeding. Dahl et al. indicate that a one-acre nursery should yield a minimum of 100,000 transplants, enough to plant an area 50 feet by 1.5 miles in length. Using this as a rough indicator of productivity, a nursery can be sized to meet your needs.

Planting in the nursery should follow the same time cycle as is recommended for dune planting generally. Sea oats planted in late winter one year could be harvested the next winter but would do better if harvested in the second year. Large nurseries can plant with a tobacco transplanter and crew. If the field is to be machine cultivated (weeding), room between plantings must match the span of the machinery; hand cultivation allows denser planting but working room between rows is required.

A nursery will make intensive demands upon the site's water and nutrient resources; supplements will probably be needed. During initial planting the soil should be wet. Planting following a strong rainstorm may be ideal. During the growth period the nursery soil at root zone depth should not be allowed to dry out. Normal precipitation will probably be adequate except in the dry season, but irrigation will be needed whenever the root zone begins to dry. Fertilization with an 8-8-8 fertilizer (see p. 42) should be done every six weeks or so from spring through summer.

Although the focus in this Manual is on use of sea oats, there is an additional plant important enough throughout much of the southeast to merit a brief note. Panicum amarum, called dune panic grass or bitter panicum may be used as a substitute for sea oats in some areas, and mixes well with sea oats in most areas, especially on the backbeach and lee side of dunes. It can be obtained from some commercial nurseries, grown in your own nursery in essentially the same manner as sea oats, or transplanted from available wild stock. It is easier to transplant than sea oats, since its long stems may be simply broken off at ground level or pulled up with whatever root comes along. Roots are not necessary for transplanting. In fact, if the stem length is over three feet long it can be broken in two and both halves planted. Minimum planting length should be about 18 inches. For transplanting in late winter or early spring, select the larger main plants rather than smaller shoots as transplant material. In planting, irrigating, fertilizing etc. use the same methods as for sea oats. Dahl et al. (see References section) provide detailed instruction on use of panic grass in dune revegetation.

Public Support Organization for Long-Term Maintenance

The following recommendations can be used as a guide to organize continuing public support for dune restoration projects. Each project must be tailored to local conditions, the size of the project, schedule of completion, available funds and public support. In addition, long range maintenance and citizen commitment to sustaining the dune system must be organized.

Projects involving a city beach or portions of a county coastal area require organization by a group of affected property owners. The following recommendations are provided as a general list of actions to organize public support. The first step is:

(1) organize a permanent executive group from those initially involved as well as new members

This group becomes the core of all future actions including designating responsibilities, and if necessary, a chairperson. Once this group is functioning the second step is:

(2) state in writing future goals and objectives

Usually the public announcement of the organization's goal in the newspaper or T.V. is desirable. From the announcement will come recruitment or additional support and identification of opposing individuals and organizations. Often early compromises or simply reassurance about the project purpose reduces opposition. Third:

(3) seek involvement of agencies which must approve application(s).

Correspondence with local, county, state or federal agencies and periodic beach tours with representatives or visiting high officials can maintain communications and improve coordination for any future work. The fourth step is:

(4) become familiar with budget(s)/funding timetables of the funding agency(ies)

Familiarity with budget cycles allows public support to influence officials (public and private) at the opportune time. Restoration often is time-limited by weather and plant adaptation factors. It is good planning to locate several alternative sponsors with varying budget cycles. For example, a local, private group with funds available in the spring may be a good source of support for emergency maintenance. The fifth step is:

(5) draw a work flow chart and distribute to work groups for the next two years.

Assign specific tasks to work groups or individuals with desired completion dates. Where one task depends on completion of a previous task the groups must understand the work flow progression and interdependence. When the first year of dune restoration is completed, experience will aid in determining needs and constructing annual work flow charts. As the sixth step:

(6) request continuing media coverage emphasizing long-term advantages of dune restoration.

When actual work begins at the beach site newspaper and T.V. coverage can assist in building public support, and provide important educational information on the protective features of dune lines. Media coverage is most effective if continuing TV and newspaper coverage is provided, especially if dune sand accumulation is visible and impressive. Still photographs (with fixed reference points) taken at suitable intervals (weekly?) can show progress and may be a valuable lesson on what to expect in future projects. The spring beach inventory and routine maintenance exercise may provide good "photo opportunities" for the media and serve to encourage public support. Step seven is:

(7) actively recruit organizational support.

Search for ways to cut expenses by requesting additional club sponsorship which can provide labor, equipment, promotion and money. The wider the organizational involvement the wider are the choices for solving dune restoration problems with local talent. Continuing support for dune maintenance requires long term commitments from clubs. Step eight is:

(8) program long range support and maintenance of dune restoration efforts.

If necessary, develop means to assure continuing management and funding of restored dune area. Research feasibility of establishing an Erosion Control District, if warranted. Involving local and county governments by requesting their dedicated support for the following years is necessary in most dune restoration projects. Step nine is:

(9) give recognition to those involved

When project is nearing completion publicly thank and praise work done by all groups. For the future work that is necessary these are the people who should be actively involved. Allegiance and dedication are fostered by successful dune restoration efforts. Group photographs taken on the beach identifying the permanent members can be effective in cementing group tenure.

(10) help other groups and communities start their own dune restoration programs

The knowledge you have gained from sand fencing, planting sea oats and maintenance considerations will greatly benefit other projects just as you have benefited from existing advice.

Florida Regulations: Summary

CHAPTER 161

BEACH AND SHORE PRESERVATION

PART I- Regulation of construction, reconstruction, and other physical activity (ss.161.011-161.212).

PART II- Beach and shore preservation districts (ss.161.25-161.45).

PART III-

STATE

Chapter 161 Beach and Shore Preservation F.S. 1979

PART I

161.021 Definitions

(3) "Beach and shore preservation, erosion control, beach preservation and hurricane protection, ---but is not limited to, erosion control, hurricane protection, coastal flood control, shoreline and offshore rehabilitation, and regulation of work and activities likely to affect the physical condition of the beach or shore."

(4) "Coastal construction" includes any work or activity which is likelly to have a material physical effect on existing coastal conditions or natural shore and inlet processes.

161.041 Permits required

any coastal construction or reconstruction or change of existing structures, or any construction or physical activity undertaken specifically for shore protection purposes, or other structures and physical activity including goins, jetties, motes, breakwaters, seawalls, revetments, artificial nourishment, inlet sediment by-passing, excavation or maintenance dredging of inlet channels, or other depositiion or removal of beach material or construction of other structures if of a solid or highly permeable design, upon sovereignty land of Florida, below the mean high waterline of any tidal water of the state, a coastal construction permit must be obtained from the DNR prior to the commencement of such work. Applications for coastal construction permits as defined above shall be made to the Division of Marine Resources upon such terms and conditions as set by the department."

161.042 Coastal construction and excavation in barrier beach inlets

"---excavation of sandy sediment as a result of any activity conducted to maintain navigable depths within or immediately adjacent to any coastal barrier beach inlet within sovereignty lands shall, after receipt of written authorization from the DER relating to the deposition of

spoil material from the excavation pursuant to chapters 253 and 403, use such sediment for beach nourishment as prescribed by the Division. Requests for such authorization shall be made by the division to the DER. For any construction immediately contiguous to any coastal barrier beach inlet which has been permitted pursuant to s.161.041, the department may require the permittee to supply beach profiles and conduct hydrographic monitoring of the impact area."

STATE

Chapter 161 Beach and Shore Preservation F.S. 1979

PART I- Regulation of construction, reconstruction, and other physical activities.

PART II- Beach and shore preservation districts.

1. The department is authorized to pay up to 75 percent of the ---biological monitoring costs, revegetation costs---provided local interests shall, as project sponsor, pay:

   (1) The costs for project engineering, including engineering supervision and inspection;

   (2) The costs for providing all required construction easements, rights-of-way, public access easements, and required vehicle parking spaces;

   (3) The costs of obtaining all required permits;

   (4) The costs of establishing erosion control lines;

   (5) All other costs.

2. 161.25 County beach and shore preservation authority; board of county commissioners.

3. 161.28 Comprehensive county beach and shore preservation program.

   "The board of county commissioners---may initiate and carry on such studies and investigations as may be necessary to plan a logical and suitable program for comprehensive beach and shore preservation within its county."

4. 161.29 Benefit categories or zones.

   "---determine nature and extent of benefits expected to accrue from the program and allocating these benefits to their proper recipients---"

5. 161.31 Establishment of districts.

   ---county commissioners serve as governing body to implement policy and program. Ad valorem tax not exceed 1 mill per year on all nonexempt taxable property within district for up to 2 years to defray organizational and administrative costs of the district.

6. 161.33 Cooperation with federal, state and other governmental entities.

   "---for the purpose of improving, furthering and expediting the beach and shore preservation program."

   County commissioners, DNR are authorized to receive from federal agencies grants for aid in beach and shore preservation program or from any source.

7. 161.35 County shoreline; supervisory and regulatory powers of board of county commissioners.

   With the consent of DNR and municipalities. The county commissioners may regulate and supervise all physical activity along the county shoreline which is likely to have a material physical effect on existing coastal processes - groins, seawalls, revetments, jetties, moles, breakwaters, and other coastal construction. Commissioners may develop standards, criteria, issue permits, and conduct inspections. May be enforced by mandantory injunction or other appropriate action in any court.

8. 161.36 General powers of authority:

   (1) make contracts of agreements
   (2) sue and be sued
   (3) acquire and hold lands and property
   (4) exercise power of eminent domain
   (5) enter on private property
   (6) construct, acquire, operate and maintain works and facilities
   (7) make rules & regulations

9. 161.37 Capital, operation and maintenance costs; district benefits tax levy -

"---to provide capital, operation, and maintenance cost of beach and shore preservation program either by debt service or direct expenditure.

"tax shall be levied upon each taxable property in proportion to benefits said property will receive---." "within a district---".

"---Commissioners shall levy sufficient ad valorem and special benefits taxes to pay off debt service on any bonds issued.

10. 161.38 Issuance of bonds----

Bonds of each issue shall be dated, shall bear interest at rates not to exceed 7 1/2 percent which mature at such time not to exceed 40 years.

Rules and Procedures for Disbursement of Erosion Control Trust Fund Funds

Chapter 16B - 23

16B-23.02 Application Procedures

(1) Any county, municipality, township, or special district may make application to the Bureau of Beaches and Shores, Division of Marine Resources, Department of Natural Resources, for funds to assist in the defrayment of expenses for erosion control, beach preservation and hurricane protection projects.

(2) Monies will be disbursed in accordance with the following:

(a) Federal aid projects: Authorized to pay up to 75% of the non-federal construction and maintenance costs of projects authorized by the Congress of the U.S., providing the local sponsor shall pay:

1. Non-federal cost for project engineering
2. Costs of all construction easements
3. Costs of all construction rights-of-way
4. Costs of public access easements
5. Costs of all vehicle parking spaces
6. Costs of all required permits
7. Costs of establishing the Erosion Control line to include surveys, recording fees and engineering.
8. Costs of preparing Environmental Assessment and, when requested by the Department, the cost of preparing an Environmental Impact Statement.
9. All other non-federal cost not involving actual construction plus those construction cost as necessary to insure the project sponsor's portion of the project shall be equal to at least 25% of the total project cost.

(b) (not recorded)

(c) Non-federal aid projects. Authorized to pay up to 75% of the costs of the project authorized for construction by the Head of the DNR (which is the Governor and Cabinet)

(d) (not recorded)

(e) The Department is authorized to pay up to 100% of the cost of acquisition of sand source data.

(f) The Department is authorized to pay the entire cost of inlet sand transfer projects when the primary purpose is beach nourishment. In the case of navigation channel construction or maintenance dredging projects, the Department is authorized to pay any additional project costs, as determined by the Department involved in placing dredged material on the beach, but in no case shall the additional cost exceed 50% of the total project cost.

(g) The Department is authorized to expend funds from the Erosion Control Trust Fund account for such erosion control, beach preservation, hurricane protection work or activity as may be in the interest of the state, as determined by the Department and subject to legislative appropriations.

16B 23.03 Project Qualifications.

For an erosion control project to qualify for funding as provided in 16B 23.03(2) above, the project sponsor shall inform the Department and/or provide the following:

(1) Permanent public access to project areas at approximately 1/2 mile intervals.

(2) Adequate vehicle parking spaces necessary in public interest, as determined by the Department.

(3) Not recorded

(4) Select a Project Engineer on a competitive negotiation basis as outlined in Chapter 287 F.S.

(5) Formal assurances of agreement and local cooperation.

(6) The project sponsor shall also agree to:

(a) Contribute in cash the local share of project construction cost and assume full responsibility for all project costs in excess of the state-federal cost limitation.

(b) Provide without cost to the U.S. and the State of Florida all necessary lands, easements and rights-of-way.

(c) Assure continued public ownership or contained public use of the shore upon which the amount of State and/or Federal participation is based, and its administration for public use during economic life of the project.

(d) Assure maintenance and repair, and local share of periodic beach nourishment where applicable, during the useful life of the works as required to serve the projects intended purpose.

(e) Maintain required public accesses and vehicle parking spaces, open and available to all on equal terms, for the life of the project.

(f) Provide an environmental assessment, and when required by the Department, an Environmental Impact Statement.

16B 23.05 Application Information Required:

(1) Name, address, telephone number of project sponsor

(2) Individual requesting funds and his/her authority

(3) Resolution of the applicant agency setting forth the public need, description of the project proposed and legal description of area involved.

(4) Print of topographic map of sufficiently large size prepared by a Florida registered land surveyor or engineer. Map msut show:

(a) Upland for 500 feet from mean low water line.

(b) Present mean high water line.

(c) Delineated Coastal Construction Setback Line.

(d) Project location referenced to section, township and range.

(e) Designated sand borrow areas, if applicable.

(f) Designated borrow area depths referenced to 1929 mean sea level datum.

(5) Project engineer, name, address and telephone number.

(6) Initial cost estimates for project.

(a) Federal contribution to initial construction cost of project.

(b) Non-federal contribution to initial construction cost of project.

(c) State funds requested.

(d) Maximum constribution applicant can make to initiate construction cost of project.

(e) Design life of project and annual maintenance cost.

(f) Maintenance cost of project to be paid by each participant for design life of project.

(7) Date construction of project to commence.

(8) Date federal and/or local funds to be available.

(9) Information on ownership of uplands in project area.

(10) Information on ownership of public access areas.

(a) Erosion Control Line: Date recorded

(b) Coastal Construction Permit: number and date.

(c) Dredge permit (if applicable): Permit and date.

(d) Certification by DER: date of certification.

(e) Approval by Division of Archives, History and Records Management: Date of Approval.

(f) Corps. of Engineers Permit: Number and Date.

(11) One copy of Final Environmental Report.

(12) One complete set of project proposal, plans and specifications prepared and signed by an engineer registered in the State of Florida, qualified in coastal engineering, include-

(a) History of all prior actions taken to prevent or control shore erosion in the project area and the results secured thereby.

(b) Any accurate local surveys which can be used to indicate progressive shoreline and offshore changes.

(c) Statistics on beach use, both for peak days and for the entire recreation season and estimates of prospective use.

(d) Available data on storm and erosion damage experienced along the shorefront in the project area.

(e) Location of project boundaries and the length of publically owned shore frontage such as bathing beaches, parks, public landings and street ends.

(f) Description of upland development of publically owned shore and/or publically used private frontage.

(g) Benefit-to-cost ration with supporting data.

(13) Two executed copies of the formal Contractual Agreement.

16B 23.06 Processing of Applications.

(1) Upon receipt of application for allocation of Erosion Control Trust funds, the Bureau of Beaches and Shores staff shall review the file and will determine compliance with Chapter 161 Florida Statutes, Beach and Shore Preservation. If the application is sufficient to support the allocation of funds, the applicant will be so notified and advised of insufficiency.

(2) Following the filing of a completed and acceptable application, an agenda item shall be reported for submission of the application to the Head of the Department of Natural Resources (Governor and Cabinet) together with the recommendation of the Executive Director of DNR. The agenda item shall identify the project and shall list the agencies, other than the Corps of Engineers to whom written notice was required to be sent, and set forth the recommendation, if any, of each. The agenda shall be accompanied by such exhibits as in the opinion of the Executive Director of the Department of Natural Resources are necessary to a fall and fair consideration of the application.

(3) Notice of the agenda item shall be sent to the applicant, which notice shall contain:

(a) The date, time and place of the meeting at which the agenda will be considered.

(b) The number of agenda.

(c) The recommendation of the Executive Director of DNR.

(d) The advice to the applicant of his right to appear in person or by agent at the foregoing meeting.

(4) Within 10 days following final action by the Head of the Department of Natural Resources, the applicant shall be notified in writing of the action of the Executive Board. If the action is to deny the application, the notice shall so state. If the approval is subject to any conditions fixed by the Executive Board, the notice shall specify the conditions.

(5) Allocated funds for approved projects will be disbursed upon receipt of a suitable resolution from the project sponsor requesting such disbursement after approval of the Head of the Department of Natural Resources. The project funding procedures are so outlined in 16B - 23.05 and 16B - 23.06 above.

16B - 23.07 Emergencies.

Upon declaration by the Govenor that a shoreline emergency of state concern exists: for a particular county, municipality, township, or special district, the Department of Natural Resources will expedite and process, on an emergency basis, application for funds from the Erosion Control Trust Fund.

SALTWATER FISHERIES

Chapter 370, Florida Statutes

Definitions:

(1) "Department" is the Department of Natural Resources

(2) "Beaches and Shores" - is the coastal and intra-coastal shoreline of this state bordering upon the waters of the Atlantic Ocean, the Gulf of Mexico, the Straits os Florida, and any part thereof, and any other bodies of water under the jurisdiction of the State of Florida, between the mean high waterline and as far seaward as may be necessary to effectively carry out the purposes of this act.

(3) "Erosion control" beach preservation" and "hurricane protection" shall include any activity, work program, project or other things deemed necessary by the Division of Marine Resources of the Department of Natural Resources to effectively preserve, protect, restore, rehabilitate, stabilize and improve the beaches and shores of this state, as defined above.

(4) "Coastal construction" includes any work or activity which is likely to have a material physical effect on existing coastal conditions or natural shore processes.

370.013 Department of Natural Resources: general function:

The Department of Natural Resources is charged with the administration, supervision, development and conservation of the natural resources of the state.

370.017 Executive director, responsibility to Board of Trustees of Internal Improvement Trust Fund.

In addition to his duties, it is the responsibility of the executive director of the DNR to advise and make recommendations to the Board of Trustees of the Internal Improvement Trust Fund on all matters pertaining to the natural resources of the state.

370.03 Department of Natural Resources - Division of Marine Resources; Powers and Duties.

(c) 1. The Division of Marine Resources shall administer, coordinate, enforce, and carry out the powers, duties, functions, and responsibilities relating to beach and shore erosion including restoration and protection against hurricane and storm damages.

2. Processing of applications and issuing of permits prior to commencement of work for all coastal construction, physical activity, or structures pertaining thereto, except those authorized to be constructed under Chapter 253, below the main high waterline of any body of tidal water within the limits of the state, and the setting of reasonable fees and costs therefor.

(d) Specific duties of the Division of Marine Resources shall include the following:

1. To administer, coordinate, and enforce the provision of Chapter 161, Beach and Shore Preservation.

2. To conduct, direct, encourage, coordinate, and organize a continuing program of research into problems of beach erosion, shoreline deterioration and hurricane protection.

3. To prepare a comprehensive, and a long-range statewide plan for erosion control, beach preservation, and hurricane protection.

4. To review all plans and activity pertinent to erosion control, beach and hurricane protection, and to provide coordination in these fields among the various levels of government and areas of the state.

5. To make recommendations to the department concerning the use of funds in the erosion control account.

6. To insure the proper regulation of shoreline alteration and development by investigating proposed work and making recommendations to the department.

7. To promote sound planning and development of shoreline upland by devising standards and working closely with local planning and zoning bodies.

8. To coordinate erosion control, beach preservation and hurricane protection activities with waterways, harbors, water control and development projects.

9. To provide a clearing service for erosion control, beach preservation and hurricane protection matters by collecting, processing and disseminating pertinent information.

10. To assist and guide localities in the preparation and execution integrated erosion, beach preservation and hurricane protection programs.

11. To provide such other services as the department may direct.

Coceolobis uvifera commonly known as sea grapes from any public land or from any private land without consent of the owner of such land or person having lawful possession thereof. Possession of either sea oats or sea grapes by other than the owner of such land shall constitute prima facie evidence of violation of this section.

However, licensed, certified nurseryman who grow any of the native plants listed in this section from seeds or by vegetative propagation are specifically permitted to sell these commercially grown plants and shall not be in violation of this section of the law if they do so, as it is the intent of the law to preserve and encourage the growth of these native plants which are rapidly disappearing from the State.

(3) Violation of this section shall constitute a misdemeanor of the second degree, punishable as provided in S. 775.082 or S. 775.083.

370.041 Harvesting of sea oats and sea grapes prohibited; possession prima facie evidence of violation.

(1) The purpose of this section is to protect the beaches and shores of the state from erosion by preserving natural vegetative cover to bind the sand.

(2) It is unlawful for any purpose to cut, harvest, remove or eradicate any of the grass commonly known as sea oats or Uniola paniculata and

Footnotes

1. At the Skidaway Institute of Oceanography Conference on America's Eroding Shoreline, March 1981, approximately 100 of the nations leading coastal geologists prepared a position paper which was submitted to President Reagan. The following summarizes their views.

   a) People are directly responsible for the "erosion problem" by constructing buildings near the beach. For practical purposes, there is no erosion problem where there are no buildings or farms.
   b) Fixed shoreline structures (breakwaters, groins, seawalls, etc.) can be successful in prolonging the life of beach buildings. However, they almost always accelerate the natural rate of beach erosion. Resulting degradation of the beach may occur in the immediate vicinity of structures or it may occur along adjacent shorelines sometimes miles away.
   c) Most shoreline stabilization projects protect property, not beaches. The protected property belongs to few individuals relative to the number of Americans who use beaches. If left alone, beaches will always be present, even if they are moving landward.
   d) The cost of saving beach property by stabilization is very high. Often it is greater than the value of the property to be saved especially if long range costs are considered.
   e) Shoreline stabilization in the long run (10 to 100 years) usually results in severe degradation or total loss of a valuable natural resource, the open ocean beach.
   f) Historical data show that shoreline stabilization is irreversible. Once a beach has been stabilized, it will almost always remain in a stabilized state at increasing cost to the taxpayer.

   For more detailed discussion of barrier islands see:

   Leatherman, S. P. Barrier Island Handbook. National Park Serv. Cooperative Res. Unit, The Environmental Institute, Univ. of Massachusetts, Amherst, MA, 101 pp.

   Pilkey, O. H., and W. Kaufman. 1979. The Beaches Are Moving. Anchor Pr., Garden City, NY, 326 pp.

2. The dune vegetational communities of the Southeastern United States have been described by numerous authors. Oosting (see references) discussed coastal vegetation throughout the Southeastern U.S. The following works treat specific sites.

North Carolina

Au, S-F. 1974. Vegetation and Ecological Processes on Shackleford Bank, North Carolina. National Park Serv. Sci. Monogr. Ser. No. 6, U.S. Dept. Interior, Washington, DC, 86 pp.

See also Graetz (1973) in reference section.

South Carolina

Stalter, R. 1974. Vegetation in Coastal Dunes of South Carolina. Castanea 39: 95-103.

See also Graetz (1973) in reference section.

Georgia

Johnson, A. S., H. O. Hillestad, S. F. Shanholtzer, and G. F. Shanholtzer, Eds. 1974. An Ecological Survey of the Coastal Region of Georgia. Nat. Park Serv. Sci. Monogr. Ser. No. 3, U.S. Dept. Interior, Washington, DC, 233 pp.

Florida - Kurz (1942), cited in reference section, discusses the dune vegetation for the entire state.

East Coast:

Poppleton, J. E., A. G. Shrey, and H. C. Sweet. 1977. Vegetation of Central Florida's East Coast: A Checklist of the Vascular Plants. Florida Sci. 40: 362-289.

Austin, D. F., K. Coleman-Marois, and D. R. Richardson. 1977. Vegetation of Southeastern Florida. Florida Sci. 40: 331-361.

South Florida:

Davis, J. H. 1942. The Ecology of the Vegetation and Topography of the Sand Keys of Florida. Carnegia Inst. Wash. Publ. 524, pp. 113-195.

West Coast:

Cooley, G. R. 1955. The Vegetation of Sanibel Island, Lee County, Florida. Rhodora 57: 269-289.

Northeast Coast:

Carlton, J. M. 1977. A Survey of Selected Coastal Vegetation Communities of Florida. Florida Mar. Res. Publ. No. 30, Florida Dept. Nat. Res., Mar. Res. Lab., St. Petersburg, FL, 40 pp.

Alabama

Deramus, R. 1970. Studies on the Flora of the Vascular Plants of Dauphin Island, Mobile County, Alabama. Ph.D. Thesis, Univ. Alabama, 85 pp.

Mississippi

Huguley, D. and L. N. Eleuterius. 1976. A Floristic Comparison of Mainland and Barrier Island Dunes in Mississippi. Mour. Mississippi Acad. Sci. 2: 71-79.

Louisiana

Lemaire, R. J. 1961. A Preliminary Annotated Checklist of the Vascular Plants of the Chandeleur and Adjacent Islands, St. Bernard and Plaquemines Parishes, Louisiana. Proc. Louisiana Acad. Sci. 24: 116-122.

Texas

Rabalais, N. 1975. The Vegetation of Padre Island. Padre Island Nat. Seashore Information Bull. No. 2, U.S. Dept. Interior, Nat. Park Serv., 12 pp.

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Blake, C. T., W. W. Woodhouse, Jr., E. D. Seneca, and S. W. Broome. 1973. Vegetative Dune Stabilization in North Carolina. North Carolina Agr. Ext. Serv. Agronomy Information Leaflet, Beach and Dune Stabilization Series No. 1, Raleigh, NC.

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Burkhalter, J. R. 1982. An Ecological Study of Coastal Strand Vegetation on the Western End of Sant Rosa Island Near Pensacola, Florida. Draft Master's Thesis, Univ. of W. Florida, Pensacola, FL.

Dahl, B.E., B.A. Fall, A. Lahse, and S.G. Appan. 1975 Construction and Stabilization of Coastal Foredunes with Vegetation: Padre Island, Texas. Misc. Paper No. 9-75. U.S. Army Corps of Engineers Coastal Engineering Research Center, Ft. Belvoir, VA, 188 pp.

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Gares, P. A., K. F. Nordstrom, and N. P. Psuty. 1979. Coastal Dunes: Their Function, Delineation, and Management. Center for Coastal and Environmental Studies, Rutgers Univ., New Brunswick, NJ, 112 pp.

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