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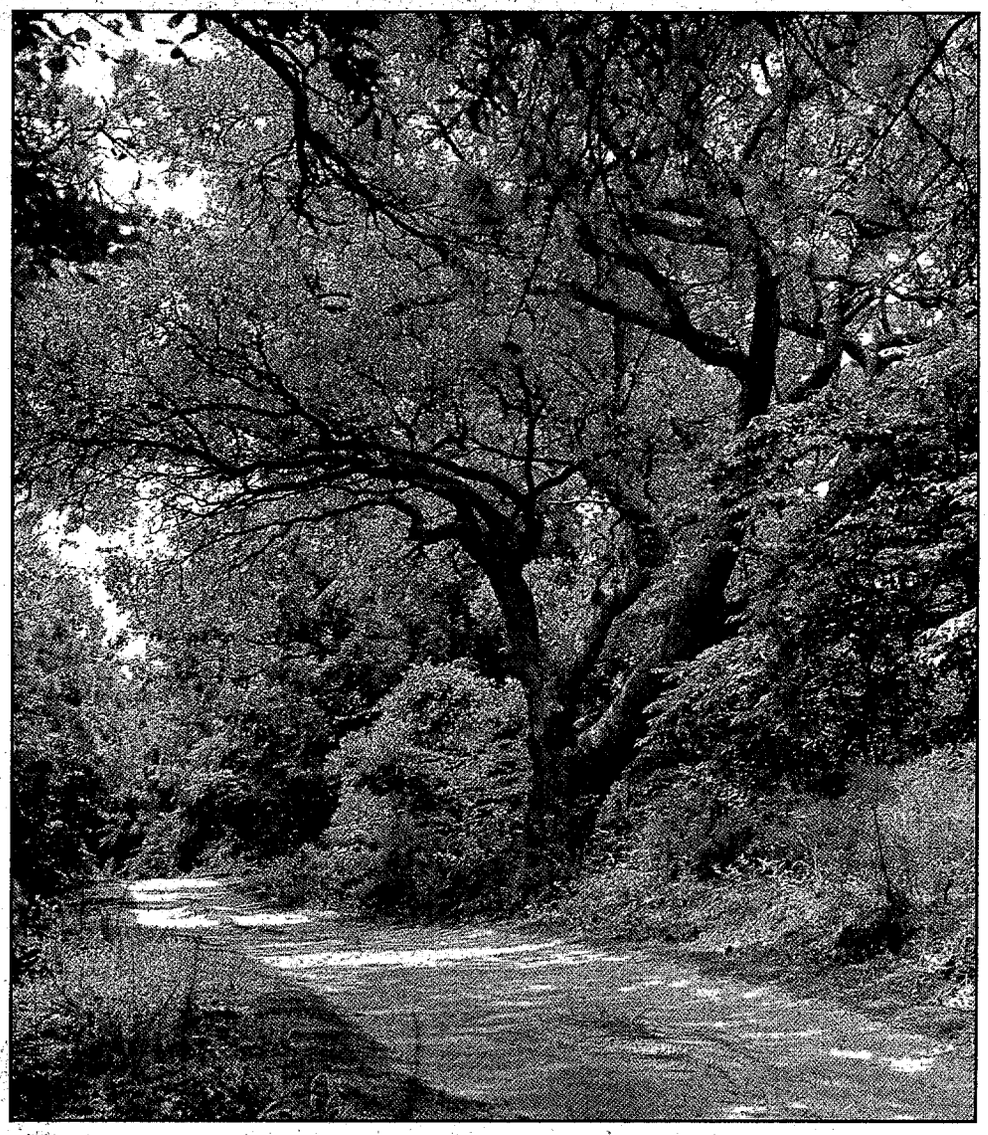
A Guide to

Protecting Maritime Forests Through Planning and Design



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A Guide to

Protecting Maritime Forests Through Planning and Design

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North Carolina Department of Environment, Health, and Natural Resources

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Introduction

The Importance of Protecting Maritime Forests

Maritime forests are a rare and highly threatened coastal resource in North Carolina. They are fragile woodlands which are able to grow and survive on some of our barrier islands and estuarine shorelines. Maritime forests are different from inland forests because of their unique adaptations to the harsh coastal environment.

Maritime forests are significant natural areas, possessing important cultural, scientific, and aesthetic values. Some of the important functions of maritime forests are island stabilization, soil production, nutrient conservation, ground water storage and storm protection. From a development standpoint, the forests are prime places to build on the barrier island. Therein lies the conflict over the use of this coastal resource.

The location of many of the oldest villages on the Outer Banks indicate that early colonists were drawn to the beauty and protection of the maritime forests. Early settlers of Old Nags Head, Ocracoke, Portsmouth, and Diamond City found homesites that were less susceptible to the frequent flooding, high winds, and harsh temperatures that were a part of island life. Abundant shell middens provide evidence of even earlier use of maritime forests by Native Americans.

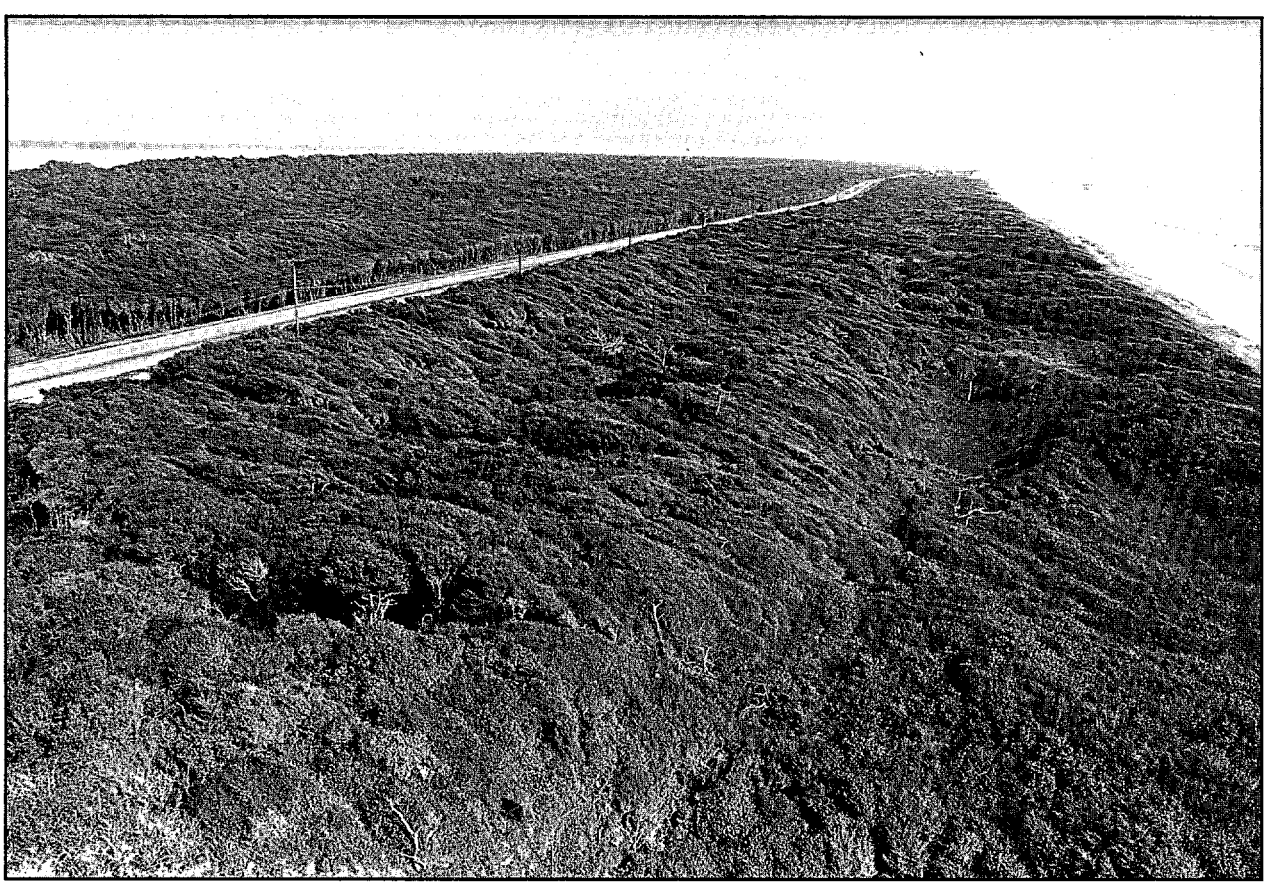
Maritime forests were not preserved by those early inhabitants. On the contrary, these areas were used extensively for hunting, logging, grazing of animals and various other needs for an expanding population. Fortunately, like most forests, maritime forests have the capacity to regenerate following human or natural disturbances provided the damage is not permanent. However, as more and more of the forests are carved up to accommodate new roads, shopping centers, condominiums and second homes, the impact is cumulative and largely irreversible.

Any level of development in a maritime forest results in a change in the natural ecosystem and the loss of important components of that system. The only way to preserve the forest as an intact ecosystem is to acquire the land and manage it as a natural area. Examples of preserved areas in North Carolina include portions of Nags Head Woods and Buxton Woods in Dare County and Shackleford Banks and Theodore Roosevelt Natural Area in Carteret County. On the other hand, carefully planned and managed development can occur while preserving some of the natural values and functions of a healthy maritime forest. The purpose of this guide is to provide information that will enable small lot owners and developers to prepare site plans which will help protect critical maritime forest resources.

A Guide to Protecting Maritime Forests Through Planning and Design was developed as part of a maritime forest protection initiative of the North Carolina Coastal Resources Commission (CRC). For over a year, the CRC explored various measures for protecting the remaining stands of maritime forest on the coast. One of those measures is educating elected officials, government representatives, land owners, developers, and the public about the importance of these resources. Through education and a better understanding of these fragile areas, each of us can do our part in protecting maritime forests.

This guide is intended for use by maritime forest land owners, developers and local planners. It explains how to identify the more fragile natural resources on a given site and provides construction guidelines that will enable you to design projects with a better understanding of the functions and values of the forest ecosystem.

We hope you will find it useful. For more information about maritime forests in North Carolina, please contact the Division of Coastal Management.



A single road through the once unbroken forest canopy along Bogue Banks.

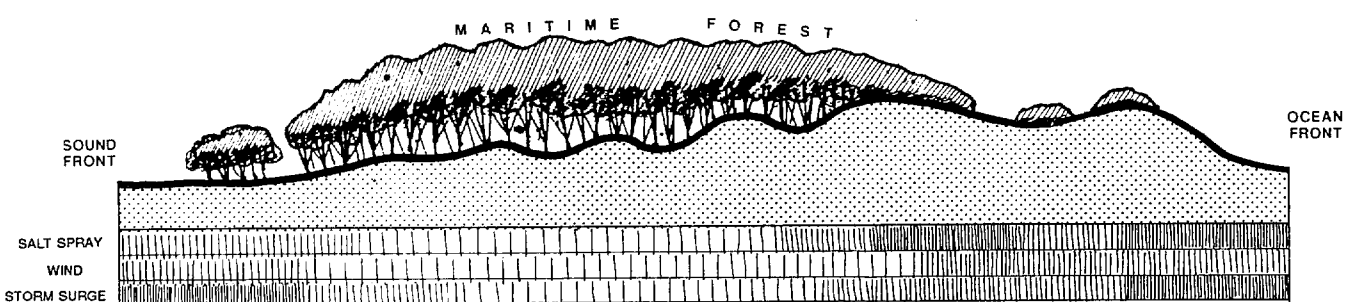
Chapter One

The Basics of Maritime Forests

Maritime forests are found in various forms along coastal environments worldwide. Although there is some debate about the precise definition of a maritime forest, in North Carolina these forests have developed under the influence of salt spray and are found on barrier islands or immediately adjacent to estuarine waters. They are dominated by oak, red cedar, holly, and pine trees and evergreen shrubs.

The structure and composition of maritime forests are controlled by natural forces: wind, salt spray intensity, and topography. The incessant salt spray from the ocean is the single most important factor. Depending on the proximity of the forest to the ocean, and the forces listed above, the maritime forest may take on several different physical forms. Closer to the beach, the forest is shielded by the foredunes and exists in a dwarf form, often less than three feet in height. The trees, shrubs, and vines are massed into a shrub thicket with tightly woven interconnected, sheared canopy.

The effects of the salt spray and wind give the forest canopy its well known windswept form. While fine sand particles carried by the wind damage the exposed leaf surfaces, magnifying the toxic effect of the salt, higher salt concentrations coincide with the growing season, damaging new growth and terminal buds. This combined interaction causes increased lateral branching toward the top of the tree or shrub and encourages elongation of branches on the protected leeward side of the plant. The canopy in this intense salt spray shear zone is a finely woven network of interlocking branches form-



	SOUNDSIDE	INTERIOR DUNE & SWALE			FOREDUNE	
	SHRUB THICKET	INTERIOR FOREST	FORESTED WETLANDS	HIGH RIDGE FOREST	SALT SHEAR	SCRUB DUNE THICKET
ECOLOGY	Wax Myrtle Yaupon Holly Intermittant low dunes and wetlands	Live Oak Loblolly Pine American Holly Stable upland forests on broader islands	Loblolly Pine Red Bay Wax Myrtle Forested freshwater wetlands in interdune swales	Live Oak Red Cedar Exposed forest on high, steep relic dunes	Yaupon Holly Live Oak Red Cedar Oceanfront forests subjected to extreme salt spray	
ECOLOGICAL FUNCTION	Storm protection Wildlife Wind buffer	Wind protection Island stabilization Climate control Nutrient cycling	Maintains water quality Shallow aquifer recharge Wildlife habitat Nutrient cycling	Deflects salt spray Storm resistance Nutrient cycling	Primary dune protection Interior forest buffer High aesthetic value	
MANAGEMENT CRITERIA	Maintain as undeveloped shrubland Clear for access only Maintain salt spray edge intact	Avoid isolationg trees Limit clearing to building and access Integrate roads with typography Limit impervious surfaces	No filling of wetlands Direct stormwater to wetlands Minimize disturbance	Avoid building on slopes over 40% Avoid ridgetop development Avoid road cuts across ridge	No disturbance of leading edge Restore with plantings when breached Minimize grading & canopy openings	

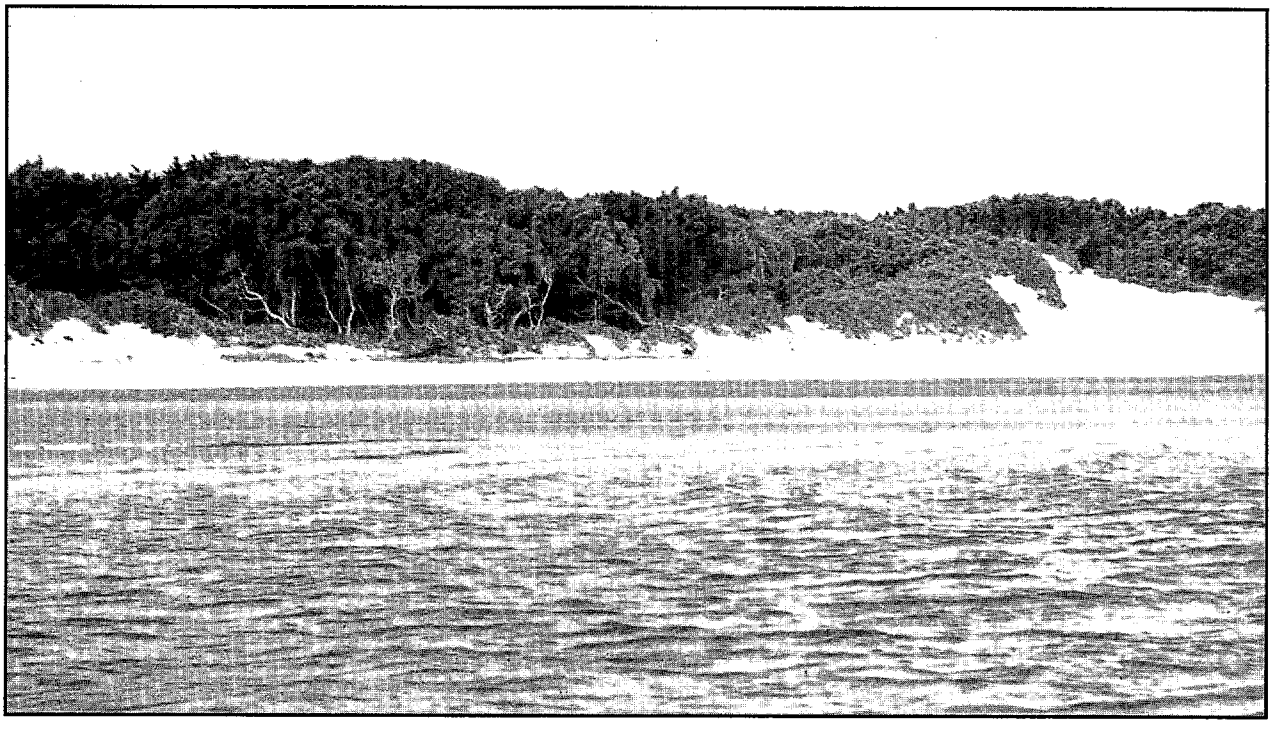
ing a common tree canopy which may extend over many acres of forest. In this way, the individual plants in the maritime forest work collectively to reduce the amount of each tree's surface area exposed to the salt spray, while protecting the understory and providing extraordinary resiliency to potentially destructive winds.

Maritime Forest Functions

The maritime forest is one of the most important coastal ecosystems. It is unique not only in its limited distribution, physical form, and species composition, but also in its functional capacity. The unusual resiliency and physical character of the maritime forest preserves its own integrity and ensures a favorable degree of environmental stability. The presence of the maritime forest also plays a significant role in the long-term maintenance and stability of North Carolina's entire barrier island system. The original settlers of Corolla, Duck, Nags Head, Buxton, Ocracoke, Portsmouth and Salter Path recognized the stability and protection provided by the forests and built their homes there.

Maritime forests perform a number of important environmental functions. The forests provide important habitat for wildlife; they protect and recharge the freshwater aquifer; they conserve groundwater by reducing evaporation; they utilize and recycle scarce nutrients in a relatively sterile environment; they bind soil, thereby gradually elevating the island; they provide hurricane protection; and they serve as a major stabilizing component of the overall barrier island system.

The long-term movement of the barrier islands as sea level slowly rises, and daily and seasonal winds and weather influence the maritime forest and any development on an island. The two main short-term forces are wind storms and hurricanes. Winds of only 10 to 15 miles per hour will move sand; moreover, winds on many islands will exceed 40 miles per hour during any month of the year. Where present, healthy and self-perpetuating maritime forests are the primary stabilizing force for shifting sands on the interior portions of the barrier island. In some cases maritime forests are being overrun and completely covered by encroaching



Maritime forests have adapted to the harsh barrier island environment.

active dunes. Typically, the maritime forest is in a delicate balance with the wind and sand, and in many cases is slowly colonizing and stabilizing previously unforested areas.

The most destructive and potentially devastating forces for barrier islands and their associated land development are severe storms and hurricanes. Maritime forests provide the only protection for development on an island during a hurricane. By absorbing the force of hurricane winds, maritime forests have proven to be the most effective protection for buildings. The reason behind this lies in the physical character of live oak and other forest species which are extremely resistant to strong winds and uprooting due to their well established root system, low center of gravity, and resilient wood. The protective features a healthy maritime forest offers for a residence on the island are incomparable, and if not properly managed, are irreplaceable.

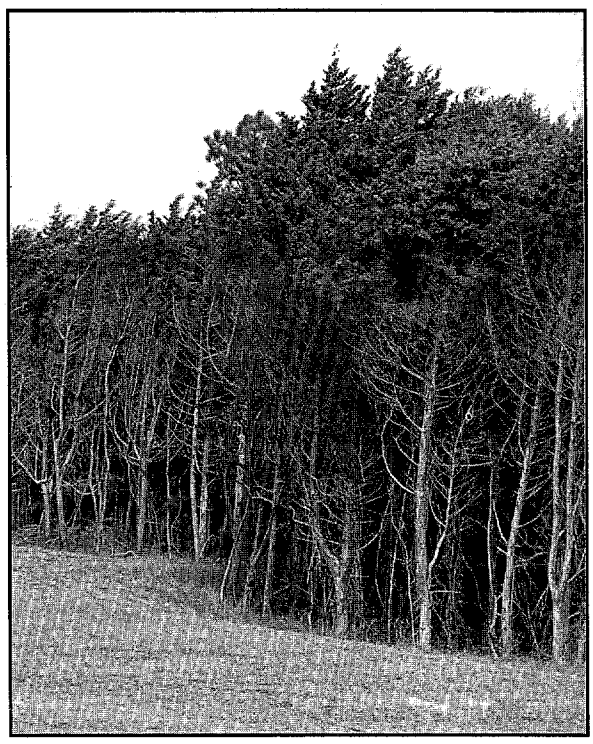
The distinct structural and functional aspects of the maritime forest which have enabled it to survive in the harsh coastal environment are precisely the features which can be used to protect associated island development. The core of any effective forest management strategy should be formed around those features which characterize a properly functioning maritime forest.

Chapter Two

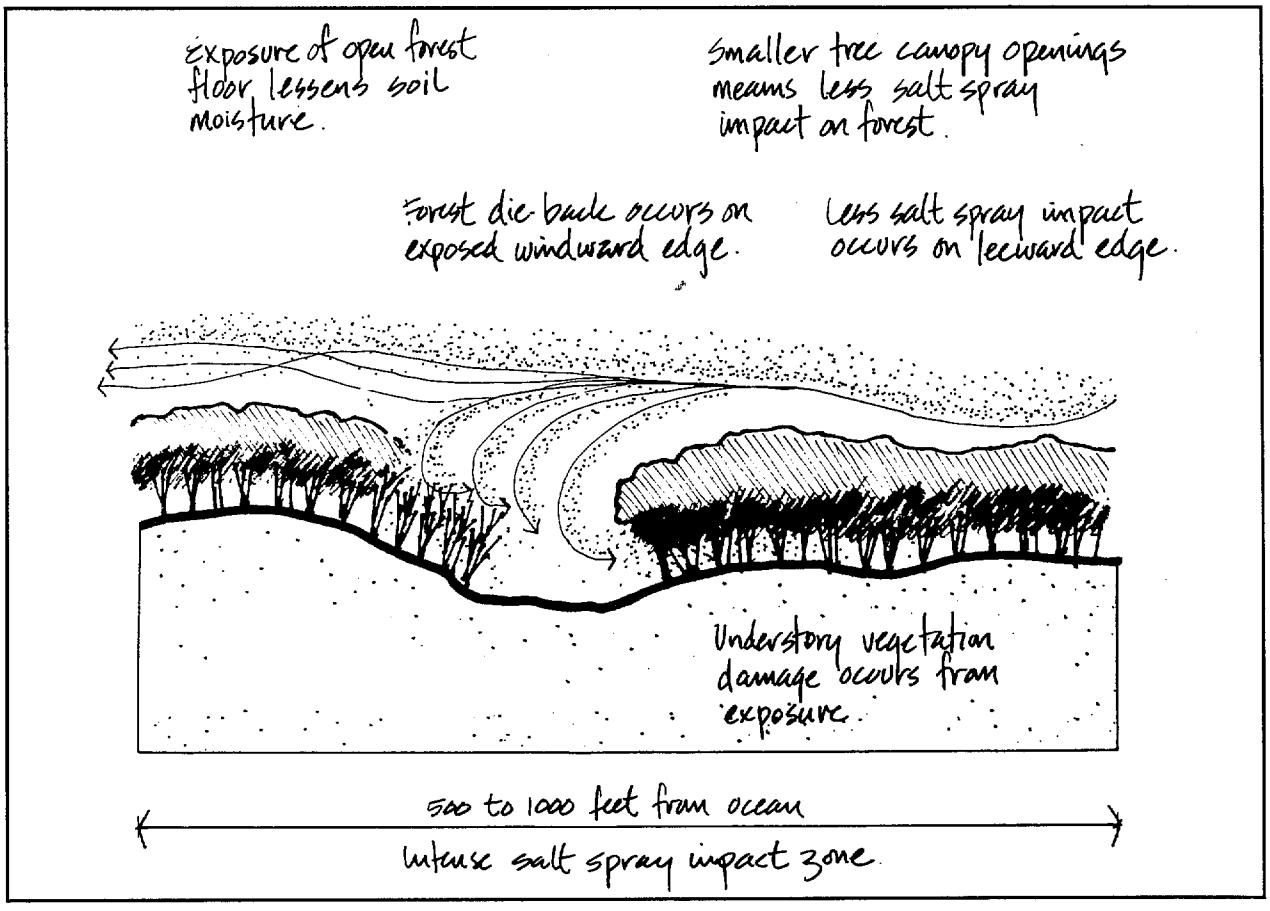
Construction in Maritime Forests

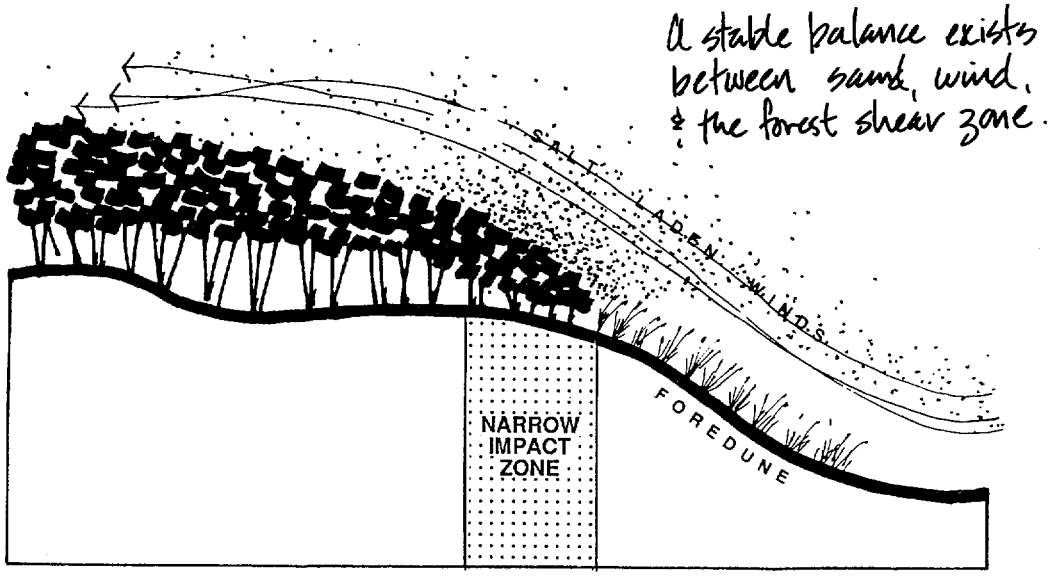
The functional and protective roles of the forest cannot be overlooked. Maritime forests generally represent the most stable sites on barrier islands and are therefore the safest and most reasonable areas in which to build.

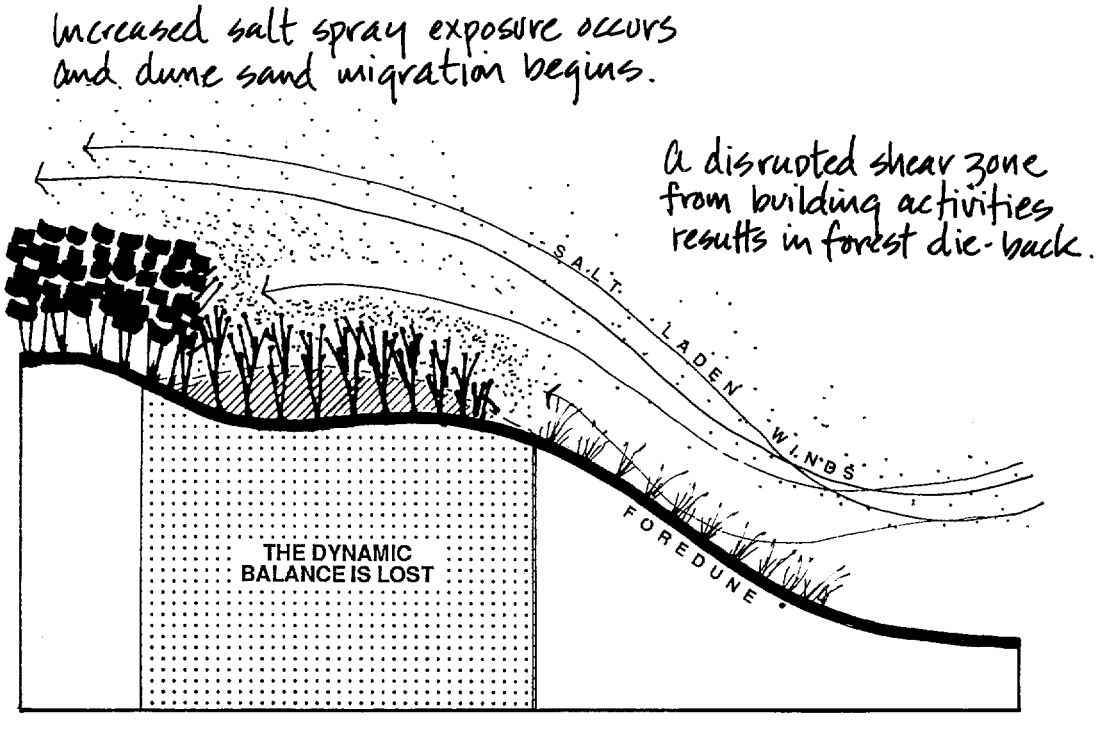
To retain their protective functions, development must follow sound management practices based on a fundamental understanding of the dynamics which control the forest's formation. Slight changes in the existing environmental conditions can disrupt the stability created by the maritime forest. Where the maritime forest has been completely cleared, an increase in salt spray exposure, and an initiation of shifting dunes is likely to occur. Clearing the forest will remove the protection it provides. Therefore, management strategies for protecting the maritime forest must be formulated around reducing the potential impact of increased salt spray, migrating sands, and saltwater intrusion.

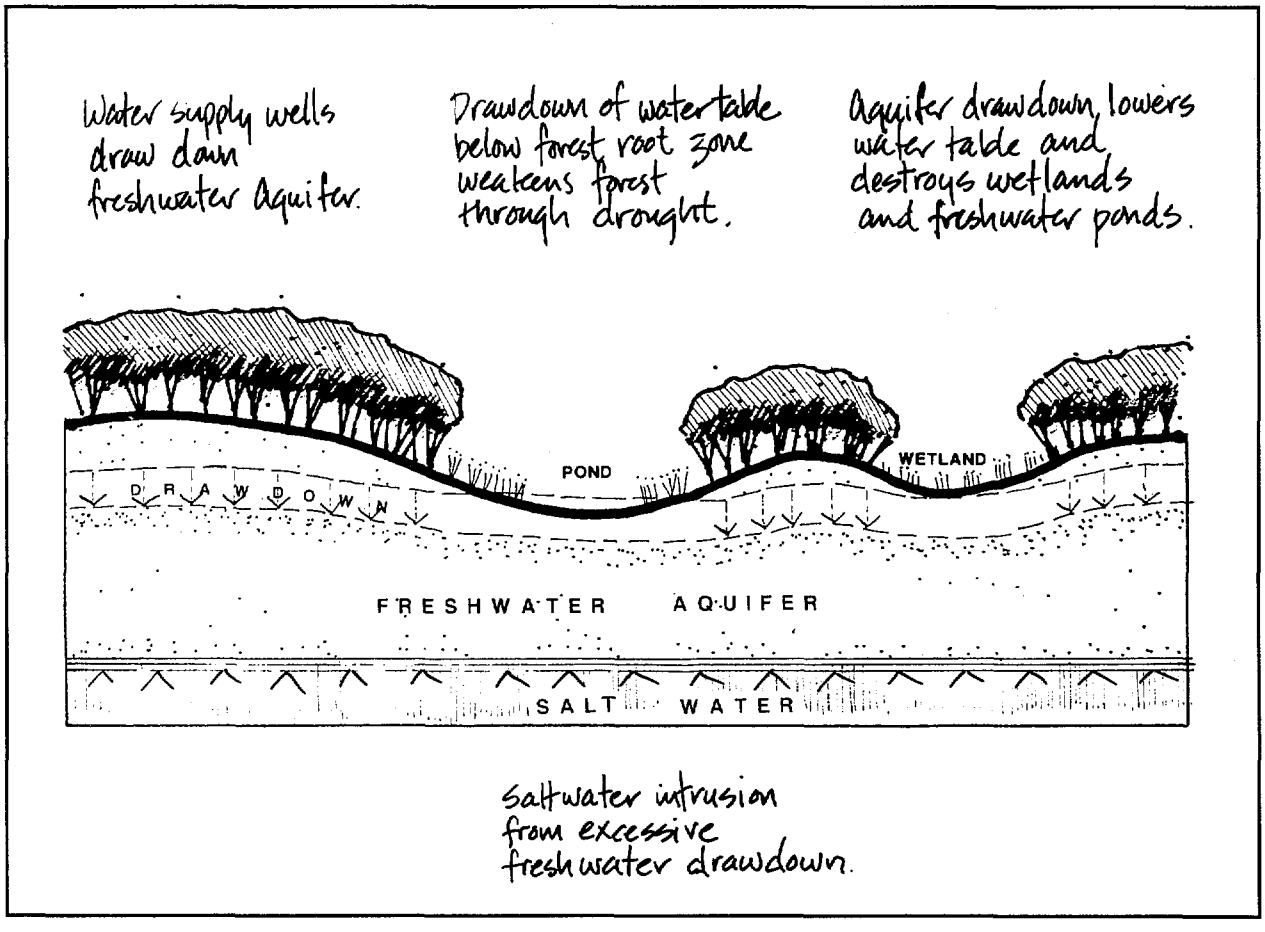


Forest die back occurs on exposed windward edge.




A stable balance exists between sand, wind, & the forest shear zone.
SALT LADEN WINDS
NARROW IMPACT ZONE
FOREDUNE


Increased salt spray exposure occurs and dune sand migration begins.
A disrupted shear zone from building activities results in forest die-back.
SALT LADEN WINDS
THE DYNAMIC BALANCE IS LOST
FOREDUNE



Two points need to be re-emphasized because they are fundamental to creating an effective management strategy for the forest. First, wind and salt spray are the overriding factors which control the structure and composition of vegetation growth in the maritime forest. Second, the forest canopy in the salt spray shear zone functions essentially as a single unit providing protection to the area beneath it and the remainder of the island in its leeward shadow.

Because of its proximity to the ocean, the maritime forest shear zone will come under more development pressure and will be most vulnerable to impacts from development activities. Development activities remove forest cover which can cause sand and dune migration, extend the influence of salt spray impact, and possibly lower the freshwater table. The depletion of nutrients has also been noted. Lowering of the water table can be partially attributed to the combined effects of development activities, including excessive pumping of groundwater, increased stormwater runoff, and increased evaporation from reduced forest cover. The maritime forest may be subjected to drought conditions as the water table drops below the root zone and may also be damaged by saltwater intrusion into the freshwater aquifer of the island. As a nutrient-sensitive ecosystem, there is some evidence that the availability of nutrients, particularly nitrogen, may be significantly diminished as a long-term effect of excessive forest removal. The extent of impact that development activities will have on maritime forests depends on the existing environmental conditions, the type and extent of the disturbance, the efforts made to protect the forest during construction, and the post-construction efforts to manage and rehabilitate the forest.

Basic Planning and Construction Guidelines

To reduce the impact of salt spray, the following basic planning and construction guidelines should be considered:

- Do not clear the understory of the residual forest. The understory provides wildlife habitat and juvenile trees for forest regeneration, and reduces salt penetration beneath the canopy.

- Leave the oceanfront forest edge intact. This will help prevent the initiation of dune migration and help reduce the risk of damaging saltwater flooding. The frontal edge is the key feature in the entire forest's canopy.

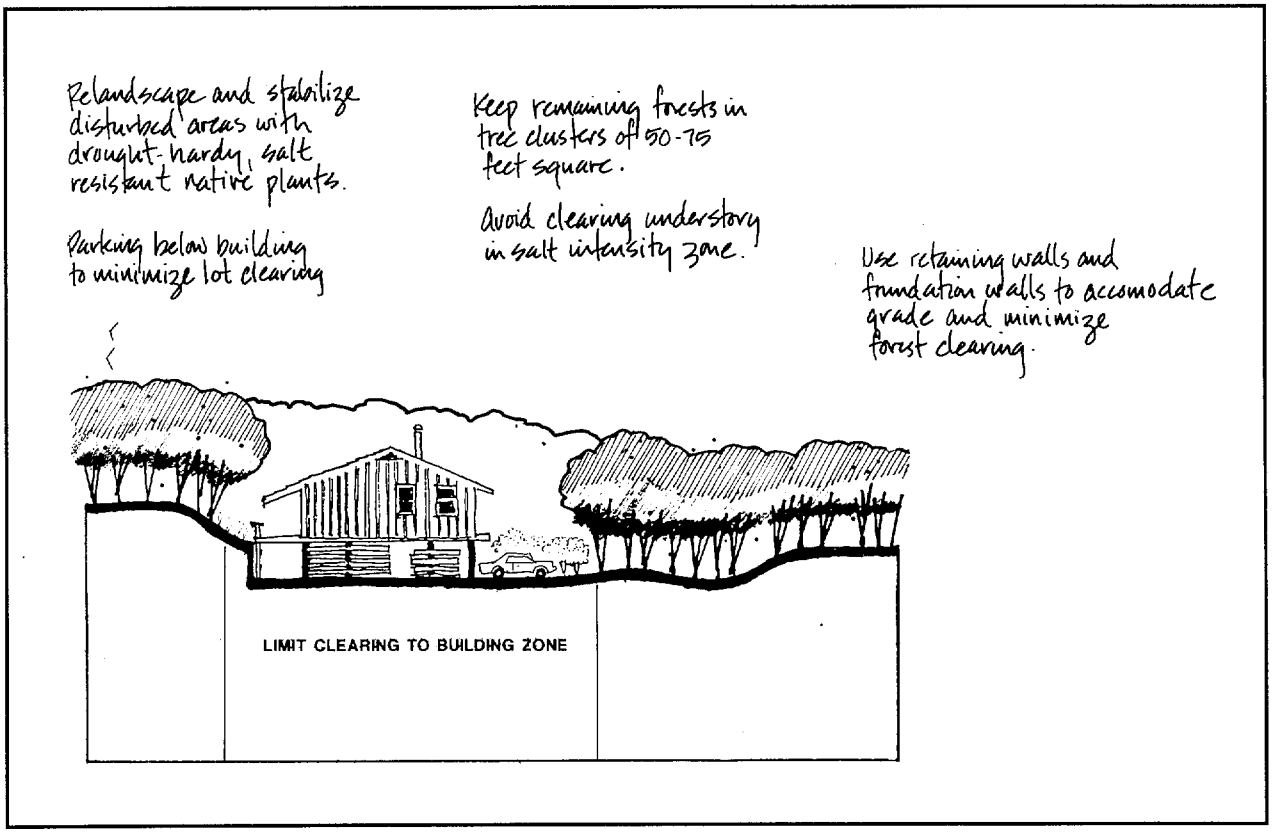
- Avoid clearing large areas of forest. Clear only as much forest vegetation as is needed for the actual construction of a building or roadway. Align roadways to follow existing contours and avoid crossing high forested ridges. Keep right of way to less than 40 feet. This will help to reduce the effects of salt spray on the newly exposed trees.

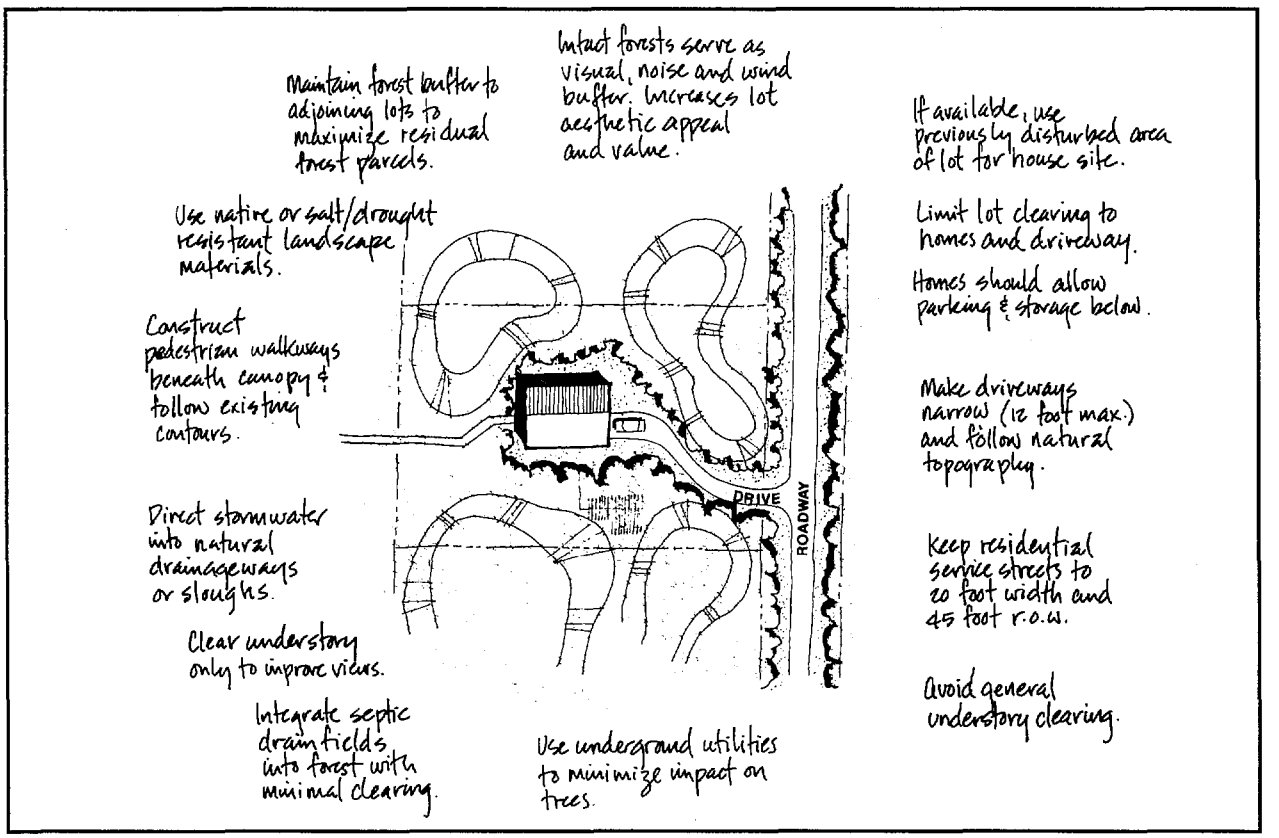
- Site buildings behind dunes and below the existing canopy line.

- In sections of residual forest, leave as large an area as possible of continuous canopy intact. Small, isolated stands will likely be eliminated in a few years.

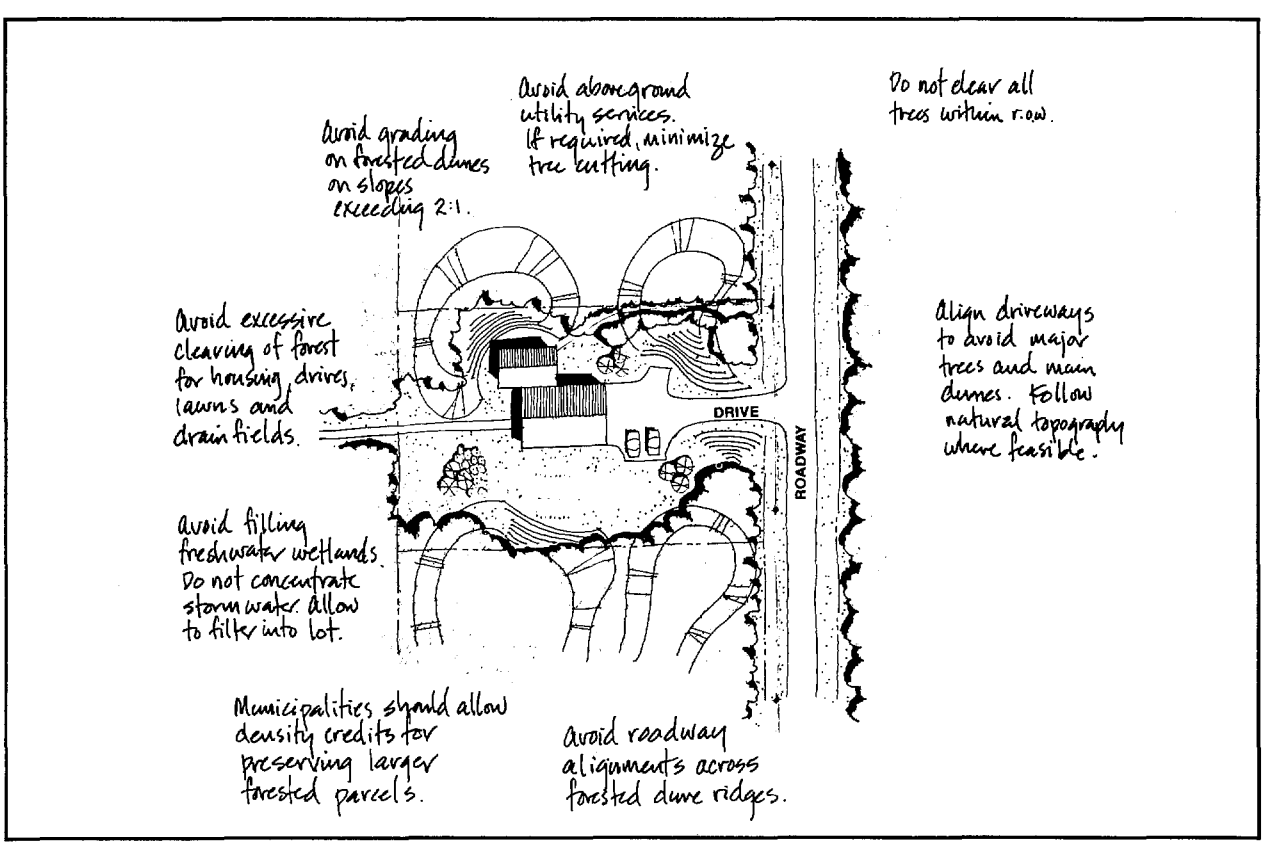
- Avoid clearing the forest during early spring and summer when new growth is particularly susceptible to salt spray damage.

- Use low pressure ground absorption septic systems. The shallow, narrow trenches used in low pressure systems can be installed with a limited amount of tree removal and canopy disturbance.





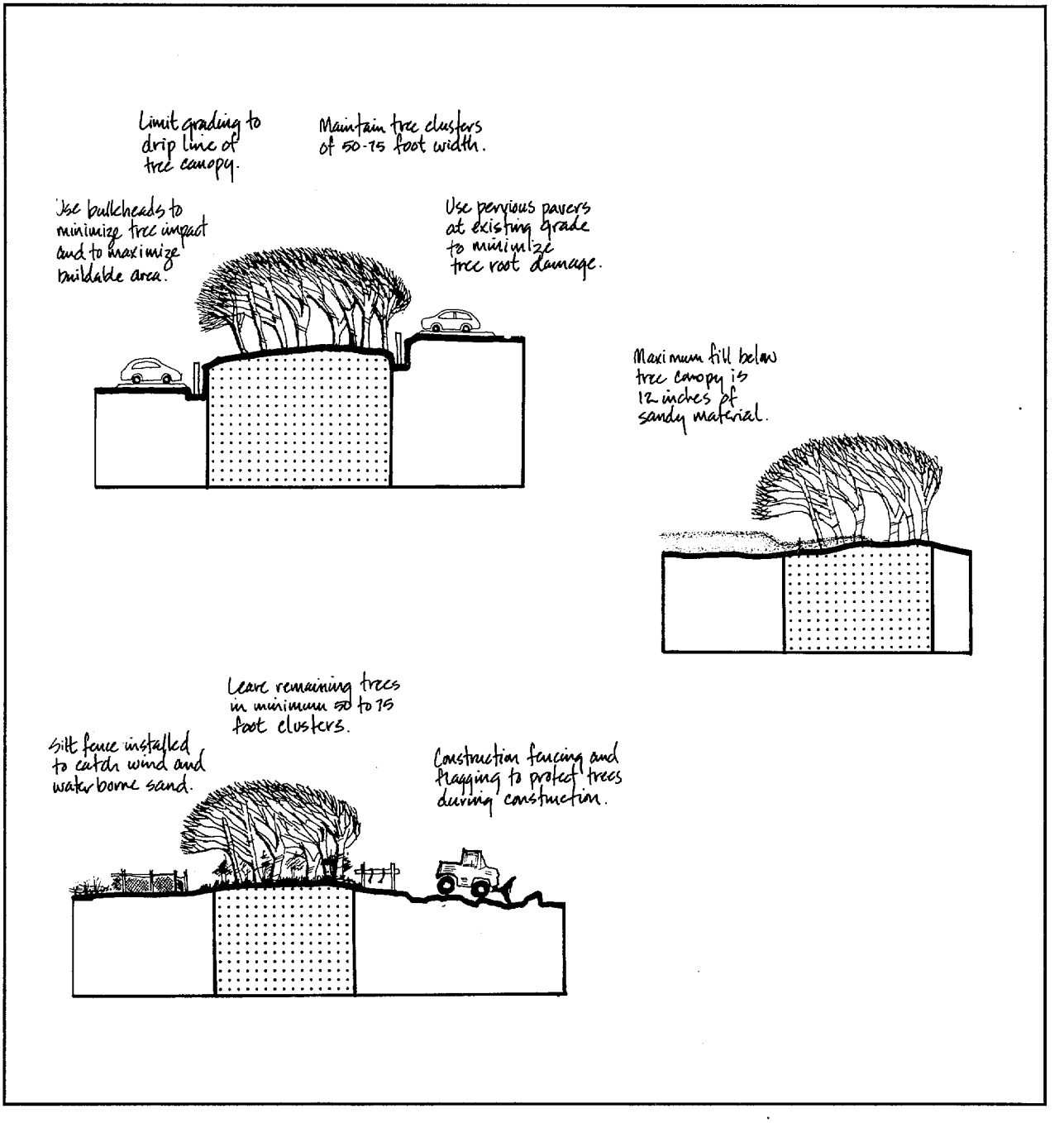
Avoid clearing large areas of forest; clear only as much vegetation necessary for construction of the home site.

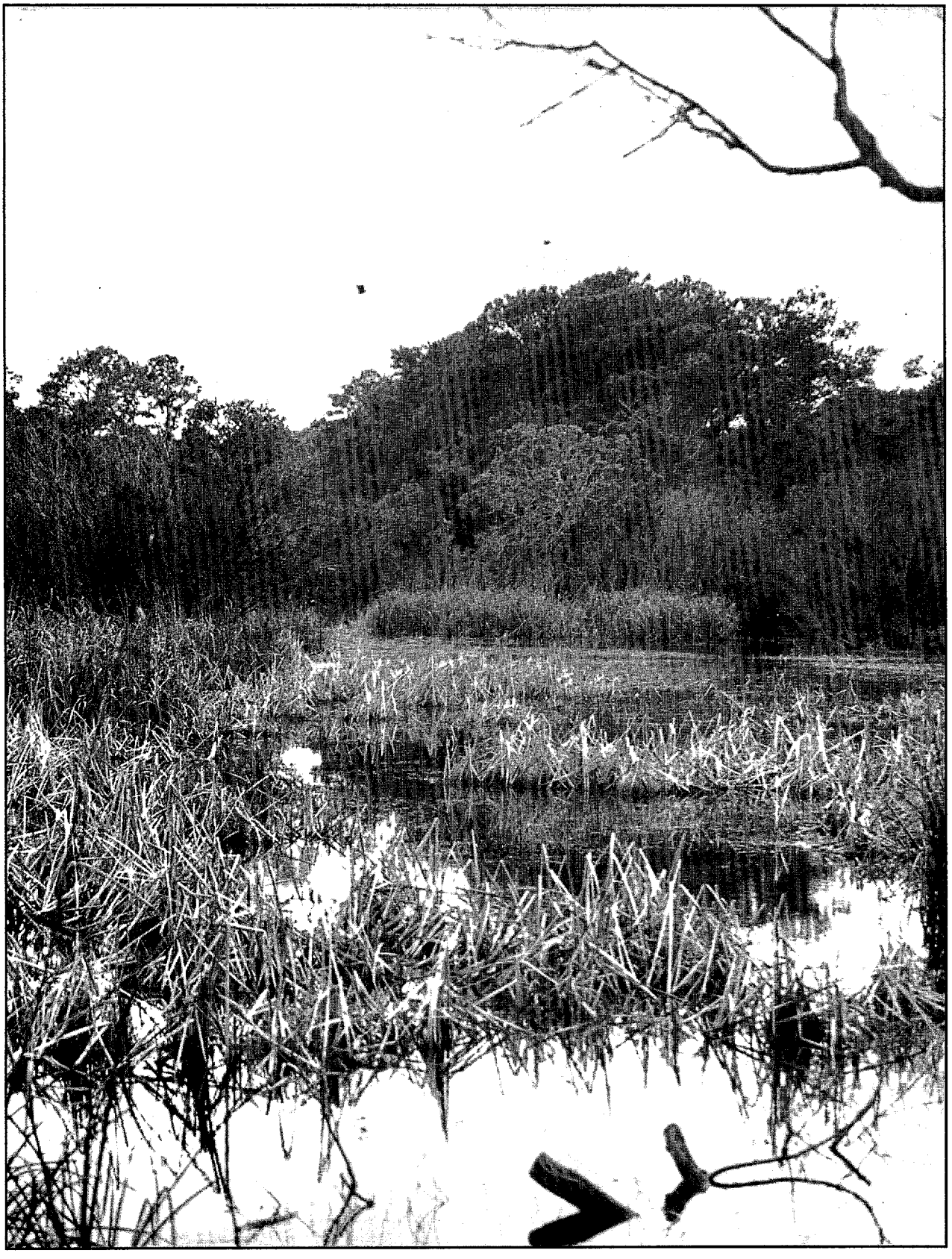


Maritime Forest Rehabilitation

To rehabilitate residual forest, the following steps should be taken:

- Place fences in front of newly exposed sections of forests which receive high levels of salt spray. Plant native shrubs and trees to help protect the forest and encourage re-establishment of the canopy angle.
- Stabilize cleared dunes or other open sandy areas with native grasses (sea oats or American beachgrass) to prevent any encroachment of shifting sand at the base of the remaining trees.
- Save individual trees and shrubs by removing damaged branches, attending to trunk scars, fertilizing and watering.





Freshwater wetlands provide excellent wildlife habitat.

Chapter Three

Land Planning for Large Scale Development in Maritime Forests

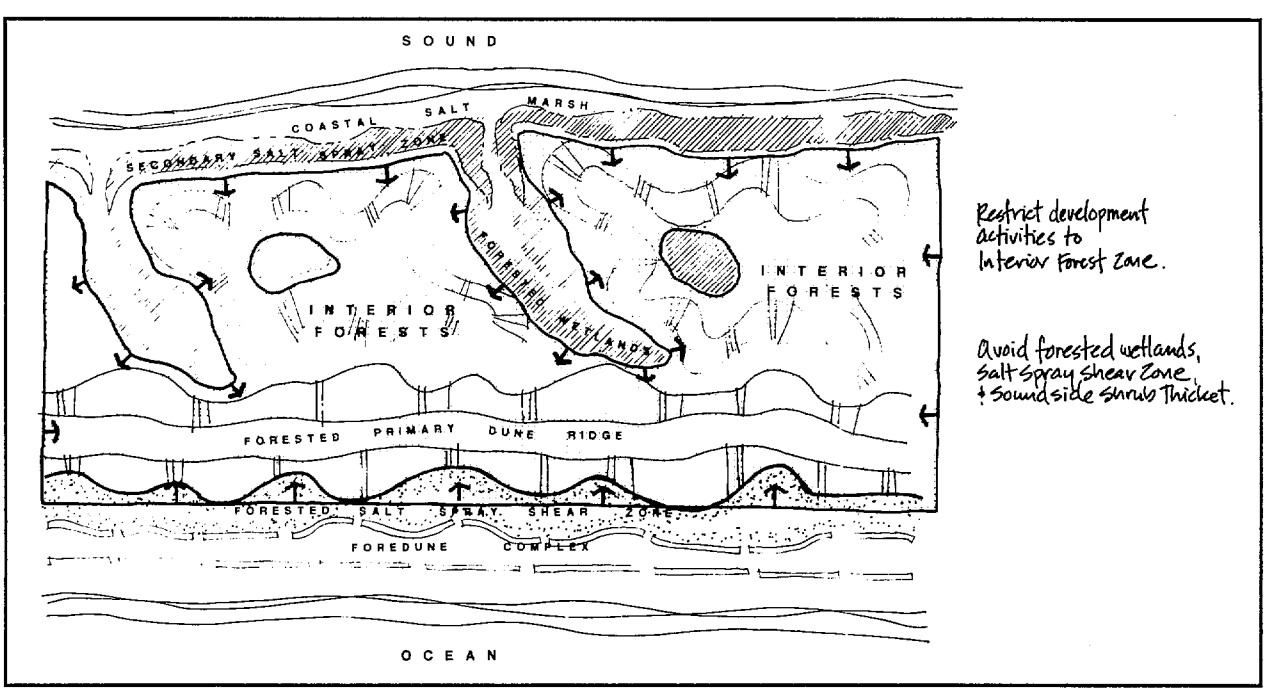
Homes which are effectively integrated into the maritime forest have significantly greater economic value than similer unforested properties. Therefore, development which preserves the integrity of the forest will result in a greater economic return.

One of the most effective planning tools available for large tracts is the cluster development concept. Clustering can protect the maritime forest because it allows a greater density of homes in less sensitive areas while leaving more sensitive areas less developed. Clustering buildings and parking areas can help keep the protective, functional, and aesthetic qualities of the forest intact. An additional advantage is reduced road construction and utility extension costs to the developer.

How to Assess a Site

Large tracts on barrier islands are often under singular ownership and are often planned as large unified residential developments. For projects ranging in size from several acres to more than one hundred acres, an overall evaluation of the maritime forest areas on the tract is necessary. Certain forest types should be avoided entirely, including the salt spray shear zone and the forested wetlands. Other forested areas, the forested dune ridge and the soundside salt spray forest, should be earmarked for very controlled development. With proper planning and construction, the interior forests can withstand more intense development.

- Locate the larger canopy trees on the site and flag them for saving.
- Determine whether there are any salt shear forest or forested wetlands on the tract and avoid building in these areas.
- Site homes and driveways to require the least amount of clearing. The forest provides an added measure of storm protection, and aesthetic and economic value.
- Make sure that home location and improvements meet local ordinance requirements for tree and forest protection.
- Survey wetlands to see if state or federal permits are necessary before construction.



General Planning Guidelines

When developing large tracts, the following general planning guidelines should be followed:

- Minimize impact on the salt shear zone. Develop more intensely in areas outside the salt shear zone, the sound side shrub thicket zone and forested wetlands. Keep forested wetlands intact as permanent open space.

- Avoid siting buildings or roadways on exposed sites at higher elevations. The impact of salt spray increases with closeness to the beach and at higher, more exposed elevations.

- Plan residential and commercial development as clustered building and parking areas.

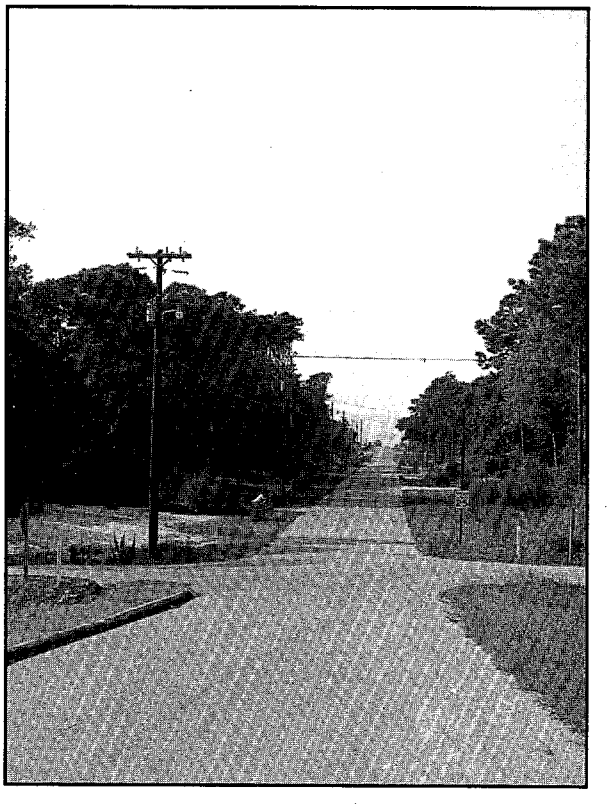
- Align roadways to follow existing contours. Avoid crossing high forested ridges.

- Major utilities should follow major roadway cuts to reduce additional forest clearing. Wastewater disposal fields should be located in non-forested areas to avoid large forest clearing and to leave more forested areas for housing.

- A higher net density cluster layout of homes allows for less forest fragmentation and greater "greenway" connections to larger preserved forest areas.

- In interior sections of remaining forest, leave as large an area as possible of continuous canopy intact, otherwise the entire group of trees may be damaged by salt spray and eliminated in a few years.

- Avoid clearing the forest during early spring when new growth is particularly susceptible to salt spray damage.



Roads should follow natural contours (left) rather than cutting the forest into a grid (right).

Specific Construction Standards

The following guidelines should be considered when developing a tract for moderate to high density attached housing:

- Limit clearing and construction within the salt shear zone to pedestrian access. Leave exposed forest edges intact.

- Use low pressure septic disposal where feasible. The shallow, narrow trenches used in low pressure systems can be installed with limited tree removal and canopy disturbance. This applies to central systems as well.

- Combine walkways (especially within the salt shear zone) to minimize forest impact. Elevate walkways above the ground but keep below the forest canopy. Keep breaks in the forest canopy to a minimum. Use hand clearing and avoid grading where possible.

- Limit residential drives to 18-foot pavement width and 40-foot right-of-way clearing. Follow existing topography.

- Use unit architecture to reduce grading of dunes. Use block foundation walls or piles to allow building to be nestled into forest. Clearing of forest next to building should not exceed 12 to 15 feet.

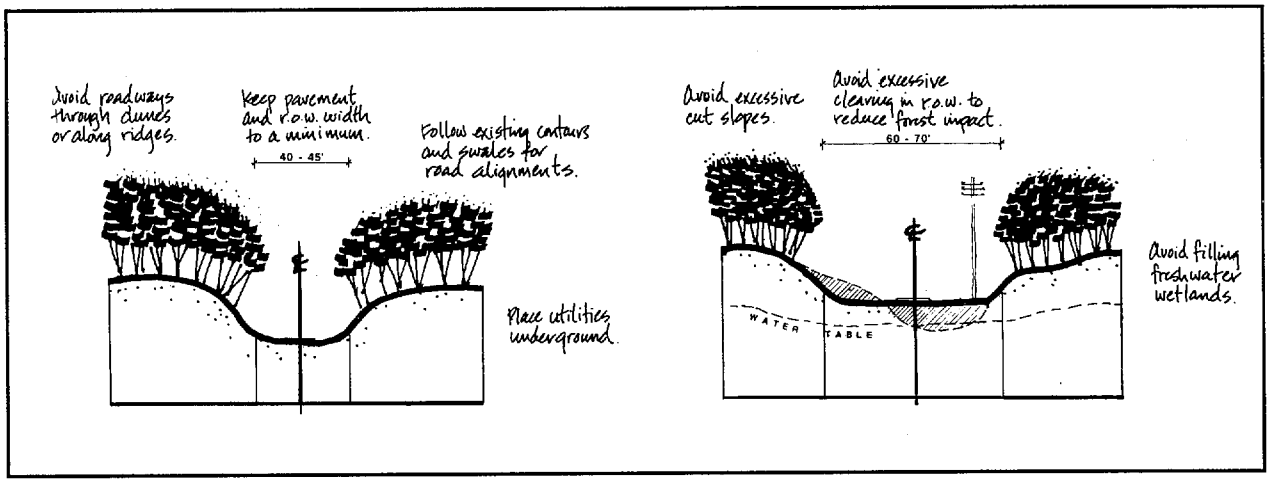
- Direct storm water run-off from rooftops and streets into low, forested areas. Leave natural drainageways intact for cost effective and low impact drainage. Use turfstone pavers or porous pavement to reduce run-off and recharge the island's shallow, freshwater aquifer.

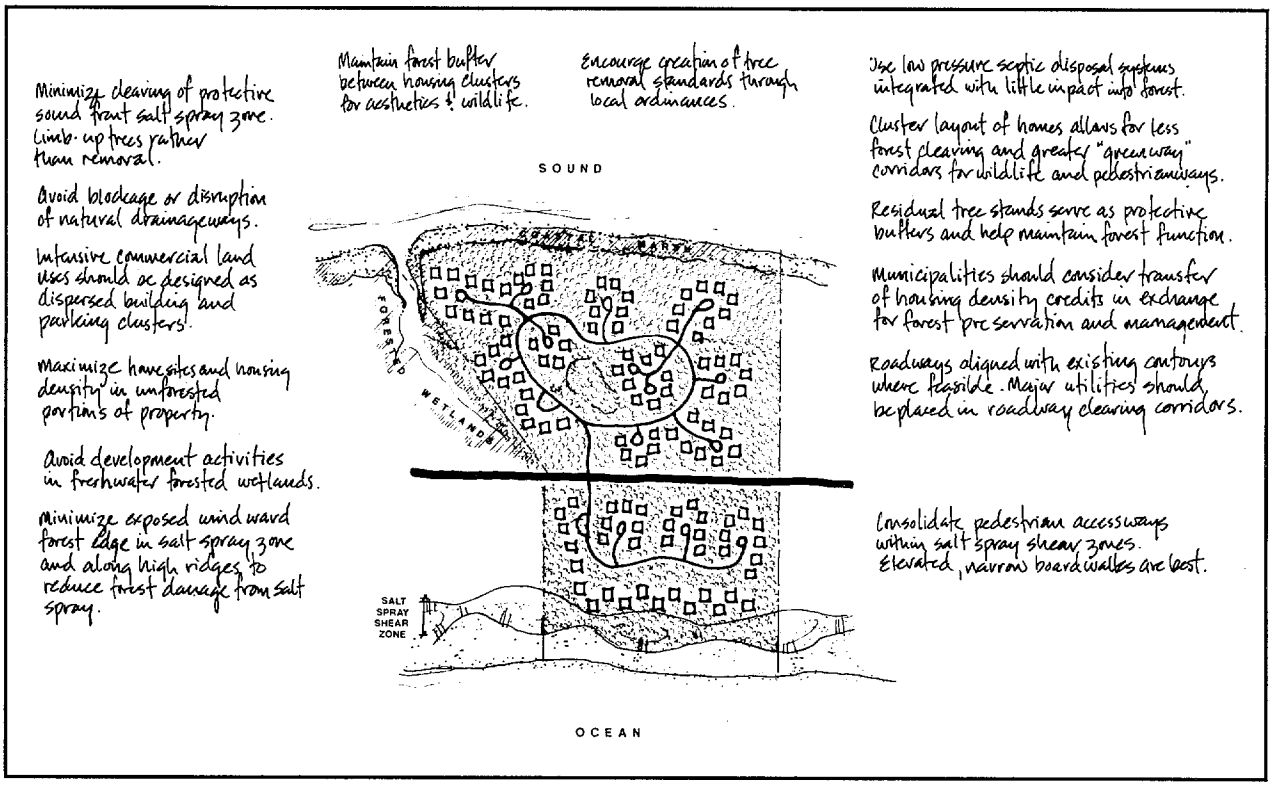
- Disperse off-street parking bays and leave forested stands or trees in between. Use turfstone around individual trees to minimize root zone destruction.

- Preserve forested stands and individual trees as buffers and project focal points.

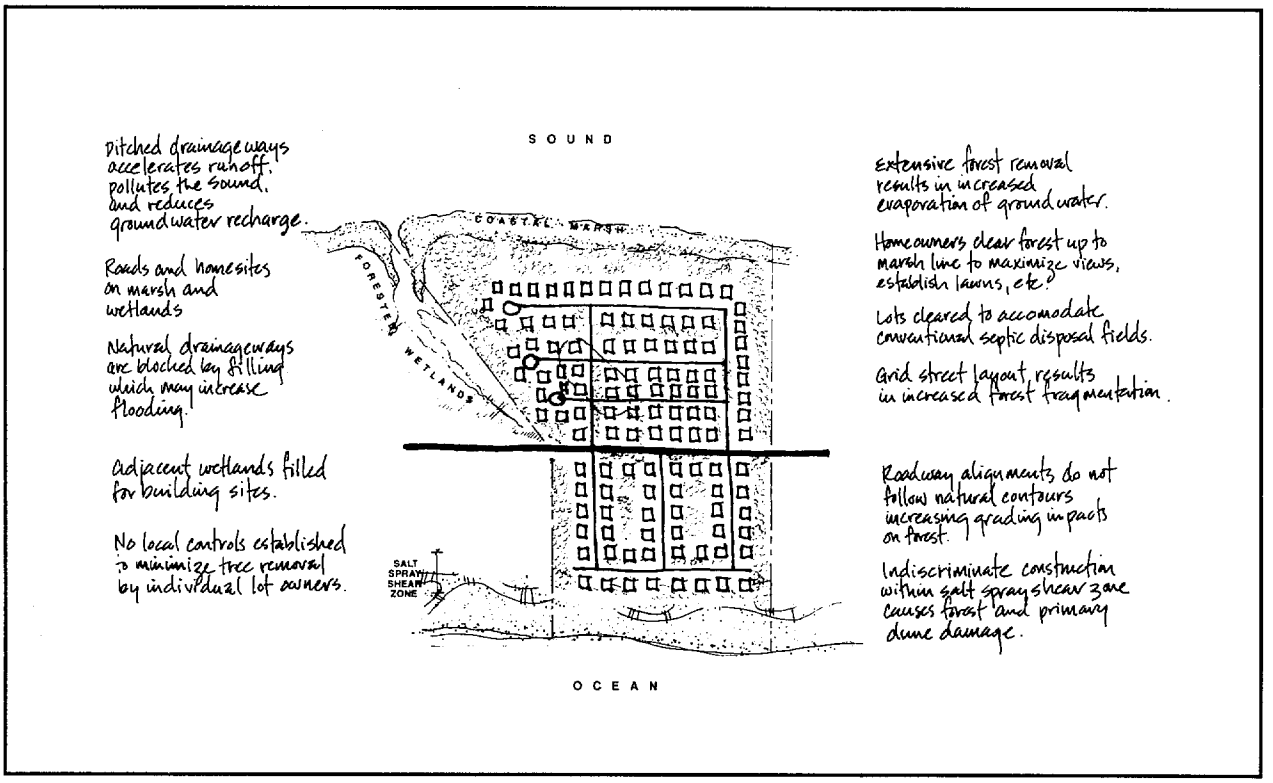
- Avoid clearing the understory of the remaining forest. The understory reduces salt penetration beneath the forest canopy and provides excellent wildlife habitat. The understory is necessary for proper forest regeneration and health.

In areas where long continuous cuts are required for roadways, salt spray fences have proven to be very effective in reducing die-back of newly exposed vegetation. However, by encouraging the growth of less salt-tolerant species behind the protective cover, re-exposure after the fence is dismantled might renew the die-back process. Some suggest allowing the exposed forest to naturally re-establish its canopy angle, a process that may be well underway after four to five years.





Cluster development leaves more of the forest intact without reducing the total number of homes.



Grid-pattern development fragments the forest causing irrepairable damage to the ecosystem.

Leaving the forest intact increases the aesthetic and economic value of the property.

Glossary

Maritime Forest Terms

active dunes - shifting, unstabilized dunes.

barrier island - an offshore elongated ridge of sand usually parallel to the mainland which separates an open body of water (usually marine) from an enclosed or partially enclosed water body (usually brackish).

canopy - the tightly woven network of interlocking tree branches that function as the "roof" of the forest. The canopy may extend over many acres of forest.

estuary - a semi-enclosed body of water where fresh water draining from the mainland mixes with salt water from the ocean.

foredunes - the first mounds of sand located landward of the ocean beach with sufficient vegetation, height and configuration to offer protection from ocean storms.

forested wetlands - areas within a forest where the water table is at or near the surface and the land is covered by shallow water at least part of the year. These areas usually contain somewhat different vegetation than the surrounding uplands and provide excellent wildlife habitat.

freshwater aquifer - an underground rock or sand formation that holds fresh water. Aquifers are the main source of coastal North Carolina's water supply.

freshwater table - the variable surface level of a groundwater body.

nutrient-sensitive - vulnerable to changes that might occur with exposure to excess nutrients, such as nitrogen and phosphorus.

primary dune - the first mound of sand located landward of the ocean beach having an elevation equal to the mean flood level for the area plus six feet.

salt spray - airborne droplets of salt water that are transported inland from the ocean or sound. May result in the death of plants or plant parts and a significant loss of vegetation cover. Airborne salt spray is the primary selective factor determining the distribution, shape, and zonation of maritime species.

saltwater intrusion - seepage of saltwater into a freshwater aquifer. In coastal areas, drawdown of the water table often allows sea water to contaminate wells.

shear zone - the seaward edge of the forest where the effects of salt spray are most severe.

shrub thicket - a dense growth of shrubs, found on stabilized dunes and protected from saltwater flooding and the most extreme salt spray.

swale - an area of lower elevation on a barrier island where the water table is at or near the ground surface.

understory - the growth of smaller trees, shrubs, vines and other vegetation below the main forest canopy; provides replacement trees for the canopy and is excellent wildlife habitat.

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State of North Carolina

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N.C. Department of Environment, Health, and Natural Resources

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