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Building and Stabilizing Coastal Dunes with Vegetation



UNC Sea Grant Publication 82-05

Credits

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Introduction

Barrier dunes are natural features that occur on seashores wherever there is a sand supply and wind to transport it. Sand is brought to the beach by wave action where it is blown landward by onshore winds. When an obstacle such as driftwood, a sand fence or vegetation is encountered, the wind velocity is reduced and sand begins to accumulate.

Plants adapted to the dune environment grow up through the sand as it accumulates, stabilizing the surfaces and promoting further accretion. Dunes formed in this manner function as flexible barriers to storm tides and waves and serve as sand reservoirs which nourish the beach during storm attack. During storms sand is often eroded from the beach and dune system and deposited as shallow sandbars offshore. In a stable beach-dune system, this sand is returned to the beach during calm weather. Thus, the nearshore un-

derwater sediments of sand, gravel and shell material, together with beach and foredunes, form a dynamic and integrated unit.

Dunes act as temporary protective barriers during storm tides of short duration, but they should not be considered permanent structures that can be expected to "hold off the ocean." Dunes are not effective against persistent day-to-day beach recession when shoreline changes are occurring. They are particularly vulnerable around inlets where shorelines are unstable (Fig. 1).

Dunes were not properly protected until recent years. Many areas were damaged by intensive use and abuse because the value of dunes and their fragile nature were not generally appreciated. One of the earliest uses of dunes was for grazing by livestock which resulted in considerable damage. Historical records of the Outer Banks indicate that they were used for cattle grazing as early as 1694. Grazing of dunes continues only in a few places,

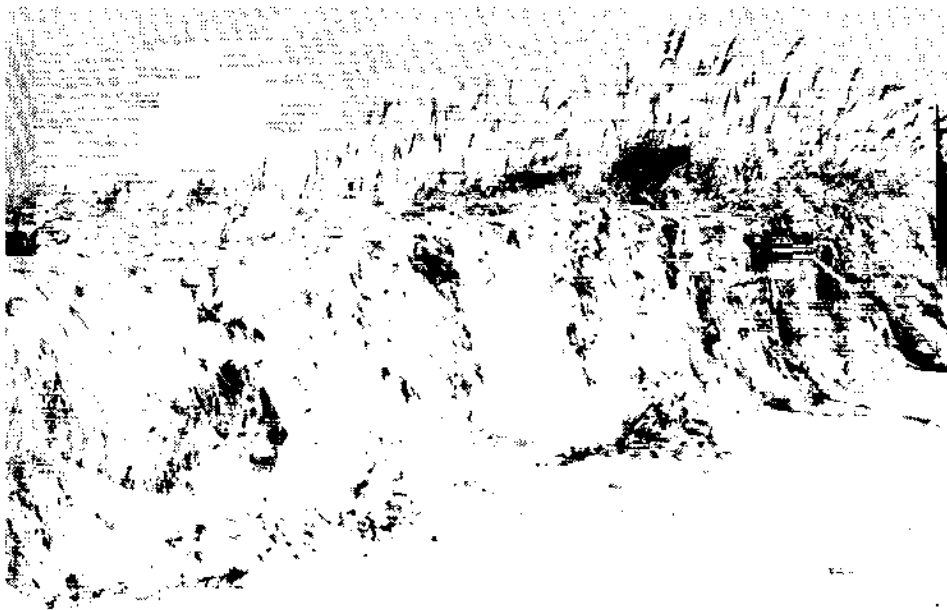


Fig. 1 The face of this dune was undercut as a nearby inlet widened. Dunes are not effective in resisting persistent beach erosion.

but human pressure such as construction, beach vehicle traffic and trampling by beachgoers is increasing, causing destruction of vegetation and deterioration of the dunes (Fig. 2). When dune vegetation is absent, there is nothing to intercept migrating sand dunes as they move inland. Large unvegetated dunes, such as those on Currituck Banks, migrate with the prevailing winds, covering roads, forests and anything else in their path. Intensive use of the beach strand increases the need to continually construct, restore, and manage dunes.

Dunes that are only slightly damaged may be repaired by transplanting bare patches, by fertilization and by protection from traffic. Where frontal dunes are absent, they may be rebuilt mechanically by bulldozing, by dredging or, preferably, by simulating the natural process of dune building by trapping blowing sand with sand fences and vegetation. Building dunes with vegetation is more economical and tends to discourage placement of the dune too close to the surf zone or in other inap-

propriate unnatural locations. A two-foot sand fence erected parallel to the surf at the point where the dune crest is desired will trap wind-blown sand and provide a good environment for the transplants (Fig. 3). If a fence is installed, it should be done several months before planting to allow filling with sand. If dune grasses are planted along newly erected or partially filled sand fences, the accumulating sand may bury the plants before they can become established.

Location of a barrier dune in relation to the surf zone is very important. Allowances should be made for normal ocean shoreline fluctuations. Vegetated dunes are effective against storm tides of short duration, but are vulnerable to undermining through beach recession and persistent wave attack. A new dune should be placed as far from the surf as practical. As the dune accumulates blowing sand, it expands seaward during storm-free periods (Fig. 4). Some severely eroding beaches along our coast do not meet these requirements for



Fig. 2 Both foot and vehicle traffic can damage dune vegetation resulting in blowouts. Strategically located crosswalks to provide access to heavily used beaches can help reduce this problem.



Fig. 3 A sand fence parallel to the surf will trap wind-blown sand and create a favorable environment for plant growth.

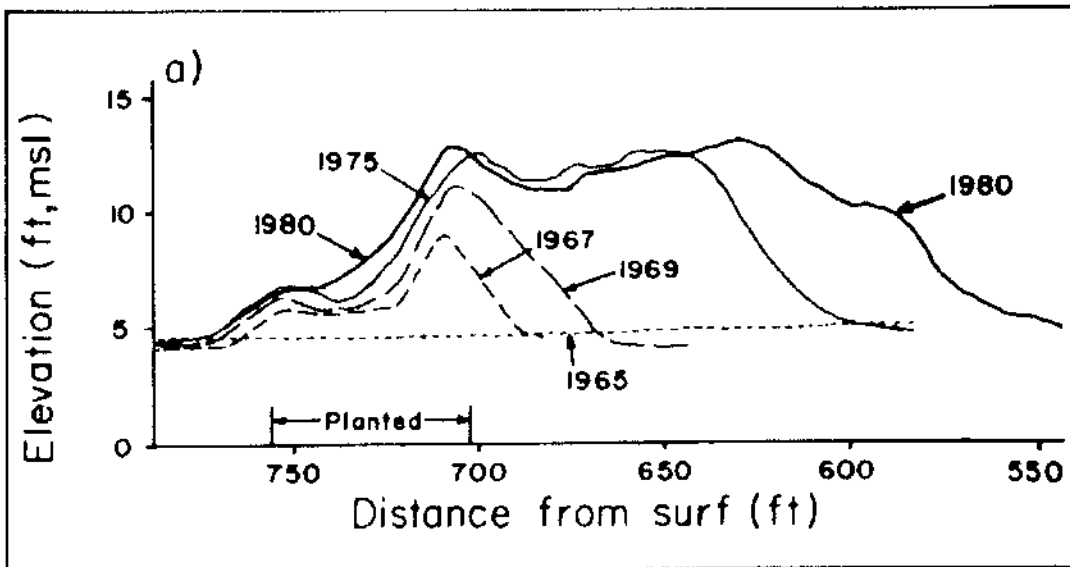


Fig. 4 Elevation transects across a transplanted dune were used to measure sand accumulation by transplanted American beachgrass.

space, and vegetated dunes cannot be established. In other areas, where there is adequate space between the ocean and property to be protected, dunes can be valuable coastal defenses. But, we must understand that dunes are fragile structures that require protection and maintenance to continue their normal function as a part of the nearshore-beach-foredune system.

Dune vegetation

Whether initiating formation of a new barrier dune or patching bare areas on an existing dune, selection of plant species is important. There are only a few species that are tolerant of the stresses of the beach environment. Plants must be able to survive sand blasting, burial by sand, salt spray, saltwater flooding, drought, heat and low nutrient supply.

The primary stabilizers of the frontal dune system along the Atlantic and Gulf coasts are perennial grasses. The North Carolina coast is a transition zone between the northern dominant,



Fig. 5b American beachgrass transplant



Fig. 5a American beachgrass (*Ammophila breviligulata*)

American beachgrass, and the southern dominant, sea oats. Bitter panicum is also an important perennial grass on frontal dunes in North Carolina.

A fourth grass, saltmeadow cordgrass, is not a true dune grass but often gives new dunes their start. It grows well in low, moist areas such as sand flats and the high salt marsh. This makes it useful for planting in areas that are poorly drained or subject to flooding where it can trap blowing sand and initiate dune growth. Saltmeadow cordgrass is more salt tolerant than the dune grasses.

A woody shrub, seashore elder, also grows well in the frontal dune environment and may be transplanted to add diversity to the dune system. This should be delayed until the dune is stabilized by grasses.

American beachgrass (*Ammophila breviligulata*)

American beachgrass (Figs. 5a and 5b) is a cool-season dune grass native to

the North, mid-Atlantic and Great Lakes coasts with North Carolina located at the southern end of its natural range. It is a vigorous, erect grass which grows in dense clumps and spreads laterally by rhizomes. This species has several characteristics that make it a good grass to transplant for dune building and stabilization. It is easy to propagate, harvest and store, and it is readily available from commercial nurseries. This grass is easy to transplant, and establishes and grows rapidly to effectively trap sand by the middle of the first growing season. The vigorous rhizomes system of American beachgrass makes it effective for filling open stands and excellent for maintenance and repair of plantings. The rhizomes spread outward 10 to 12 feet per year producing a gentle seaward slope on the dune (Fig. 6). After this grass has become established, it is capable of growing upward through up to four feet of accumulating sand in one growing season.

American beachgrass has several serious problems. It is affected by heat and drought in North Carolina and to

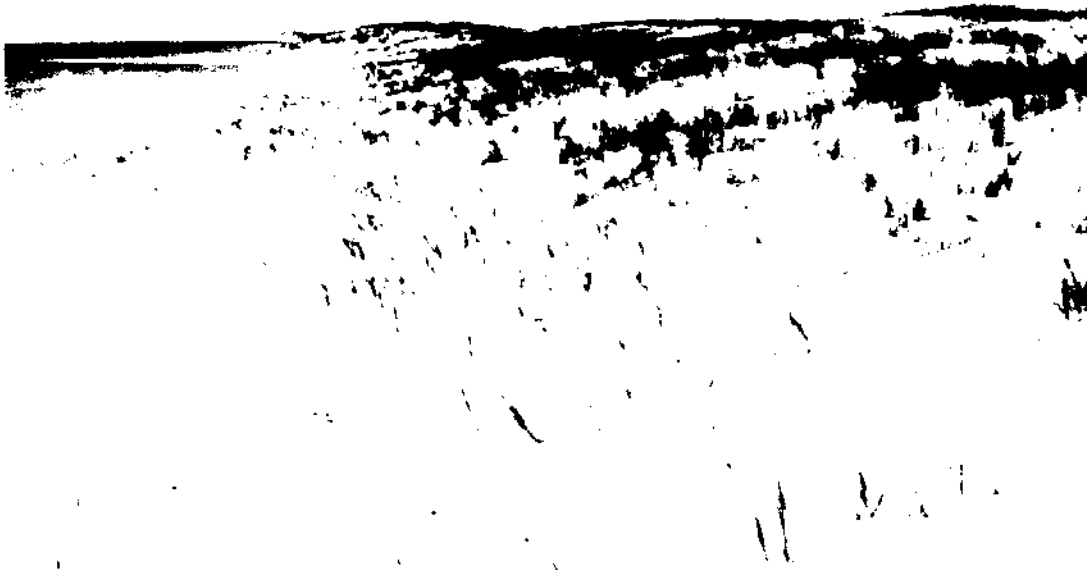


Fig. 6 American beachgrass rhizomes spreading along the seaward edge of a dune.

the south. When the sand and nutrient supply is cut off, it tends to die out and persists for only a few years behind the crest of the frontal dune. It is susceptible to a fungal disease (Marasmius blight, Fig. 7) and an insect pest known as soft scale (*Eriococcus carolinae*). Because of these problems, sea oats and bitter panicum should be included in beachgrass planting in North Carolina. Dead beachgrass patches should be transplanted with sea oats, bitter panicum or seashore elder.

Date of planting: November through March with earlier dates preferred.

Depth of planting: 8 to 10 inches.

Spacing: For repair or maintenance set hills 18 inches apart using 1 to 3 stems per hill. If stems are large and healthy, one stem per hill is sufficient. Using single stems, 1,000 plants will plant 2,250 sq. ft. on 1.5 x 1.5 ft. spacing, 4,000 sq. ft. on 2 x 2 ft. spacing and 9,000 sq. ft. on 3 x 3 ft. spacing. For dune building, a graduated pattern (Table 1) should be used that allows

sand to penetrate to the center of planting in the first two seasons, making a wider and flatter dune.

Table 1. Graduated pattern for building a foredune.

| Number of rows | Row spacing (ft.) |
|----------------|-------------------|
| 4 | 3 |
| 4 | 2 |
| 4* | 1.5 |
| 4 | 2 |
| 4 | 3 |

*Center of dune

Method of planting: Small areas and steep slopes should be planted by hand by placing single plants into individual holes made with a shovel or dibble and by firming sand around the plants. Large, flat sites can be planted more economically with tractor-drawn transplants, such as one-and-two-row tobacco transplants with planting shoes extended to make furrows 8 to 10 inches deep (Fig. 8). The transplants do



Fig. 7 American beachgrass is susceptible to a fungus disease which is characterized by a circular die-out pattern.

not need to be watered when planted. Most commercial dealers sell American beachgrass in bundles of 1,000 plants, ranging in cost from about \$35 to \$50 per 1,000. Purchase strains of beachgrass adapted to North Carolina. The Hatteras strain has been used with good results for many years and Bogue (a strain now being tested) appears to be very promising. Cape is a northern strain which should not be planted in North Carolina. It grows well initially, but declines rapidly after the first growing season.

Sea Oats (*Uniola paniculata*)

Sea oats is a warm season dune grass (Figs. 9a and 9b) ranging from the Virginia Capes southward into Mexico. It is a beautiful grass characterized by its distinctive seed heads on stems three or more feet in height. It is vigorous, drought and heat tolerant, a good sand-

trapper once established and relatively free of pests in the dune environment. Sea oats is more tolerant of reduced sand and nutrient supply than American beachgrass and persists in the back-dune area. This species has an extensive fibrous root system.

Sea oats is more difficult to propagate in nurseries than American beachgrass, and this has limited its commercial availability. It is slow to multiply and subject to pest problems when grown in nurseries away from the beach.

Sea oats transplants may be dug from existing stands. The best plants are 1- to 3-year-old seedlings, which are sometimes found in small hummocks seaward of the frontal dune. It is best to transplant as soon after digging as possible. However, plants may be kept several days by covering the roots in moist sand and wrapping with burlap or newspaper.

Sea oats transplants may also be grown from seed in a greenhouse or

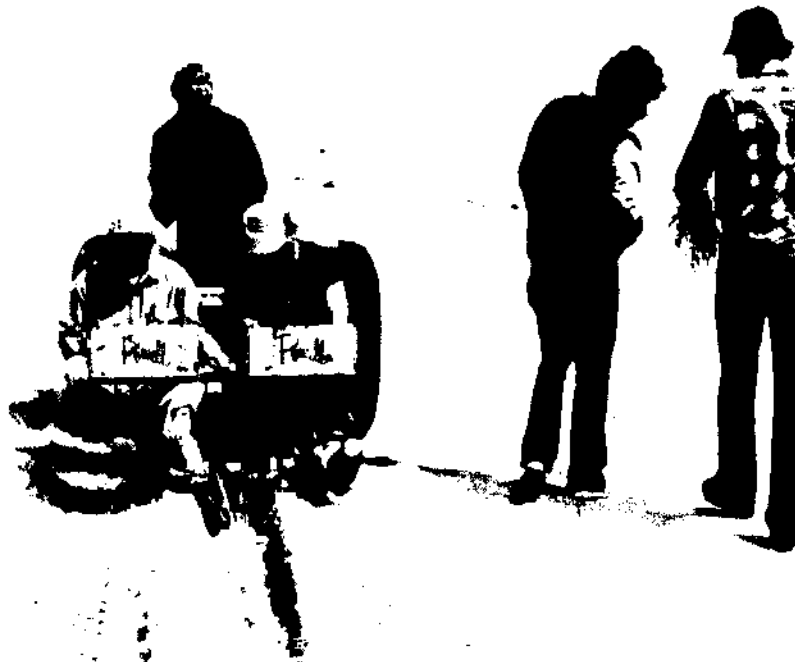


Fig. 8 A mechanical transplanter being used to plant American beachgrass. Note sand accumulation by the sand fence which was installed two months earlier (this is the same location as figure 3).

outdoors in warm weather (Fig. 10). Strip the spikelets (small compact units with scales and slender stalks) from the stems when they are mature, usually in late September through October. Store them in a cold, dry place over winter. Plant two or three spikelets in small, 2- to 4-inch pots containing a good, sterile potting soil and provide them with sun, water and fertilizer. Transfer the plants with the root ball intact to the dunes when 12 to 16 inches in height. Plant at a depth which places the root ball 2 to 3 inches below the surface of the sand. Leaves may need to be clipped if growth is excessive. Collecting plants or seed should be done only on privately owned land with permission from the landowner, not on public lands such as state and national parks.

Early growth of sea oats transplants is relatively slow. Consequently, they are not very effective as sand-trappers during the first growing season. The slow, lateral spread of rhizomes produces steep seaward dune slopes when sea oats is growing in a pure stand. It is recommended that American beachgrass and/or bitter panicum be



Fig. 9b Sea oats transplant.



Fig. 9a Sea oats (*Uniola paniculata*)

mixed with sea oats for dune building in North Carolina.

Date of planting: March through June.

Depth of planting: Take care to plant native-dug plants deep enough to keep the base of the plant moist, at least 8 to 10 inches. Pot-grown seedlings should be planted so that the top of the root ball is 2 to 3 inches below the surface of the sand.

Spacing: If a pure stand of sea oats is being planted, space hill 18 inches apart in the main area of the dune with graduated spacing extending to 3 feet apart at the edges, as with American beachgrass. Only one stem per hill is necessary.

Method of planting: Same as for American beachgrass except that more care must be taken to ensure proper depth. Sea oats alone usually require two growing seasons to fully stabilize a dune. This, and the relatively high cost of producing plants, is why interplanting with American beachgrass and/or bitter panicum, which start more rapidly, is recommended for most sites. Interplanting also cuts the risk of disease and pest infestation. Sea oats is a good

replacement for patches of dead American beachgrass.

Bitter panicum (*Panicum amarum*)

Bitter panicum is a perennial warm-season grass (Figs. 11a and 11b) ranging from the New England coast to Mexico. It is very palatable to grazing animals which may account for its scarcity on some beaches in North Carolina. It has become more widespread in recent years. Spreading must occur vegetatively through storm activity or transplanting since it apparently does not produce viable seed.

Plants grow and multiply well under nursery conditions, but it is more convenient to dig, store and transport than American beachgrass. Commercial supplies are limited, but could be expanded if demand increases. Bitter panicum is free of serious pests under both nursery and natural conditions.

There is a wide range of types of bitter panicum, from slender to large stemmed and from low growing and decumbent to tall and erect. In pure stands, the

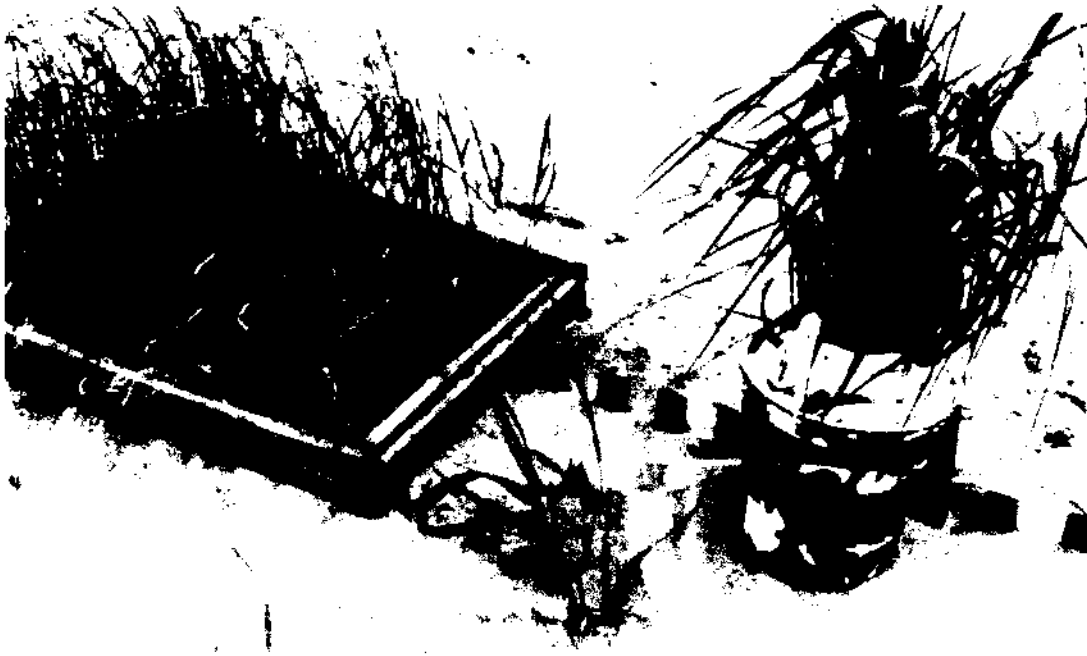


Fig. 10 Greenhouse-grown sea oats seedlings (left) and bitter panicum transplants.

decumbent types produce dune slopes steeper than American beachgrass but more gentle than sea oats. The tall, erect types produce very steep slopes. This species responds vigorously to nitrogen fertilization. Bitter panicum is useful for including in American beachgrass plantings to help assure long-term stability.

Date of planting: March through June.

Depth of planting: 6 inches.

Spacing: Same as American beachgrass when planted alone or scattered on wide spacing (2 to 4 feet) in beachgrass plantings.

Method of planting: Bitter panicum will root at every node on its stem. Place the runners in a trench and cover, leaving 6 or 8 inches sticking out of the sand. With small plants, use the same method as American beachgrass, planting 1 or 2 stems in each hill.

Saltmeadow cordgrass (*Spartina patens*)

Saltmeadow cordgrass (Figs. 12a and 12b) is useful for transplanting on low

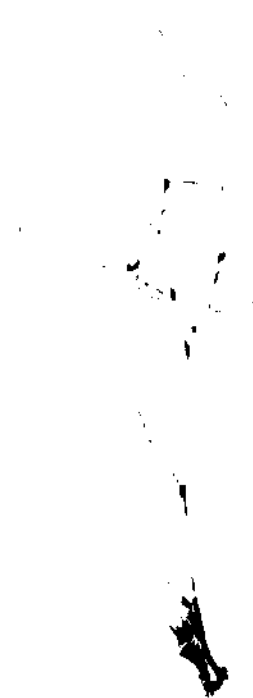


Fig. 11b Bitter panicum transplant



Fig. 11a Bitter panicum (*Panicum amarum*)

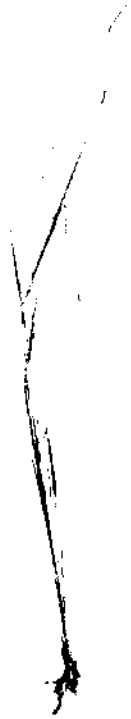


Fig. 12b Saltmeadow cordgrass transplant

areas subject to saltwater flooding. It produces many viable seeds and is often the first vegetation on moist sand flats. It can collect blowing sand, raising the elevation and creating an environment suitable for growth of the dune plants.

Saltmeadow cordgrass is easy to transplant on moist sites, but doesn't survive well when planted in dry dune sand. Plants should be dug from young, open stands where growth is vigorous. Transplants taken from thick stands usually have a low rate of survival and growth. Saltwater cordgrass responds to fertilization, but this species also persists well in moist, back-dune areas with very little attention.

Date of planting: March through May. On low flats where drying isn't a problem, you can plant through June.

Depth of planting: Take care to plant deep enough to keep the plant moist—usually 4 to 6 inches.

Spacing: Same as American beachgrass.

Method of planting: Same as American beachgrass with 1 plant of 6 to 10 stems per hill.



Fig. 12a Saltmeadow cordgrass (*Spartina patens*)

Seashore elder (*Iva imbricata*)

Seashore elder (Figs. 13a and 13b) is a low-growing woody shrub adapted to the frontal dune zone. It spreads by seeds and vegetative means. Roots develop along the stems as they are buried by sand. Although this species is not a good dune builder alone, it is a good supplement to the grasses and adds variety to the landscape. In most cases, introduction of seashore elder should be delayed until after an area has been stabilized with grass.

Plants may be obtained by rooting stem cuttings in moist sand in the same manner as most woody ornamentals. Rooted stems may also be dug from around existing plants, and seedlings may be found in the drift line in the vicinity of old plants.

Date of planting: March through June.

Depth of planting: 6 inches.

Spacing: Scattered among grasses.

Method of planting: Transplant seedlings or rooted stems by hand in the desired location. Survival is better on moist sites.



Fig. 13b Seashore elder transplant



Fig. 13a Seashore elder (*Iva imbricata*)

Choice of species

Advantages and disadvantages of each dune grass species are discussed in the individual descriptions. Which species then should one choose for dune building or repair?

It is an accepted concept of ecology that species diversity lends stability to a system. For example, if American beachgrass is the only plant species growing on a dune and a disease strikes killing the beachgrass, then wind erosion will disintegrate the dune. If disease-resistant plant species (e.g., sea oats) were present in sufficient quantities, the dune would be preserved. It follows then that striving for diverse natural dune vegetation should be the long-term management objective. However, there are practical considerations which determine species choice for initial planting.

For large scale dune plantings in North Carolina, American beachgrass has the practical advantage over other species due to its commercial availability, relatively low cost, ease of transplanting and quick establishment. It is recommended that a small percentage (10 percent) of a planting be sea oats and/or bitter panicum. For example, planting the middle row with sea oats the length of the dune would be adequate. An alternative method would be scattering sea oats or bitter panicum throughout the planting (e.g., 4 to 6 feet apart). Die-out of American beachgrass over time may leave bare spots. If these are not covered by volunteer sea oats or other vegetation, they should be transplanted with sea oats, bitter panicum or seashore elder.

For small-scale planting or dune maintenance, any of the species may be used. Sea oats seems to be the best choice in most cases since it is relatively free of pests, drought and heat tolerant, a good sand-trapper and very attractive. To patch small areas, homeowners may

thin plants from adjacent healthy stands and transplant using methods which have been described for each species. Both the transplanted patches and areas from which the plants were taken would benefit from fertilization to stimulate growth.

Fertilization

Dune sand is relatively low in plant nutrients, and dune plants are well adapted to this condition. However, dune grasses do respond markedly to fertilization. Fertilizers should not be used indiscriminately in the dune and beach area, but they are usually a necessary part of establishment and maintenance of dune grasses. This is particularly true in areas which are heavily used.

Fertilizers are useful in promoting rapid establishment of transplants by increasing their growth and sand-trapping capacity, thereby improving their chance of survival. Periodic maintenance fertilization may also be necessary to maintain vigorous stands, particularly in stable areas not receiving a fresh sand supply. Where there is sand accumulation, growth is stimulated and this is, at least in part, a nutrient effect. This can be observed on the ocean face of foredunes where American beachgrass remains particularly vigorous in the zone where wind-blown sand is accumulating. In contrast, American beachgrass tends to die out behind the crest of the foredune where the sand has been stable for some time and leaching of nutrients has occurred.

Therefore, it follows that response to fertilizer is less on areas with active sand accumulation and greater on stable back-dune areas. Sea oats is more persistent in the back-dune area than American beachgrass and less dependent on fertilization. It can exploit a large volume of soil to obtain nutrients due to its extensive root system.

When planning a dune grass fertilization program, factors which should be considered are: the objective of fertilization, the beach-dune environment and the characteristics of the plants. Growth response is primarily to nitrogen and phosphorus fertilizers. The other plant nutrients are supplied by the soil or from salt spray.

During the first growing season, fertilizer should be applied which will supply nitrogen at the rate of 150-200 lbs/acre N and phosphorus at the rate of 50/60 lbs/acre P_2O_5 . This should be split into three equal applications. Fertilizer with a ratio of 3 parts N to 1 part P_2O_5 is ideal, but many fertilizer materials can be used to supply these rates. A good choice is a combination of ammonium nitrate and concentrated superphosphate. A suggested fertilizer schedule is shown in Table 2 with rates in lbs/1000 sq. ft. Fertilizer materials used as examples in the table are a mixed fertilizer (10-10-10) and ammonium nitrate because these materials are readily available at farm and garden stores. Experience has shown that it is not necessary to use the more expensive slow-release fertilizer materials.

Fertilizer suggestions for the second and subsequent growing seasons are also presented in Table 2. Do not over-fertilize since this causes excessive growth and increases the risk of disease. Adjust fertilization to the growth and appearance of the plants. Applying excess nitrogen may also cause a pollution problem since nitrogen is very mobile in the soil and may be leached below the root zone and may contaminate the ground water.

The suggested dates of fertilization differ slightly for American beachgrass and for sea oats and bitter panicum (Table 2). This is based on the fact that American beachgrass is a cool-season grass, and its peak periods of growth are in the spring and fall. Sea oats and bitter panicum are warm-season grasses, and their major growth occurs during the warmest part of the year. In mixed plantings, which are recommended for North Carolina, use the fertilization dates suggested for American beachgrass during the first two growing seasons. In later years, fertilizing to favor sea oats and bitter panicum may be desirable.

Table 2. Suggested dune fertilization schedule for homeowners. Rates are pounds per 1,000 square feet.¹

| Date | First Year | Second Year | Subsequent years (if needed) |
|------------------------------------|-------------------------------|-------------------------------|---------------------------------|
| <u>American Beachgrass</u> | | | |
| March 15 | ---- | 10 lbs. 10-10-10 ² | 10 lbs. 10-10-10 ² |
| April 15 | 15 lbs. 10-10-10 ³ | ---- | ---- |
| June 15 | 4 lbs. ammonium nitrate | ---- | ---- |
| September 1 | 4 lbs. ammonium nitrate | 3 lbs. ammonium nitrate | ---- |
| <u>Sea Oats and Bitter Panicum</u> | | | |
| April 15 | ---- | 10 lbs. 10-10-10 ² | 10 lbs. 10-10-10 ² |
| May 1 | 15 lbs. 10-10-10 ³ | ---- | ---- |
| June 15 | 4 lbs. ammonium nitrate | ---- | ---- |
| July 1 | ---- | 3 lbs. ammonium nitrate | ---- |
| August 1 | 4 lbs. ammonium nitrate | ---- | ---- |

¹ Multiply by 43.56 to express rates in pounds per acre.

² 3.0 lbs. of ammonium nitrate plus 2.2 lbs. of concentrated superphosphate supplies an equivalent rate of N and P₂O₅.

³ 4.5 lbs. of ammonium nitrate plus 3.3 lbs. of concentrated superphosphate supplies an equivalent rate of N and P₂O₅.

Information and sources

For more information on planting dune grasses or obtaining transplants, contact the authors, Sea Grant marine advisory agents or your local Agricultural Extension office.

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Planting records and notes

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