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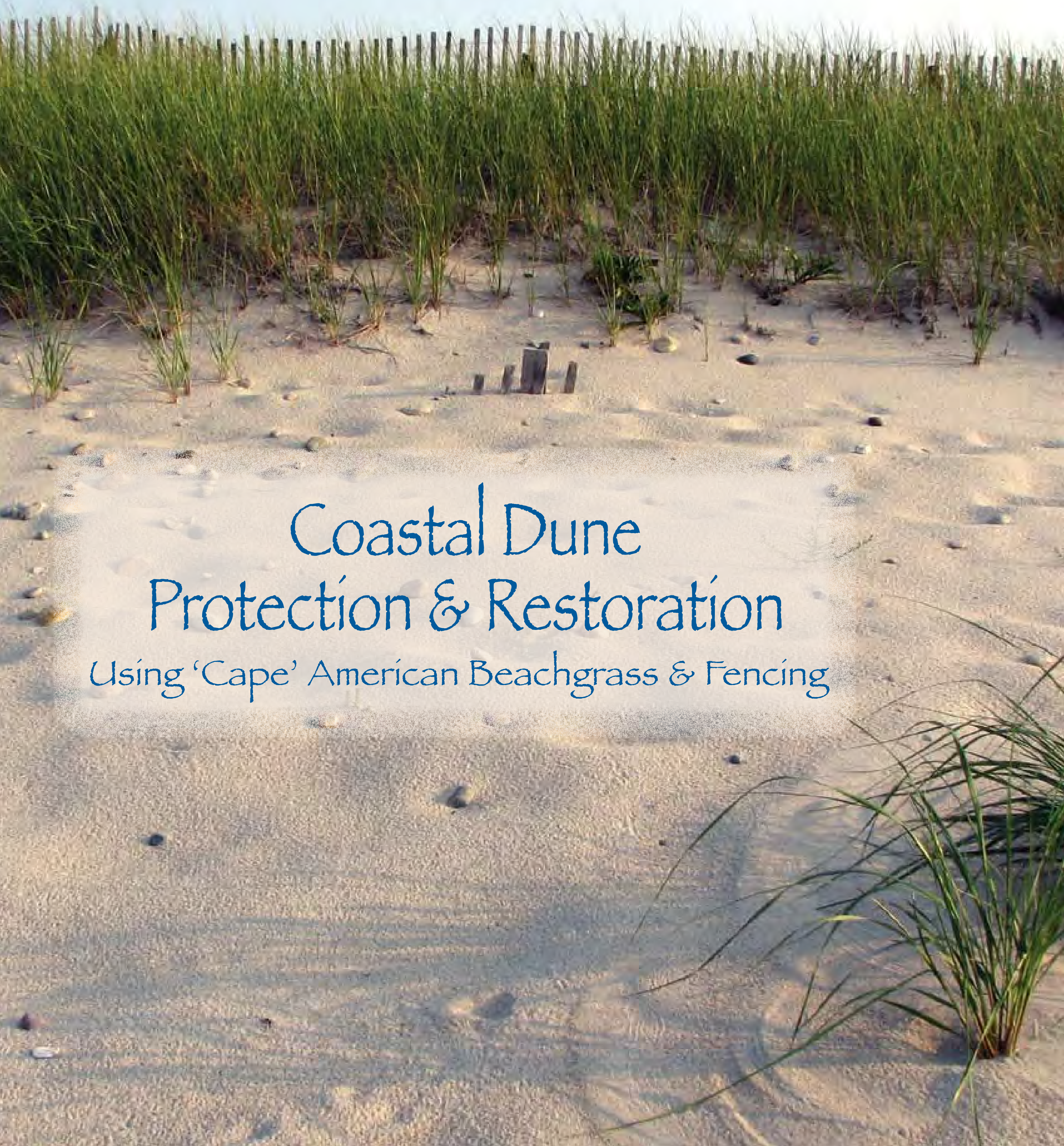
Marine Extension Bulletin
Woods Hole Sea Grant & Cape Cod Cooperative Extension



Coastal Dune Protection & Restoration

Using 'Cape' American Beachgrass & Fencing

The Origin of Cape American Beachgrass

The term 'Cape' American beachgrass, in place of simply American beachgrass, is used extensively throughout this bulletin. The USDA Soil Conservation Service (now the Natural Resources Conservation Service) tested a collection of American beachgrass which performed extremely well on sand dunes along the oceanfront. Named after its place of origin, Cape Cod, Massachusetts, it was released to the commercial market in 1971. 'Cape' is considered the industry standard and has proven to out-perform all other varieties for conservation applications from Maine to North Carolina (USDA, NRCS, 2006).

Coastal Dune Protection & Restoration

This bulletin addresses restoration of the dynamic frontal coastal sand dune system with sand fencing and 'Cape' American beachgrass. Other typical Northeast area dune plants, such as Rosa Rugosa, Bayberry, and Beach Plum occupy more stable secondary and back-dune areas (Clark and Clark, 2008).

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By Jim O'Connell

Woods Hole Sea Grant & Cape Cod Cooperative Extension

Edited by Jeffrey Brodeur, Woods Hole Sea Grant

Two Hundred Years of Planting 'Cape' American Beachgrass for Dune Stabilization

In 1714, after clearing thickly forested areas of the Province Lands for fuel, fence posts, fish weirs, and burning for croplands, colonists recognized that lack of dune vegetation created blowing sand that was threatening Provincetown and Provincetown Harbor, and they began planting beach grass and placing pine branches to stabilize the dunes (Knutson and Finkelstein, 1987.) In 1904, Massachusetts hunters introduced 'Cape Cod Grass,' brought from New England, to the Outer Banks of North Carolina. Today, sources of 'Cape' American beachgrass exist from Massachusetts to North Carolina.

Why are frontal coastal dunes so important? Coastal dunes:

- Provide landward areas by acting as a barrier to storm surge and flooding
- Provide significant wildlife habitat
- Provide a reservoir of sand that nourishes eroding beaches and feeds nearshore sand bars during storms

The beneficial functions of coastal dunes result from their ability to move and change shape and supply a reservoir of sand to the fronting beach during coastal storms. Dunes and beaches dissipate storm wave energy — minimizing effects to landward areas — in an interaction known as dynamic equilibrium.

Figure 1. Natural and artificially stabilized dunes provide protection to landward development and limit storm impacts to landward coastal resources.

Sand dunes provide unique wildlife habitat. Dunes also act as a barrier to storm surges and flooding, protecting landward development and limiting storm wave effects on landward coastal resources. During storms, coastal dunes erode and nourish fronting and downdrift beaches and nearshore sand bars. Sand bars, beaches and dunes interact within the larger coastal landform system, each exchanging sand while changing form and shape — an interaction that dissipates storm wave energy. As the storm diminishes and waves become less steep, nearshore sand bars migrate landward and weld onto the beach. Finer-grained sand is then wind-blown back into the dune area to naturally rebuild the dunes.

However, the natural dune-rebuilding process can take several years, and it may be desirable to rebuild a storm-eroded dune quicker than natural processes.

Before beginning a dunes restoration project, check with your local conservation commission. See "Permitting"on page 12.

To naturally rebuild a dune, it is important to initially determine whether there is sufficient volume of wind-blown sand available. Nearby accumulation around sand fences or the general condition of adjacent dunes can indicate availability of wind-blown sand. For example, moderately sized 3' to 8' or higher dunes in the interdune or back dune areas, with undulating sand surfaces and moderate to dense vegetation, would suggest available wind-blown sand.

If wind-blown sand is available, install sand fence and plants, based on a sketch of the area. If not, import clean sand of compatible grain size to build the dune. After the sand is shaped, sand fencing and plantings can take place.

Dune Rebuilding with Imported Sand

Through experimentation at their nearly five-mile long beach, the Duxbury Beach Reservation, Inc., in Massachusetts discovered a method to rebuild an artificial dune with imported quarry sand that is also appealing to shorebird habitat. The organization covered the quarry sand with approximately six inches of native dune sand, then planted vegetation on the natural sand veneer to create a natural appearing dune. (Figures 2-5, DBR Management Plan, 2003.)

The native dune sand was obtained from a landward, more stable, dune area land and the borrow area subsequently filled with quarry sand and recovered with native sand.

It is interesting to note that the Duxbury Beach Reservation, Inc. is now nourishing/rebuilding the backside of frontal dunes, not the eroded frontal dune scarp.

Figure 2. Building a dune with imported quarry sand (Duxbury Beach, Mass.).

Figure 3. Covering quarry sand with natural dune sand.

Figure 4. Planting the artificial dune with beachgrass.

Figure 5. Artificially built dune naturally revegetating.

Figure 6. An artificial dune 18 months after construction.

After many years of rebuilding the eroded frontal dune scarp, only to have sand erode during the next moderate storm, members realized that dune rebuilding was taking place too far seaward for protection and longevity. The dune was frequently inundated and eroded by storm wave uprush. Natural processes were suggesting a more landward location optimum for survival of the frontal dune. That optimum landward dune location is often landward of the seasonal average storm tide elevation. This elevation can generally be recognized by observing the landward toe of other frontal dunes along that section of beach.

Thus, the procedure now for rebuilding frontal dunes on Duxbury Beach following storms is to rebuild the backside of the frontal dune, not the seaward side. This approach works with landward migrating barrier beach processes.

Another example of rebuilding a frontal dune with trucked-in sand and the installation of sturdy sand drift fences can be seen in Figure 6 in Brewster, Massachusetts. Minor renourishment took place following initial construction and the dune continues to provide storm and flood protection to the landward dwellings. It should be noted, however, that this dune restoration project was on the immediate updrift side of a stone/riprap groin so the beach was wider in that particular location.

Begin dune building farthest landward from mean high water as possible.

Natural vegetated coastal dunes are found a specific distance landward of mean high water. That distance is based primarily on the landward limit and frequency of seasonal storm tides and wave inundation up the beach face, because storm tides and waves prevent vegetation from growing.

Plant vegetation at least 100 feet or greater landward of mean high water.

Less frequent storm waves at this distance allows wind-blown sand time to build dune volume and for the roots of stabilizing dune vegetation to grow. If a 100-foot buffer is not possible, begin building a dune the farthest possible distance landward from mean high water, landward of the average seasonal storm inundation area. Adjacent seaward dune vegetation generally indicates the average seasonal storm tide limits.

Sand Fences vs. 'Cape' American Beachgrass

Sand fences initially trap higher volumes of sand than 'Cape' American beachgrass alone. 'Cape' American beachgrass traps little sand during the first growing season. Once established however, 'Cape' American beachgrass traps sand at a rate comparable to multiple sand fences (Knutson, 1980).

Adding spurs to a straight sand fence, building zigzag fence configurations, or perpendicular or oblique configurations do not measurably improve long-term fence performance, and increases construction costs (Knutson, 1980; Miller, et al, 2001.)

Installing initial sand fencing or plantings too close to the sea will result in the capture of wind-blown sand at the extreme seaward portion of the beach berm, preventing the sand from reaching and building the existing eroded foredune. This will subject the new fence and plants to more frequent storm inundation and potential loss. Begin dune restoration as far landward as possible!

In experiments on Cape Cod, planted dunes produced lower and wider dunes than fence-built dunes (Knudson, 1980). Gently sloping, wider seaward-facing dunes are less prone than steep slopes to wave-induced scarping and loss of sand from storms.

Rebuilding a frontal dune

STEP 1: Draw a sketch of the dune restoration area

A sketch can be a simple drawing based on visual observations along with on-the-ground measurements of the dune restoration area made using a tape measure. A sketch could also be made on an aerial photo or satellite image. If sufficient funds are available, a survey with engineering drawings can be obtained, however, the expense may not be justified, or necessary, for smaller projects.

On the sketch, draw the locations of sand fencing and areas for planting dune vegetation, and measure the linear length of fence and numbers of culms (a culm is one single plant stem) desired, based on the plant spacing chosen (see Plant Spacing in Step 3.)

Follow this same approach for 18”, 24” or 36” on-center culm planting.

STEP 2: Install sand/snow fence in specific location.

Sand fencing is used to both capture wind-blown sand to build a dune and also to control pedestrian traffic and keep people off the fragile dune vegetation.

Posts

Install sand fence posts at or within several feet seaward of the toe of the dune scarp. If the dune is high and the seaward dune scarp is not too steep, a fence could be installed partway up the seaward dune face to add volume to the existing dune. The posts should be buried several feet into the sand to withstand occasional small wave energy—minimum depth of 4’ is optimum. Shallow posts could by dislodged easily by strong winds or waves. Posts to hold the fencing range from metal garden stakes, 2x4 posts, 4x4 posts, and 6” to 8” round timber piles. 2x4 posts should be installed with the narrow (2”) end facing seaward to minimize wind and wave effects on its stability.

Various size posts can be used. The diameter of the post depends on whether the site is located in a high energy area where the fence may be subject to wave or significant wind action, and also the amount of funds available. If it is expected that the site will be inundated by waves, larger size posts (4x4 or 6x8 round piles) should be considered with adequate depth embedment. Attach the initial sand/snow fence to the posts with 1.5” to 2” galvanized staples, attaching the fence wire to the post, or nail the fence slat directly to the post.

Figure 7. Ted Keon, Director of Coastal Resources for Chatham, Mass., uses a shovel for larger size holes for 6x8 poles while project manager Tim Friary looks on.

Figure 8. Using an excavator to dig larger size holes for 6"to 8" poles, Duxbury Beach, Mass.

Figure 9. Fence arrives on Duxbury Beach, Mass. in 50' rolls.

Figure 10. Installing 6" piles for a double row of slat style fence.

Figure 11. Fence is laid-out.

Figure 12. Fence is attached to 6" diameter posts.

Figure 13. Experienced sand fence installers Joe Grady and Dick Sjostedt attach fencing to posts. The snow fence is being held taut by a crow bar while a 2" galvanized staple is hammered into the post loosely attaching the snow fence 'wire' to the post.

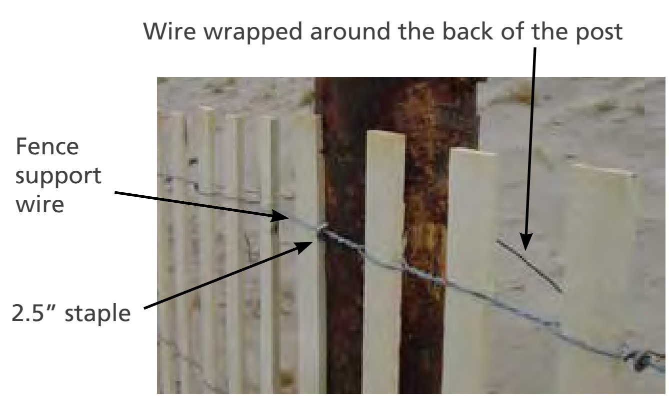


Figure 14. A wire is wrapped around the back of the post and is attached to the sand fence wire approximately 8" to either side. This adds support to the fence under strong wind conditions. A loose attachment allows the fence wire to slide and move to prevent breakage as wind shakes the fence.

Sand Fence Varieties

There are a variety of sand fence materials including wood, plastic, polyethylene, and metal. There are also many varieties and sizes of sand fencing, from the typical slat-type sand/snow fencing (Figure 15), to 2x3 vertical and horizontal fence members.

Regardless of sand fence slat size, a 50-50 ratio of open space to slats spacing between vertical members appears to perform similarly in terms of sand volume capture. Larger sizing of slats or posts (i.e. 2x3 slats and 6" posts), or having two parallel fence rows may withstand small wave action, but adds to overall expense.

Figure 15. Sand/snow fence held to 2x4 posts with tie-wraps, an alternate method of installation.

Begin dune building and planting as far landward as possible, as installing initial sand fencing or plantings too far seaward will:

- Capture wind-blown sand at that more seaward location on the beach berm and prevent that sand from reaching and building the existing eroded foredune leaving it vulnerable
- Subject the new, more seaward fence and plants to more frequent storm inundation and potential loss

Begin landward and over time build the existing foredune seaward in incremental steps. As one sand fence fills approximately two-thirds high, install another fence slightly seaward on the newly deposited sand (Figure 16).

Optional second initial fence

In addition to one sand fence placed at, or several feet seaward, of the existing dune scarp, a second sand fence could be installed one half to two-thirds up an un-vegetated foredune slope or dune scarp. Depending on the dune slope and size, and ability to install a fence up the dune slope, a second fence may expedite sand accumulation on larger dunes.

Dune building with sand fences in overwash areas

An overwash occurs when storm waves overtop the beach berm and generally break through and flatten dunes. The storm wave uprush does not return to sea but continues landward and deposits sand in a flat, fan-shaped deposit. Overwash areas in Massachusetts are often prime piping plover or tern habitat which are rigorously protected by law in Massachusetts. Before conducting any activity in an overwash area, check with your local conservation commission.

If dunes have completely eroded, significantly lowered in elevation, and/or overwashed, dune rebuilding should begin approximately mid-way into the overwash fan by installing the first sand fence, in association with planting rows of 'Cape' American beachgrass (detailed in the next section). When the first sand fence fills approximately two-thirds high, install another fence at the rebuilt seaward dune toe. Continue progressively building the dune seaward by adding sand fence 'lifts' (Figure 16).

Dunes generally grow towards the direction of maximum sand source. In Massachusetts, if a source is available, sand will be blown from the prevailing north-northwest direction in winter, and south-southwest direction in summer. Predominant east-northeast winter storms will move sand during brief winter storms. Because dune restoration generally takes place

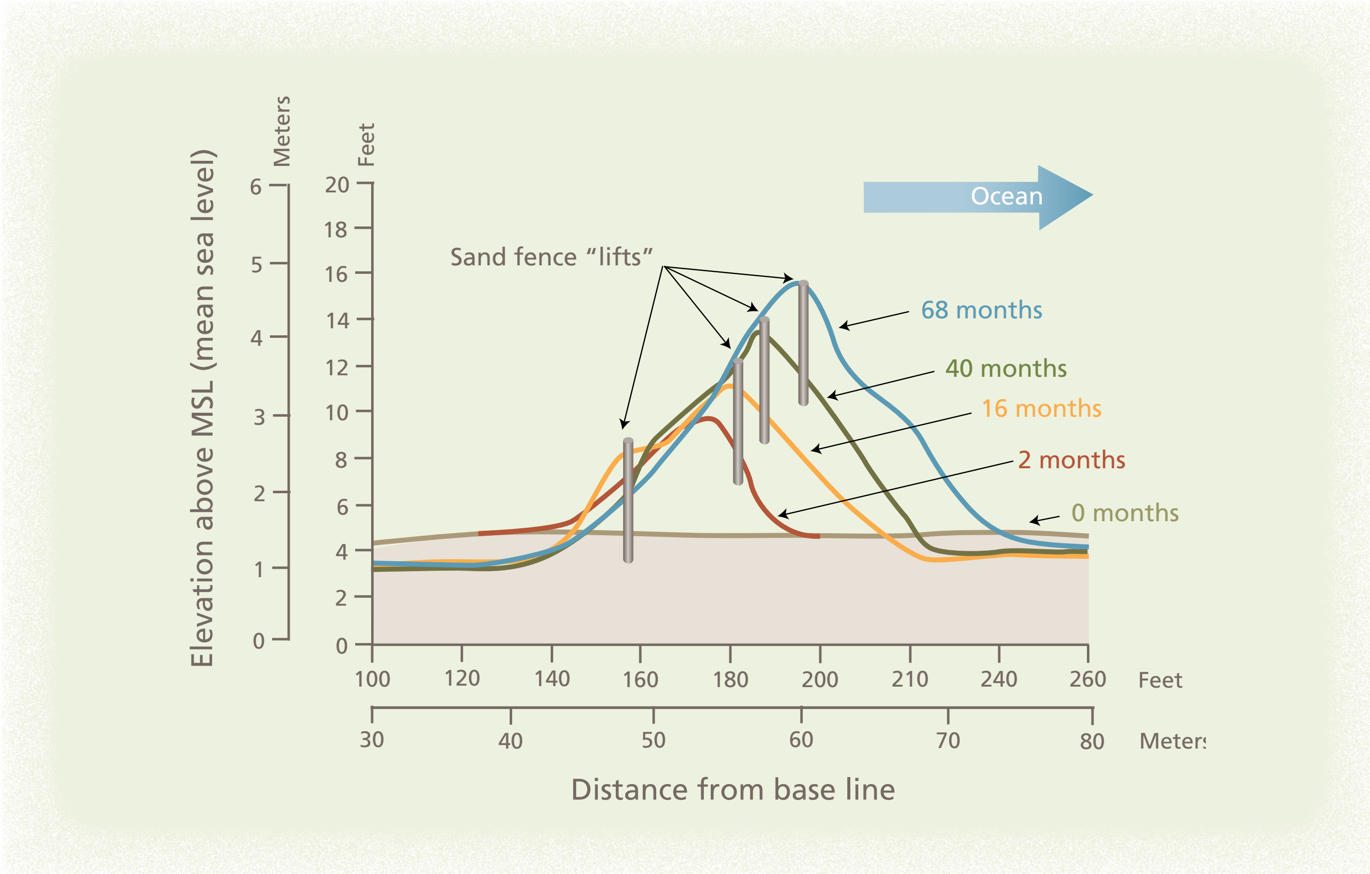


Figure 16. Building a dune through sand accumulation by installing additional sand fences, as previousy installed fence fills to approximately two-thirds. A series of four sand fence lifts is shown (from Savage and Woodhouse, 1969, in ACOE,1984).

Figure 17. Sturdy sand drift fence made of 2x3 vertical and horizontal members, with 6″ diameter posts.

Figure 18. Double row of sturdy sand drift fence — made of 2x3 vertical and horizontal rows with 6″ diameter posts which are partially buried when installed. This style of fence is generally used in areas of small waves or ice.

on the seaward dune scarp (which gets eroded during a coastal storm) and the landward dunes generally remain vegetated, the primary sand source is generally from the seaward direction, i.e., the beach. Some volume of sand, however, will blow from the prevailing west wind direction and build the backside of the dune.

STEP 3: Planting 'Cape' American Beachgrass

'Cape' American beachgrass (*Ammophila breviligulata*) is the dominant dune building plant along the North Atlantic Coast from Maine to North Carolina and along the Great Lakes (Knutson and Finkelstein, 1987).

The almost perfect performance and ease of establishment of 'Cape' American beachgrass has escalated this plant to being literally the only species extensively planted on coastal sand dunes — particularly the frontal dune — from Maine to North Carolina (Miller and Skaradek, undated, NRCS, Cape May Plant Materials Center).

Plant Spacing

'Cape' American beachgrass is generally planted 12", 18", 24", or 36" on-center, in a minimum, if possible, of 10 parallel staggered rows. **Plant spacing depends on the desired location of maximum sand accumulation and elevation.** Closer spaced plants capture sand quicker. Spacing is based on number of plants available and the presence or absence of protected shorebird habitat. Less dense plantings are generally required in shorebird habitat areas, generally 36" on-center culms.

Figure 19. Planting 'Cape' American beachgrass requires only a pogo-type hole poker (any pole or stick several feet long will do), and culms of beach grass (100 culms in a bundle as shown). Note the horizontal bar on the pogo stick is approximately 8" inches up from the bottom for ease of ensuing proper depth of the hole. Makai O'Connell planting beachgrass on Duxbury Beach, Mass.

Estimating Plant Numbers

Calculate the square footage of the area to be planted.

Determine the plant spacing desired, e.g. 12", 18", 24", or 36". Recall that more dense plant spacing, e.g. 12", traps more sand. Make sure that the highest density of beachgrass plant spacing is where the highest volume of sand is desired.

Example: If the area to be planted is 10' x 10' = 100 square feet:

- 1 plant hole per square foot = 100 plant holes
- 3 culms per hole = 300 culms of beach grass are needed.

> Due to the dense configuration of 12" spacing, one or two culms per hole can be sufficient, rather than the suggested two to three culms per hole for wider spacing.

Figure 20. Individual culms are generally planted 8" to 10" deep with two or three culms per hole. A culm is a single plant, often with two stems.

Planting Guidelines

Rapid dune stabilization or steep slopes — Plant two or three culms per hole at 12” to 18” spacing.

Rare, threatened or endangered shorebird (e.g. piping plover) habitat areas — Planting any vegetation will be significantly limited — generally 36” plants on-center is required — if planting is allowed at all. In Massachusetts, maps of potential and actual rare species habitat are available through your local conservation commission.

If your dune restoration project is within a habitat, a written opinion from the Massachusetts Division of Fisheries and Wildlife’s Natural Heritage and Endangered Species Program is required before authorization for restoration is granted. They will determine whether your project will have a short or long-term impact on rare wildlife habitat.

Maximum dune width — Plant spacing densities can be the same throughout a project area or, if space allows, can be graduated from landward dense spacing to gradually wider spacing moving seaward to obtain maximum dune width (Figure 22).

Obtaining Maximum Dune Width

In North Carolina, researchers found that decreasing the spacing of plants both landward and seaward from the dune crest increased dune width and reduced the seaward slope of the dune from about 10 percent to 5 percent (Savage and Woodhouse, 1968).

As shown in Figure 22, the most dense plant spacing are in the landwardmost location, with decreasing plant spacing or density moving seaward. This method will begin dune formation in the landwardmost area and will grow the dune seaward, resulting in a wide stable dune.

Keep in mind that a dune will grow in the direction of the source of wind-blown sand. Due to the open beach area, the source will generally be from the seaward direction.

Figure 21. Planting foredune scarps is particularly important.

Planting Season: November 1 through April

Optimum planting season for ‘Cape’ American Beachgrass from Massachusetts to North Carolina is late fall to early spring. A cut-off date of April 1 is recommended for more southern areas in this range (Fournier, NRCS, undated), and April 15 for the more northern Massachusetts areas (Tim Friary, personal communication, 2008). This seasonal constraint is due to both weather conditions and rare shorebird nesting behavioral disruptions. The temperature and rainfall during the summer months are too warm and dry to support a bare root plant (Church’s Garden’s Center, 2008).

An optimum planting time for increasing plant survival may be early to mid-March. In addition, April 1 is generally a planting cut-off date to avoid disruption to piping plover nesting behavior.

STEP 4: Fertilizing

Fertilizer may easily leach through porous sand and pollute groundwater nearby bays or estuaries causing water quality problems. Use of slow-release fertilizer is recommended. However, technical literature recommends various amounts of fertilizer, as detailed below.

Properly applying fertilizer is the key to good vigorous initial growth of newly established stands of American Beachgrass (USDA, NRC, Plant Fact Sheet, 2006). Fertilizer stimulates growth, increases stems and accelerates the spread of rhizomes. Inorganic, granular

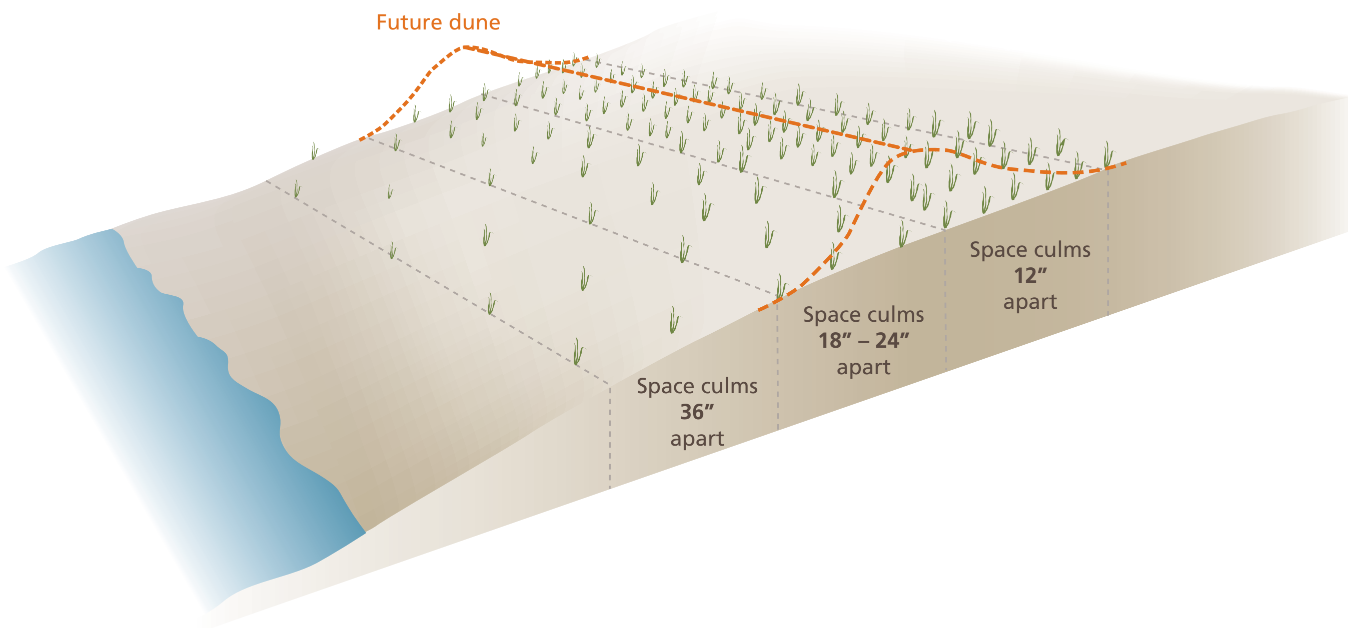


Figure 22. Graduated plant spacing seaward increase dune width and concentrates dune volume and height in the more densly planted area.

fertilizers high in nitrogen are best (N-P-K 30-10-0, 16-8-8 or 10-10-10). Apply no more than one pound N/1000 square feet in a single application (USDA, NRCS, Plant Guide, 2006).

USDA, NRCS (2006) recommends applications providing between 30-60 lbs of nitrogen per acre annually. Splitting applications into spring and early summer is more effective. Spring application should be applied at least 30 days after establishment, but not later than April 1. Once the stand is established, the rate can be reduced by half, or applied only when the stand appears to be weakening.

USDA, SCS, also recommends using 600 lbs of 10-10-10 fertilizer per acre (14 lbs per 1,000 sq. ft. 30 days after planting, but not before April 1.

Cape Cod Organic Farms recommends only 100 lbs of 10-10-10 fertilizer per acre. Even this lower application rate has resulted in a 10-fold increase in stem density (Tim Friary, personal communication, 2008).

Cape Cod Cooperative Extension suggests using 25 to 60 lbs of nitrogen per acre annually as adequate. Results are more effective if applied in two applications: one in spring within 30 days of planting, but before April 1; another application in late summer or early fall (American Beach Grass Plant – Plant Spacing Fact Sheet).

For the first year following planting American beachgrass, North Carolina Sea Grant recommends applying 4 lbs of 30-10-0 or 7 lbs of 16-4-8 fertilizer per 1,000 square feet in March or April and again in September. The second year, apply 4 lbs of 30-10-0 or 7 lbs of 16-4-8 fertilizer per 1,000 sq. ft. in March and again in September (NC Sea Grant, 2003). Fertilize only if necessary after two years.

STEP 5: Monitoring (optional)

Monitor through documentation of dune evolution. A DVD explaining how to monitor dune and beach profiles, "Dune and Beach Profiling: Training in the Use of the Emory and O'Emory Rod Methods", is available free from Woods Hole Sea Grant or Cape Cod Cooperative Extension.

STEP 6: Maintenance

Add sand lost due to storms (optional).

Replace fence and plants as needed and spread fertilizer in second year.

Survival of 'Cape' American Beachgrass

'Cape' American beachgrass evolved in areas of dune systems that experience sand accretion. Moderate sand burial processes stimulate new plant growth, and also bury the old leaves and vegetative materials, thus eliminating thatch build-up and pathogen harbor (NRCS, Cape May PMC, undated). If sufficient wind-blown sand is not available at a particular site, 'Cape' American beachgrass may only survive for a couple of growing seasons. More frequent maintenance and plant replacement may be necessary under these conditions. Incorporating seed of other dune plants into the area may also help stabilize these sand deficit areas.

As dunes mature and advance seaward, sand accumulation slows, depriving the established beachgrass its needed nutrients. Often the result is a decline in the health of plants in older stands. Over a 30-40 year period it has been observed that throughout its native range, American beachgrass is susceptible to decline after six to eight years when artificially established (Miller and Skaradek, Cape May PMC). Dunes will advance in the direction of wind-blown sand, generally seaward, until equilibrium is reached with seasonal frequency of storm wave inundation.

American beachgrass has been shown to be able to grow through at least a foot — and possibly two — of overwash sand and survive saltwater inundation (Knutson, 1980).

Preserving Shorebird Habitat

Figure 23. Preserve piping plover habitat and areas for pioneer beach and dune vegetation growth fronting the foredune by roping off the area.

The area immediately fronting foredunes for 20 or so feet seaward and overwash areas, particularly on barrier beaches, are often prime shorebird nesting habitat, particularly for the threatened piping plover. Piping plovers prefer relatively flat, unvegetated or sparsely vegetated sandy/pebble/cobble mixed sediment beach and dune areas. Thus, foredune slopes <10:1 are critical nesting habitat and generally are required to remain unvegetated or, at most, planted with beachgrass at 36" spacing. For foredune slopes between 10:1 and 6:1, consultation with your local conservation commission or state shorebird specialists should take place prior to submitting an application (Notice of Intent) to conduct dune planting.

In Massachusetts, advice should be obtained from the Massachusetts Division of Fisheries and Wildlife's Natural Heritage and Endangered Species Program for planting gently sloping foredune areas.

Preserving a 20-foot buffer zone of beach fronting foredunes to protect prime piping plover nesting habitat, and allowing an area for seaward pioneer vegetation growth, particularly on barrier beaches, is advisable.

On Duxbury Beach, sand fence and temporary symbolic fencing (orange string tied to metal posts with signs) are maintained in order to preserve plover nesting habitat and allow pioneer vegetation to grow seaward These measures keep pedestrians and off-road vehicles (ORV) out of these important areas.

Permitting

In Massachusetts, authorization, generally a permit known as an Order of Conditions, must be obtained from the town conservation commission for any activity in or adjacent to a coastal dune, including restoration.

However, before the local conservation commission can make a determination on issuing a permit, a written opinion must be obtained from the Massachusetts Division of Fisheries and Wildlife's Natural Heritage and Endangered Species Program advising on the potential short- and/or long-term impacts to protected shorebird habitat.

Potential Adverse Considerations of Dune Building and Restoration

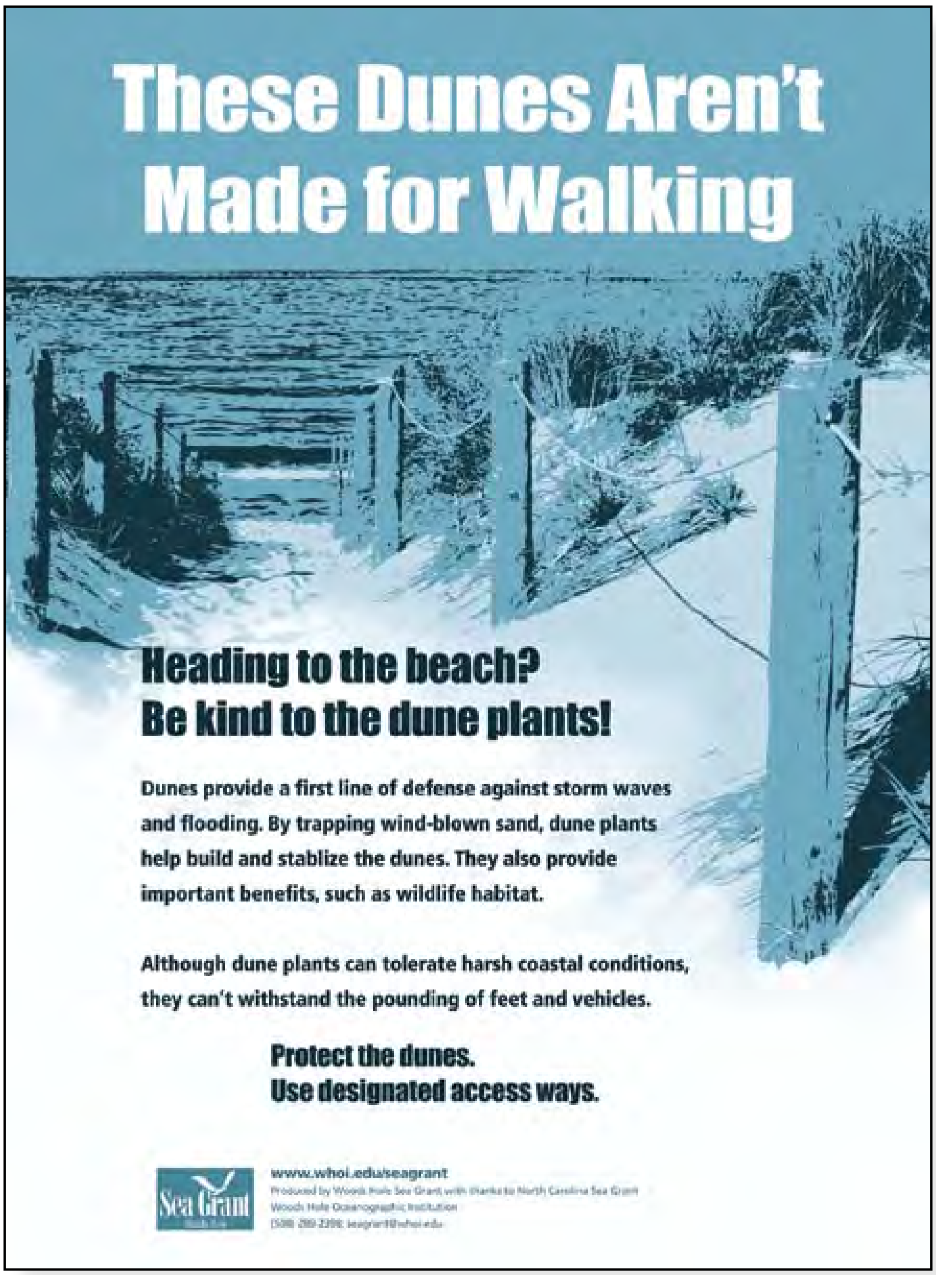
Considerations

- Sand dunes will slow but not prevent erosion.
- Dunes can provide significant protection from storm surge. But along an eroding shore storm waves will eventually overtop or erode dunes.
- Dune restoration, while a preferred and oftentimes effective protective measure, requires maintenance.
- If a dune or vegetation are placed father seaward than adjacent dunes (or approximately <100' landward of mean high water) the plants and dune will be subject to frequent wave inundation and potential loss.
- Discarded Christmas trees are not effective in maintaining a coastal dune under storm conditions. It has been shown that storm waves dislodge the buried trees, rapidly removing all accumulated wind-blown sand.

Large successful dune building projects have been shown to:

- Change adjacent micro-climate affecting ecology and adversely impacting coastal plant communities (Knutson and Finkelstein, 1987).
- Prevent barrier beach/barrier island migration by reducing frequency of overwash
- Lower landward areas by preventing or reducing overwash
- Potentially have negative impact on salt marsh vertical growth by preventing sand transport to the landward marsh surface

All-weather outdoor signs help educate and orient pedestrian traffic out of dune areas and are available free of charge from Woods Hole Sea Grant and Cape Cod Cooperative Extension.



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Joe Grady is particularly acknowledged for providing technical advice on beachgrass planting and sand fence installation techniques developed over 30 years of annual installation of several miles of sand fence and coordinating the annual planting of Cape American beachgrass on Duxbury Beach.

Additional Resources

U.S. Department of Agriculture
Natural Resources Conservation Service
Cape May Plant Material Center
Cape May, N.J.
http://plant-materials.nrcs.usda.gov/njpmc

The Dune Book
North Carolina Sea Grant
NCSU Box 8605, Raleigh, NC 27695-8605
Ask for UNC-SG-03-03. Single copies are $5.
Copies can be downloaded from the web at:
www.ncseagrant.org

Planting and Maintaining Sustainable Landscapes
(Available through the UMass Extension Bookstore)
Cape Cod Cooperative Extension & UMass
Slobody Bldg.
101 University Drive, Suite A4
Amherst, MA 01002-2385
On-line orders: umassextensionbookstore.com
($15 + shipping)

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