StormSmart Properties Fact Sheet 3: Planting Vegetation to Reduce Erosion and Storm Damage

The coast is a very dynamic environment and coastal shorelines—especially beaches, dunes, and banks—change constantly in response to wind, waves, tides, and other factors such as seasonal variation, sea level rise, and human alterations to the shoreline system. Consequently, many coastal properties are at risk from storm damage, erosion, and flooding. Inappropriate shoreline stabilization methods can actually do more harm than good by exacerbating beach erosion, damaging neighboring properties, impacting marine habitats, and diminishing the capacity of beaches, dunes, and other natural landforms to protect inland areas from storm damage and flooding. StormSmart Properties—part of the Massachusetts Office of Coastal Zone Management's (CZM) StormSmart Coasts Program—provides coastal property owners with important information on a range of shoreline stabilization techniques that can effectively reduce erosion and storm damage while minimizing impacts to shoreline systems. This information is intended to help property owners work with consultants and other design professionals to select the best option for their circumstances.

How Vegetation Reduces Erosion and Storm Damage

Dunes, banks (also known as bluffs), and other coastal landforms are susceptible to erosion from tides, currents, wind, and coastal storms. Overland runoff, which is the water from rain, snowmelt, sprinklers, and other sources that does not readily soak into the ground or evaporate but instead flows over the ground surface, can also cause erosion by dislodging vegetation, sand, gravel, and other sediments. Salt-tolerant plants with extensive root systems can help address both kinds of coastal erosion problems. First, plant roots hold sediment in place, helping to stabilize the areas where they are planted. Second, by absorbing water, breaking the impact of raindrops or wave-splash, and physically slowing the speed and diffusing the flow of overland runoff, plants reduce runoff erosion. Vegetation also helps trap windblown sand, which is particularly important for building dune volume, increasing the dune's ability to buffer inland areas from storm waves, erosion, and flooding. Finally, high grasses, shrubs, and other vegetation can be planted to limit foot traffic in erosion-prone areas.

Vegetation can be used in conjunction with many other techniques for erosion management. See the following StormSmart Properties fact sheets on related techniques: *Artificial Dunes and Dune Nourishment*, *Controlling Overland Runoff to Reduce Coastal Erosion*, *Bioengineering - Coir Rolls on Coastal Banks*, *Bioengineering - Natural Fiber Blankets on Coastal Banks*, *Sand Fencing*, and *Beach Nourishment*.

No shoreline stabilization option permanently stops all erosion or storm damage. The level of protection provided depends on the option chosen, project design, and site-specific conditions such as the exposure to storms. All options require maintenance, and many also require steps to address adverse impacts to the shoreline system, called mitigation. Some options, such as seawalls and other hard structures, are only allowed in very limited situations because of their impacts to the shoreline system. When evaluating alternatives, property owners must first determine which options are allowable under state, federal, and local regulations and then evaluate their expected level of protection, predicted lifespan, impacts, and costs of project design, installation, mitigation, and long-term maintenance.

Beachgrass was planted to stabilize an eroded dune and trap windblown sand to build dune volume. (Photo: CZM)

A variety of salt-tolerant vegetation was planted on the face of this bank to stabilize fill added to address bank erosion. (Photo: CZM)

Shrubs were planted at the top of this bank to slow runoff. On the bank face, natural fiber blankets were installed to hold soils in place until the erosion-control vegetation could get established. (Photo: CZM)

Relative Benefits and Impacts Compared to Other Options

The major benefit of vegetation projects is that unlike seawalls, rock revetments, or other "hard" shoreline stabilization structures, vegetated areas absorb and dissipate wave energy, rather than reflecting or redirecting waves onto beaches or neighboring properties. The design of a hard structure affects how much wave energy is reflected, for example vertical walls reflect more wave energy than sloping rock revetments. These reflected waves erode beaches in front of and next to a hard structure, eventually undermining and reducing the effectiveness of the structure and leading to costly repairs. This erosion also

Under the Massachusetts Wetlands Protection Act, new hard structures are typically prohibited on all beaches and dunes. On coastal banks, hard structures are only allowed when necessary to protect buildings permitted before August 10, 1978, and only if no other alternative is feasible. In many cases, vegetation projects and other non-structural alternatives are therefore the only options available for reducing erosion and storm damage on coastal properties.

results in a loss of dry beach at high tide, reducing the beach's value for storm damage protection, recreation, and wildlife habitat. Other benefits of vegetation projects are that they preserve the natural character of the coastal environment and provide wildlife habitat.

In general, the impacts of vegetation projects are relatively minor when compared to other options. Vegetation projects in habitat for protected species (i.e., species that are considered endangered, threatened, or of special concern in Massachusetts), however, do have the potential to cause significant impacts, such as removing open sand areas needed for successful nesting of piping plovers and diamond-backed terrapins. Even the planting of native plant species can cause impacts in these areas. See Design Considerations below for information on addressing this issue.

Design Considerations for Vegetation Projects

This section covers a variety of factors that should be considered to minimize adverse impacts and ensure successful design, permitting, construction, and maintenance of vegetation projects.

Appropriate Locations

Vegetation projects are appropriate for virtually any dune or bank along the coast where sand and other sediments are exposed to wind and waves. Because it is relatively difficult to get vegetation established in areas that are regularly inundated or overwashed by tides and waves, however, the longevity and effectiveness of these projects can be limited in certain locations. The techniques discussed in Protecting Plants below can help address this issue.

Protecting Plants

Plants are most vulnerable before their root systems become established. Techniques that can help stabilize dunes and banks while plants get established include: 1) installing natural fiber blankets on the ground surface before planting to hold soils in place while roots get established (see *StormSmart Properties Fact Sheet 5: Bioengineering - Natural Fiber Blankets on Coastal Banks*), 2) using temporary baffles of natural-fiber material to shelter plants from wind, and 3) installing sand fencing to help slow wind, trap sand, and reduce erosion (see *StormSmart Properties Fact Sheet 6: Sand Fencing*). Combining these techniques is more effective than using only one method. On banks, another method to protect the soil around newly planted live vegetation is to plant a salt-tolerant seed mix on the exposed soil. The plants that grow from seed can quickly stabilize the soil so it is not washed away while the live plants are becoming established.

Another important factor for successful plant establishment and survival is water availability. Since new plants with their smaller root systems have a limited capacity to find water in the surrounding soil, a consistent supplementary source of water should be provided directly to these plants while their root systems and foliage are developing. For large planting projects, the use of a temporary, automated irrigation system may be warranted for up to three summers following planting. See the Watering section below for additional details and cautions on using automated irrigation systems.

To further ensure the success of planting projects, sources of erosion, including upland runoff and waves, should be identified and addressed as part of the site evaluation and design process. Runoff should be reduced or redirected to give the vegetation the best chance of survival (see *StormSmart Fact Sheet 2: Controlling Overland Runoff to Reduce Coastal Erosion* for details). In areas subject to regular erosion from waves, tides, currents, wind, and coastal storms, additional techniques should be considered to improve site protection. For example, beach nourishment (i.e., adding sediments like sand, gravel, and cobble to widen the beach—see *StormSmart Fact Sheet 8: Beach Nourishment*) can protect vegetation projects by widening beaches in areas with relatively narrow beaches at high tide. For bank projects, dense rolls of natural fiber called coir rolls can protect newly planted areas (see *StormSmart Fact Sheet 4: Bioengineering - Coir Rolls on Coastal Banks*), hay bales can be staked at the base of the bank to provide a short-term buffer from tide and waves, and artificial dunes can be constructed with

sediment from an off-site source to buffer the base of the bank (see *StormSmart Properties Fact Sheet 1: Artificial Dunes and Dune Nourishment*).

In addition, to protect dune and bank vegetation, pedestrian access to the shoreline should be restricted to designated access paths or walkways and the number of access points should be limited as much as possible. Often, multiple properties can use a common access point. The size of access structures should be minimized as much as possible to limit shading impacts to vegetation.

Lightweight, natural-fiber, erosion-control fabric was installed on this bank to protect the plants from wind until the roots could get established. Boards were placed on top of wooden stakes to provide access during construction, which minimized impacts to the bank from foot traffic. The photo on the right was taken one year after planting. **(Photos: New England Environmental, Inc.)**

An Added Consideration on Banks - Establishing a Stable Slope

On banks, a stable slope is essential for project success. If the bottom of the bank has eroded and its slope is steeper than the upper portion of the bank, the bank is likely unstable. Even when heavily planted with erosion-control vegetation, banks with unstable slopes are extremely vulnerable to slumping or collapse that can endanger property landward of the bank. Before planting vegetation, therefore, the bank slope should be stabilized.

Ideally, soil of a similar type to that on the bank or beach is brought in as fill and added to the lower part of the bank to create a slope that matches or is less steep than the upper slope. However, if adding fill brings the toe of the bank within the reach of high tides, the fill will erode quickly and undermine the rest of the bank. In these cases, regrading the bank slope by removing sediment from the top of the bank may be a better option. While removing part of the upper portion of the bank does reduce the land area between the top of the bank and the property, it can be done in a controlled fashion that improves the overall stability and storm-damage prevention capacity of the bank. And if the slope is not stabilized, bank collapse during a storm could cause substantially more loss of land area to the sea. In addition, any investment in vegetation and other methods to prevent erosion on an unstable bank will be lost if the bank collapses. On sites where the top of the bank is well vegetated with mature, salt-tolerant species with extensive roots, the appropriate approach to stabilize the bank should be carefully developed by a professional with extensive experience successfully stabilizing similar sites.

Sediment was added to this eroding bank to create a shallower and more stable slope before the vegetation was planted. The lower bank was planted with grasses and the upper section with mixed grasses and shrubs. **(Photo: CZM)**

Plant Selection

Specific site conditions—including wind, salt, soil type and quality, moisture, shifting sands, frequency of coastal storms, and exposure to waves and overwash—dictate the plant species that can grow successfully. Native, salt-tolerant species are recommended for coastal use because they are well adapted to the harsh conditions, require less maintenance to grow and thrive, and provide more diverse food and shelter for wildlife. In addition, only plants with extensive root systems should be selected for erosion-control projects.

On dunes (particularly those closest to the beach where wind and wave action are strongest), American beachgrass is the best species to use for initial plantings. Beachgrass quickly establishes a dense root system, rapidly accumulates sand, and is very resilient to being overwashed by waves. For beachgrass to thrive, it should be planted in a location where wind-blown sand will reach the plants. Other plants recommended for use in combination with beachgrass include little bluestem, purple lovegrass, and seaside goldenrod. Further landward in dunes and beyond the reach of regular wave action, shrubs such as beach heather, lowbush blueberry, bayberry, and beach plum can be planted with grasses to add diversity and improve erosion control.

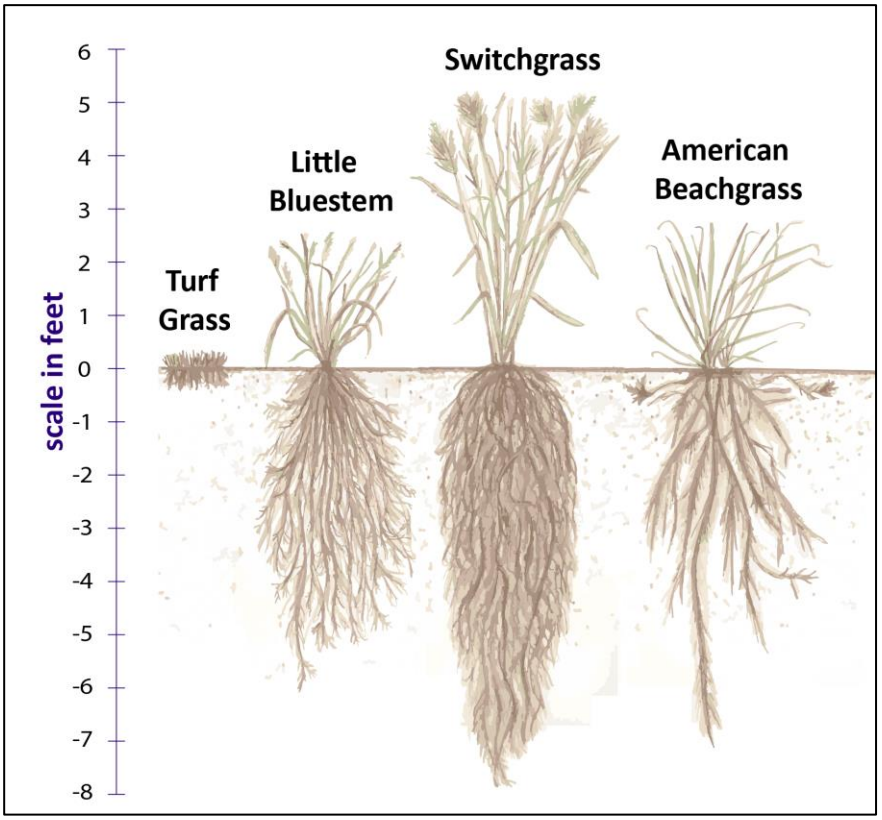
On banks, switchgrass, saltmeadow cordgrass, little bluestem, and other grasses can stabilize exposed areas quickly with their fast-growing, fibrous root systems. While American beachgrass is helpful for initial bank stabilization, it will not thrive on banks that receive little blowing sand. In these areas, it should be planted with other recommended species that will take over as the beachgrass fades. Shrubs, low groundcovers, and perennials that have extensive surface areas and root systems can be used to intercept heavy rainfall and help shelter and stabilize the underlying soils.

Northern bayberry, bearberry, and marsh elder are excellent shrubs for protecting underlying soil in coastal areas. Shrubs are best used higher up on the bank where they are not exposed to waves, and planting a mix of grasses around newly planted shrubs can help stabilize the area while the shrubs become established. Trees and large shrubs should not be planted on the face of a bank because their height and weight can destabilize the bank and

make them vulnerable to toppling by erosion or high winds. Existing trees on banks can be pruned back to help address this problem.

It is important to plant a diversity of native species because a stand of only one plant is more susceptible to complete die-out from drought, disease, or pests.

CZM's Coastal Landscaping website provides additional detailed information on appropriate plants for storm damage prevention and flood control on dunes and banks.



Turf grass has a very shallow root system compared to these other plants recommended for erosion control. **(Figure redrawn from illustration by Dede Christopher of the Tennessee Valley Authority, Benefits of Riparian Zones)**

Use Only Live Plants for Erosion Control

Only live plants should be used since brush, lawn clippings, and other dead plant materials prevent live plants from getting established and have no roots to bind soils. Discarded Christmas trees are a particular problem because they leave large, destabilizing holes when they are ripped out by waves. Sand fencing is a much more effective option and does not impede the natural growth of live plants. See *StormSmart Properties Fact Sheet 6: Sand Fencing* for details.

Never Plant Invasive Plants

Invasive species (i.e., introduced species that thrive at the expense of native plants) should never be planted in coastal areas. Oriental bittersweet, bush honeysuckle, vine honeysuckle, autumn olive, and porcelain berry vine are particularly problematic coastal invasives because they have shallow roots, spread rapidly, and can secrete toxic compounds that prevent the growth of other plants. Japanese knotweed is another common invasive that is a problem on coastal sites. Although knotweed has deep roots, it can easily be torn out of the ground, taking large chunks of the soil with it. Because of these growth characteristics, even dense stands of these six species do little to reduce erosion by storm waves, runoff, and wind.

Removing/Replacing Invasive Plants

Invasive plants should be removed and replaced with appropriate native plants if they are preventing establishment of erosion-control vegetation. Because of their tenacity, successful control of invasive plants can take years to accomplish and may require perpetual monitoring and management. This effort is particularly warranted when bank stability is severely compromised by the invasive plant or when unruly and overgrown invasives can be replaced with lower-growing native species to stabilize the bank and improve coastal views.

INVASIVE PLANTS THAT HINDER EROSION CONTROL

Bush Honeysuckle

(Photo: Leslie J. Mehrhoff, University of Connecticut)

Vine Honeysuckle

(Photo: Chuck Bargeron, University of Georgia)

Oriental Bittersweet

(Photo: James R. Allison, Georgia Department of Natural Resources)

Autumn Olive

(Photo: Leslie J. Mehrhoff, University of Connecticut)

Porcelain Berry Vine

(Photo: Nancy Loewenstein, Auburn University)

Japanese Knotweed

(Photo: Jan Samanek, State Phytosanitary Administration)

All photos courtesy of Bugwood.org with specific acknowledgements given.

The photo on the left shows a densely vegetated bank that looks stable, but isn't. The invasive black locust, Asiatic bittersweet, and autumn olive growing on the bank do not have deep, dense roots that help hold soils in place. The photo on the right shows a close up of the exposed soils and erosion at the site. In addition, the roots of these invasive plants secrete toxic compounds and the thick branches shade the area, both of which inhibit the growth of native plants that could stabilize the soil. **(Photos: Wilkinson Ecological Design)**

Removing invasive plants to replace them with native species, however, can temporarily destabilize the bank. For sites where bank regrading is not needed, invasive plants should be cut off at ground level, keeping the roots in place to minimize site disturbance. Many invasive plants can be effectively eliminated by applying limited amounts of herbicide to the cut stems, which kills the remaining root material. Herbicides can only be used in areas where they are allowed by local regulations. A direct and targeted application of herbicides, as opposed to spraying, helps

to minimize adverse impacts to existing native vegetation, soils, groundwater, and coastal waters. Invasive plants should also be removed by hand when possible, rather than with heavy equipment. For sites where regrading is needed, the roots of invasive plants can be pulled out to minimize resprouting.

Regardless of the method used, when vegetation is cut or removed, the exposed soils will become more vulnerable to erosion from wind, rain, and waves. Proper scheduling and sequencing of invasive species removal and replanting with native species will minimize this problem, as will the use of other soil stabilization techniques. Consultation with a professional experienced in replacing invasives with native plants in erosion-prone areas is recommended, as the techniques and timing vary between plants.

Time of Planting

Although specific timing varies based on the plant species selected, most vegetation should be planted in early-to-mid spring (when the growing season has started and moisture levels are relatively high) to promote root growth and successful plant establishment. Beachgrass, however, typically does best when planted in unfrozen ground from mid-November through early April, except in areas exposed to strong wind or waves, where it should be planted in early spring to reduce the likelihood it will be washed or blown away in winter storms.

Watering

Established native plants typically do not require watering. When planted at the appropriate time of year, some newly planted species, such as American beachgrass planted on dunes, also do not require watering.

In both dune and bank areas, some supplemental irrigation may be necessary to ensure success in certain circumstances. For most newly planted vegetation, it is generally recommended that a temporary, automated irrigation system be used from April through October during the first two to three growing seasons until the roots can effectively find and absorb water from the surrounding soils. These irrigation rates can typically be reduced each year, with only minimal water needed in the third year, if at all. For American beachgrass and other plants that do not typically require initial watering, temporary irrigation (i.e., for 4-6 months) is needed when these species are planted in the hot, dry summer months.

Permanent irrigation systems and heavy watering are unnecessary and are not recommended, not only because established plants do not require watering (with the exception of times of drought), but also because excess water from permanent irrigation systems generally exacerbates dune and bank erosion and can even lead to bank failure. Excess water on dunes can also reduce soil salinity levels and allow plants that will not survive in the long-term to out-compete appropriate erosion-control plants.

Temporary irrigation systems, such as aerial heads, are good for providing water to large areas of plugs and seeds, while soaker hoses and drip tubing are effective for supporting container plantings, such as shrubs. A timer may be appropriate to deliver a sufficient amount of water (enough to infiltrate well into the soil to help plants develop deep roots) at desired times (often early morning when less water is lost to the heat of the day). The temporary irrigation lines should be left at the surface (so soils will not be disturbed when the lines are removed) and the system should be removed at a determined time (such as when a local Conservation Commission issues a Certificate of Compliance for the project around year 3).

Various methods to improve water retention and nutrient content in the plants and soils can also help significantly boost the survival rates of plants, such as the application of wetting agents (e.g., Yucca extract), beneficial microbes, and organic compost. A professional may need to be contacted to help determine the most appropriate watering methods and applications that will ensure plant establishment while avoiding impacts to coastal resource areas.

Fertilizer

Because sandy soils are typically dry and lack nutrients, it may be necessary to add some organic matter such as compost before planting. For coastal settings, it is appropriate to select plants that require little fertilizer. If the plant label indicates that fertilizer is needed the first year, use only the minimum amount necessary and use slow-release fertilizers composed of water-soluble materials to prevent coastal water pollution. On artificial or nourished dunes where sand has been brought in from off-site, a limited application of time-release fertilizer 30 days after planting is often needed.

Wildlife Protection

Because vegetation can alter habitat, care must be taken with vegetation projects in protected species habitat. Selecting appropriate types of vegetation (e.g., grass vs. shrubs) and increasing the spacing between plantings can reduce impacts to nesting habitat for protected shorebirds and turtles. Detailed guidance is available from the Natural Heritage and Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife.

Heavy Equipment Use

If heavy equipment is needed for a vegetation project, equipment access must be carefully planned to avoid destruction of existing vegetation; creation of ruts; destabilization of banks, beaches, or other landforms; impacts to wildlife, particularly nesting habitat for protected shorebirds and turtles; and related impacts. When mechanical equipment is being used, contractors should keep hazardous material spill containment kits on-site at all times in case there is a release of oil, gasoline, or other toxic substances.

Permitting and Regulatory Standards

Most options for addressing coastal erosion, storm damage, and flooding are likely to require a permit under the Massachusetts Wetlands Protection Act through the local Conservation Commission. Permits or approvals may also be required from other state agencies and local departments, depending on the location and the work involved. Generally, regulatory programs are supportive of projects that naturally stabilize dunes and banks with vegetation rather than proposing a hard structure. However, before bringing in a backhoe (or even a shovel or pruning shear) to do any kind of landscaping work on a coastal property, contact your local Conservation Commission to determine if a permit is necessary.

Professional Services Required

Simple dune and bank planting projects may be done by the homeowner after permits have been obtained if needed. More complex projects that involve regrading, however, are likely to require professional services. A landscape architect, biologist, engineer, or other environmental professional with experience designing erosion-control projects in coastal areas using native, salt-tolerant plantings may need to be consulted to: 1) identify regulatory requirements and ensure the project fully conforms with those requirements; 2) determine the conditions at the site that will affect the project (such as the amount of sun or shade, high winds, wave exposure, runoff, and foot traffic); 3) identify invasive species, oversteepened slopes, runoff problems, areas of increased erosion due to adjacent hard structures or development, or other issues that must be considered as part of project design; 4) determine if other shoreline stabilization techniques are needed in addition to vegetation; 5) select appropriate plants and develop a planting and maintenance plan; 6) determine volume and composition of fill, if needed; 7) identify the best time of year to install various components of the project; 8) develop an access plan if heavy equipment is needed; 9) determine what, if any, fertilizer or irrigation is needed; 10) prepare plans for permitting; and 11) prepare design specifications for construction. The consultant can also oversee construction, monitoring, and maintenance of the project.

Project Timeline

It may take as little as two to three months to design, permit, and install a vegetation project, assuming that only a Massachusetts Wetlands Protection Act permit is required. To expedite the process, hire a consultant with appropriate experience in designing and permitting similar projects, make sure that regulatory applications are complete, and anticipate and address special considerations, such as abutter concerns, construction access issues, or time-of-year restrictions (due to endangered species issues, for example). Often, Conservation Commission staff are available to meet with applicants to go over the important factors that need to be considered early in the design process.

Maintenance Requirements

Vegetation projects require ongoing maintenance to ensure their success. Maintenance requirements will vary greatly depending on site conditions. As with all vegetation projects, watering, replacing dead plants, and similar maintenance is initially required to ensure that the vegetation that has been planted becomes successfully established. In areas subject to high rates of erosion and frequent coastal storm damage, plants may need to be replaced frequently on an ongoing basis, particularly when vegetation is not combined with other shoreline stabilization techniques. Planted areas should be inspected regularly and vegetation should be replanted or replaced as necessary. Any area damaged by storms should be restored to pre-storm conditions as soon as possible—an eroded area will continue to deteriorate and will expand rapidly if it is left oversteepened, unvegetated, and exposed to the wind, tides, runoff, and storms. If erosion or plant die-off occurs during the winter, it may not be possible to re-establish plants until the growing season begins in the spring. Other temporary measures can be used to stabilize the site, including adding fill and using natural fiber blankets (see *StormSmart Properties Fact Sheet 5: Bioengineering - Natural Fiber Blankets on Coastal Banks*). A schedule and plan for replacing sediments and vegetation should be included in the original permit application for the project so that maintenance can be conducted without additional permitting.

Project Costs

With vegetation projects, there are typically a range of options available that give increasing levels of protection with increased construction costs. In addition, whenever you hire a professional to conduct work on your property, total costs are expected to vary significantly based on site-specific considerations. The considerations that most influence the costs of vegetation projects are the severity of erosion, the size of the area to be stabilized, the type of runoff control needed, the type and number and size of plants selected, and the need for other temporary site-stabilization techniques or regrading. For comparison with other shoreline stabilization options, vegetation projects typically have relatively low design and permitting costs, low construction costs, and low maintenance costs. See the StormSmart Properties chart, *Relative Costs of Shoreline Stabilization Options* (PDF, 99 KB), for a full comparison.

Additional Information

Vegetation can be used in conjunction with many other techniques for erosion management. See the following CZM StormSmart Properties fact sheets for additional information:

- *StormSmart Properties Fact Sheet 1: Artificial Dunes and Dune Nourishment*
- *StormSmart Properties Fact Sheet 2: Controlling Overland Runoff to Reduce Coastal Erosion*
- *StormSmart Properties Fact Sheet 4: Bioengineering - Coir Rolls on Coastal Banks*
- *StormSmart Properties Fact Sheet 5: Bioengineering - Natural Fiber Blankets on Coastal Banks*
- *StormSmart Properties Fact Sheet 6: Sand Fencing*
- *StormSmart Properties Fact Sheet 8: Beach Nourishment*

The following resources also provide valuable information on vegetation:

- CZM's Coastal Landscaping website focuses on landscaping with salt-tolerant vegetation to reduce storm damage and erosion and includes information on appropriate plants, planting plans, invasive species, and tips on plant care, along with links to other references.
- CZM's *Landscaping to Protect Your Coastal Property from Storm Damage and Flooding fact sheet* (PDF, 962 KB) gives specific information for homeowners on appropriate plants for erosion control in coastal areas.
- *Coastal Dune Protection and Restoration—Using 'Cape' American Beachgrass and Fencing* (PDF, 3 MB) by the Woods Hole Sea Grant and Cape Cod Cooperative Extension Program includes case studies and tips on dune restoration, along with information on preserving shorebird habitat and understanding the permit process.
- CZM's *Environmental Permitting in Massachusetts* gives brief descriptions of major environmental permits required for projects proposed in Massachusetts.
- *Salisbury Beach Dune Walkover Access Design Standards* (PDF, 14 KB) gives general design standards for walkways over coastal dunes that minimize potential adverse effects. These standards are widely applicable.
- *Guidelines for Barrier Beach Management in Massachusetts* (PDF, 12 MB), which was produced by the Massachusetts Barrier Beach Task Force in 1994, provides an overview of the Massachusetts Wetlands Protection Act Regulations and the function of beaches, dunes, and other resource areas (in Chapter 2). It also gives information on various erosion management techniques, their potential impacts, and measures to minimize those impacts (Chapter 5).
- Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) cover work in wetland resource areas and buffer zones.
- The Natural Heritage and Endangered Species Program website provides information on protected species in Massachusetts, habitat maps, and regulatory review for projects in or adjacent to these habitats.
- The Invasive Plant Atlas of New England provides a comprehensive web-accessible database of invasive and potentially invasive plants in New England.
- The Massachusetts Ocean Resource Information System, or MORIS, is a web-based mapping tool for interactively viewing coastal data. MORIS data layers, such as endangered species habitat and shellfish, can help identify sensitive resource areas within or near the project site.

www.mass.gov/stormsmart-coasts-program

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