Management Strategy: Shoreline Protection

Shoreline protection is a management strategy that can be used to restore and protect at-risk coastlines. This strategy includes several different restoration techniques such as creating marsh sills, maintaining headland features, restoring oyster beds, constructing bank revetments, and creating living shorelines. Each of these techniques aim to reduce shoreline erosion, recover lost land cover, and enhance the resilience of a coastline. The appropriate technique for a given property will depend on the condition, specifically wave energy and tidal flow velocity, the structure of the marsh, the project budget, and/or management goals for the property. It is important to consider that in addition to initial design and construction, shoreline stabilization projects may require adaptive management and maintenance. Read through the following techniques below to see which ones may be best suited for your marsh complex.

- **Marsh Sill (shoreline stabilization)**
  - **Site Wave Energy:** Medium
  - **Installation Cost**: $2,000-$5,000 per linear foot

A marsh sill is a low-elevation structure, typically made from stone or bagged oyster shells, that is built in the water adjacent to an existing shoreline[1]. A marsh sill shields a shoreline from wave energy and reduces erosion by causing waves to break on the structure instead of the shore itself and by holding sediment in place. Along with protecting the marsh area behind the sill from erosion, marsh sills also promote the accumulation of sediment along the shore which can facilitate the recovery of lost marsh area. A marsh sill project will typically cost between $2,000-$5,000 per linear foot for initial construction[2]. The construction costs can be mitigated by using less expensive or locally sourced materials, such as oyster bags which cost between $5-$20 per bag[3]. For example, the North Carolina Coastal Federation created oyster reefs, planted over 100,000 marsh plants, and installed 1,200 ft of oyster shell bag marsh sill on the Jones Island shoreline. .[4]

Figure 1. An oyster shell bag marsh sill at Jones Island, North Carolina. Source: Living Shorelines Academy.

- **Maintain or establish headland features**
  - **Site Wave Energy:** Medium to high
  - **Installation Cost**: $5,000-$10,000 per linear foot

Figure 2. Two stone headland breakwaters at VIMS in Gloucester Point, Virginia. Source: Chesapeake Bay Program.

Headland features are coastal landforms where sections of land, typically made of rock, extend out into a body of water and in between them form horseshoe-shaped, sandy bay areas[5]. Headland features protect the enveloped shoreline and interior marsh from erosion by intercepting and slowing oncoming waves.[6] In areas where no headland features are present, manmade breakwaters can be strategically placed and shaped to mimic the protective function of natural headland features. Breakwaters are offshore structures typically made from rock, oyster shell, or concrete that lay parallel to the shoreline and reduce the energy of a wave before it reaches the shore.[7] In contrast to marsh sills, breakwaters are designed to be placed further offshore and are typically taller structures.[8] By controlling erosion, these structures can stabilize a wetland and provide shelter for marsh habitat.[7] Breakwater projects are typically more expensive and involved than other shoreline protection measures due to the additional material costs and required design and engineering expertise**.** These projects range from $5,000-$10,000 per linear foot for initial construction. [2] When breakwaters are being used to create headland features, additional sand must be brought in to form a sandbar that connects the breakwater to the shore; this will add additional costs.[6] An example of a headland breakwater project can be found on the York River in Gloucester point, Virginia. At this site, the Virginia Institute of Marine Science (VIMS) installed two stone headland breakwaters which have protected their shoreline through two major hurricanes.

- **Oyster Bed Restoration/Creation Sill**
  - **Site Wave Energy:** Low to Medium
  - **Installation Cost**: $48,500-$495,985 per acre

This technique involves creating or restoring an oyster bed to increase the oyster population adjacent to a marsh management site. An oyster bed is a solid, submerged surface on which oysters can attach and grow. Suitable oyster bed structures are made of concrete, rocks, or old oyster shells.[9] Once an oyster bed is created or restored, it can be seeded with oyster spat to establish an oyster reef.[10] An oyster reef can protect and restore a marsh area by reducing the wave energy reaching the marsh, by filtering excessive nutrients and algae out of the water, and by promoting sediment accretion along the shore[11]. The ensuing calmer and cleaner waters behind the established oyster reef may facilitate the growth of marsh vegetation. The cost of an oyster reef restoration project will depend on the size of the project and the materials selected. Oyster beds built from a mix of oyster shell and other materials cost an average of $48,500 per acre whereas beds built from concrete cost an average of $495,985 per acre.[12] In 2021, the Nansemond River Preservation Alliance and the Chesapeake Bay Foundation used a combination of oyster bed restoration techniques, including oyster castles, shell bags, and oyster catchers to restore 250 feet of eroding shoreline on the Nansemond River in Suffolk, Virginia.[13]

Figure 3. Oyster reef protecting the shoreline in Elizabeth River, Virginia. Source: Chesapeake Bay Foundation.

- **Bank Revetment**
  - **Site Wave Energy:** Medium to High
  - **Installation Cost:** $5,000-$10,000 per linear foot

This shoreline protection technique involves placing a rock, concrete, or wooden shield along a bank with a graded slope.[15] The graded bank allows waves to run up the slope, rather than erode it. Likewise, the rocks protect the underlying soil by deflecting wave energy and holding the soil in place. Bank revetments are meant for sites that have deep slopes at the shore's edge and routinely experience large waves.[2] Bank revetments are not considered a nature-based solution and are usually expensive projects due to the costs of materials and installation ranging between $5,001-$10,000 per linear foot for initial construction.[2]

Figure 4. Riprap (stone) bank revetment at Yorktown beach, Virginia. Source: Virginia Institute of Marine Sciences.

- **Vegetation Planting**
  - **Site Wave Energy:** Low – Unless combined with other shoreline protection measures
  - **Installation cost:** $1,000 per linear foot

This technique involves strategically planting vegetation along an exposed shoreline.[16] By doing so, the roots of the plants will anchor the soil in place and buffer upland areas from small waves. As a result, this technique helps to control erosion and stabilize a coastal edge. In addition to filtering runoff that reaches the shore, the native vegetation will also provide habitat and green space. This technique is a low-cost and relatively low-effort shoreline protection method. These projects typically cost less than $1,000 per linear foot to install.[2] The project costs can be mitigated by having volunteers support the planting and/or by using low-cost plant plugs. One example of a vegetation planting project can be seen at the YMCA's Camp Letts in Edgewater, Maryland. With the help of volunteers, the camp planted 4,500 marsh grasses along their exposed shoreline.[17]

Figure 5. Vegetation planting at Pivers Island, North Carolina. Source: NOAA Habitat Blueprint[18].

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