U.S. Department of the Interior
National Park Service
Natural Resource Information Division

Shoreline Processes and Mitigation Policies of the National Park Service

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For many park visitors, beaches provide an unparalleled recreational experience, be it for the excitement of surf fishing or for simply lying in the sun. At the same time, beaches may be critical habitat for several threatened and endangered species such as the loggerhead sea turtles (*Caretta caretta*) that annually hide their eggs on the beaches of Cumberland Island National Seahore. A near-shore zone may be the site of a historical landscape. As coastal populations and tourism continue to increase, so do the pressures on these fragile resources. Thus, for the ten national seashores and numerous other National Park Service units[1] in the coastal zone, an understanding of the physical processes that distinguish this narrow interface of land and sea is essential for effective management.

Shoreline Processes

Shorelines are dynamic, often violent environments, defined by the shifting of sediments to efficiently diminish the energy of waves and currents. Along the Atlantic and Gulf coasts, a nearly continuous chain of barrier islands and spits have developed over time, protecting the mainland from the direct force of winter storms and hurricanes. Broken periodically by inlets that may open or close in response to major storms, the physical characteristics of the barriers change constantly as sand is redistributed throughout the littoral zone. This movement may be perpendicular to the shore, moving sand onshore or offshore depending on wave steepness, sediment size, and beach slope. Simultaneously, movement may be parallel to the shoreline as sand, stirred up the breaking of waves, is carried along by prevailing longshore current. Under normal conditions, the shoreline at any given point along a beach may be accreting, receding, or stable, although most short-term changes will probably be imperceptible to the untrained observer.

Causes of Shoreline Erosion

Numerous natural and anthropogenic factors can contribute to erosion of existing shorelines. Natural factors can include:

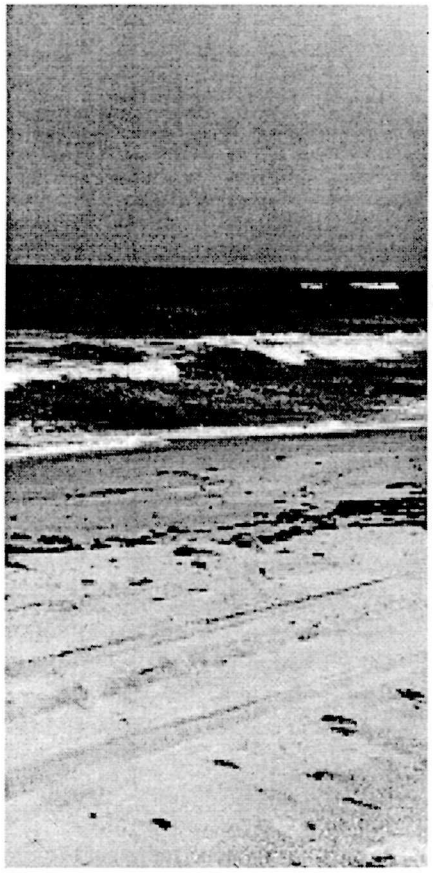
- sea level rise, which gradually exposes new section of coastline to wave energy and currents
- variability in sediment supply to the littoral zone, such as when drought conditions reduce the quantity of sediment entering rivers
- storm waves, which cause offshore transport and storage of sediment on a bar or shoal
- wave and surge overwash, where a storm surge washes sand landward of the existing shoreline
- deflation or the removal of loose material by wind, often resulting in the formation of major natural dune fields adjacent to the beach
- longshore sediment transport, when the sand carried away by longshore currents exceeds that which is supplied
- sorting of beach sediment or the transfer of smaller particles offshore.

Among the natural factors, those associated with major storms tend to be the most drastic. High, steep wind-generated waves greatly overwhelm the natural coastline defenses and accelerate offshore sediment transport while the storm surge exposes portions of the beach that are normally above the high water mark to the enhanced wave energy. The effects of storms can then be magnified by some of the more subtle natural factors such as sea level rise or reduced sediment input to the coastal and nearshore zones.

Among the anthropogenic causes of shoreline erosion are:

- land subsidence from removal of subsurface resources such as oil, gas, or groundwater
- interruption of material in transport, as when longshore transport of

[1] National parks and other entities of the National Park Service such as national monuments, national rivers, wild and scenic riverways, national scenic trails, and others are called *units* and collectively constitute the *National Park System*.



Beach in North Carolina
Photograph by E. Rockwell

sediment is interrupted by dredging or construction of jetties

- reduction of sediment supply to the coastal zone, which can be caused by the damming of rivers, thereby trapping sediment destined for the coast
- concentration of wave energy on beaches, usually through construction of vertical bulkheads or seawalls
- increased water level variation such as when the tidal range is altered by the widening of deepening of inlets
- change in natural coast protection, which has occurred where dunes and beach vegetation were removed or where offshore berms were dredged
- removal of material from the beach for mining and construction.

The two most frequently cited anthropogenic causes of erosion are the interruption of material in transport and the loss of natural coast protection. Sediment transport is usually interrupted where the need for stable, deep inlets leads to channel dredging, construction of jetties, or both. Downstream beaches are then deprived of the sediment necessary to replace what which is naturally lost. Natural coastal defenses are most often lost to coastal development, and condominiums and vacation homes replace existing dunes and increase the potential for overwash erosion and island breaching.

In most cases, however, no one natural or anthropogenic factor is solely responsible for shoreline erosion. Rather, each of several factors--some more obvious than others-- usually compounds the effects of the others and complicates mitigation of damage.

Options for Mitigation

No action. This option is based on the idea that coastal erosion is an integral part of the natural evolution of shorelines. Suggested is that existing dunes should be sufficient to protect the mainland behind them and that, when breached, may rebuild gradually through natural accretion processes, although some permanent loss will usually occur.

Beach nourishment. This option involves several methods of protecting or replenishing beaches where natural systems have failed. Sediment may be placed directly on the eroded shoreline to provide a beach is that is the lifeblood of many tourist destinations or to create a sand dune line as was done on Cape Hatteras National Seashore for many years. Sediment may also be placed at the updrift sector of the problem area, ensuring that sand is available at the necessary replenishment rate.

Anthropogenic structures. These generally fall into two classes. One is designed to act as a barrier to incoming waves and includes breakwaters, seawalls, bulkheads, and revetments. The other includes structures such as groins and jetties, designed to retard longshore transport of sediment by placing barriers perpendicular to the shoreline. The use of thee hardened structures is, however, very contentious because the protection they provide is typically very localized and often accelerates erosion of adjacent, unprotected shorelines. More innovative methods of mitigating shoreline erosion continue to be developed, including sand-bypass systems that use hydraulic pumps to transport sand across barriers and structures that reconfigure a shoreline, so that it accretes sand from offshore sources. Whether these newer techniques will pass the test of time remains to be seen.

Mandates and Policies of National Park System Units

The basis for National Park Service policies for the mitigation of shoreline erosion is in the Organic Act (16 U.S.C.1), which mandates that the National Park Service "conserve the scenery and the natural and historic objects and the wild life therein . . . [to] leave them unimpaired for the enjoyment of future generations." When shoreline processes are referred to in the authorizing legislation for a NPS unit, management is generally authorized to consult the US Army Corps of Engineers on erosion control and beach protection, so long as any instituted measures are consistent with the legislated purposes of the NPS unit.

This policy itself has gone through considerable evolution since the establishment of the first national seashore on Cape Hatteras in 1938. Initially on Cape Hatteras, the National Park Service agreed to protect and maintain a line of barrier dunes constructed by the Civilian Conservation Corps in the 1930s. During the two decades after the initial land acquisition in 1952, more than $20 million were spent to build sand fences, to plant native vegetation, and to bulldoze, dredge, and pump sand in a losing battle of stabilizing the beaches and dunes. The massive attempts of stabilization were finally abandoned in the early 1970s in favor of a more dynamic approach that allowed nature to take its course. However, with shoreline erosion continuing to pose an imminent threat to the historic Cape Hatteras Lighthouse, the value and necessity of an adaptable shoreline management policy remains ever apparent.

Currently, the Natural Resources Management Guidelines (NPS-77) of the National Park Service require that where natural shoreline processes are not influenced by human actions, control be instituted only when required by law. When natural shoreline processes have been altered by human activities or significant cultural resources are threatened, alternatives for shoreline protection will be investigated. The National Park Service must also be in compliance with any provisions of state coastal zone management plans that may be environmentally more restrictive than National Park Service management zoning, with permitting requirements by the US Army Corps of Engineers under Section 404 of the Clean Water Act (33 U.S.C. 125) and Section 10 of the Rivers and Harbors Act (22 U.S.C. 401), and with any other applicable federal legislation such as the Endangered Species Act of 1973 (16 U.S.C. 153) and the National Environmental Policy Act of 1969 (42 U.S.C. 4321).

Beach at Indian River Inlet, Delaware

Photograph by Jean Burns

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