Solutions to Coastal Flooding: Can National Parks Turn the Tide?

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Coastal regions of the US have experienced rapid population growth and environmental change over the last half century. More than 39% of the US population, or over 123 million citizens, now live in coastal shoreline counties.[1] Residential and commercial development has taken up coastal lands and consumed water resources that formerly provided ecosystem services. As a result, coastal systems and communities are now more vulnerable to flooding. While the reasons for flooding are not new—storm inundation, extreme precipitation, and tidal flooding—they are worsening in many areas due to development, rising sea levels, and stronger storms.

Significant resources and assets in 80 ocean and coastal parks are located in low-lying areas of the coast where various parks and adjacent communities have suffered storm damage, and concerns about storm surge, erosion, and tidal flooding remain high. At the same time, ecosystem services in the national parks, national wildlife refuges, and state parks provide various levels of natural resilience to coastal flooding, such as drainage and dissipation of storm surge and flood waters via beaches, wetlands, and soils, and wave dissipation via oyster reefs and coral reefs. In many places, these public lands offer rare, undeveloped shorelines along our densely populated coasts, providing the public with significant recreational and economic benefits in addition to natural flood control.

The National Park Service (NPS) is tasked by Congress to preserve natural and cultural resources unimpaired and provide recreational opportunities, as well as maintain these natural floodplain values of parks. These difficult tasks take on an entirely different dimension, however, when vulnerable inland communities rely on coastal parks as barriers to protect public infrastructure and private property. Ill-conceived or poorly coordinated coastal engineering solutions, such as hard structures on park lands or adjacent to the park, will adversely impact park resources and values. Fortunately, NPS and state and federal partners can avoid

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these problems with rigorous preparation and cooperative planning. When partners align, they can bring solutions to the table that protect the integrity of parks and achieve their mutual goals.

Storm surge, tidal flooding, and sea-level rise—what are we facing?

Storm surge is the episodic rise in seawater level during a storm, caused primarily by a storm's winds pushing water onshore. Storm surge is the main driver of coastal flooding during most extreme storms. *Storm tide* is the total observed seawater level during a storm, resulting from the combination of storm surge and the astronomical tide.[2] As a result, the highest storm tides are often observed during storms that coincide with spring tides at a new or full moon. That is unfortunately what happened during Superstorm Sandy, which occurred near the time of the highest tide along the Atlantic Coast.

In late October 2012, Hurricane Sandy merged with a developing nor'easter to become Superstorm Sandy. Weather forecasters also called it "Frankenstorm." Sandy roared across the New York–New Jersey Bight as a giant tropical storm and produced record levels of storm surge and flooding, with an estimated $70.2 billion in damage across 13 states. In many locations, storm surge was accompanied by powerful, storm-driven waves. Neighborhoods, commercial areas, and several parks in the New York City area sustained major damage. In 2015, Hurricane Matthew struck the South Atlantic seaboard; and in 2017, a succession of three major hurricanes impacted the US. Extreme rainfall from Hurricane Harvey caused widespread flooding in the Houston area. Irma and Maria caused catastrophic damage to Puerto Rico and the Virgin Islands, including Virgin Islands National Park and other NPS units, islands, and communities in the Caribbean and South Atlantic. Hurricane Maria now ranks as the third-costliest weather disaster on record for the nation, and Irma ranks as the fifth costliest.[3] Ongoing recovery from these storms is slow and painstaking.

Storms represent the extremes in flooding risk and potential damage to coastal areas.[4] Storms are headline-grabbing, episodic events. Tidal flooding is more insidious. High-tide flooding may occur more frequently on a bi-monthly or even daily basis in low-lying areas, causing long-term, chronic damage to cultural resources and infrastructure. Recurrent high-tide flooding, known as "nuisance flooding," can overwhelm stormwater drainage capacity and prompt road closures, and frequent inundation or salt-water exposure can degrade buildings and infrastructure. Frequent flooding also submerges intertidal mudflats and wetlands, and may convert them to other habitats, or subsume them entirely. Archaeological sites also are at risk. High-tide flooding impacts have been increasing in frequency and duration, including at many US Atlantic and Gulf Coast tide gauge locations.[5]

Storm tides and high-tide flooding levels are getting higher as baseline water levels increase from sea-level rise. Changes in sea level relative to land vary in location and magnitude along US coasts due to geologic change (e.g., land subsidence in places on the Atlantic and Gulf Coasts versus rising land due to isostatic rebound in Alaska) and oceanographic factors. Many parks along the Atlantic and Gulf Coasts are particularly susceptible to inundation and flooding due to their low elevation in combination with sea-level rise.[6] Along the Pacific Coast, studies show that higher projected sea levels will magnify the adverse impacts of storm surges and high waves, including at Golden Gate National Recreation Area, where managers will continue to confront erosion and rising sea levels on both the Pacific Ocean and San Francisco Bay sides.[7] Alaska and Pacific island parks also confront significant coastal hazards from storms and tsunamis.

Flooding brings a heavy human toll and puts high financial burdens on taxpayers to repair damage. National policies are late to the game of guiding coastal development in sustainable ways.[8] As a result, much of the coastal zone has been developed on low elevations with higher probabilities of flooding. In this increasingly challenging environment, NPS and other state and federal public land agencies need to be at the fore of maintaining the ecosystem services and values of public lands.

Floodplains, wetlands and shorelines—natural processes aid coastal protection

Natural shoreline processes move water and sediments in ways that create and sustain wetlands, beaches, bays, and barrier islands. Coastal parks depend on floodplain functions that, if allowed to persist naturally, provide various levels of resilience to coastal flooding and sea-level rise. Maintaining these natural processes is critical to sustaining recreational opportunities and natural and cultural resource values in parks. NPS management policies follow federal floodplain policy in Executive Order 11988 (Floodplain Management), and stipulate that the agency will manage floodplains to protect, preserve, and restore the natural and beneficial values associated with them; avoid to the extent possible the long- and short-term adverse impacts associated with their occupancy and modification; and avoid direct and indirect support of their development wherever there is a practicable alternative.

For example, the geologic process of overwash is a floodplain function that contributes to the maintenance and evolution of barrier islands. When waves wash over the foredunes during a storm and deposit sediments on top of a barrier island, the sediment builds up the elevation. Sediment deposited via overwash actually tends to equal the rate of sea-level rise.[9] When water from storm surge overtops the dunes, or pushes through the barrier island, it delivers sediment all the way into the back bay. Sediment deposited in this way creates and sustains platforms for tidal wetlands on the landward sides of barrier islands. These seemingly radical changes are not destructive in the long run. In relatively undeveloped areas where sediment is free to move, it creates new landforms that allow the island to persist, albeit in a new form and location. NPS management policies recognize the importance of overwash and other natural shoreline processes, stipulating that "processes (such as erosion, deposition, dune formation, overwash, inlet formation, and shoreline migration) will be allowed to continue without interference."[10]

Coastal wetlands also provide important floodplain functions and values to the public, including significant storm protection. Research from The Nature Conservancy estimates coastal wetlands prevented more than $625 million in property damages during Hurricane Sandy.[11] Salt marshes and tidal flats lower flood heights and dissipate storm surge energy by storing and slowly releasing surface water, rain, snowmelt, groundwater, and flood waters, and distributing them more slowly over the coastal floodplain. Wetland vegetation stabilizes shorelines in rivers, bays, tidal wetlands, and estuaries by holding sediments in place with roots and absorbing wave energy that would otherwise cause erosion. Wetlands also filter runoff, are highly productive, provide habitat for a wide diversity of species, and serve as the foundation for coastal food webs. Coral reefs also buffer storm damage by dissipating wave energy.[12]

Protection and restoration of coastal wetlands on public lands is urgently needed. Coastal watersheds in the US lost an estimated 721,720 acres of wetlands between 1998 and 2009. These estimates represent only a small fraction of the extent of coastal wetlands lost over the last century.[13] In parallel to the Executive Order floodplains policy, NPS management policies recognize that the agency must manage wetlands in compliance with Executive Order 11990 (Protection of Wetlands).[14] This order requires NPS to prevent the destruction, loss, or degradation of wetlands, preserve and enhance their natural and beneficial values, and avoid direct and indirect support of new construction in wetlands, to the extent practicable. Pursuant to the order, NPS management policies establish a "no-net-loss of wetlands" policy. At the heart of this policy is a required infrastructure and resource management planning sequence of avoiding wetland impacts, minimizing impacts that cannot be avoided, and compensating for unavoidable wetland impacts at a minimum 1:1 acreage ratio (at least one acre of wetland must be restored for every acre degraded or destroyed).

Coastal armoring—harder is not necessarily better

Solutions to avoid flood damage from storm inundation and high-tide flooding can be costly and difficult to engineer. Various types of coastal protection structures have been used extensively to reduce flood damage or erosion to protect both private and public property, including coastal park properties and cultural sites. Bulkheads, seawalls, and revetments deflect waves from vulnerable property. Jetties and groins are placed perpendicular to the shore to divert and build up sediment. Beach nourishment (i.e., artificial replenishment of sediment, usually sand) is often combined with the use of these structures.[15]

In reality, hard structures typically interfere with natural shoreline processes. Hard structures interrupt the movement of water and sediment, and as a result may actually increase erosion in attempting to control it. Jetties and groins usually cause more erosion in downdrift areas of the beach, by trapping and interfering with the long-shore transport and accretion of sediments. When jetties are used to keep inlets open, they can prevent sediments from building deltas and marsh platforms that stabilize shorelines on the bay side.[16] Seawalls and bulkheads also disrupt natural processes. Instead of allowing wave energy to dissipate naturally, they block and deflect wave energy downward. This frequently results in scouring, steepening, and shortening of shallow wetland habitats over time.[17]

The growing number of bulkheads and seawalls in bays and estuaries has raised concerns over the erosional impacts of shoreline armoring. A 2015 analysis indicates that 14% of the contiguous US shoreline is already hardened and that 64% of armoring has occurred along Atlantic and Pacific sheltered shorelines, such as estuaries, lagoons, and tidally influenced rivers where valuable wetlands provide important ecosystem services.[18] Overall, these hard structures exacerbate erosion and disrupt natural shoreline processes. Eight states have realized that hard structures are self-defeating and have banned or restricted their use.[19]

The national park system contains a significant number of coastal engineering structures. An inventory of 19 coastal parks identified 997 engineering structures in or adjacent to them, which is only a subset of all structures likely to be present in or around the 80 ocean and coastal units of the national park system.[20] In a separate study, the University of Rhode Island evaluated the potential to reestablish exchanges of sediment and ecological functions in parks by removing shore protection structures, or allowing them to deteriorate, in the NPS Northeast Region. A total of 407 individual structures were found to obstruct waves and currents that shape coastal landforms and habitats, occurring in 10 of 12 parks studied. The authors suggest that 145 structures could be removed or allowed to deteriorate. Park-specific case studies and possible removal projects are identified. (The study rejects the removal option if impractical, counter to policy, or potentially destructive to existing built resources, historic sites, or habitats.[21])

Living shorelines—viable alternatives to hardening

Living shorelines techniques typically incorporate vegetation or other living, natural, "soft" elements, either alone or in combination with some type of harder shoreline structure (e.g., oyster reefs or rock sills) for added stability. By adopting more environmentally sensitive techniques to stabilize shorelines, living shorelines offer a suite of alternatives to stem the proliferation of hardened structures such as bulkheads and seawalls. According to NOAA (the National Oceanic and Atmospheric Administration), "living shorelines maintain continuity of the natural land–water interface and reduce erosion while providing habitat value and enhancing coastal resilience."[22] In hindsight, living shoreline construction in many locations involves restoring the functions of wetlands that were supplanted or modified by coastal development, ironically at much greater expense than if they were preserved in the first place. Living shorelines nonetheless offer alternative solutions to flooding and erosion problems that may conserve natural shoreline processes and habitats. The US Army Corps of Engineers ("the Corps") has adopted Nationwide Permit 54, authorizing construction and maintenance of living shorelines. Nationwide or General Permits are streamlined permits that allow certain construction activities in tidal waters and wetlands, without having to apply for an Individual Permit. States may adopt, disallow, or modify the General Permit by incorporating additional conditions into their own permitting processes.

For example, Canaveral National Seashore in Florida utilized living shorelines to protect archaeological sites at Mosquito Lagoon (Figure 1). Erosion caused by waves and storm surge threatens oyster shell middens left by the Timucua Indians between 800 and 1400 AD, which hold significant archaeological, environmental, and paleoecological data from the period. To buffer wave energy and protect this site, called Shell Mound, bags of oyster shells and oyster restoration mats were installed to provide substrate for oysters (*Crassostrea virginica*) to attach and form a living reef. To further dissipate wave energy and stabilize sediments, marsh grass (*Spartina alterniflora*) and mangroves (*Rhizophera mangle, Avicennia germinans*) were planted in the intertidal zone gradient. These natural features are stabilizing the shoreline while providing habitat and ecosystem services.

Figure 1. Workers install oyster shell mats as part of the living shoreline project in Mosquito Lagoon at Canaveral National Seashore. M. Schwadron/National Park Service photo.

Beach nourishment—feeding our appetite for higher and wider beaches

In contrast to coastal hardening, beach nourishment involves placing sediment on the eroded shoreline, to expand its width or elevation and replace sediment in the intertidal zone. To protect housing or infrastructure, dunes may be constructed behind the beach to provide additional height and planted with vegetation for further stabilization. Depending greatly on geologic factors and location, the engineered beach and dune system can provide protection from moderate storms and water-level rise up to the newly constructed height. At the same time, raising a beach higher than the natural elevation causes erosion and formation of a steep scarp that interferes with movement of endangered species and utilization of beach habitats by plants and animals (e.g., sea turtles, shorebirds, sea oats, etc).[23]

Most coastal protection projects undertaken by the Corps in communities along the Atlantic and Gulf Coasts have focused on protecting beachfront development, with a heavy reliance on beach nourishment. Depending on the purposes of the project and its design, natural shoreline processes or habitats may or may not benefit from this approach. Nourishment projects generally do not prioritize habitat values and ecosystem services when the primary goals are damage reduction, property protection, or retention of public beaches. Planning and project designs may give only cursory treatment to environmental issues. As a result, opportunities to maintain or restore habitats and reduce environmental impacts are lost.[24]

Beach nourishment projects can serve to restore sediments to beaches and wetlands impacted by coastal protection structures or development, as part of restoration or flood mitigation projects. Coastal parks have used beach nourishment to restore habitat and cultural sites. The NPS published beach nourishment guidelines in 2012 for staff to plan and manage beach nourishment projects. Ways to avoid impacts on beach invertebrates, sea turtles, and other flora and fauna are described, as well as methods for post-project physical and biological monitoring. Best management practices to ensure long-term performance of projects are discussed. (This document only applies after a decision has been made to conduct beach nourishment consistent with NPS management policies; managers must first decide whether nourishment should be used, or other strategies selected instead.[25]

Beach nourishment involves cost considerations along with environmental concerns. The initial project costs of nourishing beaches can rise by an order of magnitude as storms and natural processes erode sediments in the project area, and new replacements of sediment are needed to maintain the original project. Periodic renourishment over the course of years or decades may run into the tens of millions of dollars. In terms of costs and benefits from storm protection, studies and assessments of certain project areas impacted by moderate storms have found that beach fill and dune-building projects have protected communities from storm surge. Wider beaches also provide significant economic and recreational benefits from beach-related tourism and visitation.[26] The taxpayer costs of long-term renourishment can be controversial, however, particularly when hurricane relief provides a 100% federal subsidy to communities in vulnerable beachfront areas, relieving the local level from any fiscal responsibilities or assumption of risks.[27]

The process drives the solution

In national parks as elsewhere, typically the intent of hard structures, beach nourishment, living shorelines, or other options is to make buildings, cultural resources, and infrastructure less vulnerable to flooding and erosion. The challenge is to find the right solution, or to remedy previous attempts that are not working and are now negatively impacting park resources and values. Selecting the right alternative for a particular place requires a two-fold process: first, evaluating hazards and understanding the geologic setting, water levels, and influences of waves, wind, tides, and currents; and second, evaluating possible alternatives for compliance with the park's enabling legislation and agencywide mandates. Are the flood risks adequately understood, taking into account potential changes to water levels from storm surge and tidal flooding? Can living shorelines or restoration of natural floodplain values be used? What are the potential impacts to park wildlife, lands, and waters, and can these impacts be avoided or adequately mitigated?

The NPS *Coastal Adaptation Strategies Handbook* describes the challenges of adapting to sea-level rise and provides information resources for park managers. It compares and contrasts the costs, benefits, and impacts of protecting NPS cultural and facility assets in place using various coastal engineering approaches, including hard stabilization structures, beach nourishment, and living shorelines. Chapters on facilities, cultural resources, and natural resources describe approaches for adapting park assets to sea-level rise by incorporating vulnerability assessments. In addition, an expanded case study is included in a chapter entitled

"Lessons Learned from Hurricane Sandy" (see Figure 2). Accompanying the handbook is a compilation of many adaptation strategies that have been recommended, tried, and even dismissed at some national park system units.[28]

The challenges and complexities of responding to coastal flooding are greatly amplified for NPS when parks are affected by landscape-level projects designed to protect navigational channels, adjacent shorelines, and private property. The major federal partner in design and construction of these projects is the Corps. Its programs include hurricane and storm damage reduction, flood risk management, ecosystem restoration, emergency operations, coastal mapping, and coastal process modeling. Under a range of authorities the Corps works with sponsors (typically states and local entities) to examine the feasibility of projects related to coastal risk reduction, including beach nourishment, barrier island restoration, and engineered storm barriers. The Corps designs and constructs these projects contingent upon project-specific congressional authorization and appropriations. It also conducts maintenance dredging of navigational waterways.

While states and communities are understandably pressured to prevent storm damage, the resulting project designs may discount the role of NPS in conserving park resources and values, including wilderness, habitat and species protections, recreational access, and natural floodplain and shoreline processes. As noted earlier, planning and design of coastal engineering projects may fail to account for environmental and floodplain concerns. These pressures may place park managers squarely on the horns of a dilemma: How can NPS reconcile proj-

Figure 2. The National Park Service is monitoring the reopening of Old Inlet, a natural, barrier island-breaching process that occurred in 2012 during Hurricane Sandy in the Otis Pike Wilderness at Fire Island National Seashore, New York. R. Beavers/National Park Service photo.

ects designed for a different public purpose, i.e., protecting non-NPS coastal infrastructure or private property outside the boundary from flooding, while avoiding adverse impacts to park resources and values?

Balanced solutions for coastal flooding in parks

Clearly, state and federal planning processes need to explicitly account for and conserve the resources and values of parks, and use the best available science when evaluating flood risks and potential projects in or around parks. Collaborative planning can ensure that NPS and partners comply with park stewardship mandates. As a starting point, NPS should have a place at the table with federal, state, and local partners when flood protection plans start taking shape. NPS policies require the agency to work with partners and the public across administrative boundaries to achieve its mission of preserving park resources and values unimpaired.[29] As stated in the document *National Park Service Natural Resource Stewardship and Science Framework,* "Long-term conservation of park resources requires working successfully beyond the boundaries of any individual park or protected area…."[30]

The Corps is required by law and its own regulations to align itself closely with NPS's mandates for protecting park resources and floodplain values. In at least six coastal park enabling statutes, NPS and the Corps (acting for the secretaries of the interior and army respectively) are required by law to plan collaboratively, i.e., to achieve "mutually acceptable" plans for beach erosion control that comply with park protections in these enabling statutes.[31] The Water Resources Development Act (WRDA) also directs the Corps to protect natural resources and floodplains. WRDA is the main legislative vehicle for authorizing water projects to be studied, planned, and developed by the Corps. WRDA stipulates that "all water resources projects should reflect national priorities" including: "(1) seeking to maximize sustainable economic development; (2) seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing the adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and (3) *protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems"* (emphasis added).[32] Protecting and restoring floodplains and natural systems directly complements NPS policy.

The Corps or other entities seeking to conduct coastal engineering activities in parks also must obtain an NPS permit. Permits issued for any park must comply with the park enabling legislation and the overarching mandate of the NPS Organic Act to prevent impairment of park resources and values, and to prevent "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress."[33] An NPS-approved permit enables the agencies to ensure that any flood or erosion control projects avoid adverse impacts to parks, or to stipulate measures to mitigate those impacts.

The Corps also considers specific effects on national park system units in its own permitting regulations under the Rivers and Harbors Act and Section 404 of the Clean Water Act. These regulatory programs govern a wide range of activities in US waters, including coastal protection structures discussed in this article, dredge and fill operations, and protection of wetlands and floodplain values. The general policies for evaluating regulatory permits include historic, cultural, scenic, and recreational values, and require the Corps give "due consideration … to the effect which the proposed structure or activity may have on values such as those associated with wild and scenic rivers, historic properties and National Landmarks, National Rivers, National Wilderness Areas, National Seashores, National Recreation Areas, National Lakeshores, National Parks, National Monuments," etc.[34]

Early collaboration pays off

While these mandates provide clear direction to NPS and the Corps, achieving them requires timely and diligent collaboration. National Environmental Policy Act regulations emphasize early collaboration to avoid conflicts, *before* an environmental impact statement is prepared.[35] WRDA requires the Corps (acting for the secretary of the army), to identify "as early as practicable in the environmental review process" all federal, state, and local government agencies and Indian tribes that may have jurisdiction over the project, or project review or permitting responsibilities, and to invite the relevant agency to become a *cooperating agency*.[36] Cooperating agency status provides a formal means for NPS to provide needed technical expertise and input into decisions affecting areas under its jurisdiction, in advance of public review and comment.[37]

Where projects take place on or adjacent to park lands and waters, the Corps and NPS may benefit from serving as *co-lead agencies*. For example, Golden Gate National Recreation Area and the Corps' San Francisco District are co-leads for a beach nourishment project at Ocean Beach in 2018. Even in cases when NPS is not a co-lead or cooperating agency, early consultation is still critical to ensure that all partners are fully aware of the affected natural, cultural, and facility assets in the planning area, and that NPS is informed of partners' concerns. Once equipped with this information, the environmental review process that follows is much smoother and more efficient, and communication breakdowns are avoided.

Moreover, a recent executive order lends even greater urgency and value to interagency collaboration by setting a time limit of two years. Under Executive Order 13807 ("Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure"), "the Federal Government's processing of environmental reviews and authorization decisions for new major infrastructure projects should be reduced to not more than an average of approximately 2 years, measured from the date of the publication of a notice of intent to prepare an environmental impact statement or other benchmark deemed appropriate by the Director of OMB [Office of Management and Budget]." This two-year limit places a high premium on prompt and efficient collaboration.

The Corps and NPS as partners in restoration

As discussed, many coastlines in the national park system have been modified and natural shoreline processes impeded, degrading both natural and scenic values in parks. In these cases, policy, science, and practice can come together with stakeholder input to bring back natural shoreline processes and restore coastal landscapes. According to NPS management policies, "Where human activities or structures have altered the nature or rate of natural shoreline processes, the Service will, in consultation with appropriate state and federal agencies, investigate alternatives for mitigating the effects of such activities or structures and for restoring natural conditions."[38]

Various parks have worked with the Corps' capabilities to mitigate erosion and restore natural and cultural resources. Assateague Island National Seashore has one such project with the Corps' Baltimore District to restore and maintain the north end of Assateague Island and counteract the erosional impacts of the Ocean City Inlet jetty. Built in 1933 to stabilize the inlet for navigation, the jetty trapped sediment from reaching the north end of the barrier island. Over decades the north end retreated 500 meters landward, and lost elevation and width, leading to unnatural rates of overwash and erosion of peat, dunes, and shoreline, including habitat for threatened and endangered species. The first phase in 2002 was a one-time nourishment project that widened the beach by 30 meters over a distance of 10.5 kilometers. The second, long-term phase, begun in 2004, addresses the source of sediment starvation. Sand dredged twice a year from the inlet channel is moved and placed into the longshore current, a practice known as *sediment bypassing*. The sand is transported by the current and accretes onto the island. The project has been successful in partially restoring the position, width, and elevation of the north end, and preventing further habitat degradation or loss of geologic integrity. Physical impacts on park resources and wildlife from the nourishment project required mitigation.[39]

Figure 3. The northern end of Assateague Island National Seashore in Maryland (known colloquially as the "North End"), where a multi-year project is restoring the island position and elevation lost to erosion caused by the Ocean City jetty. National Park Service photo.

Past is prologue

In 1980, the National Park Service sponsored a Barrier Island Forum and Workshop in Provincetown, Massachusetts. Floodplain values, ecosystem, services and coastal protection problems were well recognized, not just at barrier islands but across the coast. Robert Herbst, the assistant secretary of the interior for fish and wildlife and parks, stated: "The systems help protect areas from the full force of ocean storms. They absorb the energy of the waves and reduce flooding.… The islands are tolerant of the great power of wind and water.… What they cannot tolerate is wood and concrete where they should never be. We can foresee the consequences, yet we build on dunes which, left alone, would replenish themselves. Then, we see them destroyed and then we build [on] them again, close to the sea, and challenge nature.… We need to improve the level of protection of lands which are already under public control. That will take further coordination and consultation between the public and many other local and federal agencies."[40]

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35. White House Council on Environmental Quality, 40 CFR § 1500.5.
36. WRDA, 33 USC § 2348(e).
37. NPS, *NEPA Handbook* (Washington, DC: NPS, 2015).
38. NPS, *Management Policies 2006*, § 4.8.1.1. See also § 4.1.5, "Restoration of Natural Systems," and § 4.4.2.4, "Management of Natural Landscapes."
39. B. Hullslander and C. Schupp, personal communication.
40. B. Mayo and L. Smith (eds.), *Proceedings, Barrier Island Forum and Workshop, Provincetown, Mass., May 1980* (Boston, NPS, 1982), 1–5.

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