



CAPE HATTERAS
NATIONAL SEASHORE

Shorelines & Science Face Uncertain Times

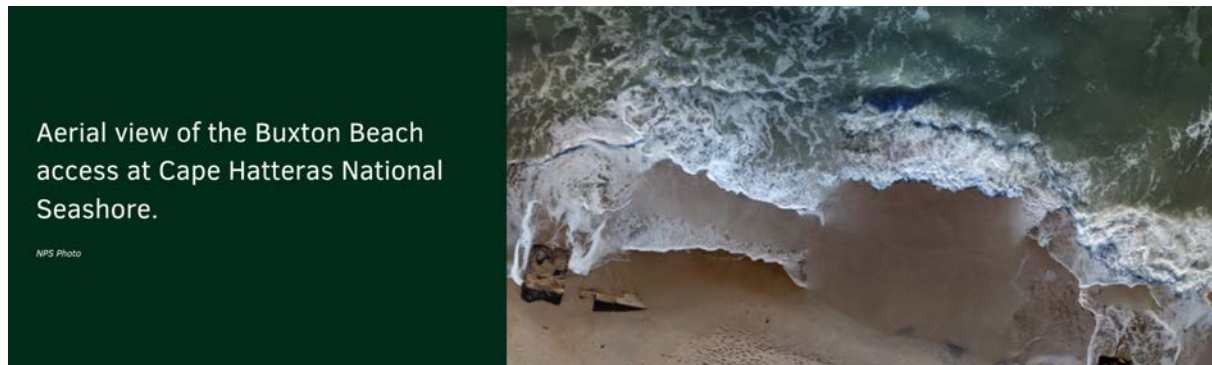


On the outer edges of the coast of North Carolina lies a narrow strip of land known as the Outer Banks. “The communities that live there, both wild and human, hold stories and lives as unique as the windswept landscape,” shared Hillary Harrison, a former National Park Ranger at Cape Hatteras National Seashore.

The Outer Banks is protected as part of that national seashore, and its survival and stories depend on the thoughtful management of the National Park Service.

The shorelines on the Outer Banks are in constant motion. The wide, sandy beaches can be reshaped overnight by the rising tide, passing storms, or shifting sands. Cape Hatteras National Seashore, located on the northern coastline on the Outer Banks, stretches 70 miles from Bodie Island to Ocracoke Inlet, and encompasses 24,470 acres of beaches, marshes and wetlands.

These rugged barrier islands are defined by change. In managing the future of Cape Hatteras National Seashore, science provides a pathway to understand what physical and biological changes are happening and how park managers can make informed decisions on the future.



Aerial view of the Buxton Beach access at Cape Hatteras National Seashore.

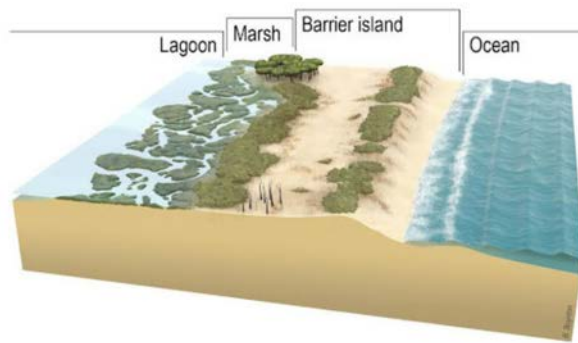
NPS Photo

A Landscape Defined by Climate Change

Waves, storms, and the shifting of sand have shaped these islands for centuries. These natural processes cannot be stopped, a dynamic that has been clear for nearly a century. What is unclear is how the increasing intensity of storms and sea level rise will affect Cape Hatteras for the decades to come.

Barrier island dynamics, coupled with impacts from sea level rise and climate change are actively reshaping coastlines at Cape Hatteras National Seashore every day. The seashore's 2016 [State of the Park](#) report stresses the urgency of collecting scientific data for long term planning needs and to further understand the potential impacts of climate change.

“Scientific information to help understand the current and projected impacts of climate change and sea level rise is also critical to improving park management. Projected sea level rise impacts may make it difficult, if not impossible, to preserve all resources and experiences.”



This illustration of a Cape Hatteras barrier island cross section shows the Atlantic Ocean on one side and the Pamlico-Albemarle Sound on the other.

USGS Illustration by Betsy Boynton.

The NPS is already being called upon to adapt to these changes, although there is still much to learn and was again emphasized in the key issues for management planning in the 2016 State of the Park report.

“The impacts of climate change on the frequency, magnitude, and intensity of storms are unknown, it is likely that sea level rise will exacerbate storm impacts. Consequently, the park faces difficult and complicated decisions regarding where, when, and if to rebuild structures and visitor facilities post-storm. Therefore, collecting scientific information such as physical monitoring data, vulnerability analyses, and appropriate scenario plans will help set the stage for long-term planning.”

“In February 2026, the [Relative Vulnerability of US National Parks to Cumulative and Transformational Climate Impacts](#) was published. The study finds that 67% of national parks are exposed to one or more potentially transformative climate change impacts including fire, drought, sea-level rise, and forest pests and diseases. In the case of coastal parks like Cape Hatteras National Seashore, “they remain threatened by rising seas and storm surge... once such transitions occur, returning to previous ecological

conditions may be impossible.”

The outermost edge of Cape Hatteras. Capes are the result of complex sediment transport processes and generally jut out into the ocean, away from the rest of the coastline. This image was taken as part of study to better understand the regional sediment dynamics along the coastline of North Carolina.

USGS Photo by Donn Blackwood.



The report underscores that “these widespread, diverse threats highlight not only the need for coordinated evaluation of vulnerabilities from multiple perspectives, but also the need for park managers to evaluate and plan for potentially irreversible ecological changes to the landscapes and resources that parks are intended to preserve.”



Lightning strikes on the beach of Cape Hatteras National Seashore. NPS Photo.

The National Park Service is entrusted with the care of 433 units covering more than 85 million acres across the United States. As climate change impacts intensify, policies weaken, and the public demands action. Park managers are seeing species disappear and ecosystems transforming in just a short amount of time.

Although responding to climate change is not new, in 2023 the agency reaffirmed the need for an accelerated and adaptive approach. Meeting this moment requires strong leadership at all levels and a commitment to be a learning organization, “one that

equips its workforce with the skills to respond, encourages innovation even when outcomes are uncertain, and actively shares lessons learned” ([NPS Climate Change Response Strategy](#)).

Future Investments & Strategic Decisions Are Required

Given the anticipated challenges due to climate change on the horizon, the NPS needs to be strategic when it comes to planning and the associated costs. A framework of science-driven research and an understanding of the long-term viability of park infrastructure and investments are necessary to shift from reactive management to proactive adaptation in our national parks.

In a place where the land itself is shifting, science is essential for making informed, cost-effective decisions. “The National Park Service is obligated to use best-available science to inform decision-making. Ongoing scientific monitoring at Cape Hatteras National Seashore reveals patterns in erosion, overwash, and sea level rise. It allows park managers to detect trends, anticipate risks, and make proactive decisions that protect ecosystems, infrastructure, and visitor experiences,” shares the ([National Park Service](#)).

At Cape Hatteras National Seashore, the estimated cost of deferred maintenance is \$183 million for existing buildings, roads, water systems, campgrounds, housing, and trails that, if left untouched, will fall into further disrepair. Many of these deferred maintenance needs are tied to impacts of climate change.



Frisco Beach access construction to expand parking lot stall and access for park visitors in 2021.

NPS Photo.

The significant investment required for addressing these needs involves making improvements, rebuilding, or relocating structures at Cape Hatteras National Seashore that have been or will be impacted by rising tides. The NPS is not only grappling with the current shoreline but also identifying where that shoreline will be in the future, so they know which resources and structures to protect. Long term monitoring and predictive modeling are necessary to help park managers avoid costly rebuilds in high-risk areas,

relocate infrastructure to more resilient locations, and partner with local, state, and federal agencies to better understand and plan for future changes.

In 2018, Hurricane Florence impacted parking and beach access at the old Frisco Pier in the national seashore. Millions of dollars were required to restore this area. Rather than just repaving and making repairs, national park staff were able to evaluate erosion data and erosion rates that modeled where the shoreline would be in 10 years. Modeling revealed the shoreline would migrate into the middle of the parking lot, and in another 20 years, the parking lot would be covered completely by ocean water. Rebuilding the parking lot would not be a sound investment in the decades to follow.

Given this information, NPS staff worked to find alternate locations further down the beach. Using the same process of analyzing erosion data and shoreline modeling, a new location for the Frisco Beach Access area was identified as a reliable and better investment for the future.

Where Private Homes Meet Public Lands



Debris along Cape Hatteras National Seashore from a home that collapsed in Rodanthe, NC in 2024. NPS Photo.

Cape Hatteras National Seashore has a complex management situation, involving management of park lands that intersect with infrastructure from local villages, such as Rodanthe and Buxton. Homes on the ocean, vulnerable to erosion and overwash, are built on the border of the national park. These privately-owned homes on the seashore are typically built on pilings with concrete driveways, parking pads, and septic systems. Since 2020, 31 privately-owned houses have collapsed due to sea level rise and 20 of those 31 collapses have occurred since November 2025. Although they are privately-owned homes, erosion has caused boundary lines to shift, which resulted in the national seashore shouldering the responsibility for the clean-up from the collapsed homes.

In December 2024, the National Park Service was required to report to Congress on erosion hotspots at Cape Hatteras National Seashore, impacts to structures and infrastructure, possible solutions, associated costs, and potential actions related to state, county, and partner activity. The report discussed the threats of climate change and sea level rise that will exacerbate erosion and increase the urgency.

In addition to the debris from the buildings, the parks will need to continue to address the pollution from septic systems that creates environmental hazards that impact habitat, wildlife, and water quality in the national seashore and beyond.

The NPS has acknowledged it must continue to use sustainable solutions with the “establishment of a broad set of adaptation tools, including the removal of threatened oceanfront structures; relocation and elevation of roadways in the form of bridges; implementation of alternative transportation options, including more ferry and air travel; and strategic implementation of beach nourishment in some locations and as an interim solution.”

Cape Hatteras National Seashore employees clean up debris on the beach from a collapsed home on September 25, 2024.

NPS Photo.



Understanding the rapidly changing world and complexity of the barrier island systems through data and scientific research, in addition to the unique situation with ever-changing park boundaries, provides the framework to navigate challenges facing Cape Hatteras National Seashore.

It illuminates what can be sustained, where to retreat or relocate when needed, and how to continue to balance visitor access with resource protection. In the case of Cape Hatteras National Seashore, the most sustainable decision is not to always rebuild and do what has always been done, but instead to adapt and see if there is a better way.

Essential Monitoring to Protect Vulnerable Wildlife

Critical habitat for protected species depends on the processes of Cape Hatteras' dynamic barrier islands for their survival. As shared in the [park's significance statements](#), "the seashore supports resident and seasonal populations of federally listed and state-listed plants and animals including species such as the piping plover, American oystercatcher, gull-billed tern, green sea turtles, loggerhead sea turtles, and seabeach amaranth."



A gull-billed tern chick within the colonial waterbird colony on Ocracoke Island, Cape Hatteras National Seashore.

NPS Photo

Long-term monitoring at Cape Hatteras National Seashore has allowed the NPS to take management actions such as temporary closures, buffer zones, and vehicle restrictions to allow wildlife like nesting shorebirds and turtles to survive.

Protections for Piping Plovers

For decades, the NPS has provided crucial and consistent data and monitoring that includes the tracking of nests, chicks, and changing habitat conditions for beach nesting shore birds, which are especially sensitive to human disturbance. After witnessing firsthand the great lengths shore birds must endure in order to survive, it's clear to Mike Murray, a former superintendent of Cape Hatteras National Seashore, that,

“without daily monitoring of nesting areas to install and maintain protective buffer zones around nests, an entire nesting season can be lost.”

As a result of balancing recreational access and protection for wildlife, monitoring goes hand in hand with the NPS Off Road Vehicle (ORV) Management Plan completed in 2012. The ORV plan informs how park management provides safe beach access for visitors while also ensuring the protection of wildlife. This management is especially critical during nesting season for endangered species and other wildlife on the seashore.



The first piping plover nest of the season was found on Ocracoke Island. NPS Photo.

The delicate piping plover can look like a ball of sand with legs, about seven inches long and well camouflaged on the beach. Monitoring identifies nests, and marks and protects them, but once hatched, a piping plover chick's buffer zone will need to increase as they traverse great distances across the sand. “Though tiny, these well camouflaged birds must travel long distances across the wide sand beaches to reach the shoreline for their food,” says Murray. “If you are driving on the beach, it can be nearly impossible to see them and there can be disastrous consequences. Monitoring helps to ensure the plovers' survival.”

Buffer zones that are made of wooden stakes, flagging, rope, and signs indicating a resource protection area have been put in place by biologists to keep out cars and pedestrians. The buffer zones around piping plovers' nests are expanded once they hatch in order to safely cover the distance plovers need on the beach to travel back and forth to the shoreline for food.

Sea Turtle Nesting and Recovery

Cape Hatteras National Seashore has monitored sea turtle activity since 1987. These ocean dwelling reptiles, some measuring up to 6 feet long, travel thousands of miles using the earth's magnetic field to land at Cape Hatteras. The most common sea turtle nesting on the seashore is the loggerhead sea turtle, though green turtles, leatherback, Kemp's Ridley, and hawksbill sea turtles will nest along the seashore as well.



All five species of turtles are protected under the Endangered Species Act and can take more than 30+ years to reach sexual maturity. The seashore serves as the nesting grounds where female sea turtles make the journey to return to the beaches they were hatched to deposit their eggs in the sand.

Nesting can take hours, as female sea turtles come ashore at night to dig their nests and lay about 100 eggs. Yet only one in 1,000 to 10,000 hatchlings survives to adulthood. From the moment they emerge, hatchlings face threats from predators, artificial lights, vehicle strikes, and the many dangers of the open ocean. An important element of the 2012 ORV Plan is that it prohibited beach driving at night during the turtle nesting season. This has reduced direct conflicts between ORV's and nesting sea turtles, which has resulted in substantial increases in the number of turtle nests occurring at the seashore annually.

During nesting season, daily monitoring allows NPS biological technicians to identify new nests laid the night before and mark off areas for their protection. In 2021, the NPS protected over 300 loggerhead nests, resulting in approximately 30,000 potential

hatchlings. Monitoring nesting turtles also allows scientists to understand how temperature affects hatchling sex ratios. Typically, cooler temperatures lend to more males and warmer temperatures produce more females. This is especially important to understand as ocean temperatures increase due to climate change.



An NPS Biological Technician observes a day nesting loggerhead sea turtle on Ocracoke Island. NPS Photo.

Close monitoring of sea turtles by NPS staff can be critical in emergency situations as well. Former Superintendent Mike Murray recalls an incident that occurred prior to the ban on night driving during the turtle nesting season. A nesting sea turtle was run over by an ORV driving on the beach at night. Unfortunately, the turtle could not be saved but NPS biological technicians, who discovered the carcass during their morning beach patrol, were able to successfully salvage the turtle's eggs.

The self-incubating eggs were buried in the sand and, two months later, NPS staff observed a number of sea turtle hatchlings emerging from the nest and making their way to the ocean. The ability for the NPS to discover and quickly respond to this incident is the reason those hatchlings were able to survive. "The NPS has the responsibility to protect those species," says Murray. "The key for sea turtle nesting success at Cape

Hatteras is to have well trained NPS staff available to conduct daily beach patrols in order to identify and protect new nests; and then to regularly monitor nesting areas until hatching occurs.”

The biggest threat to the sea turtles at Cape Hatteras National Seashore remains human activity. Understanding this threat has led to science-informed, management decisions like the implementation of night driving restrictions to reduce sea turtle nesting disturbance and improve overall nesting success.

Collectively, these efforts demonstrate that science-based management works and can continue to be effective with sustained staffing and resources

Conclusion: Parks are Proof

The mission of the National Park Service is to preserve and protect natural and cultural resources, unimpaired for future generations. Murray strongly believes that “it’s worthwhile for people who may never even visit Cape Hatteras to know these places are being taken care of by the National Park Service.”

For Cape Hatteras National Seashore, that mission means taking action to adapt to the forces of climate change and sea level rise that are impacting the park today. It means using data, monitoring, and park staff to help protect wildlife and habitat. Science informs our park managers where to invest, what to protect, and when to step back when something is no longer sustainable.

To ensure that national parks, like Cape Hatteras National Seashore, are available for the enjoyment of future generations, then it is clear we must continue to invest in science in our parks.

Cape Hatteras National Seashore is on the frontlines of the battle with climate change. There are challenges ahead, but we have seen proof that science-based management decisions help us better understand, adapt, and plan for the future.

Parks are proof, not just of change, but of how we can respond for a better tomorrow.