

National Park Service

Report to Appropriations Subcommittees on Interior, Environment, and Related Agencies Mitigating the Impacts of Threatened Oceanfront Structures and Infrastructure

Cape Hatteras National Seashore—2024

Background

Cape Hatteras National Seashore (Seashore) was the first seashore authorized in the United States. Authorized by Congress in 1937 and established in 1953 ([Aug. 17, 1937, ch. 687, sec 1, 50 Stat. 669](#)), the Seashore’s enabling legislation states that, “except for certain portions of the area, deemed to be especially adaptable for recreational uses, particularly swimming, boating, sailing, fishing, and other recreational activities of similar nature, which shall be developed for such uses as needed, the said area shall be permanently reserved as a primitive wilderness and no development of the project or plan for the convenience of visitors shall be undertaken which would be incompatible with the preservation of the unique flora and fauna or the physiographic conditions now prevailing in this area” ([50 Stat. 669 Section 4](#)).

Visitors come to the Seashore to enjoy the pristine beaches, engage in water-based recreational activities, camp, visit iconic historic structures such as lighthouses, and learn about the area’s rich history. Over the past decade, approximately 2.6 million people visited the Seashore annually, with a record 3.2 million visitors in 2021. Seashore beaches stretch 75 miles between south Nags Head on the Currituck banks and all along Hatteras and Ocracoke Islands, with hundreds of additional miles bordering the Albemarle and Pamlico Sounds.

The lands are made up of soft sediments, such as sand, and sections of the Seashore are quite narrow—sometimes less than 0.25 mile wide. The Seashore’s lands are very dynamic. Shorelines recede in many areas due to erosion and grow in some areas as sand accretes. Inlets sometimes form and persist or fill in as barrier islands are breached from storm activity. Almost all ocean-facing beaches at the Seashore are eroding, with some areas experiencing several meters of erosion annually (Flynn et al. 2023). The history of dune building to protect developed villages, Seashore facilities, and roadways have disrupted typical barrier island overwash processes that help to sustain them, thereby exacerbating erosion, sometimes from both sides of the islands (Riggs et al. 2009; 2011).

Since before the Seashore’s establishment in 1953 and for decades after, substantial efforts were made to stabilize the barrier islands through an erosion control program that included the building of dunes, installation of sand fencing, planting of trees and shrubs, and filling of island breaches. In the 1970s, on the basis of internal park research and reporting, Seashore management discontinued implementation of large erosion control projects because observations indicated that much of the Federal investment in erosion control was lost due to continued erosion and storms. However, over the past decade, partner agencies have expressed interest in implementing beach nourishment projects at the Seashore to protect important community infrastructure, such as North Carolina Highway 12 (N.C. 12) in highly vulnerable areas. For example, in 2015, Dare County proposed beach nourishment along an approximately 3-mile-long section of beach to protect a section of N.C. 12 in Buxton that was frequently experiencing ocean overwash and

affecting transportation. Seashore management reviewed the County’s application, prepared an Environmental Assessment, and issued a permit for beach nourishment in Buxton in 2017.

Recognizing that the County would submit another request to renourish the beach in Buxton within a few years, and on the basis of requests to nourish the beach in other areas, in 2020, Seashore management began preparation of a Sediment Management Framework (the framework) through the preparation of an Environmental Impact Statement (EIS). The purpose of the framework was to develop a streamlined framework for permitting sediment management at the Seashore, including the method, locations, and frequency for sediment management actions that may be permitted over the next 20 years. A Record of Decision was signed in 2021 that implemented a new framework for issuance of special use permits to agencies, including the North Carolina Department of Transportation (NCDOT), Dare and Hyde Counties, and the U.S. Army Corps of Engineers (USACE).

Under the framework, permits may be provided for beach nourishment projects that protect critical infrastructure, such as roads, bridges, electrical transmission facilities, and other public transportation facilities; to repair island damages, including breaches that also affect transportation; and to restore habitat through the placement of dredged sediment along eroded sections of barrier islands. The framework prescribes the frequency, locations, special conditions, and monitoring requirements necessary to permit sediment management projects while avoiding and minimizing impacts to the environment.

Many locations are explicitly described in the framework as likely to be considered for sediment management, such as around the N.C. 12 hotspots and other locations identified by partner agencies. Other locations where community infrastructure is not at risk are described as reference areas. A permit to nourish the beach to protect N.C. 12, consistent with tenets of the Sediment Management Framework, was issued to Dare County for its 2022 Avon and Buxton beach nourishment project.

Erosion Hot Spots

Although no universal definition of an *erosion hotspot* exists, it can generally be defined as a location where ongoing erosion is affecting something of value to the public. Shoreline change analyses along the Seashore document systemic landward migration of the barrier islands and many local erosion hotspots that affect island width and the road-based transportation corridor and other infrastructure (Flynn et al., 2023; Flynn and Hallac, 2021; NCDOT, 2019). For example, shoreline change statistics—calculated as a linear regression rate from mapped oceanfront shoreline positions between 1998 and 2022—yield an average rate of -1.25 meters per year for the extent of the Seashore (Flynn et al., 2023).

Neighboring Communities

Erosion hot spots occur in front of portions of neighboring communities at the Seashore, most notably in areas of the Villages of Rodanthe, Avon, and Buxton. Beach erosion coupled with the location of homes near the beach results in the presence of threatened oceanfront structures. Erosion has resulted in dozens of threatened oceanfront structures, some of which often are surrounded by water, even at low tide. These structures, broadly described as being situated on the open beach and highly vulnerable to erosion and wave action from the ocean, are challenging

for owners to maintain, and they often have impacts on the adjacent public beaches, natural resources, and visitors. Pieces and parts of homes—including decks, stairs, driveways, septic systems, etc.—often break apart and litter the Seashore beachfront. The ongoing presence of threatened oceanfront structures in the Villages of Rodanthe and Buxton, the two most significant communities directly affected by erosion, have affected visitor safety and enjoyment, public health, and wildlife habitat. Ultimately, catastrophic collapse of threatened oceanfront structures may occur. Ten threatened oceanfront structures collapsed in Rodanthe between 2020 and 2024, resulting in significant impacts to the Seashore because debris is typically carried by longshore currents more than a dozen miles from the collapse site. Removing debris to restore beach areas may take weeks or even months.

Beach nourishment to protect N.C. 12 was implemented in front of Buxton in 2018 and 2022. Threatened oceanfront structures in Buxton received incidental benefits from those nourishment projects because the beach was built out by hundreds of feet, and new dunes were constructed to protect areas to the west from wave action. The 2018 and 2022 beach nourishment projects in Buxton were successful in protecting N.C. 12 from direct damage. However, the projects have not completely stopped ocean overwash from affecting the highway and nearby side streets or created a stable beachfront that protects threatened oceanfront structures.

Within two years of the 2022 project, erosion—particularly during the spring of 2024—washed away large sections of newly constructed beach and dunes and damaged 10 homes to the point that most were not occupiable until repairs were made. Parts of damaged structures, including septic drain fields, washed down the beach and littered miles of Seashore beaches near the location of the Cape Hatteras Lighthouse. Whereas erosion is currently affecting houses and roadways in the Villages of Rodanthe and Buxton, eventually, erosion and a receding beach in many other villages is likely to result in the presence of threatened oceanfront structures in other villages on Hatteras Island.

Transportation Corridors

N.C. 12 is the primary transportation route at the Seashore beginning in the north at an intersection with U.S. 158 in Nags Head and continuing along Hatteras and Ocracoke Islands. A small portion of the highway is maintained by Seashore management along the northern boundary, but most of the highway is maintained by the NCDOT. The roadway connects eight unincorporated villages in Dare and Hyde Counties and provides for resident and visitor travel, the transportation of goods and services, and emergency transportation associated with medical emergencies and evacuations during storms. The Marc Basnight Bridge spans the Oregon Inlet and connects N.C. 12 from the north to Hatteras Island. Hatteras Island is connected to Ocracoke Island through a Hatteras-Ocracoke ferry operated by the NCDOT.

Chronic erosion of beachfront and dune areas has resulted in several highly vulnerable locations along N.C. 12, often referred to as N.C. 12 hotspots. The hotspots are generally described from north to south as (1) the canal zone, (2) the Pea Island visitor center, (3) the S-turns, (4) Avon, (5) north Buxton, (6) Frisco to Hatteras Village, and (7) northern Ocracoke Island. These hotspots experience dune loss; ocean overwash, where waves wash over the dune and into the roadway; and, sometimes, damages to the roadway. Those conditions can result in temporary closures of N.C. 12, dangerous driving conditions, and a general loss of transportation reliability. Erosion rates at the N.C. 12 hotspots range between -1.44 and -4.51 meters per year (Flynn et al. 2023).

The N.C. 12 hotspots are vulnerable sections of the primary transportation route along the Seashore, and they often are closed when elevated ocean conditions affect the roadway. Those conditions may occur several times each year. N.C. 12 hotspots are not the only corridors affected by coastal hazards. In locations such as Rodanthe and Buxton, large waves often wash over the dunes or under threatened oceanfront structures, flood secondary roadways, and affect community transportation. Roads can be partially or completely flooded for hours or days following these events, which also typically occur several times each year.

Update on N.C. 12 Task Force Activities

The N.C. 12 Task Force was formed in 2020 to help form consensus around conceptual solutions to improve transportation reliability at N.C. 12 hotspots. The task force and an associated subcommittee representing local communities; Federal, State, and local agencies; and environmental nongovernmental organizations evaluated the science surrounding the N.C. 12 hotspots and existing NCDOT feasibility studies on the topic. After evaluating relevant information and discussing alternative conceptual solutions, the team prepared a report in 2023 recommending the construction of bridges around all the N.C. 12 hotspots with one exception, the hotspot on the northern end of Ocracoke Island. At that location, the report acknowledged that erosion at the Southdock terminal, the docking facility on the northern end of the island, may make maintaining that facility in addition to the hotspot location on N.C. 12 difficult. Therefore, the report suggests exploring the potential relocation of the Southdock terminal to a location closer to Ocracoke Village.

Recently, members of the N.C. 12 Task Force assisted the NCDOT with its submission of a grant application to the Bipartisan Infrastructure Law's (BIL's) Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT) Grant program. The project proposal, titled *Solving Access for N.C. 12 in Dare County (SAND)*, seeks to develop long-term comprehensive plans to improve the resilience of the highway along two of the N.C. 12 hotspots, the Canal Zone and Pea Island Visitor center corridor, an approximately 11-mile-long section of vulnerable highway. In the spring of 2024, NCDOT was awarded \$1.865M to implement the project, with an estimated completion date by the end of 2026.

Potential Beach Renourishment Solutions

In 2023, Dare County released a summary report titled *Rodanthe Sand Needs Assessment*, prepared by Coastal Science & Engineering. The report evaluated the volume of sand needed to offset erosion and maintain the beach in the northern 2 to 3 miles of Rodanthe. In summary, the report indicates that about 3.8 million cubic yards of sand would be needed to restore the sand deficit and provide protection for five years along the northern section of Rodanthe. The cost associated with an initial five-year project was estimated at about \$40M, and total costs projected for 30 years, assuming a five-year renourishment interval, are estimated at \$175M.

The report also concludes that the installation of groins, or hardened structures that stop or slow long-shore transport of sand to the south, along with beach nourishment would have a higher initial investment cost but be less expensive over 30 years. The report did not evaluate the unintended consequences of groins that would likely occur following their installation. Although the potential installation of groins may slow erosion in areas upstream of the prevailing longshore currents, they would, if effective, starve downstream areas of sand, which could

exacerbate erosion on beaches farther south in the villages. In addition, hardened erosion-control structures are not permitted along oceanfront beaches in North Carolina.

Following the release of the summary report, Dare County submitted a grant application to the Federal Emergency Management Administration's (FEMA's) Building Resilient Infrastructure and Communities program requesting approximately \$40M to implement beach nourishment in Rodanthe. In July 2024, FEMA released the results of the grant application process, indicating that Dare County's application was not approved for a grant award. The National Park Service (NPS) is not aware of other sources of funding to implement a beach nourishment project to protect community infrastructure in Rodanthe.

USACE implements beach nourishment projects in some coastal areas for the purposes of reducing flood damages associated with storms. USACE is generally authorized to conduct feasibility studies to determine if the costs associated with beach nourishment in Rodanthe justify the savings associated with flood damage reduction that would be provided by beach nourishment. NPS is not aware of future plans by USACE regarding a feasibility study for beach nourishment in Rodanthe. If such a study were to be completed and the study indicated that beach nourishment provided flood damage reduction that justified the costs, USACE would then need appropriations to design and implement a project.

Regarding cost-benefit analyses associated with beach nourishment, the Western Carolina University Program for the Study of Developed Shorelines analyzed the cost of buying approximately 80 threatened oceanfront structures in Rodanthe, including the losses in property tax revenues, as an alternative to beach nourishment (Young 2023). The study author concluded that the cost of beach nourishment would be approximately three times greater over a 15-year period than buying the threatened structures. The Western Carolina University study generated public and agency discussion on the topic, and those discussions will likely continue as solutions are sought for threatened oceanfront structures.

To test the prospect of buying threatened oceanfront structures, Seashore management implemented a pilot project to mitigate the impacts of threatened oceanfront structures in Rodanthe by purchasing two structures and restoring the beach in late 2023. The pilot project was successful; Seashore management purchased two homes at fair market value using Land and Water Conservation Funds, removed the structures, and restored the beach by eliminating all hazards affecting the beach. Seashore management are evaluating plans to develop an expanded program by seeking local, State, and nonprofit partners interested in collaborating to acquire additional threatened oceanfront structures to protect Seashore beaches, nearshore waters, and visitors using those areas.

The Future

Cape Hatteras National Seashore was established more than 70 years ago on a very dynamic set of barrier islands that have been changing for thousands of years. The goal of maintaining community infrastructure in place adjacent to the beach has proven challenging, and some engineered solutions have unintentionally affected natural island renewal processes and exacerbated erosion. Beach nourishment has proven to be a short-term, but effective, solution for protecting certain resources at risk, such as N.C. 12. However, long term, local, State, and Federal agencies are recommending the implementation of more sustainable transportation

solutions that avoid or bypass erosion hotspots and allow the barrier island in those locations to function naturally.

Projections for 10 to 14 inches of sea level rise and a 10-fold increase in the frequency of damaging flood events by 2050 present challenges that will require adaptation planning in coastal villages along the Seashore to develop a sustainable future (Sweet et al. 2022). Climate change and sea level rise are likely to exacerbate erosion and increase the complexity and urgency associated with adapting to change along low-lying and highly dynamic barrier island systems. Sustainable solutions will require 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.

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