Live Dunes and Ghost Forests: Stability and Change in the History of North Carolina's Maritime Forests

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At the point where land and ocean meet, biology and geology coalesce to produce a landscape unlike any other. A ribbon of sand lines the coast of North Carolina in a chain of barrier islands that in few places is more than a half mile wide and thirty feet above sea level. These islands are inhabited by a unique collection of plants adapted to survive the salt spray, hot sun, and moving sand that define this protean landscape. Low and narrow, this string of barrier islands is often inundated by storm tides. Inlets connecting sea and sound are cut across the islands by these tides and migrate down the coast with longshore currents. Waterfowl flocks and fish schools also migrate up and down the coast with the seasons.

From the live oak woods of Smith Island to the tall pines of Buxton Woods and the mixed hardwoods of Nags Head Woods, maritime forests occupy the most stable areas. These ocean-bounded woodlands are the most complex and least studied of the barrier island vegetation types.[1] Centers of biodiversity, they have also been the centers of human habitation since before Europeans settled in America. In the mid-nineteenth century, perceptions of the natural world began to change, as early conservationists brought ideas about natural harmony from the mainland to the maritime forests of the Outer Banks. In the 1930s, these ideas informed government programs that transformed the landscape of the banks and laid the foundation for the development of a tourist-based economy in the region. Throughout the area's tumultuous history, maritime forests have stood as emblems of stability in this inconstant land.

Stories about the forests of the banks have been told for the better part of two centuries, and many accounts of the ecological history of the Outer Banks describe the

1. Dirk Frankenberg, *The Nature of the Outer Banks: Environmental Processes, Field Sites, and Development Issues, Corolla to Ocracoke* (Chapel Hill: University of North Carolina Press, 1995); David A. Burney and Lida P. Burney, "Recent Paleoecology of Nags Head Woods on the North Carolina Outer Banks," *Bulletin of the Torrey Botanical Club* 114, no. 2 (1987): 156-168; C. W. Brown, "A Palynological Study of Peat Layers from Jeanette Sedge, North Carolina Outer Banks" (master's thesis, Smith College, 1983); Vincent Bellis, *Ecology of Maritime Forests of the Southern Atlantic Coasts: A Community Profile*, Biological Report no. 30 (Washington, D.C.: National Biological Service, U.S. Department of the Interior, 1995).

deforestation of Hatteras Island in religious, moral, even mythic terms. The notion of a stable, primordial maritime forest devastated by human intervention took hold among islanders, historians, and scientists alike. There is strong evidence, however, that the Outer Banks were never totally forested and that the live dunes that threatened the maritime forests in the nineteenth and early twentieth centuries were primarily the result of geologic and climatic, not anthropogenic, processes.

In the decades following the Civil War, veterans of the Union campaigns in the Tidewater region returned to the Tar Heel State. They sought to profit from the development of the state's rich fisheries, investing in ice plants and modern fishing gear. Fish factories opened in the Beaufort area to make fertilizer out of menhaden. By 1890, an expanding cash economy operated on the Outer Banks, alongside the subsistence economy that had predominated in earlier periods.[2]

The area appeared to be undergoing an environmental transformation as well. In 1890, the adventurer-journalist John R. Spears visited Cape Hatteras. The man who traveled through Greenland and Patagonia was shocked by what he saw on Hatteras Island. At Cape Hatteras, vast piles of sand had been cut loose from their binding mat of vegetation. Like waves of water on the ocean, these sand waves, or live dunes, as the island's inhabitants called them, moved across the island, burying the remnants of the maritime forest and everything else that stood before them. As the dunes moved on, ghost forests were exposed, the dead wood left bleaching in the sun and rain. Spears contrasted the desolation of 1890 to past forest riches:

> Fifty years ago Hatteras Island, from inlet to inlet, a distance of over forty miles, was almost completely covered with a prodigious growth of trees, among which live-oak and cedar were chief in size and number. Growing everywhere in this forest were grape-vines of such great length and extent that the boys of that day (the white-haired men of this) were in the habit of climbing into the tree-tops and crawling from tree to tree, often for a distance of over one-hundred yards, on the webs the vines had woven.[3]

When Spears looked at the subsistence economy of the Outer Banks, he did not see a way of life finely tuned to the landscape it existed in. He saw laziness and indolence and condemned it. The Bankers, he claimed, "are a contented race. . . . [T]he islander . . . takes the greater part of a week to accomplish what he might do if he

2. Mark T. Taylor, "Seiners and Tongers: North Carolina Fisheries in the Old and New South," *North Carolina Historical Review* 69 (January 1992): 1-33; William N. Still Jr., "A Nickel a Bucket: A History of the North Carolina Shrimping Industry," *American Neptune* 47 (1987): 257-274; Barbara J. Garrity-Blake, *The Fish Factory: Work and Meaning for Black and White Fishermen of the American Menhaden Industry* (Knoxville: University of Tennessee Press, 1994), 13-15. For a description of the nineteenth-century subsistence economy of the North Carolina coast and its relationship to commercial fishing, see David Cecelski, *The Waterman's Song: Slavery and Freedom in Maritime North Carolina* (Chapel Hill: University of North Carolina Press, 2001), 59-76.

3. John R. Spears, "Sand-Waves at Henlopen and Hatteras," *Scribner's Magazine* 8 (October 1890): 507-512.

had to, in twelve hours. . . . If his attention is by any chance called to the sand-wave, he languidly says that it won't reach the Sound in his time. . . ."[4]

In Spears's eyes, the islanders' desire for the things that money could buy, and their unwillingness to work hard, led them to unwisely harvest trees for firewood and boatbuilding. Spears saw the desolation of Hatteras Island as a morality tale: "Thoughtless greed destroyed the protecting oaks and cedars, and now the desolating sand wave is upon the hallowed spot [the Kinnakeet cemetery]." It was this destruction, he believed, that turned the live dunes loose to wander across the island, with dire consequences for the island's human community. "Powerless against this tidal wave of sand they must flee away and hide themselves from its fury in a part of the island below the cape, where stunted groves may yet protect them in the years to come; or to wander Ishmael-like on the mainland."[5]

John Spears was not the first to notice live dunes on the Outer Banks. In the oldest account of the Nags Head resort, published in 1850, George Higby Throop titled a chapter, "The Grave of the Oaks." In it, he described "the gradual entombing of whole acres of live oaks and pines by the gradual drifting of the restless sands from the beach." Ten years later, *Harper's New Monthly Magazine* published an article in which the author described tall sand hills in the process of engulfing the Nags Head Hotel.[6]

These early accounts of the ghost forests and threatened human habitations were accurate; what was missing was the sense of opprobrium and imminent crisis so evident in John Spears's writing. (In fact, Throop seems to have found the ghost forests an attractive and romantic aspect of the Nags Head area.) The Outer Banks landscape had not changed appreciably between 1850 and 1890; what had changed was the mainland culture in which these articles were written.

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In describing the deforestation of Hatteras Island in religious and moral terms, Spears took part in a crusade that, by 1890, was more than a quarter century old. In response to the turmoil and social transformations brought on by immigration, urbanization, and industrialization, many people attempted to find a solid foundation for their personal and social life in the laws of God and nature. They feared that by violating these laws, society had evoked chaos and destruction, and that reform was

4. Spears, "Sand-Waves," 510.

5. Spears, "Sand-Waves," 512.

6. George Higby Throop, *Nag's Head and Bertie: Two Novels* (Charlotte, N.C.: Heritage House, 1958), 45. In 1850, Throop published the semi-autobiographical novel, *Nag's Head: or Two Months among "the Bankers." A Story of Sea-Shore Life and Manners*, based on his visit to Nags Head in the summer of 1849. See Richard Walser, "The Mysterious Case of George Higby Throop (1818-1896); Or, the Search for the Author of the Novels *Nag's Head*, *Bertie*, and *Lynde Weiss*," *North Carolina Historical Review* 33 (January 1956): 12-44. The dunes Throop described were moving from the ocean-side westward. Edward C. Bruce, "Loungings in the Footprints of the Pioneers," *Harper's New Monthly Magazine* 20 (May 1860): 728-729.

Adventurer-journalist John Spears blamed the "desolating sand wave" for the destruction of the Kinnakeet Cemetery at Avon. A blowout at the cemetery unearthed bones and debris. Photograph from Collier Cobb, "Where the Wind Does the Work," *National Geographic Magazine* (June 1906): 314.

necessary in order to avert catastrophe. The crusade against forest destruction was part of this trend.[7]

The forest crusade was given form and voice by the publication of George Perkins Marsh's monumental work, *Man and Nature*, in 1864. This book had a wide and influential circulation in Europe and was considered seminal by the first generation of U.S. foresters. Using his vast knowledge of history and classical literature, Marsh demonstrated that human activity had altered the landscapes of vast regions and was a primary cause of the collapse of Mediterranean civilizations. Marsh also pointed out that deforestation and landscape transformation were going on in the United States, which could expect the same catastrophic results that the Romans had witnessed.[8]

To the forest crusaders, the natural world was one of permanence, harmony, and balance, which provided a stark contrast to the chaotic and discordant world of the industrializing nation. In *Man and Nature*, Marsh argued, "Man is everywhere a disturbing agent. Wherever he plants his foot, the harmonies of nature are turned to discords." These crusaders warned of a cascade of consequences that would follow deforestation. Without leaves to shade it and roots to hold it in place, the forest soil turns to dust and is washed out to sea. Without the soil to act as a reservoir, the rain

7. Catherine L. Albanese, *Nature Religion in America: From the Algonkian Indians to the New Age* (Chicago: University of Chicago Press, 1990). Albanese defines "nature religion" as the belief in remaking society according to the natural laws necessary for human life. Donald J. Pisani, "Forests and Conservation, 1865-1890," *Journal of American History* 72 (September 1985): 340-359.

8. George Perkins Marsh, *Man and Nature*, ed. David Lowenthal (1864; reprint, Cambridge, Mass: Belknap Press of Harvard University Press, 1965).

that falls quickly runs off, speeding erosion; and both floods and droughts increase in severity. Watercourses and fields choke with debris. In the end, "the whole earth, unless rescued by human art from the physical degradation to which it tends, becomes an assemblage of bald mountains, of barren, turfless hills, and of swampy and malarious plains."[9]

Mankind had a moral obligation to conserve forest resources and pass them on to posterity, fulfilling, in Marsh's words, "the command of religion and of practical wisdom, to use this world as not abusing it." Bernhard Fernow, chief of the U.S. Department of Agriculture's Forestry Division between 1886 and 1898, thought of forests "as a sacred patrimony to be wisely used, reverently honored and carefully maintained."[10]

The forest crusaders' ideas about coastal sands were particularly relevant to the situation on the Outer Banks. Marsh included an entire chapter on "The Sands" in *Man and Nature*. In accord with the view of the harmony of nature, he held that sand dunes were stable, long-lasting landforms that were covered with forests where free of human and livestock disturbance. Fernow echoed these ideas the year before Spears's sand wave article appeared in print: "Along the shores of Lake Michigan, and along the sea-coast, we are creating shifting sands by the removal of the forest-cover, to make work for the ingenuity of our children in devising methods for fixing these sands again."[11]

The thirty years that followed the publication of *Man and Nature* saw the beginning of a profound change in the relationship between the American landscape and the people who lived in it. The frontier was settled, and the cut-and-run attitude that characterized the activities of lumbermen had begun to change. Social and economic dislocation loomed for industries dependent on forest resources and the communities those industries supported, as forests of entire regions were cut over far faster than they could regrow. In response to this situation, state and federal governments began to set aside land for watershed protection areas and national parks and forests.[12]

The year after Spears published his account of Hatteras Island, the Tar Heel State joined this movement with the formation of the North Carolina Geological Survey (NCGS). The survey's mission was to inventory the mineral, forest, and water resources of the state; educate the public about the need for their conservation; and

9. Marsh, *Man and Nature*, 36, 42.

10. Marsh, *Man and Nature*, 13; B. E. Fernow, "Our Forestry Problem," *Popular Science Monthly* 32 (December 1887): 225.

11. Fernow, "Our Forestry Problem," 233.

12. Gifford Pinchot, "The Blazed Trail of Forest Depletion," *American Forestry* 29 (June 1923): 323; Harold K. Steen, *The U.S. Forest Service: A History* (Seattle: University of Washington Press, 1976).

lobby for the passage of forest fire laws and the establishment of forest reserves in the eastern United States.[13]

Private initiative was also important to early forest conservation efforts. George Vanderbilt hired Gifford Pinchot in 1892 to make the first attempt at scientific forestry in this country at his estate outside Asheville. Joseph A. Holmes, North Carolina's first state geologist, met Pinchot in 1893. In his memoirs, Pinchot called Holmes "one of the best men I ever ran across." They maintained a lifelong friendship, and both were important figures in the forest conservation movement. Thus, the first attempt at scientific forestry in the United States and the NCGS program developed together.[14]

In 1897, the NCGS published a survey of the forests of the state. Written by Pinchot and W. W. Ashe, the survey included the first technical description of the state's maritime forests. Pinchot and Ashe reported that live dunes, made mobile by timber cutting, had engulfed fishermen's houses on Hatteras Island, and that a dune twenty feet high and some two miles long was moving across Smith's Island at Cape Fear, destroying the forest on the island's southern edge.[15]

The 1906 biennial report of the state geologist printed a section entitled, "Forestry Problems along the Banks," which described conditions on Shackleford Bank. The area had once been "heavily wooded over its entire area" within the memory of the island's oldest inhabitants. Around 1840, the cutting of timber for firewood and lumber destabilized the dunes, which began to engulf the woods on the eastern end of the island. In the closing years of the nineteenth century, Diamond City, which derived its name from the daymark of the Cape Lookout Lighthouse, had been a thriving settlement of some three hundred people on that end of the bank.[16] When the dunes and woodlands that protected it were destroyed, Diamond City was opened to the onslaught of a series of powerful storms that culminated in the hurricane of August 1899. By 1902, the people of Diamond City had given up, taken their houses apart, and rebuilt them on the mainland. In 1906, the remnants of maritime forest were still threatened by live dunes moving across the island.

The 1906 biennial report briefly mentioned the sand-binding efforts then taking place at Cape Cod and suggested that a similar project on the Outer Banks was feasible and should be investigated. To that end, the NCGS announced that a thorough inventory of the forests of the banks would be conducted the following year and a forestry plan for the area put together, which would "include not only the

13. John R. Ross, "Conservation and Economy: The North Carolina Geological Survey, 1891-1920," *Forest History* 16 (January 1973): 21-27.

14. Gifford Pinchot, *Breaking New Ground* (New York: Harcourt, Brace and Company, 1947), 56.

15. Gifford Pinchot and William W. Ashe, *Timber Trees and Forests of North Carolina*, North Carolina Geological Survey (NCGS) Bulletin 6 (Winston, N.C.: M. I. and J. C. Stewart, 1897). For a description of the maritime forests, see 144-147.

16. NCGS, *Biennial Report of the State Geologist, 1905-1906*, 47-50; David Stick, *The Outer Banks of North Carolina, 1584-1958* (Chapel Hill: University of North Carolina Press, 1958), 184-194.

Geologist I. F. Lewis described the devastation of the maritime forest by live dunes on Shackleford Bank: "an advancing sand wall, 10 to 20 feet high . . . is burying the vegetation at a rapid rate. . . ." Photograph of a forest graveyard with dead and uprooted trees from I. F. Lewis, *The Vegetation of Shackleford Bank*, North Carolina Geological and Economic Survey (NCGES) Economic Paper 46 (Raleigh, N.C.: Edwards and Broughton, 1917), facing 22.

protection of the forest and farm lands already present, but also the reforestation of the barren portions [of the banks]."[17]

In 1908, the NCGS published the results of the inventory, which focused on Hatteras Island. Author Jay Bond of the U.S. Forest Service reported that the widespread primordial forests in the area were disrupted by "careless logging" and the live dunes that resulted threatened the remaining woodland. Bond found twenty-five hundred acres of woodland directly west of the cape covered predominantly in loblolly pine. "The trees are of medium size and the lumber of relatively low value, but the accessibility of the stand and the great market for even the poorer grades will make the exploitation of this timber profitable." This suggests that the rapid disappearance of mainland forests made even marginal woodlands like the Hatteras woods attractive to lumbermen at this time. Logging operations had recently started on the sound side (northern edge) of the woods; and though they had been discontinued because of mismanagement, Bond expected timber cutting to resume in short order. He found dunes moving into these woods from the beach south and southeast of the area. The movement was rapid, as live treetops were found sticking out of the sand far upwind of the moving dune, and a half-mile wide

17. NCGS, *Biennial Report of the State Geologist, 1905-1906*, 49-50.

strip inland of the beach had been buried. Bond concluded, "If prompt measures are not taken, the destruction of the forest is certain. The lands will become a sand waste similar to the larger part of the area of the banks."[18]

For the first time, livestock were implicated in the devegetation of the islands. According to Bond, hogs were the biggest threat, rooting out large areas of dune grass near the beach. Cattle and sheep would then enter the area and eat the exposed roots, completing the devegetation. In response to this situation, Bond recommended that the state legislature pass a range law requiring the fencing in of livestock on the banks. "Without such legal protection, all measures for the control of shifting sand . . . will be useless."[19]

Bond detailed a process through which the live dunes on Hatteras Island could be stabilized. Since the sand feeding the dunes came from the beach, the first step would be building a barrier between the beach and the island's interior. Bond suggested doing this by driving one-by-six-inch planks into the sand in lines. This plank fence would slow the wind down and cause it to drop the sand it carried. Then sea oats would be planted to hold it in place. Behind this barrier, seeds of loblolly pines, held in place by a blanket of cut brush, would then be planted on the sand flats to re-establish the forest.

Though it was possible to create a barrier dune and stabilize it with vegetation, Bond's assessment of the economics of the plan was not encouraging. "To control and fix these sands will require most careful treatment and an expense entirely disproportionate to the value of the reclaimed land and of the forest lands in the lee. So long as the present conditions in respect to laws and the ownership of the greater part of the area exists, protective measures are impossible."[20]

In one of the first scientific descriptions of Outer Banks plant life, I. F. Lewis disputed Bond's assessment of the feasibility of dune stabilization. In *The Vegetation of Shackleford Bank*, Lewis contended that Bond's cost estimates were inaccurate. He believed that fences made of cut branches stuck into the sand would be just as effective in collecting windblown sand as the plank fences that Bond had suggested. In Lewis's estimation, this would cut the labor and material costs and make dune stabilization practical.[21]

Lewis repeated the assertions made in the 1906 report regarding the forested nature of the island before the Civil War, quoting an unidentified source who claimed that at one time "it was possible to sit in a tree and cast a fishing line into the water." He expanded his list of causes of dune destabilization to include forest fires, storms,

18. NCGS, *Biennial Report of the State Geologist: 1907-1908*, 47. The sound-side area is now known as Buxton Woods.

19. *Biennial Report of the State Geologist: 1907-1908*, 43.

20. *Biennial Report of the State Geologist: 1907-1908*, 44.

21. I. F. Lewis, *The Vegetation of Shackleford Bank*, North Carolina Geological and Economic Survey (NCGES) Economic Paper 46 (Raleigh, N.C.: Edwards and Broughton, 1917), 20. The name of the North Carolina Geological Survey was changed in 1905 to "The Geological and Economic Survey" to more accurately reflect the mission of the agency.

livestock grazing, and timber cutting. Once again, he warned of the impact of drifting sand on the migration of fish through the sounds.[22]

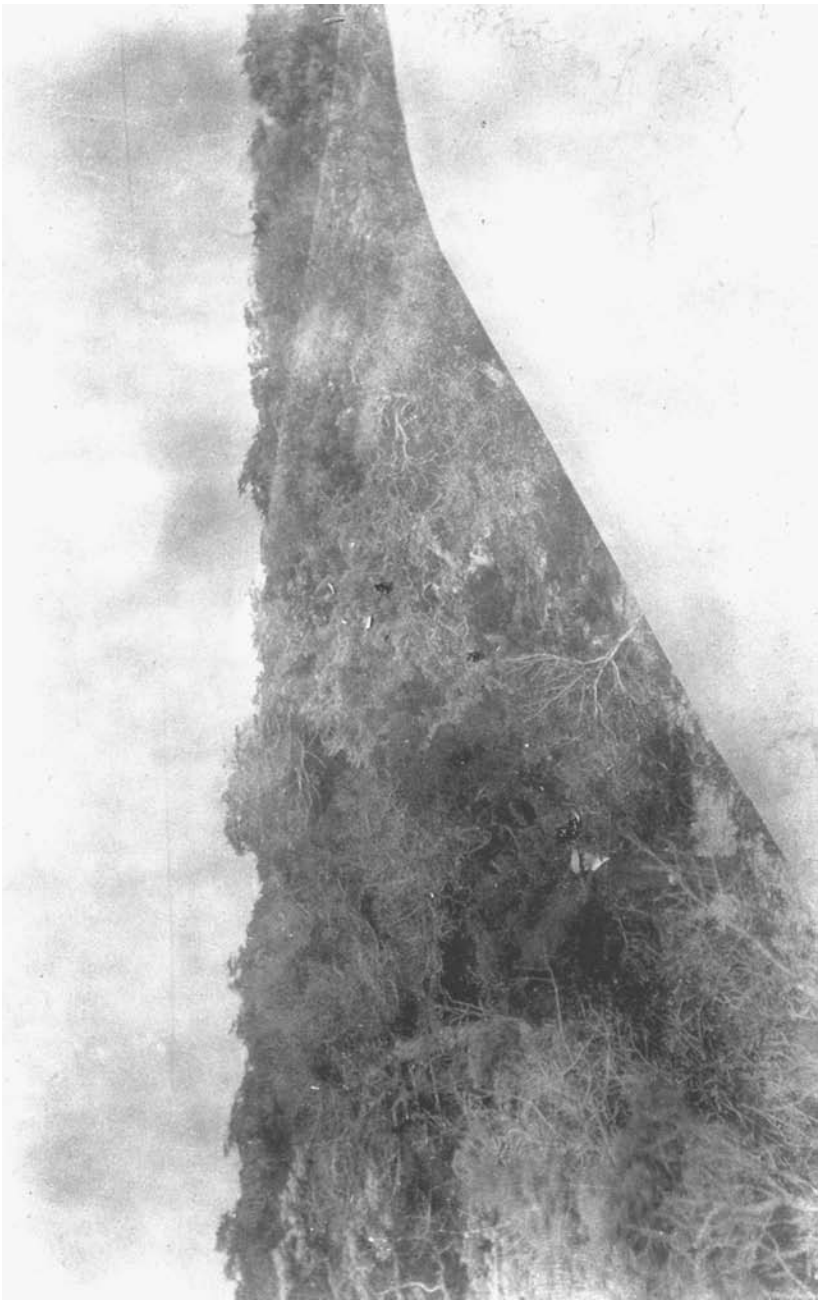
The eastern end of the island was still the sand waste that led Diamond City's residents to leave fifteen years earlier. Low dunes held together by sea oats and pennywort stretched from the lighthouse to the area called Wade's Shore, dotted with the bleached and shattered bones of the ghost forest. West of that area, the central part of the island was covered in thickets of yaupon holly up to three feet high in almost pure stands. Where breaks in the yaupon occurred, the slopes of the dunes were covered in American holly, red cedar, and wax myrtle.

Interspersed with these thickets were areas where the trees were taller. Red bay, wild olive, loblolly pine, and red cedar occupied these places in what Lewis called "thicket woodland." Where the land was higher, more open woods of live and willow oak, red mulberry, red bay, and American holly covered the dunes. Over it all, catbrier, muscadine grape, poison ivy, and Virginia creeper wove together an impenetrable web. Lewis related this complex vegetation mosaic to groundwater depth and the extent of soil development. Taller trees and more complex vegetation tended to grow where groundwater was closer to the surface and soils were deeper. Where water was less available, the vegetation was more open. All along the southern edge of this patchwork of plants, live dunes were burying everything in their move toward the sound. Lewis's report reproduces some striking photographs of the edge of the woodlands in the process of being buried by the moving dunes.[23]

The search for stability in the nature of Outer Banks forests took a different turn in the 1920s, as scientists and the public began to question the forest crusaders' notion of changeless forests. In the first decade of the twentieth century, H. C. Cowles of the University of Chicago developed the concept of classical succession, the primary theoretical foundation for the emerging science of plant ecology, which describes patterns of change in plant communities.

Cowles studied sand dune plants on the southern shore of Lake Michigan, concluding that the vegetation of a region was a single organism. Changes in plant communities were stages of that organism's life cycle that led inevitably to the "adult" stage—the climax community or formation. The nature of the climax was determined by climate and soil patterns over large areas. Pioneer species altered their environment to make it suitable for the plants that would replace them, primarily through the process of soil formation. From abandoned field to conifer stand to hardwood forest, the process was unidirectional and involved an increase in species diversity and community stability. The forest crusaders' changeless forest existed at the end of a process that was still going on in many places. Changes that occurred were solely the

22. Lewis, *The Vegetation of Shackleford Bank*, 18.
23. Lewis, *The Vegetation of Shackleford Bank*, 15-17.



I. F. Lewis described a complex mosaic of plants in his 1906 report, ranging from low-growing sea oats and pennywort to thickets of yaupon and American holly to woodlands of wild olive and red cedar to open woods of live and willow oak, red mulberry, and red bay. Along the southern edge of this tangle of plants, live dunes buried everything in their move toward the sound. This striking image depicts a man standing at the base of an encroaching sand wave on Shackleford Bank, June 11, 1902. Photograph from the North Carolina Collection, Wilson Library, University of North Carolina at Chapel Hill.

result of biological processes, such as death, reproduction, and competition. Where "retrograde succession" occurred—a movement from the "adult stage" to more "immature" plant communities—it was seen as the result of outside, usually human, disturbance.[24]

Bertram Whittier Wells, who studied with Cowles, brought these ideas to North Carolina in 1919 when he took the chair of the new botany department at North Carolina State College. Unlike the state geological survey's workers, Wells advocated conservation of plant life for its own sake and for the beauty and wonder people could experience contemplating "The Patchwork of North Carolina's Great Green Quilt."[25]

Wells defined the classic sequence of dune succession in this way:

> The woody plants [live oak, yaupon, pilentary] stand in a successional relation to the herbaceous species. As the dunes grow larger and less exposed on the landward side, the yaupon and live oak will appear. The latter will in time assume dominance and maintain its integrity as a forest community for an indefinite time.[26]

In Wells's view, one vegetation type replaced the previous one until the self-perpetuating climax community was reached. Disturbance played no part in the process.

Wells's work on the North Carolina coast led him to discover the important impact salt spray has on the growth form and distribution of coastal plants. This work culminated in 1939 with the publication of a study of the maritime forest of Smith Island. Wells found that the soils of the island could support the growth of the mixed hardwoods, considered the typical climax of the region. Despite the suitable soils, such a hardwood forest did not exist. Instead, the dune ridges of Smith Island were covered in an almost pure, single-species live oak forest, with an understory of flowering dogwood. (There were also a few sabal palmettos in the canopy as well. *Spartina* salt marsh occupied the low areas between the ridges, as it does today.) Wells wrote: "These oaks today give every evidence of being a climax. Very old living trees with trunk diameters of 3-4 feet are frequent, and scattered in them one encounters disintegrating trunks of even larger trees." In 1805, J. G. Swift, an officer in the U.S. Army, reported "a growth

24. R. P. McIntosh, "Ecology since 1900," in *Issues and Ideas in America*, ed. B. J. Taylor and T. J. White (Norman: University of Oklahoma Press, 1976), 353-372. Frederic E. Clements later expanded on Cowles's theory of classical succession. See Frederic E. Clements, *Plant Succession: An Analysis of the Development of Vegetation* (Washington, D.C.: Carnegie Institution of Washington, 1916), 24-25, 145.

25. See James R. Troyer, *Nature's Champion: B. W. Wells, Tar Heel Ecologist* (Chapel Hill: University of North Carolina Press, 1993); B. W. Wells, "The Patchwork of North Carolina's Great Green Quilt," *North Carolina Agriculture and Industry*, October 23, November 6, 27, December 11, 1924, January 22, February 12, 1925, page 1, all issues.

26. B. W. Wells, *The Natural Gardens of North Carolina* (Chapel Hill: University of North Carolina Press, 1932), 17-18.

of live oak and palmetto" on the island, further indicating the climax status of this forest.[27]

This anomalous forest on Smith Island resulted from the relentless salt spray. Live oak is the only broad-leafed tree that can survive the wind-borne salt common on the island. With the description of this "salt spray climax," Wells began to depart from the strictly classical concepts of his training. Though he still maintained that a stable self-perpetuating climax community was the endpoint of succession, his recognition of the importance of disturbance and non-biological processes to the maintenance of that community was an important step toward a more complex and realistic conception of change in plant communities.[28]

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In 1908, Jay Bond accurately described the barriers to effective erosion control resulting from ownership patterns and property values on the Outer Banks. The mainland owners of a few hunting clubs conducted small-scale erosion control work on their lands during the 1920s, but the federal government was not involved in any erosion control projects. At that time, the Outer Banks were predominantly owned by the people who lived on them. This began to change in 1928, when the Dare County commissioners, perceiving that the future lay in ties to the mainland, spent $170,000 to build a bridge across Roanoke Sound, connecting Manteo and Nags Head. Other projects followed, reflecting a change in ownership patterns: in 1930, a private toll bridge was built across Currituck Sound; in 1931, a state highway between the two bridges, called the Virginia Dare Trail, was completed, connecting Manteo to the mainland. New investors arriving from Elizabeth City and Norfolk bought land and built gas stations, hotels, restaurants, and nightclubs.[29]

Nineteen thirty-two, the year after the completion of the Virginia Dare Trail, was a tumultuous year for the nation and the Outer Banks. On the campaign trail, Herbert Hoover and FDR debated how best to solve the economic crisis. Millions were suffering through the depression, and in March, a northeaster with near hurricane-

27. B. W. Wells, "A New Forest Climax: The Salt Spray Climax of Smith Island, N.C.," *Bulletin of the Torrey Botanical Club* 66, no. 9 (1939): 629-634; Joseph Gardner Swift, *The Memoirs of Gen. Joseph Gardner Swift . . .* (Worcester, Mass.: F. S. Blanchard and Co., 1890), 53.

28. Subsequent investigations have shown that the structure of live oaks makes them less susceptible than pines to wind damage. Plato Touliatos and Elmer Roth, "Hurricanes and Trees: Ten Lessons from Camille," *Journal of Forestry* 69 (May 1971): 285-289. The differential removal of pines from Smith Island's forest by nineteenth-century storms helped to create the near pure stand of oak forests that Wells described. James R. Troyer, "Bertram Whittier Wells (1884-1978): A Study in the History of North American Plant Ecology," *American Journal of Botany* 73 (July 1986): 1058-1078.

29. A. C. Stratton and J. R. Hollowell, "Sand Fixation and Beach Erosion Control: Report on the North Carolina Beach Erosion Control Project," 1941, NC-LD 13, pp. 9-11, unpublished National Park Service report; Cape Hatteras National Seashore Archive, Manteo, North Carolina; Stick, *The Outer Banks*, 242-253.

force winds ravaged the coast of North Carolina, washing out bridges and burying the Virginia Dare Trail in sand. Hotels and cottages were destroyed, and fishermen lost their boats and nets. Two weeks after Roosevelt was elected president, another northeaster pounded the Outer Banks with five days of rain and sixty-mile-an-hour winds. The dedication of the Wright Memorial in Kitty Hawk was nearly canceled because of the storm.[30]

Nineteen thirty-two also saw the election of J. C. B. Ehringhaus as governor of North Carolina. An Elizabeth City lawyer, Ehringhaus was firmly committed to the development of the Outer Banks, appointing Manteo businessman and banker R. Bruce Etheridge as director of the state's Department of Conservation and Development. With the new administration in Washington pledging to spend government funds to put millions of destitute people back to work, and with key posts in the state government filled with people committed to the development of the Outer Banks backwater, the stage was set for major changes on the North Carolina coast.[31]

Residents of Hatteras Island began lobbying for highway access to the island. In late May of 1933, Sen. Josiah Bailey wrote to Governor Ehringhaus suggesting that state officials petition the federal government to use public works money to build a road south of Oregon Inlet. Bailey argued that such a highway would improve the efficiency of the island's Coast Guard stations, as well as provide tourists with access to "a hitherto little traveled section famed for its natural beauties and appeal to the sportsman." Describing the aftereffects of the March 1932 storm, the chief engineer of the Department of Conservation and Development, Charles Ray, told Bailey that the low elevation of the beach would make highway maintenance difficult. A dune-building program would be needed if a highway south of Oregon Inlet were constructed.[32]

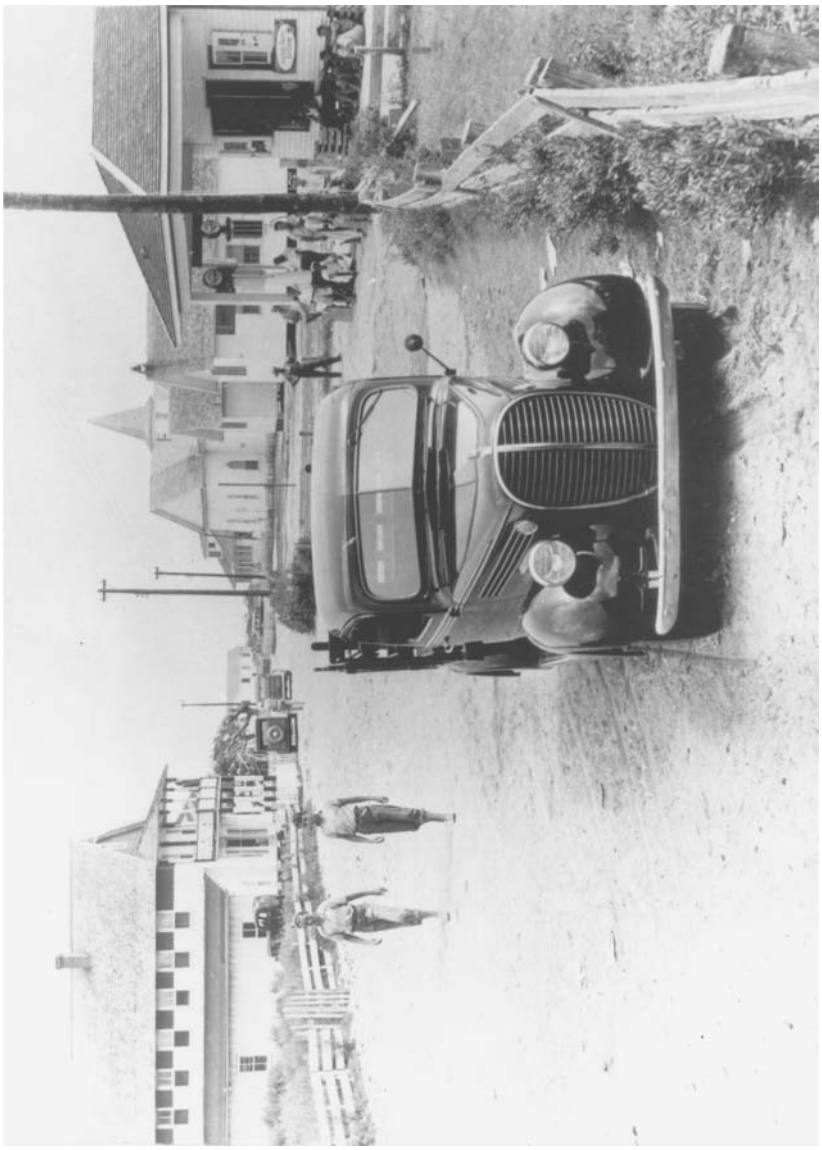
The New Deal program being developed for the Outer Banks was fleshed out a bit more when, on July 21, the Elizabeth City *Independent* published an article by Frank Stick, an artist, hunting guide, and real estate developer active in Dare County politics. Stick envisioned the Hatteras Island highway as part of a larger project and advocated setting aside a large portion of the banks as the first "National Coastal Park."[33]

30. *Daily Advance* (Elizabeth City), November 21, 1932.

31. The NCGES was reorganized by the state legislature and renamed the Department of Conservation and Development in 1925. *Independent* (Elizabeth City), September 1, 1933.

32. W. L. Gaskill to Lindsay Warren, June 19, 1933; Howard Kenfield to Warren, June 20, 1933; David L. Ballance to Warren, June 21, 1933, all in Lindsay Warren Papers, Southern Historical Collection,Wilson Library, University of North Carolina at Chapel Hill; *Independent*, June 2, 1933; Charles E. Ray to Senator Josiah Bailey, June 7, 1933, Senatorial series, Public Assistance file, J. W. Bailey Papers, Special Collections Library, Duke University, Durham, North Carolina.

33. *Independent*, July 21, 1933. Stick did not mention dune stabilization or erosion control in this article, but he later discussed the need for "sand fixation" in an article for *State Magazine*, November 18, 1933.



Ownership patterns on the Outer Banks began to change in 1928 as roads and bridges were built, tourism grew, and outsiders invested in restaurants, motels, and nightclubs. After residents of Hatteras Island began lobbying for highway access to the island, Sen. Josiah Bailey suggested that state officials petition the federal government to use public works money to build a road south of Oregon Inlet. This 1939 photograph of Hatteras village is from the files of the Department of Conservation and Development, State Archives, Office of Archives and History, Raleigh, North Carolina.

Before Stick's vision could be put into practice, the weather once again struck two powerful blows to the banks in quick succession. On August 22, 1933, and again on September 16, full-blown hurricanes swept the coast. The September storm killed twenty-one people and resulted in $3 million in damages in North Carolina alone, leading hurricane historian Jay Barnes to call it "one of the most tragic storms in North Carolina history."[34] Once again, coastal communities were devastated as transportation and communications were disrupted.

After the storms, the Department of Conservation and Development conducted an inspection tour of Hatteras Island and announced a "North Carolina Coastal Development Project." For the first time, this proposal put together dune building/reforestation work, a Hatteras Island highway, and a national coastal park. Frank Stick became the official spokesman for this project. After the devastating storms of 1932 and 1933, Stick described the damage in an article in the *Independent*. He believed that in its natural condition, the banks were covered in forest and, like the forest crusaders before him, blamed the deforestation of the banks on human immorality: "We have been a short sighted, a selfish race. We have abused nature's gifts and in self centered conceit we have wholly disregarded nature's basic, immutable laws." A year later, Stick made clear that he was not talking about the dwarf yaupon and juniper of the shrub thicket. In the mid-nineteenth century, he pointed out, "85 to 90 per cent of this hundred and fifty miles of coastland was well forested with ample growths of pine, juniper, oak, dogwood, Judas and other varieties of timber indigenous to the region. The land itself was in most places high and much of it even hilly."[35]

The need to restore the banks to their primordial, heavily forested condition was more than a public relations device. It was an integral part of official descriptions of the Coastal Development Project. In a proposal submitted by the Department of Conservation and Development to the Civil Works Administration, one of the project objectives was defined as "Reforestation through natural reproduction and state establishment of seedling nurseries, of thousands of acres of land which once supported productive forests, both for its economic and aesthetic benefits and as an added measure of erosion control."[36]

To address the beach erosion problem, advocates of the Coastal Development Project suggested using sand fences to build a barrier dune and then stabilize it with a planting of dune grasses and trees, as had the earlier work of the NCGS. But unlike

34. Jay Barnes, *North Carolina's Hurricane History*, rev. ed. (Chapel Hill: University of North Carolina Press, 1998), 67-73.

35. *Daily Advance*, September 22, 27, 1933. The process of building a barrier dune was also referred to as "sand fixation," "dune stabilization," and "erosion control." *Independent*, October 13, 1933; *Daily Advance*, August 14, 1934.

36. Memo, Department of Conservation and Development to the Civil Works Administration, October 1933, Kitty Hawk folder, Transient Division, Emergency Relief Administration, State Archives, Office of Archives and History, Raleigh, North Carolina.

the forest crusaders before them, the advocates of the Coastal Development Project had an army of unemployed men at their disposal to actually execute the work they promoted.

President Roosevelt instituted a program early in his administration in order to conserve both natural and human resources. On the Outer Banks, numerous federal agencies were involved in the erosion control project. The work was started by the Emergency Relief Administration-Transient Bureau in 1934. In 1935, the Works Progress Administration (WPA), based in a camp on the north end of Roanoke Island, replaced the Transient Bureau on the Coastal Development Project. That same year, the Civilian Conservation Corps (CCC) set up camps on Roanoke Island and at Cape Hatteras. CCC crews began the development of Pea Island Wildlife Refuge and erosion control work at Cape Hatteras State Park and other low areas of the beach.[37] The WPA "restored" Fort Raleigh, built the Waterside Theater, and premiered Paul Green's outdoor drama, *The Lost Colony*, on July 4, 1937. Five weeks later, Congress authorized the formation of Cape Hatteras National Seashore, and land acquisition began.[38]

By the time the project ended in 1941, workers had built over three million feet of sand fencing, planted 142 million square feet of dune grasses, grown and planted over two and a half million trees and shrubs, and radically altered the Outer Banks landscape from Ocracoke village to the Virginia border.[39] Protected from salt spray and storm surge by the barrier dune, these trees and shrubs have flourished, successfully establishing what was thought to be the primeval landscape of the Outer Banks. Delayed by war and oil exploration, Cape Hatteras National Seashore opened in 1953, the year after the Hatteras Island highway was completed.

* * *

The image of the Outer Banks covered from sea to sound by a forest that was later destroyed by human activity, and the idea that maritime forest is the natural culmination of the development of the vegetation of the Outer Banks persist today.

37. J. S. Kirk, W. A. Cutter, and T. W. Morse, *Emergency Relief in North Carolina* (Raleigh, N.C.: Edwards and Broughton, 1936), 333; Ronald E. Marcello, "The Selection of North Carolina's WPA Chief, 1935: A Dispute Over Political Patronage," *North Carolina Historical Review* 52 (January 1975): 59-76; *Beacon* (newspaper of Civilian Conservation Corps [CCC] Company 3423, Camp Diamond Shoals), January 1936; *Log* (newspaper of CCC Company 436, Camp Virginia Dare), February 16, 1935. See Perry Henry Merrill, *Roosevelt's Forest Army: A History of the Civilian Conservation Corps, 1933-1942* (Montpelier, Vt.: P. H. Merrill, 1981) and John A. Salmond, *The Civilian Conservation Corps, 1933-1942: A New Deal Case Study* (Durham, N.C.: Duke University Press, 1967).

38. William S. Powell, *Paradise Preserved: A History of the Roanoke Island Historical Association* (Chapel Hill: University of North Carolina Press, 1965), 145-153. See also *News and Observer* (Raleigh), July 14, 1937; and Fred Cohn to James R. Branson, May 5, 1937, Information Division, Records Concerning the Restoration of Historic Shrines, Record Group 69, National Archives, Washington, D.C.

39. Stratton and Hollowell, *Sand Fixation*, 88-89.

To address the beach erosion problem after devastating storms in 1932 and 1933, sand fences were constructed to build barrier dunes, which were stabilized with a planting of dune grasses and trees. By 1941, CCC work crews had built over three million feet of sand fencing. Photograph of sand fence from A. C. Stratton and J. R. Hollowell, "Sand Fixation and Beach Erosion Control: Report on the North Carolina Beach Erosion Control Project," National Park Service report, 1941, Cape Hatteras National Seashore, Manteo, North Carolina.

These ideas form the basis of what has thus far been written on the area's environmental history. For instance, in his 1975 folk history of Hatteras Island, Charles Williams wrote:

> Four hundred years ago the Kinnakeet Banks [the area from Cape Hatteras to Pea Island] was an unspoiled virgin land, the Paradise of the Atlantic. Its flora and fauna, or physiographic conditions then prevailing, were of indescribable beauty and majestic grandeur. . . . It was forested by stately pines, beautiful holly, giant oaks, flowering dogwood and magnificent cedars. . . . The vegetation of this semi-tropical paradise covered the face of Kinnakeet from the Pamlico Sound to the Atlantic Ocean in massive profusion. Beautiful flowers of many varieties and variegated colors spread their sweet influences over the face of the land. Grape vines covered the top of the forest on the Atlantic Ocean side of the Kinnakeet Banks and were overhanging down into the ocean and bearing grapes in abundance, the sea surging into the vines, and the ocean running purple with grape juice. . . .[40]

A number of scholars have blamed the overgrazing of livestock for the presence of live dunes and the destruction of the maritime forest on the banks. In his account of the landscape history of Dare County, John Wierwille noted that in the mid-1800s, "Overgrazing nearly defoliated many of the islands so that unanchored sands were, for the first time, influenced by winds as well as the overwash process." In 1992, John Alexander and James Lazell wrote, "This artificial deforestation [of Shackleford Bank]

40. Charles T. Williams, *The Kinnakeeter* (New York: Vantage Press, 1975), 7-8.

was perpetuated by use of this bank for livestock, left to run wild or become feral. . . ."[41] Dirk Frankenberg's widely read *The Nature of the Outer Banks* recalls the classical succession theory of Frederic Clements:

> The current degree of vegetation on the Banks is greater than it was earlier in this century and probably less than it was at the first European contact, when Captain Barlowe [*sic*] rhapsodized about the "goodly woods full of deere, hares, and fowl in incredible abundance." The variation in Outer Banks vegetation levels over time is partially the work of humans. There is no doubt that overgrazing by cattle, sheep, goats and horses contributed to an unusually bare sand environment along the Banks in the early twentieth century, a condition from which they are still recovering. Natural processes also create small areas of bare sand—dunes are overwashed and "blown out," dune migration leaves bare sand behind, inlet processes deposit bare sand on the shore. These bare sands gradually become vegetated. Vegetation develops in a sequence of stages, each one of which prepares for the next. These stages can easily be observed as one walks from the ocean to the sound. The first plants one encounters are sea oats and beach grass, which interrupt the smooth flow of wind along the beach and cause sand being transported to be deposited among them. In this way, they operate like a natural sand fence.[42]

Frankenberg goes on to describe the succession of dune grass to shrub thicket to maritime forest. He acknowledges the role of storm surge in barrier island ecology, but it is quite clear that he considers such disturbances merely local and temporary interruptions in the development of the vegetation toward a woodland climax.

Frankenberg's quotation of Barlow in support of his belief in a densely vegetated Banks deserves close examination. In 1584, Captains Arthur Barlow and Philip Amadas were sent to the New World by Walter Raleigh to scout out possible sites for future settlement. Reprovisioned in the West Indies, the captains sailed north.[43] As Barlow recounts, "we sailed along the same 120 English miles before we could find any entrance, or river issuing into the sea." He writes effusively about the riches of the new world:

> the land about us [was] very sandy and low towards the water's side, but so full of grapes as the very beating and surge of the sea overflowed them. Of which we found such plenty, as well there as in all places else, both on the sand and on the green soil on the hills, as in the plains, as well on every little shrub, as also climbing towards the tops of high cedars, that I think in all the world the like abundance is not to be found. . . . We passed from the sea side towards the tops of those hills next adjoining, being but of mean height; and from thence we beheld the sea on both sides, to the north

41. John E. Wierwille, "Remaking and Restoring the Landscape of Dare County, North Carolina," in *Beyond Preservation: Restoring and Inventing Landscapes*, ed. A. Dwight Baldwin Jr., Judith De Luce, and Carl Pletsch (Minneapolis: University of Minnesota Press, 1994), 73. Wierwille's statement about "unanchored sands" is flawed: sand on the Outer Banks is moved by wind whether or not it holds vegetation. Wierwille is also in error in claiming that the New Deal erosion control project was solely a Civilian Conservation Corps effort. John Alexander and James Lazell, *Ribbon of Sand: The Amazing Convergence of the Ocean and the Outer Banks* (Chapel Hill, N.C.: Algonquin Books, 1992), 94.

42. Frankenberg, *Nature of the Outer Banks*, 22-23.

43. David Stick, *Roanoke Island: The Beginnings of English America* (Chapel Hill: University of North Carolina Press, 1983), 36-45.

and to the south, finding no end any of both ways. . . . This island had many goodly woods full of deer, coneys, hares and fowl, even in the midst of summer, in incredible abundance.[44]

Barlow's account of the pre-European environment of the Outer Banks should be critically examined. To take his account as a description of the entire banks, as Frankenberg and others have done, is unwarranted. Barlow does not describe the nature of the 120 miles of coastline they sailed before reaching the island of "goodly woods." No one knows exactly where Amadas and Barlow landed, but consensus among historians places it somewhere east-northeast of Roanoke Island on Currituck Bank. Even today, after nearly seventy years of erosion control work that encouraged the growth of woody plants, this area is still one of the most heavily wooded places on the entire Outer Banks. Furthermore, it is clear from the text that Barlow made no distinction between ocean and sound. They passed from the ocean through an inlet and anchored in the sound. They then took a boat and landed on the shore. It was there that they saw the surge of the waters overflowing grapevines. It was the more protected sound-side beach that had grapevines growing near it, as it does today in many places on the banks. Though Barlow wrote to provide information to his sponsor, he was aware that Raleigh needed to recruit colonists and investors for future colonization efforts and that his writing would be used for this purpose. David Stick, in his account of the Roanoke Island adventure, has called him "America's first English-language publicist."[45]

The records of the North Carolina Seashore Commission illustrate how reputable scholars can misinterpret and quote a historical reference out of context. In 1965, Russell Reynolds, a professor in the Department of Romance Languages at the University of North Carolina at Chapel Hill, penned an article on the Outer Banks for the Norfolk *Virginian-Pilot*. "Sea and wind erosion," he wrote, "gradually ate away the sand and destroyed, among other things, a baseball field. . . . All of the older residents of the island remember the fine forest land that the sea has gradually taken. Many talk about standing in the surf and picking grapes and other fruit from trees now gone." When Roy Wilder Jr., director of the North Carolina Seashore Commission, wrote to Reynolds asking for confirmation of the story, Reynolds responded: "As for picking grapes while standing in the surf I must refer you to 'Bucky' Barnett, USCG [U.S. Coast Guard] Retired, and now an employee of the National Park Service. He is the one that gave me this information; however, I believe that most of the older island residents would tell you the same thing." Five weeks later, Wilder received a letter from Dennis McGinnis of the Cape Hatteras National Seashore, who had spoken with Barnett about the story. Barnett, McGinnis wrote, "said it was not true that any

44. Richard Hakluyt, *Voyages of the Elizabethan Seamen to America: Select Narratives from the "Principal Navigations" of Hakluyt*, 2d ser., 2d ed., ed. Edward J. Payne (Oxford, Engl.: Clarendon Press, 1900), 1-67.

45. Stick, *Roanoke Island*, 38, 37.

of [his] generation ever plucked grapes while standing in the surf of the Atlantic Ocean. Mr. Barnett did tell Mr. Reynolds that he had heard the older people of the island, like his Grandfather, for example, tell of doing this along the ocean shore opposite the village of Hatteras but Mr. Barnett was quick to emphasize that this took place many, many years ago."[46] The incident illustrates how facts become distorted: a newspaper story enters public awareness; the informant's clarification is filed away in the North Carolina State Archives, and a story gains legitimacy through repetition.

* * *

To those persons who are acquainted with the peculiarities of the North Carolina coast only by maps, and general report, the existence and continuance of the long, low, and narrow sand-reef would seem an inexplicable mystery. . . . If a stranger only knew of the present existence of the long and frail barrier of loose sand, and nothing of its long and victorious resistance to the ingress, and most violent assaults of the ocean, he would suppose that it would be swept away, and forever, by the first storm waves that rose higher than the ocean beach. But this occurs frequently, even by the force of moderate winds, and yet no such effects is [*sic*] even partially produced."[47]

Before the New Deal revegetation programs began, dunes on the banks had been on the move for nearly a century. Newcomers and visitors from the mainland had been claiming for nearly forty-five years that unchecked erosion would soon make the banks uninhabitable. During the public discussions about the need for erosion control during the 1930s, no one on the mainland seemed to notice that despite these dire predictions, the banks were still dotted with small but thriving settlements. Houses were moved and cemeteries uncovered. Storms hit the coast with devastating impact, but Diamond City was the only settlement destroyed by live dunes. Over and over, people claimed that the moving dunes threatened the Outer Banks with total devegetation; and yet, even today, on Shackleford Bank, where no erosion control program was undertaken, a dense maritime forest still exists.

Without a doubt, there was more woody vegetation on the Outer Banks at the beginning of the nineteenth century than at its end. The Cape Woods that harbored Diamond City were indeed washed away. The ghost forest of Kinnakeet described by Bishop and Spears did exist and was alive at some point. When Hatteras Inlet opened in 1846, the storm did wash out a section of live oak woods. Reuben Quidley, a resident of the island and Ocracoke pilot, recalled the opening of the inlet. Families living in the area "saw the sea and sound connected together, and the live oaks

46. *Virginian-Pilot* (Norfolk), October 31, 1965. Russell Reynolds to Roy Wilder Jr., December 9, 1965, Cape Hatteras folder; Dennis E. McGinnis to Roy Wilder Jr., January 13, 1966, Beach Grass folder, both in General Records (1962-1969), North Carolina Seashore Commission Records, State Archives.

47. Edmund Ruffin, *Agricultural, Geological, and Descriptive Sketches of Lower North Carolina, and the Similar Adjacent Lands* (Raleigh, N.C.: Institution for the Deaf and Dumb and the Blind, 1861), 133-134.

washing up by the roots and tumbling into the ocean. . . . [T]he growth was live oak principally, [which] did not grow tall, but [had] large trunks and spreading limbs."[48]

Definitions of Outer Banks maritime forest varied widely. In many historic accounts, there is no distinction between what is now called shrub thicket, dwarf forest, and maritime forest. In the *Scribner's Magazine* account of the Hatteras sand wave, Spears's informants may have been referring to the yaupon, oak, and juniper of the shorter-statured, more sea-swept dwarf forest. Spears had described boys climbing to the tops of trees on grapevines, and crawling between the trees for some distance on a web of the vines.[49] Though grapes are sometimes found in the canopy of Buxton Woods, it would be an exceptionally adventurous boy who would climb thirty-five or forty feet off the ground on them and then, Tarzan-like, move from tree to tree. The reference is more likely describing the dense tangle of shrub thicket, where the oak and cedar are rarely more than fifteen feet tall. Frank Stick may not have been correct in claiming that "ample growths of pine, juniper, oak [and] dogwood" once covered the banks from sea to sound. Barrier islands are notoriously unstable, and this instability greatly restricts the growth of woody vegetation.

Research over the past thirty years has contributed much toward understanding the origin and evolution of the Outer Banks as a landform and the geological processes that shaped the islands. Such research is essential to understanding the history of North Carolina's maritime forests. The Outer Banks were born in the death throes of the last great continental ice sheets. At the height of the most recent Ice Age twelve thousand years ago, glaciers thousands of feet thick covered much of northern North America, Europe, and Asia. Sea level was some three hundred feet lower, and the coast of North Carolina was one hundred miles further east because so much of the world's water was in the form of ice. Around ten thousand years ago, this ice sheet began to melt, and sea level started to rise. Sand dunes along the coast were flooded as water came up behind them. River valleys were flooded too, and as the resulting headlands were eroded, spits formed, partially closing off the river mouths. Longshore currents, caused when waves strike the beach at an angle, carried sand parallel to the shore, modifying the shape of these islands.[50]

As sea level continued to rise, these spits and coastal dune ridges were cut off from the mainland. The coastline moved west as more of the Coastal Plain was flooded, and the primordial Outer Banks moved with it. In a process called "overwash," first

48. William L. Welch, "The Opening of Hatteras Inlet," *Bulletin of the Essex Institute* 17 (January 1885): 37-42; Paul Godfrey, "Preliminary Report on a History of the Natural History of the Outer Banks from Ocracoke Inlet to Beaufort Inlet," 15-16, 18-22, National Park Service unpublished report, January 1969, Cape Lookout National Seashore, Harker's Island, North Carolina.

49. Spears, "Sand-Waves," 510.

50. Orrin Pilkey et al., *The North Carolina Shore and Its Barrier Islands: Restless Ribbons of Sand* (Durham: Duke University Press, 1998), 39-60. Physical evidence that would help reveal the origins of the banks has been destroyed by subsequent sea level rise and erosion.

Definitions of Outer Banks maritime forest varied widely, and many historic accounts failed to distinguish between shrub thicket, dwarf forest, and maritime forest. Live oaks and red cedar are abundant in this dense maritime forest among the dunes at Hammock's Beach State Park on Bear Island. Photograph by the author, taken on a research trip in 2000.

recognized in the 1970s at Cape Lookout, storm waves carried sand from the beach through gaps in the dune fields and deposited it on top of the sound-side marshes. Like a bulldozer tread turning over on itself, sand is carried off the beach and back toward the marshes, exposing fresh sand from the middle of the island to the next storm's waves. In this way, the banks migrate westward in response to rising sea level. (Overwash also leaves salt marsh peat and tree stumps—products of the growth of sound-side plants—exposed on the ocean beach.) Though the rate of sea level rise slowed around four thousand years ago as the islands neared their present locations, a comparison of nineteenth-century navigational charts demonstrates that the islands are still moving.[51] The instability caused by overwash and island migration has profound implications for the islands' maritime forests.

Instability of barrier islands also centers around the tidal inlets that penetrate the islands at intervals. As the name suggests, these breaks in the barrier give the rising and falling tidewaters access to the sounds. They open when storm winds push water over low spots on the island, eroding a channel. More often than not, these low spots

51. Paul Godfrey and Melinda Godfrey, *Barrier Island Ecology of Cape Lookout National Seashore and Vicinity, North Carolina*, National Park Service Scientific Monograph Series no. 9 (Washington, D.C.: Government Printing Office, 1976), 14, 26-46. G. T. Rude, "Shore Changes at Cape Hatteras," *Annals of the Association of American Geographers* 12 (1922): 87-95.

are areas in which inlets formerly existed. Tidal currents carry the sand of the islands into the inlets, forming tidal deltas, the collections of shoals and sandbars that make navigating the inlets of the Outer Banks such a challenge. Longshore currents running parallel to the shore carry huge amounts of sand along the beach and into these inlets. Where the tides are insufficient to move this sand out of the channel and into the tidal delta, the inlet gets shallower and eventually closes. Where it is sufficient, the inlet migrates with the longshore current, as the up-current side gets filled in and the down-current side erodes.[52]

Pushed above sea level by storm surge and ocean currents, the land that fills inlet channels lies low to the water. Once above water, the bare sand is open to wind erosion and colonization by terrestrial plants. Sand dunes may form around sea oats and sea rocket. This is the primary succession on coastal sands. But because they are low-lying, former inlets are prone to have water pushed over them during every storm. Given a certain storm frequency, plants may never get the chance to colonize these areas. For instance, Whalebone Inlet, which separated Portsmouth Island from Core Bank in the past, last closed in 1961. To this day, bare sand and a gap in the dune field mark the location of this former inlet. Other, older inlets along this section of coast have been successfully colonized by sea oats and are now covered by dunes. Nevertheless, island migration caused by rising sea level and the migration of inlets means that large sections of the Outer Banks have been the scene of frequent disturbance. In these areas, succession, when it happens at all, occurs slowly.[53]

There are indications that this was also true for the islands further north. In 1874, the area around Oregon Inlet (opened by the storm of September 1846) was described as "totally devoid of trees, and the wind sweeps across it, from the ocean to the sound, with great violence." Photographs of the area's hunting clubs published in 1909 show the same thing. In aerial photographs taken to assess the damage caused by the March 1932 storm, the area around Oregon and New Inlets is clearly a sand flat with a few small, scattered dunes. At the time, this was interpreted as the result of human-caused erosion, but it is more likely the result of geological processes operating with little influence from human agency.[54]

The sands that fill inlets are deposited in formations that can be identified by geologists in core samples. In this way, the remains of ancient inlets have been found

52. Pilkey et al., *The North Carolina Shore and Its Barrier Islands*, 121-123.

53. Roger L. Payne, *Place Names of the Outer Banks* (Washington, N.C.: Thomas A. Williams, 1985), 93; author's personal observation.

54. Nathaniel Bishop, *Voyage of the Paper Canoe: A Geographical Journey of 2,500 miles . . .* (Edinburgh, Scotland: David Douglas, 1878), 75; Horatio Bigelow, "Battery Shooting at Pea Island: Describing a Week's Sport among the Wild Fowl of the North Carolina Coast," *Field and Stream*, September 1909; aerial photographs, Oregon and New Inlets, April 1932, Coastal Study folder, Central Files, Department of Water Resources, State Archives.

to underlie 15 to 20 percent of the Outer Banks.[55] In other words, the geological record clearly shows that large portions of the banks have been highly unstable and influenced by inlet dynamics. Given this, it is virtually impossible that the entire banks were forested in the past.

The geological record also shows that the history of the Outer Banks has been punctuated by episodes of dune movement and stabilization. A recent study of the large dunes of Currituck Bank identified three periods of moving sand separated by periods dominated by plant growth and soil formation. By radiocarbon-dating soil profiles buried within the dunes, geologists determined that sand had been moving in the periods 750 to 1000 A.D., 1260 to 1700 A.D., and 1830 to the present.[56] The destabilization of the banks that resulted in the live dunes of the 1840s—the dunes reported by Spears and others—was only the most recent event in a cycle that stretches back into the prehistory of coastal North Carolina.

The human record documents this cycle as well. In the vicinity of Kitty Hawk, Edmund Ruffin described in some detail the farm of a Mr. Gallup (possibly Hodges Gallup, a Baptist minister) on the banks of Guinguy's [Jean Guite] Creek. According to Ruffin, after Gallup cleared the formerly forested land, "several considerable mounds of old oystershells, formerly accumulated near the Indian huts [were exposed], which were covered and entirely hidden by the soil when the forest was first cleared off. Thus . . . these different elevations of the surface are shown to have existed at different times."[57]

Native Americans are known to have made their camps on the wooded sections of the banks, just as the Europeans who followed them did. This report provides evidence

55. Thomas Moslow and Duncan Heron describe this "fining upward sequence": "As the updrift margin (accreting bank) of the inlet begins to fill in with sand and shell material, current velocities from tidal flow are reduced because of the decrease in inlet channel depth. This lower energy environment results in the deposition of finer sand and shell material further up the channel margin. The updrift accretion and spit development displaces the axis of tidal flow in a downdrift direction initiating the inlet migration process and eroding the downdrift or opposite margin of the inlet." Thomas Moslow and Duncan Heron, "Relict Inlets: Preservation and Occurrence in the Holocene Stratigraphy of Southern Core Banks, North Carolina," *Journal of Sedimentary Petrology* 48 (December 1978): 1275-1286; Duncan Heron et al., "Holocene Sedimentation of a Wave-Dominated Barrier Island Shoreline: Cape Lookout, North Carolina," *Marine Geology* 60 (1984): 413-434; J. W. Pierce and D. J. Colquhon, "Holocene Evolution of a Portion of the North Carolina Coast," *Geological Society of America Bulletin* 81 (December 1970): 3697-3714.

56. K. G. Havholm et al., "Stratigraphy of Back-Barrier Coastal Dunes, Northern North Carolina and Southern Virginia," forthcoming in *Journal of Coastal Research*.

57. Ruffin, *Descriptive Sketches of Lower North Carolina*, 128-129. Gallup's land-clearing affected only the local vegetation. The dunes that threatened the banks' forests moved with prevailing winds, which come from the northeast. Gallup's farm was on the west side of the bank, so sand blew from his fields into the sound or into Guinguy's Creek. Ruffin describes the bank east of Gallup's farm as being covered by a substantial forest growth. He came across live dunes and buried trees halfway across the island, a half-mile or so *upwind* of the farm. Further, the impact of the largest farm on the most densely populated part of the banks should not be taken as any indication of what was happening on Hatteras Island, where fewer people made much smaller clearings in the maritime forest.

that the forest of a native settlement was buried by live dunes that were later covered in woods. Further evidence can be found in the records of the twentieth century. Lewis's 1917 report on Shackleford Bank indicates that a sand wall was moving into the forest at that time. In 1949, the western part of the island south of the sand wall was described as being "absolutely devoid of vegetation except for the sea oats on a few small outlying dunes."[58]

Despite this lack of vegetation, the sand wall remained stable, as shown in a series of aerial photographs taken between 1939 and 1971, which reveal that the boundary between the dune field and the maritime forest in the western half of the island remained in one place. The live dunes on Shackleford Bank appear to have stabilized at some point between 1917 and 1939. This stability coincided with a period—1933 to 1953—during which the southern banks were free of significant hurricane impact. By the late 1960s, the sand wall on Shackleford was carpeted with sea oats, and in 1999, that plant cover was still intact.[59] This revegetation and dune stabilization happened without any aid from humans, during a period when the island was home to significant herds of feral livestock.

If live dunes could be stabilized without human intervention, perhaps they also could have been mobilized without the human hand. Ever since Jay Bond wrote his report on the Hatteras sand wave in 1908, free-range livestock have been held at least partially responsible for the origins of the live dunes up and down the banks. It stands to reason that having large numbers of large herbivores tramping around the islands munching plants would be detrimental to the vegetation, but that theory may not stand up to scrutiny.

In order to destabilize the seaside dunes, livestock have to eat or otherwise disturb the plants that hold the dunes together, primarily sea oats and pennywort on the Outer Banks. When investigators examined the eating habits of the horses, cows, goats, and sheep of Shackleford Bank, they found that sea oats comprised only a small part of the animals' diet. Though all the animals foraged in all areas of the island, horses and cows focused on the cordgrasses of the salt marsh and overwash flats, while

58. William L. Engles, "Vertebrate Fauna of North Carolina Coastal Islands II: Shackleford Banks," *American Midland Naturalist* 47 (1952): 706, 710. Engles's discussion of the history of Shackleford's vegetation and the impact of climate on island plants is a major contribution to the region's historical ecology. See Lewis, *The Vegetation of Shackleford Bank*.

59. See Constance Brauer, "Genetic Mapping and Erosional History of the Surface Sediments of Shackleford Banks, North Carolina" (master's thesis, Duke University, 1974); Charles Carney and Albert Hardy, *North Carolina Hurricanes: A Listing and Description of Tropical Cyclones which Have Affected the State* (Raleigh, N.C.: U.S. Weather Bureau, 1967), 6-30. There were some storms in the Cape Lookout area during this period, and sand was moved by the winds; but all records indicate that the sand wall on Shackleford did not shift position during this time. Shu-Fun Au, *Vegetation and Ecological Processes on Shackleford Bank, North Carolina*, National Park Service Scientific Monograph Series no. 6 (Washington, D.C.: National Park Service, 1974), plate 2, photograph no. 11; author's personal observation.

the goats and sheep focused on the myrtle and oak of the woodland and shrub thicket. Pennywort was not eaten, though it did suffer some localized trampling damage.[60]

When the annual plant growth was compared to the amount of fodder the animals consumed, investigators concluded that the major animal impact was on the woody vegetation. The animals slowed down—though did not stop—the growth of the myrtle and the expansion of shrub thicket into the dune field. This conclusion is supported by geologist Constance Brauer's vegetation maps of the island, which clearly show the expansion of sea oat cover in the dune field and significant growth of shrub thicket on the western half of the island. All this was going on at a time (1939 to 1971) when the island was home to a significant number of livestock. (The National Park Service removed the animals from Shackleford Bank in 1986.)[61]

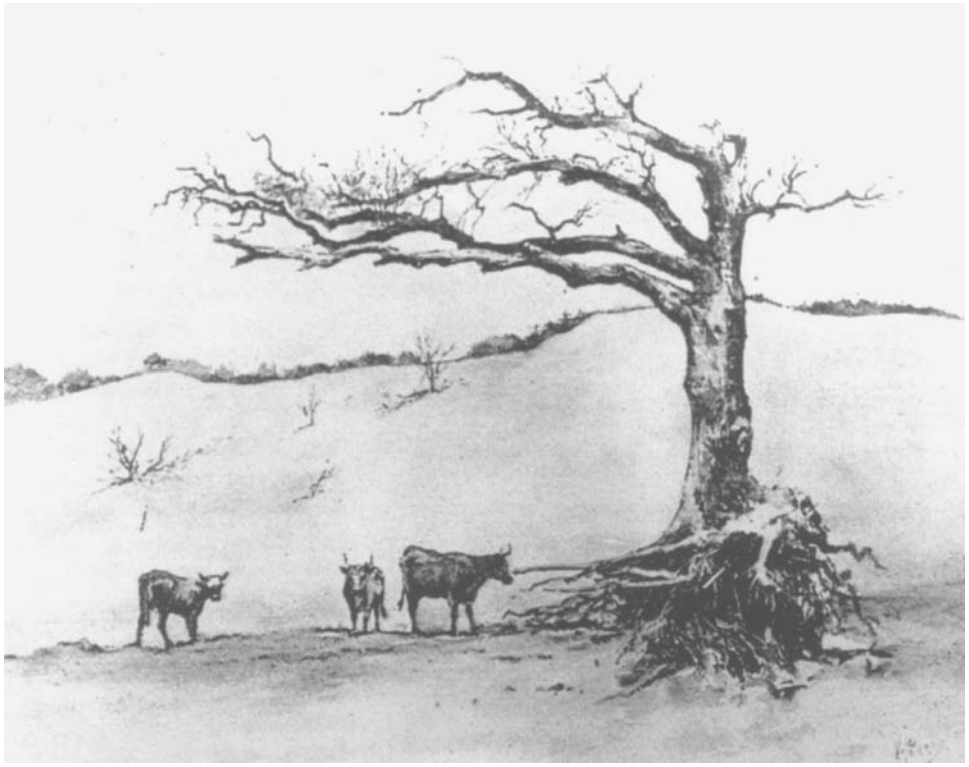
The impact of livestock may not be as straightforward as this suggests, however. On Cedar Island, on the south shore of Pamlico Sound, north of Beaufort, a herd of cows and horses has been fenced into one side of the island for at least fifty years.[62] Compared to the ungrazed portion of the island, the grazed section has sparser dune grass and lower dunes. This lower profile would make that section of the island more susceptible to overwash and erosion. The ecological, geological, or geographical factors responsible for this differing impact (as compared to Shackleford) have not yet been defined. Nevertheless, there are compelling reasons to question the assumption that livestock invariably destroyed vegetation on the Outer Banks.

There are also questions about the size of the livestock populations. Huge herds of semi-domesticated animals are said to have inhabited the Outer Banks in the past. In an oft-quoted source, an anonymous correspondent in the early years of the nineteenth century recounted, "Seven years ago an inhabitant of the Island [Portsmouth] of his own mark, sheared 700 head of Sheep—had between two hundred & fifty, & three hundred head of cattle & near as many Horses. . . ." In a frequently overlooked passage, he adds, "Frequent & severe gales of wind for the last

60. Gene Wood, Michael Mengak, and Mark Murphy, "Ecological Importance of Feral Ungulates at Shackleford Bank, North Carolina," *American Midland Naturalist* 118 (October 1987): 236-244. Scientists examining animal feces found that *Uniola* comprised 13, 12, 6, and 5 percent of the diets of horses, cows, sheep, and goats, respectively. *Spartina* comprised 50 and 32 percent of the diets of horses and cattle; while woody species made up 32 and 56 percent of the diets of sheep and goats. These animal populations fluctuated. Aerial counts during the three years of the study found that the number of cows varied from 64 to 89, and horses, from 81 to 108. Sheep and goats could not be counted because they spent most of their time undercover in the shrub thicket and forest. Wood, Mengak, and Murphy concluded that given natural oscillations in population size, at some point the number of animals would outstrip the ability of the island to sustain them.

61. Karen Dugan, National Park Service ranger, Cape Lookout National Seashore, conversation with the author, October 24, 2001.

62. Donald C. Barber, "The Impact of Horse and Cow Grazing on Barrier Island Morphology: Cedar Island, Pamlico Sound, North Carolina," unpublished manuscript, Duke University Geology Department; Donald C. Barber, Robert S. Young, and Orrin Pilkey, "Alteration of Barrier Island Morphology by Ungulate Grazing: Cedar Island, Pamlico Sound, NC," *Geological Society of America Abstracts with Programs* 23, no. 1 (1991).



Jay Bond concluded in his 1908 report that free-range livestock were at least partially responsible for the live dunes on the Outer Banks, but there are conflicting reports on the impact of livestock on dune vegetation. Drawing of cattle beneath an uprooted tree from John R. Spears, "Sand-Waves at Henlopen and Hatteras," *Scribner's Magazine* 8 (October 1890): 507.

five or six years, have at the various times, swept large numbers of them off the Island and destroyed very much the range. . . ."[63]

The impact of storms on livestock populations, and what that means for the vegetation of the islands, has not yet been considered. A careful scan of Lifesaving Service journals and newspaper accounts of nineteenth-century storms could shed some light on this question. From published accounts and secondary sources, five other instances of storm-induced livestock mortality between 1842 and 1933 have been identified.[64] Doubtless, many records wait to be discovered; and unquestionably,

63. A. R. Newsome, "A Miscellany from the Thomas Henderson Letter Book, 1810-1811," *North Carolina Historical* Review 6 (October 1929): 401.

64. After the hurricane of July 1842, Captain Etheridge of Chicamacomico saw large numbers of cattle and horses drifting down the sound. David Stick, *Graveyard of the Atlantic* (Chapel Hill: University of North Carolina Press, 1952), 5. Henry B. Ansell recalled the northeaster of March 1846: "Hogs, cattle and sheep on marshes, beach and low lands all gone; all fences blown flat, all water fences washed away. Everything, including the dead animals, had been carried down the sound to be cast on some distant shore." *Independent*, January 4, 1935. In the "Sheep Storms" of the 1880s, large numbers of sheep perished on Shackleford Bank. Stick, *The Outer Banks*, 190. During the hurricane of August 1933, the Wash

there were many instances of livestock mortality that were never recorded. It is reasonable to assume that storm-induced mortality frequently reduced the impact of livestock on the vegetation of the Outer Banks by reducing population size. Exactly what this means for the historical ecology of the banks is a subject for future investigation.

Because of their habit of rooting for food, hogs were a special concern. Bond specifically mentioned hogs feeding on sea oats roots as a factor in the mobilization of the Hatteras sand wave. Anyone who has seen the Rototiller effect of free-range hogs would assume that they would devastate barrier island vegetation. However, when Jill Baron examined the behavior of hogs on Horn Island, Mississippi, she noticed some interesting things. First, the pigs left the sea oats alone and confined their feeding to the loblolly pine stands and wet grasslands of the island. Also, the ground cover and diversity of the rooted areas recovered in a matter of months from the disturbance. Some areas had greater plant cover after recovery from rooting than before it. Within the limits of the sampling methods, no difference was detected in the vegetation of Horn Island and a nearby island with no hog population. Baron concluded:

> Intense sunlight, drought conditions and high salt levels create a desert environment few plants can tolerate, and overwash caused by hurricanes and other storms, shifting sand, drought and fire are the main damaging forces to the ecosystem. Feral hogs are a disturbance, but one that is minor compared to the intensity of these other forces. The vegetation is adapted to frequent disturbances and is characterized by its resiliency; it can easily recover from rooting damage.

Baron also noticed that the hogs scavenged on the beach and ate dead fish and crabs whenever they were available. Animal remains made up 25 percent of the stomach contents of hogs that were captured in late summer.[65] Presumably, the hogs on the Outer Banks shared this omnivorous habit and the tendency to find sea oats distasteful. Biologist William L. Engles observed that the pigs on Shackleford Bank "commonly forage on trash on the beach of Back Sound."

During the period in which live dunes started moving across the banks, the Hatteras Island hogs had a ready supply of carrion to feed on. A porpoise fishery operated on the banks from the late eighteenth century to the Civil War. During the winter months, when the bottle-nosed dolphin migrated along the shore, up to three crews would set watch and put boats into the surf to surround schools of porpoise with nets. Once surrounded, the whole pod would be pulled toward the beach. The bodies

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Woods area (east of Knotts Island) "was once again swept clean of livestock." *Independent*, September 8, 1933. Large numbers of animals washed up on the shore of Cape Lookout, "horses, cows, pigs and sheep, cats and dogs, oposums [*sic*], rabbits and 'even snakes!' " Engles, "Vertebrate Fauna," 739.

65. Jill Baron, "Effects of Feral Hogs (*Sus scrofa*) on the Vegetation of Horn Island, Mississippi," *American Midland Naturalist* 107 (January 1982): 202-205. Classical succession theory equates disturbance with damage to the ecosystem. But disturbance can be viewed as a process integral to the barrier island ecosystem, a process to which plants and animals have adapted.

were then stripped of blubber, the oil rendered, and the flesh and skin discarded.[66] The number of hogs on the island, the nature of their diet, and their impact on the vegetation are topics for future research. Despite the uncertainties, the Hatteras porpoise fishery makes it less likely that hogs were responsible for the devegetation of the Hatteras Island dunes.

This contradicts Jay Bond's assertion that Hatteras hogs were a primary cause of the moving sand. In mainland habitats less susceptible to soil disturbance than barrier islands, hogs can be quite destructive. In the pine savannas of the Coastal Plain, for example, hogs totally stopped the reproduction of the longleaf pine. Because of this, the NCGS made ending the open range a priority. North Carolina's first state geologist, Joseph A. Holmes, noted in his 1897-1898 report the damaging effects of free-ranging cattle and hogs, "especially in the pine region of the eastern counties."[67] These warnings were repeated in the 1907-1908 state geologist's report. Bond may have concluded from this report on mainland habitats that hogs on Hatteras Island similarly threatened the maritime forest.

Human activity, as well as semi-domesticated animals, directly affected the maritime forest. Residents of the banks held a variety of views about the maritime forests. Sterling Dixon of the Carteret County mainland believed that "If the old timers could have cut down everything for their use, they would have." In contrast, Thomas Kearney said of Ocracoke Island at the beginning of the twentieth century, "So highly are the trees [live oak] valued as wind-breaks by the inhabitants that none are felled, all fuel brought from the mainland." Given the scarcity of writings the Bankers left behind, it is difficult to assess how pervasive these beliefs were.[68]

Trees were cut for firewood, to clear land for kitchen gardens, and to build houses and boats. They were also cut in commercial timber harvests. These activities have been identified as primary factors in the origins of the live dunes on the Outer Banks, though the extent to which they contributed to this event is unclear. Trees on the

66. Engles, "Vertebrate Fauna," 710; George Brown Goode, *The Fisheries and Fishery Industries of the United States . . .* (Washington, D.C.: Government Printing Office, 1887), 2:308; F. W. True, "The Porpoise Fishery of Hatteras, N.C.," *Bulletin of the United States Fish Commission* 5 (1885): 3-6.

67. W. G. Wahlenberg, *Longleaf Pine: Its Uses, Ecology, Regeneration, Protection, Growth and Management* (Washington, D.C.: Charles Lathrop Pack Forestry Foundation, 1946), 78. In her study of the impact of hogs on Mississippi barrier islands, Jill Baron did not specifically examine the reproduction of the loblolly pine. However, in mainland habitats with other food sources, hogs leave loblolly pine alone. For hogs and destruction of the longleaf pine, see Robert B. Outland, "Suicidal Harvest: The Self-Destruction of North Carolina's Naval Stores Industry," *North Carolina Historical Review* 78 (July 2001): 329. NCGS, *Biennial Report of the State Geologist: 1897-1898*, 5.

68. Godfrey, "Natural History of the Outer Banks," 26; Thomas H. Kearney, "The Plant Covering of Ocracoke Island: A Study in the Ecology of the North Carolina Strand Vegetation," *Contributions from the U.S. National Herbarium* 5, no. 5 (Washington, D.C.: Government Printing Office, 1900), 71. Kearney, who spent five days studying Ocracoke Island when the live dunes were unseating Diamond City, does not mention live dunes on Ocracoke.

banks may have been cut to provide fuel for the steamers that brought Tidewater aristocrats to the Nags Head resort during the nineteenth century.[69]

Fireplaces were used for cooking and to heat houses on the banks. Deadwood was certainly collected for firewood out of the maritime forests, and live trees were harvested as well. The wrecks that earned the Graveyard of the Atlantic its name frequently left the beaches strewn with their shattered remains, and this flotsam was another source of firewood for the residents of the Outer Banks. In his history of North Carolina shipwrecks, David Stick lists 298 ships lost off the Outer Banks in the nineteenth century. This does not include ships in distress that jettisoned their cargoes of lumber and barrel staves or ships lost without a trace, save anonymous wreckage on the beach.

Wrecked vessels were also a source of building materials. As recently as 1933, a shipwreck on the Outer Banks was reported under the headline, "Heres [*sic*] Hardware and Lumber for the South Banks."[70] Using salvaged shipwrecks for construction had some advantages. Building material became available after storms, when it was most needed for construction and repair. Also, it was a full day's sailing from Hatteras Island to the lumber mills at Elizabeth City when the weather was good; thus it would be far easier to collect lumber from the beach than it would be to haul it all the way from the nearest mill. What portion of the Bankers' fuel and construction needs was met in this fashion is impossible to determine, but the existence of sources of fuel and lumber outside the maritime forests makes it less likely that human activity was a primary cause of the live dunes of Hatteras Island.

Farming probably had a negligible effect on the dunes. For the most part, agriculture on the banks was a subsistence activity. Residents cleared small kitchen gardens next to their homes, cultivating a wide variety of vegetable and fruit crops; and rather than fence livestock in, they enclosed gardens to keep the animals out. The windmills that dotted the banks in the nineteenth century were kept busy grinding corn that fishermen obtained in trade from mainland farmers. It is difficult to conceive how these small clearings, located near the sound side of the islands and surrounded by forest and thicket, could have caused the live dunes that were moving across the islands from the ocean side.[71]

Commercial logging operations were also unlikely to have been a factor in creating the live dunes. Logging in Buxton Woods started in 1899, with the harvesting of

69. Alan D. Watson, "Sailing under Steam: The Advent of Steam Navigation in North Carolina to the Civil War," *North Carolina Historical Review* 75 (January 1998): 42.

70. Bishop, *Voyage of the Paper Canoe*, 175; Stick, *Graveyard of the Atlantic*, 146-152; *Independent*, September 15, 1933.

71. John S. Billings, *A Report on Barracks and Hospitals: with Descriptions of Military Posts*, U.S. Surgeon General's Office Circular no. 4 (Washington, D.C.: Government Printing Office, 1870), 83-91; Gary S. Dunbar, *Historical Geography of the North Carolina Outer Banks* (Baton Rouge: Louisiana State University Press, 1958), 32.

Outer Banks residents harvested live trees for firewood and lumber, however it is unclear to what extent these activities contributed to the live dunes on the Outer Banks. Salvaged shipwrecks also provided wood for construction and fuel. This photograph by Charles Morgan, "Oak Staves from a wreck on Hatteras Beach, 1900," is from the North Carolina Collection.

loblolly pine from the sound side of the island.[72] Prior to this time, the distance to lumber mills and the existence of huge timber stands on the mainland made exploitation of the maritime forest pine unattractive. The location and timing of these cuts indicate that commercial timber harvesting cannot be implicated in the liberation of Hatteras Island's live dunes. Live dunes started moving into Buxton Woods many decades before the area was logged. In addition, Bond recorded that the cutting took place near the sound side of the forest, not in the area in which the sand started moving. Further examination of the deed books in Dare, Hyde, and Carteret Counties may determine whether or not such operations took place at earlier times or in other sections of the Outer Banks maritime forest.

Boatbuilding has also been cited as a factor in the liberation of the live dunes. In the nineteenth century, a host of vernacular boatbuilding styles developed along the North Carolina coast. Built out of local material to meet the needs of local watermen, hundreds of these mostly small, shallow-draft boats (under thirty-six feet long) functioned as taxis, fishing boats, and freighters and were the lifeblood of the Outer Banks communities for decades.[73] Though their construction required vast quantities

72. Susan Bratton and Kathryn Davison, "Disturbance and Succession in Buxton Woods, Cape Hatteras, North Carolina," *Castanea* 52 (September 1987): 169-170. These are the operations that state geologist Jay Bond reported in 1908 in his biennial report.

73. Mark Taylor, "Traditional Boats of North Carolina," in *Wildlife in North Carolina*, ed. Jim Dean and Lawrence S. Earley (Chapel Hill: University of North Carolina Press, 1987), 8-33. Rodney Barfield's

of wood, a closer examination of coastal boatbuilding raises questions about their impact on coastal forests.

The earliest boats were dugouts built from cypress harvested on the mainland. (Cypress does not grow on the Outer Banks.) The frame-built boats that replaced the dugouts in the early nineteenth century were built of cypress and juniper. Some scholars have identified this juniper as the red cedar (*Juniperus virginiana*) that makes up a significant portion of the shrub thickets and forests of the banks, citing its use in boatbuilding as a factor in the destruction of the maritime forest. (*Juniperus* is also a common tree in abandoned fields on the mainland.) Although red cedar was occasionally used as planking and to make the ribs of these boats, the banks cedars were generally too short and the wood too knotty to make good boatbuilding material. Rather, the boatbuilders' juniper was the Atlantic white cedar (*Chamaecyparis thyoides*) that grew in huge stands in the pocosins and other freshwater swamps of the Coastal Plain. Boatbuilders from Roanoke Island and Buxton would go to the mainland to harvest the wood they needed—cypress for ribs and juniper for planking—to build their boats.[74]

There was an increase in the use of red cedar in Beaufort boatyards after 1890, presumably because of the intense harvesting and disappearance of other timber. (*Chamaecyparis* was almost totally cut out of North Carolina wetlands by the mid-1920s, and regeneration was sporadic because of wetland drainage.)[75] However, this was much too late to contribute to the devegetation of the dunes. During the time in question—the first four decades of the nineteenth century—it appears that Outer Banks boats were primarily made from mainland timber.

Wood from North Carolina's maritime forests may also have been exported for use in shipbuilding. In a process called "live oaking," shipwrights from New England yards traveled south to cut and shape live oak from the maritime forests. On sparsely settled coastal islands and in mainland swamps, axemen and shipwrights fought debilitating heat and lethal malaria to fell the oaks and send the semi-finished members back north for assembly.[76] Live oak was preferred by many for the construction of large ships because of its great strength and rot resistance. (Its tremendous density and weight, however, made it unattractive to builders of smaller, shallow draft boats.) After the American Revolution, live oak became important in the construction of the warships, whalers, and China clippers essential to establishing American wealth and

Seasoned by Salt: A Historical Album of the Outer Banks (Chapel Hill: University of North Carolina Press, 1995), contains photographs of many of these boats.

74. Mike Alford, retired curator of maritime history and technology, Maritime Museum, Beaufort, North Carolina, conversation with the author, August 6, September 23, November 6, 1999.

75. Cecil Frost, "Historical Overview of Atlantic White Cedar in the Carolinas," in *Atlantic White Cedar Wetlands*, ed. Aimlee D. Laderman (Boulder, Colo.: Westview Press, 1987), 257-264.

76. See Virginia Steele Wood, *Live Oaking: Southern Timber for Tall Ships* (Boston: Northeastern University Press, 1981).

power. Live oak was such a critical resource that America's first forest reserves were created to preserve it, and experiments were conducted on the cultivation of the trees in the early nineteenth century. During that same time, New England live oakers went as far as the Louisiana territories to procure the wood. However, there is little indication that North Carolina live oak was widely used in New England shipbuilding. An 1832 U.S. naval report on live oaking did not record any live oak lands north of South Carolina. Virginia Steele Wood, in her 1981 description of live oaking in the construction of merchant vessels, makes no mention of activity in North Carolina, other than that on Smith Island, at the mouth of the Cape Fear River.[77]

Geography and logistics may explain why live oaking was not extensively employed in North Carolina. Large vessels were necessary to haul the huge timbers north to the shipyards, and the live oak contracts signed in 1794 for the wood to build the first ships of the U.S. Navy stipulated that the timbers would be "hauled to water navigable for vessels of eleven feet draught by the contractors." Such landings are almost nonexistent on the North Carolina coast.[78] Faced with the prospect of hauling heavy timbers for miles through the sand, live oakers apparently chose to go elsewhere.

Despite these difficulties, live oaking did take place in spots along the North Carolina coast. In 1805, J. G. Swift, a U.S. Army engineer in charge of fortifying the approaches to the Cape Fear River, estimated that there were twenty thousand live oaks on Smith Island suitable for shipbuilding. Ten years later, another survey found only three hundred suitable trees left. While the accuracy of the 1815 survey is open to question, Wilmington shipyards began building oceangoing schooners of live oak during this period, and shipbuilders could have easily procured the wood for their boats at Smith Island.[79] An examination of Wilmington newspapers of the period and other archival sources may illuminate the exact nature of live oaking on Smith Island.

77. William F. Keller, "Henry Marie Brackenridge: First United States Forester," *Forest History* 15 (January 1972): 12-23; Wood, *Live Oaking*, 88-142; U.S. War Department to U.S. House of Representatives, "Historical Statement of the Use of Live Oak Timber for the Construction of Vessels of the Navy, and Vessels Built with It; The Quantity on Lands Reserved from Sale by the United States and on Private Lands, and the Necessity for Its Preservation for Future Use," December 15, 1832, *American State Papers: Naval Affairs*, 4:191-225.

78. Tench Coxe to Alexander Hamilton, December 22, 1794, *American State Papers: Naval Affairs*, 1:10; Jonathan Price, "A Description of Occacock Inlet; and of Its Coasts, Islands, Shoals, and Anchorages . . . ," reprinted in *North Carolina Historical Review* 3 (October 1926): 625-633. In 1795, Price surveyed Ocracoke Inlet, the primary North Carolina port of entry at the time, and found at most eighteen feet of water over the bar there. Once into the sounds, though, a ship of burden would find no channels to carry it further.

79. Swift, *Memoirs of Gen. Joseph Gardner Swift*, 60; Thomas Newell and Abraham Thomas, "Summary of Information Respecting Live Oak Timbers of the Carolinas and Georgia, October 1815-November 1817," Naval Records Collection of the Office of Naval Records and Library, Record Group 45, National Archives; Malcolm Ross, *The Cape Fear* (New York: Holt, Rinehart, and Winston, 1965), 76.

The loss of 19,700 trees in one decade would seem to indicate that live oaking contributed to the live dunes on Smith Island. However, the biology of the trees and the details of the shipbuilding process provide some mitigating factors. First, in many places on the Outer Banks, such as Smith Island in the early 1800s, live oak occurs with the red bay, red cedar, yaupon, and loblolly pine. Even after intensive live oaking, there would be other trees and plants to keep the sands stabilized. Furthermore, live oak, like most oaks, grows readily from the roots. Unless the live oakers were pulling the stumps up, these stump sprouts could quickly re-establish themselves after being cut. Lastly, live oaking was not a modern clear-cut operation. The shipwrights were looking for large trees of particular shapes to fit the curves of the hulls they were building. Seed trees were probably left in close proximity to the areas where live oak was cut, facilitating the regrowth of the oaks.[80]

In 1861, Edmund Ruffin described the regeneration of forests after live oaking near Kitty Hawk, though he does not describe the live oaking operation itself:

> There were oaks and other trees of smaller size, and healthy growth. I was informed that live oaks, large enough for ship timbers, had been formerly cut down here, for that use. Of this wooded and more ancient sand-hill formation consists all of the reef [Currituck Bank] bordering here on the sound. But about midway to the present beach, the surface changes suddenly to the more recent and naked soil. . . . But formerly this present waste was covered by a forest, in part of cedars, and many of them of large sizes, of which the dead remains are still standing or lying over the surface.[81]

Ruffin's account indicates that the vegetation was able to maintain itself and the live dunes were located upwind of the area that had been cut over for live oak. Certainly removing the large oaks dramatically altered this forest, but it does not appear to have been responsible for the destabilization of the dunes. Examination of deed books in the Dare County Courthouse may shed further light on live oaking in the area.

According to Charles T. Williams, the live oak forest in the vicinity of Kinnakeet (the present town of Avon) was logged out and sold to New England shipyards by Pharaoh Farrow in the years just after the Revolutionary War. (This was the area in which boatbuilding activity led to the formation of a live dune, according to Spears.) According to Williams, Farrow was an English squire who owned hundreds of slaves and much of the land north of Cape Hatteras. The sale of slaves and oak made him the richest man on the banks, and he left trunks full of gold buried somewhere on the

80. Pinchot and Ashe, *Timber Trees and Forests*, 961. Herbivore grazing has been shown to slow down the growth of live oak stump sprouts. See Susan Bratton and Elizabeth Kramer, "Recovery of Live Oak Sprouts after Release from Browsing on Cumberland Island National Seashore, Georgia," in *Barrier Island Ecology of the Mid-Atlantic Coast: A Symposium*, ed. C. A. Cole and K. Turner (Atlanta, Ga.: National Park Service, U.S. Department of the Interior, 1992). Significantly, native deer were found to have as great an impact on sprout growth as did feral cows and hogs.

81. Ruffin, *Descriptive Sketches of Lower North Carolina*, 128-129.

island when he died.[82] The account is uncorroborated; thus the exact nature of the Kinnakeet clearcut is uncertain.

Live dunes and ghost forests also existed outside of North Carolina. In his 1890 article, John Spears described a live dune that was burying the maritime forest at Cape Henlopen, at the entrance to Delaware Bay. According to residents' recollections and a government survey, this dune started moving inland in the mid-1840s, about the same time live dunes began moving across Hatteras Island and Shackleford Bank. Frederick Merrill's 1890 account of the New Jersey coast was strikingly similar to Spears's description of Hatteras Island: in both regions, sand dunes moved inland off the beach, leaving buried trees and ghost forests in their wake. Merrill wrote:

> Near the northern end of Seven Mile Beach [in Cape May County] . . . an immense dune forty feet in height and half a mile in length had been for many years encroaching steadily upon the dense forest. The tree-tops here projected above the summit of the ridge like the heads of drowning men above the waves; while on the outer flank of the overwhelming mass of sand the gnarled, skeleton trunks of those which had perished in it stood bare and grim, showing with dreary grayness the fate of the earlier victims.[83]

The region-wide occurrence of live dunes suggests the possibility of a single cause, a process operating on a regional scale that might have impacted the vegetation of these sandy coastlines. Climate is such a process, and the world's climate underwent a shift during the time in which live dunes started moving on the coast of North Carolina.

Records documenting the freezing and thawing of rivers, lakes, and bogs in Arctic and boreal regions show that the world's climate has been warming since 1600, and that the rate of warming increased in the mid-nineteenth century. This shift in the rate of change signaled the end of what is known as the Little Ice Age.[84] This nineteenth-century warming trend had a profound impact on plant populations worldwide. The Arctic tree line in Canada and alpine tree lines in Sweden shifted in response. Forest fires became less frequent as cold Arctic air was replaced by warmer moister air masses. Cypress trees in coastal North Carolina swamps showed the effects of drought, which may have influenced the reproduction of dune plants and their ability to stabilize the sand in the face of meteorological disturbances.[85]

82. Williams, *The Kinnakeeter*, 21-22.

83. Spears, "Sand-Waves," 508; Frederick Merrill, "Barrier Beaches of the Atlantic Coast," *Popular Science Monthly* 37 (1890): 736-745, quotation, 741.

84. John J. Magnuson et al., "Historical Trends in Lake and River Ice Cover in the Northern Hemisphere," *Science* 289 (September 8, 2000): 1743-1746. See Jean M. Grove, *The Little Ice Age* (New York: Methuen, 1988), for a summary of the geological and human historical data on the Little Ice Age. Scientists have disagreed on the exact timing of the changes involved. As different vegetation types responded in various ways to the end of the Little Ice Age, the dates given for this period vary. Alpine glaciers reacted individualistically to warming weather, reflecting variations in snowfield size and aspect, altitude, and latitude.

85. Kateri Lescop-Sinclair and Serge Payette, "Recent Advance of the Arctic Treeline along the Eastern Coast of Hudson Bay," *Journal of Ecology* 83 (December 1995): 929-936; Leif Kullman, "Holocene

Sea level changes on the coast of North Carolina over the last three hundred years have not been investigated, yet there is evidence that rising sea level affected the maritime forests of the coast. In his survey of salt marshes at the mouth of the Cape Fear River, David Adams found red cedar stumps in the low marsh of Oak and Smith Islands. According to Adams, "Neither deposition nor erosion has significantly altered the ground surface level. Rise in sea level relative to the land surface has gradually replaced portions of a maritime forest with salt marsh." Paul and Melinda Godfrey found a similar situation on Shackleford Bank, where the stumps were radiocarbon dated at less than two hundred years old.[86] A complete survey and dating of these maritime forest remnants could shed some light on the history of North Carolina's coastal forests.

The nineteenth century was also a very stormy one. Forty-six hurricanes struck the North Carolina coast between 1840 and 1899. The number of storm-free years decreased and the number of years with multiple hurricanes increased after 1850. The twenty years prior to Spears's visit in 1890 were particularly impressive. Single hurricanes occurred in every year of the 1870s. The 1873 storm made a pass up the coast then turned around and struck the Outer Banks again. A pair of storms struck the coast in 1881, 1885, 1886, 1887, 1888, and 1889. (There was a single hurricane in 1883.)[87]

Northeasters and other winter gales can have an even greater impact on coastal landscapes than hurricanes. Though their winds are generally below hurricane speed, these winter storms can persist for days and sometimes weeks, pounding the coast with surf. Unlike hurricane history, the record of winter storms is still locked away in newspaper archives and Lifesaving Service journals.[88] Synthesizing these records and assessing the storms' impact on coastal vegetation is an immense research project that has not yet been undertaken.

The importance of whole-year impact is well illustrated by the changes that took place on the Outer Banks in 1846. The storms of that year left a lasting impression on the geography of the banks and the memories of people who lived through them.

History of the Forest-Alpine Tundra Ecotone in the Scandes Mountains (Central Sweden)," *New Phytologist* 108 (January 1988): 101-110; James S. Clark, "Fire and Climate Change during the Last 750 Yr in Northwestern Minnesota," *Ecological Monographs* 60 (June 1990): 135-159; Yves Bergeron and Sylvain Archambault, "Decreasing Frequency of Forest Fires in the Southern Boreal Zone of Quebec and Its Relation to Global Warming since the End of the 'Little Ice Age,' " *Holocene* 3, no. 3 (1993): 255-259; D. W. Stahle, M. K. Cleaveland, and J. G. Hehr, "North Carolina Climate Changes Reconstructed from Tree Rings: A.D. 372 to 1985," *Science* 240 (June 10, 1988): 1517-1519.

86. David Adams, "Factors Influencing Vascular Plant Zonation in North Carolina Salt Marshes," *Ecology* 44 (summer 1963): 54. Evidence of "reverse succession" such as this illustrates the difficulties of applying classical succession theories to a dynamic environment such as the Outer Banks. Paul J. Godfrey and Melinda M. Godfrey, "The Role of Overwash and Inlet Dynamics in the Formation of Salt Marshes on North Carolina Barrier Islands," in *The Ecology of Halophytes*, ed. Robert J. Reimold and William H. Queen (New York: Academic Press, 1974), 423-424.

87. Carney and Hardy, *North Carolina Hurricanes*, 5-21.

88. See Ivan Ray Tannehill, *Hurricanes: Their Nature and History* . . . (Princeton, N.J.: Princeton University Press, 1938).

These storms opened both Oregon and Hatteras Inlets, which stand today as major landmarks on the North Carolina coast. It is significant that this occurred at a time during which live dunes on the banks were said to have originated. Charles Johnson, a Union soldier stationed on Hatteras Island in 1861, recorded an old Cape Hatteras fisherman's recollections of these storms:

> Before the "great flood of '46," the open beach between Camp Wool [two miles east of the inlet] and Fort Hatteras, also that between Trent [Frisco] and Duncan Creek [off Sandy Bay at Hatteras village], was as flourishing with vegetation as any other part of the Island. A stray Northeast wind prevailed for two weeks without cessation, and swelled the breakers to such a size that they finally washed over these parts, carrying with every one, immense volumes of water into the Sound, and tearing up great trees and every other vestige of vegetation. . . . And when the waters subsided, Hatteras Inlet was cut out and the fairest portion of the Island laid under a desert of sand in which vegetation has not yet been able to show any signs of revival.[89]

In this account, the 1846 storms not only opened Hatteras and Oregon Inlets; they destroyed a large stretch of Hatteras Island vegetation. Given this wide-ranging impact, it is reasonable to assume that these storms also influenced the vegetation at Cape Hatteras and Buxton Woods, where Spears saw live dunes in motion thirty years after Johnson's bivouac.

Henry B. Ansell, a resident of Knotts Island, recalled that March 1846 opened with a gale from the northeast that gathered strength for days. At the height of the storm, opposite Knotts Island, all but the treetops and tops of the highest dunes on Currituck Bank were under water. The ghost forest of Wash Woods was uncovered as storm surf rearranged the dunes. Forty-five miles to the south, the storm opened a temporary inlet across Bodie Island. Over the summer, that inlet sanded up, and on Knotts Island, the pine and cedar trees died off. Ansell attributed this occurrence to the fact that "Salt water had stood among these trees from six to eight feet deep as could be seen by the drift that lodged on their trunks." He continued, "From these losses the Island has not recovered to this day [1902] and probably never will. . . ."[90]

The following September, a serious gale blew out of the northeast as a hurricane approached the coast. "It blew harder than the previous March storm," wrote Ansell, "and it would have done the same damage [to Knotts Island] if its predecessor had left

89. Charles F. Johnson, *The Long Roll, Being the Civil War Experiences of Charles F. Johnson of Hawkins Zouaves* (East Aurora, N.Y.: Roycrofter's, 1911), 72-73. See also Godfrey, "Natural History of the Outer Banks."

90. *Independent*, January 4, 1935. Johnson's and Ansell's accounts do not agree exactly. The former describes a single storm, while the latter refers to two distinct storms in separate seasons. C. O. Boutelle, a coast surveyor who was in the area in 1846, describes two separate storms, lending credence to Ansell's account. See U.S. Senate, *Extracts from Letters from Assistant C. O. Boutelle to the Superintendent, Dated January 10, and February 9, 1847, Relating to the New Inlets Formed across Bodie's Island in 1846*, Report of the Superintendent of the Coast Survey, S. Doc. 6, 30th Cong., 1st sess. (Washington, D.C.: Government Printing Office, 1847), 76-77.

anything to damage."[91] Near midday the following day, the wind suddenly shifted to the southwest, and the rain and tide that had built up on the mainland shore headed toward the sea, with the hurricane winds behind them. The Coast Survey reported the effects on Bodie Island:

> The force of the water coming in so suddenly, and having a head of two to three feet, broke through the small portion of the beach which had formed since the March gale, and created the inlets. They were insignificant at first—not more than 20 feet wide—and the northern one much the deepest and widest. In the easterly winds which prevailed in September, the current from the sound gradually widened them; and, in the October gale, they became about as wide as they are now.[92]

The hurricane of September 8, 1846, opened Oregon Inlet, where the March northeaster had opened a short-lived one, and the winds of the following two months made it permanent. This illustrates that, as important as single storms are, it is weather patterns that determine the shape of the islands and the nature of the vegetation that cloaks them.

While many aspects of the history of North Carolina's maritime forests need further investigation, the preponderance of the evidence presented here supports the conclusion that human activity was not the primary cause of the live dunes in the region. At the end of the Little Ice Age, an increase in the rate of sea level rise and in storm frequency increased the number of overwash events; and the vegetation responded. The near constant pummeling left the island plants with little time to recover. Dunes were laid bare, and sand started moving across the Outer Banks.

This emphasis on storm frequency leads to a more dynamic view of barrier island vegetation. As disturbance becomes less common, maritime forests expand outward from their refuges at the capes and other centers of stability. As disturbance becomes more common, they shrink, leaving behind ghost forests and wash woods. From this perspective, rather than a stable forest primeval, the vegetation of barrier islands is as dynamic a part of the island landscape as its human populations and geological structures.

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91. *Independent*, January 4, 1935.
92. Senate, *Extracts from Letters*.