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STABILIZATION OF SAND DUNES IN OREGON

Thousands of acres of sand dunes have been stabilized along the shoreline of the western coast of the United States during the past fifty years. Sand dunes and sand spits occur locally from Baja California to southern Alaska. In the 1930s active dune areas, formed through the interaction of wind, a sand supply, sand wetness, and vegetation, occupied 45, 31, and 23 percent of the coastline in Oregon, Washington, and California, respectively.[1]

There are two major sources of sand that form dunes: erosion of coastal formations by waves and the sediment from rivers. Ocean currents move the sand from eroding headlands and the mouths of rivers to indentations along the coast. Sand deposited on the beaches is exposed at low tide, dries quickly, is caught by the wind, and carried inland to form dunes. Vegetation established on the sandy surface adjacent to the beach entraps sand, accelerating dune formation.

Dunes or dune landscapes can be classified and described in several ways. Since this paper deals with the history of stabilization, (rather than the complexities of identification and classification), the effects of location, geomorphic form, age, vegetation, and climate will not be discussed. Additional information on the geomorphology, vegetation, and

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[1]Extent of dunes was determined from William S. Cooper, *Coastal Sand Dunes of Oregon and Washington*, Geological Society of America Memoir 72 (Washington, 1958), 3; William S. Cooper, *Coastal Sand Dunes of California*, Geological Society of America Memoir 104 (Boulder, Colo., 1967), 21.

climate of West Coast dunes can be found in Cooper,[2] Crook,[3] Reckendorf,[4] Ternyik,[5] and Woodhouse.[6]

The greatest amount of sand movement along the West Coast, particularly on the North Pacific Coast, takes place during the high-velocity wind storms in winter. During these storms, sand engulfs the vegetation near the beach. In spring and summer, vegetation grows up through the sand and forms a lush cover. The vegetation is covered again the next winter, and a continuous sand ridge forms layer by layer and extends, without interruption, parallel to the coastline. This barrier ridge along the beach is called a foredune.

If sand is deposited by the ocean more rapidly than it is blown inland, the beach builds oceanward. The vegetation advances to a new storm tideline, and a new foredune is formed oceanward from the old foredune. Incoming sand is deposited on the new foredune and the old foredune becomes vegetated by plants suited to the more stable conditions. This sequence produced the parallel-ridge dunes on the Clatsop Plains of the Northwest Oregon Coast.

Normal dune building and stabilizing can easily be disrupted by disturbances of the vegetative cover. When the vegetation is thinned and the sand exposed, dunes are subjected to wind erosion again.

Active, open dunes, when poorly managed, may advance onto forest land, pastureland, cropland, roads, railroads, lakes, stream channels, and coastal wetlands, and may damage residential, commercial and industrial property, and valuable wildlife habitat. Properly managed, these open dunes can provide tremendous esthetic and recreational benefits.

Many people want access to unstabilized, active, open dunes, as is apparent from the public comments made during the planning, in the

[2]Cooper, *Coastal Sand Dunes of Oregon and Washington*, 3–4, 11–20, 22; *Coastal Sand Dunes of California*, 5–18.

[3]Cristianna Stachelrodt Crook, "Beaches and Dune Handbook for the Oregon Coast: A System of Classifying and Identifying Oregon's Coastal Beaches and Dunes," mimeographed (Newport, Ore.: Oregon Coastal Zone Management Association, June 1979), 1–92.

[4][Frank Reckendorf], "Beaches and Dunes of the Oregon Coast," mimeographed (Portland, Ore.: U.S. Department of Agriculture, Soil Conservation Service, March 1975), 24–41.

[5]Wilbur E. Ternyik, "Beaches and Dune Handbook for the Oregon Coast: Dune Stabilization and Restoration, Methods and Criteria," mimeographed (Newport, Ore.: Oregon Coastal Zone Management Association, June 1979), 1–39; *Proceedings of a Workshop, Rehabilitation and Creation of Selected Coastal Habitats*: "Sand Dune Habitat Creation on the Pacific Coast," FWS/OBS, 27 (Washington: U.S. Fish and Wildlife Service, November 1980), 55–57.

[6]W. W. Woodhouse, *Dune Building and Stabilization With Vegetation*, Special Report 3 (Fort Belvoir, Va.: U.S. Army Corps of Engineers, Coastal Engineering Research Center, September 1978), 28–29.

early seventies, of the Oregon Dunes National Recreation Area and Oregon's Coastal Zone Management Plan. The public's desire for access to unstabilized dune areas has also been shown in California where large, active, open sand areas have been preserved as public parks. The area at Bodega Bay, for example, which was once half-public and half-private land, is now 90 percent public and part of the Sonoma Coast State Beach Park.

Despite the popularity of open dunes for recreational use, stabilized dunes are necessary to protect other natural features, such as lakes, wetlands, forests, and estuarian habitats along coastlines; protect improvements such as highways, parks, shipping channels, and urban development; create and maintain sheltered wetland or upland habitat for wildlife; and provide access to beaches for recreational use. Experience teaches us that unstabilized dune areas, subject to wind and water erosion, are potential threats that may extend for long distances inland. Small "blow-outs," varying from a few square yards to several acres, are often the inconspicuous forerunners of large, active sand areas unless immediately controlled.

Many large, active sand dunes have been stabilized along Oregon, Washington, and California coasts since the turn of the century. Most of the dune stabilization projects were in Oregon, which, in the early 1900s, had the largest acreage with unstable dunes. Thousands of acres of dunes in Oregon, Washington, and California have stabilized naturally as a result of the spread of European beachgrass (*Ammophila arenaria* (L.) Link), which was used in almost all stabilization areas. This paper discusses some of the dune stabilization at Warrenton, Oregon, where most of the techniques and procedures used in the West Coast were developed in the late 1930s.

The O.N. & R. railroad was responsible between 1897 and 1899 for some of the earliest stabilization work on the West Coast adjacent to the northern end of Seaside, Oregon.[7] A few years later, between 1910 and 1916, the USDA Forest Service directed the planting of trees, shrubs, and some European beachgrass on 47 acres of dunes between Florence and Coos Bay, Oregon.[8]

In 1935, in Clatsop County, Oregon, the USDA Soil Conservation Service (SCS) started the Warrenton Dune Demonstration Project, one of the most complete and extensive stabilization efforts on the West

[7]Harry N. Leckenby (Astoria, Oregon) to Radio Station KJR (Seattle, Washington), 29 November 1937, Correspondence, Soil Conservation Service, Spokane Regional Office, Record Group 114, National Archives, Washington.

[8]Willard T. McLaughlin and Robert L. Brown, *Controlling Coastal Sand Dunes in the Pacific Northwest*, U.S. Department of Agriculture, Circular 660 (Washington, September 1942), 2.

Coast. The problem was primarily caused by alterations at the mouth of the Columbia River, which separated Oregon and Washington. Construction of the south jetty began in 1885; the north jetty was constructed later. Although the jetties were needed for navigation on the river, which is a major industrial waterway, their construction caused sand to fill in the embayment at the mouth of the Columbia River. Sand flushed from the river channel accumulated behind the jetties, especially on the south of the Columbia River. This caused the beach to grow rapidly seaward. At the same time, grazing and fire destroyed the natural vegetation of tall grasses and mature forests on the adjacent dunes. As a result, about 3,000 acres of exposed active sand dunes had developed by the early 1930s. By 1935 a wind-eroded strip about one and one-half miles wide extended 13 miles along the Clatsop Plains coast.

Local residents and the Clatsop County Court requested assistance from SCS. SCS cooperated with the Agricultural Experiment Station and the Extension Service in a project to stabilize the dunes (see fig. 1). SCS also asked the Civilian Conservation Corps (CCC) for help. The CCC established Camp SCS-7 at Warrenton, Oregon, to provide the hand labor necessary to stabilize the dunes. CCC enrollees established a spike camp at Coos Bay[9] where, under the direction of SCS, they dug European beachgrass culms, which were cleaned, bundled, and shipped to the Warrenton Project to establish a nursery.[10] SCS began collecting plant material in November 1935, and by March 1936 had established the 215-acre Astoria Nursery Unit to produce beach and dune grass, collect seed, produce shrubs and trees, test plant fertilization, and test cultural methods of dune stabilization.[11] The Astoria Nursery Unit existed as a fully staffed SCS nursery until 1944.[12] By that time it had leased a 413-acre area.[13] Between 1944 and 1949, the leased area was operated by the Warrenton Dune Soil Conservation District, primarily to provide shrubs and trees for permanent stabilization. SCS discontin-

[9]Douglas Helms, "The Importance of the Civilian Conservation Corps to the Soil Conservation Service," mimeographed, U.S. Department of Agriculture SCS National Bulletin 260-3-26 (Washington, September 1983), 15.

[10]Robert L. Brown, "Progress Report, Section of Conservation Nurseries," mimeographed (Warrenton, Ore.: USDA, Soil Conservation Service, 1938), 3, 27.

[11]Robert L. Brown, Manager of Astoria Nursery Unit (1938–42), SCS Plant Record, hand-written log (Warrenton, Ore.: USDA, Soil Conservation Service, 1935), 17.

[12]Don Leach, USDA-SCS, District Conservationist (1964–1984), Clatsop County Soil and Water Conservation District, Astoria, Oregon, based on conversation with Bryson Lausch, Conservationist for Warrenton Dunes Soil Conservation District in 1940s and 1950s, Personal Communication, March 1984.

[13]A. L. Hafenrichter, "Annual Administration Report," mimeographed (Portland, Ore.: USDA, Soil Conservation Service, Division of Nurseries, Pacific Coast Region, 1942), 13.

FIGURE 1. CCC boys erect picket fence for sand dune. National Archives, Record Group 35, Records of the Civilian Conservation Corps, Washington, D.C.

ued its support of the nursery as part of reorganization of its plant materials program in 1954.

Studies at the SCS Warrenton Dunes Demonstration Project demonstrated that there are three steps in establishing permanent vegetation on coastal dune areas adjacent to the beach.[14] They are: (1) Place sand fencing to establish a foredune immediately above the beach to reduce the movement of sand from the beach inland; (2) Establish grass cover on the foredune; (3) Permanently stabilize the dune with herbaceous or woody vegetation, which usually follows the grass.

At the Clatsop Plains, winds average 16 miles per hour, with winter gales in excess of 55 miles per hour. CCC enrollees logged and split fire-killed timber, donated by Clatsop County, to build 9 miles of double-line picket fences parallel to the beach. In November 1935, prior to the expected high winds, CCC personnel (using SCS guidelines), built two rows of picket fence 30 feet apart, starting 50 feet above the high tideline. The fence pickets were 4 feet high, 4 inches wide, 4 inches apart, and even across the top. The wind deposited sand along the fence to form a foredune high enough to prevent washover by normal storm tides. Within 8 to 9 months after the fences were built, a dune formed which was 1-1/2 to 3 feet high and extended 10 to 15 feet on both sides of the fences.[15]

In late winter and early spring of 1937–1938,[16] SCS and CCC personnel planted and fertilized European beachgrass on the newly developed dune between the pickets, as well as 50 feet toward the ocean on the windward side of the fence and 100 feet to the leeward of the fence.[17] By

[14]Many reports and research papers summarize the studies at the Clatsop Plains. The Annual Nursery Report for Region 11, USDA, SCS, Spokane, Washington, summarized testing results for the Astoria Unit between 1937–1941. Other works in chronological order were: McLaughlin, *Controlling Sand Dunes*, 1–46; Robert Brown, "Permanent Coastal Dune Stabilization With Grassed Legumes," *Journal of Soil & Water Conservation* 3 (1948): 69–74; Robert L. Brown and A. L. Hafenrichter, *Factors Influencing the Production and Use of Beachgrass and Dunegrass Clones For Erosion Control*, "Effect of Date of Planting," *American Society of Agronomy* 40 (1948): 512–21; idem, "Influence of Density of Planting," ibid., 603–9; idem, "Influence of Kinds and Amounts of Fertilizer on Production," ibid., 677–84; A. L. Hafenrichter, "Lassoing the West's Rampaging Dunes," *Outdoors USA: Yearbook of Agriculture 1967* (Washington: GPO, 1967), 317–20; Brown and Hafenrichter, *Stabilizing Sand Dunes on the Pacific Coast With Woody Plants*, U.S. Department of Agriculture, Soil Conservation Service, Miscellaneous Publication 892 (Washington: February 1962), 1–18.

[15]John L. Schwendiman, "Coastal Sand Dune Stabilization in the Pacific Northwest" (Paper presented to Biometeorological Congress, Sand Drift Control Study Group 66, University of Maryland, 19–23 August 1975), 7.

[16]Willard T. McLaughlin, "An Analytical Survey of Control Practices of the Warrenton Work Area," mimeographed (Warrenton, Ore. U.S. Department of Agriculture, Soil Conservation Service, 22 September 1938), 3.

[17]McLaughlin, *Controlling Sand Dunes*, 18.

January 1938 they had planted grass from the Columbia River to Gearhart, Oregon, a distance of 13 miles.[18]

Herbaceous or woody vegetation was established one or two years after the European beachgrass had been planted. When sand has been partially to completely stabilized, the initial grasses such as European beachgrass, American beachgrass (*Ammophila breviligulata* Fernald), and, to a lesser extent, American dunegrass (*Elymus arenarius* susp. *mollis* (Trin.) Hulten), lose their vigor. Some plants die, leaving open spaces where blowouts can occur. Nitrogen can be applied annually or biennially, but a better practice is to seed permanent species, especially legumes, which can supply the necessary nitrogen.

Seaside lupine (*Lupinus littoralis* Doug.), which is native to the Oregon-Washington dunes, was one of the successful legumes used in secondary dune stabilization, particularly in the early years of the Warrenton Project. It germinates readily, has strong seedling vigor, and usually sets a crop of seed the first year. It is a perennial that forms an almost complete cover, dies down in the winter, leaves a persistent mulch, and provides nitrogen, paving the way for perennial grasses. Seeds ripen unevenly and pods shatter readily, so seeds must be collected by hand. Purple beachpea (*Lathyrus japonicus* Willd.) was another important native legume. Frequently used, it could be collected locally. Lupine withstands some vegetative competition but, as the grass sod becomes compact, it is generally supplanted by native clovers.[19]

SCS tested 75 species of native, naturalized, and exotic shrubs at the Astoria nursery. The species considered most suitable as intermediate stabilizers on Pacific Northwest dunes were not the native seaside lupine or purple beachpea, but three others. These were scotch broom (*Cytisus scoparius* (L.) Link), tree lupine (*Lupinus arboreus* Sims), and coyotebrush (*Baccharis pilularis* DC.). Shore pine (*Pinus contorta* Dougl. ex Laud.) was found to be ideally suited for semipermanent stabilization until shaded out by climax species. Permanent stabilizers, such as Sitka spruce (*Picea sitchensis* (Bong.) Carr.) and western hemlock (*Tsuga Heterophylla* (Raf.) Sarg.), slowly volunteer into stands of trees planted for semipermanent stabilization.[20]

The Oregon National Guard's Camp Rilea (founded in 1927 as Camp Clatsop) encompasses 1,800 acres in the Clatsop Plains. Part of the camp was included in the 3,000-acre Warrenton project area. In 1935, the

[18]T. A. Steele, Project Agronomist, SCS, Chehalem Mountain Project, to W. A. Rochie, Regional Conservator, SCS (Spokane, Washington), 17 December 1937, Correspondence, Spokane Regional Office, RG 114, NA.

[19]Schwendiman, "Coastal Dunes in Northwest," 11.

[20]Brown, *Stabilizing with Woody Plants*, 7–12.

camp included three miles of ocean front with dunes moving toward camp facilities and lakes.[21] The dunes in the camp were stabilized in a manner similar to that used in the rest of the project area. Camp Rilea was used for small tactical military maneuvers, which had the potential to create blowouts. The Oregon National Guard has established guidelines for the cutting or destruction of dune vegetation and has been very conscientious in performing maintenance work on stabilized areas which have been disturbed. This cooperation has contributed greatly toward the long-term stability of the dunes.

SCS and CCC completed most of the initial control work on the Warrenton Dunes project by 1941. In the spring of 1941 the dune area landowners organized a soil conservation district under the laws of the State of Oregon. The Warrenton Dune Soil Conservation District has administered the dune stabilization work since that time with technical assistance from SCS and other agencies.

To further insure permanent control of the shifting sands, in April 1948 this district adopted land use ordinances setting forth proper use of the land.[22] The ordinances divide the Clatsop Plains into two zones: zone 1 is high hazard and zone 2 is lower hazard.

Land use restrictions for zone 1 are: (1) All eroding areas and exposed dune areas must be stabilized by vegetation; (2) No livestock may graze in the zone; (3) Vehicular, equestrian, and recurring pedestrian traffic must be limited to hard-surfaced roads and trails; (4) Roads or trails cannot be built without a permit from the district; (5) No buildings may be constructed within the zone; (6) No activity is permitted that degrades the groundcover within the area.

Restrictions for zone 2 are similar except that some livestock grazing and construction activity are permitted after review by the district. Any disturbance of vegetative cover caused by these uses must be stabilized.

The ordinances are still in effect, and the benefits of proper land use have been evident for over 35 years.[23] There has been considerable recreational development on the stabilized area, including the 3,440-plus acres in Fort Stevens State Park and 800 acres in the county parks system. Private resort and residential developments have also been made possible by permanently stabilizing the dunes. Dune control has been a major factor in the economic growth of the area.[24]

[21]Oregon National Guard, *Camp Rilea, Oregon*, brochure (Salem, Ore., 1975), 1.

[22][Don Leach], "Stabilization of the Coastal Dunes of Oregon," mimeographed (Astoria, Ore.: USDA, Soil Conservation Service, February 1964), 2.

[23]Warrenton Dune Soil and Water Conservation District, *Thirty-one Years of Progress*, brochure (Warrenton, Ore., July 1964), 2.

[24]Warrenton Dune Soil and Water Conservation District, *Vegetation Restores Life to Coastal Dunes*, Clatsop County, Oregon, brochure (Warrenton, Ore., June 1951), 1.

The Warrenton Project established the dune stabilization procedures which would be used on the West Coast for the next fifty years. SCS tested a variety of plant materials and determined that European beachgrass was the principal pioneer species for establishing grass cover on sand dunes from the Straits of Juan de Fuca at the Canadian border south to Los Angeles, California.