STABILIZING SAND DUNES ON THE PACIFIC COAST

WITH WOODY PLANTS

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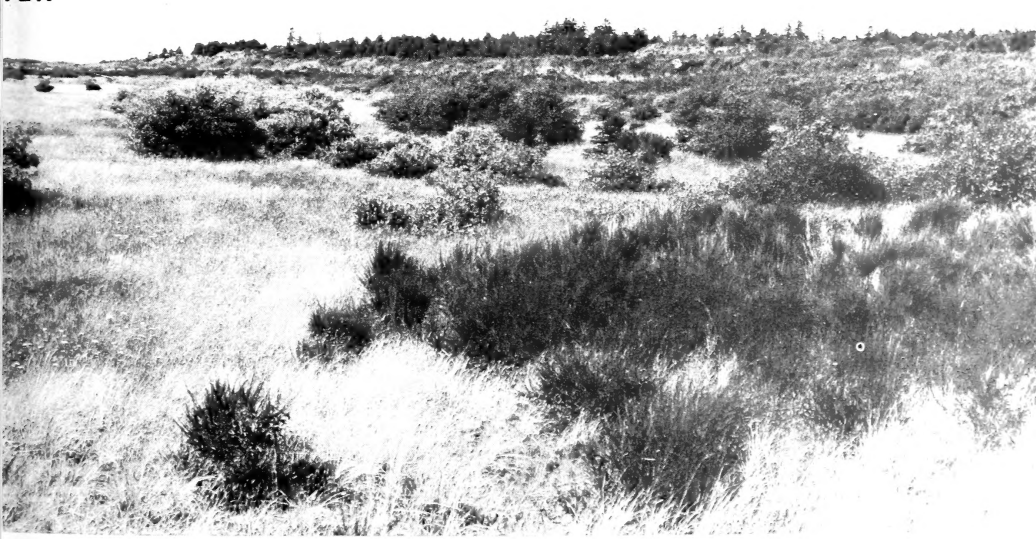

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Soil Conservation Service

U.S. DEPARTMENT OF AGRICULTURE

ESTABLISHING and maintaining permanent vegetation has proved to be the most effective and efficient means of stabilizing coastal sand dunes. The dune areas on the Pacific coast of North America are the result of accelerated erosion caused primarily by the destruction of a cover of native vegetation. In some areas the climax cover was herbaceous, in others it was woody, and in still others it was a combination of herbaceous and woody plants. The choice of plants for the reconstruction of a permanent cover depends on the inherent limitations of the site and the intended land use for the area.

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STABILIZING SAND DUNES ON THE PACIFIC COAST

WITH WOODY PLANTS

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Woody plants have been used extensively for permanent stabilization of coastal dunes in Europe. Brown (1878)[1] describes the use and culture of trees under conditions of relatively mild maritime climate on the coastal dunes of France. Minor timber products were obtained from the plantings. Gerhardt (1900) reported on experiments for stabilization of coastal dunes under more rigorous climatic conditions in Germany. He concluded that woody plants were essential to permanent stabilization.

Woody plants have been used for dune stabilization on the Pacific coast in North America. McLaren (1899) discussed the use of trees with intensive culture for dune control and recreational use on the south Pacific coast. Kellogg (1915) described the trees that were adapted for timber production on the coastal dunes of southern Oregon. McLaughlin and Brown (1942) gave a detailed report on the place and value of shrubs and trees in the permanent stabilization

[1] Literature Cited, p. 17.

ORE-75213

Figure 1.—Stabilized coastal sand dunes are used for recreation, provided precaution is taken to preserve the permanent cover from damage.

of extensive areas of eroding dunes on the north Pacific coast. They pointed out that trees and shrubs were essential to erosion control on some sites, while on others the choice between herbaceous and woody perennials for permanent stabilization depended on the use of the area. The land capability and the economic and social considerations determine the use of the stabilized area.

Most of the dune areas on the Pacific coast of North America are in land-capability classes VII and VIII.[2] Such lands have severe limitation for use because of the erosion hazard, low fertility, or low water-supply capacity. Small areas of class VI land with slightly less erosion hazard and of excessively wet class V land are interspersed with the class VII and VIII land of the dunes. Small areas of class III and IV land occur on some coastal dunes. These may be used for cultivated crops or pasture, but they require large amounts of fertilizer and supplemental irrigation. If cultivated crops are grown, extreme precautions must be taken to prevent wind erosion.

The same conditions that preclude the use of stabilized dunes for cultivated crops or pasture also limit their use for the production of major forest products such as lumber, poles, or pulpwood. Minor forest products such as Christmas trees, charcoal, and florist greenery are possible with intensive culture when areas are near markets.

The use of coastal dunes for recreation is consistent with both their land capability and their location. Large centers of population are usually located near the coast, and improved highways make them readily accessible to vacationers. Recreational use of coastal dune areas is enhanced by the proper use of trees and shrubs for permanent stabilization (fig. 1). Precautions must be taken to preserve the permanent cover from damages by overuse, careless use, and fire.

Major Uses of Woody Plants in Dune Stabilization

Woody plants have both direct and indirect conservation value when used for dune stabilization. Trees with an understory of shrubs can provide permanent stabilization. They are also used for topographical correction, for protection of areas against indiscriminate use, and for windbreaks. The permanent shrub understory provides ground cover, food and cover for wildlife, and food for human use.

The permanent cover of woody plants on coastal dunes is never established directly on eroding sites. Subclimax shrubs and trees prepare such sites for the permanent cover. The subclimax species are planted as an intermediate step between initial plantings of sand-stilling grasses and the permanent cover. Therefore, care is required when designing the steps needed for initial, intermediate, and permanent stabilization.

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[2] The land-capability classification is an interpretive grouping of soils for agricultural purposes in which all soils are placed into eight broad classes. Soils having a large number of alternative uses are placed in land-capability class I and those with few are placed in class VIII, and considering all uses collectively the risks of soil damage or limitations in use become progressively greater from class I to class VIII. In this classification the individual units shown on a soil map are first grouped into capability units. The soils in one capability unit need similar management and have the same general suitability for use. Thus they are a basic management unit for common farm crops. Capability subclasses show the kind of management problem—risk of erosion, wetness or overflow, soil or rooting-zone limitation, or climatic limitation (Klingebiel and Montgomery, 1961).

ORE-75214

Figure 2.—Normal topography of a foredune restored by planting a blowout to trees and shrubs that will wind form.

Permanent stabilization with trees suggests a forest cover. Trees having commercial value for lumber or pulpwood can be grown, but the site index on coastal dunes is usually extremely low. Therefore, the principal objective of extensive plantings is permanent erosion control. This may be supplemented with secondary value associated with recreational use of the area and protection of harbors, highways, industrial sites, and residences.

Topographical correction helps in permanently stabilizing many dune areas. The normal topography of a naturally stabilized coastal dune area is often greatly altered after the vegetation is destroyed and excessive erosion occurs. For example, a normal foredune near the high tide line has smooth, even surfaces. After vegetation is destroyed, wind erosion causes large blowouts and may remove entire sections of this foredune and deposit the sand irregularly on once smooth inland areas. These irregular surfaces are then subject to further destruction by the wind. Shrubs, in combination with trees, can be used to create a more normal surface topography (fig. 2).

Protection against indiscriminate use is necessary where many people frequent coastal areas for recreation. Experience has shown that areas permanently stabilized with grass only are used indiscriminately for roads, trails, and bridle paths, even when permanent installations are provided for such traffic. The planting of shrubs and trees here can prevent this kind of trespass (fig. 3).

Dune areas stabilized with grass only make quick conversion to cultivated crops easy when markets are attractive. Bulbs, flowers, and vegetables are often grown here. Such enterprises may be temporarily profitable with proper attention to erosion-control practices and intensive culture. The erosion hazard, however, is high, and plants with poor erosion-control value invade the area when it is abandoned. Areas planted to shrubs and trees are seldom converted to temporary cultivation.

ORE-75201

Figure 3.—Trees and shrubs planted to control traffic. Slopes and rough areas are planted, and protected flats are left in grass.

Protection for areas with several uses is a major use for woody plants on coastal dunes.

Fresh-water lakes are common in dune areas near the coast. These are favorite recreational spots, and when the areas are under public administration they are often parts of a park system. They provide bathing, boating, water sports, and fishing and hence are intensively used. Tree plantings enhance the use of these areas, provide protection against the landward winds from the ocean, and tend to minimize the erosion hazard (fig. 4).

ORE-75205

Figure 4.—Tree and shrub plantings around an interdune recreational area provide protection from wind and erosion.

ORE-75202

Figure 5.—Trees and shrubs protect this beach access road against erosion.

Principal highways parallel most coastal dune areas, and access roads to the beaches cross the dunes. Trees confine the traffic to the roads and provide additional protection from wind erosion (fig. 5). An understory of fruit-bearing shrubs and vines also enhances the public use of the area (fig. 6).

Food and cover for wildlife are provided in shrubs and trees. And when the proper species are planted there are more upland game birds, waterfowl, and game animals. One such area on the north Pacific coast has been declared a game refuge (fig. 7).

ORE-75204

Figure 6.—Planned roadside plantings provide protection, recreation, and food.

ORE-75208

Figure 7.—Shrubs and trees provide erosion control and food and cover for wildlife.

Windbreaks, properly placed, can protect small areas of specialty crops from the wind. These crops can be grown on small tracts of class III land some distance from the ocean front.

Planning for the Use of Woody Plants on the Dunes

Permanent stabilization of dune areas on the Pacific coast with long-lived woody plants is not feasible by direct planting into the eroded sand areas. McLaughlin and Brown (1942) pointed out the steps that must be taken when the permanent cover is to be woody perennials.

The initial step is to still the sand with clonal plantings of beachgrass or dune grass this way: (1) Plant 3 to 5 clones of beachgrass in hills spaced 18 to 24 inches apart. The plantings are made during the late fall and winter. The severity of the conditions on the site determines the density of the planting. (2) Fertilize the plantings with 40 to 60 pounds of nitrogen per acre in the form of ammonium sulfate. Apply the fertilizer in the early spring just as the clones begin to grow. After the fertilized beachgrass plantings have grown for one season, the area is ready for the intermediate step in stabilization.

Shrubs are used for the intermediate step. They are planted in the grasses after the sand is stilled. They are not effective for direct sand

ORE-75211

Figure 8.—Scotch broom and shore pine planted in sand-stilling grasses prepare eroded dune sites for climax woody plants.

stilling but function in two essential ways to make the site suitable for the trees that will serve as the final and permanent vegetation. Shrubs give additional protection to the growing trees against persistent desiccating winds because they are taller than the sand-stilling grasses, and they improve the fertility of the soil, which benefits survival and growth of the trees.

The final step is the planting of long-lived trees into the shrub plantings. Figure 8 illustrates the three steps—the sand-stilling grasses, the intermediate shrubs, and the trees.

Auxiliary plantings of woody shrubs and vines are often made in dune-control work. They provide additional ground cover, and many of them produce edible fruit and food for wildlife.

Shrubs for Intermediate Stabilization

Shrubs used for intermediate stabilization must establish quickly, grow rapidly, withstand strong desiccating winds, and be intolerant of shade. Leguminous shrubs are preferred because the trials conducted on the Pacific coast showed that the nitrogen they provide from their leaves and nodules assists in the establishment of the permanent trees.

A total of 75 species of native, naturalized, and exotic shrubs were tested for suitability as intermediate stabilizers on the coastal dunes of Oregon. Three species met the requirements for this use.

Scotch broom [3] met all the essentials (fig. 8). Planting stock was easy to grow from seed in nurseries. The transplants grew to an optimum height of 6 feet in 3 years. Scotch broom was adapted to all but poorly drained sites on the dunes and sites where the wind carried sand. It withstood temperatures as low as 10° F. without damage. It was quickly shaded out by the permanent trees.

Scotch broom has other desirable qualities. It can be used alone for firebreaks in tree plantings because it is rather fire resistant. It produces an abundant crop of seeds that are used for food by upland game birds and it has limited use as a source of pharmaceutical alkaloids.

Scotch broom may volunteer when seeds are carried to open mineral soil. It never volunteers into good sod or full stands of trees. It is easily controlled by mowing, surface cultivation, and herbicides. It does not spread by rhizomes or sprout from the crown.[4]

Tree lupine (fig. 9) met the requirements for intermediate stabilization except that it could not be used on sites that were exposed to strong winds or were poorly drained. It winterkilled when temperatures fell below 17° F. It was easily established by direct seeding into stands of beachgrass and attained a height of 3½ to 4 feet by the second year. Tree lupine was short lived on the dunes, but the stands were maintained by volunteer seedlings. It did not show any weedy tendencies.

Coyote brush is a native, long-lived, hardy shrub that is easily grown from seed and can be transplanted readily. Growth is slow and 3 to 4 years are required for it to reach the height of 2½ to 3 feet. Coyote brush does not sprout from the crowns and is easy to control by mowing or cultivation. It is not a legume.

[3] See list of common and scientific names of plants, back page.
[4] Scotch broom is classed as a noxious weed in some States.

ORE-35167

Figure 9.—Tree lupine can be established by direct seeding into sand-stilling grasses.

ORE–75217

Figure 10.—Gorse, a leguminous shrub adapted to coastal dune areas, should not be used because it is a noxious weed and an extreme fire hazard.

Gorse, a leguminous shrub widely naturalized to coastal conditions (fig. 10), meets some of the requirements but has several undesirable characteristics and should never be used. Its highly flammable volatile oils make it a fire hazard. It sprouts readily from the crown when mowed or burned. Gorse is intolerant of shade, but trees for permanent stabilization are hard to establish in stands of this shrub.

Trees for Stabilization

A total of 150 accessions of 80 species of trees were tested for adaptation to stabilization of dunes of the north Pacific coast. They represent most of the species recommended in the literature on dune control. Observations and some measurements were made for 10 years and some were continued for more than 20 years. The adapted species can be classified into two use groups.

Trees for semipermanent stabilization

The species in this group are easy to propagate, establish quickly, and grow rapidly on immature sites on which the sand has been stilled. The adapted species are native subclimax trees that are gradually replaced by climax species as the sites mature.

Shore pine (fig. 11) is ideally suited for semipermanent stabilization on moderate and well-drained sites on the dunes. It is easy to establish in intermediate plantings of shrubs. The rate of growth is phenomenal, averaging 2 feet per year. When used for topographical correction it quickly becomes wind formed [5] and maintains this

[5] Wind forming is described by Braun-Blanquet *et al.* (1932). Continuity of wind action is the climatic factor that affects the form of vegetation.

ORE-75209

Figure 11.—Shore pine makes an ideal semipermanent dune planting when combined with Scotch broom.

condition. Shore pine plantings are an ideal medium for the natural establishment of climax species. As the climax species overtop the shore pine, it is shaded out.

Red alder is a widely distributed native tree especially well adapted to class V land in the dunes, which is intermittently wet or has a high water table. It volunteers naturally in such areas and hence does not require planting. It does not volunteer on well-drained sites. Red alder grows to a height of at least 30 feet unless it is exposed to high-velocity winds above the dunes that normally border the wet interdune areas; then it tipburns. As the site matures and drainage improves, climax trees may volunteer in stands of alder.

Hooker willow is native to the Pacific coast, particularly to the permanently wet areas (fig. 12). It volunteers readily on such sites after the surrounding areas are stabilized. It does not require planting. Hooker willow may be replaced by alder unless the site remains wet. Average height is 10 to 15 feet.

Trees for permanent stabilization

The species in this group require mature and well-protected sites. Of the many species in experimental plantings, only five are classed as successful and all are native. They are not established by planting but volunteer into stands of trees planted for semipermanent stabilization.

Sitka spruce is widely distributed along the north Pacific coast. Growing near the eroded dune areas, it volunteers readily into good stands of subclimax trees (fig. 13). It withstands strong winds after it is established and wind forms in exposed areas. A fast-growing, well-formed tree is produced in protected areas. This tree also yields commercial timber. Sitka spruce is long-lived and is one of the climax trees of coastal forests.

ORE-75210

Figure 12.—Hooker willow volunteered and stabilized this small, permanently wet area in the dunes. Shore pine provides cover on well-drained sites.

ORE-75203

Figure 13.—Sitka spruce volunteers readily into stands of shore pine when the site is sufficiently matured.

Western hemlock is codominant with Sitka spruce in coastal forests. Like spruce, it volunteers on well-drained dune areas into established subclimax stands. It also is a long-lived tree. **Western redcedar** is also associated with spruce and hemlock and establishes by natural seeding from trees near the dune area. Both hemlock and cedar have commercial value.

Oregon crabapple is native to the north Pacific coast, where it is common on riverbanks and around the shores of lakes. It is a long-lived tree that reaches a maximum height of 15 to 20 feet. On the dunes it serves two major purposes. It is used for planting around the shores of interdune lakes and for topographical correction. In the latter case it becomes wind formed and may produce a dense mat near the ground. These attributes are ideal for stabilizing gaps in the dunes caused by blowouts. Oregon crabapple makes a well-formed tree when planted in protected places. The fruit is eaten by upland game birds, and the tree is browsed by deer. Seedlings are easy to grow and the transplants establish readily.

Douglas-fir occurs on some of the naturally stabilized dune areas of the north Pacific coast. It can be established from plantings with good nursery stock on the more mature and protected sites. It has no particular advantages over the other species in this use group, but it can be used on good sites where timber production is one of the objectives for the use of the area. Douglas-fir is damaged rather than "formed" by strong winds on exposed sites.

Shrubs for Auxiliary Stabilization

Shrubs for permanent stabilization of coastal dune areas supplement the trees. They are especially important when the areas are used primarily for recreation. Shrubs protect the soil surface by restricting traffic to prescribed areas, and many of them reduce the fire hazard. In addition, they provide food and cover for wildlife and produce edible fruit for human use. More than 150 accessions, representing 50 species, were tested on the dunes of the north Pacific coast. The successful ones were divided into three major groups.

Understory shrubs

Shrubs in this group must be shade tolerant, evergeen, long lived, and rather fire resistant. Two species were found to be well adapted, and both are native to the area.

Evergreen huckleberry occurs naturally as an understory on stabilized dunes on the coast (fig. 14). It is easily established with nursery-grown stock and attains a height of 4 to 5 feet in about 5 years. Well-drained sites are required for good establishment and optimum growth. This shrub produces good crops of edible berries that are used both for human consumption and as food for wildlife.

Waxmyrtle can be used on sites that are intermittently wet or have a high water table. It is best adapted to the southern half of the north Pacific coast. It does not produce edible fruit.

Ground-cover shrubs

Shrub species in this group are decumbent, creeping, or low and dense. They are long lived and fire resistant. Many species were tested, and three are unusually well adapted to dune-control work. All of them are native.

ORE-35170

Figure 14.—Evergreen huckleberry is well adapted as an understory shrub in tree cover on stabilized dunes; and salal makes a dense ground cover under climax trees on coastal dune areas. Florist greenery and fruit are by-products.

Salal is a decumbent evergreen shrub that roots at the nodes, spreads rapidly, and forms a dense mat on the surface of the soil (fig. 14). It is widely distributed along the coast and grows in dense shade and partial sun. Salal grows best on well-drained sites but can be used where the soil is wet but not ponded. Seedlings are easy to grow from seed, and they transplant readily. Aside from making an ideal ground cover under climax trees, salal has utilitarian values. The fruit can be used for jelly and as food for game birds, and the foliage is valued for florist greenery.

Bearberry is a creeping evergreen shrub that roots at the nodes and makes a good ground cover in partial shade, especially at the edges of open areas in tree plantings (fig. 15). It requires well-drained sites but, once established, spreads rapidly. Planting stock can be grown from seed but is easily obtained from cuttings. The fruit of bearberry provides food for wildlife.

Hardhack makes a low, dense thicket on the poorly drained swampy areas on class V land within the dune area. It is a long-lived deciduous shrub, is very resistant to fire, and produces enough sprouts to completely cover the area. It will not tolerate shading. Plantings can be made with nursery-grown seedlings, but, as coastal dune areas become stabilized, it quickly volunteers on wet sites if plants are growing near the area.

Border shrubs

These shrubs are either vines or erect plants that thrive at the edge of openings in the permanent tree cover used to stabilize dune areas.

ORE–75206

Figure 15.—Bearberry provides an excellent ground cover, especially in open areas at the edge of tree plantings.

The openings in the cover may be along highways, roads, and paths, or at the juncture between trees and permanent herbaceous plants. Border shrubs provide food and shelter for wildlife, and the fruits are often harvested for human food.

Evergreen blackberry is exceptionally well adapted to the dune areas along the north Pacific coast. It is a vigorous, spiny, decumbent evergreen shrub that produces abundant crops of edible fruit. Because of the growth characteristics and the spines, evergreen blackberry can be used to prevent indiscriminate traffic into areas planted to permanent trees. This plant is easy to establish from seedlings or crown divisions and is long lived.

Salmonberry and thimbleberry volunteer and grow naturally as erect border plants on both well-drained and poorly drained sites. They provide food and shelter for upland game birds and are lightly browsed by deer. **Twinberry honeysuckle** is similar to these two shrubs in adaptation, establishment, and use.

Other Trees and Shrubs Tested

Many species of trees and shrubs are listed in the literature on dune stabilization, some highly recommended. Most of the species thought to be adapted to the temperate zone under maritime climatic conditions have been thoroughly tested on the dunes of the north Pacific coast. A few unsuccessful species that have been widely used elsewhere are listed here.

Monterey pine gave high survival and grew more rapidly than other conifers until a sudden freeze in November of the eleventh growing season killed all but three out of a 1,000-tree plantation (fig. 16). The minimum temperature was 11° F.

Scotch pine was adapted and had a good rate of growth but the growth form was very unsatisfactory. Branches and needles were sparse and growth was deformed even when the plantings were on protected sites. Until a strain is obtained that grows rapidly and is uniformly well branched and needled, the species cannot be recommended.

Austrian pine was adapted and the trees were well branched, with a desirable growth form. However, the rate of growth during the first 5 or 6 years was especially slow.

Cluster pine had a low percentage of survival. Of the many strains tested all exhibited low survival even with good culture. The reason for low survival was attributed to the lack of a good root system on seedlings grown in nurseries and used as bare-root transplants. The root system was primarily a long taproot with few branches. Potted stock may have given better results but was deemed too expensive. The poor root system was more pronounced in cluster pine than in other pines. Low survival is undesirable in dune-control work where conditions of environment are rigorous.

Red and Pitch pine have been used in other parts of the United States for dune stabilization. Extensive trials on the coastal dunes had good survival but the rate of growth was exceptionally slow.

Black locust was not adapted to the climatic conditions of the north Pacific coast. Though survival was high, growth was slow and root sprouts formed a dense thicket. After 20 years' growth it did not exceed 10 to 15 feet even when grown in the lee of taller trees (fig. 17).

ORE–75212

Figure 16.—Monterey pine 11 years old completely killed by November 1955 freeze.

ORE–75216

Figure 17.—Survival of black locust was high, but growth has not exceeded 15 feet in 20 years.

Beach plum was not adapted to conditions on the north Pacific coast. It became established but grew slowly in the cool climate and was susceptible to blossom blight and other diseases.

Sand cherry is used on inland dunes but was not adapted to the low summer temperatures and cool wet winters of the Pacific coast. It was also susceptible to diseases.

Wild rose grew slowly and produced only an ineffective open growth. A few scattered plants of native rose occasionally volunteer in protected areas on the dunes.

Tamarisk in many places provides permanent stabilization on dune areas, but it grew slowly in summer and new wood was lost in the cool wet winters on the north Pacific coast.

Rhododendron and azalea are native to dune areas along the Pacific coast, but, when planted along with trees to provide permanent stabilization near recreational areas, they are quickly appropriated by vacationers. Plantings are therefore not successful or permanent.

Culture and Management of Woody Plantings

For dune-control work, trees and shrubs must be carefully planted. Kind and quality of nursery stock, spacing, and date of planting are the important considerations.

Seedlings of Scotch broom and shore pine are easily grown in nurseries. The broom is ready for planting as 1–0 stock and the pine as 2–0 stock. Grades for planting stock are given by McLaughlin and Brown (1942). Plantings made from wildlings have never been successful. The broom is planted into the cover of sand-stilling grasses as soon as this cover has become fully effective. The best

spacing for broom has been 8 x 8 feet. The shore pine can be planted at the same time and at the same spacing, alternating with the broom. A better practice has been to plant the pine after the broom is 1 to 2 years old, especially on critical blow areas such as those where topographical correction is the objective.

Plantings of shrubs for understory and borders in or near stands of intermediate or climax species should be spaced no wider than 6 x 6 feet to get an effective ground cover. In most cases, 1–0 nursery stock of shrubs is satisfactory, but cut-2 stock is best for huckleberry, salal, and bearberry.

Climax species of trees are usually not planted because they volunteer readily in intermediate tree and shrub plantings.

The optimum time for planting shrub and tree stock on the dunes of the north Pacific coast has been from mid-November through January. At this time the stock is quite dormant, precipitation keeps the soil moist, and evaporation rates are low. Many trials showed that plantings made before or after this period resulted in low survival. Survival during this period was uniformly higher than 90 percent.

Protection is essential to the success of most tree and shrub plantings used for the stabilization of coastal dunes. This is especially important when the use of the area is recreation. Fire, rodents, and man are the principal hazards. Fire lanes in the tree plantations and provisions for fire prevention and control are essential. In dune areas the fire lanes must have a fire-resistant vegetative cover such as Scotch broom or Clatsop red fescue. Rodents such as mice, mountain beaver, and rabbits can easily damage young plantings. They are best controlled by poisoning. Vacationers and others frequenting the recreational area must be prevented from digging plants, from creating fire hazards, and from indiscriminate tramping and trailing.

Literature Cited

Brown, J. C. 1878. Pine plantations on the sand-wastes of France. 172 p. Edinburgh.

Braun-Blanquet, J., G. D. Fuller, and H. S. Conard. 1932. Plant Sociol. 439 p. New York and London.

Gerhardt, P. 1900. Handbuch des Deutschen Dunenbaues. 656 p. Berlin.

Kellogg, F. B. 1915. Sand-dune reclamation on the coast of northern California and southern Oregon. Soc. Am. Foresters Proc. 10: 41–64.

Klingebiel, A. A. and P. H. Montgomery. 1961. Land-capability classification. U.S. Dept. Agr. Agr. Hdbk. 210, 21 p.

McLaren, J. 1899. The reclamation of drifting sand dunes. The Forester 5: 222–223.

McLaughlin, W. T. and R. L. Brown. 1942. Controlling coastal sand dunes in the Pacific Northwest. U.S. Dept. Agr. Cir. 660, 46 p.

Olsson-Seffer, P. 1910. The sand strand flora of marine coasts. Augustana Library Publications 7: 47–183. Rock Island, Illinois.

Roth, J. 1916. Die Aufforstungen der ungarischen Flugsandgebiete. Forstwiss. Centbl. 60:377–402, 464–487, 523–532. Berlin.

Stoesz, A. D. and R. L. Brown. 1957. Stabilizing sand dunes. U.S. Dept. Agr. Yrbk. (Soil) 1957: 321–326.

COMMON AND SCIENTIFIC NAMES OF PLANTS MENTIONED

alder, red	*Alnus rubra* Bong.
bearberry	*Arctostaphylos uva-ursi* (L.) Spreng.
blackberry, evergreen	*Rubus laciniatus* Willd.
broom, Scotch	*Cytisus scoparius* (L.) Link.
brush, coyote	*Baccharis pilularis* DC
cherry, sand	*Prunus pumila* L.
crabapple, Oregon	*Malus fusca* (Raf.) Schn.
douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco.
gorse	*Ulex europaeus* L.
hardhack	*Spiraea douglasii* Hook.
hemlock, western	*Tsuga heterophylla* (Raf.) Sarg.
honeysuckle, twinberry.	*Lonicera involucrata* (Richards) Banks.
huckleberry evergreen.	*Vaccinium ovatum* Pursh.
locust, black	*Robinia pseudoacacia* L.
lupine, tree	*Lupinus arboreus* Sims.
pine, Austrian	*Pinus nigra* Arnold.
pine, cluster	*Pinus pinaster* Ait.
pine, Monterey	*Pinus radiata* Don.
pine, pitch	*Pinus rigida* Mill.
pine, red	*Pinus resinosa* Ait.
pine, Scotch	*Pinus sylvestris* L.
pine, shore	*Pinus contorta* Loud.
plum, beach	*Prunus maritima* Wang.
redcedar, western	*Thuja plicata* Donn.
rose, wild	*Rosa nutkana* Presl.
salal	*Gaultheria shallon* Pursh.
salmonberry	*Rubus spectabilis* Pursh.
spruce, Sitka	*Picea sitchensis* (Bong.) Carr.
tamarisk	*Tamarix gallica* L.
thimbleberry, western	*Rubus parviflorus* Nutt.
waxmyrtle, Pacific	*Myrica californica* Cham.
willow, Hooker	*Salix hookeriana* Barr.

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