VEGETATION ZONES OF COASTAL DUNES
NEAR WALDPORT OREGON

by

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VEGETATION ZONES OF COASTAL DUNES NEAR WALDPORT, OREGON

INTRODUCTION

The sand dune area immediately north of Alsea Bay near Waldport, Oregon, is typical of many of the areas adjacent to the mouths of the larger streams and rivers of the Oregon coastline. The Soil Conservation Service estimates that over fifty thousand acres of the Oregon coastal strip is characterized by sand dune activity. The mouth of the Columbia River is contiguous to the Clatsop Plains, and another large dune area extends from Hecata Head to the region of Coos Bay, a distance of approximately sixty miles (5, pp. 1-2).

The area immediately north of Alsea Bay near Waldport, Oregon, 44° 27' north latitude and 124° 05' west longitude, was chosen to study the effect of a combination of physical factors on the zonation of vegetation on coastal sand dunes. Figure 1 is a map of the Waldport, Oregon region showing the location of the sand dune area in relation to the town of Waldport and the Coast Highway, U. S. 101. The distribution of the sand dune vegetation and the location of the transects used for the study are shown on the aerial photograph (Figure 2). A profile was taken with a hand level to show the topography of the sand dune area as it ranges in from high tide level to the crest of the forested rear dunes (Figure 3).

Oosting and Billings (1942) studied the factors affecting the vegetational zonation of the coastal dunes of North Carolina (6, pp. 131-141).

Figure 1 . Quadrangle map showing the geographical location of the sand dune area in relation to the town of Waldport, Oregon.

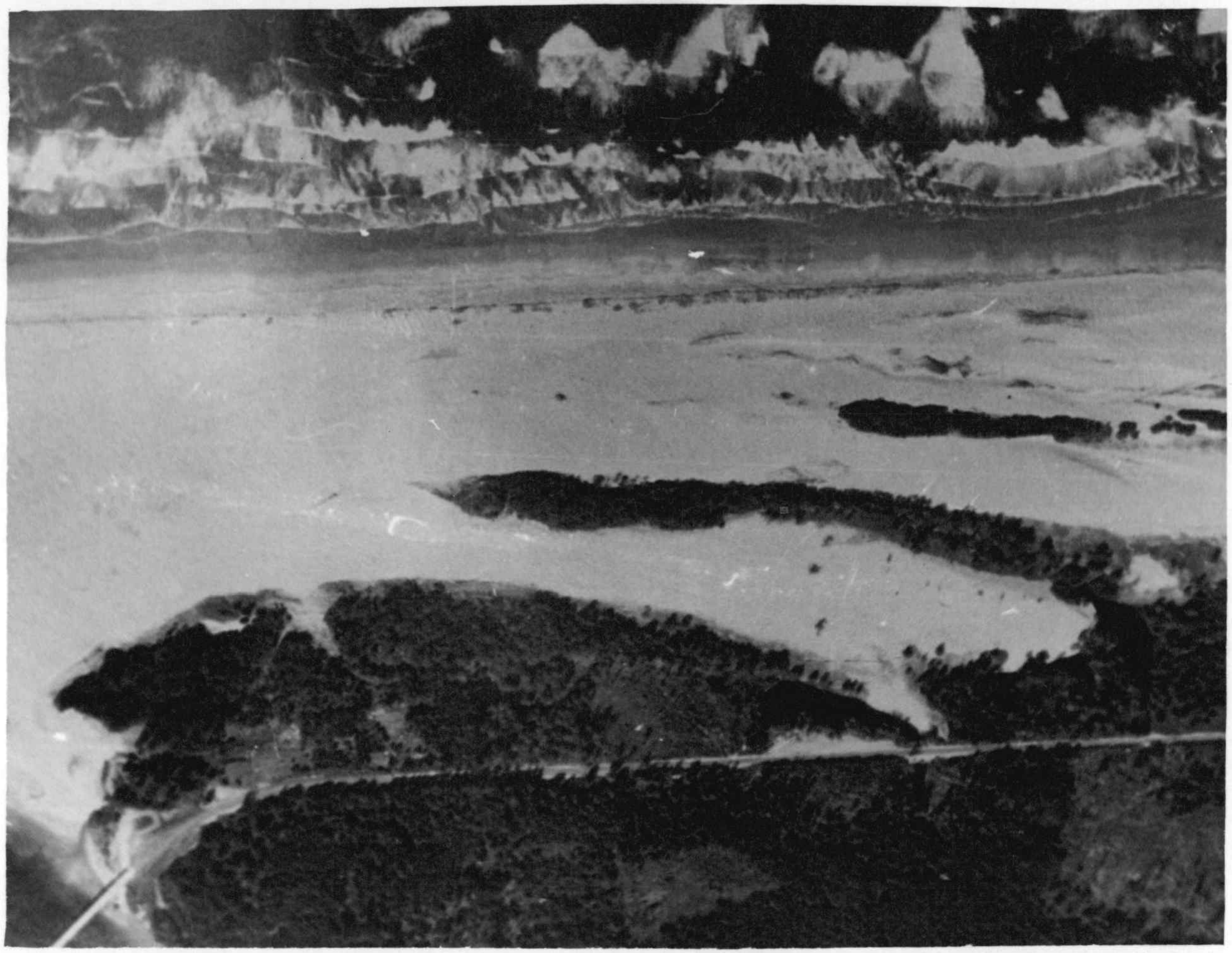

Figure 2 Aerial photograph showing distribution of vegetation and the location of the transects as they corresponded to the arrangement of the vegetation. (Photo copied from U. S. Army, Corp of Engineer's photograph).

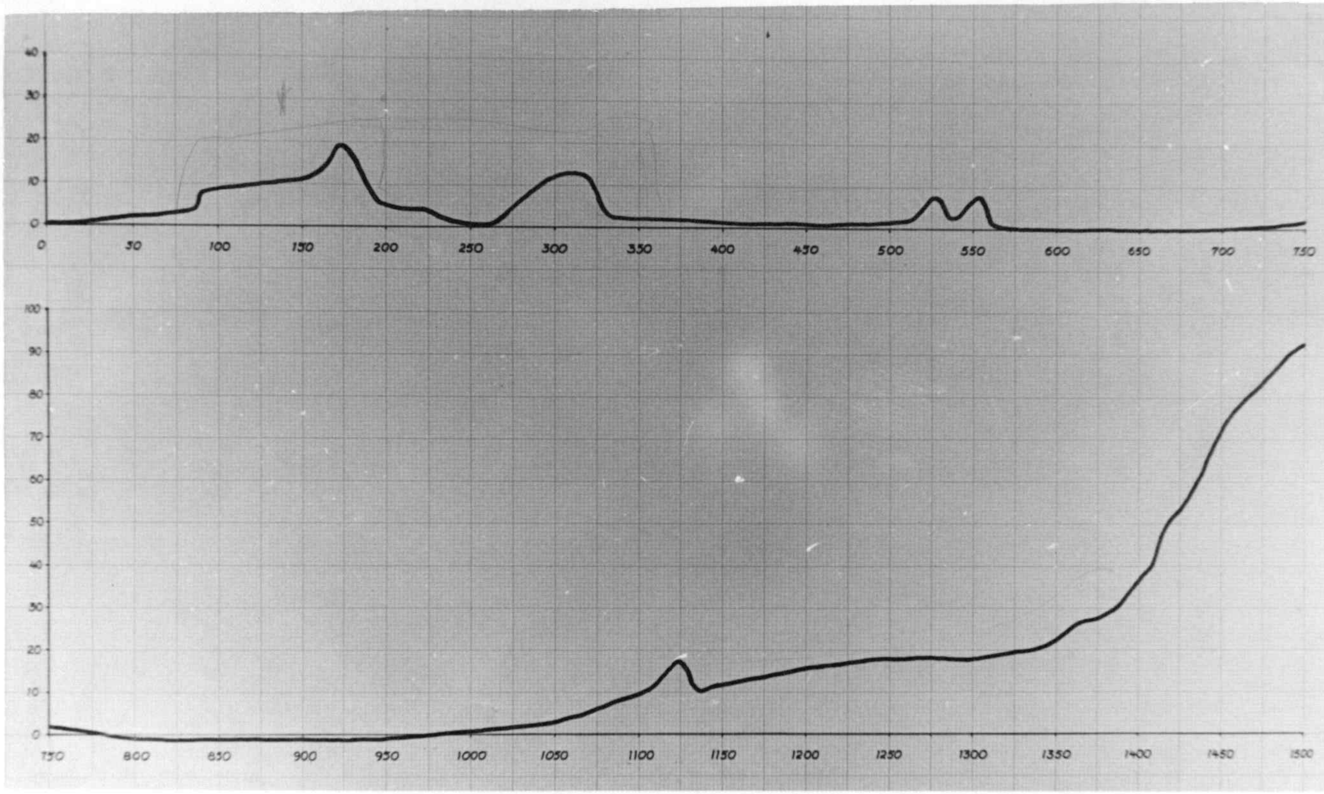

Figure 3 Profile diagram of Transect 1 showing the topography of the sand dune region as the distance away from the ocean increases. The number 0 on the vertical scale represents high tide level and not mean sea level. 0 on the horizontal scale was the point reached by the highest tide of the day. The horizontal scale was shortened to better show the height of the dunes.

Wells (1939) studied the vegetation of Smith Island, North Carolina, and found that live oak, Quercus virginiana Miller, was the dominant tree of the salt-spray climax of the island (8, p. 633).

Cooper (1936) studied the present geographical distribution of the strand and dune flora of the Pacific coast of North America and compared it with its past distribution. He lists the species that are endemic to the region. For the species that are not endemic he gives the other locations where they may be found (2, pp. 141-188).

Whitfield and Brown (1948) trace the history of man's efforts to control active sand dunes. It is estimated that 3,200,000,000 acres of the earth's surface are covered by sand dunes. The need for controlling these areas of shifting sand was realized in Germany as early as 1316 (9, pp. 70-74). These authors state: "Sand dunes in the United States, not including those in deserts, occupy an area one-tenth as large as the area of agricultural land. These dunes are found along the coasts, bordering the Great Lakes, and in practically all the inland states."

Many plants have been utilized by workers attempting to stabilize the shifting sand dune areas of the world. The plant that has been most widely used successfully is European beachgrass, Ammophila arenaria (L.) Link. Successful plantings have been made in Australia, New Zealand, France (7, pp. 17-19), Germany (4), Scotland (1, pp. 8-13), South Africa (3, pp. 168-180), and on both the Atlantic and Pacific coasts of the United States.

Other plants that have been widely used on the Pacific coast of the United States are American beachgrass, _Ammophila breviligulata_ Fern.; American dunegrass, _Elymus mollis_ Trin.; seashore bluegrass, _Poa macrantha_ Vasey; cluster pine, _Pinus pinaster_ Ait.; Scotch pine, _Pinus sylvestris_ L.; Table Mountain pine, _Pinus pungens_ Lamb.; Austrian pine, _Pinus nigra_ Arnold; Scotch broom, _Cystisus scoparius_ (L.) Link.; Hooker's willow, _Salix Hookeriana_ Barratt; silvery beach pea, _Lathyrus littoralis_ (Nutt.) Endl.; purple beach pea, _L. japonicus_ Willd.; and seaside lupine, _Lupinus littoralis_ Douglas (5, pp. 36-43).

The area chosen for this study is located approximately one mile north of the inlet of Alsea Bay and west of the Coast Highway. This part of the sand dune area extends from the inlet of Alsea Bay northward to the region of Seal Rock State Park and parallels the ocean west of the highway. The area of intensive study extends from approximately one mile north of the inlet northward along the beach for a distance of six hundred yards. Transects were taken from high tide level inland to the crest of the forested rear dunes. The transect along the south border was approximately five hundred yards in length, and the one which formed the northern border was approximately three hundred and fifty yards in length. The topography of the region determined the length of the transects.

The purpose of this study was to determine if the combination of the physical factors influenced the vegetational zonation of the sand dunes of the Oregon coast. Studies of the vegetation and the physical factors of the area, and observation of similar areas near Yaquina Bay and also near Hecata Head reveal a natural zonation of vegetation due to a combination of the factors of the environment.

METHODS

Data were collected to study the following physical factors: quantitative accumulation ratios of salt spray, wind velocity, vapor pressure deficits, rates of evaporation, soil pH, and rate and direction of sand movement. Stations were set up in the different vegetation zones which had been determined by transect studies of the vegetation of the area (Figure 3).

The littoral or foredunes were divided into two zones with the first extending from high tide level to the leeward side of the first line of foredunes. The second zone begins at the leeward side of these dunes and extends to the area of active nonvegetated dunes. The latter area was designated as the third zone, and the area made up of the forested, stable rear dunes was defined as the fourth zone. Data concerning salt spray accumulation, vapor pressure deficits, rate of evaporation, wind velocity, and soil pH were taken at each of these stations. Sand movement was noted on the active dunes and also those dunes on which the vegetative cover had been broken.

SALT SPRAY ACCUMULATION RATIOS

Quantitative measures of salt spray accumulation were obtained by salt spray traps such as the ones described by Oosting and Billings (1942) set up at each of these stations.

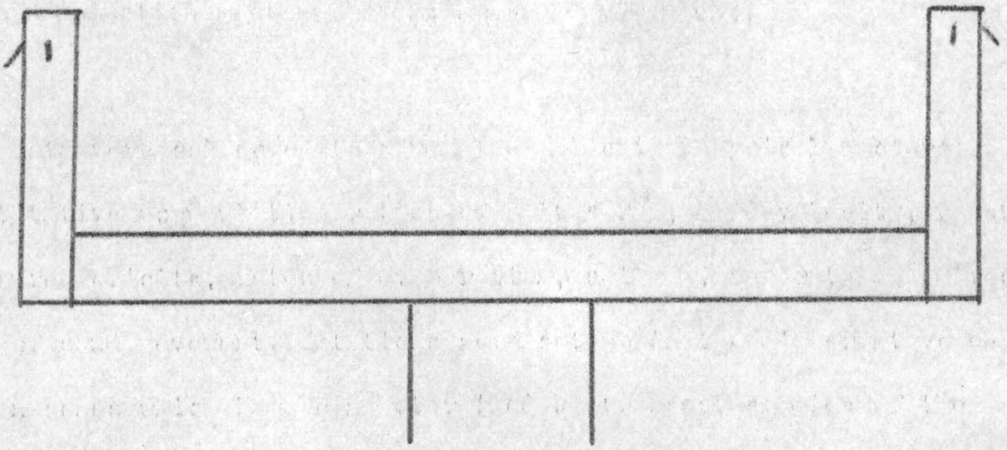

Figure 4. Side view of frame of salt spray trap over which boiled cheese cloths were stretched.

Boiled cheese cloths were stretched over wooden frames which were set up at equal height above the ground and allowed to remain for seven days. At the termination of each seven-day period the cloths were collected and previously marked areas of fifty square centimeters were cut from the cloths and placed in 100 cc. of distilled water for 72 hours to dissolve the accumulated salt. After allowing the salt to return to soluble form the solutions were titrated using silver nitrate. Precipitate was weighed and recorded in milligrams.

SOIL pH

The pH of the soil at the stations inland from the high tide level was determined by using the colometric method. The test plate had three testing compartments and the results were more satisfactory than when a test plate having only one testing compartment was used.

WIND VELOCITY

Wind velocities were measured at each of the stations with a hand anemometer and each reading was for a ten minute period to eliminate probable error due to momentary lulls in the velocity of the wind. In addition to the readings taken at each of the stations a group of readings on the windward and leeward side of a large stable dune were also made (Figure 5).

VAPOR PRESSURE DEFICITS

Vapor pressure deficits were obtained by using a sling psychrometer to get the wet and dry bulb readings. By using the barometric pressure readings announced by the Coast Guard Station these wet and dry bulb readings could be converted to vapor pressure deficits. These readings were taken at all the stations and also at the windward and leeward side of a large stable rear dune (Figure 5).

EVAPORATION RATES

Porous clay bulb atmometers were used to determine the rate of evaporation at each of the stations inland from the ocean. Atmometers

Figure 5   Stable rear dune with forest cover consisting of lodgepole pine. Windward slope experiments were made at A. and leeward slope experiments were made at B.

were placed at stations set up on the windward and leeward side of the large stable dune (Figure 5). Each of these experiments was for an eight hour period.

RESULTS AND OBSERVATIONS

SALT SPRAY FACTOR

The amount of salt accumulated from the ocean spray decreased as the distance from the ocean increased. An exception was noted whenever some barrier to the wind currents existed. The relationship of salt spray accumulation to wind velocity at the various stations is shown in Figure 6. The salt accumulation was much greater on the windward side of the dunes than on the leeward side.

The greatest amount of salt was deposited by spray at Station 1, which was located on the windward side of the first line of foredunes (littoral dunes), only fifty yards inland from high tide level.

The accumulation of wind borne salt at Station 2 was much less than at Station 1 even though the stations were spaced only fifty yards apart. This station was located among the smaller dunes to the rear of the first line of foredunes. The lesser amount of salt spray collected at this station was probably due to the protection offered by the higher line of dunes to the windward.

Station 4, located at the crest of the forested rear dune, showed a greater amount of salt spray deposit than Station 3, which was located in the wind gap between the foredunes and the rear dunes. The increase due to the location on the windward side of the rear dune accounted for the accumulation at Station 4 being almost as great as that recorded for Station 2, located almost four hundred yards nearer

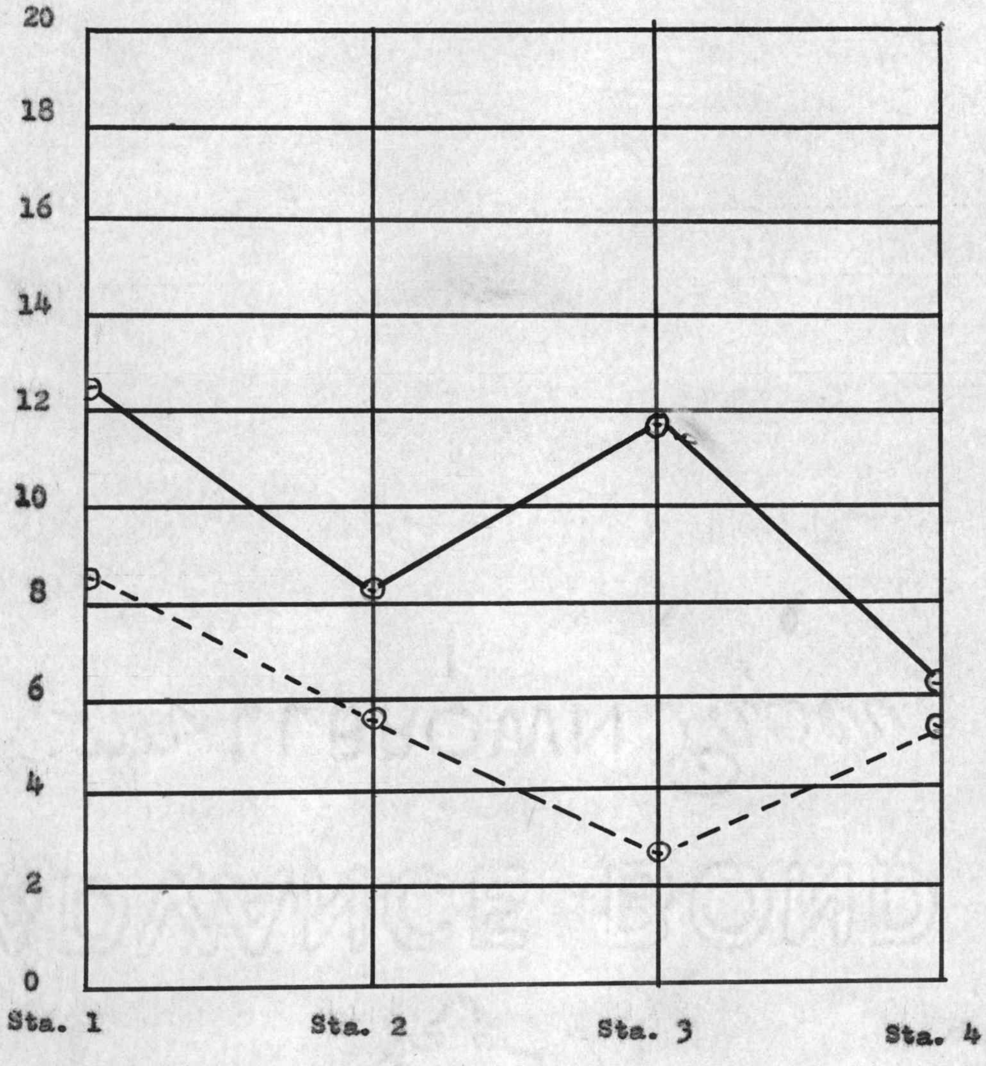

Figure 6 Salt spray accumulation ratios as compared to wind velocities at the stations as they range inland from the ocean to the crest of the rear dunes.

Salt spray ratios: mgs. salt accumulated - - - - - - - -

Wind velocities: mph. ________________

the ocean.

The data gathered at the stations located in each of the zones prompted additional experiments dealing with the windward and leeward slopes of the stable dune (Figure 5). The results of these experiments confirmed the fact that salt spray accumulation is related to wind velocity. The wind velocity on the windward slope was approximately three times as great as that on the leeward slope. The salt spray accumulation for this period was approximately nine times as great on the windward slope of the dune as on the leeward slope of the dune.

The effect of wind borne salt on the pH of the soil is noted below under edaphic factors.

WIND FACTORS

There is a direct relationship between the wind velocities recorded at the different stations and the general topography of the area. Station 1, at which the greatest average velocity was recorded, was located on the windward side of the first line of foredunes. Station 2 was located on the smaller dunes just to the rear of the first line of foredunes and thus there was a decrease in the average velocity recorded due to the protection of the higher first line of dunes. Station 3 was located in the wind gap between the foredunes and the stable rear dunes. The intensity of the wind was almost as great as that recorded for Station 1, which was located almost four hundred yards nearer the ocean.

The influence of forest vegetation in reducing wind velocity was noted at Station 4, which was located immediately below the crest of the forested dune. Even though the station was set up in a grassy clearing the fact that the trees acted as a barrier to the wind currents was quite evident. The marine air masses play a major role in the prevailing direction of the offshore winds of the Pacific coasts of Washington and Oregon. The winter winds have their origin in air masses formed off the coast of California in the direction of Hawaii thus accounting for the prevailing wind from the south or southwest most of the winter months. The average velocity for the winter months is approximately 16 miles per hour with maximum velocities sometimes as great as 80 to 90 miles per hour. The summer wind meanwhile has its origin in the air masses formed in the region of the Aleutian chain of islands. Northwesterly winds prevail during the summer months with an average velocity of approximately 13 miles per hour. Maximum velocities during the summer months seldom exceed 40 miles per hour.

MOISTURE

Fog and Relative Humidities

An interesting phenomenon was observed whenever the wind shifted from the northwesterly to southwesterly direction. An example of this was recorded September 13, 1949. The sky was clear, the wind was blowing from the northwest at 9:30 A.M. and the relative humidity was recorded as 85% on the foredunes. The wind shifted to a southwesterly direction at approximately 10:45 A.M. and by 11:15 A.M. visibility was limited to less than five hundred yards and the relative humidity at all stations was in excess of 99%.

Evaporation Ratios

The amount of water evaporating from an exposed surface steadily increased directly as the velocity of the wind. The relationship of the wind velocity to the rate of evaporation at the stations as they range inland from the ocean is shown in Figure 7.

Evaporation Rates Versus Vapor Pressure Deficits

There was a direct correlation between the rate of evaporation and the vapor pressure deficits at each of the stations (Figure 8). The fluctuation at the different stations was probably due to experimental error.

EDAPHIC FACTORS

Sand Movement

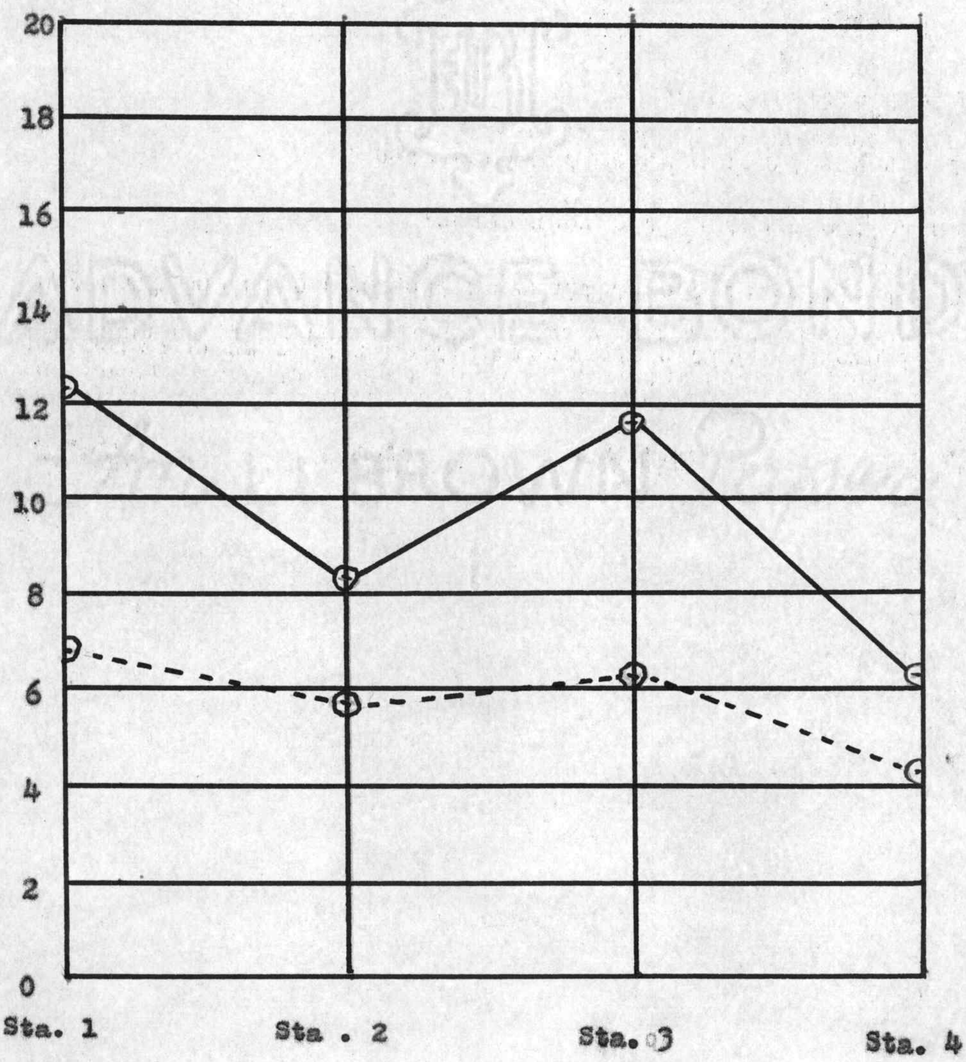

Figure 7 Correlation between wind velocities and evaporation ratios recorded at the various stations ranging from the ocean to the crest of the rear dunes.

Wind velocities: mph. ————————————

Evaporation ratios: cc water/ 10 - - - - - - - - - - -

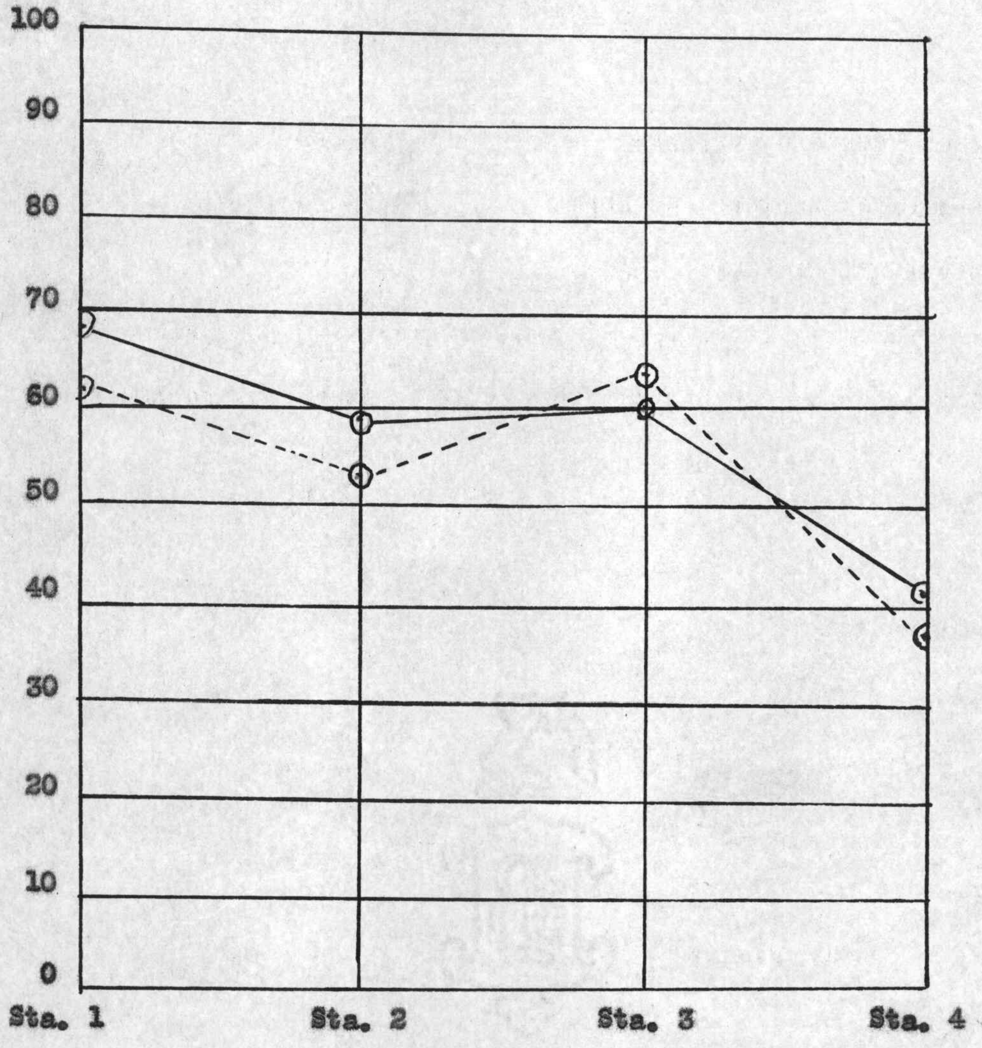

Figure 8 Correlation of evaporation ratios to vapor pressure deficits at the various stations ranging inland from the ocean.

Evaporation ratios; cc water ————————

V apor pressure deficits; mg. H g X 10 - - - - - - - - -

The movement of sand on the dune areas of the Pacific coast follows a definite pattern. The sand is washed onto the beach or strand during high tides. During low tides as the top layer of sand dries it is carried inland until some barrier such as debris or vegetation causes it to be deposited. The sand accumulates until the barrier can no longer retard its movement. The line of dunes pictured in Figure 9 shows the development of foredunes due to this accumulation of sand in vegetation. During the summer months the vegetation on this line of dunes is usually sufficient to restrict sand movement inland so that mass movements do not occur. The small active sand dunes formed by the wind in the nonvegetated third zone are classified as barchane dunes (Figure 10). The line of larger foredunes of Zone 1, the smaller grass covered foredunes of Zone 2, and the active nonvegetated dunes of Zone 3 are shown in Figure 11.

Immediately north of this area the foredunes were not as extensive and thus were not capable of halting the inland movement of sand to any great degree. In the wind gap between the foredunes and the rear dunes the large active nonvegetated dune was formed (Figure 12). This dune was approximately fifty feet high, one hundred to one hundred fifty yards long, and about seventy-five yards wide. The long axis of the dune was parallel to the beach. A large active dune encroaching on a mature stand of Sitka spruce, Picea sitchensis (Bong.) Carr., is shown in Figure 13. When the trees were covered by too much sand they died and the leaves and twigs disintegrated thus reducing the ability of the tree to stop sand movement. The

Figure 9 Line of foredunes formed by accumulation of sand among debris and the first line of salt tolerant vegetation. Large relict dunes held in place by herbaceous cover are visible behind this first line of dunes.

Figure 10 Barchane dunes of Zone III showing the abrupt slope to the leeward side of the actively shifting sand and the gradual slope of the windward side of these same dunes. The rippling effect seen in the foreground is caused by eddy effect of the wind currents.

Figure 11 General area of active dunes is shown in the foreground and foredunes having a vegetative cover which stabilize sand blown from the strand or beach. Relict dunes held in place by herbaceous cover lie in the central portion of the active non-vegetated dunes.

Figure 12 Large active nonvegetated dune located in windgap between the foredunes and the forested rear dunes. This dune exceeds the height of the surrounding active dunes by approximately fifty feet.

Figure 13 Actively shifting sand dune encroaching on a mature stand of Sitka spruce, *Picea sitchensis* (Bong.) Carr. Seashore bluegrass, *Poa macrantha* Vasey, is the grass that can be seen in the foreground.

sand was then transported further inland by the wind, exhuming the dead snags (Figure 14).

If the accumulation of sand about the base of Sitka spruce is not too rapid and too great and a sufficient photosynthetic portion of the tree is exposed, adventitious roots may develop on its main stem (Figure 15). The pictured tree was windward to a mature stand of Sitka spruce and in October when the picture was taken the upper branches were approximately fifty feet above the sand. The area was revisited March 5, 1950, for the purpose of making color photographs of this unusual occurrence. By using fixed landmarks such as the Yaquina Bay bridge and the light house immediately north of Yaquina Bay as triangulation points the tree was finally located. The accumulation of sand from the active dunes had been so great that only about six feet of the uppermost branches remained exposed.

Soil pH Factor

The differences in the pH of the soil at the stations ranging inland from the ocean to the base of the rear dune proved to be insignificant. The soil of the forested region at Station 4 shows the influence of forest litter in lowering the pH. Two very contrasting sets of data are given below:

Figure 14 Relict dunes showing snags of Sitka spruce which have been killed due to burying by actively shifting dunes. This area was located immediately south of the area shown in Figure 13.

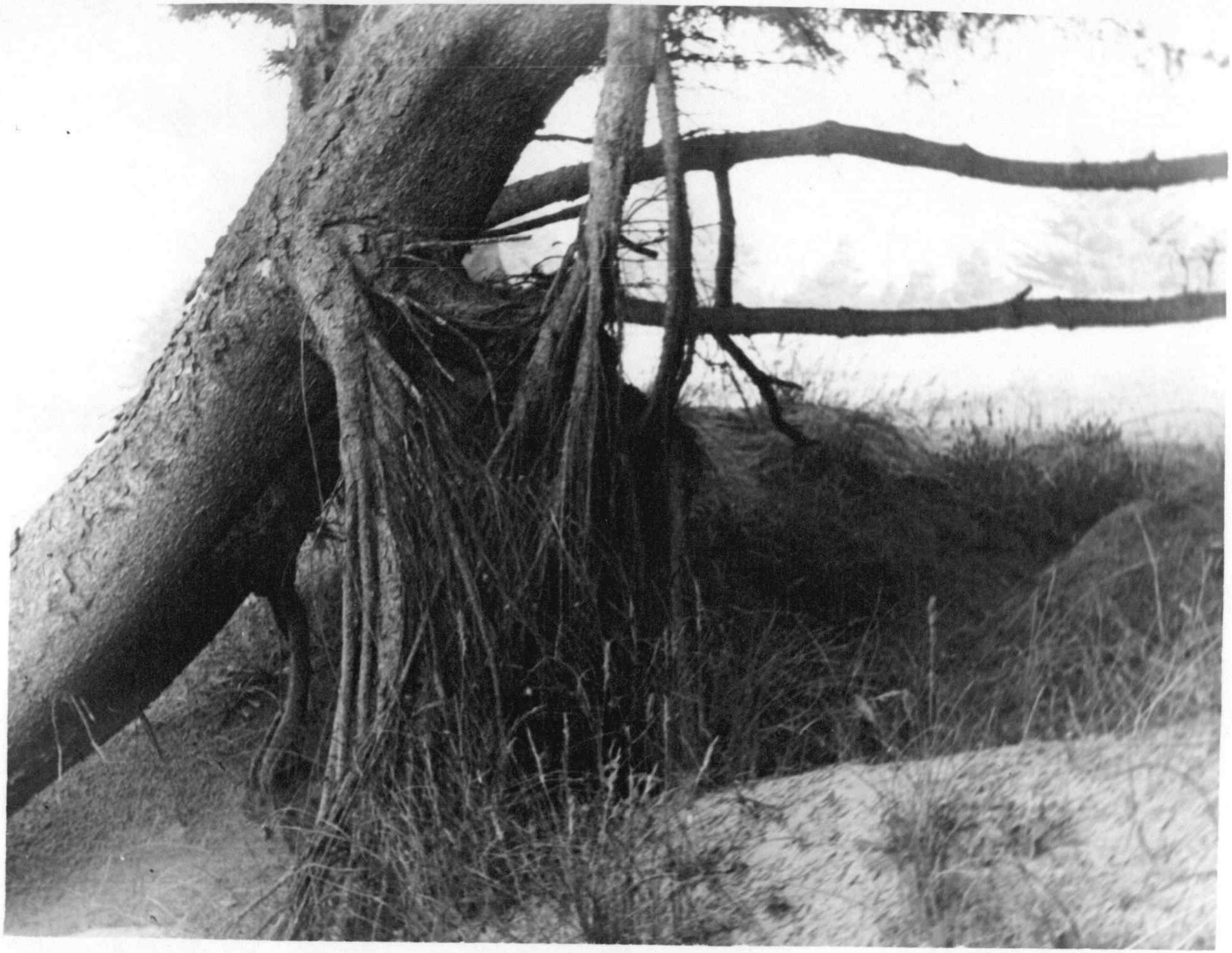

Figure 15 Sitka spruce, Picea sitchensis (Bong.) Carr., showing adventitious roots arising from the trunk of the tree due to the effect of burying by shifting sand.

TABLE 1

	Station 1	Station 2	Station 3	Station 4
1.	8.1 pH	7.9 pH	7.9 pH	6.4 pH
2.	7.1 pH	6.9 pH	6.8 pH	4.9 pH

The first set of data was collected following a two-day wind storm during which little or no rain fell. The first day the velocity of the wind often attained velocities of forty miles per hour and although the fog was constant there was not enough precipitation to be recorded at the Coast Guard Station. The second day maximum velocity of the wind was only twenty-five miles per hour and again the precipitation was less than one-hundredth of an inch. The second set of data was taken following a rainy period and the resulting pH at each station was considerably lower due to the leaching effect of the rainfall. These two sets of data clearly indicate that precipitation plays an important role in modifying the soil medium.

ZONATION OF VEGETATION

The vegetation of the region studied shows a definite zonation. A total of fifty-four species was collected while studying the vegetation of the sand dune area just north of Alsea Bay. The distribution of these plants according to the transects which extended from high tide level to the crest of the rear dune is shown in Table 2.

TABLE 2

TRANSECT	I	II	III	IV
Zone 1	6 11%	5 9%	6 11%	6 11%
Zone 2	4 8%	3 6%	16 29%	14 26%
Zone 3	3 6%	6 11%	2 4%	2 4%
Zone 4	24 44%	18 33%	14 26%	19 35%

The number of species found in each of these sections of the transects of the zones is given and also the percentage of the total plant species of the area that was represented for each section. A total of fifty-four species was recorded for the area of study. There were 7 species or 13% of the species that occurred in the area recorded for Zone 1. There were 25 species found in Zone 2 or 46% of the species were represented. In Zone 3, 6 species or 11% were present and for Zone 4 40 species or 74% of the species were recorded.

The plants found in Zone 1 are characterized by their ability to withstand salt spray and the abrasive action of wind-borne sand. These plants include sand verbena, _Abronia latifolia_ Esch.; European beachgrass, _Ammophila arenaria_ (L.) Link.: American beachgrass, _Ammophila breviligulata_ Fern.; sea rocket, _Cakile edentula_ (Bigel.) Hook.; sea rocket, _C. maritima_ Scop.; silver beach-weed, _Franseria Chamissonis_ Less.; beach silver-top, _Glehnia leiocarpa_ Mathias;

seashore bluegrass, Poa macrantha Vasey, and silvery beach pea, Lathyrus littoralis (Nutt.) Endl. Sea rocket and beach silver top are not good dune forming plants and grow in scattered locations. Cakile maritima Scop. grows only in Zone 1 of Transect 4 while the other sea rocket, Cakile edentula (Bigel.) Hook. grows in all three of the zones located to the windward of the rear dunes. American beachgrass has been reported for the general area by the Soil Conservation Service but the species was not recorded for any of the transects. European beachgrass and silvery beach pea are the most effective plants for binding shifting sand into dunes. Dunes formed by the accumulation of windborne sand about the stems of these plants are shown in Figures 16, 17, and 18.

The morphological adaptations of the plants of the foredune area are varied. The sand verbena exudes a sticky substance which causes sand particles to adhere to the leaves. These sand particles act as buffers to wind-borne sand. The leaves of silver beach-weed have a thick pubescent cover which minimizes the effect of the wind-borne salt and sand. The leaves of European beachgrass form a cylinder and though the edges do not fuse the leaves maintain this form. The silver beach pea is adapted to this habitat by having both a silky pubescent cover throughout and also by having reduced leaf surface. Sea rocket has a thick waxy cuticle covering the leaves.

The roots of all these plants with the exception of European beachgrass and seashore blue grass are quite extensive to the proportion of shoot growing above the ground. The root of the sand

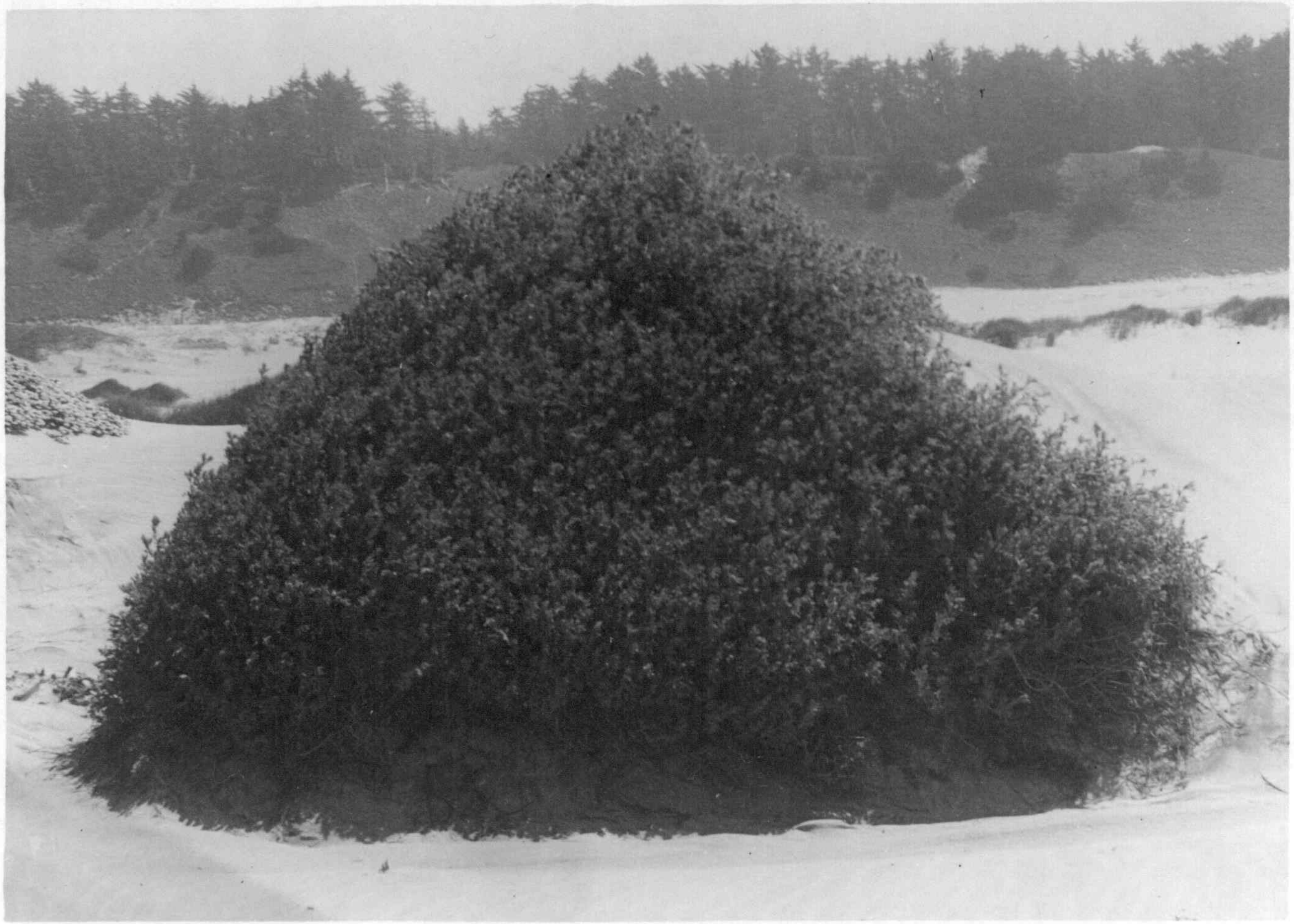

Figure 16 Foredune held in place by silvery beach pea, Lathyrus littoralis (Nutt.) Endl., and seashore bluegrass, Poa macrantha Vasey. Dunes held in place by European beachgrass, Ammophila arenaria (L.) Link., are visible to the rear of this dune as well as the forested rear dunes.

Figure 17 Foredune built by accumulating sand among plants of seashore bluegrass, Poa macrantha Vasey, European beachgrass, Ammophila arenaria (L.) Link., and silvery beach pea, Lathyrus littoralis (Nutt.) Endl.

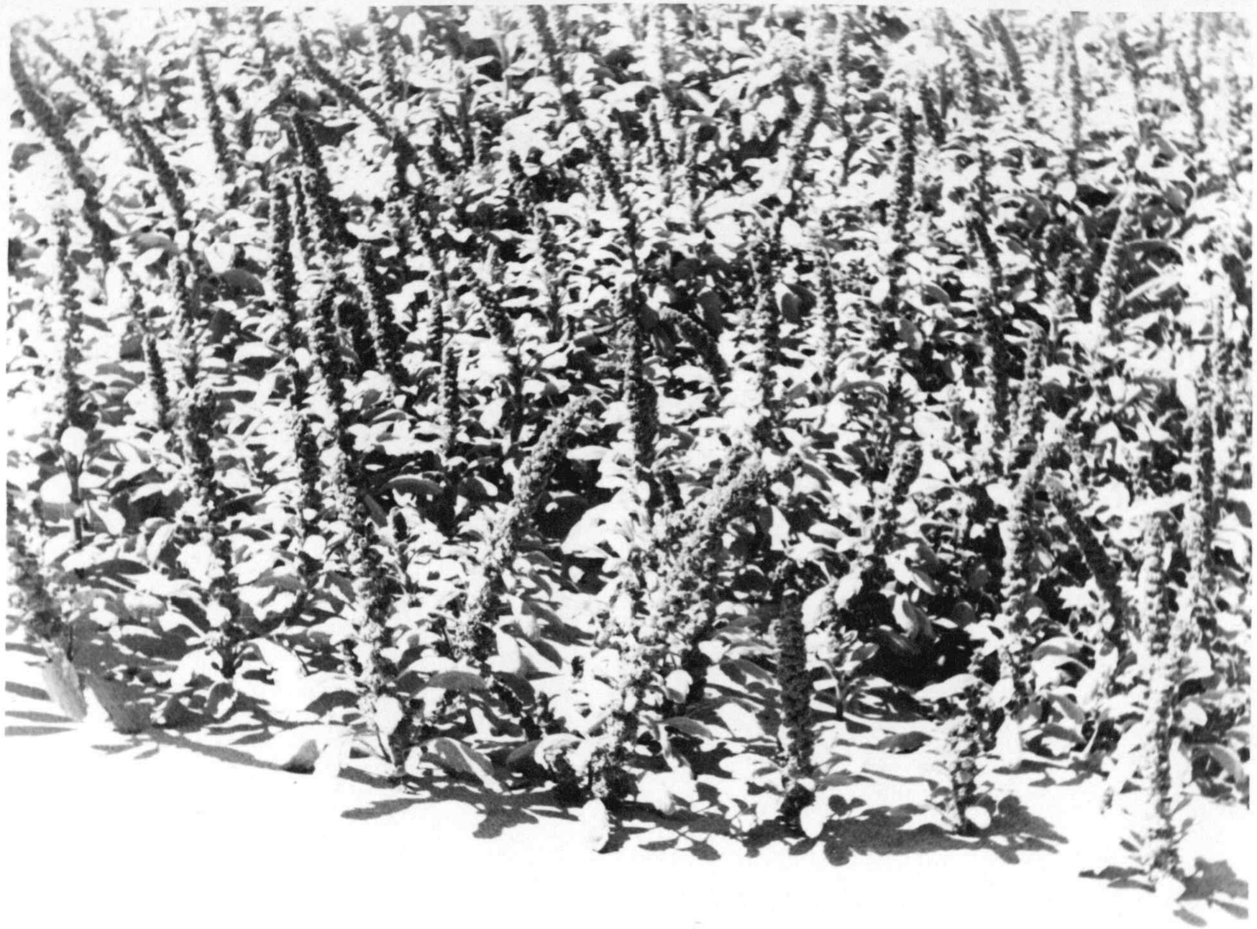

Figure 18 Growth habit of silver beach-weed, Franseria Chamissonis Less., which may often make up the vegetative cover of the dunes nearest the ocean.

verbena plant was measured and found to be over twelve feet long. The root was about six inches in diameter just below the surface of the ground.

The smaller dunes immediately to the rear of the first line of foredunes and nearer the ocean than the active nonvegetated dunes observed in the wind gap were designated as Zone 2. The vegetation found on Transect I and Transect 2 of this zone consisted of only European beachgrass, sand verbena, sea rocket, common rush, _Juncus effusus brunneus_ Engelm.; and sickle-leafed rush, _Juncus falcatus_ Meyer. The semi-marsh area pictured in Figure 19 was located in Zone 2 and Transect 3 and Transect 4 crossed it thus accounting for the number of species recorded for these transects as is shown in Table 2. Many of the plants recorded for these transects are typical rear dune or inland species. Only one woody species was recorded and it was a seedling of cascara, _Rhamnus Purshiana_ D.C. This species was able to germinate and start its first season of growth but the plant was not vigorous and will not be able to persist.

Other plants found in this marsh-like area of Zone 2 were:

Abronia latifolia Esch., sand verbena

Ammophila arenaria (L.) Link., European beachgrass

Anaphalis margaritacea (L.) B. & H., pearly everlasting

Aster Douglasii Lindl., common wild aster

Cakile edentula (Bigel.) Hook., sea rocket

Carex macrocephalea Willd., big headed carex

Cerastium arvense L., field chickweed

Figure 19 Low marsh-like area found immediately to the rear of the first line of foredunes. Transect 3 and Transect 4 crossed this area which is about 90 yards wide and 300 yards long.

Cirsium lanceolatum (L.) Scop., bull thistle

Epilobium angustifolium L., fire-weed

Erectites prenanthoides D. C., Australian fire-weed

Franseria Chamissonis Less., silver beach weed

Glehnia leiocarpa Mathias, beach silver-top

Juncus effusus brunneus Engelm., common rush

Juncus falcatus Meyer, sickle-leafed rush

Lathyrus japonicus Willd., purple beach pea

Lathyrus littoralis (Nutt.) Endl., silvery beach pea

Lupinus littoralis Dougl., seaside lupine

Plantago lanceolata L., black plantain

Polygonum paronchia C. & S., beach knotweed

Potentella anserina L., silver-weed

Rumex acetosella L., sour dock

Senecio Jacobaea L., tansy ragwort

Trifolium dubium Sibth., small hop-clover

Wythea angustifolia Nutt., wild sunflower

The vegetation on the active naked dunes which made up Zone 3 was limited to six species of plants, and of these, three species, coast strawberry, Fragaria chilensis (L.) Duch.; sand verbena, and beach silver-top, were found only on two relict dunes found on Transect 2 of Zone 3. The other plants found growing in the zone were sea rocket, common rush, and seashore bluegrass.

Several plants of the Juncus showed fasciation of the flower parts (Figure 20). The degree of fasciation of the plant shown on the left was complete for the whole head of flowers while the plant shown on the right has both normal and abnormal flowers in the same head.

The plant species recorded for the forested rear dunes consists of forty of the fifty-four species collected in the area of study.

The following species were recorded for the fourth zone:

Abronia latifolia Esch., sand verbena

Achillea Millefolium L., yarrow

Agrostis maritima Lam., maritime bent-grass

Agrostis pallens Trin., seashore bent-grass

Alnus rubra Bong., Oregon Alder

Anaphalis margaritacea (L.) B. & H., pearly everlasting

Arctostaphylos uva-ursa Spreng., kinnikinnick

Aster Douglasii Lindl., common wild aster

Berberis aquifolium Pursh., Oregon grape

Bromus pacificus Shear, Pacific brome-grass

Carex macrocephalea Willd., big headed carex

Castillejo Dixonii Fern., coast paint-brush

Cerastium arvense L., field chickweed

Cirsium lanceolatum (L.) Scop., bull thistle

Elymus mollis Trin., American dunegrass

Fragaria chilensis (L.) Duch., coast strawberry

Gaultheria Shallon Pursh, salal

Figure 20 Heads of <u>Juncus</u> <u>effusus</u> <u>brunneus</u> Engelm. showing both partial and complete fasciation of the flower parts. Many of the common rushes growing near the base of the rear dunes showed this type of fasciation.

Glehnia leiocarpa Mathias, beach silver-top

Heracleum lanatum Michx., cow parsnip

Hypochoeris radicata L., false dandelion

Juncus effusus brunneus Engelm., common rush

Juncus falcatus Meyer, sickle-leafed rush

Lathyrus littoralis (Nutt.) Endl., silvery beach pea

Lonicera involucrata Banks var. Ledebourii Jeps., twin berry

Lupinus littoralis Dougl., seaside lupine

Maianthemum biflorum D.C. var. kamtschaticum (Gmel.) Jeps., false-lily-of-the-valley

Montia sibirica (L.) Howell, candy flower

Picea sitchensis (Bong) Garr., Sitka spruce

Pinus contorta Dougl., lodgepole pine

Plantago lanceolata L., black plantain

Poa confinis Vasey, dune bluegrass

Poa macrantha Vasey, seashore bluegrass

Polygonum paronchia C. & S., beach knotweed

Pteridium aquilinum var. pubescens Underw., western brake-fern

Rhamnus Purshiana D. C., cascara

Rubus spectabilis Pursh, salmon berry

Rubus thysanthus Focke, himalaya berry

Rumex acetosella L., sour dock

Salix Hookeriana Barratt, coast willow

Trientalis europaea var. latifolia Torr., starflower

Vaccinium ovatum Pursh, huckleberry

The vegetation of the forested rear dunes shows a very high degree of layering or stratification.

The arborescent or tree layer is composed of Oregon alder, lodgepole pine, and Sitka spruce. Sitka spruce is the dominant species of the rear dune climax vegetation with lodgepole pine occupying the role of a sub-dominant. Oregon alder and lodgepole pine are the pioneer tree species of the stable rear dunes. After these trees have modified the habitat enough the Sitka spruce seedlings are able to ecige and become the dominant species.

The frutescent or shrub layer was composed of three forms of shrubs which were prostrate, ascending, and upright. The upright shrubs were cascara, coast willow, huckleberry, Oregon grape, salal, salmon berry, and twin berry. The ascending form was himalaya berry and the prostrate form of shrub was kinnikinnick. Kinnikinnick was found to be very abundant on the windward side of the rear dunes and along the crest of the rear dunes.

The herbaceous layer was made up of sand verbena, yarrow, maritime bent-grass, seashore bent-grass, pearly everlasting, common wild aster, Pacific brome-grass, big headed carex, coast paint-brush, field chickweed, bull thistle, American dunegrass, coast strawberry, beach silver-top, cow parsnip, false dandelion, common rush, sickle-leafed rush, silvery beach pea, seaside lupine, false-lily-of-the-valley, candy flower, black plantain, dune bluegrass, seashore blue-grass, beach knotweed, western brake-fern, sour dock, and starflowers. Most of these species were found on the windward slope of the rear dune and the plants that were usually found mixed with the understory formed by the shrubs were western brake-fern, starflower, field chickweed, candy flower, beach knotweed, and false-lily-of-the-valley. The rushes and sedges are confined to the lower portion of the windward side of the rear dunes and are not a part of the climax vegetation.

The moss layer was extremely well developed under the forest cover of the rear dunes.

SUMMARY

The sand dune areas of the Oregon coastline have a natural zonation of vegetation which is due to a combination of the physical factors of the environment rather than to a single limiting factor. The factors which seem to exert the most influence on the zonation of vegetation are the accumulating sand about the base of the stems of the plants, accumulating salt due to wind-borne spray on both soil and plants, and the evaporation of soil moisture. All these factors are directly related to the velocity of the wind. The evaporation of soil moisture is also influenced by the color and texture of the substratum.

The area windward to the stable dunes is subject to constant change and the study and interpretation of these changes indicate that both the plant community and the environment are dynamic rather than static.

The rear dune area may support a climax vegetation while plant succession on the windward sand dunes is usually retarded or halted at one of the seral stages.

The findings of this study agree with the overall zonation of the plants of the coastal strand proposed by Cooper (1936). The species of the strand or beach area are limited both in number and also in kinds of growth forms. The majority of strand plants are succulent herbs. Only one woody plant, a cascara seedling, was found growing elsewhere than on the rear dunes.

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