AN ECOLOGICAL STUDY OF A DISJUNCT PONDEROSA PINE FOREST IN THE NORTHERN GREAT BASIN IN OREGON

by

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INTRODUCTION

The study of isolated plant communities is one of the classic procedures of ecology. Clements (35) in discussing the relict method said, "in brief the understanding of vegetation cannot proceed out of itself alone, and one must turn to causes and processes for its interpretations, as well as to forecast its fate."

The natural relict is particularly valuable if it occurs under severe conditions of climate, soil or other factors. Isolation in a severe habitat permits observation of the species behavior when it is near the limits of its ecological amplitude. The disjunct community not only shows the vegetation which formerly existed in the general area but may also help in determining why it no longer exists generally. In a sense isolation of plant communities is similar to and may accomplish the same end as factor isolation in other scientific fields.

For these reasons it is desirable to take advantage of such isolated plant communities.

The "Lost Forest," a disjunct ponderosa pine (Pinus ponderosa Dougl.) forest is approximately 9,000 acres in area. It is located in the northwestern portion of the Great Basin which extends into south-central Oregon. The

author visited the forest many times since World War II and became intensely interested in the phenomena of the ponderosa pine growing in this unlikely area. Ponderosa pine normally requires from sixteen to twenty inches of precipitation annually for normal development but this stand of timber is growing in a region with less than ten inches precipitation and is isolated some forty miles from the nearest ponderosa pine forest. The forest has negligible economic significance. However, an understanding of the plants occurring there, their relationships with each other, with the soil and with the climate, and the history of the forest could be valuable in understanding the ecology of ponderosa pine in its more mesic habitats.

The study was approached with eight broad objectives. These were to characterize the plant communities, to characterize the soil, to determine the existing soil moisture-plant relationships, to investigate the past history of the stand, to characterize the climate both within the forest and in the immediately adjacent areas, to determine how pine trees exist in the low rainfall province, to determine stability of the stand, to determine reasons for differences in vegetation in forest and adjacent areas, and to determine impact of use by man on the vegetation.

The thesis is considerably more involved with the

literature on the geology of the area than was originally intended. This is a result of two factors. The first is the geology of the area is much more important in its own right than would normally be expected in an ecological study. The second is that in the attempt to determine the condition of plant communities prior to intensive use by early settlers (1880), it was found that the only scientific observers reporting on the area were geologists.

Considerable information on the recent land use history of the area was obtained from the non-scientific literature and from personal interviews with early settlers. In brief, this study has become involved in many separate approaches, each of which appears to shed some light on the origin and continued existence of the "Lost Forest."

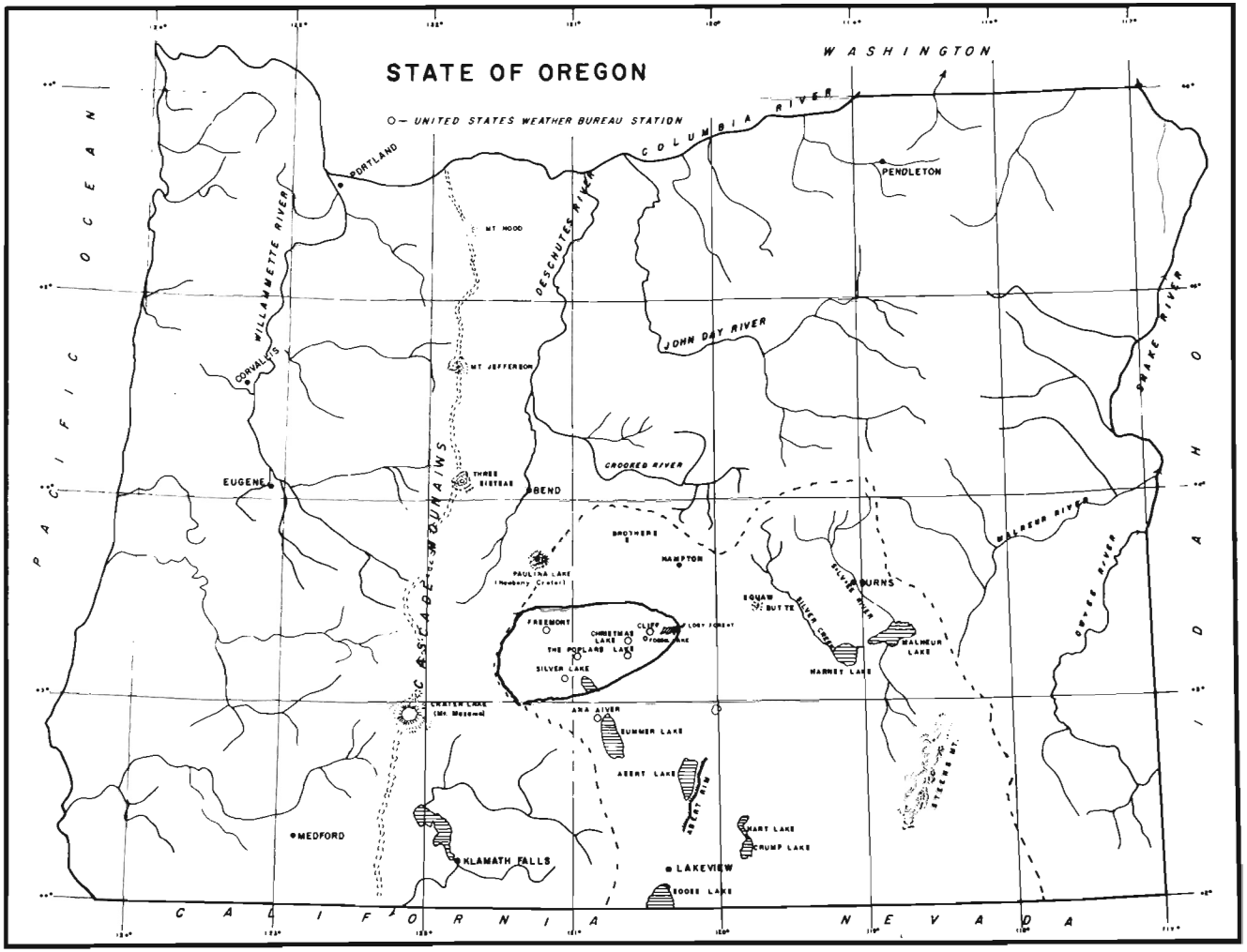

Figure 1. Location of study area. The extension of the Great Basin in Oregon is shown inside broken line. Christmas Lake Basin inside solid line.

THE CHRISTMAS LAKE BASIN

Geographical Relationships

The general area of this study is in the northwestern portion of the Great Basin which extends into south-central Oregon (see Figure 1). More precisely, the study concerns the basin occupied by modern Fort Rock Lake, Christmas Lake, Fossil Lake, Silver Lake, basins of northern Lake County, Oregon. The name Christmas Lake Basin will be used to designate the greater basin occupied by all these lakes since the modern lakes are separated by elevations of only a few feet. The Christmas Lake Basin lies between latitude 43°00' and 43°50' N, and between longitude 120°10'. The center of the basin is approximately 60 miles southeast of Bend, Oregon. Geological evidence indicates that the modern lakes which are now nearly dry were covered entirely by a large deep lake until relatively recent times. The basin has no distinct drainage.

The Christmas Lake Basin is sometimes referred to as the Great Sandy Desert, Low Desert, Cold Desert or Sage Brush Desert.

Climate

Total precipitation is low and a large percentage of it falls in the form of snow in December and January. In the years of heavier precipitation the snows frequently persist until mid-March when they are melted by warm rains. The heaviest precipitation usually occurs in December and January, frequently with a secondary maximum in May and June. Diurnal temperature ranges are typical of those of desert regions. Summer daytime maxima of 100°F are not uncommon with night time temperatures frequently falling below freezing. Daily temperatures of 80° and 90°F with 15° to 20°F at night are not uncommon. Killing frosts may occur any time of the year. Minus 39°F temperatures do occur but are not common. Daytime maxima, in winter, may not rise above freezing for several successive days.

Strong winds are characteristic of the region with the most vigorous from the southwest, particularly as storm fronts move in from coastal areas and are dissipated over the interior regions. North and northeast winds are very common during clear periods but are usually not as strong nor do they persist for as long as the southwest winds. Dust devils or small whirlwinds are a common sight in the forest and on the old lake beds to the west.

Relative humidity of the atmosphere is very low (7-15%), particularly in summer. This in part accounts for

the low temperatures of the summer nights through reduced resistance to terrestial radiation.

Topography and Physiography

The elevations of the most of the lake beds are approximately 4,300 feet above mean sea level with some of the gradual slopes adjoining them rising to 4,500 to 4,600 feet. Pine Ridge, which marks the east boundary of Fossil Lake and of the entire Christmas Lake Basin extending northward through the "Lost Forest," rises at one point approximately 4,700 feet above sea level. Some of the peaks a few miles to the east are as high as 5,000 feet. Other points which rise above the mean terrain are the Connly Hills (Figure 2) and Table Rock in the southwest portion of the Christmas Lake Basin.

There are many well defined stream beds undoubtedly formed when moisture was more plentiful but in which water now flows only when snow is melting. They empty into temporary lakes or playas, sinks or dry up as they flow.

At present, Silver Lake Basin is filled with water although it is considerably lower than it has been in the recent past. Silver Lake has had a history of disappearing and reappearing.

Some portions of Fort Rock Valley have seasonal lakes which fill after the spring snow melts. Cope (38) refers to

Figure 2. Hayes Butte, one of the Connly Hills. Note multiple shore lines.

A

Basalt on Western boundary of basin

B

Fort Rock Valley - Connly Hills - White areas are playas

C

D

Figure 3. Sagebrush and rabbit brush on north-west boundary

Hills on southwestern boundary

Christmas Lake as having two feet of water in it in 1880. This lake is also dry most of the time. Fossil Lake also has had only twenty acres of water, and that very shallow, during the period of recorded history.

There are numerous other playas which fill with water in the spring such as Little Benjamin Lake (Figure 4), ten miles north of Fossil Lake.

Outside the basin approximately twenty-five miles to the northwest is Newberry Crater whose caldera is now occupied by Paulina Lake and Lost Lake. This volcano contributed a very significant amount of pumice to the basin. Approximately eighty miles to the south and west is Crater Lake located in the caldera of ancient Mt. Mazama. Mt. Mazama erupted several thousand years previous to the Newberry Crater and distributed its ash over the entire basin. It also laid down considerable amounts of vesicular lapilli on the western portions of the basin.

Another interesting feature of the region is the presence of many sand dunes, particularly in the region east of Fossil Lake. Scattered dunes are characteristic of the entire basin but in the Fossil Lake--Lost Forest area there are several square miles of barren shifting sand dunes (Figure 5). Most of these originated from the desiccated bed of Fossil Lake. In recent years the dune fields have been enlarged by soil eroding from the lands which the early unsuccessful homesteaders cleared of native

A

Abandoned farm house.

B

Corral for capturing wild horses.

C

Mound Spring.

D

Little Benjamin Lake water hole after snow melt.

Figure 4.

Figure 5. The sand dunes of Fossil Lake.

vegetation. Prominent beaches of the ancient lakes also are still a significant feature of the basin boundary (Figures 2 and 6).

Geology

The hills and mountains surrounding the basin are composed of rocks which are primarily of volcanic origin. The rocks can be divided roughly into three classes--pyroclastics, basalts and rhyolites (56). Most of the pyroclastics underlie western, central and southern parts of Christmas Lake Valley. They form a part of "Pine Ridge" on the eastern part of the basin in the Lost Forest. The most prominent point within the forest is this wave washed mass of coarse, firmly cemented volcanic material projecting 180 feet above the otherwise gently sloping terrain (Figure 14). The pyroclastics also appear underneath the basalt caps of several of the buttes--most conspicuous of which is Table Rock. They also make up the mass of Fort Rock. The pyroclastics are rather firmly cemented material consisting of effusive rock. According to Dole (56) they probably belong to the same general period of eruption as the basalts which cover them.

The basalts are by far the most extensive of the rocks appearing in all sides of the basin and within the basin where they cover the underlying pyroclastic materials

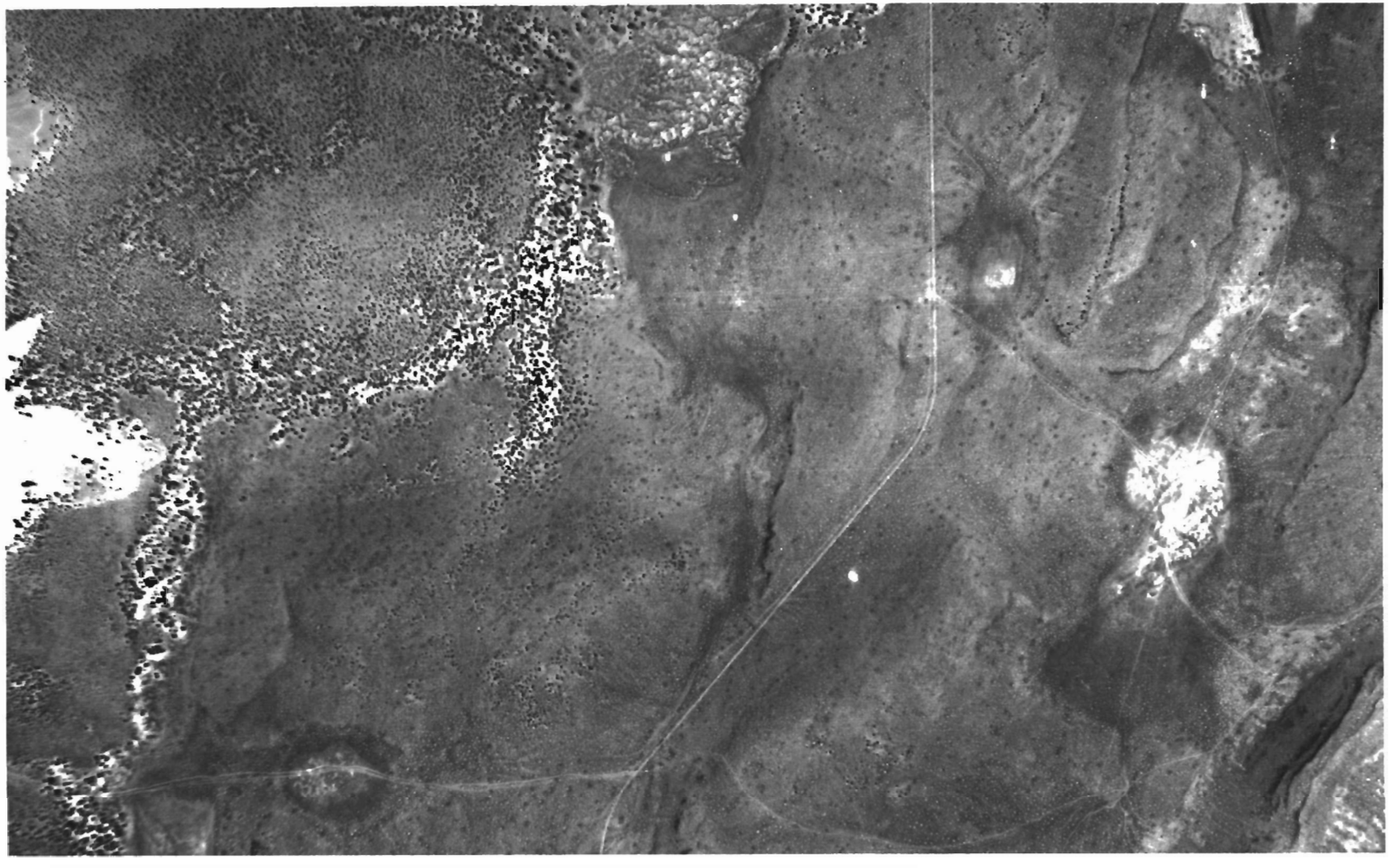

Figure 6. Old lake beaches and playas near Lost Forest. Scale of distance approximately three inches per mile.

(Figure 3). Dole (56) classifies the basalts into three age groups. The oldest are probably contemporary with the Columbia River lavas of the Miocene period. The second group of basalts are found associated with Hayes Butte and the other Connly Hills. Some older flows of the north also belong to this group. The third group of basalts are rather recently formed as determined by their occurrence above the lake sediments. These lava flows are located in the northwestern part of Christmas Lake Basin and are not particularly significant as far as this study is concerned. The third group of rock, the rhyolites, are found only at the northern fringe of the basin. They are also found to some extent as erratics.

The structure of the areas surrounding the basin is characterized by many fault blocks in the southeast and west and faulting may be responsible for the formation of the basin itself. Waring (159) in 1908, stated "that the basin also known as Christmas Lake Valley appears to be divided into three shallow basins--Fossil Lake, Christmas Lake and the desert west of 'Seven Mile Ridge' (Fort Rock Lake), and that these might be formed by down warping of the three shallow basins--with the ridges forming the divide between the basins." The beaches previously mentioned dramatically portray the history of the lakes occupying the basin during the last Ice Age (pluvial in this

area). They are conspicuous in the wave washed form of Fort Rock at Connly Hills, Pine Ridge, Summer Lake and many other places and indicate that for a considerable period of time the lake level must have stood at least 150 feet above the present dry lake bed in the Fossil Lake area. (See Figure 2.)

Volcanic ash from Mt. Mazama and possibly Newberry Crater form a considerable portion of the sediments of beds of both modern and dry lakes. Most of the ash is of silt size particles. Diatoms, which appear to flourish after volcanic activities, constitute a considerable portion of the sedimentary material in the lake beds (56).

The sands previously mentioned have their origin not only in the action of streams and the waves on lake shores but most of the dunes also contain from ten to twenty per cent of their bulk in sand-size particles of aeolian pumice.

Surface water is very scarce or totally lacking except during the winter or early spring. There are several deep wells in the area which have tapped underground reservoirs and which produce great volumes of water. In the Fossil Lake area approximately one mile from the western end of the Lost Forest are two springs. These are Sand Springs and Mound Spring (Figure 4).

Vegetation and Mammals

At the west and south of the basin immediately concerned in this study "Christmas Lake Valley" is bounded by typical ponderosa pine forest. Except for the Lost Forest and the further exception of a few isolated trees the pine forests do not extend into the lake basin area. The most characteristic plant of the basin is big sagebrush, (Artemisia tridentata Nutt.)[1]. Big sagebrush is occasionally displaced by its diminutive form A. tridentata arbuscula (Nutt.) or by A. cana. Pursh. Both gray rabbit brush (Chrysothamnus nauseosus (Pall.) Britt.) and green rabbit brush, C. viscidiflorus (Hook.) Nutt. also occur everywhere in the basin. Western juniper (Juniperus occidentalis Nutt.) is found on rocky ridges and sand dunes. Alkaline areas are occupied by greasewood, (Sarcobatus vermiculatus (Hook.) Torr.), shade scale (Atriplex confertifolia (Torr.) Wats.), saltbush (A. Nuttaliii Wats.), silverscale (A. argentea (Nutt.), winter-fat (Eurotia lanata (Pursh.) Mod.), hopsage (Grayia spinosa (Hook.) Mod.), all of which belong to the Chenopodiacae. Typical grasses of the nonalkaline areas are Sandberg's blue grass (Poa

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[1]All Plant names mentioned in text are listed in the appendix by both common names, scientific names and authorities.

Mounting block for side saddle riders, all remaining of Fremont.

Five foot ponderosa pine hollowed by rot, used for water tank.

Figure 7. Land use.

secunda Presl.), Nevada blue grass (P. nevadensis Vas.), needle-and-thread grass (Stipa comata Trin. & Rupr.), Thurbers stipa (Stipa thurbiana Piper), giant rye grass (Elymus condensatus (Presl.), alkali rye grass (Elymus triticoides Buchl.), squirrel tail (Sitanion hystrix (Nutt.) J. G. Sm.). The common grasses of the alkaline areas are salt grass (Distichlis stricta (Torr.) Rydb.), alkali grasses (Pucinellia nutalliana (Schult.) Hitchc.) and (P. lemmoni (Vas.) Scribn.). Among other common plants of nonalkaline or slightly alkaline areas are found many species of Erigonum Michx., Erigeron L., Penstemon (Mitch.) Ait., Astragalus (Tourn.) L., and Lupinus (Tourn.) L.

On the sandy areas we find such plants as the evening primrose (Oenothera sp.), sand verbena (Verbena bracteosa) and Russian thistles (Salsola kali var. tenuifolia G. F. W. Mey.

The common mammals of the area are:

Pocket mice--Perognathus parvus parvus (Peale)
Deer mice--Peromyscus maniculatus gambelli (Baird)
Blacktail jackrabbits--Lepus californicus wallawalla (Merriam)
Cottontail rabbits--Sylvilagus nutalli nutalli (Bachman)
Woodrats--Neotoma cinera alticola Hooper
Ground squirrels--Spermophilus Cuvier
Marmots--Marmota Blumenbach
Mule deer--Dama hemionus hemionus (Rafinesque)
Antelope--Antilocapra americana oregona V. Bailey
Porcupines--Erithizon dorsatum epixanthum Brandt
Chipmunks--Eutamius minimus scrutator Hall and Hattfield
Bobcats--Lynx rufus fasciatus Rafinesque L. r. pallescens Merriam
Western moles--Scapanus Pomel

Mouse-eared bats--Myotis Kaup
Coyotes--Canis latrans lestes Merriam
Kangaroo rats--Dipodomys Gray

Land Use

The advent of white man in the Great Basin is very recent. According to the "Illustrated History of Central Oregon" 1905, (99), there were still no settlers in what is now Lake County, as late as 1865. The Silver Lake post office was founded in 1875. In 1876, Dr. Thomas Condon (118) mentions two ranches in the Silver Lake area and one ranch somewhere within ten to fifteen miles of Fossil Lake. He also comments about the remoteness of the area so that the impression is obtained that it was little used at that time. Russell (138) after his visit to the Christmas Lake Basin in 1882 later spoke of it as being far removed from settlement and "occupied only by wild animals, antelope and wild sheep" and Waring (159) stated, "Two years ago (1905) there was only one family living in Christmas Lake Valley (eastern portion of the Basin)." Waring also said that by November 20, 1906, 120 claims of 320 acres each had been taken up and the land cleared of sage brush and other shrubs. At about the same time a U. S. post office called Cliff was established at Sucker Flat.

Most of these claims were abandoned by 1920 (Figure 4A). Those that were not abandoned then were deserted during the

early part of the drought of the 1920's and 1930's. Many of the fields which were cleared for agricultural purposes have been stripped of the surface soil by the strong winds. In fact, in some areas tracts as large as forty acres have had six or eight feet of sandy soil removed. This has contributed greatly to the extent of the shifting-dune area which previously had only Fossil Lake as the source of its sand (Figure 8).

Prior to the advent of white men, Indians frequently crossed the country; and from the testimony of their camp sites, during periods when the lakes were filled, they or their paleolithic ancestors occupied the area in considerable numbers. Means of evaluating their impact upon the ecology of the area are not available. However, they may have and probably did resort to fire from time to time in their quest for game.

Soils

Soils of the basin are for the most part unknown and uncorrelated. The Soils Atlas of the Pacific Northwest (93) shows the area partially in the Brown Zone and partially in the Sierozem Zone. It appears, however, that the soils of the Christmas Lake Basin properly belong in the Sierozem Zone group. This is apparent from direct observation of the soils, the precipitation, mean temperatures

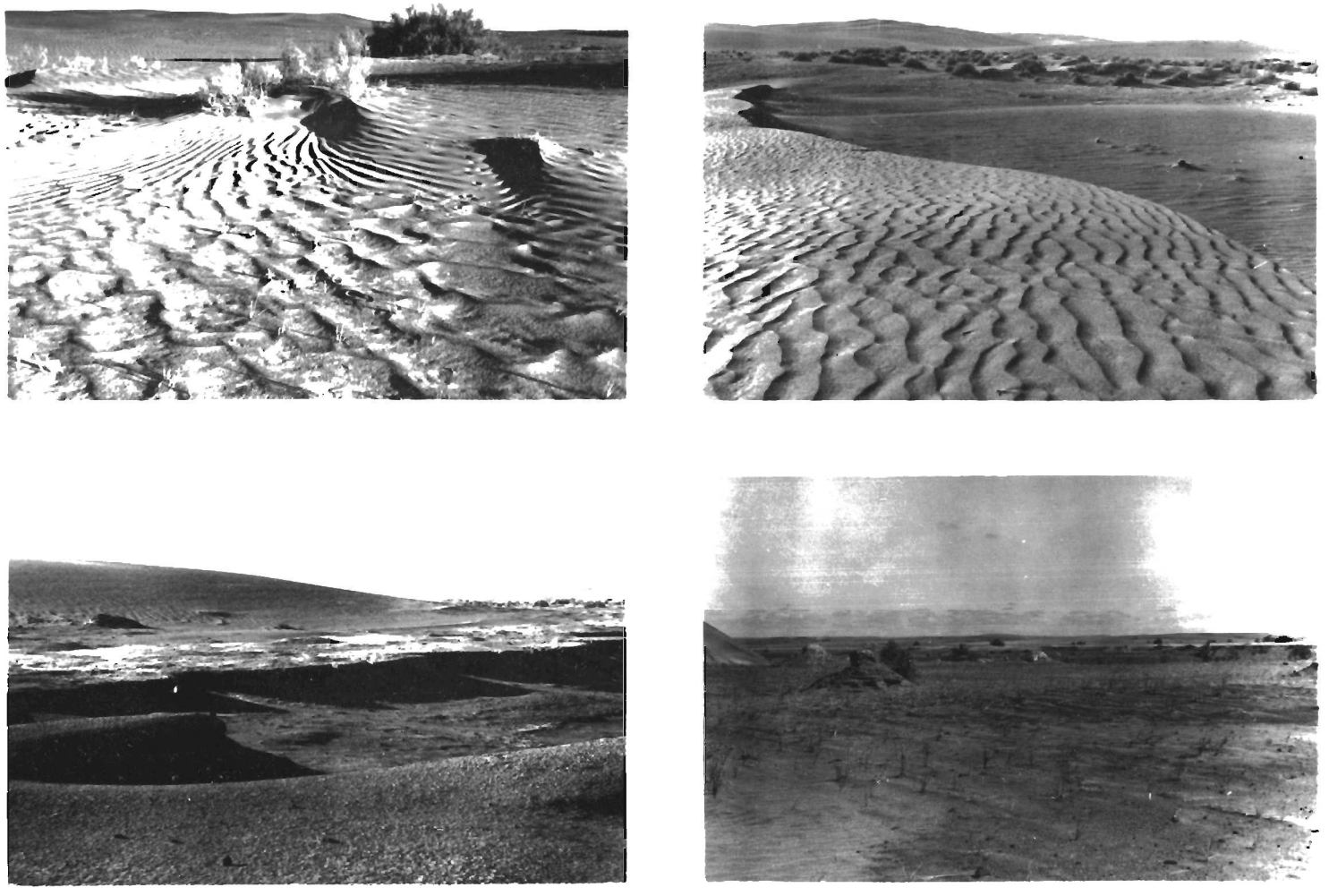

Figure 8. Wind erosion on bed of Fossil Lake.

and vegetation of the basin.

Sierozem soils are (93) associated with five to ten inches precipitation, mean January temperatures of from 20° - 30°F, July temperatures of 65° - 75°F. Basin precipitation and temperatures fall within those ranges. Typical vegetation on Sierozem desert soils is Artemisia tridentata, Agropyron spicatum (Pursh.) Scribn. & G. M., Graya spinosa, Atriplex confertifolia. On alkaline soils within the zone the common indicators are Sarcobatus vermiculatus and Distichlis stricta.

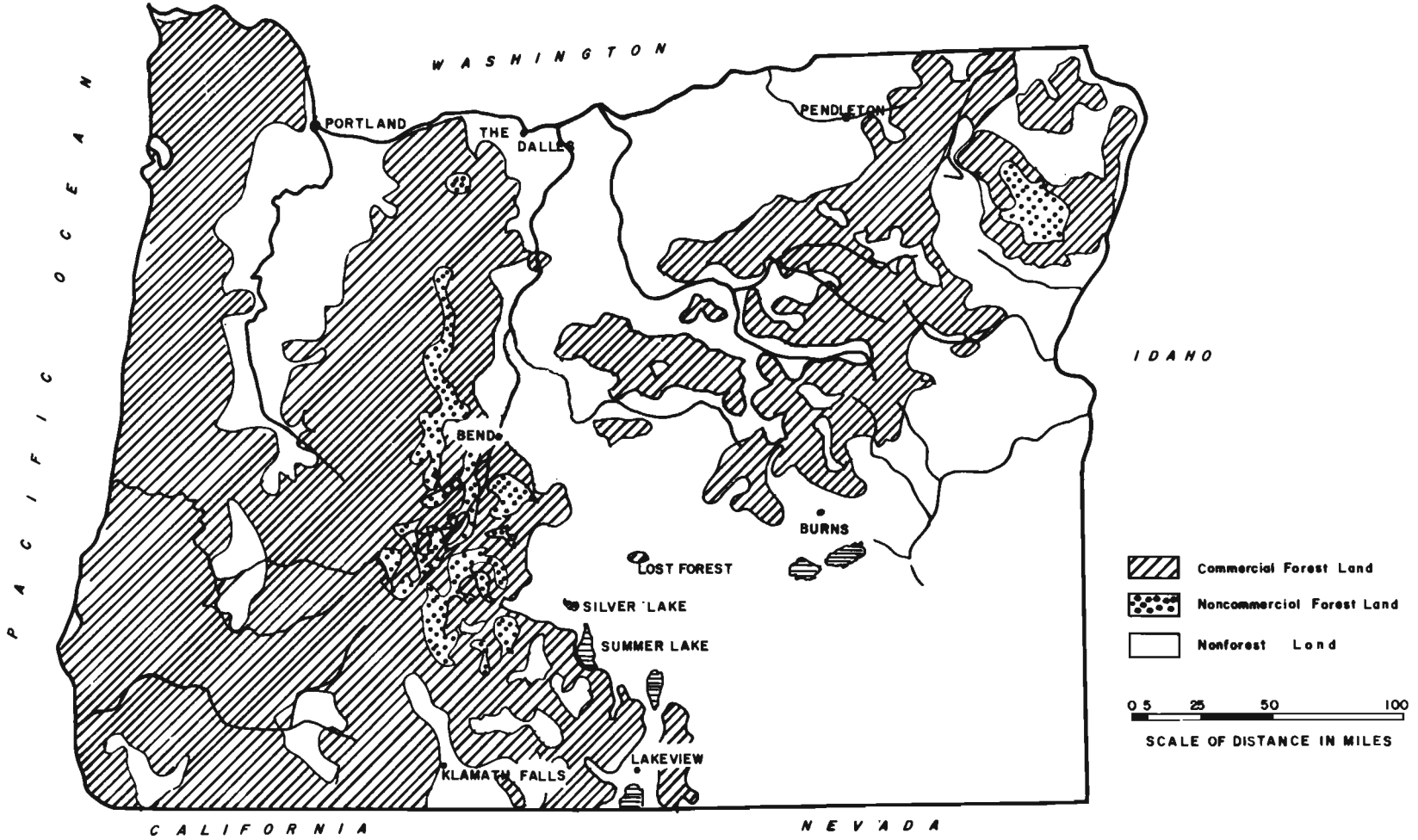

Figure 9. Generalized forest types of Oregon.

THE LOST FOREST AND FOSSIL LAKE AREA

Location

The Lost Forest is located on the eastern rim of the Fossil Lake basin which is in the eastern portion of Christmas Lake basin. Since low ridges of but approximately twenty-five feet now separate each of the modern lakes, there was a continuous lake over the entire basin throughout most of the pluvial and post pluvial times. The Lost Forest, which is referred to indirectly in the older literature by the name "Pine Ridge," is approximately 9,000 acres in size. It extends from the dry lake bed of the ancestral Fossil Lake eastward one mile beyond Pine Ridge. Total east-west length is approximately six miles and it is two and one-half miles in width. It is almost exactly thirty airline miles due east of the town of Fort Rock.

General Description

The most conspicuous plant species of the Lost Forest-Fossil Lake area is ponderosa pine, Pinus ponderosa. Waring (1908) (159) commented that the growth of pine trees at Pine Ridge on the eastern edge of the Christmas Lake Valley

among the dead trunks of junipers is a unique occurrence in this region. There is nothing intrinsically outstanding about the appearance of the trees themselves, only in their location in relation to the "Sage Brush Desert," the sand dunes and other pine forests. In fact, by commercial standards it would scarcely be considered as forest at all. The trees are very short and are extremely limby (Figure 10). Spacing is wide and irregular over most of the forest; many trees are relatively large in diameter but stem size appears dwarfed by the broad dense crowns.

In most of the area many junipers are interspersed among the pine. In other localities only a few pines may occur, with the junipers providing the predominant upper story. In still other portions scattered pines appear above a low cover of shrubs. The most conspicuous shrubs in the understory are big sage (Artemisia tridentata) and gray rabbit brush (Chrysothamnus nauseosus). Nearly all the stems of the pine trees have a distinct "lean" toward the east, probably as a result of the strong, prevailing southwesterly winds. This is particularly noticeable when the trees are compared to the junipers which are apparently not affected by the winds.

In a few hundred acres in the eastern portion of the forest, sage and rabbit brush are for the most part replaced by a rank growth of bitter brush (Purshia tridentata (Pursh.) D. C.). This area, which lies on the west basin

Figure 10. Typical midsummer morning view of Lost Forest.

slope of Pine Ridge, also contains a few large mountain mahogany (Cerocarpus ledifolius Nutt.). In the portion of the Lost Forest lying west of Pine Ridge and constituting three-fourths of its total area, grasses are not abundant. Here, however, occasional clumps of the grasses Stipa comata and Stipa thurberiana are very conspicuous. Small shifting sand dunes are a familiar sight within the forest and are also characteristic of the area immediately surrounding the forest except for the northern boundary beyond which the dunes have not drifted. The common grass of these shifting dunes is Elymus sp.

The vegetation beyond the northern boundary is characterized by a very dense stand of big sage except for a few small playas which support the diminutive form A. tridentata variety arbuscula. The western and southwestern end forest is bordered by large sage and by shifting sand dunes. One of the latter is encroaching upon a part of the forest burying many standing pine trees (Figure 11). These dunes are sometimes occupied by Russian thistles as well as grasses. The south and southeastern portions are bounded by sage and juniper. The eastern portion terminates in big sage cover except that there the terrain is frequently broken by sand dunes which have become fixed by the luxuriant growth of sage and occasionally by dense stands of large junipers. Many of the latter reached three and four

Figure 11. Sand dunes entering western end of Lost Forest.

feet in diameter.

Approximately one thousand acres of the total nine thousand acres in the forest lies on a mesa on the eastern side of Pine Ridge. Except around the rim of the mesa where the sands have accumulated to considerable depths, pine trees are either of extremely poor form or have succumbed to the drought, leaving junipers as the predominant tree. In this area is found the most interesting single vegetative association in the entire forest and vicinity. The entire mesa is covered with a conspicuously luxurious growth of the bunch grass Idaho fescue (Festuca idahoensis Elm.) which is almost completely absent in the rest of the forest.

Land Use

Most of the area has been logged in recent years. From 1952 to 1956 the United States Department of the Interior, Bureau of Land Management conducted timber sales in the area. The sales were aimed primarily toward removing beetle-susceptible trees. The low stumps left from this operation served to distinguish the planned harvest from cuttings of ranchers and others who have in the past exercised unofficial free-use-permits. Evidence of both regulated and unregulated cuttings is found throughout the forest west of Pine Ridge. There has been no cutting on

the Idaho fescue mesa previously described except for a few junipers and a few pine trees near a long abandoned homestead bordering the extreme northeastern tip of the forest.

There are a number of portable mill sites scattered throughout the forest. The debris has been burned and most of the sites seeded to crested wheat grass, (Agropyron cristatum (L.) Gaertn.) which has not yet become a serious competitor of native plants except in the disturbed areas. The recent cutting was very light and apparently had no significant effect upon the plant communities.

The entire forest has been heavily grazed by horses in the past. In fact, the last of the bands using the general area was captured in the early 1950's. Corrals were built in and near the forest for the purpose of capturing the animals. They were probably constructed circa 1920. The greatest grazing pressure of the area since 1920's was probably by these herds of wild horses. The cattle were restricted to areas near the source of water which during that period was the Wardall Well, approximately three miles west of the western end of the forest. This condition was particularly limiting since most of the ranchers at that time distributed salt only at water holes. No attempt was made to evaluate the effect of sheep grazing but it had apparently ceased for the most part before the

1920's.

In 1943, the area was heavily used by the United States Army for battle maneuvers in preparation for desert warfare. The effect this usage had on the overall status of present vegetation is not known but it does appear that the activity was restricted to limited areas. The sites of heavy military usage were avoided in analyzing the vegetation.

Topography

The topography of the Lost Forest can best be described as a gently sloping plain, extending from the level of Fossil Lake on the west to Pine Ridge five miles eastward (Figures 12 and 13). Pine Ridge rises approximately 200 feet in about one-fourth mile horizontal distance to the level of the Idaho fescue mesa previously mentioned and then declines in a gradual slope for about fifty feet to the eastern boundary one mile away. Two well eroded basalt rims, one at one-half mile into the forest from the west and one located at one mile further east provide a more precipitous break in the gradual slope--these rise about thirty feet in a distance of one hundred feet.

The ubiquitous sand dunes provide some local relief but the only conspicuous feature in the topography is the previously described outcropping of breccia in the south

Figure 12. Aerial view of Lost Forest from Pine Ridge looking west toward Fossil Lake.

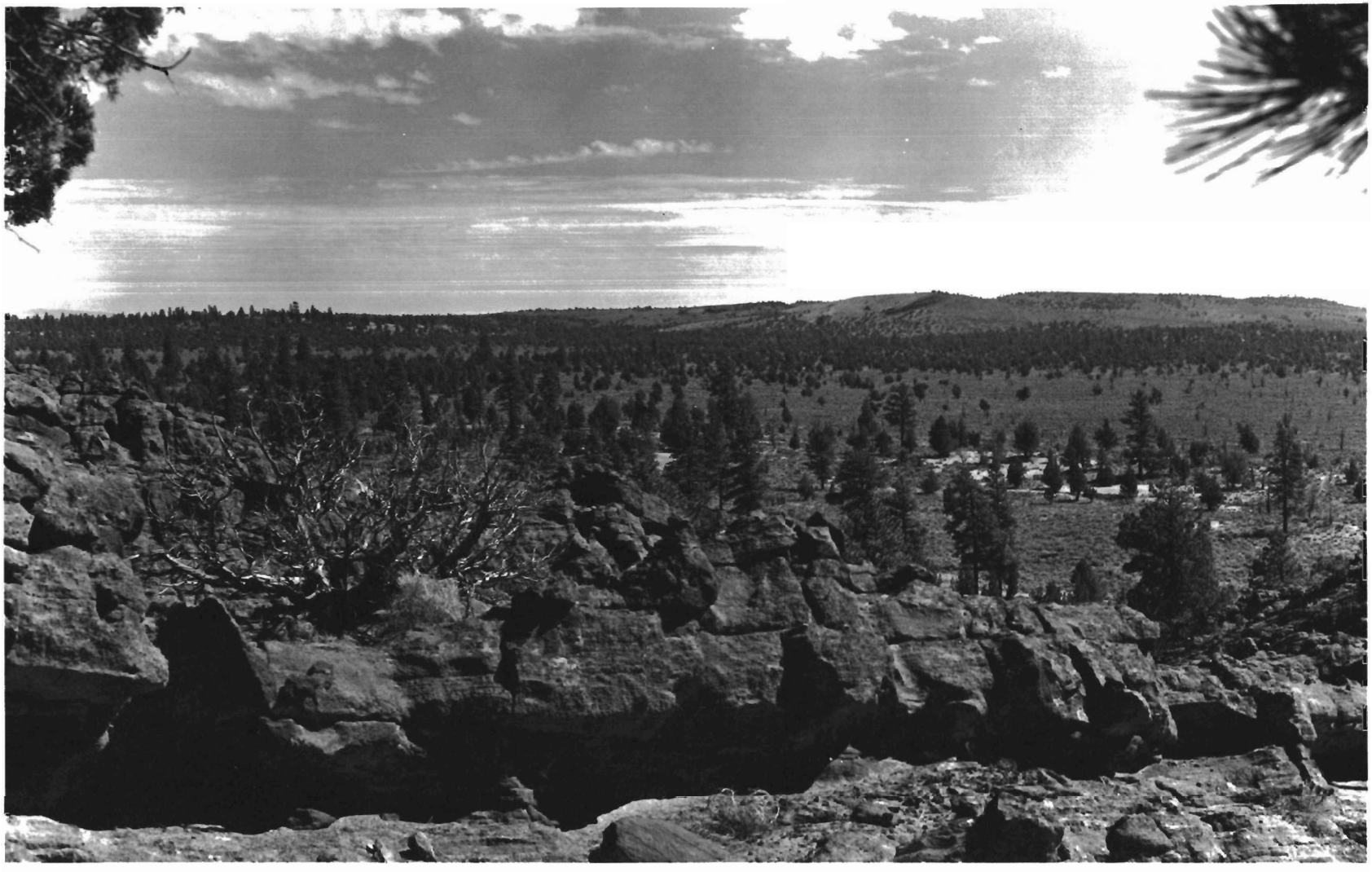

Figure 13. View from breccia outcropping in center of forest looking east toward Pine Ridge.

Figure 14. Breccia outcropping in winter.

central portion of the forest (Figure 13).

Fossil Lake and Dunes

As previously mentioned sand dunes are encroaching upon the western edge of the forest. There is also a large range of dunes one mile within the eastern end of the forest (Figure 15). As the dunes move forward they bury living pines and junipers, while dead skeleton-like trees are exhumed as the dunes continue their migration.

Condon (114) described the dunes in 1877 as covering an area six miles long and at least two miles wide. The total area occupied by the dunes at the present time is much closer to 22 square miles than the 12 described by Condon. Although Dr. Condon's estimates were somewhat subjective, it appears that the dune fields have been growing in size. Cope (1889) (38) in his visit to Fossil Lake states that they found the sand dunes two miles east through the sage from Fossil Lake. At the present time dunes may be found on all sides of the lake which is now completely dry. This is additional evidence that the dunes are increasing and advancing from modern Fossil Lake.

Fossil Lake, as its name implies, has been the site of many fine pleisteocene fossil finds (Cressman, 41). The animals, of course, may have had no lasting effect upon vegetation of the forest but it is to these fossils that

Figure 15. Shifting dunes on Pine Ridge in eastern end of forest.

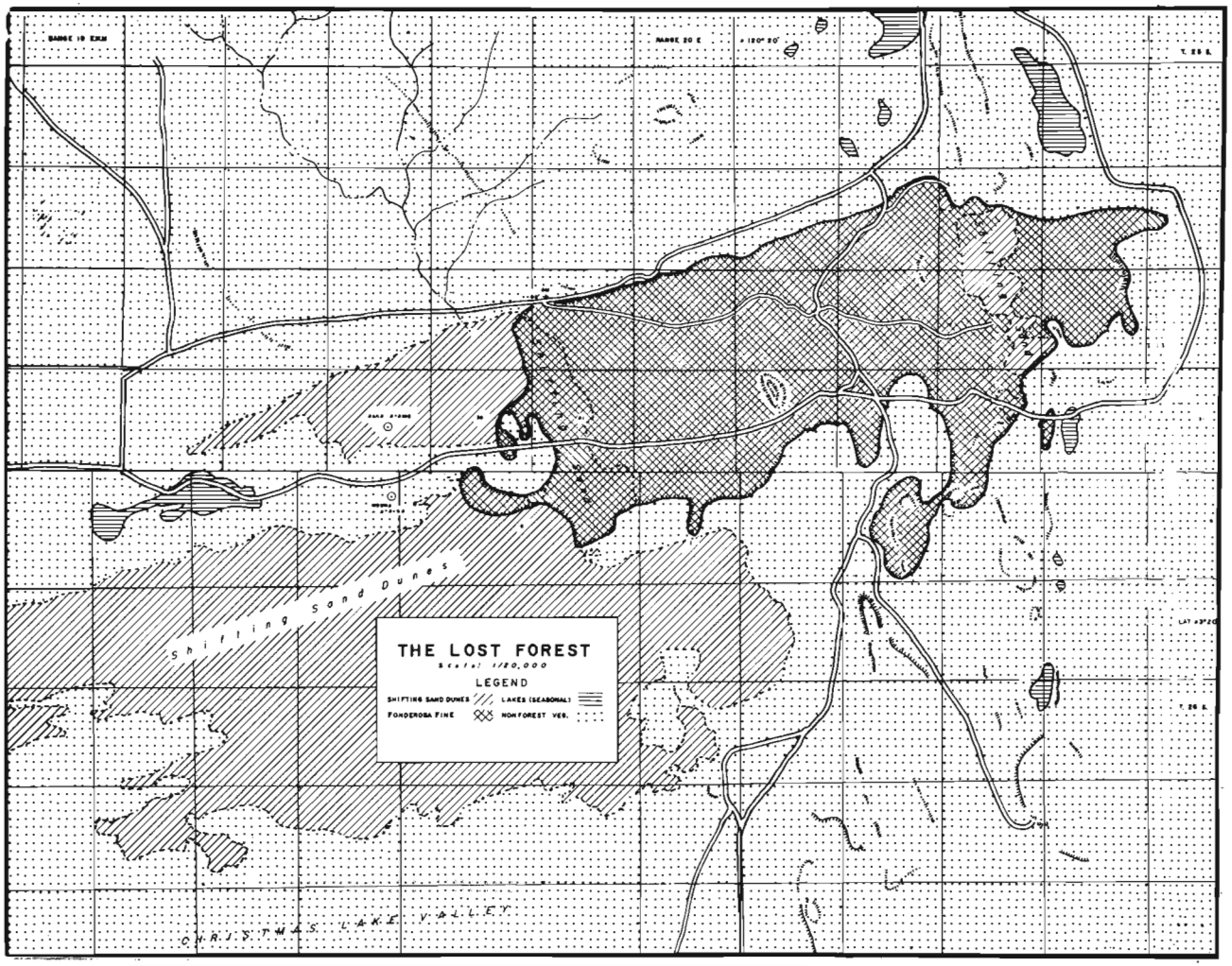

Figure 16. Lost Forest and vicinity.
one inch = 8,500 feet

we are indirectly indebted for some of the early scientific observations made in the area by Professor Cope, Dr. Condon and others.