A Statistical Analysis of the Forest Succession
on the McDonald Forest

by

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Approved:

Redacted for privacy

Professor of Forestry
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I. INTRODUCTION

The Willamette Valley of western Oregon lies within the region forested by the hemlock-cedar climax of the Coast Forest (Weaver and Clements, 1938). The relative absence of both western redcedar (Thuja plicata) and western hemlock (Tsuga heterophylla), the two chief dominants of this association, however, suggests that this restricted area is not favorable for their existence. The mean annual precipitation of the Willamette Valley would seem to support this forest climax, but the low summer rainfall and high evaporation coefficient, however, evidently have prevented the development of this climax at any time during the post-Pleistocene as indicated by pollen analyses of peat profiles (Hansen, 1941, 1942). This area is classified as having a humid, microthermal climate, with inadequate summer precipitation (Thornthwaite, 1931). The Willamette Valley also lies within the Humid Transition life zone (Merriam, 1898).

Douglas-fir (Pseudotsuga taxifolia) is the dominant species throughout the area with lowland white fir (Abies grandis) associated with the Douglas-fir on the moister sites. Oregon white oak (Quercus garryana) occurs in the dense forest as old, large, relict specimens, and in pure stands or in association with young Douglas-fir invading open areas. Observations suggest that oak is succeeded by Douglas-fir and the latter is replaced, at least partially, by lowland white fir. Other hardwoods of this area are bigleaf maple (Acer macrophyllum), Oregon ash (Fraxinus oregona) and red alder (Alnus rubra), the latter two species occurring most frequently in the moister sites and on flood plains. Another characteristic of the foothills section of this area is the presence of non-forested patches of land occurring mostly on the south slopes. It is apparent that these grassland areas are being invaded by Oregon white oak and Douglas-fir.
In the hemlock-cedar association of the Coast Forest, western hemlock, western redcedar, and Douglas-fir are the chief dominant species. The latter persists as a subclimax because it is intolerant of shade, and does not reproduce on the forest floor. Thinning out of the overstory of mature Douglas-fir by insects, windthrow, disease, and lack of reproduction allows the more tolerant under-story of western redcedar, lowland white fir, and western hemlock reproduction to expand. Gradually these species assume predominance, and a stabilized forest of these species persists if fire or lumbering do not disrupt the forest succession. If the climax forest is destroyed, Douglas-fir invades the deforested area. Lack of competition for light permits it to flourish until the shade-tolerant species regain a foothold. If forest succession is not disrupted the climax condition is eventually attained. A study of the composition of forests of various ages has shown that without fire or logging, a Douglas-fir forest probably would be converted to the climax type in five or six centuries (Munger, 1940).

The purpose of this study is to determine the successional trends in the oak-Douglas-fir forest of the Willamette Valley and adjacent foothills of the Coast Range. The data for these interpretations have been obtained by a statistical analysis by means of sample plots on a representative area of this forest. The factors influencing the maintenance of this type of stand may be within the control of man (Hoffman, 1920). It is hopes that the results and conclusions of this study will serve as a silvicultural basis for farm woodland management and grazing practices in this area. It has been shown that the principles of plant succession have been applied successfully in maintaining the desired type of vegetative cover both in forestry and grazing. In the hemlock-cedar climax of the Puget Sound region, Douglas-fir is a subclimax species, and also the most important commercial species. By clear cutting and providing an adequate seed source as security against subsequent loss by
fire even-aged stands of Douglas-fir reproduction can be obtained. The climax type in the hemlock-cedar forest of this region can be maintained by tree selection cutting (Münger, 1939). In range management the intensity of grazing is regulated so as to maintain the maximum forage in relation to what the area can support. In some cases the climax vegetation is less desirable than a subclimax or disclimax type, and grazing practices must be regulated accordingly (Stoddart and Smith, 1943).

Undoubtedly successional trends and relationships as determined from data derived from statistical studies elsewhere have served to develop silvicultural and grazing practices in those areas.

II. DESCRIPTION OF AREA

A. Location

The area studied lies within the boundaries of the McDonald Forest belonging to the Oregon State College, School of Forestry, at Corvallis, Oregon. This forest lies in Townships 10 and 11 South, Range 5 West, Willamette Meridian. The area of the McDonald Forest is 4,801.66 acres lying west of U. S. Highway 99W and about six miles north of Corvallis. This area is representative of the country in the eastern foothills of the Coast Range and the western fringe of the Willamette Valley.

B. Geological History

This area is generally well marked where the Oregon Coast Range descends on the east to the Puget trough. The details of topography have been determined partly by the relative resistance of the rocks which are predominately of Tertiary age. The highest peaks are the result of volcanic rocks contemporaneous with or intruded into these sediments. The low mountain range of this section is of relatively recent birth (Eocene) and presumably has never been very high (Fenneman, 1931).

C. Physical Features

The McDonald Forest includes practically the full width and six miles of the length of a large ridge which runs northeast and southwest.
The highest point on the ridge occurs within one-half mile of the south-west side of the forest. The two highest elevations within the forest are 1425 feet and 1550 feet. Along the edges of the forest the elevations drop to 450 feet at Oak Creek and Jackson Creek and 550 feet at the Peavy Arboretum and Sulphur Springs. In general, streams and ridges run northwest and southeast from the main ridge. The study was made on the southwest end of the McDonald Forest in Sections 17, 18, 19 and 20, Township 11 South, Range 5 West, Willamette Meridian in the Oak Creek drainage. At the head of the creek the canyon sides are quite steep, changing to gentler slopes toward the south boundary of the area. North exposures are in the minority with many long gentle south slopes. Oak Creek runs south from its source forming a trough; thus the two main exposures are east and west.

The soils of the McDonald Forest belong to the Hill Group of residual soils and originate from igneous basaltic rocks. These soils are Olympic clay and Olympic clay loam series. Some of the higher country of the McDonald Forest is classed as rough mountainous land (Powers, Jones, and Ruzek, 1931).

A check through weather records of Corvallis as far back as 1890 reveals the following climatic conditions influencing timber growth as it affects this problem: The annual rainfall reached a high of 58.06 inches in 1937 and a low of 23.78 inches in 1930 with an average of 39-40 inches. The greatest monthly rainfall recorded was 16.69 inches in November, 1896. Maximum rainfall in one day was 3.43 inches on January 3, 1907. The longest period of drought occurred in 1914 when no trace of rain was recorded in either July or August. One rainless June, nine rainless Julys, six rainless Augusts have occurred.

Heavy snowfalls sufficient to cause breakage in timber occurred in January, 1890; December, 1892; in the winters of 1893 and 1895; January, 1909; January, 1911; January, 1916; December, 1919; January, 1937.
These snowfalls ranged from 12 inches to 35 inches in the above mentioned months. Winters of no snowfall were 1906, 1912, 1915, 1925, 1934, 1940. Light snows were recorded as late as April, 1911, and 1933; the earliest in the fall was 5 inches in October, 1935. A severe ice storm occurred in January, 1942, which caused considerable breakage.

The range of the last killing frosts in the spring runs from March 2 in 1930 and February 20 in 1940 to May 31 in 1919. The first killing frost in the fall ranges from September 22 in 1904 to November 30 in 1937.

The lowest winter temperatures recorded reached -5° in February, 1899, -1° in January, 1909, -14° in December, 1919 and -8° in December, 1924. Other winters the temperatures have gone only as low as 26° in December, 1910, 25° in January, 1912, 26° in February, 1914, 26° in December, 1935, and 25° in December, 1939.


The maximum yearly temperature has occurred four times in June and three times in September.

The McDonald Forest is a State Game Refuge. The deer population is fairly concentrated on the area where the study was made. Restricted grazing of sheep and cattle has been allowed within the past year. Rodents are numerous, and their dirt mounds are especially noticeable on the open grassy hillsides but less common throughout the timbered areas.

D. History of the Area

From 1845-1855 the first large numbers of settlers began to migrate to the coast country and this is the period to which hearsay assigns great fires. Prior to that time the Indians are said to have kept the country burned off to facilitate hunting game and gathering wild wheat seed for food. David Douglas on September 27, 1826 wrote in his journal
as he went west from a camp 58 miles up the Willamette River that there was not a blade of grass unburned except along the fringes of the streams (Morris, 1934). Ring growth studies in stumps of old relict specimens reveal that this country has been subject to fires for at least 296 years or since 1647. Fires have not been as severe nor as frequent since around 1848. This assumption is based on the facts that large numbers of trees of the 90-year age class now exist on the area and as settlers made improvements on their farms some effort was made to prevent fires.

Second-growth Douglas-fir has been cut from most of the area covered by this study. By a study of annual rings of trees left standing the time of logging was determined to be about 1915-1920. This has been verified by a member of the School of Forestry staff.

Many abandoned farms are to be found throughout the area concerned in this study. Hill farming and grazing have been practiced in this country since the earliest settlements. The large open grassy hillsides afforded excellent pasturage before the land began to be reforested. As trees invaded the grasslands, they excluded more and more grazing land from the farm economy.

E. The Vegetation of the Area

Oregon white oak is the only oak of commercial importance indigenous to the Pacific Northwest. It is a medium-sized tree seldom reaching more than 50 to 75 feet in height and 2 to 3 feet in diameter. Boles of this species are usually short and crooked even when grown under forest conditions. It has a well developed lateral root system and a wide-spreading, round-topped crown, especially in solitary specimens. This tree thrives best in deep, rich loam in regions where the yearly rainfall does not exceed 30 inches and where the humidity is very low during the summer months. Large seed crops are produced every few years but due to the inability of germinating seeds to penetrate the
heavy sods upon which they are disseminated reproduction from seed is slow. Stump sprouts and root suckers are vigorous, and reproduction is obtained by this means (Harlow and Harrar, 1941).

A Typical Oak Fringe

The low summer humidity requirement together with its habit of reproducing readily by root suckers accounts substantially for the persistence of Oregon white oak on this area and also explains its aggressiveness in invading grasslands when conditions for seed dissemination and germination are suitable. This species forms distinct fringes around grassland areas with individual trees and small clumps dispersed throughout these areas. These fringes of oak are usually narrow and beyond them is the Douglas-fir type with an intermingling of relict specimens of oak becoming decadent or already dead.

Ring growth studies of stumps of these relict specimens show that they grow at a slow rate throughout life. In the coniferous forest these large oaks persist until the forest canopy closes over them whereupon they rapidly succumb to the intense competition. Pure stands are found particularly on hillsides in this area, seed dispersal apparently being effected when the acorns fall from the trees and roll downward. Possibly rodents are instrumental in seed dispersal, but to what extent it is hard to say.
Douglas-fir grows in a variety of soils, and on the McDonald Forest site conditions range from the poorest to the best for this species. In youth, Douglas-fir forms extensive, pure, even-aged stands. Anchorage is provided by a well developed, wide-spreading lateral root system. Seed is produced in abundance after the twenty-fifth year. Heavy seed crops are produced at intervals of two or three years. Crowns of this species are very inflammable and fire is its worst enemy (Harlow and Harrar, 1941).

On the area covered in this study there is a large number of old, open-grown trees of the "wolf tree" type which furnish a seed source for the area. These may not be expected to seed the surrounding areas effectively at greater distances than 300-400 yards (Isaac, 1936). It is from these very old trees of this type that growth ring studies have been made revealing the past fire history of the area. Because these trees are, in general, so widely scattered over the area the effective range of seed dispersal of the individual tree does not overlap that of its neighbor and patchwise stands result. In many cases these patches or islands of Douglas-fir timber are normally stocked stands producing good quality timber. Natural pruning is progressing
satisfactorily. On the other hand, there are areas on which physical
features have precluded the uniform germination and establishment of
seedlings; therefore poorly stocked stands are the result.

Bigleaf maple occurs singly or in small groves associated with the
other timber species of this area. It is more abundant near the creek
bottoms in the better quality soils. Long clear boles and narrow crowns
are developed under forest conditions. When open grown the trunk breaks
up into several ascending branches to form a globose crown. The root
system is shallow and wide-spreading (Harlow and Harrar, 1941). This
tree seems much more tolerant under forest conditions than oak.

Grand fir or lowland white fir, like bigleaf maple, is found prin-
cipally on flood plains and gentle slopes on the area studied. As a
rule it occurs singly but it is not uncommonly found in groups or small
pure stands. Young trees are quite tolerant and have been found on
this area forming dense thickets of sapling-sized trees. Older trees
usually have long spire-shaped crowns and in maturity the crown becomes
more dome-shaped. The root system is deep and spreading (Harlow and
Harrar, 1941).

The four species described above are the principal forest trees in
this area. Other species occupying a place of lesser importance in the
composition of the forest are found widely scattered or concentrated on
flood plains, in ravines and in gorges depending upon each species' in-
dividual requirements. Red alder is the main species found on the flood
plains with willow (Salix sp.) in association. Red-stemmed dogwood
(Cornus stolonifera) and some Oregon ash (Fraxinus oregona) occur also
on flood plains. Western yew (Taxus brevifolia) and flowering dogwood
(Cornus nuttallii) inhabit the moister aspects and steep canyon sides.
Scattered over the more exposed slopes and occupying similar sites are
black haw (Crataegus douglasii), Madrona (Arbutus menziesii), the bitter
cherry (Frunus emarginata), and cascara (Rhamnus purshiana).
The more predominant shrubby species of the area are thimble berry (Rubus parviflorus), snow-berry (Symphoricarpos albus), salal (Gaultheria shallon), and poison oak (Rhus diversiloba). A plant commonly invading the grasslands in advance of the tree growth is the common wild rose (Rosa rubiganosa). Under the shade of the forest canopy sword-ferns are numerous. In the more open areas bracken ferns often form a dense ground cover.

The open grassy areas previously referred to are supporting a cover of native grasses. Many of these areas not yet being invaded by trees have been taken over partially by wild rose. The extent of invasion by wild rose ranges from a few clumps per acre to as high as an estimated 20 per cent of the surface area. The result is excess competition for the grass as well as a reduction in actual grazing area for livestock.

St. John's Wort (Hypericum perforatum) is a weed that is prevalent on some areas and is very undesirable from a standpoint of forage value and its effect on the composition of the grassland vegetation.

F. Effects of Logging and Burning

As a result of logging and burning, parts of the area studied have undergone a retrogression. The young growth Douglas-fir was heavily cut during 1915-1920, and although appearance of the remaining stumps indicate light burning these patches are now supporting an extremely dense cover of brushy species. Ostensibly this heavy ground cover precludes establishment of Douglas-fir reproduction except by gradual encroachment from the edges of these brushlands. Such conditions, however, seem to represent the extreme condition.

Other tracts have been reforested extensively but from a forestry point of view they are not fully stocked with any one species or combination of species. The trees on these areas are therefore open-grown and limby. However, there are more extensive areas adjoining these brushlands and open Douglas-fir and oak forests that are heavily re-
forest. Fires of the past from all indications have for the most part been ground fires. It is well known that such fires leave an irregular pattern of burned over land. This irregular pattern is exemplified in the heterogeneous nature of the forest that is present on the area.

Pure stands of oak exist as invaders of the grassland areas. The grassland areas have probably been maintained as such in the past by the annual burning of the woods by Indians. Since the exclusion of fire by the white man Douglas-fir is advancing out beyond the previous peripheries of the coniferous timber. This is brought about by the protection from summer desiccation afforded by the shade of the oaks. The invasion of abandoned farms by Douglas-fir and oak, especially the former species, is obvious. Often uncut Douglas-fir timber lies adjoining the abandoned farms and reforestation takes place readily.

Grazing has been permitted on the area where this study was made. The most obvious damage to the vegetation has been trampling along the fence rows. This, however, is not extensive enough to be of any economic consequence. Grazing has been light on the area and browsing damage is barely noticeable. During a heavy snow in January, 1943, sheep were observed to be browsing Douglas-fir seedlings that extended above
the snow. No other green feed was available at the time. Where sheep have been concentrated for some time on an area regardless of weather conditions, there are indications that they have browsed Douglas-fir seedlings. Browsing on oak is not as noticeable nor as extensive. There is little indication of such damage to oak.

Moles seem to be very abundant and their mounds are numerous and wide-spread. These mounds of loose dirt may afford suitable seed beds for germination of tree seedlings. On the other hand they probably facilitate gathering by birds and rodents any seeds that fall on them.

III. METHODS

A. Collection of Data

Samples were taken in square plots, 25 feet by 25 feet. The sample plots were laid off by the use of a six-foot stick calibrated in feet. This measuring device seemed better adapted to operation by one man than a steel tape when the time saving element was considered. Plots 25 feet by 25 feet were arbitrarily chosen as being sufficiently large to be representative of the area. One hundred plots were taken for this study well distributed over the area.

In distributing the sample plots a box azimuth compass was used and distances between plots estimated by pacing. Sample plots were established at three chain (198 feet) intervals along each line except where no trees or tree reproduction was found, or where the plot would have to be established in a non-forested ravine. In such cases, the distances between plots had to be adjusted to fit the pattern of forest stands. Any deviation from the three-chain interval between plots was recorded in the field notes so that each plot could be returned to readily for checking if need be. Where a transect followed a fence, plots were established one-half chain distance from the fence in order to avoid the influences of cutting of trees when the fence was constructed, and also the trampling and browsing by stock. Each three-chain station served
as a corner for the plot established at that station. Plots were always laid off by measuring 25 feet along the transect in the direction the transect was being run and 25 feet to the right, i.e., if a transect is being run from south to north each station on that transect would be the southwest corner of the respective plot.

All trees on each plot were measured for diameter at breast height or a point 4 feet above ground and outside the bark. This measurement will be referred to in this paper hereafter as DBH. Stumps were measured at stump height. Measurements were taken by means of a steel diameter tape. Trees under 1 inch in diameter were merely counted as "small trees or seedlings".

Growth ring counts were made on stumps of both oak and Douglas-fir in order to make a comparison in growth rate of the two species. The diameters were measured at stump height with the diameter tape.

The data was recorded in an ordinary pocket-sized notebook. Diameters were recorded opposite the species and a brief description of the sample plot and immediate vicinity was recorded on the same sheet with the rest of the data. Location, slope or exposure and date were entered as a heading for each data sheet. Each sheet was numbered the same as the sample plot its data represented.

B. Presentation of Data

The data are presented both in tabular and graphical form. The graphical presentation is effected by means of phytographs. Lutz (1930) developed this method while making a study of the composition of a virgin forest area in northwestern Pennsylvania. The method consists of constructing a polygonal figure formed on four axes representing what are considered to be the most important criteria for characterizing the ecological position of a tree species in a forest association. The four criteria selected were: (1) abundance, i.e., the number of trees of a given species represented as a per cent of the total number
of trees of all species 1.0 inch DBH and over; (2) frequency, i.e., the number of sample plots in which are found one or more trees 1.0 inch DBH or over of a given species expressed as per cent of total number of sample plots; (3) number of size classes in which each species is represented; and (4) basal area of each species expressed as per cent of total basal area of all species of trees 1.0 inch DBH and over.

Graphical presentation of four measurements simultaneously makes possible an integral picture of the relationships between the several measurements and an impression of the "mass effect" of the several factors may be obtained. These features and the further possibility of isolating any particular factor for purposes of analysis make the method desirable for this particular study.

Several other writers have found phytographs useful in presenting data for similar studies. Cain used this method in his study of a virgin hardwood forest (1934) in Posey County, Indiana and also in a study of the composition of an oak woods near Long Island, New York (1938). Oosting and Billings (1939) have presented their data in this manner for a study of the edapho-vegetational relations in a virgin hemlock forest in North Carolina.

IV. INTERPRETATION OF DATA

Growth ring studies of oak and Douglas-fir stumps show the growth rate of the latter species to be from 3 to 5 times that of oak. It has been pointed out earlier that oak precedes Douglas-fir on most of the areas, particularly those areas that were previously grassland. These facts account for the greater number of oaks 1.0 inch DBH and over.

There is a very wide difference in the basal area of the oak and Douglas-fir, the latter species representing about four times that of the oak. This is further evidence of the more rapid growth by the Douglas-fir. However, about one-third of the basal area of Douglas-fir represents
PHYTOGRAPHS OF THE PRINCIPAL FOREST TREE SPECIES, MACDONALD FOREST.

AO: per cent of total density; BO: per cent frequency; CO: per cent of four size classes represented; DO: per cent of total basal area.
Data based on 100 sample plots.
stumps left from logging. On this area the Douglas-fir was still of a comparatively small size when clear cut and had not yet completely crowded out the scattered old oaks. From this seed source oak reproduction has become established particularly on the more exposed sites. This accounts for the abundance of small oaks on areas that were previously forested by Douglas-fir. This is an example of retrogression. The frequency of oak and Douglas-fir is nearly the same, the latter being found in six more sample plots than the oak. The reason for this is that some sample plots were taken on north slopes where the oak has long ago been crowded out and also pure stands of older Douglas-fir contained only widely scattered relict oaks.

Table I

<table>
<thead>
<tr>
<th>Species</th>
<th>Abundance No.</th>
<th>Abundance %</th>
<th>Frequency No.</th>
<th>Frequency %</th>
<th>Size Classes</th>
<th>Basal Area BA</th>
<th>Area %</th>
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<tbody>
<tr>
<td>Pseudotsuga taxifolia</td>
<td>378</td>
<td>40.2</td>
<td>76</td>
<td>76</td>
<td>4</td>
<td>242.7</td>
<td>72.7</td>
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<td>44.5</td>
<td>71</td>
<td>71</td>
<td>4</td>
<td>62.6</td>
<td>18.7</td>
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<tr>
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<td>40</td>
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<td>20</td>
<td>20</td>
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<td>17.0</td>
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<td>6.3</td>
<td>15</td>
<td>15</td>
<td>4</td>
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<td>1</td>
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<td>2.5</td>
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<td>1</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td>Arbutus menziesii</td>
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<td>1.1</td>
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<td>1.1</td>
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<td><strong>Totals</strong></td>
<td><strong>943</strong></td>
<td><strong>100.0</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>333.6</strong></td>
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</table>

Bigleaf maple trees are fewer in number but higher in frequency than lowland white fir indicating that bigleaf maple is more widely and evenly scattered over the area. The lower frequency of the lowland white fir is probably due to reproduction being more or less concentrated near the primary seed source. However, lowland white fir has gained a substantial foothold from a standpoint of abundance of trees 1.0 inch DBH and over. Except for a few suppressed trees of small size the lowland
white firs are vigorous and competing strongly for their places in the forest canopy.

<table>
<thead>
<tr>
<th>Species</th>
<th>Under 1&quot;</th>
<th>1.0&quot;-3.0&quot;</th>
<th>3.0&quot;-10.0&quot;</th>
<th>10.0&quot; and over</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudotsuga taxifolia</td>
<td>598</td>
<td>94</td>
<td>154</td>
<td>130</td>
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<tr>
<td>Quercus garryana</td>
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<td>12</td>
<td>19</td>
<td>9</td>
</tr>
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<td>170</td>
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<td>4</td>
</tr>
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<td>Cornus nuttallii</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Crataegus douglasii</td>
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<td>Taxus brevifolia</td>
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</tr>
<tr>
<td>Rhamnus purshiana</td>
<td>8</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prunus emarginata</td>
<td></td>
<td>3</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Salix sp.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arbutus menziesii</td>
<td>6</td>
<td>4</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

Table II shows a significant relationship between the various species and the number that is represented in each size class. In general the forest growth is open enough to permit germination of Douglas-fir seed. This is shown in the table by the large number of Douglas-fir seedlings. These seedlings were found to be more heavily concentrated on areas where an over-story of oak existed with a Douglas-fir seed source in the immediate vicinity. This was particularly true on south slopes. A careful count on one sample plot with a southwest exposure revealed 94 Douglas-fir trees under 1.0 inch DBH. On open areas having scattered single oaks or clumps, the Douglas-fir reproduction is found concentrated on the northeast side of the oaks. These clumps of reproduction are well defined with none or only an occasional seedling outside the areas covered by the shadow cast by the oak tree during the hottest part of the afternoon. This indicates that the partial shade cast by the oaks or other species prevents desiccation and is responsible for the establishment of Douglas-fir seedlings. Where heavy brush or dense forest conditions are not encountered and an adequate seed source is present
small Douglas-fir reproduction is generally abundant. It is in the
dense forest situations that lowland white fir is gaining a foothold.

While lowland white fir is not so well represented by abundance in
the larger size classes it does show a comparatively high number of
small reproduction less than 1.0 inch DBH. This reproduction was found
under dense forest conditions and this fact is indicative of the species'
ability to reproduce under a more dense shade than Douglas-fir. On
this area, Douglas-fir reproduction was not found under as low light
intensities as was lowland white fir. Table III showing the basal area
of dead trees and stumps is rather misleading for lowland white fir.
Two large stumps were found on one plot which raised the proportion of
dead trees or stumps to nearly one-half of the total basal area. This
same consideration must be applied to the analysis of the data for
Douglas-fir.

Both basal area and number of trees 10 inches DBH and over are
high because of the large number of stumps on the area. Therefore
practically all of the basal area for the dead material in this species
consists of stumps and is not a result of decimation by natural causes.
However, 13.9 per cent of the total basal area of Oregon white oak is
dead trees with only one stump measured on the area. These oak trees have died from natural causes and especially heavy competition from the faster growing conifers. Most of these dead oaks were of the smaller size classes.

Table III
Dead Trees and Stumps
Basal Area
(sq. ft.)

<table>
<thead>
<tr>
<th>Species</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas-fir</td>
<td>85.8</td>
<td>35.3</td>
</tr>
<tr>
<td>Oak</td>
<td>8.7</td>
<td>13.9</td>
</tr>
<tr>
<td>Maple</td>
<td>0.3</td>
<td>1.7</td>
</tr>
<tr>
<td>White fir</td>
<td>2.9</td>
<td>49.1</td>
</tr>
</tbody>
</table>

The greatest number of oaks are in the two size classes from 1.0 inch to 10.0 inches DBH indicating the slow growth of the species and the probable establishment of the oak stand following the 1919-1920 logging. These size classes are particularly prevalent on the areas that have been logged during that period.

The five principal species on the area that are represented in all four size classes are Douglas-fir, Oregon white oak, bigleaf maple, lowland white fir, and western yew. The latter two species both reproduce under dense shade if other conditions are suitable.

V. APPLICATION TO MANAGEMENT

Economically this area is not producing either forage or timber to its fullest capacity. To bring the land into optimum production of timber within a reasonable period of time would require extensive planting the success of which would be doubtful especially on the south and southwest exposures.

It would seem practical to manage the existing stands of Douglas-fir for permanent timber production, including those adjacent areas of satisfactorily stocked reproduction. Where this reproduction is coming in
under the shade of the older oaks and has become well enough established
the oaks should be harvested.

Those areas best suited topographically to forage production, south
slopes in particular, should have some range improvement work done on
them. Rose bush eradication on this area would probably constitute a
major expense item along with preparation of the soil and sowing the
area to a good mixture of range plant species. At the same time the
carrying capacity of the range would be greatly increased.

It is believed, however, that if the area is not disturbed more than
by moderate grazing that it will eventually support a commercial stand
of coniferous timber. On the other hand, if intensive range improve-
ment is done the normal succession toward tree growth may be halted for
an indefinite period.
SUMMARY

One hundred sample plots were taken on the McDonald Forest in the Willamette Valley of western Oregon to determine the successional trend of a white oak-Douglas-fir community. This area has been logged and has been burned over. Parts of the area have retrogressed. The vegetation ranges from grass and brush to oak and Douglas-fir each in pure stands or in the two species in association. It was found that the greatest number of "seedlings and small trees" consists of Douglas-fir, while the greatest proportion of trees 1.0 inch DBH and over is of white oak. The greatest concentration of lowland white fir seedlings and saplings was found to occur in the dense forest and near the original seed source. Previously non-forested areas are being invaded by white oak which is closely followed by Douglas-fir. The absence of white oak and Douglas-fir reproduction under the dense forest canopies and the abundance of lowland white fir under these same situations indicates a successional trend of white oak to Douglas-fir followed by a climax forest of lowland white fir. This is further suggested by the presence of relict oaks in the dense Douglas-fir stands.
LITERATURE CITED


