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FOREST RESEARCH NOTES

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TABLE OF CONTENTS

Forest Research Notes No. 33
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STOCKED QUADRATS VS. NUMBER OF TREES AS A BASIS FOR CLASSIFYING REFORESTING LAND

By

Thornton T. Munger

The stocked quadrat concept of classifying land according to its degree of reforesting has largely replaced the method of classifying land according to the number of seedlings or saplings per acre. However, questions are asked frequently concerning the technique of employing this method and concerning the relationship between the stocked quadrat classes and the number of trees per acre. It is the purpose of this note to answer these questions, to define the stocked quadrat method, and to review the techniques for applying it. 1/

Definition of the Stocked Quadrat Method. This method or concept looks at a unit of land, be it a mil acre, a square rod, or a hundredth of an acre, as the basis for deciding how satisfactorily that unit of area is stocked, i.e., whether or not it needs planting, how nearly it will attain normal productivity. This concept considers the tract of logged off land or old burn as though it were a checkerboard, with the squares or quadrats of the dimension that would provide space for the ultimate ordinary growth and development of a single tree. Therefore, the presence of at least one tree of the size prevailing on the tract would constitute stocking for that quadrat. The only question then is: What proportion of the quadrats have a tree established on them? The proportion of them that contains at least one established tree is an expression of the status of stocking. This is a direct expression of the need for planting or for more natural regeneration and bears a direct relation to the growth and ultimate yield of that area. It is the simplest, most practical, and most sound method of getting at what the managing forester really wants to know.

This concept presupposes that the forester is interested only in whether or not each quadrat has at least one established seedling. It is immaterial to him how many more seedlings any quadrat had and he does not count them.

What Should be the Size of the Quadrats? If a tract sprinkled with Douglas fir seedlings and saplings up to Christmas tree size is being classified, it seems reasonable to say that at least one tree of that age and species every 10 or 15 feet is sufficient to assure a stand that will develop satisfactorily through the pole stage and attain normal volume by the time it is merchantable. For that class of reproduction a quadrat size of 13.2 feet on a side has been adopted in this region; this is a convenient fraction of an acre—1/250.

1/ Considerable material on this subject by Haig, Cowlin, Kolbe, Briegleb, Isaac, Munger, and others already exists in printed or manuscript form which has been freely used herein.

For poles whose crowns would interlace if the trees were only 13 feet apart a quadrat of 20.9 feet on a side 1/100 of an acre has been chosen as a reasonable unit to express stocking for that size class. For very small seedlings, squares smaller than 13.2 feet on a side have been employed to rate stocking. Mil acres, or quadrats 6.6 feet on a side, may be the technically ideal units of area for small reproduction of certain species. Thus the size of quadrat used for a given species, kind of product, and age of reproduction should allow for average expected mortality and amount of competition desired.

The size of the quadrat adopted might, of course, be adjusted to each set of conditions, but it is not practicable to use too much refinement in varying the size of the quadrats. When using the 13.2 foot quadrat it is the practice not to count as sufficient single, very young seedlings whose mortality rate is high, but to consider that it takes three or four of them to be equivalent to an established tree. On the other hand, when using small (mil acre) quadrats it is usually the practice to accept as sufficient evidence of stocking any single seedling no matter how small. In Forest Survey practice in Douglas fir, seedlings that are in their second season and are healthy are considered established.

It should be pointed out that the same concept may be employed and the same results arrived at by mechanical sampling methods whether the sample is a foot square, a yard square, a rod square, or any dimension up to the maximum growing space considered necessary for the size of tree in question.

In uneven aged stands, such as ponderosa pine, the size of the square can be made elastic to suit the stand. Upon the usual quadrat, of a size to suit seedlings and saplings, can be superimposed a larger quadrat to take in any tree that has the effect of stocking that quadrat, e.g., one at least four inches in diameter. To illustrate, if in sampling a heavily cut selection forest there are no seedlings or saplings on a certain 13.2 foot quadrat but there is a 12 inch tree at the side whose roots and crown dominate the quadrat and it would fall within a superimposed quadrat 20 or 25 feet on a side, that quadrat should be considered stocked. The distance to which a quadrat would be extended would depend upon the size of the nearest neighboring tree and other silvical considerations. A definite size for the superimposed quadrat or quadrats might be adopted, for example, 20.9 feet for pole sized trees and at most 26.4 feet for large trees.

The size of the quadrat employed has, of course, no bearing on the spacing that is advocated for planting, chiefly because the dimension of the quadrat is not a measure of the distance between natural seedlings, as will be shown presently.

Relation of Number of Seedlings Per Acre to Stocked Quadrat Rating

The most correct statement of the relation of number of trees per acre to stocked quadrat rating is to say there is no constant relationship. The two concepts are entirely different. It is almost always fallacious to attempt to convert a stocked quadrat rating to number of trees or vice versa, without much field work by both methods. Only in perfectly spaced plantations would this relationship be consistent. Natural reproduction is so unevenly distributed in most places and there is such a range in ages, sizes, and mortality probabilities of seedlings, that land with a high count of seedlings might or might not be well stocked.

However, there is a sliding scale relationship between number of quadrats stocked and number of seedlings per acre, which has been worked out quite thoroughly for average Douglas fir logged off land and old burns carrying various sizes of seedlings and small saplings. This principle stands out: If a high percentage of the quadrats are classed as stocked, i.e., have at least one established tree, there are sure to be several more than one seedling or sapling on many of the quadrats. Contrariwise, if only a small percentage of the quadrats are stocked, very few of them will have more than the one established seedling or sapling.

In connection with the forest survey of the Douglas fir region the total number of seedlings was counted on a large assortment of quadrats on land of various grades of stocking with reproduction from one to about 15 or 20 years old. The following table, taken from that study, shows for four groupings of stocked quadrats (column 1) the probable minimum and maximum number of seedlings per acre (column 4):

Percentage of squares with one or more established seedlings	Range in average number of stocked quadrats per acre	Range in average number of seedlings per stocked quadrat	Probable minimum and maximum number of seedlings per acre
0 to 9	0 to 24	1.0 1.2	0 29
10 to 39	25 to 99	1.2 3.2	30 319
40 to 69	100 to 174	3.2 8.6	320 1459
70 to 100	175 to 250	8.6 20.4	1460 plus

In connection with the forest survey of Lewis County, Washington a strip survey count was made of the seedlings on sets of 13.2 foot quadrats at 10 chain intervals across cut over land and burned areas. The tracts gridironed had previously been classified either ocularly or by quadrat examination, chain by chain, into the three classes well stocked, medium stocked, and poorly stocked, terms which are defined later, corresponding to the last three percentages of stocking in column 1 of the previous tabulation. On 1,200 quadrats every seedling was counted. The average number of seedlings per stocked quadrat is shown in the following table, column 3. Since some quadrats had an abnormal number of seedlings, the data were also computed to eliminate all over 15 trees per quadrat. This resulted in the number of trees per stocked quadrat shown in column 4 of this table:

Stocking class	Percent of quadrats stocked	Average total number of seedlings per stocked quadrat	Average number of seedlings per stocked quadrat excluding all over 15 per quadrat
Good	94.7	15.5	8.2
Medium	61.5	4.7	4.4
Poor	28.9	2.2	2.2

Technique of Applying the Stocked Quadrat Method

It is sometimes erroneously supposed that classifying land by the stocked quadrat concept implied gridironing the area and making a record for certain sized squares at stated intervals. On the contrary, stocked quadrat classification may be employed by any extensive or intensive method, depending upon the use of the data. Those experienced in this concept can rate, or actually type map, areas they can see by ocular estimate as to whether 10, 20, 40, 60, etc., percent stocked. For detailed type mapping a complete coverage by examining squares on mechanically spaced lines is desirable. To obtain an average rating and an estimate of the errors of sampling for a large area, the running of random strips within bands of uniform width upon which squares are checked at stated intervals, is the recommended technique. Whatever the procedure, ocular estimating or systematic line plot surveys, the stocked quadrat system is faster and more expressive of the desired end result than complete seedling counting.

A stripping method employed by the Forest Survey on hundreds of miles of line to get an estimate of the status of regeneration for large areas consisted in the following steps: One man working alone with merely a staff compass, tally register (for recording paces), a steel tape (for checking size of quadrat), and a notebook ran a course across tracts of logged off or burned over lands which could not be mapped ocularly according to their degree of restocking. At stated intervals (the distance might be 1, 2, 5, or any other chainage as dictated by statistical needs) the compass staff was set up regardless of the ground cover. This marked the common corner of four squares whose sides were each 13.2 feet and run parallel and transverse to the course. The examiner then looked at the square ahead and to his right. If he saw an established seedling he passed to the next square and so clockwise around the four. If a seedling was not apparent on a square he searched until he found one or the square had been thoroughly covered. Measuring to the boundaries of a quadrat was necessary occasionally. If all four quadrats had a seedling apiece he tallied "4", if only three had a seedling he tallied "3", etc.; or he might have tallied each quadrat separately as "1" or "0". When the tract had been gridironed the figures were quickly added up to give the percentage of all the quadrats that are stocked.

This grouping of quadrats by fours gives a better estimate of the average degree of stocking in the vicinity of each group than if one quadrat were observed at each interval along the line, but a greater total number of quadrats must be tallied in the group method than in the single quadrat method to obtain the same reliability in the estimate of the average stocking for the entire tract. The taking of four quadrats with a common corner was done merely as a means of getting many more quadrats in a day's work than would be possible when the squares were uniformly distributed along a line.

Circle plots may, of course, be used instead of squares, but that does not permit taking, at one stop, four with a common center, and the latter is a great saving in field work. For permanent plot work the square is far superior to the circle, for the boundary of a square is easier to determine than the periphery of a circle.

There is considerable confusion as to the adjectives to use in describing stocking, regardless of the method employed. What is satisfactory stocking? What is good stocking? What is nonstocked for practical purposes? After much analysis of stands and much discussion, the Pacific Northwest Forest Experiment Station adopted, and others have accepted, the following handy classes, as fairly expressing the status of regeneration for the bulk of land in the Douglas fir region that comes up for this kind of classification:

Good stocking	= 70 to 100	percent	of	squares	are	stocked
Medium "	= 40 to 69	"	"	"	"	"
Poor "	= 10 to 39	"	"	"	"	"
Nonstocked	= 0 to 9	"	"	"	"	"

This classification is, of course, purely arbitrary, though convenient for rough grouping. In precise work it is better to use the actual percentage of stocked quadrats. If the size of the quadrats were varied or a departure from the standard method of counting established seedlings were employed, this arbitrary classification would lose its significance.

If the area in question is to be broken down into types or compartments to show the variations in stocking in various parts of the tract, such as might be needed for a planting plan, the stocked quadrat tallies can be platted graphically on a base map or the tallies can be grouped for statistical expression to show the acreage in each category.

If groups of stocked quadrats on a strip survey line are being assembled to determine how much of the area falls in each of the four classes defined above, it is best to average together four consecutive sets of quadrats (not three) to have them fall most accurately from the point of view of mathematical soundness into the above arbitrary and unequal divisions.

If the reproduction consists of more than one species and it is desirable to have data on its composition, a tally by species may be made on each fifth or tenth quadrat. This will then give an indication of the percentage of species on the whole tract or compartment.

Forest Research Notes No. 33
Pac. N. W. For. Exp. Sta.
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SUSTAINED YIELD OF SWORDFERN

By

Leo A. Isaac

Swordferns harvested for floral decorations are the basis of a mil lion dollar minor forest product industry in western Oregon and Washington, and during the past year prices reached a new high 13 cents to the picker for a bunch of 52 fronds.

Fern picking provides a livelihood for many persons, especially in the Coast Range, and several firms make a business of buying the bundled ferns of the pickers, packing them in refrigerated storage depots and ship ping them widely over the country. The trade demands fronds without de fect or blemish, so the picker must be rather selective. Usually from a third to two thirds of the season's fronds are taken, sometimes in one trip over the area, sometimes in the course of two or more coverages. If the fronds are very long a green stub is left, for a merchantable frond when trimmed need be only 24 inches long, though usually about 30 inches is cut.

Since the plant (Polystichum munitum) is evergreen the fronds may be collected through almost the entire year. For a period in the summer the plant has the green fronds of two seasons. The previous season's fronds are picked up until about July when harvesting of the current season's fronds begins.

Time was when picking was free on private and public land alike, but in recent years picking rights are being sold, and on some national for ests fern "stumpage" is being sold like any other forest crop.

Because of overpicking, logging, fire, or a combination of causes, prime plants are becoming scarce in some localities where they once were abundant. In order to aid in guiding this new industry to a sustained yield basis, it was important to know the effect of season and intensity of pick on the size and vigor of the plant.

Accordingly, in 1938 a study was started at Cascade Head Experimental Forest in the Oregon coastal region by picking on five dates throughout the year and by four intensities, several hundred marked plants. Six years of records have now accumulated and been assembled in a report of which this is a digest. Records were kept of the number and length of fronds of plants treated with 25, 50, 75, and 100 percent picks and on un picked checks in July, September, October, December, and February, on two sets of replicated plots. These were supplemented by records of random picked plants such picking as takes place in unregulated commercial picking.

The records show that fern crops fluctuate from season to season, both in height growth and number of fronds, just as farm crops do. However, the records clearly show the effect of picking, particularly of heavy picking. The percent of increase or decrease in the number and length of fronds for the several degrees of picking from 1938 to 1943, averaged for the pick of all dates, is shown below:

	Percent of increase or decrease 1938 1943	
	No. fronds	Height
	Percent	Percent
Check plants	+24.0	17.1
25% pick	+ 1.9	18.1
50% "	18.1	22.8
75% "	41.3	38.8
100% "	71.2	70.0
Random pick	18.9	21.3

It will be noted that the seasonal average for even the 25 percent pick showed a slight decrease in both number of fronds and in plant height. But the effect of the intensity of picking is not the same for all picking dates as it is for the seasonal average. The records indicate no harmful effects from a 25 percent pick in the spring and summer but a sufficient depletion resulted from the fall and winter pick to reduce the seasonal average below the untreated check.

The 50 percent and heavier picks all showed a somewhat proportional reduction in both number of fronds and plant height at all seasons, but the greatest reduction followed the late fall and early winter picks.

The random pick at five different seasons of the year, that removed a total of 38 percent of the fronds, resulted in a plant deterioration slightly less than the average for 50 percent picks.

Normal fern fronds in this locality average about four feet in height. By the end of the 6-year period of picking the average height for different percents of removal was: 25 percent 40 inches, 50 percent 34 inches, 75 percent 30 inches, and 100 percent 15 inches.

The 75 and 100 percent picks have already reduced the average frond below merchantable size, and the 50 percent pick is approaching the limit. About a quarter of the plants on the 100 percent picked plots have died during the 6 year period and some plants have died on other picked plots, except the 25 percent.

The data gathered to date from this study, while still meager, show conclusively that an annual pick of more than 25 percent of the fronds will result in a gradual decline of the swordfern plant and that even a pick of that amount is harmful if it is all made in the fall or early winter. The swordfern industry is spreading and building up, but if it is to be maintained on a sustained yield basis it is evident that the annual harvest should not exceed 25 percent of the current year's fronds from any plant and that heavy picks must not be made in the early fall and winter.

Forest Research Notes No. 33
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January 24, 1945

SOME OBSERVATIONS ON SLASH BURNING WEST OF THE CASCADES

By

William G. Morris

The fall of 1944 provided an unusually liberal number of days when conditions were favorable for broadcast slash burning in the Douglas fir region. Detailed measurements and observations of the burning conditions, along with descriptions of the fire behavior, were made by the author on 11 days. These records are a useful supplement to those collected by the Experiment Station on accidental fires during many previous years. A brief summary of the recent observations for five cases may be of interest and value to slash burners. Too high a wind velocity proved to be the greatest unpredictable danger on these slash fires, a fact that has been pointed out by experienced slash burners and fire fighters many times in the past.

The records made on each fire included: (1) The age, kind, amount, uniformity of distribution, compactness, amount of breakage, and moisture content of the slash; (2) moisture conditions of the soil and duff; (3) slope, aspect, and shape of the slash area; (4) rainfall and general weather conditions for a period preceding the fire; (5) relative humidity, wind velocity, wind direction, and cloudiness at the time of the fire; (6) equipment used in lighting the fire, number of men used per acre, and order of progress in lighting the fire with reference to wind direction, topography, and surrounding cover types; (7) rate of spread and behavior of the fire; (8) degree of slash clean up, amount of duff destroyed, depth of charring and discoloration in the soil, scorching of seed trees, and burning of surrounding areas.

Case 1. One fire on flat ground after five inches of rainfall during the previous four weeks and with an afternoon relative humidity of 38 percent quickly spread beyond control in a fir slash of moderate density when a strong wind came up averaging 9 to 12 miles per hour during the afternoon and reaching 20 miles in gusts of a few seconds. The fire crossed a large area of slash and then about a mile of last year's burned slash. It stopped of its own accord after burning about two chains into green timber where the duff just beneath the surface was wet. Much of the spread of this fire was due to spotting ahead.

Case 2. A week later, after a light rain and more dry weather, a fire in the same vicinity and in similar fuel and topographic conditions spread slowly and caused no difficulty of control on two afternoons when the wind velocity was one to five miles per hour and the relative humidity was as low as 24 percent, but a brief period of stronger wind in the evening spread the fire and made control difficult. One rule of thumb that fits these cases would be: On flat ground a dry slash with moist duff underneath can be burned safely at rather low relative humidities as long as the smoke goes straight up or rises high before drifting away, but as soon as it flattens out near the ground, watch out for spot fires and other dangers of spread.

Case 3. A fir slash from high lead logging, which left a moderate amount of solid to badly split, large cull fir and small hemlock logs on a steep south slope, was burned in late September and in the Coast Range on an overcast, misty day after a week of clear weather that followed a 9-day period in which more than 2 1/2 inches of rain fell. The duff in the bordering green timber was somewhat moist but the mineral soil under it was dry. The fire was set in the late afternoon and rain began a few minutes after. A light wind was blowing up the slope. The fire was easily set and it spread at a moderate rate. One narrow, steep gully ran down the main slope. Here the piles of debris, the chimney effect of the gully, and added draft of the wind blowing into it developed such a concentration of heat at the top of the gully that the fire swept across a tractor constructed fire line and several chains through green timber before stopping at the ridge top. The damage could have been prevented if, when the fires were set, more consideration had been given to the chimney effect and greater heat that usually occurs at steep gullies. Setting fires more slowly from the top down would have prevented this.

Case 4. Three days earlier and a few miles away another fire on a similar slope with no gullies was burning in a fir slash from tractor logging. The day was clear and warm. The fire caused no difficulty of control and burned much less intensely than the above fire. Slash from tractor logging seems to burn with less heat and in damp weather does not burn as completely as that from high lead logging. The latter is usually broken up more completely and large quantities of split logs, chunks, pieces of bark, broken limbs, and stirred up rotten wood are bunched together in a better arrangement for a hot fire than the unbroken tops with limbs attached, which are left after tractor logging.

Case 5. A fog belt spruce hemlock slash from high lead logging of the previous year was observed during the burning on two days in late September. The previous four days had been clear and warm with heavy night dew, but in the nine days before that about 2 1/2 inches of rain had fallen. On the days of the fire the weather was clear and warm but the afternoon relative humidities fell only to 59 percent. The northwest wind averaged 4 1/2 to 7 miles per hour and the ground was level to moderately sloping west in aspect. The fire burned wherever set in concentrations of logs and other coarse fuels but showed no tendency to spread in the moss and thin litter between the concentrations. The fires burned sluggishly with short flames even in the log piles. The fuel on this slash area burned with less vigor than that described on the other areas for several reasons: Spruce and hemlock are not as resinous as Douglas fir; the slash was older; moss, swordfern, and other green plants had begun to cover the thin layer of fuel between the concentrations; the fog belt climate prevented the fuels from drying out as much as on the other areas.

Forest Research Notes No. 33
Pac. N. W. For. Exp. Sta.
January 24, 1945

SAMPLE SCALING BY TREES

By

Thornton T. Munger*

It has been suggested that in log selling transactions a saving of scaling labor could be made if only a fraction of the logs were scaled. Lexen, in articles in "The Timberman" and the "Journal of Forestry," presented the mathematical aspects of this subject and explained how to determine the variability of a batch of logs and thus the proportion of the logs that would have to be scaled to get within a certain degree of accuracy. To test this proposal on Pacific Coast logs, Briegleb made a study of five sets of scale books from national forest timber sales--four in the Douglas-fir region, one in eastern Oregon. The results are presented in "The Timberman" of February 1944.

Since there seemed to be some chance for practical application of sample scaling in large transactions of ponderosa pine, a further test was made of a set of 18 scale books involving 103,208 logs from central Oregon. The logs in this case were somewhat more variable than those from the eastern Oregon case. The results, however, indicated that by scaling only a fraction of the logs in a fair sized transaction the error would probably be within a rather small limit. For example: To be within a 2 percent limit of error, 33 percent of the logs must be scaled in a 10,000-log transaction, 20 percent in a 20,000 log transaction, and only 5 percent in a 100,000 log transaction.

In this particular central Oregon case there seemed to be a better chance of making a saving in scaler's time if the sampling could be by trees instead of by logs. This was practicable here because the scaling was done with calipers on the felled and bucked trees at the stump. A mathematical test was, therefore, applied to the volumes of the 28,518 trees covered by these same 18 scale books. It was possible to segregate the individual trees because the scalers had indicated with a pencil line in the log number column the dividing point between the trees. The trees varied in scaled volume from 30 to 5,580 board feet per tree. All were ponderosa pine.

The purpose of the statistical analysis of the volumes of this batch of trees was to determine their variability from which can be derived the proportion of the trees that would have to be scaled in transactions of various sizes to get within certain limits of error. This mathematical test indicated that the coefficient of variation of the volumes of these trees was 77.57, which is somewhat higher than the variation in the logs, and indicates that a larger proportion of trees will have to be scaled than of logs to attain the same degree of reliability.

The table below, compiled from an accepted formula, gives the size of sample necessary to attain various limits of error, when the variation in the volumes of the trees is expressed by the coefficient of variation

* Acknowledgment is made to W. G. Morris and to Inga Fulkerson for their parts on the mathematical work on this project.

of 80. This is a little more than the factor found in this study, 77.57, and would thus tend to conservatism. The limit of error, as used in the table, is the amount by which the volume based on a sample is likely to differ from the actual volume of the entire batch of trees only one time out of about 20.

Size of Sample Required for Trees that Vary in About the Same Degree as the Batch Studied in Central Oregon

(For coefficient of variation of 80)

Limit of error	Number of trees in transaction								
	1,000	2,500	5,000	10,000	20,000	50,000	100,000	200,000	500,000
Pct. of actual vol.	Percent of the total number of trees which must be scaled								
.5					84	67	51	34	17
1.0			84	72	56	34	20	11	5
1.5		82	70	53	36	19	11	5	2
2.0	86	72	56	39	24	11	6	3	1
2.5	80	62	46	29	18	8	4		
3.0	74	53	37	22	13	6	3		
3.5	68	46	29	17	10	5	2		
4.0	62	39	24	14	7	3	2		
4.5	56	34	20	12	5				
5.0	51	29	17	10	4				

From this table the proportion of the trees that must be sampled to attain a certain degree of accuracy may be read off. For example, in a timber sale transaction involving 100,000 trees, 51 percent of them would have to be scaled to arrive at a half percent limit of error, but only 6 percent to get a 2 percent limit of error. In a transaction involving 10,000 trees, 39 percent of them would have to be scaled to attain a limit of error of 2 percent.

In the application of sample scaling the buyer and seller must first agree on the limit of error that will be acceptable for the transaction in question. The proportion of the total number of trees which should be sampled is then read from the table. The selection of the sample is most important. No conscious or unconscious personal bias can enter in. All trees must be counted and marked in some way to avoid duplication or omission. The sample that is to be scaled must be selected by some mechanical or random method, such as the black and white marble method.

If there is more than one species or class of product in the transaction, a separate sampling scheme will have to be used for each, or the minor products may be fully scaled in the usual fashion.

In estimating the volumes of a large number of standing trees, such, for example, as are being marked for cutting in a sale or land exchange transaction, the same system and the same proportion of sampling may be applied as above prescribed for scaling, provided the timber has about the same coefficient of variation.

Forest Research Notes No. 33
Pac. N. W. For. Exp. Sta.
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PONDEROSA PINE REPRODUCTION TAKING OVER AREA FROM WHICH LODGEPOLE REMOVED

By

William G. Morris

Extensive areas of pumice soil on the flats of central Oregon are covered with stands of lodgepole pine with here and there a large, old ponderosa pine and with numerous ponderosa pine seedlings scattered throughout the lodgepole stand. The lodgepole is practically worthless on the present-day market except for fuel wood and is used for that only when ponderosa pine is unavailable at a reasonable price. Furthermore, lodgepole in this part of its range does not attain a large enough size to make it desirable, as compared to ponderosa pine, before it becomes decadent. It sometimes grows faster in the early years but probably grows slower after reaching a diameter of 12 inches d.b.h. or less. It appears desirable in central Oregon if silviculturally and economically practical to convert lodgepole areas to ponderosa pine.

To investigate the silvicultural problems of such conversion on a typical area of lodgepole with a suppressed ponderosa pine understory on the Pringle Falls Experimental Forest, an area of one acre was completely cleared of the lodgepole overstory and reproduction and the ponderosa pine reproduction was carefully left unmolested.

Following are data that describe the stand before the lodgepole was cut:

Size of trees	Number of trees	
	Lodgepole pine	Ponderosa pine
Under 1.5 ft. ht.	120	509
1.6 - 4.5 "	321	1,577
1 in. d.b.h.	468	368
2 " "	37	9
3 - 16 " "	316	1
Over 16 " "	0	0
Total	1,262	2,464

Total cubic volume: Lodgepole 2,100 cubic feet or about 25 cords; ponderosa 5 cubic feet. Age of the lodgepole averaged 70 years and that of some of the ponderosa was probably nearly as great.

Another 1-acre plot was established in the adjacent undisturbed lodgepole stand as a check to determine the relative growth of the ponderosa pine understory when released and when not released from the overstory. The growth of the terminals on the treated plot did not increase appreciably until about eight years after the lodgepole was removed. Measurements of the length of the ponderosa pine leader growth for 1943 on the two plots showed an average growth of 0.2 feet on the released plot but only 1/5 as much on the unreleased plot. The five fastest growing trees on the released plot grew 0.5 to 0.6 feet, but the five fastest growing trees on the unreleased plot grew only 0.2 feet. The difference in current leader growth on the two plots is especially striking in the larger individuals five to eight feet in height.

It would appear from this single experiment that ponderosa pine seedlings and small saplings, even after decades of suppression under lodgepole, will respond to release, though the response is slow in coming. The improvement of these well-nigh worthless stands of low grade lodgepole pine and suppressed ponderosa pines is possible by stand improvement measures, but the costs will be high and the economic justification questionable at this time.

Forest Research Notes No. 33
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January 24, 1945

RESULTS OF PRUNING TO DIFFERENT HEIGHTS IN YOUNG DOUGLAS-FIR

By

Leo A. Isaac

The age at which and extent to which it is advisable to prune young Douglas-fir are as yet unsolved forest problems, but some specific information is now provided for one age class by a study started in 1937 on the Wind River Experimental Forest in southern Washington.

The pruning was done on a site III, 28-year-old stand of pure Douglas-fir that followed logging and slash burning. Two hundred crop trees, i.e., dominant and codominant, healthy trees, were selected. They had in 1937 an average diameter of 5.5 inches and an average total height of 40.6 feet. One of four treatments was assigned to each crop tree by random lottery, as follows:

(1) Pruning dead limbs at bottom of crown.
(2) Pruning lower 1/4 of live crown.
(3) Pruning lower 1/2 of live crown.
(4) Pruning lower 3/4 of live crown.

The branches were cut off flush with the bole with pruning saws in the late fall of 1937, the workmen using ladders.

In December 1943 measurements were again made of the height and diameter and observation made of any sunscald injury or epicormic branch development. The results for the several treatments for the 6-year period are shown in the following table:

Extent of pruning	Six-year period - 1937 to 1943: Average growth			
	D.B.H.	Height	New branches developed	Sunscald injury
	Inches	Feet	% of trees	% of trees
Dead limbs only	1.1	9.2	0	0
1/4 of live crown	1.2	9.4	2	2
1/2 of " "	1.0	7.9	0	12
3/4 " " "	.5	5.3	15	35

Naturally the pruning of dead limbs had no effect on growth; therefore, this group was used as the basis for comparison with the other three treatments.

The trees from which the lower quarter of the live crown was removed showed slight increase in both diameter and height growth, but it was not great enough to be significant.

When half of the crown was removed the trees showed a significant decrease in both diameter and height growth, and 12 percent of the trees showed a sunscald injury to the bole.

When three-fourths of the live crown was removed, diameter growth was more than cut in half and the reduction in height growth was nearly as great. In addition, 15 percent of the trees were developing "water sprouts" or epicormic branches. Thirty-five percent of the boles had sunscald injury. Both epicormic branches and sunscald seriously reduce the quality of lumber produced, and the latter sometimes results in the entrance of decay.

An examination of 18 trees on an adjoining plot five years after pruning, by Dr. Bedwell and Dr. Wright of the Office of Forest Pathology, showed no entrance of decay where pruned limbs had healed over.

The live limbs on the lower quarter of the bole are usually suppressed and are in the process of dying and so are not contributing largely to nourishing the tree. It is evident from the table that their removal does no harm and may actually benefit the tree.

The heavy pruning--50 and 75 percent--appears to be harmful; whether or not any pruning heavier than 25 percent should be practiced depends on whether or not retarded growth continues to be manifest in future years.

Measurements of pruning height showed that when the lower quarter of the live limbs was removed in a stand of this nature it gave an average pruned height of 19½ feet. This would provide an average clear butt log of at least 18 feet with an occasional one of 24 feet. Pruning to this height can be accomplished from the ground with a handsaw and 7-foot and 14-foot pole saws.

A time study by Theodore Kachin, made in a similar stand in the immediate vicinity, showed the hourly output per man to be eight trees, exclusive of overhead and supervision, or 64 trees per day. At a rate of 75¢ per hour, the actual labor cost would be $9.38 to prune 100 crop trees per acre.

The study thus reveals that pruning to at least one-quarter of the live limbs can be done in a stand of this character without loss of growth, and preliminary examinations show as yet no entrance of decay. Such pruning will result in at least one 18-foot clear butt log on the crop trees at a cost that is not prohibitive.