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NOTE: Contrary to the usual practice of devoting each issue of Forest Research Notes to several short articles on current projects, this issue is devoted entirely to a single topic--the growth of selectively cut stands of western yellow pine. This article by Dr. Meyer releases in preliminary form some of the very significant results of the three years' field study of the growth and yield of this important forest type. As the great mass of tree and plot measurements are further computed, the final results will be published in more formal and complete form.

T.T.M., Director.

PRELIMINARY ALINEMENT CHARTS FOR DETERMINING GROWTH IN SELECTIVELY CUT STANDS OF WESTERN YELLOW PINE

Introduction

An investigation of the growth and yield of western yellow pine has been under way at the Pacific Northwest Forest Experiment Station for the past three years. Some of the results of the study are now available and are presented herewith. The attached alinement charts showing the growth of selectively cut forests are based upon the detailed measurements of 179 plots, involving increment measurements of over 5600 trees in stands which were partially cut 10 to 62 years ago.

This study is concerned primarily with the growth that normally takes place in stands which have been cut heavily by the tree selection method, because this method is in general use in the western yellow pine type on the national forests and the Indian reservations, is coming rapidly into more general use on private lands, and is the silvicultural method preeminently applicable to this type.

It is desirable to be able to predict the probable yield for 10-60 years in the future of stands with various amounts of reserve, and of various structures (a composition of thrift, age, and dominance classes) on each site quality of land. The accompanying charts now make this possible for Sites III, IV and V. They are used instead of tables, which might be prepared, but which would necessarily be very bulky and less convenient than charts.

There is one chart for growth in total basal area, one for growth in cubic foot volume, and one for merchantable board foot volume.

In order to apply these charts to any particular selectively cut forest, it is necessary to make a survey of the area and ascertain

- (a) Its site quality
- (b) The volume per acre of the reserve stand (or basal area)
- (c) The percentage of trees in the vigorous growing classes, such as the dominant "bull pine" and thrifty, mature trees.
- (d) The probable rate of mortality, whether normal or otherwise.

With this information on hand and using the technic described below, the probable rate of growth and the final yield can be predicted for any cutting cycle up to 60 years.

Factors affecting the growth of selection stands

1. Site - In the North Pacific region, site quality in western yellow pine forests is determined by the average height of the mature dominant trees. The system provides for five quality classes, of which Site Class IV is the most common in eastern Oregon and Washington, Site Classes V and III less common, and Sites II and I rare. A graph showing the form for classifying sites by total height of trees is contained in Forest Research Notes, No. 4, of June 27, 1930. In the growth charts presented herewith, provision is made for Sites III, IV, and V.

2. Years after cutting - The longer the cutting cycle is, up to certain limits, the larger is the final cut. Rate of growth declines somewhat with the passage of time.

3. Reserve volume - The volume growth and the final yield attained are naturally dependent upon the volume left after cutting. The larger the volume up to certain limits, the larger the increment and the larger the cut at the end of the first cycle.

4. Structure of the reserve stand by tree classes - By structure of the stand is meant the presence of certain age and dominance classes. Dunning's tree class system is recognized as the basis for this classification. An abnormal or subnormal proportion by volume of dominant immature and thrifty mature trees (Classes 1 and 3, respectively) affects the rate of growth and makes the yield of certain stands deviate from the predicted yield of stands of average structure.

5. Mortality - Mortality acts directly in reducing the final yields by removing actual volume and indirectly by removing the basis of potential increment.

Means by which the growth charts take these factors into account

Site - Each of the three site classes found commonly in this region is represented by a separate "years after cutting" scale on the alinement charts. The scale for Site V will give lower yields than that for Site IV, and Site IV lower than Site III.

Years after cutting is indicated on each of the site scales on the left-hand side of the chart. Any age from 10 to 60 years can be used.

Reserve volume is indicated by the central scale. The curve in the scale is necessitated by the change in growth rate with increasing size of the reserve volume.

Final yield is read on the right-hand scale.

Structure of the stand - An adjustment for the proportion of thrifty trees is introduced after an estimate of the gross yield is made from the charts as they stand according to the following rules:

Percentage of tree classes 1 and 3		Reduce or increase gross yield at the following rates valid for a 60-year cycle.
Range	Actual Average	
0-24	12.0	-25%
25-49	36.8	-13%
50-74	62.2	+ 2%
75+	84.0	+15%

Mortality - Like structure, an adjustment for mortality must also be introduced in order to arrive at the net yield. There is always some mortality; in some parts of the region it is greater than in others. Hence the rate which is applicable to a certain set of conditions is largely a local problem. In extreme cases, it is conceivable that no

net growth takes place for a decade or two after cutting. On the average a reduction of 15% of the computed gross annual increment is recommended. Smaller rates can hardly be expected, while higher rates will be common.

Limits of utilization

Board foot alinement chart - Includes all trees in, above, or entering the 11.6 - 12.5 inch diameter class any time during the assumed cutting cycle.

Volume table used reads for total height of the tree, D.B.H. (outside bark), Scribner volume to an 8-inch top and a $1\frac{1}{2}$ -foot stump.

Cubic foot alinement chart - Includes all trees in, above, or entering the 6.6-7.5 inch diameter class during the assumed cycle. This leaves out the advance and subsequent reproduction which will not affect the merchantable yields of the first cutting cycle, but which will form the foundation for later cuts.

Volume table used reads in terms of total height, D.B.H. (outside bark), total cubic foot volume inside bark, no stump allowance.

Basal area alinement chart - Includes all trees considered in the cubic foot alinement chart.

Reading the growth charts

Knowing the length of the cutting cycle, the size of the reserve stand per acre, and the site quality of the land, take the chart for the unit of measure desired, either basal area, cubic foot volume, or board foot volume: locate the proper site-age scale and select the length of the cutting cycle; on the central scale for reserve volume select the actual volume; with a straight edge span these two points, and project the line until it intersects the scale for final yield, where the value will be read.

The final gross yields can be predicted rapidly for any set of reserve stand conditions and for any number of years after cutting. Interpolations are unnecessary since the scales can be read for any values whatsoever.

The net yield is obtained by making in successive order the adjustments for structure and for mortality as explained above.

Example to illustrate use of charts in making growth prediction

Example 1 - Upon examination a certain tract of selectively cut western yellow pine forest is found to be Site Quality IV, with an average cubic-foot volume per acre of 425 feet composed 25-49 per cent of tree classes 1 and 3. The cutting cycle is assumed to be 60 years. Mortality risk is normal.

Using the chart,

Gross yield at 60 years:	1050 cu.ft.
Reduction of 13% for structure:	<u>-137</u>
Gross yield taking structure into account:	913 cu.ft.
Less original reserve:	<u>-425</u>
Gross total increment:	488 cu.ft.
Reduction of 15% for mortality:	<u>- 73</u>
Net total increment:	415 cu.ft.
Net annual increment:	$\frac{415}{60} = 6.92 \text{ cu.ft.}$

Example 2 - Upon examination another tract is found to be Site Quality V, with an average board-foot volume per acre of 2,600 feet Scribner rule, composed 75% of tree classes 1 and 3. The cutting cycle is 40 years. Mortality slightly higher than normal or 20% of the gross increment.

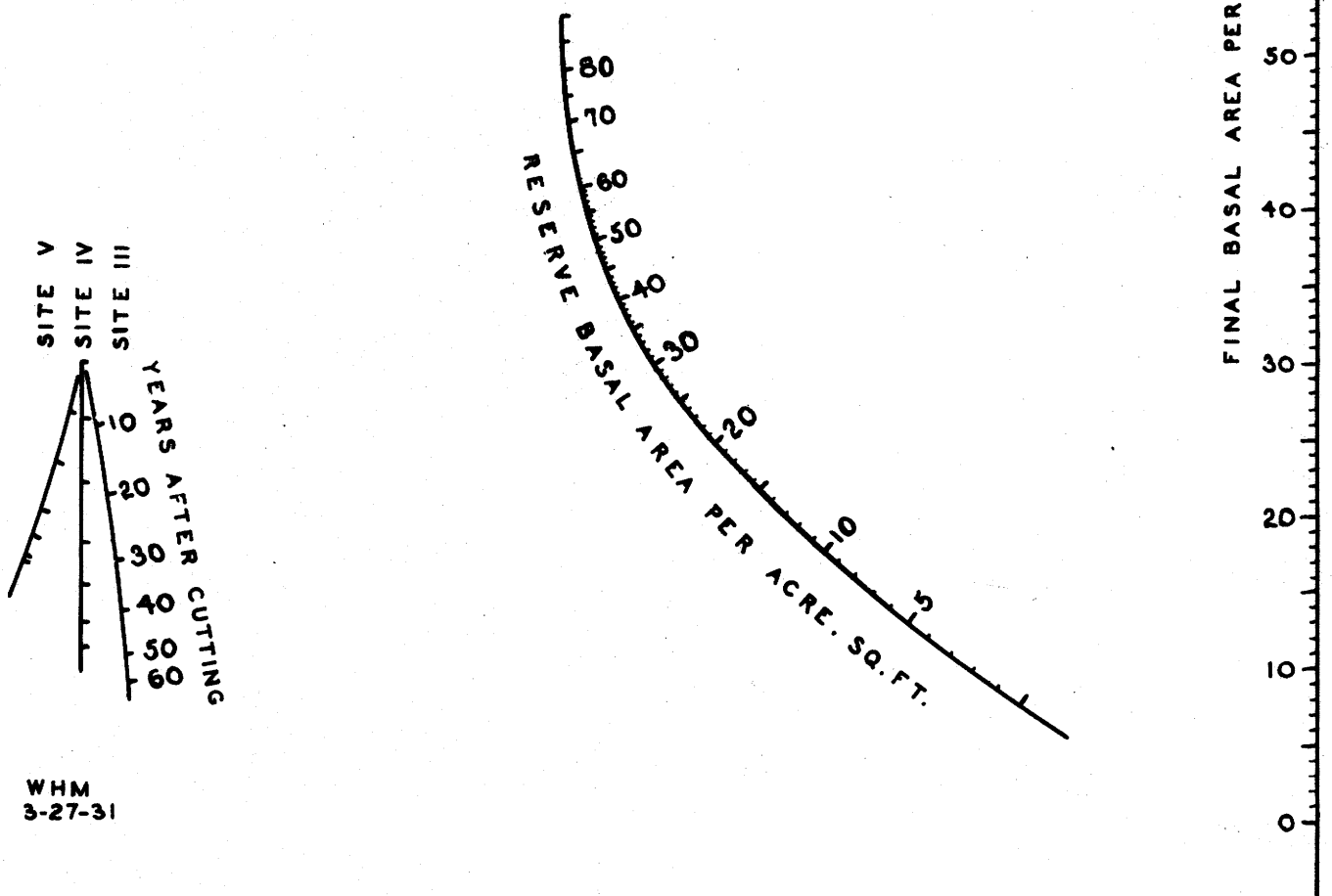
Gross yield per acre at 40 years:	4350 bd.ft.
Increase of $\frac{15\%}{60} \times 40 = 10\%$ for structure:	+435
(Since cutting cycle is shorter than 60 years)	
Gross yield adjusted:	4785 bd.ft.
Less original reserve:	<u>-2600</u>
Gross total increment:	2185 bd.ft.
Reduction at 20% for mortality:	<u>-437</u>
Net total increment:	1748 bd.ft.
Net annual increment:	$\frac{1748}{40} = 43.7 \text{ bd.ft.}$

Walter H. Meyer

R-NW
ME-101

PACIFIC NORTHWEST FOREST EXPERIMENT STATION

BASAL AREA GROWTH
IN
SELECTIVELY CUT STANDS
OF
WESTERN YELLOW PINE

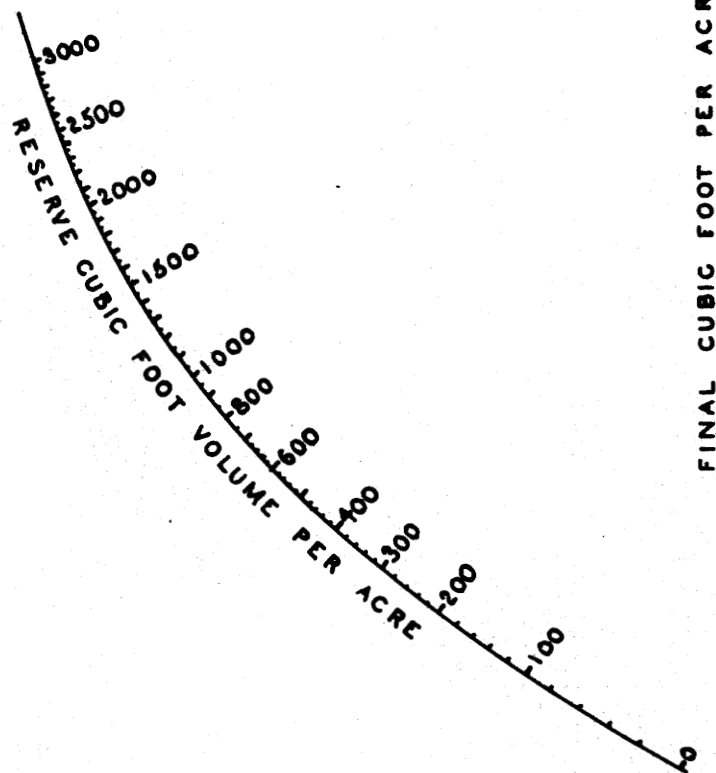
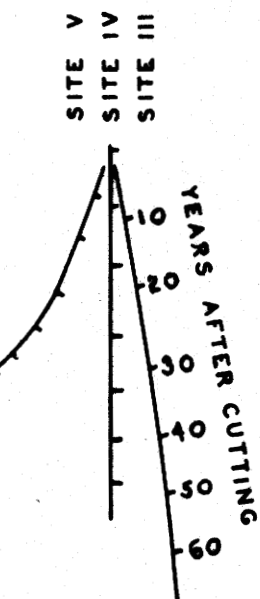


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PACIFIC NORTHWEST FOREST EXPERIMENT STATION

CUBIC FOOT VOLUME GROWTH
IN
SELECTIVELY CUT STANDS OF
WESTERN YELLOW PINE

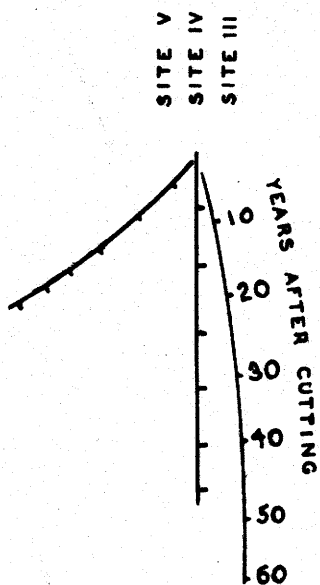


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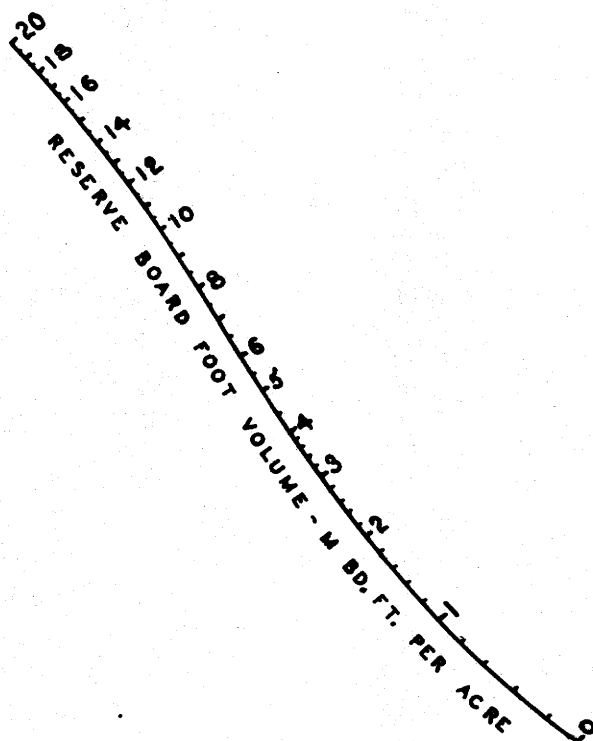
PACIFIC NORTHWEST FOREST EXPERIMENT STATION

BOARD FOOT VOLUME GROWTH
IN
SELECTIVELY CUT STANDS
OF
WESTERN YELLOW PINE

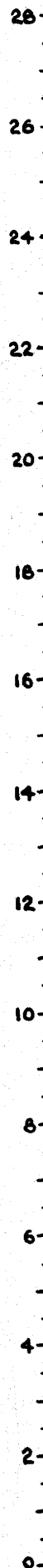
SCRIBNER RULE



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FINAL BOARD FOOT VOLUME - M BD. FT. PER ACRE



Status of the Inventory Phase of the Forest Survey of the Douglas Fir Region - Practically all available private and other cruise records have been transcribed, except for about one month's work copying O and C cruises. Good progress is being made in all phases of the field work. On the national forests field work is over 50 per cent complete; two forests, the Siskiyou and Rainier, are completed and work is in progress on the other ten west side forests with twenty-one men on this work this summer.

Six men, one to a county, are type mapping and eight men are adjustment cruising on the lands outside the national forests. The following table shows the status of this work:

Status of Field Work on Forest Survey Timber Inventory
On Other than National Forests

Oregon					Washington				
: Adjustment :					: Adjustment :				
: Type mapping: Cruising :					: Type mapping: Cruising :				
County	:Comp.:	In prog:	:Comp.:	In prog:	County	:Comp.:	In prog:	:Comp.:	In prog:
Benton	x	-	-	-	:Cowlitz	x	-	x	-
Clatsop	x	-	x	-	:Grays				
Columbia	x	-	x	-	: Harbor	-	x	-	x
Coos	-	x	x	-	:Lewis	x	-	x	-
Lincoln		x	-	-	:Pacific	-	x	x	-
Linn	x	-	x	-	:Wahkiakum	-	x	x	-
Marion	x	-	-	-	:Whatcom	-	x	-	-
Multnomah	x	-	-	-	:				
Polk	x	-	-	-	:				
Tillamook	x	-	-	x	:				
Yamhill	x	-	x	-	:				
x - indicates status					Comp. = completed				
					In prog. = In progress				