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PRELIMINARY GUIDES FOR THE MANAGEMENT OF LODGEPOLE PINE IN OREGON AND WASHINGTON

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There are some 2 million acres of lodgepole pine in eastern Oregon and Washington. Much of it was formerly classified as noncommercial; the trees were small, many were limby, and there was very little market for the low-value products. But the type has lately gained in commercial importance, and results of such little forest research as has been devoted to lodgepole pine stands in this region suggest that their value and growing capacity have not been fully appreciated. Increased demands for poles and sawlogs and the current prospects of a pulpwood market are now encouraging timber owners to make plans for the orderly management of lodgepole pine forests. They find that information on growth and management and even on existing volumes of lodgepole pine is scarce.

Research in this region has included study of the ecology of the type, a little work on volume tables, a few test thinnings in young stands on the Wallowa and Whitman National Forests and on the Pringle Falls Experimental Forest, and a limited survey, made by the Experiment Station in 1947, of partial cuttings. The purpose of this note is to summarize results of these studies and to outline management practices that appear advisable. Some information from the Rocky Mountain region that seems to apply generally to lodgepole is drawn upon.

Thinning

Immature stands of lodgepole pine respond very favorably to moderate thinning. In the 55-year-old stand at Pringle Falls (table 1) diameter increment in thinned plots is from $1\frac{1}{2}$ to $2\frac{1}{2}$ times as great as in unthinned. The most rapid growth has been made by the trees of medium size, those from about 7 to 10 inches in d.b.h. Net volume growth, even in the first few years following thinning, when growing stock has been severely reduced, surpasses that of unthinned stands. And what is most important, this net volume is being added mostly on trees that will live through to merchantable size and will become merchantable much sooner than those of unthinned stands. On the Pringle Falls plots, for example, there were at time of cutting in 1934, 68 trees per acre 8 inches d.b.h. and larger on the unthinned, and 70 on the plot thinned to 12 x 12 feet. By 1946 these numbers had increased to 98 and 132, respectively. Mortality from bark beetles and other causes was fairly heavy, causing a loss equal to 38 and 31 percent, respectively, of the gross growth on the two thinned plots and 63 percent on the check plot.

Comparatively light thinning (to about a 6 x 6 foot spacing) in the 35-year-old Wallowa stands increased the diameter growth rate to a lesser degree. However, mortality was negligible, and the net volume growth rate of from 63 to 147 cubic feet per acre per year is even better than with the heavier thinnings at Pringle Falls. The Wallowa stands appear to need another thinning at this time; they are still too crowded for satisfactory growth of crop trees. Studies in the Rocky Mountain region confirm that there is little response to a single light thinning such as these on the Wallowa; heavier or repeated thinnings are required to bring such stands quickly to merchantable pole and sawlog size.

Although benefits from proper thinning in such immature stands are well proved, there are few places with a market for the material cut. As markets for small poles and pulpwood open up and forestry becomes more intensive, thinnings of some sort will be made in many young lodgepole pine stands. These are more likely to be "thinnings from above," in which the trees cut are chiefly the larger ones of the stand, than the complete thinnings applied on the sample plots, in which principally the smaller trees were removed.

Harvest Cuttings1/

A study of harvest cuttings in mature or mixed-age stands from which mostly the larger trees were removed for logs, poles, or ties, also showed that acceleration of growth occurred in the residual trees.

1/ The data in this section are condensed from an office report, "A preliminary study of results of partial cutting in lodgepole pine stands of central Oregon," by Walter G. Dahms. Pacific Northwest Forest & Range Experiment Station. October 1948.

Table 1.--Descriptive data and increment after thinning for lodgepole pine study plots

Location	Plot	Year thinned	Average spacing	Volume thinned per A.	Age when thinned	No. yrs. growth measured	Stand after thinning per acre: No. trees 1/	Stand after thinning per acre: Volume	Increment from year of thinning to last remeasurement: Gross annual increment per A.	Annual mortality per A.	Net annual increment per A.	Net growth pct. 2/	Average annual diameter increment per tree
			Ft.	Cu. ft.				Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Pct.	In.
Pringle Falls	11	1934	16 x 16	1,218	55	12	164	1,228	77	29	48	4.0	.176
	12	"	12 x 12	943	55	12	298	2,238	98	30	68	3.0	.119
	13	--	Check	0	55	12	630	2,648	90	57	33	1.2	.066
Wallowa	1	1928	6½ x 6½	?	35	15	976	1,315	149	2	147	11.2	.062
	2	--	Check	0	35	12	1,332	?	(Only portion of stand measured)				.050
	3	1928	6 x 6	?	35	11	688	452	73	0	73	16.2	.069
	4	"	6 x 6	?	35	11	480	429	63	0.1	63	14.7	.076
	5	--	Check	0	35	10	?	?	(Only portion of stand measured)				.067
Whitman	X	1933	9 x 9	?	40	5	?	?	(Only sample trees measured: thinned area)				.073
	XX								(Only sample trees measured: unthinned area)				.046

1/ Number of trees 2.6 inches d.b.h. and larger; this limit includes all trees on the Pringle Falls thinned plots, but not on the Wallowa plots.
2/ Based on volume just after thinning.

Character of Virgin and Cut-over Stands

Lodgepole pine stands are usually thought of as being even-aged. Many of them, especially the younger stands that have come in after fires, are strictly so; but in the Deschutes Basin, and probably elsewhere, most of the present "virgin" stands are uneven-aged with trees ranging from young saplings to those 150 or more years old. Even where the range in age is not so great the spread in tree size is often so wide that the forest should be cut and handled, at least for the initial period of management, as if it were uneven-aged. Commercial cuttings for ties, saw-logs, and power poles have left a variable and patchy stand of small trees, often with some larger, knotty, crooked, or defective trees. A typical cutting for cross ties, for example, removed 52 percent of the board-foot volume (in trees 12 inches d.b.h. and larger) or 27 percent of the cubic-foot volume (in trees 4 inches and larger), but left an average of 400 trees per acre from 1 inch to 23 inches d.b.h.

Just what sort of reserve stands are left in such selection cuttings? What are their growth possibilities? What can we learn from them to help guide future cutting practice? To answer such questions, four areas in central Oregon, cut from 1 to 11 years previously, were covered by line-plot surveys in 1947. Growth was determined from increment borings; mortality estimated by a tally of dead trees.

Site quality of the study areas is medium, as are most of the commercial lodgepole stands of the vicinity. Height of the typical dominant and codominant stand averages about 60 to 70 feet at 80 years of age.[2] The data and conclusions given here do not apply to the lodgepole pine of higher elevations where the trees are generally so very short, crooked, and limby that their highest use is for watershed cover. The study was limited to pure or nearly pure stands of lodgepole. Mixtures with ponderosa pine and other species are common in transition zones, but they are special problems in themselves, in which the management of the other species is usually of dominant interest.

Merchantable volume of the stands before cutting on the four study areas was relatively light (table 2), but the figures for number of trees and total cubic volume indicate fairly good stocking. Even the reserve stands after cutting have a substantial growing stock--equivalent to 35 to 48 percent of the "normal" for fully stocked stands at 80 years, as given in the yield tables published by the British Columbia Forest Service.[2] (A strict comparison is not possible because of the uneven age of these stands.)

In general the ground was found to be well occupied by trees: 92 percent of all of the 4-mil-acre quadrats examined were stocked with seedlings or larger trees in 1947. New reproduction was starting in nearly all openings.

2/ British Columbia Forest Service. Volume, yield, and stand tables for some of the principal timber species of British Columbia. 53 p. Victoria, B. C. 1936.

Table 2.--Original stand and reserve stand in 1947 on four lodgepole pine cutting areas in central Oregon

(Per acre basis)

Name of area	Original stand			Cut trees		Reserve stand 1947			
	No. trees 4" & up	Volume 1/				No. of trees		Volume 1/	
		Cu. ft.	Bd. ft.	No.	Volume 1/	4" + d.b.h.	8" + d.b.h.	Cu. ft.	Bd. ft.
					Bd. ft.				
Pringle Falls	223	2,887	6,126	19	3,170	198	78	2,224	3,259
Chemult	319	3,509	7,775	25	3,725	280	75	2,600	4,133
Walker Mt.	140	2,624	6,806	17	2,980	110	66	1,855	4,058
Big Springs	331	2,935	4,036	63	2,932	261	78	2,028	1,654

1/ Cubic-foot volume in trees 4 inches d.b.h. and larger; board-foot (Scribner) volume in trees 12 inches d.b.h. and larger.

The cuttings did little or nothing to improve the health and quality of the stands. Mistletoe and canker are common in trees of all sizes, causing deformities, slow growth, and occasionally death. Very limby or crooked trees were left. The reserve volume (in trees 4 inches d.b.h. and larger), according to present or potential product or quality, was: Pole trees, 33 percent; sawlog trees, 43 percent; rough trees, 17 percent; and cull trees, 7 percent. The "rough" trees are of doubtful merchantability. The stands would now yield per acre from 2 to 6 power poles of class 5 or better, 35 feet or more in length, plus 1,043 to 2,177 board feet of fair sawlog trees. The study areas are in stands of at least fair quality and density. In many other spots in this territory the "virgin" stands are so open grown that nearly all trees are stubby, limby, and forked, and they seem to hold little promise for management. Whether in any given case this condition results from the particular history of these spots and could thus be corrected, or is due to inherent unfavorable site factors, remains to be determined.

Increment and Mortality

The stands left after cutting are growing at a gross rate of from 27 to 53 cubic feet per acre per year. This rate approaches and in two cases exceeds that for the entire stand before cutting (table 3). The annual gross growth rate of 62 to 101 board feet compares fairly favorably with that for selectively cut mature ponderosa pine stands in the region. If board-foot volume is computed to include trees 10 and 11 inches d.b.h., the growth rate is from 90 to 134 board feet per year. It should be realized, however, that a large part (62 to 67 percent) of this board-foot increment consists of ingrowth--trees just growing to sawlog size.

Table 3.--Periodic annual gross increment, mortality, and net increment per acre on 4 lodgepole pine cutting areas

Name of area	In period since logging: Length of period	Gross increment		Mor- tality	Net incre- ment	In 5-year period prior to logging: Gross incr.	Mor- tality	Net incr.
	Yrs.	Cu.ft.		Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.
Pringle Falls	7	32		14	18	26	14	12
Chemult	1	46		14	32	59	14	45
Walker Mt.	6	27		31	- 4	21	31	-10
Big Springs	11	53		9	44	71	1/	1/
		Bd.ft. 2/	Bd.ft. 3/	Bd. ft. 3/	Bd. ft. 3/			
Pringle Falls	7	74	117	34	83			
Chemult	1	101	90	42	48			
Walker Mt.	6	100	108	82	26			
Big Springs	11	62	134	20	114			

1/ Not determined.
2/ Trees 12 inches d.b.h. and larger.
3/ Trees 10 inches d.b.h. and larger.

Mortality has been rather heavy. Where there are many old trees (over 120 years) in the stand the losses may exceed growth, as in the Walker Mountain area. Bark beetles are often the final agency in causing mortality, but cankers, heart rot, possibly drought, and other causes are frequently primary or contributing causes of loss. Some windbreak, usually of trees with heart rot, has occurred, but it has not been extensive. In general, the deaths do not seem to have resulted from partial cutting as similar losses are occurring in uncut stands. Stands of lodgepole pine over 120 years old have suffered very destructive epidemics of the mountain pine beetle in parts of the Rocky Mountains and the Northwest. These beetles continue to be a serious and unpredictable threat to lodgepole. Partial cutting on a stand-improvement basis should, however, reduce the susceptibility to such attacks. ?

The gross rates of growth in terms of board feet may be compared with "predicted" rates according to the scheme presented by E. M. Hornibrook[3] of the Rocky Mountain Forest and Range Experiment Station. This scheme gives estimated gross yields based on the volume of reserve stand and years after cutting. Predicted growth (trees 10 inches d.b.h. and larger) for the four cutting areas averages 16 percent higher than the measured; on three of the areas the estimated rate is higher, on one area lower. Such deviations are not surprising, especially since the scheme is not expected to give very accurate estimates for the first few years after cutting, when growth response is notably variable and

3/ Hornibrook, E. M. A preliminary yield table for selectively cut lodgepole pine stands. Jour. Forestry 38(8): 641-643. August 1940.

mortality high. Thus, the Rocky Mountain system, which is based on more extensive study of a wide range of cuttings, appears to furnish a fair rough estimate of gross growth for partially cut stands in Washington and Oregon. Reliable mortality estimates are difficult to make; data are inadequate in both regions. A set of permanent plots in the Rocky Mountain region showed an average mortality of 31 board feet per acre per year; data for the present study indicated an average of about 40 board feet. This should be much reduced under more intensive management.

Crown Vigor the Key to Growth Rate

A scheme of classifying lodgepole pine trees by crown vigor has been described by R. F. Taylor.4/ (See figure 1.) The classification takes account of the length, volume, shape, and density of the crown, and color and length of needles. In the present study, trees were classified in Taylor's four vigor classes (A, B, C, and D, from best to poorest). Except in the Chemult area, where the sample was small, there were large and significant differences between the growth rates for the four classes (table 4). The average rates are about in the proportion of 100, 90, 53, and 24. In terms of board-foot volume growth of a 12-inch tree, for example, this means a range in current growth percent from 3.0 percent for class A to 0.8 percent for class D. Unfortunately, the proportion of class A and B trees is low in most present stands, averaging only 21 percent on the three study areas (table 4), but it would increase under management if stand improvement selective cutting were followed.

Table 4.--Growth of lodgepole pine trees by Taylor crown vigor classes, after logging

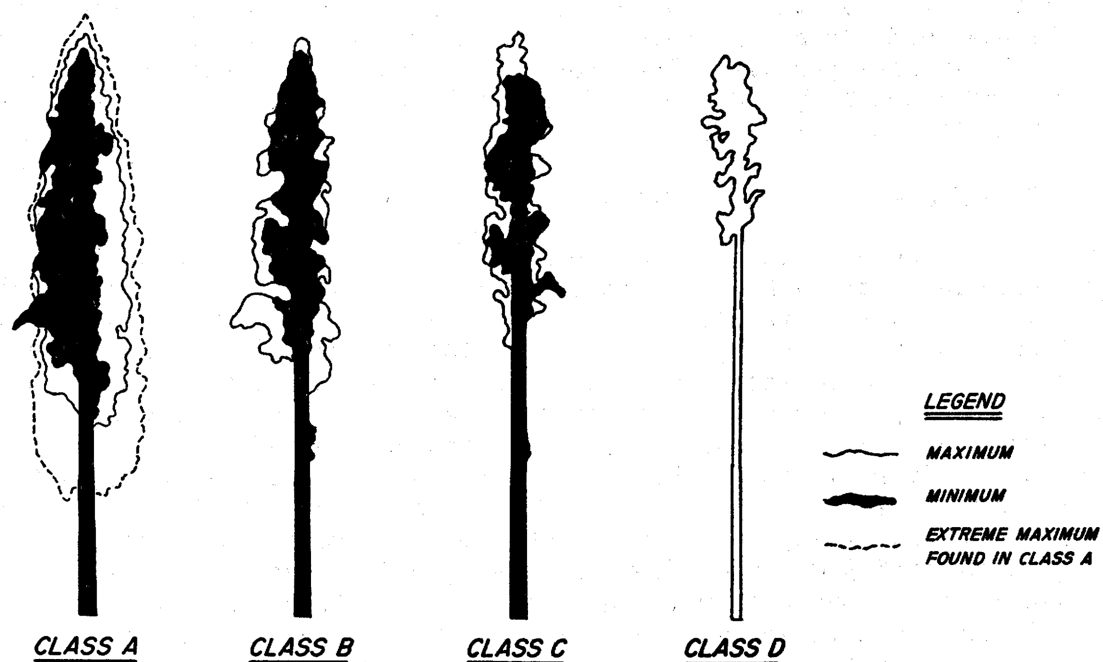
Name of area	Crown vigor class A	B	C	D
	Annual diameter increment - inches			
Pringle Falls	--	.11	.05	.02
Walker Mt.	.10	.10	.07	.03
Big Springs	.15	.13	.08	.04
Average	.125	.113	.067	.030
	Growth percent (of board-foot vol.) of a 12-inch tree			
Average	3.0	2.7	1.7	0.8
	Percentage of total number of trees in each class			
Average	6	15	59	20

4/ Taylor, R. F. A tree classification for lodgepole pine in Colorado and Wyoming. Jour. Forestry 35(9): 868-875. September 1937.
_________ The application of a tree classification in marking lodgepole pine for selection cutting. Jour. Forestry 37(10): 777-782. October 1939.

FIGURE I

LODGEPOLE PINE CROWN CLASSES

Rocky Mountain Forest and Range Experiment Station
COLORADO AND WYOMING



VIGOR CLASS A *

Crown area: 30 percent or more of the "extreme" maximum outline of vigor Class A.
Crown length: 50 percent or more of the bole length.
Crown vigor: dense, full, of good color, and pointed.

VIGOR CLASS B *

Trees that are too good for Class C but not quite good enough for Class A.
Crown area: usually more than 30 percent but less than 50 percent of the "extreme" maximum outline of vigor Class A.
Crown length: usually more than 50 percent but less than 60 percent of the bole length.
Crown vigor: moderately dense, of good color, pointed or slightly rounded.

VIGOR CLASS C *

Crown area: 17 to 30 percent of the "extreme" maximum outline of vigor Class A.
Crown length: 40 to 50 percent of the bole length, or less in trees of more than average vigor, according to the degree of vigor present, to a minimum of 20 percent.
Crown vigor: sparse, bunchy, color poor, never pointed.

VIGOR CLASS D *

All live trees of poorer vigor than Class C. Includes trees with Class A, B, or C outlines but with dying tops or stag-heads.

* Exceptions to these rules occur. For example, certain trees with Class A outline but extremely sparse crown, pointed top, and branches with upward twist at tips. These are usually Class A. Also trees with sharply pointed wide top but short crown length. These are usually Class A or B. With practice these and other exceptions will become familiar to the marker.

Crown vigor was the most important single factor relating to growth of individual trees that could be recognized and classified. Size of tree had no definite relation, and degree of release, site, etc. seemed to have only a minor effect. The Rocky Mountain studies showed a reasonable relation of diameter growth to density of stand (as measured by reserve volume); the present study did not have a wide enough range of data to show this trend. Crown vigor classification is a valuable tool in timber marking and as further information is developed should be useful in growth prediction. The characteristics that define the four crown vigor classes need to be checked further in relation to growth in this region and possibly modified for application here, but until that is done the Rocky Mountain definitions will serve as helpful guides.

Suggestions for Lodgepole Pine Management

Many questions about the management of lodgepole stands are unanswered, but from the facts now evident tentative "guides" are proposed:

(1) Change from a negative to a positive attitude toward lodgepole pine and its possibilities for management. Cutting should be based on planned silviculture rather than "logger's choice."

(2) For each forest unit or sale area, study the stand structure--size, age, and thrift of trees and their distribution over the area--both on the tract as a whole and acre by acre.

(3) Outline flexible cutting plans that will remove insofar as possible mature, defective, and unthrifty trees and will yield a profitable cut of merchantable products. Make trial markings and readjust methods as necessary. It is important to adapt marking to the special conditions in different parts of the stand to retain adequate thrifty growing stock. This may mean leaving some parts untouched in the first operation. In uneven-aged stands a flexible selection method is best--small mature groups may be clear-cut in one place, single tree selection applied in another spot, the older trees in a two-storied stand cut entirely or partially elsewhere, and a thinning from above applied to dense even-aged groups.

(4) Avoid making extensive and continuous heavy selection cuttings because of danger of windfall. Generally, less than 35 percent of original cubic volume or basal area should be removed in a single thinning or tree selection cutting.

(5) If the stand is mostly mature and is remote from markets, a heavy cutting may be necessary. To avoid excessive exposure to strong winds in this case, alternate selectively cut strips found effective in the Rocky Mountain region[5/] should be applied here. In this system heavy selection cutting is confined to strips not over 150 feet wide which alternate with uncut strips laid out at right angles to prevailing winds. A light salvage cut may be made at the same time in the reserve strips or they may be left uncut until the stand is stabilized,

5/ Rocky Mountain Forest & Range Experiment Station. Annual report for the calendar year 1947. Mimeo. pp. 28-32.

when moderate or light selection cuttings are made. This system gives protection from wind and avoids large continuous accumulations of slash and promotes natural restocking, but is poorly adapted to steep and broken terrain. In the Northern Rocky Mountain region, for even-aged mature stands from 120 or more years old, LeBarron[6] recommends clear-cutting in patches. Patches should be less than 50 acres in size and interspersed with uncut timber of equal or greater area. The clear-cut areas should be irregular in shape to fit variations in topography and timber stand.

(6) In selection marking, give close attention to crown vigor of trees to be cut or left. Leave for future growth as many trees of vigor class A, B, and the better C's as possible. Where vigorous trees are crowded by inferior or slow-growing trees, cut some of the latter. Improve health and quality of reserve stand by removal of mistletoed, diseased, defective, and very knotty trees. Next, cut to improve spacing of reserve stand.

(7) Protect healthy young growth in logging. Where the young stand is badly overstocked, some destruction by logging may have a thinning effect, but this is a crude practice difficult to control.

(8) Vary slash treatment with stand and hazard conditions. The Rocky Mountain Station recommends that slash be lopped to promote establishment of adequate and uniform but not overdense stands of reproduction. Pile and burn where required for fire protection. Lopping of tops is usually done by the logger and thus facilitates later piling and burning on firebreak strips or the scattering of slash in skid trails where needed to check erosion. The value of such practices should be tested in this region.

(9) Develop plans for integrated utilization, considering future possible products and markets as well as present. Promote full utilization for products of greatest value from trees that should be cut. After sawlog or tie operations, encourage post-logging cuttings for small poles or fuelwood to remove cull and top material and diseased, defective, or very low-grade trees and to thin overdense pole patches. Better still, arrange for a combined or integrated operation.

(10) If there is no prospect of fuelwood or pulpwood cuttings to improve the stand and if stand betterment funds are available, use such funds to: (a) Cut or poison cull wolf trees suppressing young growth; (b) improve health of young stand by removal or poisoning of trees badly infected with mistletoe or canker; (c) thin badly overstocked spots giving moderate release to trees of good form and crown vigor; and (d) encourage reproduction where needed by stirring soil or by carefully timed slash burning.

6/ LeBarron, Russell K. Cutting lodgepole pine in the Northern Rocky Mountains. Proc. Soc. Am. For. Meeting, 1947. pp. 399-403.