RECENT DEVELOPMENTS IN PINE SILVICULTURE

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Within the last few years a revolution in ponderosa pine logging methods has taken place and is probably still taking place. Tractors have replaced horses, and trucks, traveling on cheap roads, are fast replacing railroad equipment hauling on expensive roads. The modern tractor requires no road in most pine country; it can ramble out a quarter mile, half mile, or even a mile and haul in a single tree, for not very much more per thousand feet than for a dozen trees. To lay down a network of truck roads sufficient for tractor skidding costs but a fraction as much as to build the railroad spurs necessary for a horse skidding job. With this lowering of skidding costs and of "fixed-per-acre-costs" there comes a flexibility in pine logging that has given the silviculturist a great opportunity, and he is taking advantage of it by radically modifying the method of cutting ponderosa pine stands for continuous production.

It is of this we wish to speak today, particularly as it applies to Oregon and Washington, the territory of the Pacific Northwest Forest Experiment Station.

In the horse days, before the modern tractor, arch, and truck invaded the woods, it was thought that the cut must be at least 75 or 80 percent of the stand to make the operation profitable. It was the prevailing practice then on the national forests, Indian reservations, and other public lands, practicing the best sustained yield forestry they knew, to mark for cutting 75 to 85 percent of the merchantable volume. This presupposed a cutting cycle of about 60 years. With such heavy cutting there wasn't much choice but to leave the obviously immature and thriftiest trees. Marking was a simple matter.

Some silviculturists argued even in those days that lighter cutting would be better forestry and wished that it were economically feasible. Meanwhile a knowledge of the silvics of ponderosa pine was accumulating from one source and another and pieced together it pointed toward the wisdom of lighter cutting. A permanent sample plot to test lighter cutting alongside of the conventional 80 percent cutting was established as early as 1913 and another series again in 1927. The accumulated evidence, gleaned from studies of Westveld, Meyer, Weidman, Keen, Munger, and the unpublished observations of many others, indicates several advantages to light cutting and therefore a shorter cutting cycle from the silvicultural viewpoint, which we will briefly review.

1. Under light cutting the fire hazard following logging is much less and the great expense of slash disposal can partly be saved.
2. The windfall hazard is less following light than heavy cutting.
3. A light cut means rapidly going over a working circle, perhaps in 30 years instead of 60 and thus removing from the whole stand the very most mature trees in double quick time, and so salvaging many trees that would not survive through a longer cutting cycle.
4. Likewise a light cut can remove from the whole working circle in relatively quick order the types of trees that are particularly susceptible to bark beetle attack, and thus forestall insect losses.
5. The light cut preserves "forest conditions" better than an 80 percent cut, a consideration from the point of view of soil erosion, excessive insolation, and aesthetics.
6. The light cutting, short-rotation practice installs a transportation system of permanent roads and puts the whole tract under management in quicker order than under heavy cutting, thus making possible better protection, more salvage, and intensive utilization of special products, over the whole working circle.

These silvicultural advantages of light cutting, obvious though they were, could not bring about a change to light cutting, unless and until it was shown that lighter cutting was financially feasible. By 1935 the revolution in logging methods was well advanced and Brandstrom then began a series of economic studies of the cost of every step in logging by modern machine methods. His studies were much more than logging-cost studies. They analyzed the economic composition of the forest and of the individual tree to determine not only the cost of converting the tree into lumber but the value yields of every type of tree and log. Concurrently sawmill production studies were carried on under the direction of Lodewick at several plants to give the sales realization values of six log grades for every diameter class.

Brandstrom's work was by no means limited to showing the relative costs of light and heavy cutting. His great contribution was in showing from the long-term financial viewpoint the order of cutting that should be followed to attain maximum value increment with the minimum of logging cost and of carrying charges.

Out of these economic studies of Brandstrom and Lodewick, when combined with the growth studies of Meyer, the mortality studies of Keen, and the observations and experience of many others, has developed a system for cutting ponderosa pine forests, which we at the Experiment Station have named the maturity selection system.

Not very much has been written about this method, although in somewhat modified form it has already been applied to hundreds of thousands of acres in Oregon and Washington, and so we hope to introduce it to you today and explain very briefly its underlying philosophy.

The maturity system contemplates harvesting first the trees that are most mature, economically and biologically, from the entire working circle. How economic and biologic maturity are determined will be explained later. Under this system the forester thinks of the whole tract and not just the acre he is marking. Thus he prefers to leave standing some mediumly mature trees on this year's cutting so that he can get sooner to some very overmature trees in the back end of the tract. The exact percentage of cut is not important; it should vary according to the stand structure, fixed charges, etc. It might be anything from 25 to 65 percent; the important consideration is to go over the virgin acreage quickly, harvest the overmature trees quickly, put the whole forest in growing condition, establish transportation everywhere, and retire the capital in the nonproductive elements of the stand. This method is possible because of the great range and variety in the age, thrift, size, form, quality, and value of the trees in a virgin ponderosa pine stand. This is so obvious to anyone who works in these woods that enlargement on this point is unnecessary. It is not unusual in a tract to find that the stumpage value of individual trees ranges from plus $8 to minus $3 and the net growth rate from plus 4 percent to minus 3 percent.

Now let us consider what we mean by economic and biological maturity and how we determine them. We must grant that growing of timber **for use** is the principal objective of forestry and, therefore, unless there are other complicating objectives like recreation or watershed protection, the forester's job is to grow the crops that will pay the best dividends. This means harvesting first the trees whose net carrying charges per thousand feet of timber capital are the largest. The carrying charges are made up of four elements—and please note that two of these are biologic and two financial; here is where the biological or silvicultural considerations are blended with the financial or economic considerations. These four elements are:

1. The gross volume growth of the tree in percent.
2. The mortality probability in percent,
3. A carrying charge, usually assumed to be 3 percent, on the capital represented by each tree, on the very logical assumption that capital released by the cutting of a tree can be put into other

TABLE 1

Samples of Tree Classification and Evaluation from Pringle Falls Plot 37

Keen tree class	D.B.H.	Volume shipping tally	Grade of first two logs	Lumber sale value per M'	Logging * and milling cost per M'	Marginal * value per M'	Annual rates of: Gross growth	Mor-tality	Net growth	Annual-carrying charges: Percent	Dollars Per M'
	In.	Bd. Ft.		Dol's.	Dol's.	Dol's.	Pct.	Pct.	Pct.		
4C	35	1,761	1-3	23.72	17.28	6.44	.4	2.7	-2.3	5.3	.34
4A	32	1,630	1-2	23.57	17.38	6.19	.5	.4	.1	2.9	.18
3B	27	844	1-5	22.00	17.75	4.25	.9	1.0	- .1	3.1	.13
3B	28	1,178	3-5	19.37	17.49	1.88	.8	1.0	- .2	3.2	.06
2B	22	675	4-4	19.79	18.86	.93	1.6	.6	1.0	2.0	.02
2A	19	319	4-4	19.75	21.16	-1.41	2.5	.2	2.3	.7	None

* Exclusive of road construction costs, profit, loss, and stumpage.

TABLE 2

MATURITY SELECTION SYSTEM MARKING SCHEDULE

Assuming a 50 Percent Cut for a Typical Central Oregon Tract in 1941 Showing the Minimum Diameter to Which Trees of Each Tree Class and Log Grade Composition Should be Cut

From a Timber Stand Analysis by Donald Bruce

Keen Tree Class	Log Grade Composition *: 1-1	1-2	1-3	1-5 or 2-2	2-3	2-5	3-3-3 or 4-4-4	3-3-5 or 4-4-5	3-5 or 4-5	5-5
	Minimum Diameter at B.H. to Which Trees Should be Cut—Inches									
1 & 2	- †	-	-	-	-	-	-	-	-	-
3A	27	29	38	43	-	-	-	-	-	-
3B	24	25	31	33	-	-	-	-	-	-
3C & D	20	21	23	24	27	-	-	-	-	-
4A	All	All	All	All	33	45	-	-	-	-
4B	All	All	All	All	24	30	38	-	-	-
4C & D	All	All	All	All	All	All	All	All	34	

* "1-2" signifies that butt log is grade 1 and that the second log is grade 2.

† A "dash" signifies that there will be no cutting in this class and log grade composition.

TABLE 3

Stand Statistics for Five Assumed Cuts Whose Order of Cutting is According to Magnitude of Carrying Charges

Order of cutting	No. of trees	Av. tree volume	Av. sales value	*Av. Costs per M.	Av. marginal value	Pct. total marginal value	Av. gross growth rate	Av. mortality rate	Av. net growth rate	Net annual carrying charge	
		Bd.Ft.	Dol's.	Dol's.	Dol's.	Pct.	Pct.	Pct.	Pct.	Pct.	Dol's.
1st 20%	14	2,319	24.62	16.88	7.74	45.6	.33	2.3	-2.0	5.0	.39
2nd 20%	16	2,039	23.00	17.28	5.72	33.8	.47	1.0	- .5	3.5	.20
3rd 20%	21	1,545	20.32	17.44	2.88	16.9	.63	1.1	- .5	3.5	.10
4th 20%	31	1,026	19.43	18.07	1.36	7.9	1.02	.7	.3	2.7	.04
5th 20%	66	465	19.21	19.96	- .75	- 4.2	1.49	.9	.6	2.4	None
Tot:100%	148	1,081	21.35	17.90	3.45	100.0	.78	1.2	- .4	3.4	.12

* Exclusive of investment in roads, profit, risk, and stumpage.

capital investments yielding that much interest.

4. The capital value of each tree as it stands, i.e., its lumber realization value less cost of falling, logging, and milling on a per thousand feet basis.

When the first three elements are combined and applied to the capital value of the trees we have a net cash cost for carrying that tree which takes into account its rate of growth, its chances of surviving bark beetles, etc., and its present value on the stump.

An illustration (table 1) will help to clarify how these four elements are derived and combined, using a half-dozen typical, but quite contrasting, trees from an actual study plot.

One of the tenets of this system is that it is not good forestry in this type to cut the ponderosa pine trees that will not pay their way to and through the mill, that is, the negative value trees. They are not occupying valuable room that justifies paying hard cash to remove them, they may have a price increment that will justify harvesting them later, they are doing no silvical harm to the forest, and may do some good.

The criticism is sometimes made by those who do not thoroughly grasp the significance of the combination of these four elements or who do not mentally subscribe to Dr. Schenck's dictum "it is the best forestry that pays the best in the long run", that the maturity selection system is just economic selection or "high-grading." Such an interpretation fails to recognize the differences between taking out a tree because it will yield a good revenue and taking out a tree because it is costly to hold on account of low net growth and high carrying charge, i.e., economic and biological maturity.

This method would not be sound forestry were it not for the fact that in these pure ponderosa pine forests high intrinsic value and biological maturity are coincident much of the time. The big, old, often stag-topped yellow-barked trees are the ones that have the high-quality lumber, and their mortality probability often offsets their growth. From every point of view they are the trees to cut first. If we had measures of growth rate, of mortality probability, and of marginal value that were absolutely reliable for every tree the marker could apply this formula and fix an order of priority for cutting of every tree with a good deal of assurance. As it is we have to deal in averages in making up a marking rule and group the trees that are to be cut according to certain specifications of size, tree class, and log grade composition. Such a rule can only be made after study of the structure, growth, and health of the local timber, because the distribution of the various size classes, tree classes, and log grades varies greatly from place to place, (as you all know,) and after the decision has been made what percentage of the volume will be taken in the first cut.

Donald Bruce, of the consulting forester firm of Mason and Bruce, recently made up such a rule for a tract of timber in central Oregon, based on a 50 percent cut by the maturity selection system. This rule (presented in table 2) shows, for example, that no class 1 or 2 trees will be cut; that class 3A trees with a log structure of 1-1, i.e., both the first and second log of No. 1 grade, will be cut if over 27 inches in diameter; that the 3A trees with a 1-3 log structure will be cut only if over 38 inches in diameter; and that all the 4C and 4D trees will be cut except a tree under 34 inches in diameter with a 3-5 or 4-5 log structure, an unusual type of tree. Since it is very difficult for the marker to carry in mind a marking rule that embodies so many elements, Mr. Bruce thought of the idea of putting the rule on a Biltmore stick. He has made a stick for field use on one face of which is given the rule for the class 3 trees, on the other the class 4 trees. The diameter limit to which a tree of each log grade content should be cut is indicated at the appropriate point on the Biltmore stick.

As just stated, if we could get a perfect growth, mortality, and carrying charge rating for every tree there would need to be no exceptions to the rule. But having to deal with a rule that applies to the average tree of its class there must be some exceptions—perhaps a 3B tree that is a leaner or a twin, class 2 trees that ought to be taken out of a thicket to give release, or a class 3C or 4 tree that under the rule should be cut but must be left to avoid making too big an opening. The skillful marker will perhaps not want to divert from the strict application of the marking rule for more than 10 percent of the trees. Needless to say, marking under the maturity selection system requires a far higher degree of skill than marking under the conventional 80 percent cut method. After there has been made a study of the local stand structure the field marker has to size up a tree for tree class and log grade, as well as diameter and any factor that might make it an exception to the rule. When only 40 or 50 percent of the volume is cut there are lots of questionable trees to be thoroughly looked over.

You may be interested in seeing how cutting by this system would really work on paper for a specific tract. We have here an analysis for a 7½-acre plot on the Pringle Falls Experimental Forest which contains 148 trees that have been carefully measured, classified, and log-graded and their value, net growth rates, and carrying charges computed as we showed a few minutes ago.

When these trees are arranged in order of priority of cutting, according to the formula just explained, and then divided into five groups of equal volume from the top down, they show (table 3) striking differences.

As a sequel to the revolution in logging methods and as a consequence of the silvical, entomological, and economic studies that have been made of ponderosa pine management, a very large amount of light cutting is being done in Oregon and Washington. Not all of this follows, by any means, the full principles of the maturity selection system. On the national forest timber sales, the selection of trees for cutting is based on tree class, regardless of present stumpage value, together with strong emphasis on mortality probability (or insect susceptibility) and thriftiness or lack of it. A few instances will illustrate the present practices and trends in pine silviculture in Oregon and Washington.

1. On the Malheur National Forest the pioneering experiment in 40 percent maturity selection cutting was begun in 1936 on the big Hines Lumber Company timber sale. It was a success and ever since then all the government timber cut there has been on a basis that leaves about 60 percent of the merchantable volume standing. The cut amounts to approximately 80 million board feet a year on this basis. The selection of the trees for harvesting on this and other national forest sales does not follow in letter the principles of the maturity selection system but puts the emphasis on the biological factors—thrift and susceptibility to bark beetles—rather than on the economic factors—value and cost of holding.

2. On the Deschutes National Forest pre-cutting exchange agreements have been made with the two large companies operating out of Bend—Shevlin-Hixon and Brooks-Scanlon—whereby the Forest Service marks for cutting both the company and the government lands providing for a 50 percent reserve. Thus, in this territory about 150 million feet are cut each year, leaving about a township of cut-over land in excellent growing condition, with about this same volume of standing trees upon it.

3. On the Whitman National Forest there is another 45 million feet a year cut by this light marking method, part of it from lands formerly privately owned and taken over by exchange.

4. On other national forests in Oregon and Washington there is cut each year on the light selection basis another 50 million feet or so; in the latter State conditions seem to require a somewhat heavier cut than in Oregon—perhaps about 60 percent.

5. The Indian Service likewise is employing on its timber sales on the reservations a lighter cut than heretofore, which parallels closely the principles of the maturity selection system. On the Klamath Indian Reservation, in the

face of severe insect depredations, this modernized form of excellent forestry involving about a 60 to 70 percent cut based on tree class, beetle hazard and size selection is being practiced on some 20,000 acres a year involving a cut of some 175 million feet.

6. The Klamath Falls operation of the Weyerhauser Timber Company is conducting an interesting experiment in very light marking—13 percent or so —by a system called the sanitation-salvage system, on areas of high insect hazard. While this method differs in principle from the maturity selection system, it is a most appropriate and progressive procedure where there is a great threat of insect activity. By this method some 5 million feet of trees will be cut this year, well in advance of the main operation where there is a grave probability of there being serious bark beetle losses.

7. Another private operation merits special mention as an exponent of the new developments in pine silviculture —the J. Neils Lumber Company. On its Klickitat operation it adopted in 1939 in toto the maturity selection principle of cutting and is now harvesting annually about 30 to 35 million feet on a 50 percent cut. These are but a few examples of the revolution in pine silviculture.

Thus, in these many logging operations in eastern Oregon and Washington on public and private lands two-thirds of a billion feet per year are being cut on a lighter basis than heretofore. This results in an area of perhaps 100,000 acres of cut-over land being left annually in a condition silviculturally superior to the land logged heretofore in the following particulars:

1. More of the productive forest capital is left standing and the non-productive is retired in logical order.
2. Each operating unit is more quickly converted from the stagnant to the growing condition.
3. The mean annual increment is larger.
4. Trees which otherwise might die and be a total loss are salvaged.
5. The hazard of bark beetles and wind is lessened and the danger of fire better controlled.
6. Forest conditions and the indirect benefits of forests are better conserved.
7. The entire working circle is more quickly put under management for protection and salvage.

Tuberculin Testing in High Schools: Its Educational and Preventive Value

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In recent years the tuberculin skin test has become an important factor in the campaign against tuberculosis. The test has been criticized, as a case-finding procedure, the claim being made that relatively few cases of active tuberculosis are discovered by this method. This is quite true, and if evaluated from the standpoint of case-finding alone, the tuberculin testing program would be very expensive and not nearly as effective as some other methods.

The value of the tuberculin testing program also depends greatly upon the type of community in which the work is carried on. In congested city districts, or in other localities, where the percentage of positive reactors to the tuberculin test is more than one-third of the total number tested, it is generally conceded that mass x-raying of the entire group to be investigated is preferable to doing the preliminary tuberculin tests and then x-raying all the positive reactors. In smaller towns and rural communities, however, where the percentage of positive reactors to the skin test is around 15%, or lower, the procedure of doing the tests first, followed by chest films of the positive reactors, is still a feasible and effective