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ANALYSIS OF LOGGING COSTS AND OPERATING METHODS IN THE DOUGLAS FIR REGION

The outstanding publication of this Forest Experiment Station in recent weeks is the bulletin of the above title by Axel J. F. Brandstrom, Senior Forest Economist. Through the generosity of the Charles Lathrop Pack Forestry Foundation and the cooperation of the West Coast Lumbermen's Association, an edition of 2500 has been printed. Most of the edition has been distributed to lumbermen, foresters and librarians. This bulletin of 115 pages of text, 47 illustrations and 54 tables has attracted much attention and its conclusions have been much discussed. It has undoubtedly started some new lines of thought and introspection in the logging industry.

This treatise is the result of a comprehensive study of logging costs in the Douglas fir region made by the Station in 1931 and 1932. Intensive time and cost analyses were made in 14 different logging operations scattered throughout the region, covering all phases of logging and virtually every known type of logging machinery and methods. Some 40,000 logs scaling about 35 million feet were followed through various phases of logging.

The objectives of these studies were twofold: First, to obtain basic data on the relation of size of log and tree to logging costs as a part of a broader study of selective logging and timber management, on which further publications are to follow. Second, they were designed to give basic data for the comparison of the cost efficiency obtained in logging with various methods and types of machinery. It is in connection with the latter question that the present bulletin is particularly significant, pending the completion of the selective logging project as a whole.

Following a foreword by Colonel Greeley, an introductory chapter gives a brief sketch of the growth and development of lumbering in the Douglas fir region. The second chapter gives a description of the various logging methods covered in the studies, while the third chapter goes into the basis of the time and cost studies and the methods followed in the analysis of the data. In the fifteen succeeding chapters are given the results of the studies, classified under the various headings of yarding, swinging, loading, roading, falling and bucking, railroad, motor truck and water transportation, etc. Following this detailed presentation of the data, the last four chapters are devoted to a discussion of the interrelation and significance of the findings as they apply to the logging operation as a whole.

Most significant among the findings are:

(1) Variation in the size of logs or trees within an area that is clear cut in conventional fashion has a strikingly potent effect on costs. The cost of logging small logs or trees is much higher than that of large logs or trees.

(2) The average log size within each area gives a fairly reliable index to the degree in which variations in the size of the individual logs affect the cost.

(3) Small flexible yarding machinery, such as small gasoline donkeys and tractors, give considerably lower costs than the large

machinery, and provide at the same time the means for intensive selection of individual trees or small areas of timber.

(4) Clear cutting of virgin timber typical of this region leads to great inefficiency in loading, railroad transportation, and other activities of the logging operation, owing to the fact that the spread in log and tree sizes within a given area is usually very great and under clear cutting all of these size classes have to be handled with only one type of equipment. Under these conditions it becomes necessary to provide equipment that is designed to handle the large timber with a fair degree of efficiency leading to inefficiency in handling the smaller timber.

To remedy the situation, the report, based on the factual data obtained from the detailed cost studies, recommends that the timber be logged selectively, by size classes, each major size class to be logged with a specially designed outfit adapted to fit the size of the timber. This would generally require logging an area in three separate cuts, first the large timber, second the medium size timber, and third the small timber, each logged with a specialized set-up of logging and transportation equipment. The three cuts might follow each other in rapid succession if the timber is to be clear cut, or they may be taken years apart if the timber is to be selectively cut and managed.

Selective logging as here argued is advocated primarily as an operating method designed to improve the efficiency of the logging operation, as rendered possible through specialization of equipment and methods to fit the wide range of size of virgin timber. A saving of about 30% of present logging cost is shown in the examples cited. That selective logging, aside from the improvement in logging efficiency, is most effective to promote the proper financial management of the timber, both from a long term and short term point of view, is also pointed out, but this phase of the question is not gone into fully, being reserved for a second report now being prepared by Mr. Brandstrom that is to deal with questions on timber management as distinct from direct operating efficiency in logging.

The conclusions reached in the studies gain considerable force, owing to the fact that prior to publication of the report, the theories evolved were thoroughly tested by a large operating company in this region. Through a series of practical logging experiments carried on in a large scale in the summer of 1932 and 1933, results were obtained which verify in all important respects the conclusions drawn from the detailed time studies. This has already led to the adoption of the proposed logging methods in three different tracts controlled by the company that ventured to undertake the experiments, and a small beginning in the same direction has also been made by several other operations during the last summer. Present indications are that many more will follow.

Thornton T. Munger

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THE INTENSITY OF TIMBER CRUISES AND ITS RELATION TO ACCURACY

Timber estimators are fond of arguing the relative accuracy of various intensities of cruising. Four runs through a forty are often considered to give an accurate estimate, especially if compared to a two-run and one-run cruise. Actually the real issue is connected with the size of area for which an accurate estimate is desired and with the variability of the stand on this area. Were the stand absolutely homogeneous, it is evident that a single plot would give an accurate estimate. As soon as variability increases as a factor, more and more plots or strips must be taken to get a satisfactory answer. Depending upon stand conditions and demands for accuracy, a cruise may error by being too intensive, i.e., too expensive, as well as being too extensive, i.e., too unreliable.

In order to make comparisons, the strip tallies on a four-run job were recorded separately by strips and forties in 800 acres of the ponderosa pine type on the Pringle Falls Experimental Forest. A study of the various combinations of strips and of the variation in the stand permits one to draw a few conclusions which are applicable to this type. Casual inspection would classify this forest as a continuous stand, but examination of the strip tallies shows that the poorest forty based upon the four-run cruise ran 7 thousand board feet to the acre, while the best forty ran 23 thousand feet. If a one-run estimate were used, then the poorest forty would have been 2 thousand feet and the best 30 thousand feet. Apparently the stand is far from being homogeneous and the placement of the strips will have a great effect upon the final result.

First of all the variation within a forty should be considered. The poorest set of strips showed acre values of 11, 8, 0 and 17 thousand feet, a variation represented by a standard deviation of approximately 6.2 thousand feet, while the most constant forty had values of 16, 15, 13, 12 thousand feet per acre, or a standard deviation of 1.3 thousand feet. The average variation of a forty, based upon 20 forties, is expressed by the standard deviation 3.6 thousand feet. The significance of this measure can be illustrated as follows: if an average forty in this forest type is cruised by a one-run cruise, then the true average stand per acre in 68 out of a hundred forties cruised will be within 3.6 thousand feet per acre of the estimated value, or in 95 stands out of a hundred within 2 x 3.6 or 7.2 thousand feet of the estimated value. Quadrupling the number of strips should halve this error, if the placement of the timber were not a factor. The average stand being 15.6 thousand feet per acre, a four-run cruise may still have back of it, therefore, a standard error of $\frac{3.6}{2 \times 15.6}$ or 11.5 percent. Actually the

error for a four-run cruise is not as low as theoretically indicated, since the groupiness of the timber has a moderating effect and tends to draw together the errors of the one, two and four-run cruise. Obviously absolute accuracy, or even a moderate degree of relative accuracy, in every forty estimate is unattainable without greater intensity than a four-run cruise.

A second consideration is the accuracy of the estimate of units larger than a forty. One way to approach the problem is empirically to determine the errors of one, two, and four-run cruises over 80 acres, quarter sections, half sections, sections and so on. Another way is to determine the size of area which must be covered to get within a standard error of 1 thousand board feet per acre, for instance, in the estimate for the entire area. Each of these approaches dismisses the location of the timber within the unit, but considers simply the accuracy of the final estimate. The computations for the tract in question show that to get within a standard error of 1 thousand feet per acre, about $2\frac{1}{2}$ sections must be covered by a one-run cruise. If the number of strips is doubled, then only $1\frac{3}{4}$ sections must be covered to get within the standard error of 1 thousand board feet. If the number is again doubled, to four runs through a forty, then between one and one and a half sections must be covered. The two-run cruise is apparently somewhat more superior to the one-run cruise in actual practice than the four-run is over the two-run.

Another cruising test made along similar lines in the ponderosa pine type near Klamath Falls revealed similar relationships, namely, that the estimate of a single forty by even a four-run cruise is far from accurate and that even a moderate degree of accuracy, such as a standard error of 1 thousand board feet per acre, can not be attained unless areas of the size indicated above were covered. This second stand included a certain amount of sugar pine and Douglas fir. With the units and number of strips mentioned, the sugar pine would be estimated to within $\frac{1}{4}$ thousand board feet per acre and the Douglas fir to within $\frac{1}{2}$ thousand board feet. For scattered species of great value, probably nothing short of a 100 percent cruise is satisfactorily accurate.

C. W. Kline
W. H. Meyer

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SMOKED GLASSES FOR LOOKOUTS

Fire lookouts frequently experience extreme eye strain caused by the general glare of intense light and the constant searching necessary to detect the first puff of smoke from an incipient fire. It has been found that, as a result of eye strain, lookouts are much less efficient in the afternoons than in the forenoons--and in Region Six the peak loads for lookouts come in the afternoons. Anything which reduces eye strain improves the efficiency of lookouts.

Although at most lookout stations, the interior woodwork has been stained a dark color and the shutters are being used as awnings, many lookouts feel that still further eye protection is needed. A simple way for lookouts to obtain additional eye protection is to wear dark glasses or goggles. Experiments to determine the best type of goggles for lookout use have just been concluded. These investigations show:

1. A neutral tint is best. "Smoked" glass is an example of a neutral tint; it has a fairly uniform transmission throughout the visible spectrum and thus causes very little distortion of the colors encountered out of doors. No "filter" has been found which eliminates haze without also decreasing the visibility of distant wisps of smoke. The object in wearing goggles of smoked glass is not to make small columns of smoke visible when these can not be seen with the unaided eye, but is to reduce the general level of light intensity, that is, to eliminate the glare that causes eye strain.

2. The best density of smoked glass for lookout use varies according to the individual requirements of each lookout and whether the glasses will be worn inside the station or outside. Some individuals can endure more intense light than others and therefore prefer lighter glasses. As nearly as could be determined, the best density of smoked glass for lookout service (the glasses to be worn inside the lookout houses) transmits from 25 to 30 percent of the visible radiation ("light"). For out-of-door use, as, for example, on a tower without a house, such glasses are too light and lenses transmitting from 10 to 15 percent of light are needed.

3. The lenses should be made of optical glass accurately ground and carefully polished. Such lenses do not distort vision. The "drug-store" type of sun glasses has lenses of pressed glass which ordinarily so distort vision that the eye muscles are strained unnaturally and eye fatigue rather than eye relaxation results. For example, in one pair of these cheap glasses, the right lens was of the type used for near-sighted persons, and the left lens was the far-sighted type. Lookouts are valuable because of their eyesight; their vision must be assisted, not hindered.

4. The best shape for these goggles is the so-called "sport" type, having pear-shaped lenses hinged at the nose-piece and extending well around the sides of the eyes. The ordinary round lens is not well suited to use by lookouts as light strikes in at the side and is reflected back into the eyes. The sport type of goggle fits many different individuals, thus making it unnecessary to purchase several sizes of frames. The bows should be easily adjustable without tools to fit individual requirements.

Richard E. McArdle

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HEREDITY TESTS OF DOUGLAS FIR SEED AND THEIR APPLICATION TO FOREST MANAGEMENT

To get the best possible results, what type of seed tree should be left to restock cut-over areas; and from what types of trees should seed be collected for planting stock?

Heredity tests begun in 1912 at the Wind River branch station indicate answers to these questions. In these tests, seed was collected from both old and young trees, healthy and conky trees, in dense and open stands, on good soils and poor gravelly soils, from low as well as high altitude. Obviously not all forms of parent trees could be found in one locality, and a total of 13 different localities had to be sampled in Oregon and Washington to cover all conditions. The planting stock was produced in the Wind River Nursery and outplanted in 5 plantations on 4 national forests in western Oregon and western Washington. These 19-year-old progeny of the first generation at the time of the last measurement (1931), averaged 27.3 feet in height for the best strain on the best planting site and 4.0 feet in height for the least vigorous strain on the poorest site.

The results indicate that when a forest is cut, leaving a residual stand to supply the new crop by natural reseeding, the character of the tree is not very important.

On the other hand, if a certain area is denuded and seed must be brought in from another source, the question immediately arises, what source to choose; whether seed from lower altitudes, or higher altitudes, from more southern or more northern latitudes is acceptable. So far as survival, but not growth, is concerned, no significant difference was found in stock from different sources. Low altitude stock survived in high altitudes as well as high altitude stock. Stock from Oregon planted in Washington, survived as well as the native stock. Stock from damp habitats survived well in dry habitats. The greatest mortality for any strain under the most adverse conditions (4600 feet elevation on shallow soil) was only 24 percent.

Although no effect was found on survival, seed source had a significant effect upon rate of growth. When planted in the mild climate of the Coast Range, the stock from parents growing between 2800 and 3850 feet in the Cascades was 25 percent below the average height of all other strains; but when planted in its native and more severe climate at 4600 feet elevation in the Cascade Range, it was 27 percent above average height. Likewise, coast stock was 19 percent above the average height of the 12 other strains when planted in its native habitat, but 18 percent below the average when planted in the Cascade Range. Certain local strains, however, are apparently adapted to extreme differences in altitude or climate, while others are not.

W. G. Morris

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CONVERSION FACTORS - DOUGLAS FIR CORDWOOD

Studies made on old growth Douglas fir cordwood in the autumn of 1933 in the vicinity of Molalla, Oregon have aided in the establishment of conversion factors heretofore unavailable. Measurement of 52 cords as piled in the woods by the cutters (48 inches wide, 52 inches high and 8 feet long) showed a solid wood and bark content of 91.5 cubic feet per cord. The individual pieces were all split wood, varying in cross-section from triangles and sectors to squares. They numbered 64 to 103 pieces per cord, averaging 82. The end area of the average stick was approximately 40 square inches.

From 68 to 80 percent, averaging 74 percent, of the total tree volume including bark, was converted into cordwood in 14 relatively sound trees. An average of 3 percent of the total tree volume remained in stumps and 23 percent in unused tops. Stumps were cut high only when pitchy or showing distorted grain. Tops were utilized to the first bad falling break or large limb.

A factor of 121 was indicated for reducing total tree volume, including bark, into cord volume, and a factor of 103 for reducing volume table figures, showing cubic feet without bark, into cords with bark. Further studies in other tracts may modify these tentative results.

J. E. Lodewick
H. M. Johnson

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TIMBER DEPLETION IN WESTERN WASHINGTON AND WESTERN OREGON - 1925-1929

During the period 1925-1929 the average annual depletion of sawtimber from cutting operations in western Washington and western Oregon amounted to 9,891 million board feet, log scale. Log production accounted for 95 percent of this depletion, fuelwood 3.5 percent, pulpwood 1 percent, and veneer blocks, shingle bolts and posts 0.5 percent.

The depletion of timber less than sawtimber size (16 inches at breast height) annually amounted to 82,420,000 cubic feet of solid wood, of which fuelwood production accounted for 74 percent, poles and piling 16 percent, pulpwood 9 percent, and posts, mine timbers, hewed ties and excelsior bolts 1 percent.

Sixty-seven percent of the sawtimber and 51 percent of the non-sawtimber depletion occurred in western Washington, the remaining percentages in western Oregon. The depletion represents only the material actually utilized, and does not take cognizance of the large quantity of sound material left in the woods as waste.

Of the sawtimber depletion Douglas fir supplied 73 percent, western hemlock 13 percent, western red cedar 7 percent, Sitka spruce 4 percent, and miscellaneous softwoods and hardwoods 3 percent. Of the depletion less than sawtimber size Douglas fir constituted 76 percent, the hardwoods 8 percent, western red cedar 7 percent, western hemlock 4 percent, white fir 2 percent, Sitka spruce 1 percent, and miscellaneous softwoods 2 percent.

H. M. Johnson

STATION NOTES

Experiment Station Office Moves - On the first of July the office of the Station was moved from its long outgrown quarters in the Lewis Building, where it had been for nine years, to the U. S. Court House at Sixth and Main Streets. Here, in a new monumental, modern office building, 27 rooms have been allotted for the use of this unit of the Forest Service on the fourth floor, which is largely occupied by the Department of Agriculture. Certain of the rooms were designed especially for the Station's use, giving a maximum number of small rooms for individual workers, a photographic dark room, an assembly room, and a laboratory where a small experimental kiln and other facilities have been installed. The library gives adequate room for our growing collection of technical publications, and is convenient for the public which is welcome to use it.

NIRA and CWA Speed Up Office Work - The curtailment of the regular allotments to the Experiment Station since July 1 have been partly compensated for by the allocation for forest research of certain Public Works funds and certain Civil Works personnel. Under the former, 19 persons have been employed, 15 of whom are assigned to the Forest Survey to assist in the great task of compiling the estimates and maps of the 30,000,000 acres of forest land in western Oregon and Washington. Under the CWA program, 48 men and women have been employed for a few weeks, mostly for computation, drafting, map coloring, typing and equipment construction and repair.

Survey of the Experimental Forests - Intensive management and development of the Experimental Forests require a detailed series of type maps, forest description and timber estimates. These are being made as one of the projects at certain of the CCC camps. Qualified forest engineers and cruisers were appointed as foremen, and they trained selected enrollers in the camps to run compass, chain, rod, etc. Field work has been completed on the two divisions of the Wind River Experimental Forest and begun on the Pringle Falls Experimental Forest and the proposed Cascade Head area. A very intensive job of forest description, typographic mapping involving accurate control, and cruising has been done. Triangulation tablets, bench marks, section corner and section line markers have been set to permanently monument the areas. It is a most useful contribution of the CCC to the needs of the Station.

MAJOR PUBLICATIONS, ARTICLES, AND MANUSCRIPTS PREPARED SINCE LAST ISSUE OF FOREST RESEARCH NOTES, MAY, 1933

Brandstrom, A.J.F.	Analysis of Logging Costs and Operating Methods in the Douglas Fir Region. (Published under auspices of the West Coast Lumbermen's Association)
Johnson, H. M.	Oregon White Oak: Its Properties and Uses. (The Timberman, September, 1933)
Lodewick, J. E.	Salvaging Fire-killed Timber. (West Coast Lumberman, September, 1933)
Johnson, H. M.	The Small Sawmill Industry in the Douglas Fir Region. (The Timberman, October, 1933)
McArdle, R. E. and Isaac, L. A.	The Ecological Aspects of Douglas Fir Natural Regeneration in the Pacific Northwest. (Paper at the Fifth Pacific Science Congress)
McArdle, R. E.	The Wolf Creek Fire. (Four L Lumber News, October 15, 1933)
Meyer, W. H.	Volume Tables for Western Hemlock: Western Oregon and western Washington. (Mimeo. November, 1933)
Morris, W. G. and Dague, C. I.	Weather During the Tillamook Fire. (The Timberman, December, 1933)
Munger, T. T.	Practical Application of Silviculture to Overmature Stands Now Existing on the Pacific. (Paper at the Fifth Pacific Science Congress)
Munger, T. T., Cronemiller, L. F., and Buck, C. J.	Report of the Committee on Prevention of Forest Fires to Governor Julius L. Meier
Munger, T. T., Rapraeger, E. F. and Kolbe, E. L.	Financial Aspects of Ponderosa Pine Forest Management Under Public Ownership. (Ms. August, 1933)
Rapraeger, E. F.	Motor Truck Hauling in Oregon and Washington. (The Timberman, June, August, September, October, 1933)

Rapraeger, E. F.	Two Pacific Coast Log Loading Methods for Motor Trucks. (American Lumberman, August, 19, 1933. Also Southern Lumberman, October 15, 1933)
Wilson, S. A.	Variation in the 1930 Assessed Valuation and Taxation of Selected Timberlands in Clatsop, Tillamook, Benton, and Lane Counties in Oregon. (Ms. October 27, 1933)
Wilson, S. A.	The Tillamook Fire. (Four L Lumber News, September 15, 1933)